Personal System/2 3.5-inch Diskette Drives Technical Reference

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3.5-inch Diskette Drives

Figures v

Notices vii
Trademarks and Service Marks vii

Preface ix
Description 1
Programming Considerations 2
Secure Media Mode 3
Electrical Interface 4
  DC Power 4
  Input Signals 4
  Output Signals 7
Connectors 10
  40-Pin Card-Edge Interface 10
  34-Pin Header Interface 11
  Enhanced 34-Pin Header Interface 12
Specifications 13

Notes:

Figures

1. Diskette Drive Identification 1
2. Diskette Drive Media Compatibility 2
3. Data Rate Selection 5
4. Enhanced Commands 5
5. Drive Type ID 1—0 8
6. Media Type 1—0 9
7. Enhanced Status 3—2 9
8. Signal Assignments for the 40-pin Card-Edge Interface . . . 10
9. Signal Assignments For the 34-pin Header Interface 11
10. Signal Assignments For the Enhanced 34-Pin Header Interface 12

Notes:

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Preface

This technical reference is for those who develop hardware and software products for IBM Personal Computers and IBM Personal System/2 products. Readers should understand computer architecture and programming concepts.

This technical reference should be used with the following publications, which contain additional information about many of the subjects discussed in this document.

IBM Personal System/2 Hardware Interface Technical Reference—Architectures

IBM Personal System/2 Hardware Interface Technical Reference—Common Interfaces

IBM Personal System/2 Hardware Interface Technical Reference—System-Specific Information

IBM Personal System/2 and Personal Computer BIOS Interface Technical Reference

Information about hard disk drives, adapters, and external options are in separate option technical references.

Warning: The term *reserved* describes certain signals, bits, and registers that should not be changed. Use of reserved areas can cause compatibility problems, loss of data, or permanent damage to the hardware. When the contents of a register are changed, the state of the reserved bits must be preserved. When possible, read the register first and change only the bits that must be changed.

Notes:

Description

This technical reference provides system-specific hardware and software interface information for the IBM* Personal System/2* family of products. It is intended for developers who provide hardware and software products to operate with PS/2* systems.

This document describes four 3.5-inch diskette drives:

- 720KB Diskette Drive
- 1.44MB Diskette Drive
- 2.88MB Diskette Drive
- Enhanced 2.88MB Diskette Drive

The 720KB Diskette Drive exists in 41-mm high and 27-mm high versions. The 1.44MB Diskette Drive exists in 41-mm high, 27-mm high, and 19-mm high versions. The 2.88MB diskette drives exist in a 27-mm high version only. The information in this technical reference applies to all drives, except where specifically noted otherwise.

The 1.44MB Diskette Drive is identified externally by a "1.44" printed on the diskette eject button, and the two 2.88MB Diskette Drives are identified externally by a "2.88" printed on the diskette eject button. No external identifier indicates a 720KB drive. The following figure illustrates these identifications.

Diskette Drive	Identifying Mark
3.5-inch - 720KB	None
3.5-inch - 1.44MB	1.44 on eject button
3.5-inch - 2.88MB	2.88 on eject button

Figure 1. Diskette Drive Identification

The 720KB Diskette Drive uses 1.0MB diskettes with 80 tracks per side. The 1.44MB Diskette Drive uses either 1.0MB or 2.0MB diskettes with 80 tracks per side. The 2.88MB Diskette Drive uses either 1.0MB, 2.0MB, or 4.0MB diskettes with 80 tracks per side.

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Warning: 1.0MB media can be reliably formatted only to 720KB capacity, 2.0MB media can be reliably formatted only to 1.44MB capacity, and 4.0MB media can be reliably formatted only to 2.88MB capacity. Using media formatted to an unsupported capacity can result in loss of data.

