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(54) Title: METHOD FOR ACTIVE POWER MANAGEMENT IN A SERIAL ATA INTERFACE

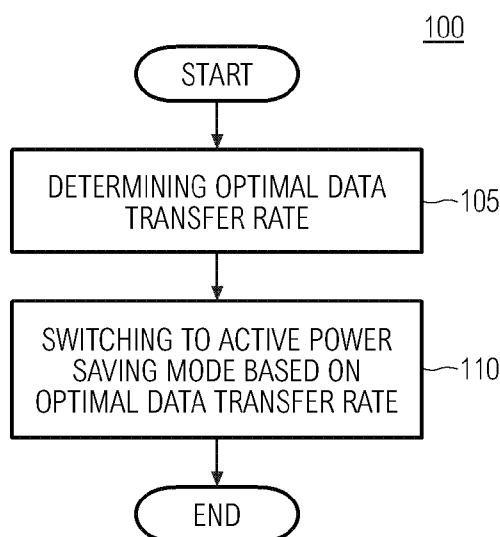


FIG. 1

(57) Abstract: A method for active power management in a Serial ATA interface for data transfer between a host and a device, the method starts with the determining of an optimal data transfer rate for transferring data between the host and the device. Then switching the Serial ATA interface into an active power saving mode based on the optimal data transfer rate is performed.

METHOD FOR ACTIVE POWER MANAGEMENT IN A SERIAL ATA INTERFACE

BACKGROUND

[0001] Serial ATA (SATA) Interfaces are used as interfaces between a peripheral device such as a hard disk drive and a host such as a personal computer. SATA interface is primarily designed for transfer of data between such a host and attached device.

[0002] In attempting to better manage power consumption and power savings in SATA, SATA power management is typically handled by three interface power states. The three SATA interface power states are: PhyReady, Partial, and Slumber.

[0003] In PhyReady state the interface is synchronized and capable of receiving and sending data. In Partial and Slumber states are the two power saving modes. In both Partial and Slumber states, the interface is not in condition for any active receiving and sending of data. The difference between Partial and Slumber states is mainly in the time required for them to be restored to PhyReady state. SATA standards stipulate that time required to restore from a Partial state to a PhyReady state be no more than 10us while the time required to restore from a Slumber state to PhyReady state is no more than 10ms.

[0004] These interface power states maybe initiated either by the Host or the Device and are often referred to as Host Initiated Power Management (HIPM) or Device Initiated Power Management (DIPM). The interface power states can further be associated with the Device power management states. In both HIPM and DIPM, what triggers a switch of a power saving mode to the Partial and

Slumber interface power state is the lack of activity or data transfer in the interface when the interface is in a PhyReady state.

[0005] HIPM and DIPM are not direct user managed methods for power management on the interface and the switching to power savings modes are dependent on a lack of activity on the SATA interface. In addition, once in the power saving modes, no data transfer occurs on the interface until the interface is switched back to the PhyReady State.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] For a detailed description of embodiments of the invention, reference will now be made to the accompanying drawings in which:

[0007] FIG. 1 is a flow chart showing a method for active power management in a Serial ATA interface;

[0008] FIG. 2 shows a data flow of the determining of the optimal data transfer rate of FIG. 1; and

[0009] FIG. 3 is a flow chart showing the switching to active power saving mode of FIG. 1.

DETAILED DESCRIPTION

[0010] SATA interface is currently slated for a maximum data transfer rate of 6.0Gps with additional slower rates at 3.0Gps and 1.5Gps. Power consumption of such a Serial ATA interface when transferring data between host and devices at the higher 6.0Gps rate is substantially higher than rates of 3.0Gps or 1.5GPs. Actively switching to a data transfer rate of the interface to 3.0Gps or 1.5Gps can

result in overall reduction of power consumption as compared to running a data transfer rate of 6.0Gps.

[0011] Currently, optimal data transfer rates are first automatically established by the host and device at the start of power up operations in a system using SATA interface. Such optimal data transfer rates are dependent on whether such a data transfer rate is supported by both the host and the device. Actively switching the established optimal interface transfer rate to a lower interface transfer rate can result in overall reduction of power consumption on the interface.

