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(54) Title: BACKUP POWER SUPPLY CONTROLLERS

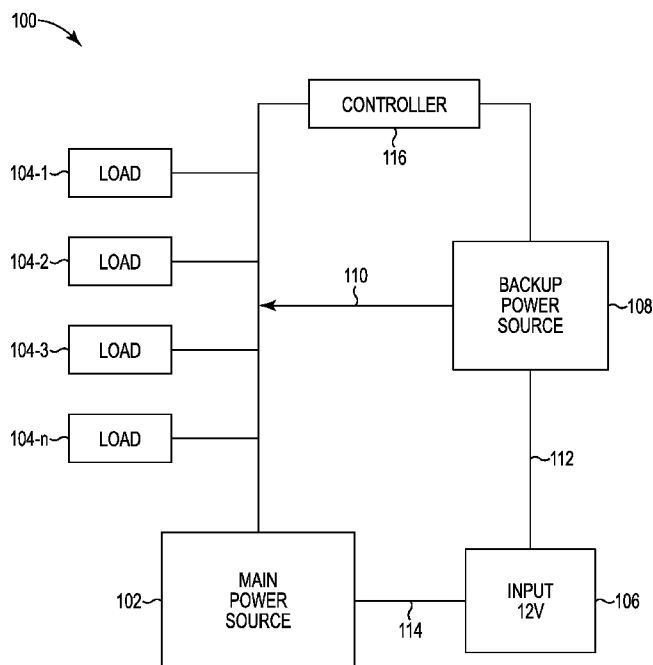


Fig. 1

(57) Abstract: Example implementations relate to backup power supply controllers. For example, a backup power supply controllers system can include a controller to monitor a discharge current for a backup power source. The controller can detect a main power supply failure based on a discharge current being outside of a threshold value. The controller can regulate power to a particular load from the backup power source in response to the detected discharge current being outside of the threshold value.

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- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

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BACKUP POWER SUPPLY CONTROLLERS

Background

[0001] As reliance on computing systems continues to grow, so too does the demand for reliable power systems and back-up schemes for these computing systems. Servers, for example, may provide architectures for backing up data to flash or persistent memory as well as back-up power sources for powering this back-up of data after the loss of power. Backup power supplies may sometimes include energy components such as capacitors or batteries.

Brief Description of the Drawings

[0002] Figure 1 illustrates a block diagram of an example of a backup power supply controllers system, consistent with the present disclosure.

[0003] Figure 2 illustrates an example of a system for backup power supply controllers, consistent with the present disclosure.

[0004] Figure 3 illustrates a flow diagram of an example of a process of backup power supply controllers, consistent with the present disclosure.

[0005] Figure 4 illustrates a flow diagram of an example of a method of backup power supply controllers, consistent with the present disclosure.

Detailed Description

[0006] A computing data enclosure system can include a number of nodes that support a number of loads. In some examples, the number of nodes can be a number of servers. The number of loads can include storage controllers and/or devices associated with the servers. For example, the number of loads can include cache memory, dual inline memory modules (DIMMs), Non-Volatile Dual In-Line Memory Modules (NVDIMMs), smart array control logic, and/or control logic (e.g., Asynchronous DRAM Refresh (ADR) logic), among other storage controllers and/or devices associated with the number of servers. A computing data storage system can include a backup power source operatively coupled to the number of nodes to support the number of loads in an event of a failure of a main power supply.

[0007] A failure in the main power supply can be due to a main power source failure. Failure of a main power source can occur when, for example, the main power supply fails momentarily and/or fails for an extended period of time. For example, a load may not be receiving adequate power (e.g., voltage, current, watts, etc.) from the main power source, which can cause the load to receive backup power from a backup power source. Failure can include a loss of power or a drop in power below a threshold value to nodes and/or loads from the main power supply. As used herein, adequate power refers to a level of power that is within a predetermined voltage and/or current standard for a particular load. By determining the power from a backup power source to a node is adequate, damage to the motherboard may be avoided.

