# POMPEII FIRMWARE DESCRIPTION

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## OVERVIEW

Pompeii is an HP-IL disc drive that use the Sony 3.5 inch microfloppy. Pompeii will support both the SUBSET/80 command set and the FILBERT command set to allow the devices to be compatible with existing HP-IL devices and future devices. Pompeii will be the first HP-IL peripheral to use SUBSET/80 and will implement the command set in full, although the implementation of the command set on HP-IL requires that the SUBSET/80 transparent commands be different since these commands are channel dependent. The FILBERT commmand set will also be included in ROM in the devices. Either command set can be used without change in hardware since the commands used in each command set do not overlap. The SUBSET/80 command set uses secondary addresses to indicate phases of transactions and the FILBERT command set uses device dependent commands to issue commands.

Pompeii will be battery-powered by a 6 volt lead-acid dry cell battery. Pompeii will have the same footprint as the Vesuvius printer to allow the printer to be stacked on top of it. Pompeii will have only one double-sided 3.5 inch microfloppy drive.

This description is divided into seven parts. The first part describes the hardware parts of the system that affect the firmware. The next part describes the characteristics of the Sony microfloppy drive and its implementation in the system. The HP-IL messages that are supported and how the device will respond to each message is outlined in the next section. Then the devices specific action to SUBSET/80 messages are described. The next section describes the implementation of the FILBERT command set on Pompeii. The next section provides examples on how the SUBSET/80 command set is implemented on HP-IL and how it corresponds to the HP-IB implementation. The last section describes the diagnostics available on Pompeii.

## HARDWARE DESCRIPTION

Pompeii's hardware is based around the 68B09 microprocessor with 16 Kbytes of ROM and 2 Kbytes of RAM. The WD2793 Floppy Disc Controller will be used to interface the system to the Sony micro-floppy, and the HP-IL integrated circuit will be used as the HP-IL interface. To conserve power, various parts of the device will be powered down after a certain amount of time has elapsed after the last access to the device. After 2 seconds, the motor to the Sony drive will be shut off and the head will be unloaded. After approximately 30 seconds of inactivity, the Sony drive will be completely powered down and all of the controller board except the RAM, the HPIL chip, and a simple wake-up circuitry will be powered down.

There will be two red LEDs visible from the front of Pompeii. One will be a red LED that will indicate that power is on. This LED will also indicate that the battery is low by flashing. The other LED will be used to indicate that the device is performing selftest. This LED will remain on if the device failed selftest.

The device will perform a selftest when powered on. The selftest will be performed on as many of the components in the box as possible, including the RAM, ROM, FDC, PIA and HP-IL. Additionally, a write test and then a read test will be performed if possible. The write test will be performed only if the media is not writeprotected and neither the write test or read test will attempted if no media is loaded in the drive.

After the power-up sequence, the device's address will be undefined (unconfigured). The device's parallel poll response will be disabled since it has not received the Parallel Poll Enable message yet. The device's SRQ response will also be disabled. The SUBSET/80 QSTAT byte will be set to 2 to indicate power had been off.

A preliminary estimate of the battery life is given below for various duty cycles of usage. The charging time of the battery to 80% of capacity is approximately 5 hours. The standby life (no access to the disc) is greater than 3 days. If the accesses are greater than 1 minute in duration, a duty cycle of about 20% can be maintained if the charger is plugged in.

| Time between three-second accesses | Battery life without charger | Battery life with charger |
|---|---|---|
| 0 seconds | 40 minutes | 60 minutes |
| 10 seconds | 95 minutes | 2 hours |
| 30 seconds | 2 hours | 3 hours |
| 60 seconds | 4 hours | 20 hours |
| 90 seconds | 6 hours | continuous |

## MICROFLOPPY DISC DESCRIPTION

Pompeii will use the Sony 3.5 inch double-sided microfloppy drive. The specifications for the drive are given below in Table 1. When used with double-sided discs, the disc will appear as one large volume of 160 tracks minus the tracks reserved for spares and system use. There are 2 spares and one track for system use reserved per side, so there are 154 tracks available for data. Pompeii will be a "dumb" floppy since it will power down the Sony drive and therefore could not easily detect if the media has been changed.

## DISC COMPATIBILITY

Devices using the Sony double-sided drives will be able to read and write to single-sided formatted discs. If a single-sided disc with HP format is inserted in the double-sided drives, the 70 tracks on the bottom head are accessible. However, if the device is asked to initialize a single-sided disc, it will be done in the double-sided microfloppy format unless the Set Format Options command is performed before the format.

Pompeii supports 256, 512, and 1024 byte sectors. Pompeii can be made to format the disk in any one of these formats by using the Set Format Options command. The format is automatically learned by Pompeii when the disc is accessed so no special action is necessary to read or write disks of the different formats.

Table 1. DOUBLE-SIDED MICROFLOPPY DRIVE SPECIFICATIONS

| | |
|---|---|
| **RECORDING SPECIFICATIONS** | |
| **HP DOUBLE DENSITY FORMAT** | |
| Encoding: | MFM |
| Rotational Speed: | 600 RPM |
| Bit Density @ 600 RPM @ Track 79: | 8717 BPI |
| Track Density: | 135 tracks per inch |
| Tracks per surface: | 80 |
| Surfaces used per disc: | 2 |
| **ACCESS TIME** | |
| Track-to-Track Seek: | 15 msec/track, plus 42 msec settling |
| Maximum Track-to-Track Seek (80 tracks): | 1242 msec |
| Average Track-to-Track Seek: | 447 msec |
| Maximum Rotational Latency: | 100 msec |
| Average Rotational Latency: | 50 msec |
| Spindle Motor on time: | 400 msec |
| Maximum Data Access Time (Seek plus Latency plus Motor on time): | 1.742 sec * |
| Average Data Access Time: | 497 msec |

CAPACITY

| Bytes/sector | 256 | 512 | 1024 |
|---|---|---|---|
| Sectors/track | 16 | 9 | 5 |
| Tracks of data | 154 | 154 | 154 |
| Bytes per disc | 630K | 709.6K | 788K |

* If in the powered down mode, an additional 1.4 seconds is required to power up the sony drive.

## DISC OPERATIONS

Disc operations that don't require data transfer, such as a seek, consist of simply setting up the track, sector, and data registers of the FDC, giving it the appropriate command and then waiting for the FDC to signal that the operation was completed. The status register is then checked to see if the operation completed successfully.

