



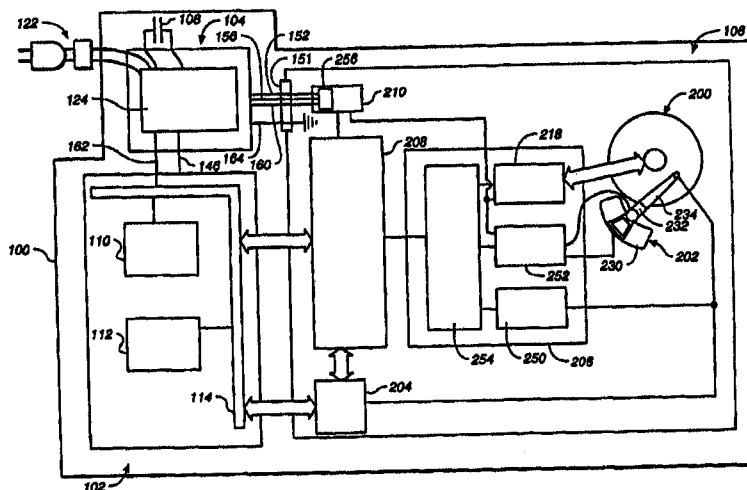
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(54) Title: DUAL MODE DISC DRIVE AND METHOD



(57) Abstract

Disc drives (106) have a data storage disc (212), a motor (216) for rotating the data storage disc and a servo controller (206). The disc drive (106) includes a power source evaluator (210) that evaluates an electrical property for evaluating whether a battery power source (108) or a line power source (122) is supplying power to operate the disc drive. The servo controller (206) receives a signal from the power source evaluator (210) and provides a different instruction regarding the spin angular velocity depending on the evaluation regarding the power source. In accordance with one embodiment of the invention, a method (300) for operating a disc drive is provided in which the availability of line power to a power source is evaluated (304). Subsequently, the angular velocity of the rotating disc (212) is adjusted (306) based on the evaluation of the availability of line power to the power source.

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DUAL MODE DISC DRIVE AND METHODFIELD OF THE INVENTION

The invention relates generally to portable disc drive data storage units. More particularly, the invention relates to disc drive data storage units with a plurality of operational angular velocities for a disc drive motor.

BACKGROUND OF THE INVENTION

Disc drives are used for storing information, typically as magnetically encoded data, and more recently as optically encoded data, along a disc surface. The disc spins at high rotational velocities such that an adjacent head or slider flies above the disc surface on a cushion of air. The head generally includes a transducer or focusing device for reading or writing the data or for transmitting focused light between the disc and a transducer. A suspension arm is used for accessing different data tracks radially positioned on the rotating discs by positioning the head accordingly.

In an increasingly mobile society, portable electronic devices using disc drive data storage units have found wide popularity. In particular, the demand for mobile computing capability has resulted in the popularity of portable computers, known as laptops. Disc drives for portable computers and other portable electronic devices have significant constraints with respect to size, weight and power consumption. A suitable hard disc drive for a portable computer is described, for example, in U.S. Patent 5,872,669 to Morehouse et al., entitled, "Disk Drive Apparatus With Power Conservation Capability."

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Since portable electronic apparatuses equipped with a disc drive generally can operate for only a limited period of time under battery power, the level of power consumption is an important criteria for evaluating disc drive performance. In particular, battery life, i.e., the length of time a battery can be used before the voltage of the battery drops below minimum functional values, depends directly on the power consumption including power consumption of the disc drive. Power consumption of a portable disc drive can be reduced by spinning down the disc during periods of non-use.

In addition, the performance parameters of a portable disc drive are selected to reduce power consumption. Particularly, the portable disc drives generally have lower disc spin speeds than high performance stationary disc drives. However, low spin speeds result in slower operation times because more time is needed to position the read/write head at the proper position over the disc surface. Specifically, the seek time to locate a particular data track is a function of the access to servo information stored on the disc. Thus, slower spin speeds results in slower access to servo information. Also, positioning the head at the proper sector within a data track takes longer at slower rotation speeds. Thus, use of portable disc drives results in reduced disc drive performance due to slower spin speeds.

