SECTION III
OPERATION

3.1 INTRODUCTION

This section explains the manual operation of the disk drive and defines the interface functions with regard to timing, levels, and interrelationships.

3.2 CARTRIDGE HANDLING AND STORAGE

The magnetic coatings on the disk surface have the ability to retain recorded intelligence for an indefinite period. The recorded data does not tend to weaken or fade with age; however, the physical properties of the recording medium are susceptible to damage.

It is important that the disk cartridge be properly handled and stored so that the integrity of the recorded data is maintained. A damaged or contaminated cartridge can impair or prevent recovery of data and can result in damage to the disk drive.

CAUTION

DO NOT ATTEMPT TO INSTALL OR USE A CARTRIDGE WHICH DOES NOT HAVE A DISK-DRIVE COMPATIBLE BIT-DENSITY RATING OR IS SUSPECTED OF DAMAGE OR CONTAMINATION.

A disk drive which has been damaged or contaminated due to use of a defective cartridge should not be operated with other cartridges until the disk drive has been inspected and/or reconditioned by qualified service personnel. The rated density of each cartridge must be compatible with that of the disk drive being used.

The following methods will ensure maximum protection of disk cartridges.

(1) The head port door on front load cartridges should be kept closed when the cartridge is not inserted in a disk drive. This prevents the ingress of dirt and secures the disk internally.

(2) Top load cartridges should have the bottom cover in place at all times when the cartridge is not inserted in a disk drive. Do not allow the bottom cover to accumulate dirt or other debris.

(3) Cartridges can be stored either horizontally or vertically. Front load cartridges must always be positioned to avoid objects which could damage the hub or cause the air inlet door to be pushed open.

CAUTION

DO NOT PLACE CARTRIDGES IN A STACK CONTAINING MORE THAN 5 CARTRIDGES.

(4) Avoid exposure of the cartridge to any magnetizing force in excess of 50 oersted or loss of stored data may result.

NOTE

The 50 oersted level of magnetizing force is reached at a distance of approximately 76.2 mm [3 inches] from a typical source, e.g., motors, generators, transformers.

(5) Do not store the cartridge in direct sunlight; temperatures outside the range of 0.6° to 60°C (33° to 140°F) should be avoided for non-operational storage.

(6) Internal, as well as external, damage to a cartridge can result when dropped. If a cartridge is dropped, it should be inspected by a qualified service representative.

(7) Front load cartridges should be labeled only in the area of the label frame which is molded as part of the handle; top load cartridges should be labeled only in the handle recess area. Placement of labels in any other area may cause improper operation or contamination.

3.3 DISK DRIVE PREPARATION

The initial check-out procedure in Section II should be performed prior to placing the disk drive in a system environment.

Optimum data reliability can be obtained only when the protective dust cover is installed on the disk drive. Also, to ensure proper operation and data reliability, it is necessary that disk cartridges be temperature stabilized at the disk drive ambient temperature for 2 hours.

For 200 tpi models, the time required to ensure cartridge interchangeability and data compatibility is as follows.

(1) Initial Power Turn-on: the disk drive shall be considered stabilized after 15 minutes in the Run mode.

(2) Place the ON/OFF switch in the ON position and observe that the associated indicator becomes illuminated.

(3) Observe that the SAFE indicator becomes illuminated within 2 seconds of the ON indicator illumination.

3.4 CARTRIDGE LOADING AND UNLOADING

The following paragraphs describe the proper method to load and unload disk cartridges. Procedures for front load models are contained in Paragraphs 3.4.1 and 3.4.2; procedures for top load models are contained in Paragraphs 3.4.3 and 3.4.4.

3.4.1 LOADING A CARTRIDGE, FRONT LOAD MODELS

Refer to Figures 3-1 through 3-3 in conjunction with the following procedure.

(1) Verify that the SAFE indicator is illuminated as described in Paragraph 3.3.

(2) Referring to Figure 3-1, grip the handle formed by the top of the front bezel and move the handle out and downward; this will open the disk drive door and cam the cartridge receiver into position to accept a cartridge.

CAUTION

DO NOT ATTEMPT TO INSTALL A CARTRIDGE WHICH DOES NOT HAVE A DISK-DRIVE COMPATIBLE BIT-DENSITY RATING OR IS SUSPECTED OF DAMAGE OR CONTAMINATION.

(3) Grip the cartridge by the molded handle and position the cartridge in the receiver opening as shown in Figure 3-2. Note that the raised portion of the cartridge top is aligned between the guide rails at the top of the receiver. Slant the cartridge to match the slope of the bottom of the receiver.

(4) Press the cartridge slowly but firmly most of the way into the receiver; relax the grip on the cartridge handle and press the cartridge fully into the receiver, seating it completely within the receiver as shown in Figure 3-3.

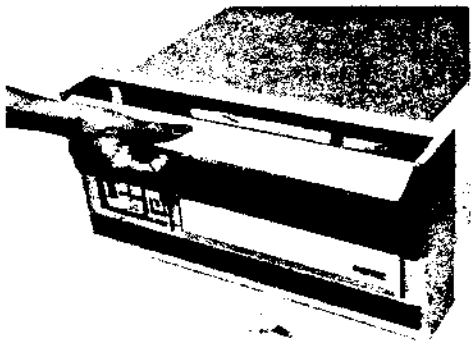

Figure 3-1. Cartridge Loading/Unloading, Front Load Models

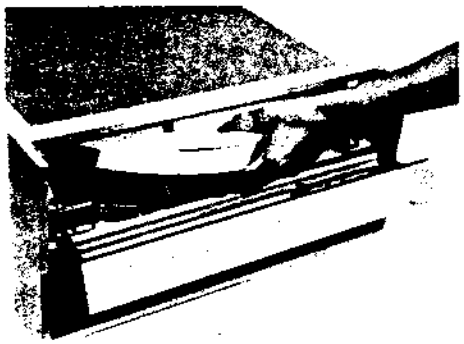

Figure 3-2. Cartridge Loading/Unloading, Front Load Models

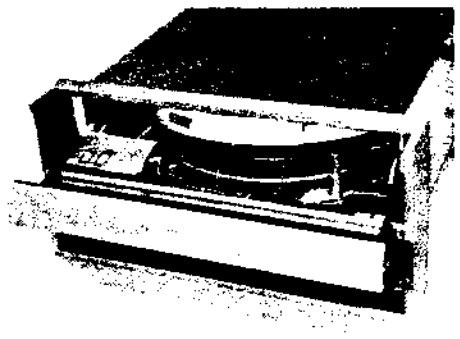

Figure 3-3. Cartridge Inserted, Front Load Models

(5) Close the door on the front of the disk drive by moving the door handle (top of the front bezel) up and toward the drive. As the door is closed, the cartridge will be positioned onto the spindle.