[0008] A backup power source can be a secondary power supply that is used to provide power to the loads when the main power source is removed, failed, and/or is compromised. A secondary power supply is a power supply that can provide power when a main power supply associated with a main power source fails. For example, a node and/or a load may encounter a main power source failure, such that the node and/or load may not receive adequate power.

[0009] In accordance with examples of the present disclosure, a backup power source support system can detect a backup power operation (e.g., backup operation) by monitoring a discharge current and/or an input voltage associated with the backup power source (e.g., battery). The discharge current, as used herein, refers to a discharge current from a backup power source, such as a battery. Monitoring the discharge current and/or input voltage of the backup power source can detect power provided to a load by the backup power source when one or more nodes experience main power source failure.

[0010] A load can be supplied backup power in an instance of main power failure within an enclosure, which may still be providing an input (e.g., 12V input) to the backup power source (e.g., battery). That is, the backup power supply can provide support in environments where 12V input to the backup power source is still present while the load requires backup power. Data retention failure can be avoided and/or mitigated by supplying backup power from the backup power source by initiating a backup power operation in centralized backup power configurations and/or distributed backup power configurations in which 12V input is still available to the backup power source.

[0011] In some examples, the main power source can provide power to a plurality of loads and/or nodes. In some instances, the main power source can fail to deliver power to each load among the plurality of loads. When the main power source fails to provide adequate power to a particular load, the backup power source can provide power to the particular load while the remaining loads continue to receive power from the main power source.

[0012] The figures herein follow a numbering convention in which the first digit corresponds to the drawing figure number and the remaining digits identify an element or component in the drawing. Elements shown in the various figures herein may be capable of being added, exchanged, and/or eliminated so as to provide a number of additional examples of the present disclosure. In addition, the proportion and the relative scale of the elements provided in the figures are intended to illustrate the examples of the present disclosure, and should not be taken in a limiting sense.

[0013] As used herein, “logic” is an alternative or additional processing resource to perform a particular action and/or function, etc., described herein, which includes

hardware (e.g., various forms of transistor logic, application specific integrated circuits (ASICs), etc.) in addition to computer executable instructions (e.g., firmware, etc.) stored in memory and executable by a processor. Further, as used herein, “a” or “a number of” something can refer to one or more such things. For example, “a number of widgets” can refer to one or more widgets. Also, as used herein, “a plurality of” something can refer to more than one of such things.

[0014] Figure 1 illustrates a block diagram of an example of a backup power supply controllers system 100, according to the present disclosure. As illustrated in Figure 1, the system 100 can include a backup power source 108 controlled by a backup power control module (not shown), coupled to an input 106 (e.g., 12 Volt input, etc.) via a link 112. The backup power control module can control the backup power source 108, such as battery operations. The input 106 can be coupled to a main power source 102 via link 114. The links 112 and 114 can include a physical link such as an electrical connection (e.g., wires, etc.). In some examples, a 12 volt input may or may not be present to enter a backup power operation. That is, in some examples, a 12 volt input may or may not be supplied to the backup power source from the main power source to enter a backup power operation.

[0015] The backup power source 108 can be utilized for a centralized or distributed backup power configuration. A centralized backup power configuration can be when the backup power source is located external to the node. A distributed backup power configuration can be when the backup power source is located internal to the node. For example, the backup power source 108 can be located on a node or outside of a node (e.g., located internally or externally to the node). A node can share the backup power source 108 with a plurality of other nodes. The backup power source 108 can be located internally or externally to the node. That is, the backup power source 108 can be a single power source to power a plurality of nodes when the main power source is not providing adequate power.

[0016] The controller 116 can enable a transition from a main power source 102 to the backup power source 108. The controller 116 can enable and/or disable a power source (e.g., main power source, backup power source) supplying power to the loads 104, from the main power source 102 and/or the backup power source 108.

[0017] In some examples, the main power source 102 can be controlled by a main power module (not illustrated). The main power source 102 and the main power module can be coupled by a link to the loads 104. The link can include a physical link such as an electrical connection (e.g., wires, etc.) and enable communication between the main power source and the main power module.