The portability of the device provides the user with the option of transporting the device between locations for use. While portable electronic devices can be used at remote locations where line power is not available, they are often used at a desk or other locations where line voltage is readily available. The

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alternative location may or may not have line voltage available. However, due to power saving designs of the disc drive, the user must tolerate reduced performance characteristics of the disc drive even when power
5 consumption is not a concern because line voltage is available at the particular location.

The present invention addresses these and other problems, and offers other advantages over the prior art.

10

SUMMARY OF THE INVENTION

The present invention relates to disc drives that have at least two modes of operation, such that, for example, the disc drive can operate with increased power consumption when line voltage is available and
15 with lower power consumption when only battery power is available. Having a higher power consumption mode for use when line power is available provides for improved disc drive performance when power conservation is not a consideration. The disc drive includes a power source
20 evaluator for determining the appropriate mode of operation for the disc drive. Power mode selection can be made by the user and/or through an automatic selection by evaluating the power source. User input can be used to select a power mode regardless of the
25 power source.

In accordance with one embodiment of the invention, a method for operating a disc drive is provided in which selection of operation in a high or low power mode occurs by examining an electrical
30 property. Subsequently, the angular velocity of the rotating disc is adjusted based on the selection of the power mode.

These and various other features as well as advantages which characterize the present invention will

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be apparent upon reading of the following detailed description and review of the associated drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic layout of a portable electronic device with a processor, a power supply and a disc drive.

Fig. 2 is a schematic layout of the power supply of the device in Fig. 1.

Fig. 3 is a schematic layout of an alternative embodiment of the power supply of the device of Fig. 1 with a fragmentary view of the disc drive.

Fig. 4 is a schematic layout of another alternative embodiment of the power supply of the device of Fig. 1 with a fragmentary view of the disc drive.

Fig. 5 is a schematic view of a disc assembly of a disc drive.

Fig. 6 is a flow chart outlining performance of a read/write operation by a disc drive.

Fig. 7 is a flow chart outlining performance of a specific embodiment of a read/write operation by a disc drive.

DETAILED DESCRIPTION

To achieve improved performance characteristics when power conservation is not critical, the performance of portable disc drives can be enhanced when line power is available. In particular, preferred portable disc drives are designed to operate in at least two power modes. One or more power modes generally are operative when an external power source is available. One or more other power modes generally are used when the drive is running from battery power. Thus, during periods when line voltage is available, the user can take advantage of disc drive performance more comparable to corresponding disc drives for stationary devices. A

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power source evaluator is used to determine the characteristics of the power source such that the appropriate operation mode can be selected. In preferred embodiments, the operator can switch to a desired power mode as an approach to select the power mode or to override default power mode selection.

Disc drive data storage systems can be based on, for example, magnetic, optical or magneto-optical data storage. Appropriate portable disc drive data storage systems can be involved in the reading and/or writing of data with respect to the disc. The portable disc drive can involve one or more discs, and the disc can have any shape and size, although the discs generally are round. Preferred embodiments include, for example, portable hard disc drives with a plurality of fixed discs. In alternative embodiments, the discs within the portable drive unit are interchangeable.

To read and/or write data with respect to the disc, a head is positioned above the appropriate part of the disc to perform the operation. The head is used to transmit the data onto and/or off from the disc. To accomplish this function, the head can include a transducer such that the data is converted between an electrical signal and a storage form, such as a magnetic or optical feature associated with the disc. Alternatively, the head can include a transmitter, such as a lens or the like, that is used to transmit the local information at the disc surface to a remote transducer that forms a corresponding electrical signal.

To access desired portions of the disc, the head is mounted on a movable arm connected to an actuator. The disc generally is spun at high velocity such that the head can access any point along a circumference of the disc at a single position of the

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arm. Generally, the arm can be moved roughly radially along the disc surface to access data tracks along radii of the disc. When the disc is spinning at high speeds, the head flies above the disc surface on a cushion of air.