Since there is no hardware timer, all timeouts are implemented in wait loops. There are wait loops needed for the head load, motor on, and erase head timings. The head will be loaded and the motor turned on only before those operations that access the disc. The head will be unloaded and the motor will be turned off if no further microfloppy commands have been given by the host within 2 seconds of the end of the last operation.

The seek process will be as follows:

1. Set up the FDC with the current and desired track number.
2. Give the FDC the Seek command with the verify option enabled.
3. If the seek is successful, the status will reflect this.
4. If the seek fails with a seek error, a Step command will be given up to 4 times. If the track is still not located, a restore of the head to track 0 will be performed, followed by a Seek to the desired track (go to step 2). If this outer loop fails after 5 tries, the seek will end with an error.

Since a seek process checks to make sure that the head is over the correct physical track, the location will not be verified again before performing a read, write, format, etc. The FDC automatically does 5 re-tries when looking for an ID field on a read, write, read address, etc. If the track is not found, the process ends with an error. At this point a call to the seek routine will be performed, and the read, write, etc. will be tried again. If the data can't be read because of a CRC error, the device will perform up to 3 re-tries, setting the appropriate status bits, Unrecoverable Data and/or Unrecoverable Data Overflow.

## SPARING

All sparing is done by the peripheral. The two spares per disc surface are the two innermost tracks on the disc. A spare track will have its cylinder, head and sector ID fields all set to 0FFH.

The microfloppy will give a No Spares Available error if a Spare Block command is given to it. No autosparing is done during normal use, only during an Initialize Media command. Any

data that can't be read will cause an Unrecoverable Data error. At no time will Marginal Data be set as that would indicate to the host that a Spare Block command should be given.

## HP-IL MESSAGES

The device's response to each HP-IL message is described below. In SUBSET/80, some of these messages could be classified as Transparent messages since they are used to implement a particular type of channel. However, in this description they will be described separately from the SUBSET/80 messages since their transaction sequence is different from the transaction sequence of SUBSET/80 messages. The loop sequences used should follow the examples given in "The HP-IL System: An Introductory Guide to the Hewlett-Packard Interface Loop".

### DATA GROUP

Data Byte : If a talker, will check to see that the byte received was the same as the byte sent. If the frame is not the same as the one sent, then an ETE frame will be sent. If the error occured during the execution phase of a SUBSET/80 command, the device will go to the reporting phase. If a listener, the device accepts the data byte and passes it to the next device. NOTE: In order to make data transfers as fast as possible, the data byte will not be checked until after the next data byte is sent, so the ETE might be sent one frame later.

End Byte : If a listener, accepts the byte and passes it on. In a SUBSET/80 command sequence, the controller of the loop uses an End byte to indicate to the device that the last parameter or opcode is being sent or that the last byte is being sent in a data transfer. The device sends the End Byte in SUBSET/80 to indicate that the last byte during the execution phase or report phase is being sent. The device will not send End Bytes when responding to the HP-IL Ready commmands Send Status, Send Device ID, or Send Accessory ID.

### COMMAND GROUP

Interface Clear: The device is removed from talker or listener status.

Device Clear: The device will clear itself. This command is the same as the SUBSET/80 Universal Device Clear command. For a complete description of the sequence of operations performed by a clear, refer to the SUBSET/80 documentation.

Selected Device Clear. If listener, will have same response as the Device Clear command.

Go To Local: No response.

Local Lockout: No response.

Remote Enable: No response.

Not Remote Enable: No response.

Parallel Poll Enable 0-15: If a listener, the device will enable its parallel poll response capability according to the last four bits of the message. The device's power-on state is its parallel poll response capability is disabled.

Parallel Poll Disable: If a listener, the device will disable its parallel poll response capability.

Parallel Poll Unconfigure: The device will disable its parallel poll response capability.

Group Execute Trigger: No response.

Loop Power Down: Pompeii will immediately go into its power down mode.

Enable Asynchronous Requests: No response.

Auto Address Unconfigure: The device's address is set to the default value of 2.

Listen Address 0-30: If the address matches, the device is removed from talker status and becomes a listener.

Unlisten: Device is removed from listener status.

Talk Address 0-30: If address matches, device is removed from listener status and becomes a talker. If the address doesn't match, the device is removed from talker status.

Untalk: The device is removed from talker status.

Device Dependent Listener 0-31: These commands are used by the FILBERT command set only. The device will respond to these commands as described in the FILBERT command set description.

Device Dependent Talker 0-31: These commands are used by the FILBERT command set only. The device will respond to these commands as described in the FILBERT command set description.

Secondary Address 0-31: These commands are used by SUBSET/86 only. They are used to indicate the phase of a transaction. If the device is a listener or a talker, then the device will interpret the command and take the proper action.

Null: No response.

READY GROUP

Take Control: No response.

Ready For Command: The HP-IL chip will handle the automatic response to this command.

Send Data: If the device is a talker and has received the proper secondary command or device dependent command, the device will begin sending data. If the device is a talker and has not received the proper secondary or device dependent commmand, it will send back an ETO message.

Send Status: If talker, sends the FILBERT status bytes as outlined in the FILBERT command set description.

Send Device ID: If talker, sends the bytes for device ID.

Send Accessory ID: If talker, sends one byte with value of 010H as the accessory ID. SUBSET/80 hosts must do a SDI or a SUBSET/80 command to determine if the device also implements the SUBSET/80 command set.

Not Ready For Data: This command is not fully supported in SUBSET/80. In SUBSET/80, if the device receives a NRD message while it is sending data, it will retransmit the NRD message and then send a EOT message when it receives the last data byte it sent. This will cause a message length error if this occurs during a SUBSET/80 data transfer, unless the data byte just sent was the last byte of the transfer. The device will not start sending data where it left off if it receives another SDA message. In FILBERT, this command will be supported in full.

End Of Transmission-OK: If talker, sent after a data transfer has completed successfully.

End Of Transmission-Error: If talker, sent after a bad HP-IL error check.

Auto Address 0-31: If device has earlier address or the address is 31, then no resoponse. Otherwise, the device accepts the address as its own, increments the message by one, and retransmits it.

Auto Extended Primary 0-31: No response.

Auto Extended Secondary 0-31: No response.

Auto Multiple Primary 0-31: No response.