[0018] The main power module can control the main power source. Each of the number of modules (e.g., power control module, main power module etc.) can include instructions that when executed by a processing resource (e.g., computing processor, processor, etc.) can function as a corresponding engine as discussed further in association with Figure 2.

[0019] In some examples, the controller 116 can monitor a discharge current to the plurality of loads 104. As used herein, the discharge current is the current drawn from the backup power source 108. That is, the discharge current is the current drawn by a node and/or load from the backup power source 108. In some examples, the controller 116 can monitor the discharge current at the backup power source 108.

[0020] The controller 116 can detect a discharge current at the backup power source 108 and determine if the discharge current is outside a threshold value (e.g., discharge threshold value). For example, the discharge threshold value can be approximately 100 milliamps (mA). In this example, a discharge current greater than 100 mA can indicate a node and/or load 104 is currently drawing power supply from the backup power source 108. The node and/or load 104 drawing power from the backup power source 108 can indicate a failure of the main power source 102 for the node and/or load 104. That is, the node and/or load 104 may not be receiving adequate power from the main power source 102.

[0021] The controller 116 can monitor an input voltage of the backup power source 108 in addition to the discharge current of the backup power source 108. In some examples, the discharge current can be relied upon when a conflict exists between threshold values of the input voltage and threshold values of the discharge current. That is, the discharge current can be a priority reading. A conflict, as used herein, can exist when either an input voltage or the discharge current is outside of a threshold value. For example, a conflict can exist when the input voltage is within an

input threshold value (e.g., 12 volts) and the discharge current is outside of a discharge threshold value (e.g., greater than 100 mA). In another example, a conflict can exist when the input voltage is outside an input threshold value and the discharge current is within a discharge threshold value.

[0022] In some examples, the discharge current can be given priority when a conflict exists. For example, the discharge current can be given priority (e.g., relied upon, etc.) when the discharge current is outside of a discharge threshold value and the input voltage is within an input threshold value. In another example, an input voltage of 12 volts can indicate that the input voltage is within the input voltage threshold (e.g., a normal reading), while a discharge current exceeding 100 mA can indicate node and/or load power draw from the backup power source. In this example, the discharge current can be relied upon to initiate a backup power operation to supply power from the backup power source 108.

[0023] In some examples, the input voltage can be outside of a threshold value (e.g., input voltage value), and the discharge current can also be outside of a threshold value (e.g., discharge current value). In this example, a conflict does not exist and both or either of the threshold values can be used to initiate a backup power operation.

[0024] The controller 116 can regulate backup power to the load from the backup power source 108 in response to a detected input voltage and/or discharge current of the backup power source 108. That is, a backup power operation can be initiated based on the detected values of the input voltage and/or discharge current of the backup power source 108. For example, the detected discharge current and/or input voltage can indicate the node and/or load is drawing power from the backup power source 108, indicating a failure of the main power source 102. The backup power operation can include supplying a particular load with power from the backup power source 108. Supplying the node and/or particular load with power from the backup power source can provide adequate power to the node and/or particular load and can prevent data loss associated with the node and/or particular load.

[0025] In some examples, the load can be supplied with power from the backup power source 108 while a remaining plurality of loads in an enclosure comprising the load receive power from a main power source 102. For example, a particular load (e.g.,

104-2) can draw power from the backup power source 108, while the remaining loads (e.g., 104-1, 104-3, 104-n) can draw power from the main power source 102. In some examples, the controller 116 can monitor the supplied backup power to the load 104 for a period of time, as further discussed in association with Figures 3 and 4.

[0026] Figure 2 illustrates an example of a system 220 for backup power source controllers, consistent with the present disclosure. As illustrated by Figure 2, the system 220 can include a backup power source 208, a main power source 202, a controller 216, and the node 228.

[0027] As illustrated in Figure 2, the node 228 can host a number of loads (e.g., loads 204-1, 204-2, 204-3, and 204-n, collectively referred to herein as loads 204). For example, the node 208 can include a number of devices, such as local memory or data storage. The node can include a number of computing devices (e.g., controller 216, etc.) that can each include memory.