Diskette Type	Formatted Capacity	Drive Compatibility
1.0MB	720KB	3.5-inch 720KB, 1.44MB, and 2.88MB
2.0MB	1.44MB	3.5-inch 1.44MB and 2.88MB drives
4.0MB	2.88MB	3.5-inch 2.88MB drive only

Figure 2. Diskette Drive Media Compatibility

These drives are direct-access devices containing a spindle motor, head-positioning mechanism, and read/write/erase electronics. A drive-in-use indicator illuminates when the drive is selected. A spindle mechanism spins the diskette at a constant speed of 300 revolutions per minute (rpm). A sensor generates an index signal once per revolution of the spindle motor. The two read/write heads are positioned over the desired track of the diskette by a stepper motor. One step of the stepper motor results in a one-track linear movement of the read/write heads. An optical sensor generates a signal when the heads are positioned over Track 0.

During a write operation, data is provided to the drive in modified-frequency-modulation (MFM) coded form by the diskette drive controller. If the diskette is write-protected, the write-protect sensor on the drive inhibits the write operation.

Programming Considerations

The IBM 2.88MB Diskette Drive can read, write, and interchange data with 1.0MB diskettes formatted to the 720KB capacity and 2.0MB diskettes formatted to the 1.44MB capacity, provided that the diskette controller is programmed for perpendicular-mode operation and zero (0) nanoseconds precompensation. Otherwise, data loss may result. To avoid compatibility problems, it is recommended that all diskette operations be performed using the IBM BIOS interface.

Secure Media Mode

The Enhanced 2.88MB Diskette Drive provides secure-media functions and supports the 'security command' signal (-SECURITY COMMAND). The secure-media functions require that both the drive and drive interface support this signal.

The secure-media functions allow access to a diskette drive to be controlled through a set of enhanced commands. These commands provide a means of controlling access to the media in the diskette drives. Through these commands, programs can eject a diskette, or disable the load-and-eject mechanism to prevent media from being removed or inserted.

Note: While -SECURITY COMMAND is active, the drive does not respond to any read, write, or format commands.

When -SECURITY COMMAND goes from active to inactive (positive transition), the selected drive interprets the state of DATA RATE SELECT (1,0) as an enhanced command to be performed. See Figure 4 on page 5 for command encoding.

The enhanced drive commands are:

Lock Drive: This command places the drive in the secure-media mode and disables the load and eject mechanisms in the diskette drives. If a diskette is present, it cannot be removed; if a diskette is not present, it cannot be loaded.

Note: Allow 500 milliseconds after an Eject Media command before issuing Lock Drive command.

Unlock Drive: This command places the drive in the normal operating mode and enables the load and eject mechanisms.

Eject Media: This command is the same as pressing the eject button on the front of the drive; it causes the drive to eject a diskette if one is present. This command is ignored if the drive is in the secure-media mode.

Electrical Interface

The diskette-drive interface consists of control, data, and power. The following information describes the control and data signals. For pin assignments, see "Connectors" on page 7.

DC Power

DC power is supplied through the signal-cable interface. Some models use both +12 V dc and +5 V dc; others use only +5 V dc. The maximum power consumption for all drive types is 3.5 W.

Input Signals

All input signals operate between +5 V dc and ground, with the following definitions:

- The inactive level is +2.0 V dc minimum
- The active level is +0.8 V dc maximum.

All input signals are complementary metal-oxide semiconductor (CMOS) compatible.

The following are descriptions of the control input signals:

-HIGH DENSITY SELECT: This signal is used to select the operational mode of the 1.44MB diskette drive. When active, the 500 kbps data rate is selected. When inactive, the 250 kbps data rate is selected.

-DATA RATE SELECT (0, 1)/ENHANCED CMD (0, 1): These signals are driven by the diskette drive controller to select the data rate of devices on the diskette drive interface. If both the drive and the controller support the secure mode, these signals can also be used to issue enhanced commands to the drive (see page 3 for information on these commands).

Note: When used to issue commands, these signals must be stable for 500 nanoseconds before and after the -SECURITY COMMAND signal is driven inactive.

The following table shows the transfer rates selected.