[0012] Referring to FIG. 1, a method 100 for active power management in a Serial ATA interface for data transfer between a host and a device according to one embodiment is shown. The method 100 starts with the determining 105 of an optimal data transfer rate for transferring data between the host and the device. Then switching 110 the Serial ATA interface into an active power saving mode based on the earlier determined optimal data transfer rate is performed.

[0013] Referring to FIG. 2, the determining 105 of the optimal data transfer rate further comprises a set of communication signals according to the Serial ATA protocol between the host and the device. On POWER ON of a system comprising the host and the device, the host initiates communication by transmitting COMRESET 205 to the device. The device responds by transmitting a COMINIT 206 signal to confirm its readiness for additional instructions. The host responds with a COMWAKE 207a command which is similarly echoed by the device, if the device is ready and active. After a predetermined length of time, the device transmits a ALIGN 208a signal comprising the highest data transfer rate available to the device. If the host is able to support that highest data transfer rate, host responds with a corresponding ALIGN 208b signal and synchronization of the host and device occurs. The device then transmits a STATUS RESET FIS (FIS 34) 210 to the host. The host and device would then have selected that highest or maximum data transfer rate supported by both the host and the device as the optimal data transfer rate.

[0014] However, if the data transfer rate sent by the device in the ALIGN 208a signal cannot be handled by the host for whatever reason, the host will not respond. After a predetermined period of time, when the device has not received the corresponding ALIGN 208b signal from the host, the device will send another ALIGN 208a signal comprising a data transfer rate lower than the earlier sent data transfer rate in the ALIGN 208a signal. The selected data transfer rate is the next available lower data transfer rate according to the Serial ATA standards. The device will continue sending and lowering the data transfer rates until the host responds to accept the data transfer rate. That accepted data transfer rate will then be designated the optimal data transfer rate. The optimal data transfer rate is usually the highest available data transfer rate supported by both the host and the device.

[0015] Referring to FIG. 3, now that the optimal data transfer rate has been determined 105, the switching 110 to active power saving mode is further shown. An option for following predetermined 305 instructions may be made available for selecting of a lower data transfer rate to reduce consumption of power. If a predetermined 305 instruction had been provided, the next step would actively result in choosing 315 from available data transfer rates according to the predetermined instructions provided. The predetermined instructions should specify a lower data transfer rate available than the optimal data transfer rate.

[0016] Alternatively, if predetermined 305 instructions are not available, the method in this embodiment automatically selects 310 from the available data transfer rates the data transfer rate immediately slower than the optimal data transfer rate. The optimal data transfer rate is usually the highest available data transfer rate supported by both the host and the device. Choosing the lower data transfer rate which is slower than the earlier optimal data transfer rate will result in the Serial ATA interface transferring data at the lower data transfer rate and thus consuming less power.

[0017] In operation, the above embodiment may be performed by a system having a Serial ATA interface and at least one host and at least one device. Upon powering up such a system utilizing the Serial ATA interface. The host and device carry out Serial ATA communications protocol to determine the maximum data transfer rate available between the host and the device. If active power management of the system is desired, a user may provide instructions in advance to the system for switching to a power saving mode. The instructions may be for example to switch to a power saving mode when the system is running on batteries only. For example, a laptop disconnected from the power supply from the mains and running solely on batteries. Once such an instruction is provided, the system then initiates switching to a power saving mode by lowering the data transfer rate of the Serial ATA interface from the maximum data transfer rate available utilizing the process described in Figure 2 and limiting the interface speed either at the device or the host.

[0018] In another embodiment, the method for active power management in a Serial ATA interface for data transfer between a host and a device may further be activated at the stage of establishing of maximum data transfer rate communication protocol. In this embodiment, the host of such a system would have received predetermined instructions not to accept a higher data transfer rate or not to accept higher than a predetermined data transfer rate. As such, during the establishing of the maximum data transfer rate communication protocol, the host would refuse to transmit at a higher data transfer rate ALIGN 208a request from the device and only transmit at a lower data transfer rate.