[0028] The backup power source 208 can include a processing resource 222 connected to a memory resource 234, (e.g., a computer-readable medium (CRM), machine readable medium (MRM), database, etc.). In some examples, a memory resource (e.g., memory resource 234) may be a non-transitory storage medium and/or a non-transitory machine readable medium, where the term “non-transitory” does not encompass transitory propagating signals. The memory resource 234 can include a number of computing modules. Similarly, in some examples, the main power source 202 can include a processing resource connected to a memory resource (e.g., a computer-readable medium (CRM), machine readable medium (MRM), database, etc.).

[0029] Figure 2 illustrates a backup power control module 226. The backup power control module 226 can include a computer readable medium (e.g., memory resource 232, etc.) storing instructions executable by a processing resource 222. The system 220 can include any combination of hardware and program instructions configured to share information. The hardware, for example, can include a processing resource 222 and/or a memory resource 232 (e.g., computer-readable medium (CRM), machine readable medium (MRM), database, etc.). A processing resource 222, as used herein, can include any number of processors capable of executing instructions stored by a memory resource 232. Processing resource 222 may be implemented in a

single device or distributed across multiple devices. The program instructions (e.g., computer readable instructions (CRI)) can include instructions stored on the memory resource 232 and executable by the processing resource 222 to implement a desired function (e.g., monitor input voltage and discharge currents, regulate power, etc.).

[0030] As used herein, an engine can include hardware firmware, logic, and/or executable instructions. An engine includes at least hardware (e.g., logic in the form of an application specific integrated circuit (ASIC)) to perform particular actions, tasks and functions described in more detail herein in reference to Figures 3 and 4. For example, the instructions can be executable to monitor discharge current and/or input voltage of a backup power source 208.

[0031] In some examples, the instructions can be executable to detect the discharge current and/or input voltage of the backup power source 208, where the discharge current and/or input voltage is outside of a threshold value. In some examples, the instructions can be executable to activate backup power to the load from the backup power source 208 in response to the detected discharge current and/or input voltage of the backup power source 208. In these examples, the remaining loads among the plurality of loads 204 can receive power from the main power source 202.

[0032] Engines and/or the number of modules (e.g., backup power control module 226) can be sub-engines/modules of other engines/modules and/or combined to perform particular actions, tasks, and functions within a particular system and/or computing device. Engines and/or modules described herein can be located in a single system and/or computing device or reside in separate distinct locations in a distributed computing environment (e.g., cloud computing environment). The system 200 can perform a number of functions and operations as described in Figures 3 and 4, and include the apparatus and methods for power supply controllers as described herein.

[0033] The backup power source 208 can be a battery that is external to the node 228 and external to the controller 216 supporting the node 228. The backup power source 208 can provide power to the node 228. The backup power source 208 can support different controllers (not illustrated by Figure 2) to support a plurality of nodes on a different chassis.

[0034] The node 228 can include a number of components 230, such as a basic input/output system (BIOS). The number of components can allow the node 228 to communicate with the backup power source 208 and the controller 216. The node 228 can, in some examples, include a Baseboard Management Controller (BMC) unit that enables communication between the backup power source 208, sub-modules and/or the loads 204. The BMC unit can include computer executable instructions stored on the node 228.

[0035] The backup power control module 226 can have instructions stored in a non-transitory storage medium (e.g., memory resource) to communicate between the components 230 and the plurality of loads 204 to protect (e.g., maintain adequate power) the plurality of loads 260 with backup power, as discussed further in relation to Figures 3 and 4.

[0036] Figure 3 illustrates a flow diagram of an example of a process 340 of power supply controllers, consistent with the present disclosure. Although illustrated in simplified form in Figure 3, the process 340 can include fewer and/or additional functions. At 342, the process 340 can include monitoring a backup power source. Monitoring the backup power source, as used herein, refers to observing and/or tracking at least discharge current and/or input voltage for a backup power source (e.g., battery). For example, the discharge current associated with a battery can be monitored at 120 mA.

[0037] At 346, the process 340 can include a determination as to whether an input and/or discharge value (e.g., input voltage, discharge current) is outside of a respective threshold value associated with the backup power source. The respective threshold values can include an input threshold value and/or a discharge threshold value.