CAUTION

IF THE CARTRIDGE IS NOT PROPERLY INSERTED IN RECEIVER, THE DOOR WILL NOT CLOSE. DO NOT ATTEMPT TO FORCE THE DOOR CLOSED OR DAMAGE TO THE CARTRIDGE AND THE DISK DRIVE WILL RESULT; REPEAT STEPS [1] THROUGH [5].

DO NOT ATTEMPT TO START THE DISK DRIVE UNTIL THE DOOR IS FULLY CLOSED.

3.4.2 UNLOADING A CARTRIDGE, FRONT LOAD MODELS

Refer to Figures 3-1 and 3-2 in conjunction with the following procedure.

(1) Verify that the SAFE indicator is illuminated as described in Paragraph 3.3.

(2) Referring to Figure 3-1, grip the door handle formed by the top of the front bezel and move the handle out and downward, opening the door.

(3) Grip the cartridge by the molded handle and pull the cartridge slowly out of the receiver (Figure 3-2).

(4) Unless another cartridge is to be inserted immediately, close the door to exclude dirt and contamination from the interior of the drive.

3.4.3 LOADING A CARTRIDGE, TOP LOAD MODELS

Refer to Figures 3-4 through 3-9 in conjunction with the following procedure.

(1) Verify that the SAFE indicator is illuminated as described in Paragraph 3.3.

(2) Grip the handle formed by the top of the front bezel and slowly pull the disk drive from the cabinet on its slides until the cartridge area is accessible.

(3) Ensure that the cartridge lock arm is positioned away from the disk area as shown in Figure 3-4.

NOTE

The cartridge lock arm must be rotated completely into its recess.

(4) With the cartridge positioned as shown in Figure 3-5, press the cartridge release/lock (with the thumb) all the way to the side. Holding the cartridge release/lock, grip and pull the cartridge handle smartly to the vertical position shown in Figure 3-6. The cartridge is now released from the cover.

(5) Referring to Figure 3-7, place the cartridge over the cartridge adapter bowl with the handle recess pointing downward (approximately 30 degrees) toward the rear of the drive. Slide the lowered edge of the cartridge under the fixed retainer arm; then lower the cartridge into the adapter, positioning it so that the keys on the wall of the adapter engage the key notches in the base of the cartridge.

NOTE

Correct positioning of the cartridge has been obtained if the cartridge rim is fully seated against the adapter bowl along the complete periphery of the rim. When the cartridge is correctly seated it cannot be rotated or tilted.

CAUTION

DO NOT ATTEMPT TO FORCE-SEAT ANY CARTRIDGE; DAMAGE TO THE CARTRIDGE AND DISK DRIVE WILL RESULT.

(6) Lower the cartridge handle into the handle recess and allow the release/lock to return (Figure 3-8). This will cause the cartridge hub to engage the spindle clutch.

(7) Invert the cartridge cover (removed in Step 4) and place it over the cartridge, aligning the cover edge over the ridge along the cartridge rim.

(8) Position the cartridge lock arm over the cartridge cover (allowing the arm to cam upward) until the arm comes to rest against the stop provided by the side of the recesses in the adapter bowl (Figure 3-9).

CAUTION

IF EITHER THE CARTRIDGE OR COVER HAS NOT BEEN PROPERLY POSITIONED IT WILL NOT BE POSSIBLE TO ROTATE THE ARM INTO THE CORRECT POSITION; THIS WILL PREVENT THE DISK DRIVE FROM STARTING. DO NOT ATTEMPT TO FORCE THE ARM. ROTATE THE ARM BACK INTO THE RECESS AND CORRECTLY POSITION THE CARTRIDGE COVER.

(9) Push the disk drive into the cabinet until the catches engage.

3.4.4 UNLOADING A CARTRIDGE, TOP LOAD MODELS

Refer to Figures 3-10 and 3-11 in conjunction with the following procedure.

(1) Verify that the SAFE indicator is illuminated as described in Paragraph 3.3.

(2) Grip the handle formed by the top of the front bezel and slowly pull the disk drive from the cabinet on its slides until the cartridge area is accessible.

(3) Rotate the cartridge lock arm away from its position over the cartridge cover to the recess in the bowl as shown in Figure 3-4.

(4) Lift the cartridge cover out of the disk drive (Figure 3-8) and invert it.

(5) Press the cartridge release/lock (with the thumb) all the way to the side. Holding the cartridge release/lock as shown in Figure 3-10, grip and pull the cartridge handle smartly to the vertical position. The cartridge is now disengaged from the clutch.

(6) Carefully lift the cartridge out of the adapter bowl and place it into the cartridge cover as shown in Figure 3-11.

(7) Press the cartridge handle into the cartridge cover recess and release; this causes the cartridge hub to engage the cover, thus securing the disk.

Figure 3-4. Cartridge Loading Top Load Models (Lock Arm Away from Disk Area)

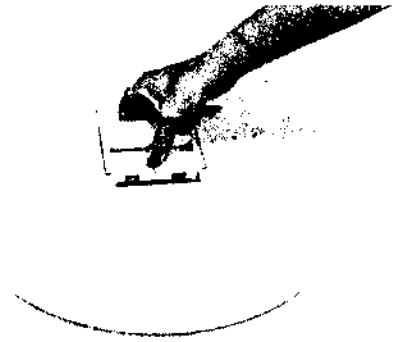

Figure 3-5. Cartridge Loading, Top Load Models (Release/Lock Down)

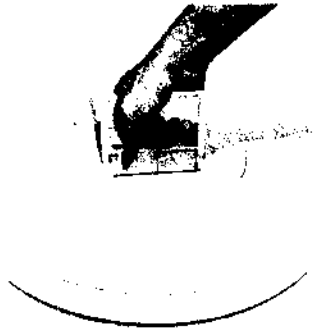

Figure 3-6. Cartridge Loading, Top Load Models (Release/Lock Up)