Powering the disc drive with a battery generally introduces significant constraints with respect to power consumption. First, portable disc drives generally have operated at lower voltages than stationary disc drives powered exclusively by line power. In particular, laptop computer disc drives generally operate at five volts, i.e., the voltage often used for digital circuits. In preferred embodiments discussed in this application, the portable disc drive operates at a higher voltage when line voltage is available than when only battery power is available. Preferably, a voltage of 12 volts is used for the motors of the disc drive when line voltage is available, since 12 volts or higher is generally produced by conventional ac adapters for portable electronic devices and since 12 volts is the voltage generally used by high performance disc drives in stationary computer disc drives. Use of a higher voltage reduces resistance in the disc motor and in the actuator coil.

In addition, portable disc drives generally operate at slower spin speeds to reduce power consumption and the corresponding rate of battery discharge. Slower spin speeds result in correspondingly slower seek times to identifying a desired data storage track as the actuator positions the heads for accessing the data. Total access times for reading or writing data are the sum of a latency period and a seek period. When line power is available, the disc can be operated at a higher spin speed to reduce total access times.

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The seek profiles for positioning the head along the right data track can be adjusted accordingly based on the angular velocity of the disc and the voltage applied to the actuator motor. In preferred embodiments, the user can select the power mode to override any default selections.

The disc drive is connected to a power supply circuit. The disc drive controller includes a power source evaluator that can measure the voltage or other property of the current coming from the power source to evaluate whether to operate in a high power mode or a low power mode. In alternative embodiments, the power supply is connected to the power source evaluator of the disc drive such that a signal from the power supply, such as from a current meter, indicates whether line power is available to the disc drive. The signal from the power supply can be an analog signal or a digital signal. If line power is available, the controller can implement operation by the disc drive in high power consumption mode, such as instructing the motor controller to operate at a higher velocity, instructing the actuator to implement an alternative seek profile and adjusting the processing of servo sampling information from the head to account for the different spin speeds.

A. Disc Drive Apparatus

Referring to Fig. 1, an apparatus 100 includes a processor 102, a power supply 104, a disc drive 106, and a battery 108. For convenience, the packaging of processor 102, power supply 104 and disc drive 106 may not have all of their components physically separated within apparatus 100. Processor 102 generally includes memory 110, such as RAM memory and the like, microprocessing chip 112, and a data bus 114. The

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precise configuration will depend on the function of the apparatus. In preferred embodiments, the apparatus is a laptop computer, although apparatus 100 can be other portable electronic devices using a disc drive data storage system.

Power supply 104 includes an adapter 122 for accessing line voltage, and a power supply circuit 124. Power supply 104 is connected to battery 108. A suitable power supply circuit 124 is shown in Fig. 2. Battery 108 is connected to power supply circuit 124 with battery wire 130. Adapter 122 includes a plug 132 connected to a transformer/rectifier 134 and a wire 136 to connect with power supply circuit 124. Transformer/rectifier 134 converts AC line power to DC voltage and steps down the line voltage generally to 19 Volts, although other voltages can be used as desired. Transformer/rectifier 134 can be omitted if an appropriate voltage direct current source, such as a vehicle's cigarette lighter, is used as an external power source.

In this embodiment, power supply circuit 124 has a low voltage segment 138, a battery voltage segment 139 and a high voltage segment 140. Low voltage segment 138 generally is at 5 volts or 3.3 volts, which are standard voltages for operating digital circuitry. High voltage segment 140 generally is at 19 volts, which is the standard voltage for transformed line power for both recharging batteries and operating stationary disc drives and auxiliary equipment such as fans. The voltage of battery 108 is typically 12 to 14.4 volts. High voltage segment 140 is connected to battery wire 130 by way of charge unit 142, which has circuits that mediate the charging of battery 108 when line power is available. Battery wire 130 is connected to low voltage

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segment 138 by a DC to DC transformer 144, which can include a converter controller. Low voltage segment 138 is connected by way of wire 146 to processor 102 to supply power for processor 102.

5 High voltage segment 140 is connected to low voltage segment 138 by way of a DC-DC transformer 150. Power supply circuit 124 is connected to disc drive 106 through a connector 151. In a typical commercial embodiment, connector 151 includes two pins for power and two pins for ground. In the embodiment of Fig. 2, 10 a wire 152 is connected to switch 154 and to disc drive 106. Switch 154 selects between supplying high voltage from high voltage segment 140 if line power is available and low voltage from low voltage segment 138 if line 15 power is not available. Switch 154 can be, for example, a solid state relay or a mechanical relay. In alternative embodiments, switch 154 can be a manual switch that is set by the user. Low voltage segment 138 can also be connected to disc drive 106 with wire 156 to 20 supply low voltage power for processors and other low voltage components when wire 152 is supplying high voltage power. Disc drive 106 can include a DC-DC transformer to supply low voltage from high voltage power supplied from wire 152 as an alternative to having 25 a separate low voltage power supply, wire 156. Ground wire 164 also connects power supply 104 and disc drive 106.

30 In alternative embodiments, only power from low voltage segment is supplied to disc drive 106 using wire 156. In these embodiments, switch 154 and associated connections are not present. Then, disc drive 106 operates at the lower voltage in both a higher power consumption mode and a lower power consumption mode.

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The availability of line power and corresponding high voltage power in high voltage segment 140 is evaluated with meter 158, which can be a voltmeter, current meter or the like. Thus, meter 158 examines the properties of the electrical power in high voltage segment 140. The results of the examination in the form of a reading from meter 158 can be used for evaluating the availability of external power and for determining corresponding power mode of the disc drive.

10 The reading from meter 158 generally is supplied to processor 104 by way of connection 160 to allow the monitoring of power usage and to disc drive 106 by way of connection 162, such that disc drive 106 can switch between a higher power consumption mode when line power is available and a lower power consumption mode when line power is not available. Meter 158 can include, for example, amplifiers, A-D converters, digital processors and the like to condition the signal relating to the availability of high voltage power.

20 An alternative embodiment of power supply 104 is shown in Fig. 3. In this embodiment, switch 154 is omitted. In this embodiment, battery voltage is supplied to disc drive 106 through wire 170, and low voltage is supplied again through line 156. Wires 156, 164 and 170 from power supply 104 lead to connector 151 of disc drive 106. Wires 156 and 170 connect, respectively, to diodes 172, 174. If high voltage is supplied to diode 174, diode 172 closes, high voltage is supplied by wire 176. In one embodiment, diodes 172, 174 include diode-connected field effect transistors.

30 A second alternative embodiment for power supply 104 is shown in Fig. 4. In this embodiment, high voltage segment 140 is connected to diode 180, and low voltage segment 138 is connected to diode 182. Diodes

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180, 182 connect to common wire 184, which connects with wires 146, 156. If high voltage is available in segment 140, diode 180 opens and diode 182 closes such that high voltage is supplied to 146, 156. If high voltage is not available in high voltage segment 140, diode 180 closes and diode 182 opens such that low voltage is supplied to wires 146, 156. In this embodiment, wires 156, 164 are connected to connector 151 of disc drive 106. Disc drive 106 includes a DC-DC converter 186 to supply low voltage to appropriate processors and other appropriate components of disc drive 106 if high voltage is supplied to wire 156.

A variety of alternative designs can be used for power supply circuit 124. Power supply circuits generally are described further in U.S. Patent 5,581,772 to Nanno et al. If one or more disc drive motors are designed to operate at higher voltages when line power is available, conventional power supply circuits can be modified to supply a higher voltage to disc drive 106 when line power is available, for example with a switch 154.

Referring to Fig. 1, disc drive 106 includes a disc assembly 200, actuator 202, I/O buffer 204, servo controller 206, disc drive processor 208 and power source evaluator 210. Referring to Fig. 5, disc assembly 200 has one or more discs 212 on a spindle 214. Spindle 214 connects with spindle motor 216. Spindle motor or disc motor 216 preferably is designed for operation at two spin speeds, and, in preferred embodiments, for two voltages, e.g., 5 volts and 12 volts. The design of spindle motor 216 can be based on conventional motor design criteria. The operation of disc motor 216 is controlled by disc velocity controller 218, which is connected to disc drive processor 208.

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Disc assemblies capable of operating at different spin velocities are described further in U.S. Patent 5,764,430 to Ottesen et al., entitled "Disk Drive Having Optimized Spindle Speed For Environment."

5 Referring to Figs. 1 and 5, actuator 202 includes an actuator motor 230, an actuator arm 232 and one or more suspension assemblies 234. Each suspension assembly 234 includes a load beam 236 and a head 238. Head 238 is located adjacent a disc surface. A
10 suspension assembly 234 can be supplied for both the top surface and the bottom surface of a disc, such that data can be stored on both surfaces. Similarly, if a plurality of discs 212 are included, one or two suspension assemblies are supplied for each disc. The
15 actuator drive is used to laterally or rotationally move the head(s) 238 radially across the disc surface(s). The heads are designed with a suitable air bearing surface such that the fly height of the head does not vary outside of its operating range in the high power
20 and low power operation modes. Heads with negative pressure air bearing surfaces provide relative insensitivity of head aerodynamics with respect to disc angular velocity.

I/O buffer 204 is connected to a transducer
25 used for reading and/or writing data from discs 212. The nature of the transducer depends on the approach used for data storage. For example, for a magnetic data storage, the transducer could be a magneto-resistive element mounted on the head, while for optical data
30 storage, the transducer could be a light detector, while the head has a lens used to transmit light from the disc to the transducer. I/O buffer 204 conditions the data appropriately for transmission to processor 102, such as

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by amplifying the signal and/or converting an analog signal to a digital format.

Referring to Fig. 1, servo controller 206 includes servo sensor or position detector 250, actuator
5 servo controller 252, disc velocity controller 218, and servo processor 254. Position detector 250 is connected to a transducer, for example, at head 238, such that position detector 250 receives sampled positioning data from the transducer sampled from the disc. This
10 position information is relayed to servo processor 254 for evaluating the position of the read/write heads. Positioning information, such as track addresses, is placed at locations along the disc such that the positioning information can be used to control the
15 actuator to the desired track and sector along the disc surface. The disc can include distinct course positioning information relating to track position and fine position information relating to the sector along the disc.

20 Servo controller 206 controls the supply of power to actuator motor 230 and may monitor the velocity of the actuator, for example by measuring the back electromotive force, which reflects the velocity. Servo processor 254 evaluates the remaining distance to be
25 traveled by the actuator and determines the corresponding current to supply to actuator motor 230.

Disc drive processor generally includes a microprocessor and suitable memory. Disc drive processor 208 coordinates the operation of disc drive
30 106. In particular, disc drive processor 208 receives read/write requests from processor 102 and instructs servo controller 206 accordingly. Also, disc drive processor 208 coordinates the dual mode operation of

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disc drive 106 based on the availability of line power from power supply 104.

Power source evaluator 210 determines the appropriate high power or low power mode of operation of disc drive 106. Power source evaluator 210 can include a volt meter or other sensor 256 to evaluate properties of the power coming from power supply 104. For example, if 12 volt power is being supplied by power supply 104, line power is available to power source 104, and disc drive 106 can be operated in high power mode. Alternatively, power source evaluator 210 can include a signal processor that processes an analog or digital signal received from power source 104, in which the signal directly indicates if line power is available. Power source evaluator 210 can be incorporated into processor 208, in alternative embodiments.

In addition, the user can input an instruction selecting the desired power mode. This selection can be made by sending an instruction to processor 208 generally through processor 102. Alternatively, this can involve setting a switch associated with power source evaluator 210. User selection of the power mode can replace the automated power mode selection. In this way, the user selects the power mode using a manual or an electronic switch in power supply 104 or power source evaluator 210. An electronic switch can be controlled through processor 102. Alternatively, user selection of the power mode can be used to override the selection made by an automatic selection approach which can be associated with power source evaluator 210.