IDENTIFY GROUP

Identify (no service request): The device automatically retransmits the message with the SRQ bit and the parallel poll bits set according to the devices current status.

Identify (with service request): Same as identify with no service request.

## SUBSET/80 COMMAND SET

The CS/80 and SUBSET/80 instruction set programming manuals contains an overview of the command set and should be referred to for a complete description of the command set. This section will describe the specific actions the device will take in response to each of the commands. First, a list of the commands is given and then a brief description of each command in alphabetical order is given.

As mentioned above, the HP-IL messages are not included in SUBSET/80 description. The transparent commands included in this description all have the same type of transaction sequence as the other SUBSET/80 messages. The SUBSET/80 Transparent messages Universal Device Clear, Selected Device Clear, and Identify are not implemented since they have corresponding HP-IL messages. The Loopback commands are not implemented since with HP-IL the loop is checked with every message sent. The Channel Independent Clear command is used to allow only one unit within a device to be cleared, and the HP-IB Parity Checking command is used to allow the SRQ response to be enabled and disabled. The SUBSET/80 command set does not require that the Transparent commands be implemented since they are channel dependent, so the command set implemented here meets the standards.

SUBSET/80 COMMAND TABLE

| | |
|---|---|
| Real Time Commands: | Locate and Read<br>Locate and Write |
| General Purpose: | Describe<br>Initialize Media<br>Locate and Verify<br>Release (No Op)<br>Release Denied (No Op)<br>Spare Block<br>Door Lock<br>Door Unlock |
| Complementary: | Set Unit<br>Set Volume<br>Set Address<br>Set Length<br>Set Mask<br>Set RPS (No Op)<br>Set Release (No Op)<br>Set Return Addressing Mode<br>No Op |
| Transparent: | Cancel<br>Channnel Independent Clear<br>HP-IB Parity Checking |
| Diagnostic: | Initiate Diagnostic<br>Request Status |
| Device Dependent: | Validate Key<br>Download<br>Set Format Options |

CANCEL

Opcode: 09H

Parameters: None

Description: This command causes a graceful termination of long transactions, leaving the device in the reporting phase.

The device will look for a cancel during long command executions such as Initialize Media. Cancel will not cause an immediate response usually, but eventually it will be seen and acted upon.

The Cancel command supresses message length errors.

CHANNEL INDEPENDENT CLEAR

Opcode: 08H

Parameters: None

Description: If this command is directed to the controller or to the microfloppy, the same actions are taken as described in the HP-IL Device Clear command.

DESCRIBE

Opcode: 35H

Parameters: None

Description: The controller fields returned for the 9144 are:

C1, C2 = installed unit byte. C1 will always be 80H, C2 will be 1 corresponding to 1 drive.
C3, C4 = 7, maximum instantaneous transfer rate.
C5 = 4 for one drive being connected.

The unit description for the microfloppy will be:

U1 = Generic device type 129, since disc change is not supported
U2-U4 = 091140, product number
U5-U6 = variable, depending on bytes per block of current disk
U7 = 1, number of blocks which can be buffered
U8 = 0, burst mode not implemented
U9-U10 = variable, depending on current disk
U11-U12 = 7 Kbytes/sec maximum continuous average transfer rate
U13-U14 = 3500, 35 seconds read retry time
U15-U16 = 8000, 30 seconds maximum access time
U17 = variable, depending on current disk
U18 = 0, no fixed volumes
U19 = 1, one removable volume

The volume description field is:

V1-V3 = 0
V4 = 1, maximum head address for double-sided, 0 for single-sided discs
V5-V6 = variable, sectors per track
V7-V12 = variable, maximum sector address
V13 = current interleave factor or maximum value if unknown

To determine the correct values for the volume description field, the disc is accessed. Cylinder 0 on head will be read to get the current interleave, disc type ID, etc. If this track is unformatted, the bottom surface of the disc will beaccessed. If it's formatted as single-sided, the volume description field parameters will be returned as such. If neither side of the disc is formatted, the disc will be regarded as the default type of disc. If no disc is in the drive, V1-V6 will reflect the default format, but the addr. field, V7-V12, will be zero.

DOOR LOCK

Opcode. 4DH

Parameters: None

Description: This command will cause the illegal opcode error bit to be set. Drivers can use this command to see that the devices do not have door locks.

DOOR UNLOCK

Opcode: 4CH

Parameters: None

Description: This command will cause the illegal opcode error bit to be set. Drivers can use this command to see that the devices do not have door locks.

DOWNLOAD

Opcode: 31H

Parameters: P1 = F2H
P2 = A5H
P3-P5 = Device number
P6 = Download revision number in unsigned binary

Description: This command is used to download code into the RAM of the device, which will then be executed. This command is mainly used for special service routines and diagnostics.

HP-IB PARITY CHECKING

Opcode: 01H

Parameters: P1 = 00H to disable SRQ response
02H to enable SRQ response

Description: This command is used to enable and disable the device's SRQ response. The device's power-on state is SRQ disabled.

INITIALIZE MEDIA

Opcode: 37H

Parameters: P1 = byte indicating how sparing should be handled
P2 = block interleave number

Description: This command will initialize a media, one track at a time. The procedure consists of:

1) writing a worst case pattern
2) verifying the pattern
3) formatting the track with the desired interleave or sparing the track if defective
4) verifying the pattern
5) step to the next track

None of the spares present on the disc at format time are preserved. If a track is truly defective, it will be spared again by this Initialize Media procedure.

There are two spare tracks on each side of the double-sided disc. If more tracks need to be spared than provided for by these set-aside tracks, the command will end in error.

The disc can be formatted with an interleave from 1 to the maximum sectors per track. An interleave of 0 is the same as an interleave of 1. If the the interleave parameter passed is greater than the maximum number sectors per track, the maximum will be used.

Periodically during the execution of the Initialize Media command, the HP-IL will be scanned. If a Clear or Cancel command is recognized, the Initialize Media command will be terminated with no errors.

Some possible status errors are:

| | |
|---|---|
| 35 = Not Ready | No disc in drive |
| 36 = Write Protect | Disc is write protected |
| 34 = No Spares Available | Ran out of spare tracks |
| 55 = Auto Sparing Invoked | At least one track was spared |

INITIATE DIAGNOSTIC

Opcode: 33H

Parameters: P1 = CCH
P2 = 01H
P3 = 00H

Description: This command instructs the device to perform its diagnostic routine. This routine is the same as that performed at power-on.