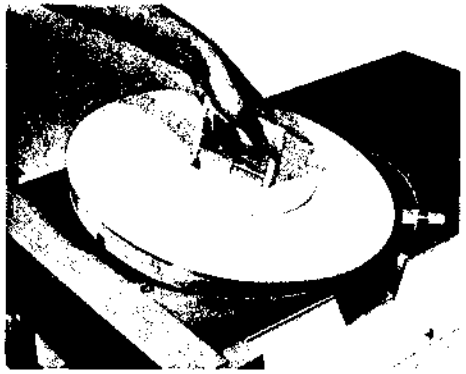

Figure 3-7. Cartridge Loading, Top Load Models (Cartridge Positioned Over Adapter Bowl)

Figure 3-8. Cartridge Loading, Top Load Models (Cartridge Loaded, Release/Lock Down)

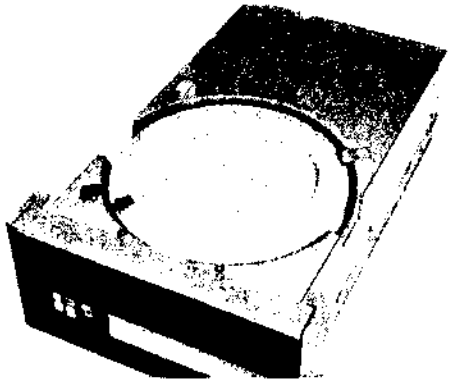

Figure 3-9. Cartridge Loading, Top Load Models (Lock Arm Over Cartridge Cover)

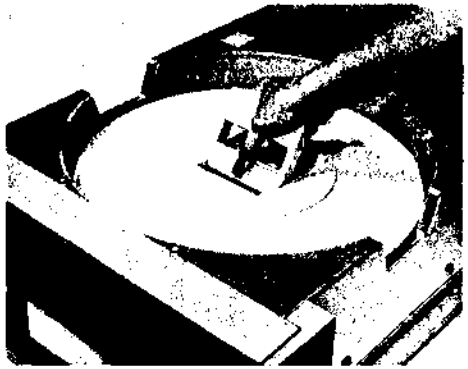

Figure 3-10. Cartridge Unloading, Top Load Models

Figure 3-11. Cartridge Unloading, Top Load Models

3.5 SELECTING WRITE PROTECTION

When the disk drive is equipped with WRITE PROTECT switches, the operator should select the appropriate switch setting at the time the cartridge is inserted. On front load models, the switches are mounted inside the door, behind the operator switch panel; the drive must be in a Safe condition as indicated by the SAFE indicator to open the door and gain access to these switches. On top load models, the switches are mounted at the left rear of the cartridge adapter and are accessible through the top of the dust cover only when the unit is pulled forward out of the cabinet.

To select protection for a particular platter, set the applicable switch to the ON position. To enable writing for a particular platter, set the applicable switch to the OFF position.

When a WRITE PROTECT switch is set to the ON position, the particular disk (upper or lower) is protected from write operations regardless of any write commands which may be received. When a WRITE PROTECT switch is set to the OFF position, write operations may then be executed.

3.6 STARTING THE DISK DRIVE

Upon completion of the relevant cartridge load procedure, the disk drive may be started as follows.

(1) Depress and release the RUN/STOP switch/indicator located on the operator control panel.

NOTE

Illumination of RUN/STOP indicates that there are no inhibiting conditions and that the disk drive is rotating the disk[s].

(2) Observe that the READY indicator becomes illuminated within 60 seconds after actuating the RUN/STOP switch/indicator.

NOTE

Illumination of READY indicates that the disk drive is ready to accept interface commands.

3.7 STOPPING THE DISK DRIVE

To stop the disk drive while RUN/STOP is illuminated, perform the following procedure.

(1) Depress and release the RUN/STOP switch/indicator.

(2) Observe that the SAFE indicator becomes illuminated within 25 seconds; this indicates that the disk(s) has come to a stop and the cartridge may be removed or changed.

3.8 DESIGNATING UNIT NUMBER

When the disk drive is equipped with a Unit Number Selector Switch, the setting of this switch determines which interface UNIT SELECT line the drive will respond to, i.e., the switch position specifies the device (unit) address.

The operator should set the switch to the appropriate position as specified by the system and software operating procedures for the particular installation.

The switch is set by moving the thumbwheel until the desired number appears in the window adjacent to the thumbwheel. Positions 1, 2, 3, or 4 may have significance.

A drive may be designated a particular unit number, subject to the restriction that different units on the common I/O bus must not have the same number assigned. Since the switches in different units are not interlocked, if two (or more) drives are accidently assigned the same unit number and that number is then selected by the controller, undefined operation may occur.

CAUTION

LOSS OF DATA MAY OCCUR IF THE UNIT NUMBER SELECTOR SWITCH IS REPOSITIONED DURING A WRITE OPERATION.

3.9 CE ALIGNMENT

Prior to placing the disk drive into operation, it is recommended that the CE alignment procedure contained in Section VI be performed. Because misalignment of only 200 μinches is significant and PERTEC cannot control the amount of shock a unit may encounter during shipping, it is recommended that the CE alignment procedure be performed on 100 tpi models; the CE alignment is mandatory on 200 tpi models.

3.10 PERIODIC MAINTENANCE

Periodic maintenance requirements of the disk drive are detailed in Section VI of this manual. Periodic cleaning of heads and disks, and filter changing should be performed according to the prescribed schedules and procedures.

3.11 INTERLOCK PROTECTION

The operator should not attempt to force or override the various protection interlocks provided by the disk drive. These interlocks are designed to prevent damage to data contained in disk cartridges, and to the disk drive equipment. Front load models are interlocked by a switch which senses when a cartridge is correctly inserted into the receiver. When a cartridge is not inserted in the receiver, or the cartridge is incorrectly inserted, the switch will not be actuated and this condition is sensed by the logic which prevents the disk drive from responding to RUN/STOP operator commands and START/STOP DISK DRIVE interface line commands.

If the door is not properly closed on front load models, either as a result of the cartridge being incorrectly inserted or because of operator error, the switch will not be actuated by the cartridge; this results from the fact that as the receiver lowers a properly inserted cartridge down onto the spindle clutch, the cartridge body (if it is in the correct position) actuates the switch lever. Additionally, the door is locked whenever the disk drive is not in a Safe condition. The Safe condition is indicated when the SAFE indicator is illuminated.

