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DISK DRIVE ACCESSING SYSTEM AND METHOD OF ACCESSING A DISK DRIVE

The present invention relates to a disk drive accessing system and to a method for accessing a disk drive.

Hard disk data storage systems contain one or more magnetic disks on which data is stored in sectors which lie in concentric tracks on the disks. A transducer (or head) flies above a track and writes, or magnetically encodes, the data in a sector on the track. The head is also capable of reading the magnetically encoded data from the sectors.

An electro-mechanical actuator operates within a negative feed back, closed loop servo system. The actuator moves the head radially for track seek operations and holds the transducer directly over a track for track following operations.

Typically, a stack of disks is mounted on a spindle. Each surface on each magnetic disk has one corresponding head. All the heads are moved together by the electro-mechanical actuator to different tracks on the disk surface. The collection of the tracks under all the heads at any given radial position along the disk stack is known as a cylinder. Data read from the sectors by the heads is demodulated in a disk drive interface and provided to a host computer.

In the past, serial or classical disk drive interfaces (such as the ESDI or ST506 interfaces) demodulated the data read from the track on a magnetic disk and provided it in serial form. An additional component, known as a disk drive controller, checked the integrity of the data provided by the serial disk drive interface and converted the serial flow of data

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The PC-AT type host computer contains a table of disk drive types, which correspond to the drive types with which the host computer will operate. That table contains the number of cylinders, heads and sectors per track for each drive type entered in the table. This table is fixed in a Basic Input/Output System (BIOS) ROM located in the host computer.

A power up program, which is also stored in the BIOS ROM, provides the disk drive controller with the disk drive parameters, from the table, which correspond to the disk drive type with which the host computer is programmed to operate. The disk drive controller then configures itself to match the table entry corresponding to the disk drive parameters provided by the power up program.

However, all disk drive types included in the table in the IBM PC-AT computer use a sector number of seventeen sectors per track. This fixed table imposes a limitation on the maximum disk drive capacity that the host computer can access. In other words, if the host computer cannot command a disk drive to configure itself for more than seventeen sectors per track because of the fixed table in the BIOS ROM, the computer is unable to access the maximum capacity for some high capacity disk drives, which are installed for operation with the host computer. This is an increasing problem with the advances currently being made in enlarging disk capacity.

The computer typically addresses the disk drive through BIOS calls. Presently, typical BIOS programs allow up to one thousand and twenty four cylinders, sixteen heads and sixty four sectors per track to be addressed. Hence, the maximum disk drive capacity addressable by the BIOS is 1,048,576 blocks (536,870,912

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bytes). But, if the computer cannot address more than seventeen sectors per track because of the fixed list in the BIOS, the addressable disk drive capacity is cut down to 278,528 blocks (142,606,336 bytes).

According to the present invention, in one aspect, there is provided a disk drive accessing system for retrieving data from and writing data to a disk drive, comprising a system controller having a basic input/output system memory device containing an address parameter table corresponding to a pre-determined type of disk drive whereby the system controller can access address locations on a disk drive in operation based on address parameters in the address parameter table, an adapter for coupling the system controller to the disk drive, and characterised by an instruction device carried by the adapter and configured to cause the system controller to identify the respective disk drive and to revise the address parameter table, used by the system controller for accessing the address locations on the disk drive, to correspond to the respective disk drive identified.

Advantageously, the instruction device is arranged to cause the system controller to prepare a revised address parameter table, which is suitable for use by the system controller to access substantially all of the address locations on the identified disk drive. The system controller may achieve this by co-operating with disk drive configuring means for configuring the disk drive based on the revised address parameter table whereby substantially all the address locations on the identified disk drive are accessible by the system controller.

According to the present invention, in another aspect, there is provided a method for accessing a disk

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drive employing a system controller having a basic input/output system memory device containing an address parameter table corresponding to a pre-determined type of disk drive, wherein the system controller accesses address locations on the disk drive based on address parameters in the address parameter table, characterised by identifying the respective disk drive and revising the address parameter table used by the system controller for accessing the address locations on the disk drive to correspond to the respective disk drive identified.