[0038] At 344, the process 340 can include not detecting input and/or discharge values (e.g., input voltage, discharge current) outside of respective threshold values. The input and/or discharge values can include a range of respective input and/or discharge values within a respective threshold range. That is, the discharge current and/or the input voltage can operate at particular levels without indicating a backup power operation to be initiated by a controller. For example, a discharge current of less

than 100 mA and/or an input voltage of more than 9V can be maintained without indicating a respective value outside of the input and/or discharge threshold values. A backup power operation may not be initiated by a controller when the power from the backup power source is within the predetermined threshold values (e.g., current less than 100mA, voltage greater than 9V). In response to not detecting input and/or discharge values outside of the respective threshold value (e.g., the discharge current and/or input voltage are within a predetermined threshold range), the process 340 can include continuing to monitor the backup power source at 342.

[0039] At 350, process 340 can include providing backup power to be supplied to a particular load from the backup power source, if an input and/or discharge value is outside of a respective input and/or discharge threshold value is detected at 348 (e.g., input voltage, discharge current). The backup power source can be monitored outside of a predetermined threshold in response to the backup power source input and/or discharge values no longer within the respective input and/or discharge threshold values. For example, an input voltage and/or discharge current from the backup power source can be monitored. The monitored input voltage and/or discharge current can indicate a main power source failure. The input voltage and/or discharge current values outside a respective input and/or discharge threshold value can initiate a backup power operation to provide backup power to a number of loads.

[0040] At 352, the process 340 can include monitoring the supplied backup power. For example, the backup power supplied to the particular load from the backup power source can be monitored for duration (e.g., time), consumption rate (e.g., amount), and/or location (e.g., node/server). Monitoring the supplied backup power can assist in determining power failures associated with the main power source.

[0041] At 352, the backup power supplied to the particular load can be monitored for a time threshold. For example, the supplied backup power can be provided to the particular load for a period of time before the main power source provides power to the particular load.

[0042] At 356, the process 340 can include monitoring the input and/or discharge values (e.g., discharge current and/or input voltage) from the backup power source. The process 340 can be iterative. For example, the process can continue to monitor the

input and/or discharge values in a cycle. In this example, the process can monitor the input and/or discharge values and upon monitoring input and/or discharge values within respective threshold values, continue monitoring.

[0043] Figure 4 illustrates a flow diagram of an example of a method 460 of power supply support, according to the present disclosure. At 462, the method 460 can include monitoring input and/or discharge values (e.g., input voltage, discharge current, etc.) of a backup power source. In some examples, the input and/or discharge values can include a discharge current and an input voltage. The discharge current can be measured in milliamps (mA) and the input voltage can be measured in volts (V). The discharge current can be measured at the backup power source (e.g., battery). The input voltage can be measured at the backup power source (e.g., battery).

[0044] At 464, the method 460 can include detecting a failure in a main power source based on the input and/or discharge values outside of a respective threshold value (e.g., input threshold value, discharge threshold value). The main power source failure can be detected from the input and/or discharge values (e.g., input voltage, discharge current) of the backup power source associated with a load among the plurality of loads, where the input and/or discharge value(s) are outside of the respective threshold value (e.g., input threshold value, discharge threshold value). The input voltage and/or discharge current outside of a respective threshold value can indicate a failure from a main power source. For example, the load may be drawing a discharge current exceeding 100 mA, which is outside of the discharge threshold value, which can indicate failure from a main power source. Detecting the main power supply failure can include recognition of planned and/or unplanned failure of the main power source.

[0045] In some examples, the respective threshold values can be predetermined. The respective predetermined threshold values can be determined by a user or the system, depending upon particular input and/or discharge value ranges. Detection of input and/or discharge values can be based on the respective predetermined threshold values, which can be used to compare to the input and/or discharge values (e.g., discharge current and/or input voltage).

[0046] At 466, the method 460 can include providing power to the load from the backup power source in response to the detected input and/or discharge values of the backup power source. In some examples, remaining loads among the plurality of loads can be provided power from a main power source. That is, a plurality of loads not experiencing main power source failure can continue receiving power from the main power source while a particular load can be provided power from the backup power source.