Top load models are interlocked by a switch which senses the postion of the cartridge lock arm. This switch will be actuated only when the lock arm is fully rotated toward the spindle and when the correct height is sensed by the cartridge lock arm. This condition will exist when a cartridge has been correctly seated on the aligning keys and the cartridge bottom cover has been correctly positioned over the top of the cartridge. In the case of an incorrectly inserted cartridge, or when a cartridge having a non-compatible bit density rating is inserted, the correct height will not be sensed by the switch and therefore the disk drive will be unable to respond to RUN/STOP operator commands or START/STOP DISK DRIVE interface line commands. Additionally, if a cartridge is inserted without a cover, or only a cover is inserted, the correct height will not be sensed and the disk drive will not respond to commands.

To prevent removal of a cartridge during unsafe conditions, the cartridge lock arm will be locked whenever the drive is not in a Safe condition.

In addition to the electro-mechanical interlock protection, additional interlocking is provided via certain logic within the disk drive. If the operator should actuate the RUN/STOP switch/indicator, or if the interface should command a Stop sequence as a result of a change of state on the START/STOP DISK DRIVE line during the time that a Write and/or Erase operation is in progress, the heads will not be unloaded immediately from the storage surfaces even though the disk drive prepares to execute a Stop sequence.

Only when the controller has completed the current Write and/or Erase operation will the heads be unloaded from the storage surface. This prevents the loss of data in the event that the operator attempts to stop the disk drive during the time that a write data transfer is in progress.

An additional interlock prevents changing the Write Protect status during a Write and/or Erase operation. If either a Write and/or Erase operation is in progress, the status of the write protection cannot be changed electrically regardless of the positions of the WRITE PROTECT switches.

Only after completion of the current Write and/or Erase operation will the write protection status change to agree with the particular switch setting.

This is primarily applicable to top load models, although the same logic is present in all machines. The purpose of this arrangement is to prevent loss of data in the event an operator should change the condition of the WRITE PROTECT switches during the time the controller is in the process of a write data transfer.

3.12 SAFE CONDITION

The Safe condition for both front and top load models is indicated by illumination of the SAFE indicator and is defined by:

(1) Power correctly applied.

(2) Disk not rotating.

(3) Heads retracted.

(4) Emergency or fault conditions not being detected by the logic.

(5) Disk drive not executing a brake cycle or a stop sequence.

It should be noted that although the disk drive is in a Safe condition, it is not necessarily enabled to respond to start commands. The conditions which inhibit starting the disk drive are:

(1) The cartridge is not properly inserted.

(2) Power is not applied.

(3) An internal emergency or fault condition exists and is being detected.

(4) The ACTIVATE EMERGENCY UNLOAD line is being asserted.

3.13 EMERGENCY AND FAULT DETECTION

When power to a disk drive is lost when the disk is spinning, it is impossible for the disk drive to maintain disk speed at a value which assures that the heads will continue to fly above the surface of the disk.

In order to protect the data and the cartridge, as well as the disk drive, it is necessary to remove the heads from the surface of the disk as fast as possible when a power fault is detected. The process of removing the heads from over the disk in an emergency situation is referred to as Emergency Unload. Additionally, there are other conditions which are undesirable, either from the standpoint of potential hazard to data or to the disk drive.

It is also important to be able to communicate emergency conditions to the disk drive via the ACTIVATE EMERGENCY UNLOAD interface line and cause the disk drive to enter an Emergency Unload mode. This is appropriate in situations when a fault or the failure of power to the computer and/or controller could result in a situation where the controller can no longer maintain control of the interface lines. All of these conditions are sensed by the disk drive logic and one or more of these conditions may cause the disk drive to perform an emergency unload.

Notwithstanding conditions communicated via the ACTIVATE EMERGENCY UNLOAD interface line, the conditions which can cause an emergency unload are summarized as follows.

(1) Loss of ac or dc power.

(2) Disk speed does not remain within tolerance or is at an incorrect speed at the time it is tested.

(3) Positioner error is detected.

(4) Write circuit faults that could affect the stored data are detected.

3.14 MANUAL CONTROLS

The operational controls and indicators are located on the front panel of the disk drive; additionally, one or two rocker-type switches may be located inside the drive which provide protection from inadvertent write operations. The following paragraphs describe the functions of these controls.

3.14.1 ON/OFF

The ON/OFF power control is a rocker-type switch/indicator which provides the operator a means of energizing and de-energizing the power to the drive. The indicator is illuminated when power is ON and the internal +5v power is operational.

3.14.2 RUN/STOP

The RUN/STOP control is a momentary action switch/indicator which provides a means for selecting the operational status of the drive. The alternate action arrangement is provided by the disk drive logic. The control will be illuminated when actuated and the drive has been properly conditioned to allow the disk to be brought to operating speed.

When the illuminated switch/indicator is depressed again, a Stop sequence will be entered and the disk will decelerate to a stop. The cartridge may be unloaded at this time.

If a cartridge has been incorrectly inserted or an emergency condition exists, the operation of the RUN/STOP control is inhibited. Under this condition, the control will not become illuminated and the Run status will not be achieved.

3.14.3 READY

This is an indicator which is illuminated when the disk drive achieves a Ready condition. The Ready condition is defined in Paragraph 3.17.1.

3.14.4 SAFE

This is an indicator which is illuminated when it is possible to safely insert or remove the disk cartridge. When the SAFE indicator is extinguished, protective cartridge locks prevent removal of the disk cartridge.

CAUTION

DO NOT ATTEMPT TO FORCE REMOVAL OF A DISK CARTRIDGE WHEN THE SAFE INDICATOR IS EXTINGUISHED. FAILURE TO OBSERVE UNSAFE CONDITION CAN RESULT IN DAMAGE TO THE EQUIPMENT.

3.14.5 PROT (PROTECT)

Two indicators, mounted in a common housing, are provided to indicate the data protection status of the disk(s). This status information can be from the WRITE PROTECT switches (Paragraph 3.14.7), or from a hard-wired configuration.

When the upper PROT indicator is illuminated, the upper (removable) disk is protected from a write operation; protection of the lower (fixed) disk is indicated by illumination of the lower PROT indicator.

The indicators are extinguished when the respective switch (or hard-wired configuration) is set to permit write operations.

3.14.6 UNIT NUMBER SELECTOR SWITCH

A 4-position thumbwheel switch may be included on the front panel of the disk drive to provide a means for selecting one of several peripheral units on a common I/O bus.

