DISK DRIVE DESIGN GUIDE

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10/4/84

1.0 INTRODUCTION

This document describes guidelines for the design of disk drives for use on the Atari serial bus. It contains the information necessary to achieve:

- Compatibility with existing Atari disk drives.

- Conformance with SIO protocol, including the new SIO fast mode.

- Uniformity among differnet types of drives.

2.0 DISK DRIVE TYPES AND CONFIGURATIONS

Disk drives are characterized by "type" and by "configuration". "Type" refers to the physical characteristics of the drive, e.g., the number of tracks. "Configuration" refers to the logical characteristics of the drive, i.e., how the drive appears to the computer. Any given disk drive can be of only one type, but it may support several different configurations.

The primary reason for having a drive support multiple configurations is to maximize the degree of compatibility among different types of drives. Obviously, the physical charactersitics (type) of a drive will determine which configurations it is able to support and which it is not able to support.

It should be emphasized that while a given drive can be of only one type, it is entirely possible to write a disk controller which is capable of supporting several different types of drives. Jumpers on the PC board can be used to tell the controller what type of drive it is controlling. (The PERSEPHONE disk controller was designed this way.)

2.1 TYPES

The type of a disk drive is determined by the following four physical characteristics of the drive:

- Media size (8-inch, 5.25-inch, or 3.5-inch).

- Rotational speed (288 RPM or 300 RPM).

- Number of tracks (40 or 80).

- Number of heads (1 or 2).

From the standpoint of controller design, there is no difference between a 5.25-inch drive and a 3.5-inch drive; hence, we will not distinguish between these two types of drives. Furthermore, since 8-inch Atari drives are not contemplated, we will not discuss 8-inch drives at all.

It should be noted that there are other physical characteristics of the drive mechanism which must be taken into account by the controller (e.g., head step rate, head step and settle time, and spindle motor start-up time). However, these other physical properties of the drive do not affect the ability of the drive to support a given configuration, and so they will not be considered here.

2.2 CONFIGURATIONS

The configuration of a drive determines the following logical characteristics of the controller's behavior:

- Recording mode (FM or MFM).

- Number of sectors per track (16, 18, or 26).

- Number of bytes per sector (128 or 256).

- Number of logical tracks (40 or 80).

- Number of sides (1 or 2).

A given type of drive is not likely to support more than six combinations of these characteristics, which we will denote by the names SS/SD, SS/2D, SS/DD, DS/DD, SS/QD, and DS/QD. It should be noted, however, that the actual logical characteristics of the drive depend on both the configuration and the type; thus, the name "SS/DD" may mean different things on different types of drives. We will discuss each configuration below.

The configuration of a drive can change only when the controller is commanded to change by means of a PUT OPTION TABLE command. When the drive is powered on, it automatically goes into its default configuration. If the drive has 40 tracks, or if the drive has 80 tracks and the controller supports 40-track emulation, then the default configuration is SS/SD for 288 RPM drives and SS/DD for 300 RPM drives. If the drive has 80 tracks and the controller does not support 40-track emulation, then the default configuration is SS/QD.

2.2.1 THE SS/SD AND SS/2D CONFIGURATIONS

The SS/SD and SS/2D configurations are identical except in the case of a GENERIC FORMAT command or a GET OPTION TABLE command; hence, for our present purposes we will not distinguish between them.

The SS/SD and SS/2D configurations can be supported only by 288 RPM drives. An 80-track drive configured to SS/SD or SS/2D must emulate a 40-track drive by stepping twice for each track change.

In these configurations, the controller must be able to operate in either of two modes: FM mode or MFM mode. The controller itself must automatically select the correct mode, based on the diskette currently inserted in the drive.

In FM mode, the logical characteristics of the controller are:

- 1 side.

- 40 logical tracks.

- FM recording mode.

- 18 sectors per track.

- 128 bytes per sector.

In MFM mode, the logical characteristics of the controller are:

- 1 side.

- 40 logical tracks.

- MFM recording mode.

- 26 sectors per track.

- 128 bytes per sector.

2.2.2 THE SS/DD CONFIGURATION

Any type of drive can support the SS/DD configuration. An 80-track drive configured to SS/DD must emulate a 40-track drive by stepping twice for each track change.

For 288 RPM drives, the logical characteristics of the SS/DD configuration are:

- 1 side.

- 40 logical tracks.

- MFM recording mode.

- 18 sectors per track.

- 256 bytes per sector.

For 300 RPM drives, the logical characteristics of the SS/DD configuration are:

- 1 side.

- 40 logical tracks.

- MFM recording mode.

- 16 sectors per track.

- 256 bytes per sector.

2.2.3 THE DS/DD CONFIGURATION

Any type of drive with two heads can support the SS/DD configuration. An 80-track drive configured to SS/DD must emulate a 40-track drive by stepping twice for each track change.

For 288 RPM drives, the logical characteristics of the DS/DD configuration are:

- 2 sides.
- 40 logical tracks.
- MFM recording mode.
- 18 sectors per track.
- 256 bytes per sector.

For 300 RPM drives, the logical characteristics of the DS/DD configuration are:

- 2 sides.
- 40 logical tracks.
- MFM recording mode.
- 16 sectors per track.
- 256 bytes per sector.

2.2.4 THE SS/QD CONFIGURATION

The SS/QD configuration can be supported only by 80-track drives.

For 288 RPM drives, the logical characteristics of the SS/QD configuration are:

- 1 side.
- 80 logical tracks.
- MFM recording mode.
- 18 sectors per track.
- 256 bytes per sector.

For 300 RPM drives, the logical characteristics of the SS/QD configuration are:

- 1 side.

- 80 logical tracks.

- MFM recording mode.

- 16 sectors per track.