[0047] At 468, the method 460 can include monitoring, for a period of time, the provided power to the load from the backup power source. For example, the backup power source can provide backup power to a particular load for a period of time. The amount of backup power provided to the load can be monitored to for power consumption, time, and/or power consumption changes.

[0048] Monitoring the provided backup power can determine the amount of time the power from the main power source has failed the particular load. For instance, the particular load consuming backup power for a period of ten seconds can indicate that the main power source failed the particular load for ten seconds.

[0049] In some examples, the method 460 can include selecting the discharge current as a priority reading when a conflict exists between the input and/or discharge values. For example, if the input voltage (e.g., input value) is within an input threshold value (e.g., 12V) and the discharge current is outside of a discharge threshold value (e.g., greater than 100 mA), the discharge current (e.g., discharge value) can be relied upon to initiate a backup power operation. That is, when a detected input voltage value conflicts with the discharge current value, the discharge current value (e.g., discharge value) can be the reading relied upon to determine the backup operation response.

[0050] In the present disclosure, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration how a number of examples of the disclosure may be capable of being practiced. These examples are described in sufficient detail to enable those of ordinary skill in the art to practice the examples of this disclosure, and it is to be understood that other examples may be capable of being used and that process, electrical, and/or structural changes

may be capable of being made without departing from the scope of the present disclosure.

[0051] The above specification, examples and data provide a description of the method and applications, and use of the system and method of the present disclosure. Since many examples may be capable of being made without departing from the spirit and scope of the system and method of the present disclosure, this specification merely sets forth some of the many possible example configurations and implementations.

What is claimed is:

1. A backup power supply controllers system, comprising:
 - a controller to:
 - monitor a discharge current for a backup power source;
 - detect a main power supply failure based on a discharge current being outside of a threshold value; and
 - regulate power to a particular load from the backup power source in response to the detected discharge current being outside of the threshold value.
2. The system of claim 1, wherein the discharge current is the current drawn from the backup power source and is a priority value that is relied upon when a conflict exists between the discharge current and an input voltage at the backup power source.
3. The system of claim 1, wherein the system comprises at least one of:
 - a centralized backup power configuration; and
 - a distributed backup power configuration.
4. The system of claim 1, wherein the particular load is supplied with power from the backup power source while a number of other loads in an enclosure comprising the particular load receive power from a main power source.
5. The system of claim 1, wherein the backup power is derived from a single power source associated with each of a plurality of loads including the particular load.
6. The system of claim 1, wherein the backup power is supplied to the plurality of loads upon a main power source failure.
7. The system of claim 1, further comprising the controller to monitor the supplied backup power to the particular load for a period of time.

8. The system of claim 1, further comprising the controller to:
 - monitor an input voltage; and
 - detect when the input voltage is outside of an input threshold value, wherein the input threshold value is 9 volts (V).
9. A non-transitory computer readable medium storing instructions executable by a processing resource, wherein the instructions are executable to:
 - monitor input and discharge values for a backup power source coupled to a plurality of loads, wherein the input and discharge values of the backup power source includes a discharge current;
 - detect input and discharge values outside of a respective threshold value of the backup power source associated with a particular load among the plurality of loads; and
 - regulate power for the particular load with the backup power source in response to the input and discharge values being outside of the respective threshold value, while remaining loads among the plurality of loads receive power from a main power source.
10. The medium of claim 9, wherein the input and discharge values include an input voltage and the discharge current is a priority reading when a conflict exists between the input voltage and the discharge current.
11. The medium of claim 9, wherein the discharge current is the current drawn from the backup power source.
12. The medium of claim 9, wherein power provided by the backup power source to the load is supplied for a period of time.
13. A method for backup power supply controllers, comprising:

monitoring input and discharge values of a backup power source to a plurality of loads, wherein the input and discharge values includes a discharge current and an input voltage;

detecting a failure in a main power source based on the input and discharge values outside of a respective threshold value;