Data Rate Select 1 0	Data Transfer Rate
0 0	500 kbps
0 1	Reserved
1 0	250 kbps
1 1	1000 kbps

Figure 3. Data Rate Selection

The following shows the enhanced command selected.

Data Rate Select 1 0	Resulting Command
0 0	Eject Media
0 1	Lock Drive
1 0	Unlock Drive
1 1	Reserved

Figure 4. Enhanced Commands

-DRIVE SELECT: This signal enables or disables all drive interface signals except -MOTOREN. When this signal is active, the drive is enabled. When it is inactive, all controlled inputs are ignored and all drive outputs are disabled.

Notes:

1. This signal must be stable for 500 nanoseconds before and after the -SECURITY COMMAND signal is driven inactive.
2. (720KB Diskette Drive, 41mm-high only:)
   If -MOTOREN is also inactive, the drive is in a low-power standby mode. When the drive is in standby mode, allow 10 microseconds for -TRACK 0 and -WRITE PROTECT to become valid after -MOTOREN and -DRIVE SELECT become active.

-MOTOR ENABLE: When this signal is made active, the spindle starts to rotate. There must be a 500 millisecond delay after -MOTOREN becomes active before a read, write, or seek operation is initiated. When inactive, this signal causes the spindle motor to decelerate and stop.

-DIRECTION IN: When this signal is active, -STEP moves the heads toward the drive spindle. When this signal is inactive, -STEP moves the heads away from the drive spindle. This signal is stable for a minimum of 1 microsecond before and 1 microsecond after the trailing edge of the step pulse.

Note: After a direction change, a 15 millisecond seek-settle delay is required before the next -STEP pulse is issued.

-SECURITY COMMAND: This signal is used to place the diskette drive in the secure-media mode and to issue &enhance. commands to the diskette drive. The signal requires that the drive supports the secure-media mode. While this signal is active, the drive does not respond to any read, write, or format commands. When this signal is changed from active to inactive, the selected drive latches DATA RATE SELECT (1,0) and decodes the command to be performed. (For more information on these commands, see "Secure Media Mode" on page 3.)

Note: -DRIVE SELECT and DATA RATE SELECT (1,0) must be stable for 500 nanoseconds before and after -SECURITY COMMAND goes inactive. If -DRIVE SELECT is made inactive while -SECURITY COMMAND is active, the drive will not latch in an enhanced command.

-STEP: A 1-microsecond active pulse of this signal causes the read/write heads to move one track. The state of -DIRECTION IN at the trailing edge of -STEP determines the direction of motion.

Note: A 15-millisecond head-settle time must be provided after the last step-pulse occurs before a read, write, or seek operation is initiated.

-WRITE DATA: A 250-nanosecond minimum pulse on this signal causes a flux transition to occur on the medium if -WRITE ENABLE is active.

Note: The write data must be precompensated by 125 nanoseconds for the 720KB Diskette Drive and the 1.44MB Diskette Drive, and by 0 nanoseconds (no precompensation) for the 2.88MB Diskette Drive, regardless of the diskette type installed.

-WRITE ENABLE: When active, this signal enables the write-current circuits. -WRITE DATA controls the writing of information. Motor-start and head-settle times must be observed before this line becomes active.

-HEAD 1 SELECT: Making this signal active selects the upper head; otherwise, the lower head is selected.

Output Signals

All output signals from the drive can sink at least 4.0 milliamps at the active (low) level. All output signals are CMOS-compatible.

-INDEX: When the drive senses the index, it generates an active pulse of at least 1 millisecond on this line.

-TRACK 0: This signal is active when the read/write heads are over Track 0. Track 0 is determined by a sensor, not a track counter. The drive can seek to Track 0 under control of the system even if there is no diskette inserted. The Track 0-indication can be used to determine whether a drive is installed in the system.

-WRITE PROTECT: When active, this signal indicates that a diskette with an open write-protect window (write-protected diskette) is in the drive and the drive will not write to it.