- 256 bytes per sector.

2.2.5 THE DS/QD CONFIGURATION

The DS/QD configuration can be supported only by 80-track drives with two heads.

For 288 RPM drives, the logical characteristics of the DS/QD configuration are:

- 2 sides.

- 80 logical tracks.

- MFM recording mode.

- 18 sectors per track.

- 256 bytes per sector.

For 300 RPM drives, the logical characteristics of the DS/QD configuration are:

- 2 sides.

- 80 logical tracks.

- MFM recording mode.

- 16 sectors per track.

- 256 bytes per sector.

2.3 SERIAL BUS MODES

In addition to type and configuration, a disk drive is further characterized by it current serial bus mode. There are two possible

modes: Slow mode and Fast mode.

In slow mode, all serial bus communication takes place at 19200 baud. In fast mode, command frames are transmitted at 19200 baud and data frames are transmitted at 38400 baud.

The drive must default to slow mode when it is powered on. It can change its mode only when commanded to do so by a SET SIO SPEED command.

The only disk operation that is affected by the drive's current serial bus mode is GENERIC FORMAT. For the GENERIC FORMAT command, the current serial bus mode may affect the sector interleave pattern.

Note that only Rev 4 and later versions of the Atari Operating System support the SIO fast mode.

3.0 DISK FORMATTING

When the disk controller receives a GENERIC FORMAT or DUAL DENSITY FORMAT command, it must format the entire diskette and then verify the entire diskette. This section describes the two format commands and specifies the data pattern that is to be written on the diskette during formatting.

3.1 FM FORMATS

In FM recording mode, the diskette is to be formatted as follows:

Number of bytes		Value and description	
40	$00	Post-index gap (Gap I)	
6	$00	Pre-mark gap (end of Gap III)	
1	$FE	ID address mark (IDAM)	
1	Track number ($00 thru $4F)		
1	Side number ($00 or $01)		R
1	Sector number ($01 thru $1A)		E
1	$00	Sector length	P
1	$F7	Writes 2 CRC bytes	E
11	$00	Post-ID gap (start of Gap II)	A
6	$00	Pre-mark gap (end of Gap II)	T
1	$FB	Data address mark (DAM)	
128	$FF	Data	
1	$F7	Writes 2 CRC bytes	
12	$00	Post-data gap (start of Gap III)	
16+	$00	Gap IV	

3.2 MFM FORMATS

In MFM recording mode, the diskette is to be formatted as follows:

Number of bytes		Value and description	
60	$4E	Post-index gap (Gap I)	
12	$00	Pre-mark gap (end of Gap III)	

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        3         $F5   Writes $A1 MFM sync byte          |
        1         $FE   ID address mark (IDAM)            |
        1         Track number ($00 thru $4F)               |
        1         Side number ($00 or $01)                  R
        1         Sector number ($01 thru $1A)              E
        1         $00 or $01  Sector length             P
        1         $F7   Writes 2 CRC bytes                E
       22         $4E   Post-ID gap (start of Gap II)     A
       12         $00   Pre-mark gap (end of Gap II)      T
        3         $F5   Writes $A1 MFM sync byte          |
        1         $FB   Data address mark (DAM)           |
 128 or 256       $FF   Data                              |
        1         $F7   Writes 2 CRC bytes                |
       24         $4E   Post-data gap (start of Gap III)  |
                                  ------------------+
      16+         $4E   Gap IV
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3.3 INDEX ADDRESS MARKS

It should be noted that the above formats do not use the index address mark (IAM). This is because FDC chips which are designed for minifloppy drives may not be guaranteed to be able to write the IAM.

Industry standard practice is to include the IAM on 8-inch disks and to omit the IAM on 5.25-inch and smaller disks. In the past, Atari has departed from industry standard by including the IAM in both the 810 and the 1050 disk drive. This has not caused a problem because the FDC chips used in the 810 and 1050 (the 1771 and 2793 respectively) are designed to handle 8-inch drives. Future disk drives are likely to use less-expensive FDC chips which cannot handle 8-inch drives (e.g., the 1770), and so it is prudent to omit the IAM. The 810 and 1050 drives have no problem reading diskettes which do not have an IAM.

3.4 SECTOR INTERLEAVE PATTERNS

The sector interleave pattern depends on the recording mode, the number of bytes per sector, the rotational speed of the disk, and the serial bus mode. In addition, on double-sided disks, the interleave pattern is different on the second side of the disk than it is on the first side.

For FM, 288 RPM, 128 bytes per sector, fast or slow mode, side 0:

1,3,5,7,9,11,13,15,17,2,4,6,8,10,12,14,16,18

For MFM, 288 RPM, 128 bytes per sector, fast or slow mode, side 0:

1,3,5,7,9,11,13,15,17,19,21,23,25,2,4,6,8,10,12,14,16,18,20,22,24,26

For MFM, 288 RPM, 256 bytes per sector, slow mode, side 0:

1,7,13,6,12,18,5,11,17,4,10,16,3,9,15,2,8,14

For MFM, 288 RPM, 256 bytes per sector, fast mode, side 0:

1,3,5,7,9,11,13,15,17,2,4,6,8,10,12,14,16,18

For MFM, 288 RPM, 256 bytes per sector, slow mode, side 1:

18,12,6,13,7,1,14,8,2,15,9,3,16,10,4,17,11,5

For MFM, 288 RPM, 256 bytes per sector, fast mode, side 1:

18,16,14,12,10,8,6,4,2,17,15,13,11,9,7,5,3,1

For MFM, 300 RPM, 256 bytes per sector, slow mode, side 0:

1,15,14,13,12,11,10,9,8,7,6,5,4,3,2

For MFM, 300 RPM, 256 bytes per sector, fast mode, side 0: