IBM

SC18-2274-00

OEM FUNCTIONAL SPECIFICATIONS for IBM-H3xxx-Ax (133/171/256/342MB) 3.5-Inch Hard Disk Drive with ATA Interface

Revision (0.0)

IBM

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for
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First Edition (June 1993)

Technical information about this product is available from your local IBM representative or at **http://www.ibm.com/harddrive**

Contents

1.0 General

This document describes the characteristics of the IBM-H3xxx-Ax 3.5-Inch hard disk drives which conform to the AT Attachment or Integrated Drive Electronic (IDE) interface as defined by the Common Access Method (CAM) committee. It also defines the hardware functional specifications. For details about the interface specification, refer to *ATA Interface Specification*.

1.1 References

- ATA Interface Specification (IBM Form No. SC18-2275-00)
- ISO/IEC Draft. ANSI X3.221 (Information Technology AT Attachment Interface for Disk Drive)

2.0 General Features

The 3.5-Inch hard disk drives consist of the following four models.

- H3133– A2 (133MB, two R/W heads)
- H3171– A2 (171MB, two R/W heads)
- H3256– A3 (256MB, three R/W heads)
- H3342– A4 (342MB, four R/W heads)

The drives provide the following common features for all models.

- Sector format of 512 bytes/sector
- Close-loop actuator servo
- Dedicated head-landing zone
- Automatic actuator lock
- Interleave factor 1:1
- Three segmented 32KB of buffer implementation with read look-ahead buffer
- 96KB sector buffer
- ECC On The Fly (EOF)
- Automatic error recovery procedures for read and write commands
- Self diagnostics at power on and resident diagnostics
- PIO Data Transfer– Mode 2

3.0 Fixed Disk Subsystem Description

This chapter describes the subsystems.

3.1 Control Electronics

The drive is electronically controlled by an microprocessor, several logic modules, digital/analogue modules, and various drivers and receivers. The control electronics perform the following major functions.

- Controls the power-up sequence and calibrates the servo mechanism.
- Monitors various timers for head settle, servo failures, and so on.
- Analyzes servo signals to provide closed loop control.
- Controls the voice-coil motor driver to position the actuator.
- Monitors the actuator position and determines the target track for seek operations.
- Constantly monitors error conditions of the servo and takes corresponding action if an error occurs.
- Controls starting, stopping, and monitoring of the spindle.
- Controls and interprets all interface signals between the host controller and the drive.
- Controls read/write accessing of the disk media, including defect management and error recovery.
- Performs self-checkout (diagnostics).

3.2 Head Disk Assembly

The head disk assembly (HDA) is assembled in a clean room environment and contains the disk and actuator assembly. Air is constantly circulated and filtered when the drive is operational. Ventilation of HDA is accomplished via an absolute breather filter.

The spindle is directly driven by an in-hub, brushless, sensorless DC drive motor. Dynamic braking is used to quickly stop the spindle.

3.3 Actuator

The read/write heads are mounted in the actuator. The actuator is a swing-arm assembly driven by a voice coil motor. A closed-loop positioning servo controls the movement of the actuator. An embedded servo pattern supplies feedback to the positioning servo to keep the read/write heads centered over the desired track.

The actuator assembly is balanced to allow vertical or horizontal mounting without adjustment.

When the drive is stopped by a power-off condition, the actuator automatically moves the head to a dedicated landing zone outside of the data area, where the actuator is locked.

4.0 Fixed Disk Characteristics

This chapter provides the characteristics of the fixed disk.

4.1 Formatted Capacity

Description	H3133-A2	H3171-A2	H3256-A3	H3342-A4
Physical Layout				
Bytes per sector	512	512	512	512
Sectors per track (ID/OD)	56/84	56/84	56/84	56/84
Number of heads	2	2	3	4
Number of disks	1	1	2	2
Data sectors per cylinder	112/168	112/168	168/252	224/336
Spare sectors per zone	224/336	224/336	336/504	448/672
Data cylinder	620/1140	1280/1140	1280/1140	1280/1140
No. of ID data sectors	69440	143360	215040	286720
No. of OD data sectors	191520	191520	287280	383040
Total data bytes (Note 1)	133611520	171458560	257187840	342917120
Logical Layout (Note 2)				
Number of heads	15	10	16	16
Number of sectors/track	17	34	36	48
Number of cylinders (Note 3)	1023	984	872	872
No. of sectors	260865	334560	502272	669696
Total logical data bytes	133562880	171294720	257163264	342884352

Table 1. Formatted Capacity

Notes:

1. Total data bytes
   - The maximum physical usable data capacity.
2. Logical layout
   - Logical layout is a imaginable HDD parameter (number of heads) which is used to access the HDD from the system interface. Logical layout to physical layout (actual head, sector) translation is done automatically in the HDD. The default setting can be obtained by issuing the IDENTIFY DRIVE command.
3. Logical cylinders
   - This number includes one cylinder which is used for the diagnostic program.

4.2 Data Sheet

Data transfer rates Buffer to/from media Host to/from buffer	 19.0(ID)/26.4(OD) MB/sec 8.3 MB/sec
Data buffer size Number of buffer segments	96 KB 3 x 32KB
Rotational speed	3600 RPM
Recording density	55000(ID)/53000(OD) BPI
Track density	2800 TPI
Areal density	154(ID)/148(OD) Mb/sq.in.
Data bands (for ZBR)	2

Table 2. Data Sheet

4.3 Performance Characteristics

The drive performance is characterized by the following parameters:

- Command overhead
- Mechanical positioning
  - Seek time
  - Latency
- Data transfer speed
- Buffering operation (look-ahead)

Note: All of the above parameters contribute to drive performance. Other parameters contribute to the performance on the actual system. The following specifications define the bare drive characteristics, not the system throughput which depends on the system and the application.

4.3.1 Command Overhead

Command overhead is defined as the duration:

- From the time the command from a host system is written into the command register
- To the assertion of DRQ for the first data byte of a READ command when the requested data is not in the buffer.
- but excludes the time required for:
  - Physical seek time.
  - Latency time.

Read Command Case (Drive is in quiescence state)	Time
Total	Less than 4 msec.

Table 3. Command Overhead

Note: The above table shows the average time and includes the servo interrupt processing time.

4.3.2 Mechanical Positioning

The following tables show the positioning time.

4.3.2.1 Average Seek Time (Including Settling Time)

Command Type	Typical	Max.
Read	14 msec.	15 msec.
Write	16 msec.	17 msec.

Table 4. Mechanical Positioning Performance

“Typical” and “Max” for the performance specifications mean:

Typical Average of the drives tested at nominal environmental and voltage conditions.

Max Maximum value measured on any one drive over the full range of the environmental and voltage conditions. (See 7.2, “Environment” on page 26 and 7.3, “DC Power Requirement” on page 27 for ranges.)

The seek time is measured from the start of the actuator's motion to the start of **a reliable Read/Write operation**. Reliable read or write implies that error correction/recovery is not used to correct for arrival problems. The seek time does not include the “command overhead” described earlier.