-READ DATA: Each flux-transition detected on the media provides a 125-nanosecond minimum active pulse on this line.

Note: The 500-kilobit-per-second rate is used by the 1.44MB Diskette Drive and 2.88MB Diskette Drive. The 1-megabit-per-second rate is used by the 2.88MB Diskette Drive.

-DISKETTE CHANGE: This signal is active unless a diskette is present and a -STEP pulse has been issued by the diskette controller while the drive is selected. The presence of a diskette is determined by a sensor.

-DRIVE TYPE: This signal is used to distinguish between 720KB and 1.44MB drives. When active, a 1.44MB drive has been selected. When inactive, a 720KB drive has been selected.

DRIVE TYPE ID 1-0/ENHANCED STAT (0, 1): These signals are driven by the selected drive to indicate the drive-type information. The following figure shows the relationship of these signals to the -SECURITY COMMAND signal (SC).

Note: If a drive supports the -SECURITY COMMAND signal, the these signals are driven to binary 11 when the -SECURITY COMMAND signal is active.

Drive Type 1 0	Type of Drive	
	SC = 1	SC = 0
0 0	1.44MB 3.5-inch	Non-secure 1.44MB 3.5-inch
0 1	2.88MB 3.5-inch	Non-secure 2.88MB 3.5-inch
1 0	5.25 inch, 1.2MB	Non-secure 5.25 inch, 1.2MB
1 1	Reserved	Secure drive

Figure 5. Drive Type ID 1 – 0

MEDIA TYPE ID 1-0/ENHANCED STAT (2, 3): These signals are driven by drives that support media sensing to identify the type of media in the drive. In addition, if the drive supports the -SECURITY COMMAND signal, it uses these signals to report the locked state of the drive when -SECURITY COMMAND is active.

The following shows the type of media indicated; these signals are supported for 3.5-inch media only.

Media Type 1 0	Type of Media Sensed
0 0	Reserved
0 1	4.0MB
1 0	2.0MB
1 1	1.0MB

Figure 6. Media Type 1 – 0

The following shows the locked state indicated. Both the drive and drive interface must support the -SECURITY COMMAND and the signal must be active for this information to be valid.

Enhanced Status 3 2	Drive State
0 0	Drive secure, media not present
0 1	Drive secure, media present
1 0	Drive unlocked
1 1	Reserved

Figure 7. Enhanced Status 3 – 2

Connectors

Two types of interface connectors are used: a 40-pin card-edge connector, or a 34-pin header connector.

Some diskette drive models have an integral interface adapter that converts the header interface on the drive to the 40-pin card-edge interface used in some PS/2 models.

40-Pin Card-Edge Interface

This connector shows a drive interface that is used by drives and controllers that do not support media sense. (See the system specific technical reference for more information.) Odd-numbered pins are in the left row and even-numbered pins are in the right row.

Pin	Signal	Pin	Signal
1	Ground	2	-High density select
3	Reserved	4	Reserved
5	Ground	6	Reserved
7	Ground	8	-Index
9	Ground	10	Reserved
11	Ground	12	-Drive select
13	Ground	14	Reserved
15	Ground	16	-Motor enable
17	Ground	18	-Direction in
19	Ground	20	-Step
21	Ground	22	-Write data
23	Ground	24	-Write enable
25	Ground	26	-Track 0
27	Ground	28	-Write protect
29	Ground	30	-Read data
31	Ground	32	-Head 1 select
33	Ground	34	-Diskette change
35	Ground	36	Ground
37	Ground	38	+5 V dc
39	Ground	40	+12 V dc

Figure 8. Signal Assignments for the 40-pin Card-Edge Interface

34-Pin Header Interface

This connector defines a drive interface that is used by drives and controllers that do not support media sense. (See the system specific technical reference for more information.) Odd-numbered pins are in the left row and even-numbered pins are in the right row.