B. Control of Disc Drive Operation

To perform a read or write operation, processor 102 sends the instruction to disc drive 106. To perform the operation, the disc drive moves the

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actuator arm to the correct track and locates the correct sector within the track. The total access time is equal to the seek time plus the latency time. The seek time is the time it takes to move to the correct track, and the latency time is the time to move to the correct sector, which on average is the time for one half of a revolution of the disc. In the high power mode, both the seek time and the latency time can be reduced.

Thus, if the disc drive provides for different modes of operation depending on the power availability, the disc drive adjusts the performance parameters accordingly. To make the adjustment, the disc drive must evaluate at appropriate times the nature of the available power. Generally, this evaluation is performed as a part of every read/write operation. In the discussion below, the disc motor speed and other operations dependent on power mode are performed within the context of a read/write operation, although evaluation of the power mode can be performed separately to adjust the disc motor speed.

The procedure performed by the disc drive processor(s) is outlined in the flow diagram of Fig. 6. After procedure 300 begins 301, the disc drive receives a read/write instruction 302, selects the power mode 304, adjusts 306 the disc motor speed (if needed), determine a seek protocol 308, activates the seek operation 310, performs the read/write operation 312 and ends 314. Portable disc drive 106 can have other modes of operation such as a sleep mode to spin down the disc motor 216 in periods of inactivity. The discussion below can be modified straightforwardly to account for additional modes of operation.

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Generally, when the disc drive is started from an off position, the appropriate disc motor speed is also evaluated at this time even though a read/write operation may not be immediately in progress. In preferred embodiments, the disc drive uses a ramp unload the head away from the disc surface when the disc spins down. Similarly, the head is loaded from the ramp onto the disc surface after the disc is spinning. Use of load and unload operations reduce the start-up torque. In these embodiments, the motor can be configured to more optimally to run at two spin speeds starting from a stopped condition.

Generally, the disc drive processor 208 receives 302 the read/write instruction from processor 102. In preferred embodiments, power source evaluator 210 selects 304 the power mode based on an examination of the power received from power source 104, by examining a signal received from power source 104 through connection 162 or by examining a signal input by the user. An evaluation of the power mode may determine whether or not line power is available. If line power is available, the disc drive can operate in a higher power consumption mode. If line power is not available, the disc drive operates under a lower power mode of operation that conserves battery power. Thus, an evaluation of the power mode involves a selection between a high power mode of operation and a low power mode of operation. As described above, a different voltage can be used in the high power mode in comparison with low power mode.

In alternative embodiments, power mode selection at step 304 simply involves examination of a user-set switch that determines the power mode for operation of the disc drive. The user-set switch can be

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located in the power supply 104 or in the disc drive 106. With a user-set switch, the user can operate in low power mode even if line power is available to save power, or the user can operate in high power mode if
5 line power is not available and if high power mode does not require higher voltage than is available without line power. Similarly, in preferred embodiments, a user-override is available such that an automated power mode selection can be changed either with a user-
10 operated switch or through an override command input with processor 208 or processor 102. With any type of user control, power source evaluator 210 still determines the selected power mode for instructing servo controller 206, for example, based on the position of a
15 user controlled switch.

Once the power mode is determined, the disc velocity is adjusted 306, if the disc motor is not operating already at the desired speed. The speed of the disc motor is adjusted by adjusting the power, i.e.,
20 voltage and current, going to disc motor 216. Disc velocity controller 218 mediates the control of disc motor 216. Conventional portable disc drives operate presently at 4000-4900 revolutions per minute (rpm). An improved disc drive modified to implement the present
25 invention can be configured to operate at about 4000-4900 rpm in low power mode and at about 8000-9800 rpm in high power mode.

Based on the evaluation of the power mode, the corresponding seek protocol can be determined 308.
30 After the seek protocol is determined, the seek operation can be activated 310 by supplying power to the actuator motor for the calculated amount of time. Once the desired track is found, the desired sector along the track is located and the read/write operation is

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performed 312. Further description of an embodiment of a seek operation under varying disc drive operating parameters is described in U.S. Patent 5,764,430 to Otteson et al., entitled "Disk Drive Having Optimized Spindle Speed For Environment."