LOCATE AND READ

Opcode: 00H

Parameters: None

Description: This command finds the data at the target address and transmits it to the host.

If the present location of the read/write head is not at the target track, the head is stepped to the proper cylinder and the sector ID is read to verify the location of the head. The actual sector(s) ID is not verified at this time, only the track ID. If any error occurs up to this point, the proper status bits are set up, QSTAT is set to 1, and the reporting phase is entered, skipping the execution phase.

Once the proper track is located, the execution message is requested, unless the current length is 0, in which case no execution message is requested.

At least one sector (block) of data is read from the disc and then passed to the host. The cycle of reading a sector or data and then passing it to the host over the HP-IL will continue until the number of bytes as set by the current length parameter is passed.

If the correct sector for a read cannot be found, a restore to track 0 followed by a seek for the correct track is performed. Re-seeking will be performed up to five times.

If the data is read with a CRC error, up to two retries will be performed before the read ends in error. In all cases, all the data requested as defined by the length parameter will be passed to the host.

Some possible status errors:

| | |
|---|---|
| 35 = Not Ready | No disc in drive |
| 33 = Unitialized Media | Unformatted disc present |
| 44 = End of Volume | Reads extend to end of disc |
| 41 = Unrecoverable Data | Seek fails or data error |
| 40 = Unrecov. Data Overflow | More than one error 41 |
| 59 = Recoverable Data | Seek or read succeeds after retries |
| 52 = Latency Induced | Seek or read succeeds after retries |
| 57 = Recov. Data Overflow | More than one error 59 |

LOCATE AND VERIFY

Format: 04H

Parameters: None

Description: This command instructs the device to perform an internal verification of a section of data to ensure that it can be read.

This command is basically the same as a Locate and Read except that 1) the data is not made available to the host, 2) retries on reading the data are not performed, 3) the device stops reading after the first error.

Some possible status errors:

| | |
|---|---|
| 35 = Not Ready | No disc in drive |
| 33 = Uninitialized Media | Unformatted disc |
| 44 = End of Volume | Verify went to end of disc |
| 41 = Unrecoverable Data | Seek fails or data error |
| 40 = Unrec. Data Overflow | More than one error 41 |

LOCATE AND WRITE

Opcode: 02H

Parameters: None

Description: This command transfers data from the host to the microfloppy, starting at the target address.

If the present location of the read/write head is not at the target track, the head is stepped to the proper cylinder and the sector ID is read to verify the location of the head. The actual sector(s) ID is not verified at this time, only the track ID. If any error occurs up to this point, the proper status bits are set up, QSTAT is set to 1, and the reprorting phase is entered, skipping the execution phase.

Once the proper track is located, the execution message is requested, unless the current length is 0, in which case no execution message is requested.

The actual writing of the data occurs once the sector buffer is filled with data from the host. This cycle of filling the buffer and then transferring the data to the microfloppy will continue until the number of bytes as specified in the length parameter is written on the microfloppy. If only a portion of a sector's worth of data is passed by the host, the remainder of the sector is filled with zeros.

Some possible status errrors:

| | |
|---|---|
| 35 = Not Ready | No disc in drive |
| 33 = Uninitialized Media | Unformatted disc present |
| 36 = Write Protect | Disc is write protected |
| 44 = End of Volume | Reads extend to end of disc |
| 41 = Unrecoverable Data | Seek fails or data errror |
| 40 = Unrecov. Data Overflow | More than one error 41 |
| 59 = Recoverable Data | Seek succeeds after retries |
| 52 = Latency Induced | Seek succeeds after retries |
| 57 = Recov. Data Overflow | More than one error 59 |

NO OP

Opcode: 34H

Parameters: None

Description: This command is ignored.

RELEASE (NO OP)

Opcode: 0EH

Parameters: None

Description: This command will be treated as a No Op.

RELEASE DENIED (NO OP)

Opcode: 0FH

Parameters: None

Description: This command will be treated as a No Op.

REQUEST STATUS

Opcode: 0DH

Parameters: None

Description: This command instructs the device to return the status report.

See te SUBSET/80 command set description for details.

There are certain staus bits that can be set by all the commands. These are:

5 = Illegal Opcode
9 = Illegal Parameter
10 = Message Sequence
12 = Message Length
19 = Controller Fault
22 = Unit Fault
30 = Power Fail

The Power Fail status will indicate that a new disc has been inserted into the drive.

SET ADDRESS

Opcode: 24H

Parameters: 6-byte unsigned binary number for single vector address, MSB first

Description: This command sets the value of the single vector target address.

The target address is incremented after each read, whether it was successful or not and will point to the block after the one just read.

Some possible status errors:

7 = Address Bounds  Address passed is too large

SET FORMAT OPTIONS

Opcode: 31H

Parameters: P1 = F3H
P2 = 5FH

Description: This command is used to tell the peripheral to format the media in a special way. The execution message consists of a single byte that specifies the format. This format option remains selected until power is cycled or a clear command is executed. The following format options are supported.

| Format option byte | Format written |
|---|---|
| 0 (default) | 512 byte sectors<br>9 sectors/track<br>2 sides<br>77 tracks of data/side |
| 1 | 256 bytes/sector<br>16 sectors/track<br>2 sides<br>77 tracks of data/side |
| 2 | Same as 0 |
| 3 | 1024 bytes/sector<br>5 sectors/track<br>2 sides<br>77 tracks of data/side |
| 4 | 256 bytes/sector<br>16 sectors/track<br>1 side<br>66 tracks of data/side<br>(this is HP single_sided format) |

SET LENGTH

Opcode: 18H

Parameters: P1-P4 = unsigned binary number, MSB first (except all 1's means entire volume)

Description: This byte defines the number of bytes in a data transfer. No matter what the current length parameter is set to, all read and write operations to the micr floppy will be done on a full sector basis. The number of data bytes transferred over the HP-IL will be as defined by the length parameter.

SET STATUS MASK

Opcode: 3EH

Parameters: P1-P8 = Bit positions in each byte corresponds to the error bit position in the error reporting fields of the status report. "1" means to mask the error.

Description: This command allows masking of error conditions reported by the Request Status command. The 8 bytes following the command opcode indicate which error bits are to be masked. At power-on, no bits are masked.