Preferably, the present invention takes advantage of a built in feature in a BIOS power up program, which orders a host computer to search for and execute BIOS extensions during a power up sequence. By taking advantage of this built in feature, the present invention may adapt a disk drive accessing system for accessing a storage capacity on at least one disk drive.

The present invention also provides a method of accessing a disk drive characterised by accessing a basic input/output system extension memory device to retrieve BIOS extension instructions, comprising identifying the disk drive to be accessed, determining address parameters for the disk drive identified, the address parameters corresponding to substantially the maximum storage capacity of the disk drive identified, providing the address parameters to the disk drive accessing system, the address parameters suitable for being used by the accessing system in accessing the maximum storage capacity of the disk drive, and configuring the disk drive being accessed using the address parameters determined.

Preferably, in the above method, an address parameter table corresponding to a pre-determined type

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of disk drive is retrieved and is written to an operations memory device, and this address parameter table is revised based on the address parameters determined for the identified disk drive. The address parameter table may, for example, be revised by replacing the location of the address parameter table in the operations memory device with the location of the determined address parameters.

The present invention, in a still further aspect, provides a data storage system comprising: a disk drive having address locations for storing data, a system controller suitable for accessing the address locations on the disk drive to retrieve data from the disk drive and to write data to the disk drive, an adapter for coupling the system controller to the disk drive, and characterised by memory means carried by the adapter for storing instructions for the system controller.

Preferably, the memory means of the above system comprise a BIOS extension memory including a program sequence for instructing the system controller to identify the disk drive type and to revise accordingly an address parameter table, which corresponds to a predetermined disk drive type and which is stored in a memory of the system controller.

The system controller may comprise an operational memory for storing instructions for the system controller to be accessed by the system controller during operation. In use, a location of the revised address parameter table may be transferred by the system controller to the operational memory such that the location of the revised address parameter table effectively replaces a location in the operational memory of the address parameter table corresponding to a predetermined disk drive type.

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The present invention is described further, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a block diagram of a data storage system;

Figure 2 is a top view of a disk in the data storage system shown in Figure 1;

Figure 3A is a more detailed block diagram of a host computer and adapter of a prior art data storage system;

Figure 3B is a more detailed block diagram of a host computer with adapter of a data storage system according to the present invention; and

Figure 4 is a block diagram of an alternative embodiment of data storage system according to the present invention.

Figure 1 is a block diagram of a hard disk data storage system 10, which includes a host computer 12, an adapter 13 and a disk drive 14. The disk drive 14 includes a disk drive controller 16, conditioning logic 18, a rotary actuator 20, transducers or read/write heads 22, 24, 26, 28, 30, 32, 34, 36, 38 and 40 (heads 22 to 40), magnetic disks 42, 44, 46, 48 and 50 (disks 42 to 50) and a spindle 52. During operation of the disk drive 14, the disks 42 to 50 spin with the spindle 52. The heads 22 to 40 fly above the disks 42 to 50 either reading magnetically encoded data from the surfaces of the disks 42 to 50 or encoding (writing) information on the disk surfaces. While reading information, the heads 22 to 40 produce signals representative of the data on the disk surfaces and provide those signals to the conditioning logic 18. The conditioning logic 18 conditions the signals and provides them in serial form to the drive controller 16.

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This flow of information from the heads 22 to 40 to the drive controller 1 is indicated by arrows 54 and 56.

The drive controller 16, in turn, converts the serial data received from the conditioning logic 18 into parallel data and provides it to the adapter 13. The adapter 13 adapts the information received from the drive controller 16 for compatibility with a data bus in the host computer 12. The host computer 12 also provides the adapter 13 with control information for the disk drive 14. The adapter 13 adapts the information received from the host computer 12 for compatibility with the drive controller 16. Based on that control information and position error information read from the disks 22 to 40, the drive controller 16 provides control signals to the conditioning logic 18 and the actuator 20. This is indicated by arrows 58 and 60.