The procedure 400 for performing a read/write operation with a specific embodiment of the determination of the seek protocol is shown in Fig. 7. The basic features of determining the seek protocol are relevant for either power mode. After procedure 400 begins 401, the disc drive receives a read/write instruction 402, selects the power mode 404, adjusts 406 the disc motor speed (if needed), evaluates the actuator arm position 408, calculates 410 the distance to be travelled, derive 412 timing to power actuator motor, activates the seek operation 414, performs the read/write operation 416 and ends 418.

In particular, the disc drive processor 208 receives 402 the read/write instruction from processor 102. Power source evaluator 210 selects 404 the power mode based on an examination of the power received from power source 104, by examining a signal received from power source 104 through connection 162 or by examining a signal input by the user.

Once the power mode is determined, the disc velocity is adjusted 406, if the disc motor is not operating already at the desired speed. To determine the seek protocol, the arm position is evaluated 408, the distance to be traveled by the arm to perform the read/write operation is determined 410 and the timing to power the actuator motor is calculated 412. The timing for powering the actuator motor should take into account the acceleration and deceleration times for moving the arm.

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The speed of the rotating disc and the voltage applied to the actuator motor can affect these times, such that different protocols are selected based on the power mode of the disc drive. In general, the servo sample rates are fixed for the disc in terms of evaluating a particular sector by a specified number of counts from an index, which are stored on the disc surface as position indicators. Thus, if the faster disc speed is specified to be an integral multiple of the slower disc speed, such as twice as fast, the same sampling rate can be used at the faster disc speed with only every other sample being used to evaluate the position. While non-integral changes in disc speed can be accommodated, the control equation coefficients generally would have to be modified accordingly.

After the seek protocol is determined, the seek operation can be activated 414 by supplying power to the actuator motor for the calculated amount of time. Once the desired track is found, the desired sector along the track is located and the read/write operation is performed 416. In preferred embodiments, seek times in high power mode are from about 4 to about 6.5 milliseconds and total access times are from about 7 to about 10.7 milliseconds.

In a first aspect, the invention pertains to a disc drive 106 including a data storage disc 212, a motor 216 for rotating the data storage disc, a power source evaluator 210, and a servo controller 206. Power source evaluator 210 has a sensor 256 that evaluates an electrical property. The evaluation can involve a determination of whether a battery power source 108 or a line voltage power source 122 is supplying power to operate disc drive 106 of a power mode selected by the user. Servo controller 206 receives a signal from the

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power source evaluator 210 indicating the selection between a high power mode and a low power mode. Servo controller 206 provides a different instruction regarding spin angular velocity to disc motor 216
5 depending on the evaluation regarding power source 104.

In some embodiments, disc drive 106 includes a plurality of data storage discs 212. In preferred embodiments, disc motor 216 and/or actuator motor 230 operate at either a low voltage or a high voltage.
10 Sensor 256 of power source evaluator 210 can be a volt meter, an analog circuit or a digital processor. Disc drive 106 generally includes servo processor 254 that determines a seek protocol depending on the power mode evaluated by power source evaluator 210. Disc drive 106
15 generally includes an actuator 202 with a head 238 mounted on a suspension assembly 236.

In another aspect, the invention pertains to a method 300 of operating a disc drive 106 comprising a data storage disc 212 and a disc drive motor 216, method
20 300 including selecting 304 the power mode by examining an electrical properties from power source 104. Method 300 further includes adjusting 306 angular velocity of disc 212 by providing an instruction to disc drive motor 216 according to the selection 304 of the availability
25 of line power to power source 104.

The selection of the power mode can involve a determination of whether line power is being supplied to a power supply 104. Alternatively, the selection of the power mode can involve the evaluation of a user
30 instruction regarding the power mode. The examination of the electrical property as part of the selecting step 304 can include measuring voltage of the current, measuring an analog signal from power source 104, or measuring a digital signal from power source 104.

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Adjusting step 306 of the angular velocity of disc 212 can include selecting a desired voltage from a plurality of voltages to supply to disc drive motor 216 and/or providing suitable current to disc drive motor 216 to
5 obtain the desired angular velocity.

