# POWER ON, MATED, AND ACTIVITY INDICATOR FOR ELECTRONIC DEVICES INCLUDING STORAGE DEVICES

## FIELD OF THE INVENTION

The present invention relates generally to redundant arrays of information storage device units (so-called "RAID" systems), and more specifically to devices for alerting a user to the power on, device mated, and activity status of each storage device unit in such systems.

## BACKGROUND OF THE INVENTION

It is known in the art to provide a memory system that includes a plurality of devices for storing, redundantly or otherwise, and/or retrieving data. Frequently the devices are hard disk storage units, each of which has a connector enabling the unit to plug into (or be unplugged from) a bay in a console rack holding many such units. As used herein, the term "bay" refers to an opening in the console rack sized to receive and hold one hard disk storage unit.

FIG. **1** depicts a system **10** that includes a memory system **20** typically coupled by a small computer system interface ("SCSI") 68-pin bus **30** to another device or system **40**, e.g., a computer/workstation, or further memory system. Memory system **20** may also be coupled via an output SCSI bus **40'** to other devices, noted generally as **40'**, which other devices may in fact include further memory systems such as system **20**, a computer/workstation, or other systems.

Memory system **20** has a fixed number of bays, twelve such openings in the configuration of FIG. **1**, and at any given time some or all of the bays will hold storage units. Memory system **20** includes a plurality of storage units, here shown as hard disk units 1 through 12 (abbreviated as DISK **1**, DISK **2**, etc.), each such unit occupying a bay. DISK **10** is shown partially removed from bay **25–10**, and it is understood that in general any hard disk or other storage unit may be inserted into any bay. Typically, the hard disk units will have a large storage capacity of 1 GB or more.

Each storage unit has a separate connector that matingly engages a connector at the rear of a bay within console rack **50**. Console rack **50** globally provides operating power (e.g., $V_{cc}$), control, data, and other signals to each storage unit through a connector when the storage unit is plugged into console rack **50**. In many systems **20**, access to the storage units is gained by opening a panel door **60**.

Some memory systems omit panel door **60**, or provide a transparent panel door to allow an unimpaired view of the storage units. However, in many memory systems, the panel door **60** may be closed and opaque, or indeed panel door **60** may be located (and access to the storage units occurs) on a side of console rack **50** not readily viewable.

Memory system **20** permits individual storage units to be unplugged and withdrawn from the system, or plugged into the system, even while global operating power is provided by console rack **50** to the storage units. For example, FIG. **1** shows hard disk drive unit ten unplugged from console rack **50**, notwithstanding that all of the bays (including the tenth bay) are receiving operating power.

Memory system **20** should therefore permit a technician to readily discern how many storage units are presently plugged into the console rack. Accordingly, an array of indicators **70**, typically light emitting diodes ("LEDs"), is located on a readily visible surface of the console rack to indicate how many disk drive units are present therein. Each bay typically includes a switch at the rear of the console rack. When a storage unit is in the bay and is firmly plugged into a mating console rack connector, the switch is depressed, which causes the associated LED to turn on. Thus, in array **70**, the LED for disk **10** is off, whereas all other LEDs are on. (In the figures herein, an LED that is on is depicted by a solid circle that emanates radiation, an LED that is off is depicted by an empty circle that does not emanate radiation, and an intermittent LED is indicated by an empty circle that emanates radiation.)



At any given time, one or more of the storage devices plugged into the console rack may be active, e.g., may be writing, reading, or seeking data. Some storage units are manufactured with an LED **80** that is lit when the storage unit is active. Thus, in FIG. **1**, disk drive storage units **1**, **4**, **7** and **10** include such LEDs, and indeed LED **80** on disk drive unit **4** is shown lit to denote that disk four is presently active. Other storage units are not manufactured with such LEDs, and thus it is unknown whether disk drive storage units **2**, **3**, **5**, **6**, **8**, **9**, **11**, **12** are presently active.

Alternatively, a handle on a storage unit may obscure an LED **80** thereon, making it difficult to discern whether the storage unit is presently active. Absent some sort of activity indicator, there is a probability of inadvertently removing a presently active storage unit (e.g., disk drive unit **4** in FIG. **1**) from the console rack. Removal of an active storage unit can impact the integrity of the memory system data, including data transmitted over bus **30** and/or bus **30'**.

One disadvantage of memory system **20** in FIG. **1** is that a technician must open panel door **60** to learn for certain how many storage devices are mounted within console rack **50**. Where, for example, there are many systems **20** (or **40** or **40'**), discerning how many storage devices are mounted within each system can be time consuming and a source of human error. The technician may consult documentation showing a map of what storage unit is in what column and row in an array of storage units. However, upon opening panel door **60**, the technician can readily forget and remove the wrong storage unit. While FIG. **1** depicts twelve storage units, other systems may include a greater or lesser number of storage units.

Further, it is important that the technician not remove a storage unit that is currently active, e.g., in the process or reading, writing, or seeking data. To remove an active storage unit can cause erroneous data to be coupled to SCSI bus **30** and/or **30'**, as well as to be stored on the active hard disk unit that is inadvertently removed from console rack **50**.

Thus, there is a need for a mechanism that permits a technician to readily learn how many storage devices are plugged into a memory system, even when a direct view of the storage devices is not possible. Further, there is a need to identify a presently active storage unit to alert a technician to defer removal from the memory system until the unit is inactive. Preferably such mechanism should not impose a substantial hardware overhead to implement.

The present invention discloses such a mechanism.

## SUMMARY OF THE INVENTION

The present invention is used with a memory system that comprises a plurality of storage units that may individually be plugged into or unplugged from SCA-connector (single connector attachment) bays in a console rack, even when operating power is provided to the bays. The present invention provides each bay with a circuit that signals the power on, mated, and activity status of storage units in the console rack. The circuits use parallel-coupled LEDs activated by logically combined signals available from the SCA connector pins.