The masked error bits will not be reported by either Request Status or QSTAT. If an error bit is not masked, it reports a hard error (QSTAT=1) when set. The only exception to this is the Power Fail error bit. This bit reports a power-on status (QSTAT=2) when set.

Some possible status errors:

8 = Parameter Bounds — Trying to mask an unmaskable bit

SET RELEASE

Opcode: 3BH

Parameters: 2 bytes

Description: This command will be treated as a NO Op.

SET RETURN ADDRESSING MODE

Opcode: 48H

Parameters:

Description: This command should not be used by new drivers.

SET RPS

Opcode: 39H

Parameters: 2 bytes

Description: This command will be treated as a No Op.

SET UNIT

Opcode: 2XH

Parameters: None

Description: This command is used to specify a specific unit within the device. The controller is always unit 15. The microfloppy will be unit 0.

Some possible status errors:

6 = Module Addressing Illegal unit number

SET VOLUME

Opcode: 8XH

Parameters: None

Description: This command is used to specify the desired storage volume of a specified mass storage device. In this device there is only one volume, so the only valid volume number is 0.

Some possible status errors:

6 = Module Addressing Volume not equal to 0

SPARE BLOCK

Opcode: 06H

Parameters: One byte

Description: This command instructs the device to spare out the track indicated by the target address.

The device's response will be:

34 = No spares available

VALIDATE KEY

Opcode: 32H

Parameters: P1 = 11H
P2 = 02H

Description: This command causes the device to compare the key passed during the execution phase to the key stored on the microfloppy. If the keys agree QSTAT will be 0.

This command enables a host to implement some form of security for certain software products. A downloadable binary program will be made available to software vendors selected by the host divisions that will enable a key to be written in the privileged area on a disc. A software package can then issue the Validate Key command, passing to the device the presumed key stored on the disc. The key stored on the disc will be examined and QSTAT will indicate if the key on the disc matches the key passed in th command. Presumably, the applications software will abort the program if the keys don't match.

Some possible status errors:

| | |
|---|---|
| 37 = No Data Found | Incorrect key or no key |

## FILBERT COMMAND SET

The extended Filbert command set will also be supported on both Pompeii and Buzzard. This can be done since the two command sets use different HP-IL commands. SUBSET/80 uses secondary addresses to indicate phases in a transaction and Filbert uses device dependent commands.

### DEVICE COMMMANDS

The device commands in the extended Filbert command set are listed below. The commands are split into two groups. Listen commands are executed when addressed as a listener, and talk commands are executed when addressed as a talker. No action is taken on any device dependent command until the RFC following it has been received. If any other frame follows the device dependent command, then the command is not executed. Any DDL or DDT commands other than the ones listed below will cause all states to be cleared

### LISTEN COMMANDS

| | |
|---|---|
| WRITE TO BUFFER 0 | A0 |
| WRITE TO BUFFER 1 | A1 |
| WRITE | A2 |
| SET BYTE POINTER | A3 |
| SEEK | A4 |
| FORMAT | A5 |
| PARTIAL WRITE | A6 |
| HOME (REWIND) | A7 |
| CLOSE RECORD | A8 |
| TRANSFER BUFFER 0-1 | A9 |
| EXCHANGE BUFFER | AA |
| VERIFY RECORDS | AB |
| DOWNLOAD | AC |

### TALKER COMMMANDS

| | |
|---|---|
| SEND BUFFER 0 | C0 |
| SEND BUFFER 1 | C1 |
| READ | C2 |
| SEND ADDRESS | C3 |
| EXCHANGE BUFFERS | C4 |
| TRANSFER BUFFER 0-1 | C5 |
| SEND PHYSICAL ATTRIBUTES | C6 |
| SEND MAXIMUM ADDRESS | C7 |

## LISTEN COMMANDS DESCRIPTIONS

### WRITE BUFFER 0

Data bytes following this command are stored in BUFFER 0 starting at the location pointed to by the BYTE POINTER. When the buffer fills, the contents of the buffer are written to the NEXT RECORD. Following bytes fill the buffer from the beginning again. This command is the same as the WRITE command except that the BYTE POINTER and PARTIAL WRITE flag are not cleared when the command is received.

### WRITE BUFFER 1

Bytes are stored in BUFFER 1. No action is taken when the buffer fills. The BYTE POINTER wraps around and extra bytes are written over the bytes at the beginning of the buffer. The PARTIAL WRITE flag is cleared.

### WRITE

This command sets flags that cause the buffer contents to be written to the NEXT RECORD when an END frame or CLOSE RECORD is received, or the buffer fills. After the buffer is written to the NEXT RECORD, the record after the one just written becomes the NEXT RECORD. The BYTE POINTER and PARTIAL WRITE flag are set to zero when this command is received. If the last record on the media is written, the L STATE mode is cleared and NEXT RECORD is set to 0. If another DAB is received, size error is set. If a CLOSE RECORD is received just after the buffer has filled, the contents of the buffer will be written to the NEXT RECORD resulting in two sequential records containing the same data (the buffer contents have not been changed since the previous record was written).

### SET BYTE POINTER

Data bytes received after this command are put in the BYTE POINTER register. The last byte received is the only valid byte. The data frame is taken as a binary value. The bytes of each buffer are numbered from 0 to 255D.

### SEEK

This command sets the NEXT RECORD. The PARTIAL WRITE flag is cleared. A two byte binary number specifies the NEXT RECORD. The first byte received is the most significant. If only one byte is sent the command is aborted. Bytes sent after the first two are disregarded. If a record number larger than the last addressable

record is received, a size error is generated and the NEXT RECORD remains the same.

FORMAT

Immediately after receiving this command the entire media is initialized. The format used will be 256 bytes/sector, 16 sectors per track, 2 sides, and 77 data tracks per side. The Subset/80 command Set Format Options can be used to change the format to single_sided HP format if desired. The interleave used will be 9. This is the only time that record headers are written on the media. The PARTIAL WRITE flag is cleared and the contents of BUFFER 0 and 1 are destroyed. Format will fail and write protect the media if motor speed is not within specifications. Format will take between 1 and 2 minutes to complete with double-sided drives. Due to errors in the format routines of certain hosts, a check is done after a write to the first sector to make sure that if LIF format is being written on the disc after the format that the correct extension fields and directory size are written. If not, then these are overwritten with the correct data.