4.3.2.2 Full Stroke Seek

Function	Typical	Max.
Read	28 msec.	30 msec.
Write	30 msec.	32 msec.

Table 5. Full Stroke Seek Time

Full stroke seek is measured as the average of 1000 full stroke seeks with a **random head switch** from both directions (inward and outward). The full stroke seek time also does not include the command overhead.

4.3.2.3 Average Latency

Rotational speed	Time for a revolution	Average Latency
3600 rpm	16.7 msec.	8.33 msec.

Table 6. Latency Time

4.3.3 Drive Ready Time

Condition	Typical	Max.
Power-On to Ready	10 sec.	31 sec.

Table 7. Drive Ready Time

Legend:

Ready The condition in which the drive is able to perform a media access command (for example read, write) immediately.

Power On This includes the time required for the internal self diagnostics.

4.3.4 Data Transfer Speed

Description	H3171-A2	H3342-A4
Disk-Buffer Transfer (Outer)		
(Instantaneous)	2.5 MB/sec.	2.5 MB/sec.
(Sustained)	2.08 MB/sec.	2.17 MB/sec.
Disk-Buffer Transfer (Inner)		
(Instantaneous)	1.7 MB/sec.	1.7 MB/sec.
(Sustained)	1.39 MB/sec.	1.45 MB/sec.
Buffer-Host	8.3 MB/sec.	8.3 MB/sec.

Table 8. Data Transfer Speed

Legend:

- Instantaneous disk-buffer transfer rate (MB/sec) equals:
  (Number of sectors on a track) * 512 * (Revolution/second)

  Note: The number of sectors per track will vary because of the linear density recording.

- Sustained disk-buffer transfer rate (MB/sec) is defined by considering the head/cylinder change time. This gives a local average data transfer rate.
  (Sustained transfer rate) = A/ (B+C+D)

  A = (Number of data sectors per cylinder) * 512
  B = (Number of surface per cylinder) - 1) * (Head switch time)
  C = (Cylinder change time)
  D = (Number of surface) * (One revolution time)

- Instantaneous buffer-host transfer rate (MB/sec) defines the maximum data transfer rate on an AT Bus. It is also dependent on the speed of the host.

4.3.5 Buffering Operation (Look-Ahead)

To improve the total performance, the drive uses its own buffer for look-ahead. 96KB of the buffer is divided into three segmented blocks; two of the three segments are maintained as independent look-ahead buffers in least-recently-used fashion and one segment is used for the write buffer.

5.0 File Organization

5.1 File Format

When the drive is manufactured, the sector continuity in the physical format is maintained by the defect flagging strategy (described in the following section) to provide maximum performance to users.

5.2 Cylinder Allocation

	Logical Cylinder	**Block/Track**
Microcode	-4/-3	64
Primary map	-2	8
Reserved	-1	64
CE cylinder	0	64
Reserved	1	16
OD data zone	2..1141	84
OD spare cylinder	1142..1443	84
ID data cylinder	1144..2423	56
ID spare cylinder	2424..2425	56
Dummy write	2426	N/A

Table 9. Cylinder Allocation

Microcode cylinder
The microcode cylinders are on cylinders -1 to -4. They contain the down-loaded microcode, which is loaded when power is turned on to run with the ROM code. Two copies of the same executable code are written.

Data cylinder
This cylinder contains the user data, which can be sent and retrieved via read/write commands. Since the drive has two zones, the value of sector-per-track is different between the outer cylinders and the inner cylinders.

Spare cylinder
The spare cylinder includes reassigned data from a defective location. Data from an outer cylinder is reassigned to the OD spare cylinder, and from an inner cylinder to the ID spare cylinder.

Primary map
The primary map is a list of defective areas of the recording surfaces found during the manufacturing process and is used by the drive for formatting.

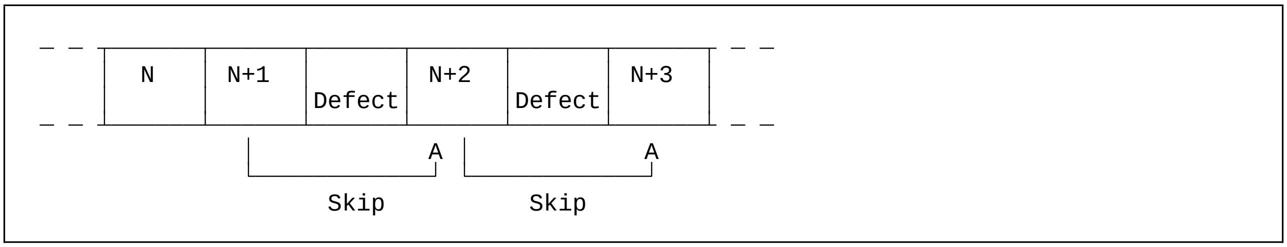
Dummy write
The dummy write cylinder is allocated for the calibration and extensive error recovery by the drive.

6.0 Defect Flagging Strategy

Media defects are remapped to the next available sector during the manufacturing format process. The mapping from LBA to the physical location is calculated with an internally maintained table.

6.1 Shipped Format

- Data areas are optimally utilized.
- Extra sectors are not wasted as a spare throughout the user data areas.
- All spare sectors are located on one of four spare tracks spread on the user data area.
- All sectors generated by defect flagging are absorbed by the four spare tracks.



Defects are skipped without any constrain, such as track or cylinder boundaries. The calculation from LBA to physical is done with an internal table.

7.0 Specification

This chapter provides specifications of the drives.

7.1 Electrical Interface Specifications

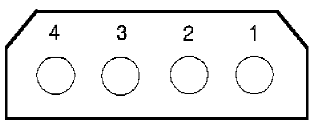
This section provides the interface specifications.

7.1.1 Connectors

Refer to Appendix B for location of the connectors.

7.1.1.1 Power

The DC power connector is designed to mate with AMP (part 1-480424-0) using AMP pins (part 350078-4) strip or (part 61173-4) loose piece, or their equivalents. Pin assignments are shown in Table 10.



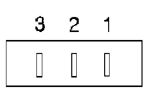
Pin	Voltage
1	+ 12 V
2	GND
3	GND
4	+ 5 V

Table 10. Power Connector Pin Assignments

7.1.1.2 Alternate Power

The 3-pin DC power connector is designed to mate with the MOLEX (5480-03) using MOLEX pins (5479) or their equivalents. The pin assignments are shown in Table 11.

Each line is connected to the corresponding voltage lines of the power connector as shown in Table 10.



Pin	Voltage
1	+ 5 V
2	+ 12 V
3	GND

Table 11. Alternate Power Connector Pin Assignments

7.1.1.3 AT Signal Connector

The AT signal connector is a 40-pin connector.

7.1.2 Signal Definitions

The pin assignments of interface signals are shown in Figure 1.