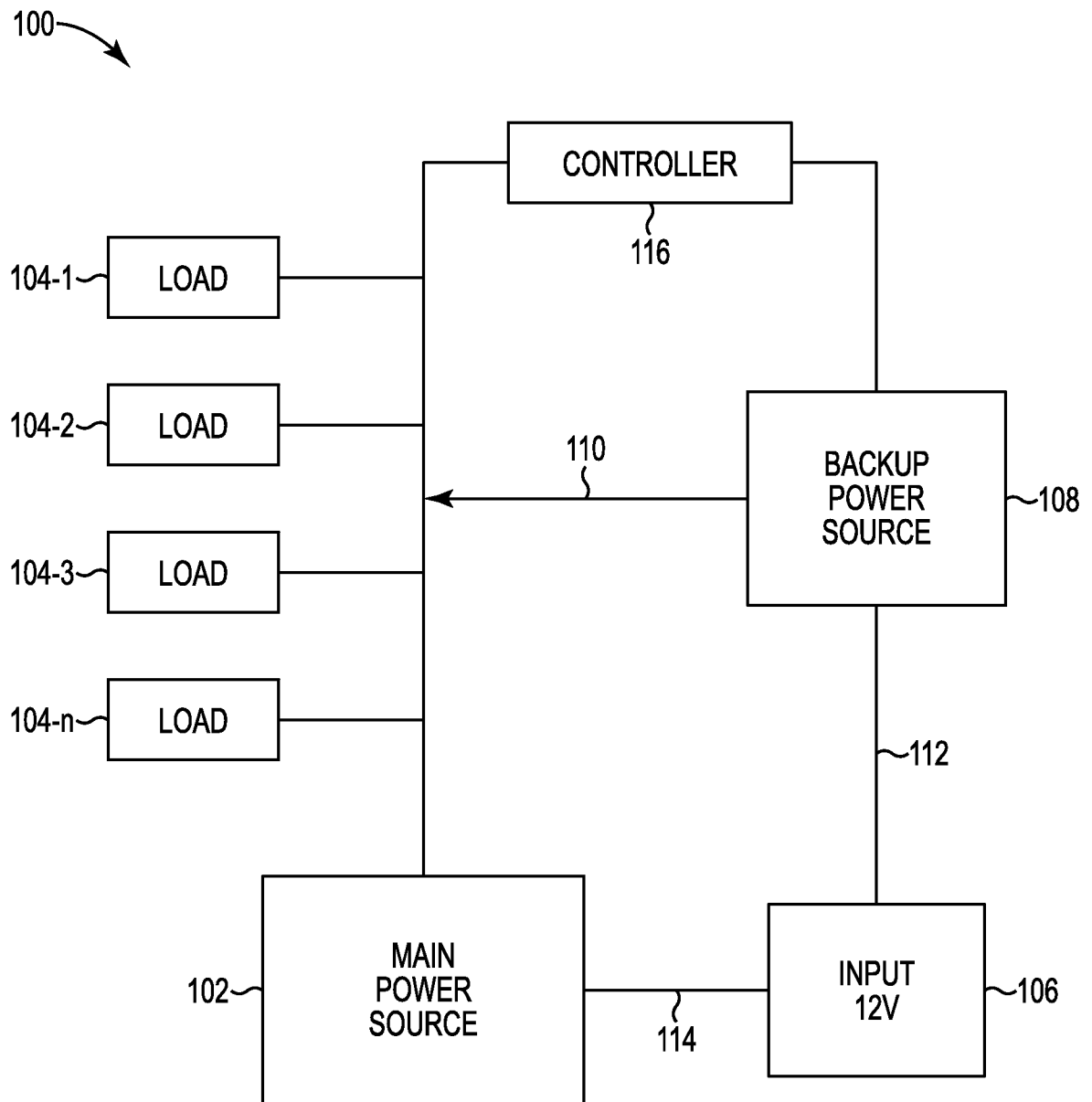
regulating power to a particular load from the backup power source in response to the detected input and discharge values; and

monitoring, for a period of time, the power to the particular load from the backup power source.