PARTIAL WRITE

When this command is received the NEXT RECORD is read. The NEXT RECORD remains the same. The head remains over the track containing the NEXT RECORD. The PARTIAL WRITE flag is set. The following rules apply when in PARTIAL WRITE mode:

A) After every read the record just read remains the NEXT RECORD.

B) After every write:

if the buffer was filled the NEXT RECORD number is incremented, the new NEXT RECORD is read, and the head remains over the track containing the new NEXT RECORD.

if the buffer was not filled the NEXT RECORD remains the same and the head remains on the same track.

Writes occur when the buffer fills, or when an END frame or CLOSE RECORD is received.

The buffer is filled when the BYTE POINTER rolls over to zero when no END frame or CLOSE RECORD is received, or when the BYTE POINTER is pointing to the last byte in the buffer and an END frame is received. (The END frame is placed in the last byte of the buffer resulting in a full buffer.)

The buffer is not filled if the BYTE POINTER is not at the end of the buffer when an END frame is received or if a CLOSE

RECORD is received. (The buffer will never be full when a CLOSE RECORD is received.)

If the BYTE POINTER is at the first byte of the buffer and a CLOSE RECORD is received, the buffer is written back to the NEXT RECORD. (The buffer contents are the same as the NEXT RECORD.)

If the maximum addressable record is written and the NEXT RECORD gets incremented then the LSTATE mode will be cleared, the NEXT RECORD will be set to 0, and size error will be generated if another DOF frame is received.

HOME (Previously REWIND)

This command sets the NEXT RECORD to 0 and restores the drive to track 0.

CLOSE RECORD

This command causes the buffer contents to be written to the NEXT RECORD. If PARTIAL WRITE mode is active the NEXT RECORD number remains the same. If not active the NEXT RECORD number is incremented. If the WRITE BUF 0 flag has been cleared then no action is taken. END frames act the same as CLOSE RECORD unless PARTIAL WRITE mode is active.

TRANSFER BUFFER 0-1

BUFFER 0 is copied into BUFFER 1. The contents of BUFFER 1 are lost. BUFFER 0 is used for buffering records on and off the media.

EXCHANGE BUFFERS

The contents of BUFFER 0 and BUFFER 1 are exchanged.

VERIFY RECORDS

The sector headers and data are read and verified with their checksums. The first record checked is the NEXT RECORD. This should be set by the SEEK command before verifying records. A two byte binary number specifies how many record to verify. The first byte received is the most significant. If only one byte is sent the command is aborted. If records greater than the maximum addressable record are to be verified then the verification stops with the last record on the media and NEXT RECORD is set to 0. If the verify fails, the NEXT RECORD will contain the address of the sector that failed.

DOWNLOAD

The first DAB received after this command is the starting address MSB, the second byte is the LSB. Successive bytes are loaded into memory starting at this address. When an EOI frame is received a subroutine call is made to the location specified by the starting address. This command is intended for service use only. No range checking is done.

TALK COMMANDS DESCRIPTION

SEND BUFFER 0

When this command and a subsequent SDA are received the BUFFER 0 contents are sent starting with the byte pointed to by the BYTE POINTER. When the entire buffer is sent the NEXT RECORD is read into the buffer and sent. THe NEXT RECORD is then incremented. This continues until the maximum addressable record is sent, an NRD sequence has been executed, or an error condition is detected. If the maximum addressable record is sent and an NRD sequence has not been executed, an EOI is sent and the NEXT RECORD is set to 0.

SEND BUFFER 1

When this command and a subsequent SDA are received the BUFFER 1 contents are sent starting with the byte pointed to by the BYTE POINTER. Sending stops when the entire buffer has been sent or an NRD sequence has been executed.

READ

The NEXT RECORD is read and placed in BUFFER 0. The NEXT RECORD number is incremented. The BYTE POINTER is set to zero. The contents of BUFFER 0 are then sent. When the last byte has been sent the new NEXT RECORD is read and sent. This continues until the maximum addressable record has been read and sent or an NRD sequence has been executed. If the maximum addressable record is sent and an NRD sequence has not been executed, an EOI is sent and the NEXT RECORD is set to 0.

SEND ADDRESS

The NEXT RECORD number (two bytes) and the value of the BYTE POINTER (one byte) are returned after this command and a subsequent SDA are received. The order is most significant byte, least significant byte, and then the BYTE POINTER.

EXCHANGE BUFFERS

This command is the same as the DDL EXCHANGE BUFFERS.

TRANSFER BUFFER 0-1

This command is the same as the DDL TRANSFER BUFFER 0-1.

SEND PHYSICAL ATIRIBUTES

Twelve bytes of the LIF Level 1 extension field are returned after this command and a subsequent SDA are received. The most significant byte of word 12 is sent first, then the least significant byte of word 12. This is done for words 12 to 17. (See LIF document page 15)

SEND MAXIMUM ADDRESS

Two bytes representing the record number (in binary) of the last (highest) physical record on the media are returned after this command and a subsequent SDA are received. The most significant byte is sent first.

STATUS

One byte of status information will be returned when the Send Status command is received. The following table outlines the possible status messages that could be returned. If the device is busy, status message of 32D will be returned.

| Status Byte | Condition | Description |
|---|---|---|
| 0 | Idle | Everything is OK |
| 15 | Stall | A seek was attempted to a blank media. |
| 20 | No media | No media is in drive |
| 21 | Low battery | Low battery |
| 23 | New media | A new disc is in the drive |
| 24 | Blank | A foriegn or unformatted media is in the drive |
| 25 | Record number error | The record could not be found |
| 26 | Checksum error | A CRC error occurred on a read or too many tracks |

| | | |
|---|---|---|
| | | were spared by FORMAT |
| 28 | Size error | An access to a record greater than the maximum addressable record was attempted |
| 29 | Write protect | Disc is write-protected |

## MESSAGE STRUCTURES

The messages that are used were separated into two distinct groups, HP-IL messages and SUBSET/80 messages. This was done because the message sequence used when a SUBSET/80 message is sent always has a certain structure. SUBSET/80 transactions may consist of three separate phases: command, execution, and reporting. Each SUBSET/80 phase is indicated by the controller sending the proper secondary address command that corresponds to the phase of the transaction. Transactions in which only HP-IL messages are sent will not follow this structure.