PIN	SIGNAL	I/O	Type	PIN	SIGNAL	I/O	Type
01	–HRESET	I	TTL	02	GND		
03	HD07	I/O	3–state	04	HD08	I/O	3–state
05	HD06	I/O	3–state	06	HD09	I/O	3–state
07	HD05	I/O	3–state	08	HD10	I/O	3–state
09	HD04	I/O	3–state	10	HD11	I/O	3–state
11	HD03	I/O	3–state	12	HD12	I/O	3–state
13	HD02	I/O	3–state	14	HD13	I/O	3–state
15	HD01	I/O	3–state	16	HD14	I/O	3–state
17	HD00	I/O	3–state	18	HD15	I/O	3–state
19	GND			(20)	Key		
21	(Resv)			22	GND		
23	–HIOW	I	TTL	24	GND		
25	–HIOR	I	TTL	26	GND		
27	(Resv)			28	CSEL	I	TTL
29	(Resv)			30	GND		
31	HIRQ	O	3–state	32	–HIOCS16	O	OC
33	HA01	I	TTL	34	–PDIAG	I/O	OC
35	HA00	I	TTL	36	HA02	I	TTL
37	–HCS0	I	TTL	38	–HCS1	I	TTL
39	–DASP	I/O	OC	40	GND		

Figure 1. Interface Signal Pin Assignments

Legend	***Meaning***
O	Output from a drive.
I	Input to a drive.
I/O	Common input/output.
OC	Open-collector or open-drain output.
Resv	Reserved pin; the pin has no connection.
TTL	Transistor transistor logic.

HD00-HD15 A 16-bit, bi-directional data bus between the host and the HDD. HD00 through HD07 are used for register and ECC access. HD00 through HD15 are used for data transfer. These signal lines are three-state lines and have a 24 mA current sink capability.

HA00-HA02 The address used to select the individual register in the HDD.

– HCS0 A chip select signal generated from the host address bus. When active, one of the command block registers (data; error; features when written, sector count; sector number; cylinder low, cylinder high, drive/head and status; command when written, registers) can be selected. (See Figure 4 on page 22.)

– HCS1 A chip select signal generated from the host address bus. When active, one of the control block registers (alternate status, device control when written, and drive address registers) can be selected. (See Figure 4 on page 22.)

– HRESET This line is used to reset the HDD. It is kept in a low logic state when power is turned on and is kept in a high logic state after power is turned on.

– HIOW The rise of this line gates data from the data bus to a register or data register of the HDD.

– HIOR When in a low state, this signal gates data from a register or data register of the drive onto the data bus. The data on the bus are latched on the rise of – HIOR.

HIRQ The interrupt is active only when the drive is selected and the host activates the – IEN bit in the device control register. At all other times, this signal is in a high impedance state irregardless of the state of the IRQ bit. The interrupt is set when the IRQ bit is set by the drive CPU. IRQ is reset to zero by a host read of the status register or a write to the command register. This signal is a three-state line with a 24 mA sink capability.

– HIOCS16 This indicates to the host that a 16-bit data register has been addressed and that the drive is prepared to send or receive a 16-bit data word. This signal is an open-drain output with a 24 mA sink capability. An external resistor is needed to pull this line to +5 Volt.

– DASP This is a time-multiplexed signal which indicates that a drive is active, or that drive 1 is present. This signal is driven by a open-drain driver and internally pulled-up to +5 Volt through a 10 kilohm resistor.

During power-on initialization or after – HRESET is negated, – DASP is asserted by drive 1 within 400 milliseconds to indicate that drive 1 is present. Drive 0 allows up to 450 milliseconds for drive 1 to assert – DASP. If drive 1 is not present, drive 0 may assert – DASP to drive a LED indicator.

– DASP is negated following the acceptance of the first valid command by drive 1. Anytime after – DASP is negated, either drive may assert – DASP to indicate that a drive is active.

– PDIAG This signal is asserted by drive 1 to indicate to drive 0 that it has completed its diagnostic tests. This line is pulled-up to +5 Volt in the HDD through a 10 kilohm resistor.

After a power-on-reset, a software reset, or – HRESET, drive 1 negates – PDIAG within 1 millisecond (to indicate to drive 0 that it is busy). Drive 1 then asserts – PDIAG within 30 seconds to indicate that it is no longer busy, and is able to provide status.

After the receipt of a valid Execute Drive Diagnostics command, drive 1 negates – PDIAG within 1 millisecond to indicate to drive 0 that it is busy and has not yet passed its drive diagnostics. If drive 1 is present, then drive 0 waits for up to five seconds from the receipt of a valid Execute Drive Diagnostics command for drive 1 to assert – PDIAG. Drive 1 should clear BSY before asserting – PDIAG, because – PDIAG is used to indicate that drive 1 has passed its diagnostic tests and is ready to post status.

If – DASP is not asserted by drive 1 during the reset initialization, drive 0 posts its own status immediately after it completes its diagnostic tests, and sets the drive 1 status register to 00h. Drive 0 may be unable to accept commands until it has finished its reset procedure and is ready (DRDY equals 1).

CSEL (Cable Select) (Optional)

The drive is configured as either drive 0 or 1 depending on the value of CSEL.

- If CSEL is grounded, the drive address is 0.
- If CSEL is open, the drive address is 1.

KEY Pin 20 does not exist. The corresponding female side should be blocked out to prevent incorrect insertion of the connector.

Note: IORDY (Pin 20: I/O channel ready) is not supported.

7.1.3 Interface Logic Signal Levels

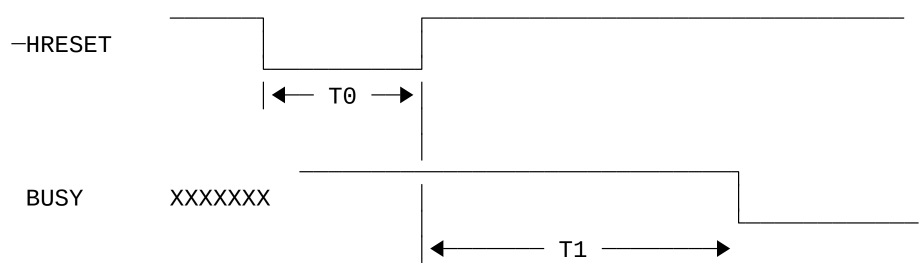
The interface logic signals have the following electrical specifications:

```
Inputs:   Input High Voltage      —    2.0 V min.
          Input Low Voltage       —    0.8 V max.

Outputs:  Output High Voltage     —    2.4 V min.
          Output Low Voltage      —    0.5 V max.
```

7.1.4 Reset Timings

The HDD reset timing is shown below.

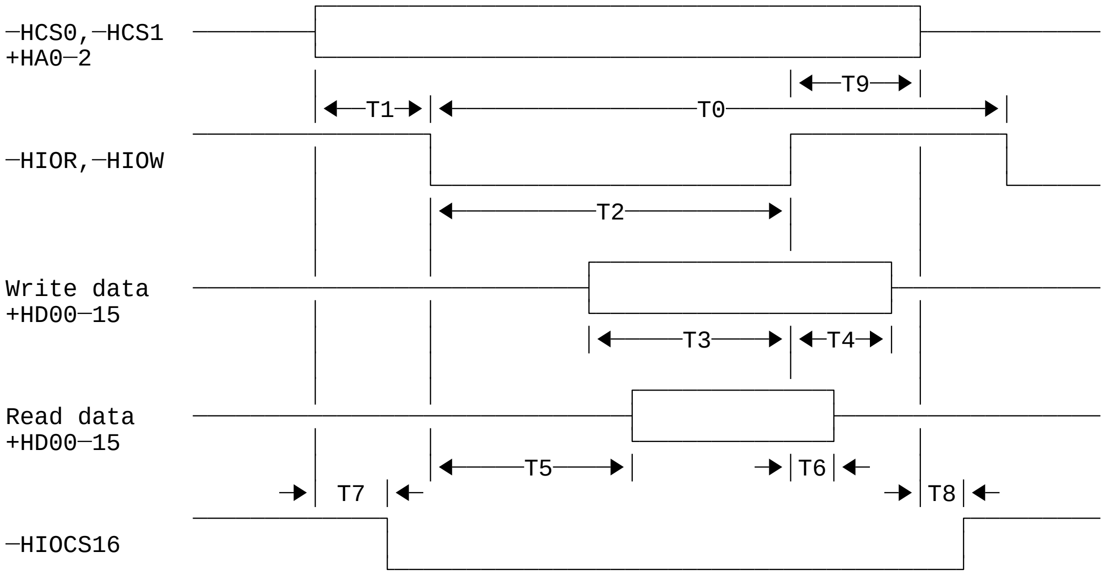


	PARAMETER DESCRIPTION	Min. (usec)	Typ. (sec)	Max. (sec)
T0	—HRESET low width	25		
T1	—HRESET high to Not BUSY	—	6	18

Figure 2. System Reset Timing

7.1.5 PIO Timings

The PIO cycle timings meet the Mode 2 specification of the ATA description.



	PARAMETER DESCRIPTION	MIN (nsec)	MAX (nsec)	Note
T0	Cycle time	240	−	1
T1	−HCS0−1, +HA00−02 valid to −HIOR,−HIOW active	30	−	
T2	−HIOR,−HIOW pulse width	100	−	
T3	+HD00−15 setup to −HIOW high	30	−	
T4	−HIOW high to +HD00−15 hold	15	−	
T5	−HIOR low to +HD00−15 valid	−	60	
T6	−HIOR high to +HD00−15 hold	5	−	
T7	−HCS0−1, +HA00−02 valid to −HIOCS16 assertion	−	40	
T8	−HCS0−1, +HA00−02 invalid to −HIOCS16 negation	−	30	
T9	−HIOR,−HIOW high to −HCS0−1, +HA00−02 hold	10		

Note 1: The drives do not support less than 240 nsec of cycle time.

Figure 3. PIO Cycle Timings

7.1.6 Addressing of HDD Registers

The host addresses the drive through task file registers. These registers are mapped into the host's I/O space. Two chip select lines (– HCS0 and – HCS1) and three address lines (HA00-02) are used to select one of these registers, while a – HIOR or – HIOW is provided at the specified time.

The – HCS0 is used to address command block registers, while the – HCS1 is used to address the control block registers. The following table shows the I/O address map.

Addr.	–CS0	–CS1	HA2	HA1	HA0	–IOR = 0 (Read)	–IOW = 0 (Write)
						Command Block Registers	
1F0	0	1	0	0	0	Data	Data
1F1	0	1	0	0	1	Error	Features
1F2	0	1	0	1	0	Sector count	Sector count
1F3	0	1	0	1	1	Sector number	Sector number
1F4	0	1	1	0	0	Cylinder low	Cylinder low
1F5	0	1	1	0	1	Cylinder high	Cylinder high
1F6	0	1	1	1	0	Drive/Head	Drive/Head
1F7	0	1	1	1	1	Status	Command
						Control Block Registers	
3F6	1	0	1	1	0	Alt. Status	Device control
3F7	1	0	1	1	1	Drive address	–

Figure 4. Task File

Note: The “Addr.” field in the figure is shown only an example.

7.1.7 Cabling

The maximum cable length from the host system to the HDD, plus the circuit pattern length in the host system, cannot exceed 45.7 cm.

7.1.8 Jumper Settings

The seven-position jumper block shown below is used to select the master or slave, the cable selection, and the LED output port.

```
        Pin pitch is 2 mm.

        JP1      JP2      JP3      JP4      JP5      JP6      JP7
       Master   Slave   Cable Sel
        ON       ON       ON       NC       NC       NC       LED

        1        3        5        7        9        11       13

        2        4        6        8        10                14
   /──────────────────────────────────────────────────────────────────────/
                                  Raw Card
   /──────────────────────────────────────────────────────────────────────/
```

Figure 5. Jumper Pins

Notes:

1. The JP1, JP2, and JP3 jumper positions should not be selected concurrently.
2. JP1 is the position for master, JP2 is for slave, and JP3 is for the cable selection mode.
3. To enable the CSEL mode (cable selection mode), the JP3 jumper must be installed. In the CSEL mode, the drive address is determined as follows:
   - When CSEL is grounded or at a low level, the drive address is 0 (Master).
   - When CSEL is open or at a high level, the drive address is 1 (Slave).

   The CSEL signal, ATA interface pin 28, is controlled by the host system.
4. JP7 is the position for an external LED.

7.1.8.1 The Jumper Pin Assignments

JP	Pin No.	Status	Description	Signal Name
1	1	—	GND	
	2	In	−Device Address Select Line	−C/+D
2	3	—	NC (Slave position)	
	4	—	NC	
3	5	In	Cable Selection (Pin 28)	
	6	In	−Device Address Select Line	−C/+D
4	7	—	NC	
	8	—	NC	
5	9	—	NC	
	10	—	NC	
6	11	—	NC	
	12	—	NC	
7	13	Out	+LED	+LED
	14	Out	−LED	−LED

Figure 6. Jumper Pin Assignments

7.1.8.2 Signal Description

In Figure 7 on page 25, "on" means a shunt jumper is installed, and "off" means the shunt jumper is not installed.

- LED output (+LED pin 13)

  This pin has a maximum current source capability of +18 mA at a nominal condition. This pin is designed to drive an LED.

- LED output (−LED pin 14)

  This pin has a current sink capability of −100 mA at 0.25 V for the worst case. This pin is designed to drive an LED.

7.1.8.3 Shipping Default Condition

The jumper is set to "Device ID = Master" when the drive is shipped.