Any drive may be assigned (designated) a particular unit number (unit address); subject to the restriction that different units on the bus may not have the same number assigned. Since the switches in different units are not interlocked, if two (or more) drives are accidently assigned the same unit number and that number is then selected by the controller, undefined operation may occur.

When the thumbwheel switch is not included, the disk drive will respond only to UNIT SELECT NO. 1 line.

3.14.7 WRITE PROTECT SWITCHES

One or two rocker switches may be included in the D3000 Series Disk Drive. The purpose of these switches is to selectively protect the disks from inadvertent write operations. One switch selects protection for the upper (removable) disk; the other selects protection for the lower (fixed) disk.

The switches are located inside the drive enclosure, near the removable disk cartridge. On front load models the switches are mounted to the rear of the operator control panel. Access can be obtained to these switches only after the door is opened. On top load models the switches are mounted at the left rear of the cartridge adapter and are accessible only when the unit is pulled forward out of the cabinet.

When a WRITE PROTECT switch is set to the ON position, the particular disk is protected from write operations regardless of any write commands which may be received. When a WRITE PROTECT switch is set to the OFF position, write operations may then be executed.

The PROT indicators (Paragraph 3.14.5) indicate the status of the protect switches.

3.15 D3000 INTERFACING

The D3000 interface is described in two sections: Controller (or Formatter) to Disk Drive, and Disk Drive to Controller (or Formatter).

The interface is arranged such that as many as four different disk drives may be operated on the interface by a common controller. This is accomplished by providing a group of (disk drive) input lines and a group of output lines which become a common I/O bus. This bus is time-shared by the various drives that may be connected with the bus, i.e., daisy-chain arrangement.

3.16 INTERFACE INPUTS (CONTROLLER TO DISK DRIVE)

All signal names are chosen to correspond to the logical true condition. All interface lines are low-true at the interface with the low (true) condition considered to be 0v, and the high (false) condition considered to be +3v.

3.16.1 UNIT SELECT LINES

There are four UNIT SELECT lines. A low level on one of these lines will connect one pre-determined disk drive to the common I/O bus.

The low level on these lines enables all I/O lines except:

(1) BUSY SEEKING (Paragraph 3.17.2)

(2) MALFUNCTION DETECTED (Paragraph 3.17.10)

(3) ACTIVATE EMERGENCY UNLOAD (Paragraph 3.16.2)

(4) START/STOP DISK DRIVE (Paragraph 3.16.13)

These lines are enabled at all times. Thus, it can be seen that a unit must be selected to determine its ready status but it is not necessary to select a unit to determine its busy status.

When the Unit Number Selector Switch is included, the units are identified to switch positions and select lines on a one-to-one basis, i.e., switch position 1, UNIT SELECT NO. 1 line, etc.

After a unit has been selected and the I/O bus has been allowed 2 μsec to stabilize, the selected disk unit will recognize inputs and provide stable outputs.

3.16.2 PLATTER SELECT

This is a level which determines which platter is selected in dual platter models. When the level on this line is low, the top (removable) platter is selected; when the level on this line is high, the bottom (fixed) platter is selected, as shown in Table 3-1.

3.16.3 HEAD SELECT

This is a level which determines which head and corresponding storage surface (top or bottom) is selected.

In dual platter models a low condition on this line selects the top storage surface of the selected platter. When high, the line selects the bottom storage surface of the selected platter.

In single platter models, a low condition on this line selects head 0 and the top storage surface of the platter; when high, head 1 and the bottom storage surface are selected, as shown in Table 3-1.

3.16.4 CYLINDER ADDRESS STROBE

This is a pulse which, when low for a minimum of 0.5 μsec and the disk unit is selected and ready, causes the RESTORE INITIAL CYLINDER line (Paragraph 3.16.6) and CYLINDER DEMAND ADDRESS lines (Paragraph 3.16.5) to be sampled. This will initiate a Restore operation or a Cylinder Seek operation, depending on the state of the RESTORE INITIAL CYLINDER line.

For a Restore operation, the CYLINDER DEMAND ADDRESS lines are ignored and the positioner will initialize at cylinder 000 (decimal).

For a Seek operation, if a legal address is presented on the CYLINDER DEMAND ADDRESS lines, the positioner will seek the cylinder address specified by the states on these lines. If an illegal address is presented, then the positioner will not move and the illegal condition will be reported on the ILLEGAL CYLINDER ADDRESS line.

The desired operation is initiated on the trailing edge (low to high transition) of the pulse.

The RESTORE INITIAL CYLINDER line must be in a stable state at least 0.5 μsec prior to the leading edge (high to low transition) of the strobe pulse.

The CYLINDER DEMAND ADDRESS lines must be in a stable state at least 0.5 μsec prior to the trailing edge of the strobe pulse. They must remain in that state during the trailing edge and for at least 0.5 μsec after the trailing edge of the strobe.

The BUSY SEEKING line (Paragraph 3.17.2) will go to a low level within 1.0 μsec after the leading edge of the strobe pulse.

Table 3-1
Platter and Head Selection

PLATTER SELECT Line Logic Level	HEAD SELECT Line Logic Level	Dual Platter Models			Single Platter Models		
		Platter	Storage Surface	Head No.	Platter	Storage Surface	Head No.
Low	Low	Top	Top	0	Top	Too	0
Low	High	Top	Bottom	1	Top	Bottom	1
High	Low	Bottom	Top	2	None	None	
High	High	Bottom	Bottom	3	None	None	

If a strobe pulse is issued to the disk drive when the positioner is executing a previous command (and the BUSY SEEKING line is low), then the results will be as follows: the new operation will not be commenced; the operation currently in progress will continue to completion; and, an indication of an illegal address will be given on the ILLEGAL CYLINDER ADDRESS line.

3.16.5 CYLINDER DEMAND ADDRESS (9 LINES)

These lines specify the cylinder address for accessing a specific cylinder. The address is represented by the binary value with a low logic level corresponding to a binary one.

The most significant bit for 203 cylinder models is bit number 7; the most significant bit for 406 cylinder models is the address extension bit. The least significant bit for all models is bit number 0.

The decimal cylinder number may be expressed as the sum of the *true* bit weights.

Bit Number	Ext.	7	6	5	4	3	2	1	0
Decimal Bit Weight	256	128	64	32	16	8	4	2	1

The range of legal addresses for 203 cylinder models is from 000 thrugh 202 (decimal); the range of legal addresses for 406 cylinder models is from 000 through 405 (decimal).