The control signals provided by the drive controller 16 to the conditioning logic 18 dictate, for example, the data of which head should be demodulated by the conditioning logic 18 and provided to the drive controller 16. The control signals provided to the actuator 20 cause the actuator 20 to rotate. Rotation of the actuator 20 causes the heads 22 to 40 to move radially with respect to the disks 42 to 50.

Figure 2 shows a typical disk surface. The surface of the disk 42 contains a plurality of tracks. For clarity, only two tracks, 62 and 64 are shown in Figure 2. Each track on the surface of the disk 42 is divided into sectors. The sector divisions on the track 62 are indicated by the radially oriented lines 71, 73, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 95, 97, 99 and 101. The head 22 is positioned over a sector 68 of the track 62 on the disk 42. As the disk 42 rotates in the direction indicated by arrows 66, the head 22 flies

above the track 62 and data is read from or written to the track 62.

As the actuator 20 rotates and moves the heads 22 to 40, the head 22 moves radially with respect to the disk 42 along an arc indicated by arrows 70. All the heads are moved together as the actuator 20 rotates. Therefore, the heads 22 to 40 are simultaneously moved over corresponding tracks on each disk as the actuator 20 rotates. The collection of tracks under the heads 22 to 40 at a given radial position is known as a cylinder. Therefore, the number of cylinders and the number of tracks per surface on the disks 42 to 50 is the same. Also, the number of tracks per cylinder is the same as the number of the heads 22 to 40 in the disk drive 14.

An individual data sector on one of the disks 42 to 50 is addressed by its cylinder address, head address and sector number. The term "address" in cylinder address and head address implies a number in a sequence starting with 0. The term "number" in sector number implies a number in a sequence starting with 1. For example, the first sector available in the disk drive 14 is addressed as cylinder 0, head 0 and sector 1. Hence, when the host computer 12 accesses a particular sector or sectors on one of the disks 42 to 50, it specifies to the drive controller 16 the requested sector number, head address and cylinder address. The drive controller 16, in turn, causes the actuator 20 to move the heads 22 to 40 to the correct cylinder. The drive controller 16 also controls the conditioning logic 18 to demodulate information from the correct head.

Figure 3A is a more detailed block diagram of the host computer 12 and adapter 13 in the prior art. The host computer 12 includes a CPU 72, a CMOS RAM 74, a

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BIOS ROM 76, a system RAM 102 and, in this embodiment, a ninety eight pin I/O connector 78. The adapter 13 includes a ninety eight pin edge connector 80, decoding logic 82 and a forty pin connector 86. The decoding logic 82 adapts information sent by either the CPU 72 or the drive controller 16 for compatibility with the ninety eight pin data bus configuration of the host computer 12, or the forty pin data bus configuration of the drive controller 16, respectively.

The host computer 12 is a typical PC-AT type computer. Therefore, it contains a table of disk drive types, which is fixed in the BIOS ROM 76. The table defines the number of cylinders, heads and sectors per track for each drive type in the table. During power up, the CPU 72 accesses the BIOS ROM 76 for power up instructions. A BIOS power up program causes the CPU 72 to retrieve a drive type from the CMOS RAM 74, which allows the CPU 72 to retrieve the appropriate drive parameters from the BIOS ROM 76. The location of the drive parameter table in the BIOS ROM 76 is then stored by the CPU 72 in the system RAM 102. The location of the table is then available to the CPU 72 from the system RAM 102 for as long as the computer remains powered. The drive parameters in the BIOS ROM 76 corresponding to the drive type stored in the CMOS RAM 74, themselves, correspond to the drive type which the host computer 12 expects to be installed. Then, before accessing the disk drive 14, the CPU 72 retrieves the address parameters stored in the BIOS ROM 76 at the location indicated in the CMOS RAM 102 and sends them, via the adapter 13, to the drive controller 16. The drive controller 16 then configures the disk drive 14 for being accessed according to the drive parameters sent by the CPU 72.