Pin	Signal	Pin	Signal
1	Ground	2	-High density select
3	+5 V dc	4	Drive type ID 1
5	Ground	6	+12 V dc
7	Ground	8	-Index
9	Ground	10	Reserved
11	Ground	12	-Drive select
13	Ground	14	Reserved
15	Ground	16	-Motor enable
17	Ground	18	-Direction in
19	Ground	20	-Step
21	Ground	22	-Write data
23	Ground	24	-Write enable
25	Ground	26	-Track 0
27	Ground	28	-Write protect
29	Ground	30	-Read data
31	Ground	32	-Head 1 select
33	Ground	34	-Diskette change

Figure 9. Signal Assignments For the 34-pin Header Interface

Enhanced 34-Pin Header Interface

This connector defines the drive interface for drives and controllers that support media sense. Odd-numbered pins are in the left row and even-numbered pins are in the right row.

Pin	Signal	Pin	Signal
1	Ground	2	Data rate select 1
3	+5 V dc	4	Drive type ID 1/Drive status 1
5	Ground	6	+12 V dc
7	Ground	8	-Index
9	Drive type ID 0/Drive status 0	10	Reserved
11	Ground	12	-Drive select
13	Ground	14	-Security Command †
15	Ground	16	-Motor enable
17	Media type ID 1/Drive status 3	18	-Direction in
19	Ground	20	-Step
21	Ground	22	-Write data
23	Ground	24	-Write enable
25	Ground	26	-Track 0
27	Media type ID 0/Drive status 2	28	-Write protect
29	Ground	30	-Read data
31	Ground	32	-Head 1 select
33	Data rate select 0	34	-Diskette change

† This signal is not supported by all drives or all systems (see page 3).

Figure 10. Signal Assignments For the Enhanced 34-Pin Header Interface

Specifications

Size

- Height: 41.0 mm (1.6 in.), 27.0 mm (1.1 in.), 19.0 mm (0.75 in.) maximum
- Width: 102 mm (4.0 in.) maximum
- Depth: 150 mm (5.9 in.) maximum

Weight

- 0.68 kg (1.5 lb) maximum for 41 mm high versions
- 0.45 kg (1.0 lb) maximum for 27 mm high versions
- 0.25 kg (0.6 lb) maximum for 19 mm high versions

Voltage

- +12 V dc
- +5 V dc

DC Power

- 3.5 W maximum

Track Density: 135 tracks per inch

Number of Tracks: 80 per side

Number of Heads: 2

Maximum Transfer Rate

- 720KB Diskette Drive: 250 kbps (MFM)
- 1.44MB Diskette Drive: 500 kbps (MFM)
- 2.88MB Diskette Drive: 1000 kbps (MFM)

Access Time

- Track-to-Track: 3 ms (6 ms for 41 mm high drives and all 720KB drives)
- Seek Settle Time: 15 ms
- Average: 94 ms (173 ms for 41 mm high drives and all 720KB drives)

Rotation Speed: 300 rpm ±1.5%

Motor Start Time: 500 milliseconds

Medium

- 1.0MB 3.5-inch
  - Unformatted Capacity:
    - 1.0MB (500KB per side)
    - 6.25KB per track
  - Formatted Capacity:
    - 720KB (360KB per side)
    - 4.5KB per track
  - Standards Compliance:
    - ANSI X3.137
    - ISO 8860-1
    - ECMA 100
- 2.0MB 3.5-inch
  - Unformatted Capacity:
    - 2.0MB (1MB per side)
    - 12.5KB per track
  - Formatted Capacity:
    - 1.44MB (720KB per side)
    - 9KB per track
  - Standards Compliance
    - ANSI X3.171
    - ISO 9529-1
    - ECMA 125
- 4MB 3.5-inch
  - Unformatted Capacity:
    - 4MB (2MB per side)
    - 25KB per track
  - Formatted Capacity:
    - 2.88MB (1.44MB per side)
    - 18KB per track
  - Standards Compliance:
    - ISO 10994-1
    - ECMA 147