3.16.6 RESTORE INITIAL CYLINDER

This is a level which, when low at the time of a CYLINDER ADDRESS STROBE (Paragraph 3.16.4), will cause the positioner to be restored to initial cylinder (cylinder 000). When this level is high at the time of a CYLINDER ADDRESS STROBE the positioner will seek to the cylinder specified by the address.

3.16.7 WRITE ENABLE

A low level on this line causes the write electronics in the disk to be conditioned for writing, provided the unit is selected and ready. Data to be written are controlled by the WRITE DATA SIGNAL line (Paragraph 3.16.9).

If a Write Protection condition does not exist and the positioner is not moving, write current will be allowed to flow in the selected (write) head.

Certain applications may require that all write data pulses be correctly recorded. Therefore, it is recommended that changes of state on the WRITE ENABLE line be accomplished during a time when no data pulses are being transmitted on the WRITE DATA SIGNAL line.

3.16.8 ERASE ENABLE

This is a level which, when low and the unit is selected and ready and no Write Protection condition exists, causes erase current to flow in the selected erase head. ERASE ENABLE must be true when any write operation is being performed.

The ERASE ENABLE line must be placed in the low state within 1.0 μsec when the WRITE ENABLE line is placed in the low state.

When the WRITE ENABLE line is placed in the high state (any low to high change of state), the erase current must remain enabled for a period of time thereafter; the minimum time is defined as the minimum erase gap time. (The erase current may remain enabled for a period of time greater than the minimum erase gap time.)

3.16.9 WRITE DATA SIGNAL

The bit-serial write data pulses on this line control the switching of write current in the magnetic head. The write electronics must be conditioned for writing.

For each high to low transition on the WRITE DATA SIGNAL line, a flux change will be produced at the write head gap. This will cause a flux change to be stored on the selected disk surface.

The data and clock form the combined write data signal and the double frequency method of phase mode encoding is used. The repetition rate of the high to low transitions when writing all zeros is equal to the nominal data rate ±0.25 percent. The repetition rate of the high to low transitions when writing all ones is equal to twice the nominal data rate ±0.25 percent.

NOTE

It is recommended that the WRITE DATA SIGNAL be turned off when performing a READ operation.

3.16.10 READ ENABLE

This is a level which, when low and the unit is selected and ready, enables the outputs from the read electronics, i.e., READ DATA and READ CLOCK.

When this line is low, the read electronics must detect one clock transition before any clock and data pulses may be transmitted, i.e., the first clock transition of preamble or gap will not be transmitted but all others will be transmitted assuming the required conditions are met. This arrangement prevents pulses of less than normal duration from being transmitted.

When the READ ENABLE line is high, the read electronics outputs are immediately disabled and, if any data or clock pulses are in progress, these pulses will be shaved.

NOTE

It is recommended that the controller be designed such that the low to high transition of READ ENABLE is timed or caused by a clock pulse transition.

3.16.11 TRACK OFFSET

The TRACK OFFSET PLUS line and the TRACK OFFSET MINUS line provide a means of margin testing.

When one of these lines is low and the unit is selected and ready, the heads are slightly offset from the normal track center. The direction of the offset is determined by the active line. A plus direction is defined as being toward the disk center; a minus direction is defined as being away from the disk center. Table 3-2 defines the operational condition of the disk drive when the track offset function is used.

Table 3-2

TRACK OFFSET Operation

TRACK OFFSET PLUS Logic Level	TRACK OFFSET MINUS Logic Level	Operational Condition of Disk Drive
High	High	Normal operation with heads centered over track.
Low	High	Operation with heads offset in the plus direction.
High	Low	Operation with heads offset in the minus direction.
Low	Low	Operation with heads centered over track under control of offset lines and reduced read amplifier gain.

When either of the TRACK OFFSET lines is placed at a low logic level, the positioner requires one-fourth of adjacent track seek time to seek the new position and settle out. A busy signal on the BUSY SEEKING line will not be given for TRACK OFFSET settling. The settling time for any TRACK OFFSET is in addition to seek time as indicated by a BUSY SEEKING line.

In general, the use of the TRACK OFFSET lines during a write operation is not recommended. Unless there is some means to guarantee that the entire track will later be erased (with the same offset control), then errors may be induced.

Prior to a read operation, the TRACK OFFSET lines should be conditioned for the type of operation desired. Assume a track of data has been previously recorded under normal conditions; the margin for recovery can be tested by reading and checking the data first with TRACK OFFSET PLUS, and then with TRACK OFFSET MINUS. If adequate margins exist, then all data will be correctly read.

For the case when both TRACK OFFSET PLUS and TRACK OFFSET MINUS are simultaneously TRUE, read amplifier gain is reduced and the recovery margin is tested with the heads centered over the track.

3.16.12 ACTIVATE EMERGENCY UNLOAD

This is a level or a pulse which, when low for a period of at least 1.0 μsec, causes the disk drive to enter an Emergency Unload sequence. The write and erase currents (if any) will be disabled and the heads will be retracted and unloaded from the storage surfaces. The drive will revert to a not-ready condition within 5.0 μsec after recognition of the command, although unloading of the heads will not be completed this quickly.

As it is not necessary for a drive to be ready or selected in order to recognize the command, the command may be issued at any time. All disk drives on the common I/O bus will unload when the command is issued. When this command is a continuous low level the disk drive is prevented from loading the heads.

The primary use of this line is the protection of the stored data in the event of power failure or other faults in the controller or computer. During such fault conditions, it may be impossible to maintain correct control of the interface for more than a few microseconds after the fault occurs or is detected.

Additionally, this line may be used to prevent the loading of the heads (and hence protection of stored data) before the software has properly initialized and gained correct control.

Residual data errors can be expected in a given track if ACTIVATE EMERGENCY UNLOAD is commanded while a write operation is in progress.

3.16.13 START/STOP DISK DRIVE

This is a level which, when low and the following conditions and restrictions are met, allows the controller to start and stop the disk drive remotely. The function performed and the resulting actions depend on the condition of the drive at the time this line goes low. When the START/STOP DISK DRIVE line is held at a high logic level,or is not connected the line has no effect on the operation of the disk drive.

Conditions and restrictions effecting this line are:

(1) This line is enabled at all times regardless of the state of the UNIT SELECT lines. Therefore, all disk drives on the common I/O line may respond to this line.

(2) A true level on this line will cause the disk drive to commence a Start sequence if the drive is not already in a Run condition, or if the RUN/STOP switch/indicator is not depressed and none of the following inhibiting conditions exist.