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However, where the actual physical storage capacity of the disk drive 14 is greater than any of the disk drive types present in the table in the BIOS ROM 76, the host computer 12 is incapable of accessing the entire physical storage capacity of the disk drive 14. Hence, some of the physical storage capacity of the disk drive 14 is wasted.

Figure 3B is a block diagram of the host computer 12 and adapter 13 of the present invention. The components of Figure 3B are the same as those shown in Figure 3A except that a BIOS extension 84 is added to the adapter 13.

When the CPU 72 accesses the BIOS ROM 76 during the power up program, one of the operations in the power up sequence is that the CPU 72, after executing the instructions of the BIOS ROM 76, looks for any BIOS extensions which are to be accessed for instructions to be executed during power up. Upon looking for a BIOS extension, the CPU 72 locates the BIOS extension 84.

In this preferred embodiment, the BIOS extension 84 is a programmable read only memory (PROM) containing several instructions. First, the BIOS extension 84 instructs the CPU 72 to interrogate the disk drive 14 and identify its actual type (i.e. its actual physical configuration). This can be done either by retrieving a model number from the drive controller 16 or by retrieving the actual physical capacity of the disk drive 14. Then, the CPU 72 is instructed to determine address parameters, such as the number of cylinders, the number of heads and the number of sectors per track for the disk drive 14. The CPU 72 sends this information to the drive controller 16 which, in turn, configures the disk drive 14 for being accessed.

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Also, the BIOS extension 84 instructs the CPU 72 to store the location of the drive parameters for the identified drive, which are tabulated and stored in the BIOS extension 84, into the system RAM 102. Hence, after power up, and during operation of the data storage system 10, the CPU 72 does not need to interrogate the disk drive 14 each time it accesses the disk drive 14. Rather, all of the essential address parameters are stored in the BIOS extension 84 for ready access by the CPU 72.

Figure 4 is a block diagram of another embodiment of the present invention. The data storage system shown in Figure 4 is the same as that shown in Figure 1 except that a second disk drive 88 is added to the data storage system. The disk drives 14 and 88 are coupled in a known master/slave relationship. The BIOS extension 84 in the adapter 13 operates in the same way as described with reference to Figure 3B except that it instructs the CPU 72 not only to interrogate and determine drive parameters for the disk drive 14 but also to interrogate and determine drive parameters for the disk drive 88. The location of the drive parameters in the BIOS extension 84, which are appropriate for the drive 88, is stored in the system RAM 102 as well.

The only additional step which must be taken is that the host computer 12 must be initialised to recognise the number of drives attached. However, the type of drive attached and its corresponding address parameters are automatically provided to the CPU 72 by instructions in the BIOS extension 84.

It should be noted that the adapter board 13 is capable of being provided with hardware jumpers to allow the location of the BIOS extension 84 in the system memory to be selectable. This reduces the possibility

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of conflict with memory space occupied by other BIOS extensions located on other adapters 13.

The present invention allows the entire physical storage capacity of even high capacity disk drives to be utilised by a host computer. By using a BIOS extension to accomplish this, the high capacity disk drives used are automatically integrated into an existing system. This eliminates re-writing the BIOS stored in the BIOS ROM 76 and thereby possibly creating other problems in the operating system of the host computer 12.

Also, by mounting the BIOS extension 84 in the adapter 13, hardware need not be added to mother boards in the host computer 12. This eliminates any re-design or re-layout of the hardware in the host computer 12.

In addition, many customers who contemplate buying high capacity disk drives require that they have a chance to evaluate the disk drives before purchasing them. With the present invention, the adapter 13 can be coupled to any high capacity disk drive and the disk drive can be evaluated with no change whatsoever to the potential customer's system.