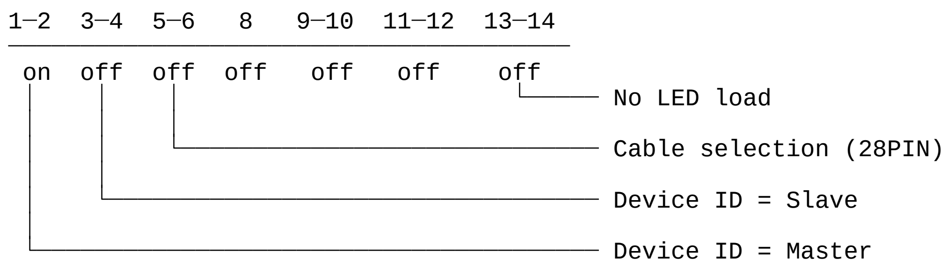


Figure 7. Jumper Default Condition

7.1.8.4 Jumper Location

The jumper location on the card is shown in Figure 8.

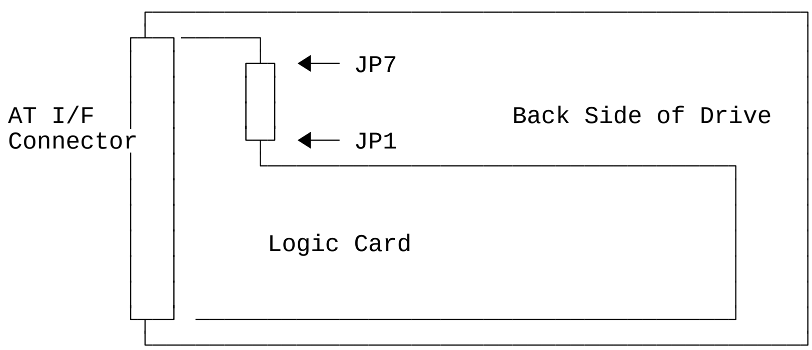


Figure 8. Jumper Location

7.2 Environment

The following environmental conditions should be maintained for drive operation.

7.2.1 Temperature and Humidity

Operating Conditions	
Temperature Relative Humidity Maximum Wet Bulb Temperature Maximum Temperature Gradient Altitude	5 to 55˚C (See note) 8 to 90 % non-condensing 29.4˚C non-condensing 15˚C / hour -300 to 3,000 m
Shipping Conditions	
Temperature Relative Humidity Maximum Wet Bulb Temperature Altitude	-40 to 65˚C 5 to 95 % non-condensing 35˚C non-condensing -300 to 12,000 m
Storage Conditions	
Temperature Relative Humidity Maximum Wet Bulb Temperature Altitude	0 to 65˚C 5 to 95 % non-condensing 35˚C non-condensing -300 to 12,000 m
Note: The system has to provide sufficient air movement to maintain a surface temperature below 60˚C at the center of the top cover of the drive.	

7.2.2 Corrosion Test

The hard disk drive must not show any signs of corrosion, (inside and outside of the HDA) and be functional after being subjected to seven days of a 50˚C temperature with a 90 % relative humidity.

7.3 DC Power Requirement

The following voltage specifications apply when measured at the drive power connector. Damage to the electronic circuits of the drive may result if the power supply cable is connected or disconnected while power is applied to the drive (hot plug/unplug is not allowed). There are inductive loads in the drive which can cause high voltage spikes on the drive if the power connection is opened. There is no special power on/off sequencing required.

Input Voltage

+5 Volts Supply	5V (+/− 5% during run and spin up)
+12 Volts Supply	12V (+10%,−8% during run and spin up)

Power Supply Current

(All values in amperes)	+5 Volts Pop Mean	+5 Volts Std. Dev	+12 Volts Pop Mean	+12 Volts Std. Dev
Idle average	0.16	0.02	0.14	0.02
Idle ripple(peak−to−peak)	0.15	0.02	0.13	0.02
Seek peak	N/A	N/A	0.54	0.03
Seek average	0.30	0.02	0.20	0.02
Start up(max)	0.50	0.02	1.10	0.03
RND R/W peak	0.46	0.02	0.54	0.03
RND R/W average	0.37	0.02	0.25	0.02

The power supply generated ripple as seen at the drive power connector is:

	Maximum	Notes
+5 V DC	100 mV pp	0−10 MHz
+12 V DC	150 mV pp	0−10 MHz

During drive start up and seek, a 12 volt ripple is generated by the drive (referred to as dynamic loading). If several drives have their power daisy chained together, then the power supply ripple plus other drive's dynamic loading must remain within the regulation tolerance of +10/-8%. A common power supply with separate power leads to each drive is a more desirable method of power distribution.

To prevent external electrical noise from interfering with the drive's performance, the drive must be secured with four screws in the user system frame which has no voltage differences at the four screw positions, and has less than +/-300 millivolts peak to peak level difference to the ground lead of the power connector.

7.4 Reliability

This section provides the reliability data for the drives.

7.4.1 Data Integrity

No more than one sector can be lost at a hard reset or power loss condition during a write operation.

7.4.2 Cable Noise Interference

To avoid any degradation of performance throughput or error rate when the interface cable is routed on top or comes in contact with the HDA assembly, the drive must be grounded electrically to the system frame by four screws. The common mode noise or voltage level difference between the system frame and power cable ground or AT interface cable ground should be in the allowable level specified in the power requirement section.

7.4.3 Mean Time Between Failures (MTBF)

The MTBF is 250,000 power-on hours (POH).

7.4.4 Usage

The drive withstands 720 POH per month (43200 POH for 5 years), with 50 on/off cycles per month and a drive access (seek/read/write operation) rate of 20% of power on time. The fixed disk subsystem meets the maximum failure rate described in the reliability section.

7.4.5 Contact Start Stop (CSS)

The drive withstands a minimum of 20,000 contact start/stop cycles under the 40˚C environment.

7.4.6 Useful Life

The useful life of the drives is a minimum of five years.

7.4.7 Preventive Maintenance

None.

7.4.8 Data Reliability

- Probability of not recovering data .... 1 in 10E13 bits read
- ECC implementation

  A Read Solomon Error Correcting Code of degree 8 with non-interleaved is used to cover the data fields. The ECC polynomial is derived from:

```
g(X) = (X + 1)(X + A)(X + A**2) — — — (X + A**7)
```

ECC On The Fly covers one or two symbols of error in one sector. (1 symbol = 10 bits)

7.4.9 Seek/ID Mis-Compare Errors

A non-recoverable seek/ID mis-compare error is defined as a seek operation that cannot be corrected by the fixed disk error recovery procedure. Seek errors occurring for field format operations are considered to be non-recoverable.

No drive has more than one non-recoverable seek/ID mis-compare error per 5 million seek operations (1 in 5 x 10E6) when operated at the full range of voltage and environmental conditions.

7.4.10 Equipment Errors

A recoverable equipment error is any error other than a seek/ID mis-compare error or read error that is detected and corrected by the drive error recovery procedure. Examples are write fault, drive not ready and internal drive errors.

No drive has more than one recoverable equipment error per 10E8 bits reads, 10E6 bits writes, or 10E6 seeks operations when operated at the full range of voltage and environmental conditions.

7.5 Mechanical Specifications

This section provides the mechanical specifications of the drives.