[0019] In this embodiment, referring to FIG. 1, the method similarly involves a determining of the optimal data transfer rate. Referring to FIG. 2, the host and the device determining 105 of the optimal data transfer rate further also comprises a set of communication signals according to the Serial ATA protocol between the host and the device. However, the host in this embodiment has already received predetermined instructions not to transmit a higher data transfer rate in its ALIGN 208b request to the device. An example would be that instead of transmitting a

6.0Gps transfer rate in its ALIGN request to the device, it transmits a 3.0Gps instead. This limits the device to a lower data transfer rate even if a higher one e.g. 6.0Gps was available. The device then transmits the STATUS RESET FIS 210 based on the accepted lower data transfer rate which is now the accepted optimal data transfer rate.

[0020] The method further then switches to an active power saving mode by selecting the optimal data transfer rate which is lower than the maximum data transfer rate available to the host and the device.

[0021] In yet another embodiment, the method may be device initiated. The device may have received predetermined instructions from the host to ensure that the device would transmit at a data transfer rate that is lower than what is available itself and to the host. At the determining 105 of the optimal data transfer rate, the device refuses to transmit a ALIGN 208a signal with a higher data transfer rate, even if the host or the device is able to operate at that higher transfer rate. The predetermined instructions would instruct the device to only transmit a predetermined lower data transfer rate or other than a higher data transfer rate.

[0022] Numerous variations and modifications will become apparent to those skilled in the art once the above disclosure is fully appreciated.

CLAIMS

What is claimed is:

1. A method for active power management in a Serial ATA interface for data transfer between a host and a device, the method comprising:
determining an optimal data transfer rate for transferring data between the host and the device; and
switching the Serial ATA interface into a active power saving mode based on the optimal data transfer rate.
2. The method of claim 1 wherein the determining of the optimal data transfer rate comprises selecting the optimal data transfer rate from a predetermined plurality of available data transfer rates.
3. The method of claim 2 wherein the switching the Serial ATA interface into the power saving mode comprises selecting one of the predetermined plurality of available data transfer rates which is slower than the optimal data transfer rate so as to lower power consumption during data transfer between the host and the device.
4. The method of claim 3 further comprising providing an option for following predetermined instructions for selection of one of the predetermined plurality of available data transfer rates.
5. The method of claim 2 wherein the switching the Serial ATA interface into the power saving mode comprises selecting one of the predetermined plurality of available data transfer rate which is immediately slower than the optimal data transfer rate so as to lower power consumption during data transfer between the host and the device.

6. The method of claim 1 further comprising providing an option for deciding whether to switch the Serial ATA interface into a power saving mode.
7. The method of claim 1 wherein the switching into a power saving mode is initiated by the host.
8. The method of claim 1 wherein the switching into a power saving mode is initiated by the device.
9. The method of claim 1 wherein the determining of the optimal data transfer rate comprises selecting the optimal data transfer rate according to predetermined instructions provided to the host.
10. The method of claim 9 wherein the predetermined instructions provided to the host are to not transmit at a maximum data transfer rate available to the host and the device.
11. The method of claim 9 wherein the predetermined instructions provided to the host are to not transmit higher than a predetermined data transfer rate.
12. The method of claim 10 wherein the switching the Serial ATA interface into the power saving mode comprises selecting the optimal data transfer rate which is lower than the maximum data transfer rate available to the host and the device.
13. The method of claim 1 wherein the determining of the optimal data transfer rate comprises selecting the optimal data transfer rate according to predetermined instructions provided to the device.
14. The method of claim 13 wherein the predetermined instructions provided to the device are to not transmit at a maximum data transfer rate available to the host or the device.

15. The method of claim 13 wherein the predetermined instructions provided to the device are to not transmit higher than a predetermined data transfer rate.

16. The method of claim 13 wherein the switching the Serial ATA interface into the power saving mode comprises selecting the optimal data transfer rate which is lower than the maximum data transfer rate available to the host or the device.