- The disk cartridge is improperly inserted.
- Power is not applied.
- An internal emergency condition exists.
- The ACTIVATE EMERGENCY UNLOAD line is being asserted.

When used for commanding a start operation, a pulse of not less than 260 μsec, or level change may be used.

(3) A true level on this line will cause the disk drive to enter a Stop sequence if the drive is in a Run condition and the RUN/STOP switch/indicator is not depressed. The sequence will be completed if the WRITE ENABLE and ERASE ENABLE interface signals are high.

When used for commanding a Stop operation, a pulse of not less than 60 sec, or a level change, may be used.

(4) Since the START/STOP DISK DRIVE line performs the same function as the RUN/STOP switch/indicator, priority is by first actuation.

If the START/STOP DISK DRIVE line is actuated continuously, the RUN/STOP switch/indicator is locked out during this period; conversely, if the RUN/STOP switch/indicator is depressed and held, the START/STOP DISK DRIVE line is locked out during this period.

3.17 INTERFACE OUTPUTS (DISK DRIVE TO CONTROLLER)

All signal names are chosen to correspond to the logical true condition. All interface lines are low-true at the interface with the low condition considered to be 0v, and the high condition considered to be +3v.

3.17.1 READY

This is a level which, when low, indicates that the disk unit is in a Ready condition. The Ready condition is defined as that condition which exists when the following requirements are met.

(1) All power is applied and correct.

(2) A cartridge is correctly inserted.

(3) The disk is rotating at the correct speed.

(4) The heads are loaded.

(5) No equipment faults are detected.

(6) The logic is prepared to recognize commands.

3.17.2 BUSY SEEKING (4 LINES)

This group of four lines provides signals indicating (on separate lines) that the drive is busy seeking a new cylinder position. These lines do not require that the drive be selected in order to enable these signals; therefore, the current status is always indicated.

When the Unit Number Selector Switch is set to a given number, the corresponding BUSY SEEKING line number will be indicated.

When a BUSY SEEKING line is low, it indicates that the drive is executing or processing the previous operation commanded by CYLINDER ADDRESS STROBE.

The appropriate line will go low within 1.0 μsec of the leading edge of any strobe that is recognized.

If the operation commanded does not result in positioner motion (illegal address or address same as current position) the line will go high within 2.0 μsec of the trailing edge of the strobe.

If the operation commanded results in a normal cylinder seek operation, the line will remain low for the duration of the cylinder seek time (defined as the time from the trailing edge of strobe to the trailing edge of BUSY SEEKING). At the end of the seek operation, the line will go high.

If the operation commanded results in a restore operation, the line will remain true for a maximum of 3 seconds (specified time is from the trailing edge of strobe to the trailing edge of BUSY SEEKING). At the end of the restore operation the line will go high.

The readiness of the disk drive to perform a read/write operation is inferred by a high level on the BUSY SEEKING line; however, the unit must also be selected and ready to execute read/write operation.

3.17.3 SECTOR PULSE.

The pulses on this line may be used for sectoring a disk if the address marker method is not utilized. These pulses occur at regular intervals during each revolution of the disk. These pulses, in essence, divide the disk (surface) into *N* equal segments, where *N* is the number of pulses.

In disk drive models utilizing the 5440-type cartridge, the SECTOR PULSE line provides electronically generated pulses of predetermined number; the number is specified at the time of order. This may be readily changed in the field by plugging in a different programming-array plug. This plug configures the disk drive to generate a specific number of sector pulses.

For disk drives incorporating a fixed disk as well as a 5440 removable disk, the number of sector pulses for the fixed disk are also determined by a plug-in array.

In disk drive models utilizing the 2315-type cartridge, the SECTOR PULSE line provides pulses derived from the sector ring on the cartridge. One pulse for each sector slot is issued (this applies only to the removable disk). In some applications it may be desirable to utilize electronically generated sector pulses in lieu of sectoring by the 2315-type cartridge sector ring. This can be configured by plugging in the appropriate programming-array plug. The sector pulses for the removable disk will then be similar to the arrangement described previously for the 5440-type cartridge.

The number of sector pulses that may be accommodated by a 2315-type cartridge sector ring is determined by machining and mechanical limitations. Therefore, cartridges are available with 8, 12, 16, 24, 32, and 48 sectors as standard items.

In disk drives incorporating a fixed disk as well as a 2315-type removable disk, the number of sector pulses for the fixed disk are also determined by a plug-in array.

In all cases, the pulses on the SECTOR PULSE line correspond only to the respective platter as selected by the PLATTER SELECT line. This is accomplished by a multiplexer internal to the disk drive.

The number of sector pulses that may be accommodated by the electronically generated sectoring is listed in Table 1-1.

The duration of any sector pulse is 8.0 +2.0 μsec. The SECTOR PULSE line is low during the duration of the pulse, and high at all other times. If a unit is selected at the moment that a sector pulse is in progress, that pulse duration will be shortened, i.e., the pulse will be shaved an indeterminate amount. This will have the effect of introducing a time uncertainty (instantaneous jitter) just for the shaved pulse.

3.17.4 SECTOR COUNT LINES

These lines specify the sector count presented in binary format. This count indicates the particular segment of the disk surface currently under the read/write heads. The signals on these lines are, in essence, the states of a binary counter. In all cases, the count presented corresponds only to the respective platter as selected by the PLATTER SELECT line; this is accomplished through the use of separate counters multiplexed internal to the disk drive.

The count is represented by the binary value with a low level corresponding to a binary one. The most significant bit is bit number 6; the least significant bit is bit number 0.

For convenience of description the sector count may be expressed in decimal as the sum of the true bit weights as follows.

Bit Number	6	5	4	3	2	1	0
Decimal Bit Weight	64	32	16	8	4	2	1

The signals on the SECTOR COUNT lines change state 2.4 +1.6 μsec prior to the leading edge of the sector pulse, assuming non-shaved pulses.

The sector pulse immediately following an index pulse defines the beginning of sector zero and, at the time of this sector pulse, the SECTOR COUNT lines will present a zero value. Thereafter, the value will be incremented until the maximum count is achieved. The maximum count that will occur is (N — 1) where N is the number of sector pulses. This is determined by the particular configuration as described under SECTOR PULSE (Paragraph 3.17.3).