7.5.1 Physical Dimensions

The following chart describes the dimensions for the IBM-H3xxx-Ax hard disk drive form factor. (See Appendix B.)

Dimension	Value (mm)
Height	25.4 ± 0.4
Width	101.6 ± 0.4
Length	146.0 ± 0.6
Weight	480 gram (maximum)

7.5.2 Mounting Holes

The mounting hole location and size for the hard disk drive is shown below. For the details, see Appendix B.

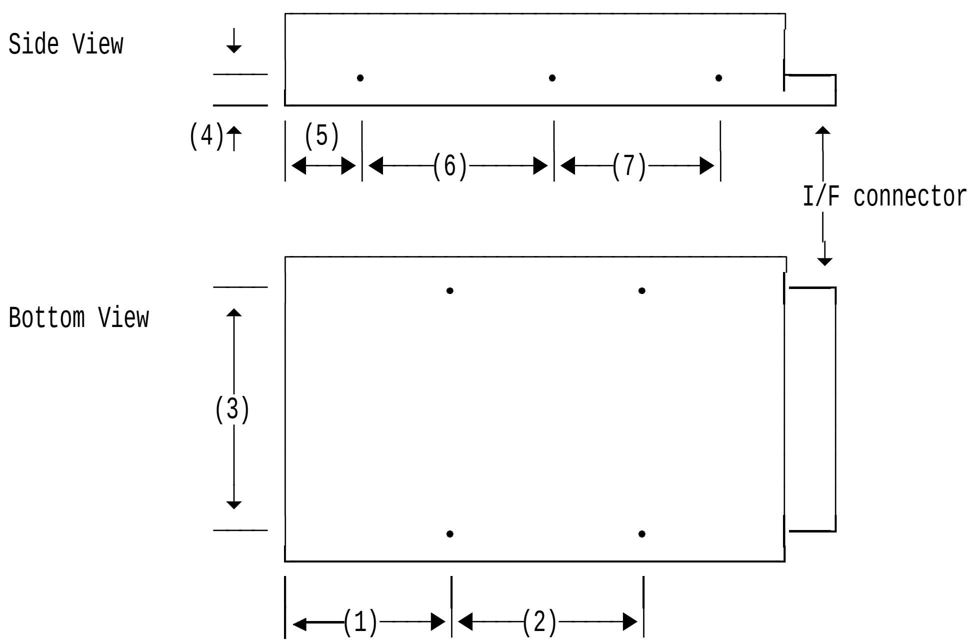


Table 12. Hole Locations							
Thread	(1)	(2)	(3)	(4)	(5)	(6)	(7)
6-32 UNC	60.3	44.45	95.25	6.35	16.0	60.0	41.6

7.5.3 Connector and Jumper Description

Refer to Appendix B for locations of the interface connector and the jumpers.

7.5.4 Drive Mounting

The drive functions in all axes (6 directions). Performance and error rate stay within specification limits even if the drive is operated in other orientations from which it was formatted.

For reliable operation, it is recommended to mount the drive in the system securely enough to prevent excessive motion or vibration of the drive during seek operation or spindle rotation, using appropriate screws or equivalent mounting hardware. Consult with the issuer of this specification for the actual application, if necessary.

The drive level vibration test and the shock test are to be conducted when the drive is mounted to a table using the bottom four screws.

7.5.5 Shipping Zone and Lock

A dedicated “shipping” (or “landing”) zone on the disk, not on the data area of the disk, is provided to protect the disk data during shipping, movement, or storage. At power down, the heads are automatically parked and a head locking mechanism secures the heads in this zone.

7.6 Vibration and Shock

All vibration and shock measurements in this section are for the disk drive without the mounting attachments for the systems. The input level is applied to the normal drive mounting points.

7.6.1 Operating Vibration

7.6.1.1 Random Vibration

The hard disk drive meets IBM Standard C-S 1-9711-002 (1990-03) for the V5L product classification.
The test is 30 minutes of random vibration using the power spectral density (PSD) levels shown below in each of three mutually perpendicular axes. The disk drive will operate without non-recoverable errors or degradation in throughput more than 5% when subjected to the below random vibration levels.

Table 13. Random Vibration PSD Profile Breakpoints (Operating)

5	17	45	48	62	65	150	200	500	Hz
0.02	1.1	1.1	8.0	8.0	1.0	1.0	0.5	0.5	$\times 10^{-3}$ G^2/Hz

Note: Overall RMS (root mean square) level of vibration is 0.67 G rms.

7.6.1.2 Swept Sine Vibration

The hard disk drive will meet the criteria shown below while operating in the respective conditions.

No errors 0.5 G 0-peak, 5-300-5 Hz sine wave, 0.5 oct/min sweep rate with 3 minutes dwells at 2 major resonances

No data loss 1 G 0-peak, 5-300-5 Hz sine wave, 0.5 oct/min sweep rate with 3 minutes dwells at 2 major resonances

7.6.2 Non-Operating Vibration

The disk drive does not sustain permanent hardware damage or loss of previously recorded data after being subjected to the environment described below.

7.6.2.1 Random Vibration

The test consists of a random vibration applied in each of three mutually perpendicular axes with the time duration of 10 minutes per axis. The PSD levels for the test simulating the shipping and relocation environment are shown below. (IBM STD C-H 1-9711-005)

Table 14. Random Vibration PSD Profile Breakpoints (Non-operating)

2	4	8	40	55	70	200	Hz
0.001	0.03	0.03	0.003	0.01	0.01	0.001	G^2/Hz

Note: Overall RMS (root mean square) level of vibration is 1.04 G rms.

7.6.2.2 Swept Sine Vibration

- 2 G 0-peak, 5-500-5 Hz sine wave
- 0.5 oct/min sweep rate
- Three minute dwells at two major resonances

7.6.3 Operating Shock

The hard disk drive meets IBM Standard C-S 1-9711-007 for the S5 product classification.
The hard disk drive meets the following criteria while operating in the respective conditions described below. The shock test consists of ten shocks inputs in each axis and direction for total of 60. There must be a delay between shock pulses, long enough to allow the drive to complete all necessary error recovery procedures.

No errors 5 G, 11 ms half-sine shock pulse

No data loss, seek errors or permanent damage
10 G, 11 ms half-sine shock pulse

No data loss or permanent damage
15 G, 5 ms half-sine shock pulse
30 G, 4 ms half-sine shock pulse

7.6.4 Non-Operating shock

The drive will operate with no degradation of performance or permanent damage after subjected to shock pulses with the following characteristics.

7.6.4.1 Trapezoidal shock wave

- Approximate square (trapezoidal) pulse shape.
- Approximate rise and fall time of pulse = 1 ms.
- Averaged acceleration level = 50 G.
  (Averaged response curve value during the time following the 1 ms rise time and before the 1 ms fall with a time “duration of 11 msec”.)
- Minimum velocity change = 4.23 meters/sec

7.6.4.2 Sinusoidal shock wave

- Approximate half-sine pulse shape.
- Maximum acceleration level = 75 G.
- Shock duration = 11 msec.