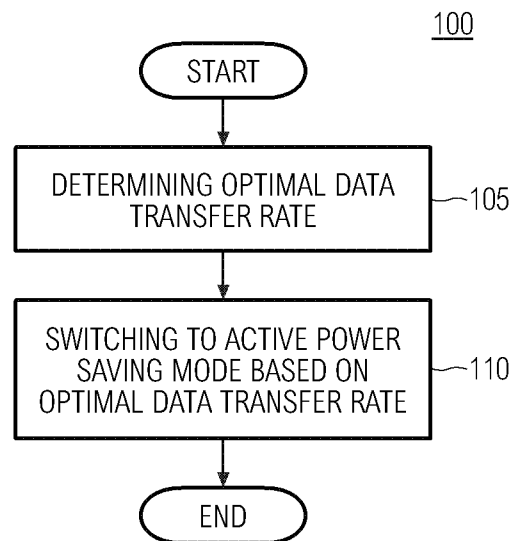
17. A method for active power management in a Serial ATA interface for data transfer between a host and a device, the method comprising:

determining from a predetermined plurality of available data transfer rates
an optimal data transfer rate for transferring data between the host
and the device;

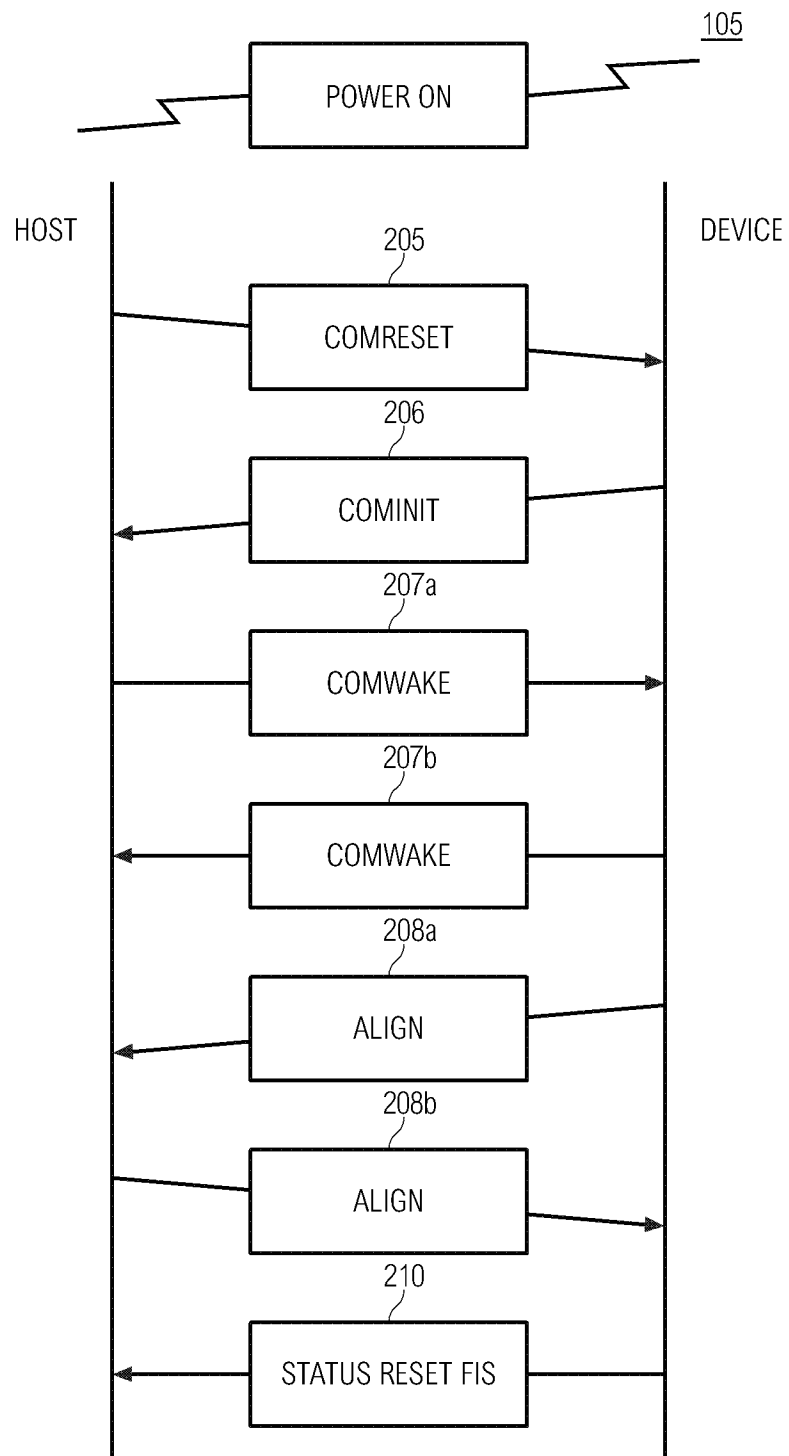
providing an option for switching the Serial ATA interface into a power
saving mode;