In a further aspect, the invention pertains to a disc drive including a power evaluation means and a controller. The power evaluation means evaluates a signal determinative of operation in a high power mode
10 or a low power mode. The controller is configured to adjust angular velocity of a motor based on the evaluation of power mode from the power evaluation means.

It is to be understood that even though
15 numerous characteristics and advantages of various embodiments of the present invention have been set forth in the foregoing description, together with details of the structure and function of various embodiments of the invention, this disclosure is illustrative only, and
20 changes may be made in detail, especially in matters of structure and arrangement of parts within the principles of the present invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed. For example, the
25 particular elements may vary depending on the particular application for the disc drive while maintaining substantially the same functionality without departing from the scope and spirit of the present invention. In addition, although the preferred embodiment described
30 herein is directed to a portable disc drive for a portable computer system, it will be appreciated by those skilled in the art that the teachings of the present invention can be applied to other portable

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electronic devices using a disc drive, without departing from the scope and spirit of the present invention.

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WHAT IS CLAIMED IS:

1. A disc drive comprising:
 - a) a data storage disc;
 - b) a motor for rotating the data storage disc;
 - c) a power source evaluator with a sensor that evaluates an electrical property; and
 - d) a servo controller that receives a signal from the power source evaluator indicating a selection between a high power mode and a low power mode, the servo controller providing a different angular velocity instruction to the disc motor depending on the power mode.
2. The disc drive of claim 1 further comprising an additional data storage disc.
3. The disc drive of claim 1 wherein the disc motor operates at a high voltage or at low voltage.
4. The disc drive of claim 1 wherein the sensor of the power source evaluator comprises a volt meter.
5. The disc drive of claim 1 wherein the sensor of the power source evaluator comprises an analog circuit.
6. The disc drive of claim 1 wherein the power source evaluator comprises a user-set switch.
7. The disc drive of claim 1 further comprising an actuator comprising a head mounted on a suspension assembly.
8. The disc drive of claim 7 wherein the head comprises a magneto-resistive transducer.
9. The disc drive of claim 7 wherein the head comprises a lens.

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10. The disc drive of claim 7 wherein the actuator further comprises an actuator motor that can operate at a high voltage or at a low voltage.

11. The disc drive of claim 7 further comprising a servo processor that determines a seek protocol that depends on the power mode evaluated by the power source evaluator.

12. A method of operating a disc drive comprising a data storage disc and a disc drive motor, the method comprising steps of:

- a) selecting operation in a low power mode or a high power mode by examining an electrical property; and
- b) adjusting angular velocity of the disc by providing an instruction to the disc drive motor according to the selected power mode.

13. The method of claim 12 wherein the examining the electrical property, within evaluation step (a), comprises measuring a voltage indicative of whether line power is being supplied to the power source.

14. The method of claim 12 wherein the examining the electrical property, within evaluation step (a), comprises measuring an analog signal from the power source, wherein the analog signal indicates if line voltage is being supplied to the power source.

15. The method of claim 12 wherein the examining the electrical property, within evaluation step (a), comprises measuring a digital signal from the power source, wherein the digital signal indicates if line voltage is being supplied to the power source.

16. The method of claim 12 wherein the examining the electrical property, within evaluation step (a),

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comprises determining which power mode is selected in a user instruction.

17. The method of claim 12 wherein step (b) adjusting the angular velocity comprises selecting from a plurality of voltages a desired voltage to supply to the disc drive motor.

18. The method of claim 12 wherein step (b) adjusting the angular velocity comprises providing suitable current to the disc drive motor to obtain the desired angular velocity.

19. The method of claim 12 further comprising a step (c) determining a seek protocol for operation of an actuator, the determination of the seek protocol depending on the evaluation of the availability of line power to the power source.

20. A disc drive comprising:

- a) a power evaluation means for evaluating a signal determinative of operation in a high power mode or a low power mode; and
- b) a controller configured to adjust angular velocity of a motor through a power output based on the indication of power mode from the power evaluation means.