Also, the present invention allows future disk drive designs, with even larger capacities, to be automatically integrated with existing host computer systems. No additional programming is required of the BIOS in the BIOS ROM 76 or that in the BIOS extension 84. This allows the full capacity of these disk drives to be used even in systems which lack appropriate drive type tables in the BIOS ROM 76.

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1. A disk drive accessing system for retrieving data from and writing data to a disk drive, comprising a system controller (12) having a basic input/output system (BIOS) memory device (76) containing an address parameter table corresponding to a pre-determined type of disk drive whereby the system controller can access address locations on a disk drive in operation based on address parameters in the address parameter table, an adapter (13) for coupling the system controller to the disk drive, and characterised by an instruction device (84) carried by the adapter and configured to cause the system controller to identify the respective disk drive and to revise the address parameter table, used by the system controller for accessing the address locations on the disk drive, to correspond to the respective disk drive identified.

2. A system according to claim 1 characterised in that the system controller comprises an operational memory (102) for storing instructions for access during operation, the operational memory including a location for the address parameter table, and in that the instruction device is arranged to replace the location for the address parameter table with a location for address parameters for the respective disk drive for revising the address parameter table.

3. A system according to claim 1 or 2 characterised in that the instruction device is arrange to identify a maximum number of cylinders, a maximum number of heads and a maximum number of sectors in the respective disk drive for determining a revised address parameter table such that substantially all the address locations on the

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respective disk drive are accessible by the system controller during operation.

4. A system according to any of claims 1 to 3 characterised in that the BIOS memory device includes a power up routine and in that the instruction device is arranged to cause the system controller to identify the respective disk drive and to revise the address parameter table during execution of the power up routine.

5. A system according to any of claims 1 to 4 characterised in that the instruction device is configured to cause the system controller to identify each of a plurality of respective disk drives and to determine an associated revised address parameter table corresponding to each of the plurality of respective disk drives identified whereby the address locations on each of the plurality of respective disk drives are accessible by the system controller during operation.

6. A system according to any preceding claim characterised in that the instruction device comprises a BIOS extension memory device.

7. A method for accessing a disk drive employing a system controller (12) having a basic input/output system (BIOS) memory device (76) containing an address parameter table corresponding to a pre-determined type of disk drive, wherein the system controller accesses address locations on the disk drive based on address parameters in the address parameter table, characterised by identifying the respective disk drive and revising the address parameter table used by the system controller for accessing the address locations on the disk drive to correspond to the respective disk drive identified.

8. A method according to claim 7 characterised in

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that the step of identifying comprises interrogating the respective disk drive to identify a maximum number of cylinders, a maximum number of heads and a maximum number of sectors in the respective disk drive, and in that the step of revising the address parameter table comprises determining address parameters corresponding to said maximum number of cylinders, heads and sectors and revising the address parameter table based on the determined address parameters.

9. A method according to claim 7 or 8 characterised in that the steps of identifying and revising are performed during a power up sequence.

10. A method according to any of claims 7 to 9 characterised in that the step of identifying comprises identifying each of a plurality of respective disk drives, and in that the step of revising comprises determining address parameters for each of the plurality of respective disk drives and respectively revising the address parameter table based on the determined address parameters for each of the plurality of respective disk drives.

11. A method of accessing a disk drive characterised by accessing a basic input/output system (BIOS) extension memory device to retrieve BIOS extension instructions, comprising identifying the disk drive to be accessed, determining address parameters for the disk drive identified, the address parameters corresponding to substantially the maximum storage capacity of the disk drive identified, providing the address parameters to the disk drive accessing system, the address parameters suitable for being used by the accessing system in accessing the maximum storage capacity of the disk drive, and configuring the disk drive being accessed using the address parameters determined.

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12. A data storage system comprising a disk drive (14) having address locations for storing data, a system controller (12) suitable for accessing the address locations on the disk drive to retrieve data from the disk drive and to write data to the disk drive, an adapter (13) for coupling the system controller to the disk drive, and characterised by memory means (84) carried by the adapter for storing instructions for the system controller.