switching the Serial ATA interface into a power saving mode by selecting one of the predetermined plurality of available data transfer rate which is slower than a maximum data transfer rate so as to lower power consumption during data transfer between the at least one host and the at least one device.

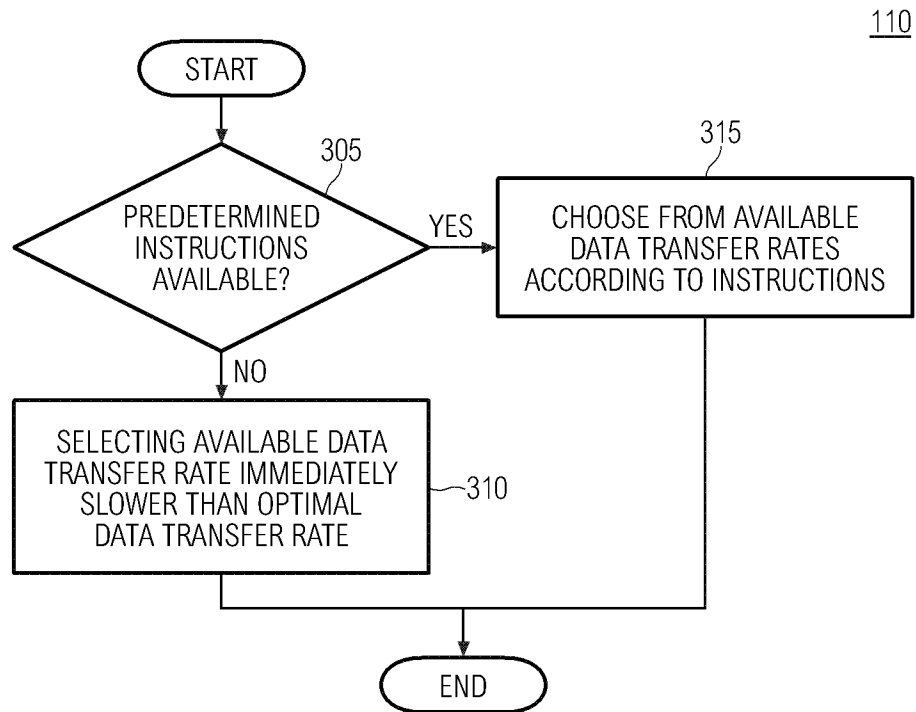
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**FIG. 1**

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**FIG. 2**

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**FIG. 3**

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2009/046530**A. CLASSIFICATION OF SUBJECT MATTER****G06F 1/32(2006.01)i, G06F 13/14(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G06F 1/32; G06F 1/26; G06F 12/02; G06F 13/38

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

(Chinese Patents and application for patent)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords:serial ATA, Power saving mode

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006-0026315 A1 (SI-HOON HONG et al.) 02 February 2006 See FIGS.1-4, abstract, paragraphs 46-53	1-17
A	US 2008-0184051 A1 (CHEONG WOO-SEONG et al.) 31 July 2008 See FIG.4, abstract, paragraphs 19-32	1-17
A	US 2005-0005178 A1 (BASHFORD PATRICK R. et al.) 06 January 2005 See FIG.1, abstract, paragraph 18	1-17
A	US 2008-0133951 A1 (IGARI FUBITO) 05 June 2008 See FIG.7, abstract, paragraphs 45-55	1-17



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

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Date of mailing of the international search report

25 FEBRUARY 2010 (25.02.2010)

Name and mailing address of the ISA/KR

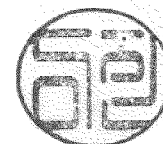
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2009/046530

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