The HP-IB sequences used during a SUBSET/80 transaction is outlined in the CS/80 Instruction Set Programming Manual. These same sequences will be used as they apply to HP-IL to make the HP-IL implementation as close as possible to the HP-IB implementation. The main difference occurs when the device starts and stops sending data. The controller must send the Send Data message to the device when it wants the device to send data and the device must send an End Of Transmission message when it is done sending data. The controller will always send the last data byte as an End Byte. The device will use this byte as a signal that the last parameter or opcode has been sent during the command phase of a sequence, or that the last byte has been sent during the execution phase of a sequence. The device will send its last data byte during the execution phase and report phase as an End Byte, also.

The sequences used during a Locate and Read transaction and a Locate and Write transaction are shown below. These sequences should show exactly how the HP-IB seqences map into the HP-IL sequences.

### LOCATE AND READ

Command Phase:

| | |
|---|---|
| LADn | First, the controller addresses the device as a listener. |
| RFC | |
| SADS | Next, the controller sends out the secondary address for the command phase of the transaction. |
| RFC | |
| DABxx | The controller then sends 0 to N complemetary commands to the device (xx = the value of the data byte). |
| . | |
| . | |
| . | |
| DABxx | |

| | |
|---|---|
| END00 | The controller sends the opcode for Locate and Read as an End Byte. |
| UNL | The controller unlistens the device. |
| RFC | |

Execution Phase:

| | |
|---|---|
| TADn | The controller addresses the device to be a talker. |
| RFC | |
| SAD14 | The controller sends out the secondary address to indicate the execution phase |
| RFC | of the transaction. |
| SDA | The controller sends the Send Data message which the device replaces with its first data byte. |
| DABxx | The device sends 1 to N data byte. |
| . | |
| . | |
| DABxx | |
| ENDxx | The last data byte will be sent as an End byte. |
| ETO | The device sends the End Of Transmission message to signal to the controller that it is done. |
| UNT | The controller untalks the device. |
| RFC | |

Reporting Phase:

| | |
|---|---|
| TADn | The controller addresses the device to talk. |
| RFC | |
| SAD16 | The controller sends the secondary address for the reporting phase of the trans- action. |
| RFC | |
| SDA | The controller sends the Send Data message which the device replaces with the QSTAT |
| ENDxx | byte (xx = QSTAT) sent as an End Byte. |
| ETO | The device sends the End Of Transmission |

message to indicate it is done.

| | |
|---|---|
| UNT | The device is untalked. |
| RFC | |

LOCATE AND WRITE

Command Phase:

| | |
|---|---|
| LADn | First, the controller addresses the device as a listener. |
| RFC | |
| SAD5 | Next, the controller sends out the secondary address for the command phase of the transaction. |
| RFC | |
| DABxx | The controller then sends 0 to N complemetary commands to the device (xx = the value of the data byte). |
| . | |
| . | |
| DABxx | |
| END02 | The controller sends the opcode for Locate and Write as an End Byte. |
| UNL | The controller unlistens the device. |
| RFC | |

Execution Phase:

| | |
|---|---|
| LADn | The controller addresses the device to be a listener. |
| RFC | |
| SAD14 | The controller sends out the secondary address to indicate the execution phase of the transaction. |
| RFC | |
| DABxx | The controller sends out 1 to N bytes of data to be written, with the last one transmitted as an End Byte. |
| . | |
| . | |
| DABxx | |
| ENDxx | |
| UNT | The controller untalks the device. |
| RFC | |

Reporting Phase:

| | | |
|---|---|---|
| TADn | | The controller addresses the device to talk. |
| RFD | | |
| SAD16 | | The controller sends the secondary address for the reporting phase of the transaction. |
| RFC | | |
| SDA | | The controller sends the Send Data message which the device replaces with the QSTAT |
| | ENDxx | byte (xx = QSTAT) sent as an End Byte. |
| | ETO | The device sends the End Of Transmission message to indicate it is done. |
| UNT | | The device is untalked. |
| RFC | | |

## DIAGNOSTICS

The 9114A has three diagnostic modes: power-on selftest, bus initiated diagnostics, and service diagnostics initiated by jumpers on the PC board. The power-on selftest is done every time that power is switched on. The bus initiated diagnostics include the Subset/80 Initiate Diagnostic command and downloadable code to do specific tests. The service diagnostic tests are designed to allow tests to be performed on the unit without having a host computer present or when bus communication is not possible.

### POWER-ON SELFTEST

Whenever power is switched on, a selftest is performed on as many components as possible. The procedure during power up is as follows. First the processor, ROM, RAM, and HP-IL chips are tested. The processor is tested by doing several different instructions to test its different registers. Then a checksum is performed on the ROM and compared to a precalculated value. Next the RAM is tested by writing an incrementing pattern into all RAM locations and then reading it back. Then the complement of this pattern is written and read back. Next the HP-IL chip is tested by writing and reading from several different registers in the chip. If any of these first four tests fail, the processor will immediately go into a loop where it will blink the selftest LED off for a brief moment every five seconds. This is done since it is better not to continue if any of these components are bad.

Next the floppy drive and the components associated with its interface are tested. The Peripheral Interface Adapter (PIA) is tested first by writing and then reading from several registers. Then the Floppy Disc Controller (FDC) is tested in the same way. After these two chips are tested, the testing of the Sony drive takes place. First a seek test is performed. This tests that the FDC can communicate with the drive by having it seek away from track 0 and then back to track 0. The TRACK 0 line is tested to make sure that movement takes place. This is all the tests that are performed if no disc is in the drive. It should be noted that this is the first test to check the interface to the drive and that there are many conditions that could cause its failure. A few examples of conditions that can cause failures are disconnected cables, FDC test jumper in wrong position, and Sony address switch in wrong position.

If a disc is in the drive, a motor speed test will be performed next. The head is stepped to track 35 and then it is loaded, and the speed of the motor is calculated by measuring the time between index pulses. This time is checked to see if the motor speed is within tolerance. The final test to be performed is a write and read compare test. This test is performed only if the disc is formatted with a short sector (HP single-sided format) or with a system cylinder (the new format for double-sided discs). The first thing that is checked is if the disc is write-protected. If it is, then

only a read test will be performed. If the disc is not write-protected and is in the proper format, then a pattern will be written on the privileged area of the disc and then read back and compared with the pattern that was just written.

If all the floppy drive tests passed, then the selftest LED will go off. If not, the test that failed can be determined by executing the Subset/80 Request Status command. The status bits P1-P6 will contain a code to indicate which test failed. These codes are the same as the ones described in the Initiate Diagnostics description below.