3.17.5 INDEX PULSE

This is a pulse which is true once per disk revolution and is utilized to define the sector reference (sector zero). The index pulse always occurs during the sector just prior to sector zero, i.e., during sector N — 1, where N is the maximum number of sectors. (Refer to SECTOR COUNT lines, Paragraph 3.17.4, and SECTOR PULSE lines, Paragraph 3.17.3.)

The duration of the index pulse is 10.4 +3.0 μsec. The INDEX PULSE line will be low for the duration of the pulse. At all other times, the line will be high. If a unit is selectd at the moment that an index pulse is in progress, that pulse duration will be shortened, i.e., the pulse will be shaved an indeterminate amount.

In all cases, the pulse on the INDEX PULSE line corresponds only to the respective platter as selected by the PLATTER SELECT line. This is accomplished by a multiplexer internal to the disk drive.

3.17.6 READ CLOCK

This is a pulse which goes true at the beginning of a new bit cell during a read operation. The leading edge of this pulse defines the beginning of the new bit cell.

During a portion of each bit-cell time, the READ CLOCK line will be high and remain in this state until the next bit cell time is to be defined by a pulse leading edge.

This line is utilized to establish a timing reference for purposes of interpreting pulses on the READ DATA line.

3.17.7 READ DATA

The signals on this line define the content of the data read during a Read operation.

The signal is a pulse for each *logic one* bit read from the disk. The line will be low during the time of the phe pulse. The line remains high for each *logic zero* bit read from the disk.

The timing of pulses on this line is relative to the READ CLOCK line (Paragraph 3.17.6). The relative timing is such that a *logic one* bit should be interpreted if the READ DATA line is low at any time when the READ CLOCK line is high between consecutive pulses on the READ CLOCK line.

3.17.8 ILLEGAL CYLINDER ADDRESS

This is a level which, when low, indicates that an illegal cylinder address was detected during the last CYLINDER ADDRESS STROBE.

The line will go low within 1.0 μsec after the trailing edge of the strobe only when an illegal condition is detected. The line will go high within 1.0 μsec of the leading edge of the strobe if the line is is not already high at the time of the strobe. These actions will take place only if the strobe is recognized. The unit must be selected and ready in order to recognize the strobe.

An illegal condition will be indicated for either or both of the following.

(1) The cylinder address specified at the time of the strobe exceeds the range of legal addresses for that particular model of disk drive.

(2) A strobe is issued to the drive while it is busy seeking.

The following actions will clear (or prevent) an illegal address indication.

(1) An address within the legal range is present with the strobe.

(2) A RESTORE INITIAL CYLINDER operation is commanded.

(3) The disk drive becomes not-ready as the result of an operator-initiated Unload or Emergency Unload operation.

3.17.9 FILE PROTECTED

The level on this line indicates the selected platter is protected from a Write operation.

When the FILE PROTECTED line is low, it indicates that the drive will not perform a Write or Erase operation regardless of a command on the WRITE ENABLE or ERASE ENABLE lines; when the FILE PROTECTED line is high, it indicates that the selected platter is not protected and data may be written.

Depending upon the configuration of the disk drive, write protection may be provided for either or both platters.

Changes of state on this line, as applicable, will occur within 1.0 μsec of a platter select change (assuming the unit is selected).

It is recommended that the controller test the state of the line prior to attempting a Write operation.

3.17.10 MALFUNCTION DETECTED

This is a plse which, when low, indicates detection of one of the following malfunctions.

(1) Loss of ac or dc power.

(2) Disk speed does not remain within tolerance.

(3) Positioner error is detected.

(4) Write circuit faults that could affect stored data.

Any of the above items listed necessitate unloading the heads and the drive will commence an emergency unload sequence coincident with the trailing edge of the malfunction pulse; duration of the pulse is between 0.2 μsec and 2.0 μsec.

Any disk drive on the I/O bus can pulse this line regardless of whether or not it is selected. The line will not be pulsed if the malfunction is detected before the drive achieves a Ready condition. The drive will become not-ready within 5.0 μsec after the leading edge of the pulse on the MALFUNCTION DETECTED line. Software diagnostics can determine which drive has detected a malfunction by selecting one drive at a time, determining its ready status, and comparing the results with the previous status.

As all disk drives on the I/O bus could pulse the MALFUNCTION DETECTED line asynchronously and independently, the time between pulses in a group may become arbitrarily small.

In the case of power failures, etc., the pulses may overlap or occur simultaneously.

NOTE

It is recommended that the leading edge of a malfunction pulse be used to initiate diagnostic action and that once the condition has been flagged, additional pulses can be disregarded until after the flag is cleared. The flag need not be cleared before diagnostic action is commenced.

3.17.11 DUAL PLATTER

This is a level which, when low, indicates the number of different platters contained in the disk drive. A valid level will exist on the line whenever the particular disk drive is selected, regardless of whether the particular drive is ready or not.

The following identifies the logic condition of this line with regard to the type of disk drive and number of platters.

Logic Level	Type of Disk Drive Indicated	No. of Platters
High (false)	Single Removable Platter	1
Low (true)	Dual Platter — One Fixed, One Removable	2

This line may be used by the controller or formatter to determine in advance the legal number of storage surfaces available in a specific disk drive. This allows utilization of different model disk drives on a common I/O bus.

3.17.12 DOUBLE TRACK DRIVE

This is a level which indicates the number of usable cylinders that a particular disk unit is capable of accessing. A valid level will exist on the line whenever the particular disk drive is selected, regardless of whether the particular drive is ready or not.

Logic Level	Type of Disk Drive Indicated	Corresponding tpi
High (false)	203 cylinders	100
Low (true)	406 cylinders	200

This line may be used by the controller or formatter to determine in advance the range of legal addresses that a specific disk drive can accommodate. This allows utilization of different model disk drives on a common I/O bus.

3.17.13 SPECIAL INTERFACE SIGNAL

The special interface signal is used on both 100 and 200 tpi models. On 100 tpi disk drives, the special interface signal line is used to provide either the RUN status or SAFE status of the disk drive to the interface. On 200 tpi disk drives, the special interface signal line is dedicated to provide INTERNAL TEMPERATURE GO status to the interface. The INTERNAL TEMPERATURE GO signal becomes a low-true logic level approximately 5 minutes after the disk drive indicates READY. This time delay is required to allow the internal temperature of the disk drive and cartridge to stabilize before commencing a WRITE or READ operation.

These signals are optional and must be specified at the time of order. It is important to note that only one of these signal options can be provided at a time.