All shock input shall be applied to the drive's three mutually perpendicular axes. The heads are not displaced from the landing zone as a result of this test.

7.7 Acoustics

7.7.1 Sound Power

7.7.1.1 Unit Sound Power Level Testing

Sound power emission levels are measured according to ISO 7779. The statistical upper limit of the A-weighted sound power levels given in Bels relative to 1 pico Watt are shown in the following table.

Mode	Statistical upper limit
Idle	4.5 Bels
Operating	4.8 Bels

Table 15. A-weighted Sound Power Level

Mode definition

Idle mode
: Power on, disks spinning, track following, unit ready to receive and respond to interface commands.

Operating mode
: Continuous random cylinder selection and seek operation of the actuator with a dwell time at each cylinder. Seek rate for the drive can be calculated as shown below.

Dwell time = (0.5 + N) × 60/RPM
Seek rate = 1 / (Average seek time + Dwell time)
where N = number of maximum data surfaces (N=4 for H3342-A4)

7.7.1.2 Sound Power Acceptance Criteria

Statistical upper limit $(L_{WAu})_{stat}$ is calculated with the following formula.

$$(L_{WAu})_{stat} = (L_{WAu})_m + k \times (s_t)_{WAu}$$

where:

$(L_{WAu})_m$ is the mean value of the A-weighted sound power level for samples of N drives.
$(s_t)_{WAu}$ is the total standard deviation for A-weighted sound power level
$(s_t)_{WAu} = \mathrm{SQRT}((s_R)_W{}^2 + (s_P)_{WAu}{}^2)$
$(s_R)_W$ is the standard deviation of reproducibility for sound power level.
Assume $(s_R)_W = 0.075$ B.
$(s_P)_{WAu}$ is the standard deviation of the samples for A-weighted sound power level.
k is a coefficient determined by number of samples (N) as shown below.

N	3	4	5	6	7	8	9	10	11	12	13	14	15
k	3.19	2.74	2.74	2.49	2.33	2.22	2.13	2.07	2.01	1.97	1.93	1.90	1.87

7.8 Identification

7.8.1 Labels

The following labels are affixed to every hard disk drive shipped from the drive manufacturing location in accordance with appropriate hard disk drive assembly drawing.

- A label containing the IBM logo, IBM part number and the statement “Made by IBM Japan Ltd.”.
- A label containing the drive model number, date code, formatted capacity, place of manufacture, and UL/CSA/TUV logos.
- A bar code label containing the drive serial number.
- An user designed label per agreement.

The labels may be integrated with the other labels.

7.9 Safety

7.9.1 Underwriters Lab (UL) Approval

The product is recognized for use in Information Processing and Business Equipment according to UL 1950. The UL Recognition will be maintained for the life of the product. Vendor/manufacturer marking for UL approval appears on the drive.

7.9.2 Canadian Standards Authority (CSA) Approval

The product is certified for use in Information Processing and Business Equipment according to the following CSA standards.

- C22.2 No. 0-M1989
- C22.2 No. 0.4-M1982
- C22.2 No. 950-M1989

The CSA Certification will be maintained for the life of the product. Vendor/manufacturer marking for the CSA certification appears on the drive.

7.9.3 IEC Compliance

The product is certified for compliance to IEC 380, IEC 435, and IEC 950. The product will comply with these IEC requirements for the life of the product.

7.9.4 Flammability

Printed circuit boards used in this product is made of material with a UL recognized flammability rating of V-1 or better. The flammability rating is marked or etched on the board. All other parts not considered electrical components are made of material with a UL recognized flammability rating of V-1 or better. However, small mechanical parts such as cable ties, washers, screws, and PC board mounts may be made of material with a UL recognized flammability rating of V-2.

7.9.5 Safe Handling

The product is conditioned for safe handling in regards to sharp edges and corners.

7.9.6 Environment

The product does not contain any known or suspected carcinogens.

Environmental controls meet or exceed all applicable government regulations in the country of origin. Safe chemical usage and manufacturing control are used to protect the environment. An environmental impact assessment has been done on the manufacturing process used to build the drive, the drive itself and the disposal of the drive at the end of its life.

Production also meets the requirements of the international treaty on chloroflurocarbon (CFC) control known as the United Nations Environment Program Montreal Protocol, and as ratified by the member nations. Material to be controlled include CFC-11, CFC-12, CFC-113, CFC-114, CFC-115, Halon 1211, Halon 1301 and Halon 2402. Although not specified by the Protocol, CFC-112 is also controlled. In addition to the Protocol IBM requires the following:

- All packaging used for the shipment of the product do not use controlled CFCs in the manufacturing process.
- All manufacturing processes for parts or assemblies include printed circuit boards, do not use controlled CFC materials after May 15, 1993.

7.9.7 Secondary Circuit Protection

Fuses are provided in both 5V and 12V input of the hard disk drive for over current protection.

7.10 Electromagnetic Compatibility

The hard disk drive, when installed in the host system and exercised with a random accessing routine at maximum data rate meets the following worldwide EMC requirements:

- United States Federal Communications Commission (FCC) Rules and Regulations (Class B), Part 15. IBM Corporate Standard (A 6 dB buffer shall be maintained on the emission requirements).
- European Economic Community (EEC) directive number 76/889 related to the control of radio frequency interference and the Verband Deutscher Elektrotechniker (VDE) requirements of Germany (GOP).

Appendix A. Test Points

The drive provides access to certain electrical signals to facilitate manufacturing and verification tests.

A.1 R/W Channel

A.1.1 Analog

1. Read Data

   Read data is a differential signal that has been amplified and filtered and represents the signal being read by whatever head is currently selected. The filtration is bandwidth limiting only, not differentiation. The signal does not have any Automatic Gain Control (AGC).

2. AGC Read Data

   AGC read data is the differential read signal after being bandwidth filtered and has passed through an automatic gain control (AGC) amplifier that is used to keep the overall track amplitude set to a fixed value.

A.1.2 Digital

1. Read Data

   Read data is a pulse for every valid transition recorded on the disk surface.

2. Read Clock

   Read clock is a pulse or window that is used by the data decoder as a basic clock to decode read data.

3. Read Gate

   Read gate is active any time a physical sector or ID field is being read.

4. Write Gate (indicates when a write operation is occurring)

   Write gate is active any time write current is being applied to one of the R/W heads.

5. Write Fault

   Write fault becomes active when conditions in section "Write Safety" are not satisfied.

A.2 Servo Channel

A.2.1 Digital

All digital test points are TTL compatible and capable of sinking a minimum of 250 microampere.

1. SRV_AREA

   When the servo system is working correctly in a normal operation, the SRV_AREA shows the timing of embedded servo area. The area is protected from the write operation.