BUS INITIATED DIAGNOSTICS

There are two types of bus initiated diagnostics, the Initiate Diagnostics command and downloaded code. The Initiate Diagnostic command is very similar to the power-up selftest. It performs the PIA test, FDC test, drive seek test, motor speed test and write/read compare tests that were described in the power-up selftest. If the diagnostic fails, the parameter bytes P1 through P6 will contain the error code (in hex):

| P1 | P2 | P3 | P4 | meaning |
|---|---|---|---|---|
| 00 | 00 | 00 | 01 | FDC failure |
| 00 | 00 | 00 | 02 | Seek test failure |
| counts | | 00 | 03 | Index test failure |
| XX | FDC | 00 | 04 | Write test failure |
| XX | FDC | 00 | 06 | Read test failure, head 0 |
| XX | FDC | 00 | 07 | Read test failure, head 1 |
| index | | 00 | 08 | Read compare failure, head 0 |
| index | | 00 | 09 | Read compare failure, head 1 |
| 00 | 00 | 00 | 10 | PIA failure |
| 00 | 00 | 00 | 11 | Low battery |

Also, downloadable binary programs that initiate certain tests are available. These tests are loaded into the peripheral using the Subset/80 Download command. The test will be performed and the success or failure of the test is indicated by the QSTAT value at the end of the Download command. A QSTAT of 0 means success. If the QSTAT is 1, and the Diagnostic Result bit is also set, then the test failed. Some of the tests indicate the cause of the failure by returning codes in P1-P6.

The downloadable tests are:

Drive seek -- the heads are stepped to and from track 0.

Motor speed -- the head of the chosen drive is stepped to track 35 and loaded on the disc. The index period is measured and compared to the specification for the drive. If the test is successful, P7 and P8 will contain the index coun If the test failed, P1-P4 will indicate the failure.

| P1/2 | P3/4 | meaning |
|---|---|---|
| 0 | 1 | no disc in drive |
| 0 | 2 | counts > 65535 |
| counts | 3 | index period out of spec |

To determine the index period from the counts parameter, multiply the counts by 9.1875 usec and then add 90 msec.

Verify -- The disc is verified; i.e., each sector on the disc is read and checked for CRC errors. If the test fails, one of the following error codes will be in P1-P4.

| P1/2 | P3/4 | meaning |
|---|---|---|
| 1 | 0 | no disc in drive |
| 2 | FDC status | seek error |
| 3 | 0 | low battery error |
| 4 | FDC status | verify error |

Write/read compare -- the disc is first written with a worst case pattern and then each sector is read and compared against what was written. The possible error codes are:

| P1/2 | P3/4 | meaning |
|---|---|---|
| 1 | 0 | no disc in drive or low battery |
| 2 | 0 | the disc is write protected |
| 3 | FDC status | seek error in finding track 0 |
| 4 | FDC status | seek error in write |
| 5 | FDC status | error in sector write |
| 6 | FDC status | seek error in read |
| 7 | FDC status | error in sector read |
| 8 | address | compare failed |

Format -- the disc is initialized one track at a time with a worst case pattern, verified, initialized with a data of 0FFH, and verified again. The default physical format is used. Possible errors are:

| P1/2 | P3/4 | meaning |
|---|---|---|
| 1 | 0 | no disc in drive or low battery |
| 2 | 0 | the disc is write protected |
| 3 | FDC status | seek error |
| 4 | FDC status | error in restore |
| 5 | FDC status | error in initialize |
| 6 | FDC status | sparing process failed |
| 7 | FDC status | sparing process failed |
| 8 | FDC status | error writing short sector |

| | | |
|---|---|---|
| 9 | FDC status | error writing system cylinder |
| 10 | FDC status | error writing wear on sys. cyl. |

The preceding tests all use the same binary program (in hex).

```
34 36 32 7A AD 9F FF XX 81 00 27 13 AF E4 10 AF 62 5F ED
30 E4 06 10 AD 9F FF C2 32 66 35 B6
```

Depending on the value of XX, the different tests invoked are:

| XX | test |
|---|---|
| D8 | drive seek |
| D6 | motor speed |
| D2 | verify |
| DA | write/read |
| D0 | format |

SERVICE DIAGNOSTICS

If a 9114A fails in such a way that communication over HP-IL is not possible, or if a host computer is not available, the service diagnostic tests can still be performed. The service diagnostic testing ablility of the 9114 consists of being able to select any of the following tests by moving the three jumpers on the pc board labeled "SVC TEST" to the position of the desired test and then moving the jumper labeled "START SVC" towards the "START SVC" lettering to initiate the service test. The indication of the results of a test are as follows. The self test LED is put on for one second at the beginning of a test, and then off for one second to show that the LED works. Then the test will be performed. A successful test is indicated by the LED blinking. A failure causes the LED to stay on. The test results are displayed for 5 seconds, and then the device performs a complete power-up sequence.

0 NO TEST

1 RAM/ROM/FDC/PIA TEST: This test tests all of the indicated chips in the order shown. The RAM is tested and then the LED is blinked twice to indicate it passed, the ROM is tested and then the LED is blinked three times to indicate it passed, the FDC is tested and then the LED is blinked four times to indicate it passed, and then the PIA is tested and the LED is blinke five times to indicate it passed.

| | | |
|---|---|---|
| 2 | HPIL CHIP TEST: | This test reads and writes from several registers in the HPIL chip and then sends HPIL frames around the loop and checks each frame when it is received. An HPIL cable must be used to connect the input and output of the HPIL port. |
| 3 | WRITE/READ TEST: | The entire disc is written with a worst case pattern and then it is read back and compared to see if it was written correctly. A nonwriteprotected formatted disc must be in the drive. |
| 4 | VERIFY TEST: | All sectors in the data area of the disc are checked for CRC errors. A formatted disc must be in the drive. |
| 5 | SEEK TEST: | Commands are given to the FDC to move the head on and off of track 0. The track 0 indicator is checked to see that movement occurs. |
| 6 | MOTOR SPEED: | The head is stepped to track 35 and loaded. The period of the index pulse is measured and compared against the specification. A disc must be in the drive. |
| 7 | FORMAT: | The disc if formatted. A 011 pattern is written first and verified and then a 111 pattern is written and verified. |