2. AGC_HOLD

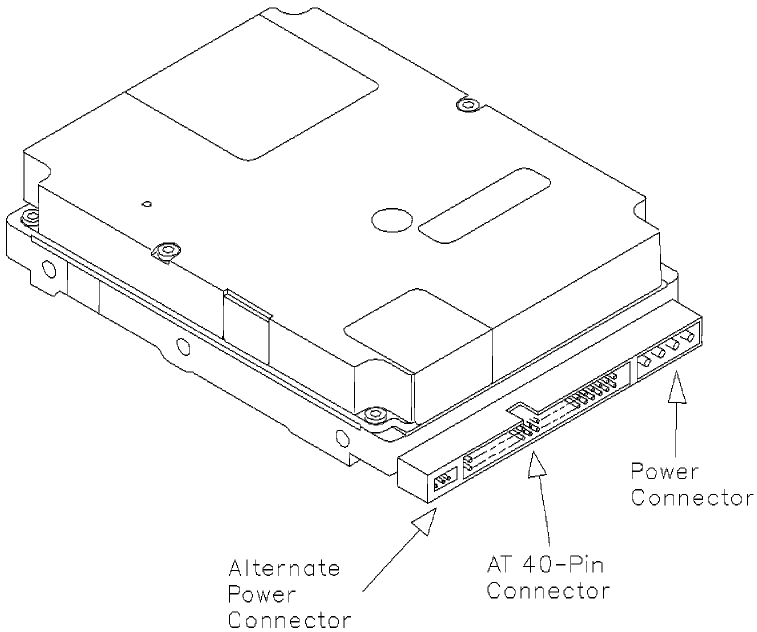
   When the servo system is working correctly with locking to the embedded servo pattern, the AGC_HOLD signal is activated on the servo pattern to get PES from wedge burst pattern except the write operation.

3. Index Pulse

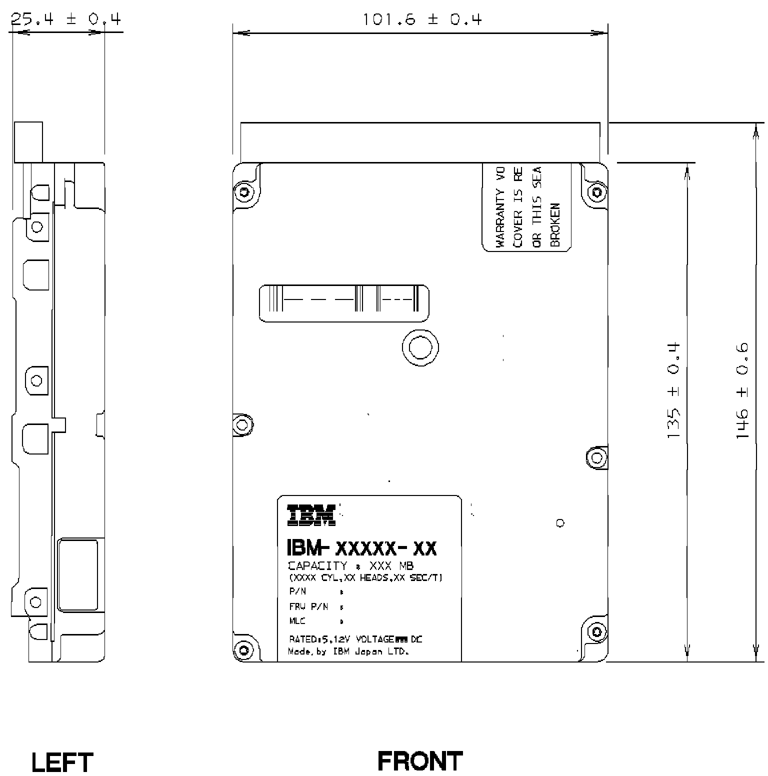
   The index test point must correspond with the beginning of the first physical sector of a track. The minimum pulse width is 2 microseconds.

Appendix B. Mechanical Drawings

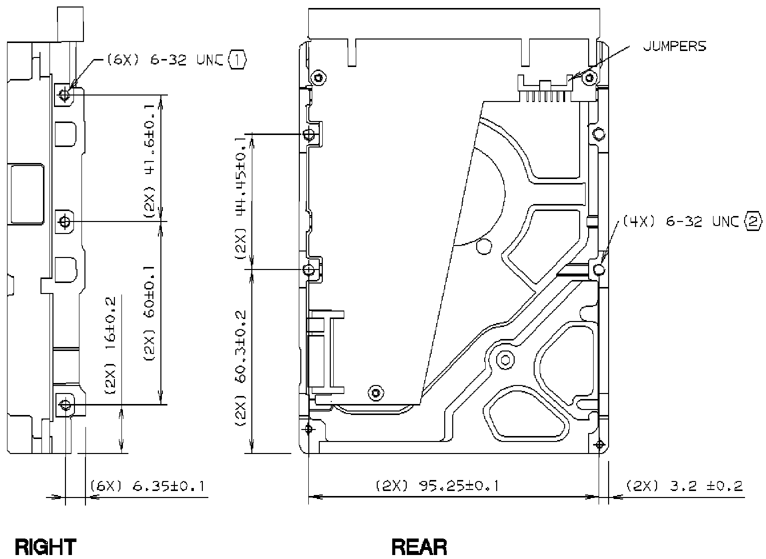
B.1 Isometric View



B.2 Outline Dimensions

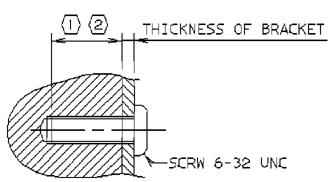


B.3 Mounting Holes

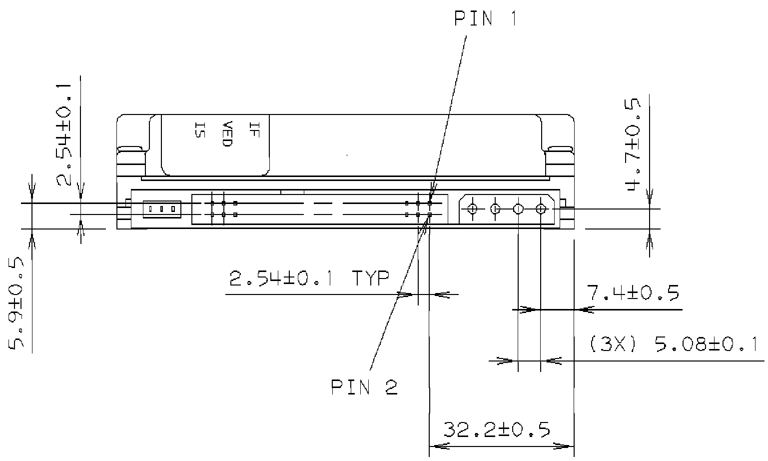


1. MAX ALLOWABLE PENETRATION OF NOTED SCREW TO BE 3.5 mm (SEE DETAIL A).

2. MAX ALLOWABLE PENETRATION OF NOTED SCREW TO BE 6 mm (SEE DETAIL A).



B.4 Interface Connector



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