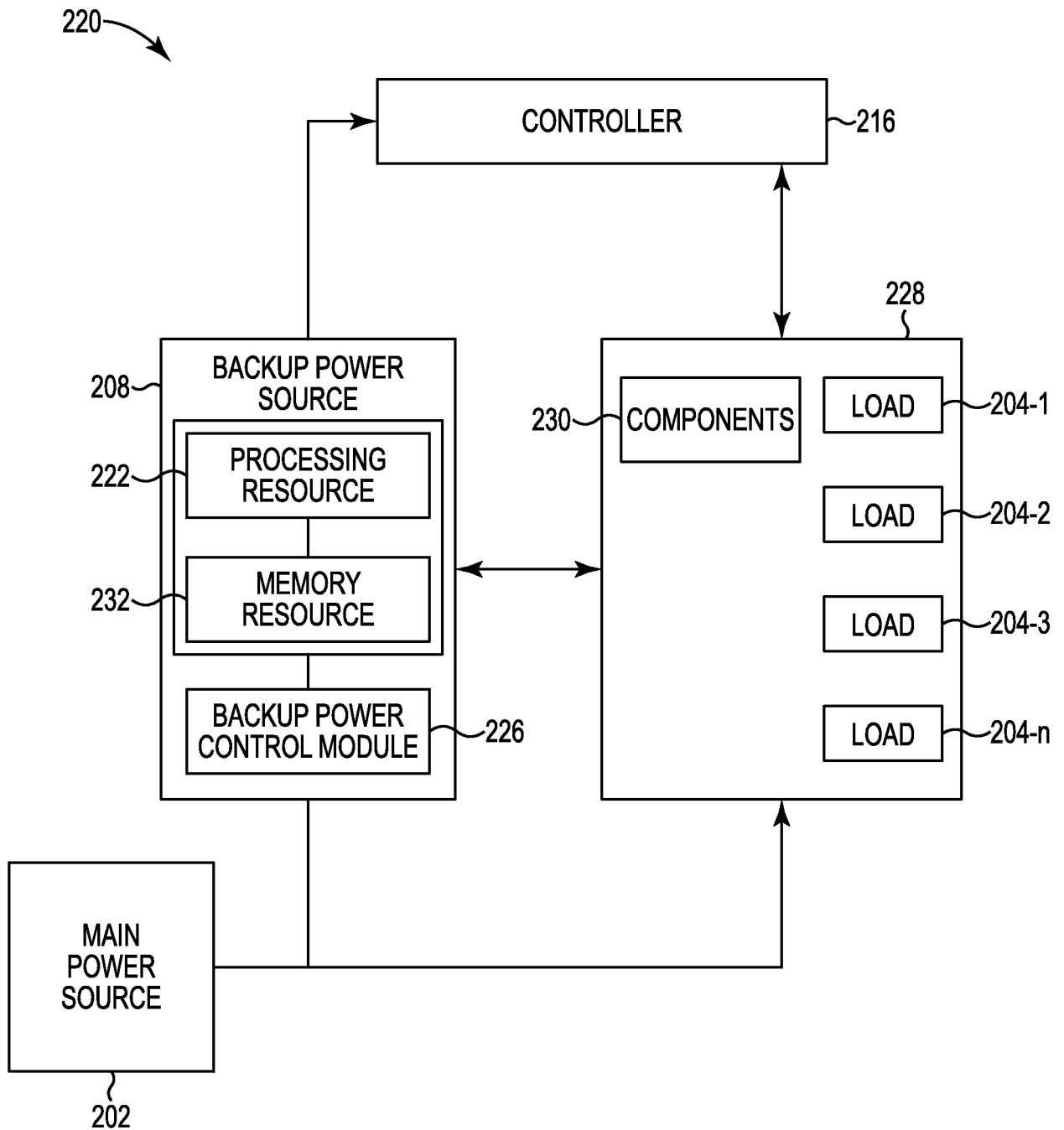
14. The method of claim 13, further comprising selecting the discharge value as a priority reading when a conflict exists between the input and discharge values.

15. The method of claim 13, wherein remaining loads among the plurality of loads are provided power from the main power source.

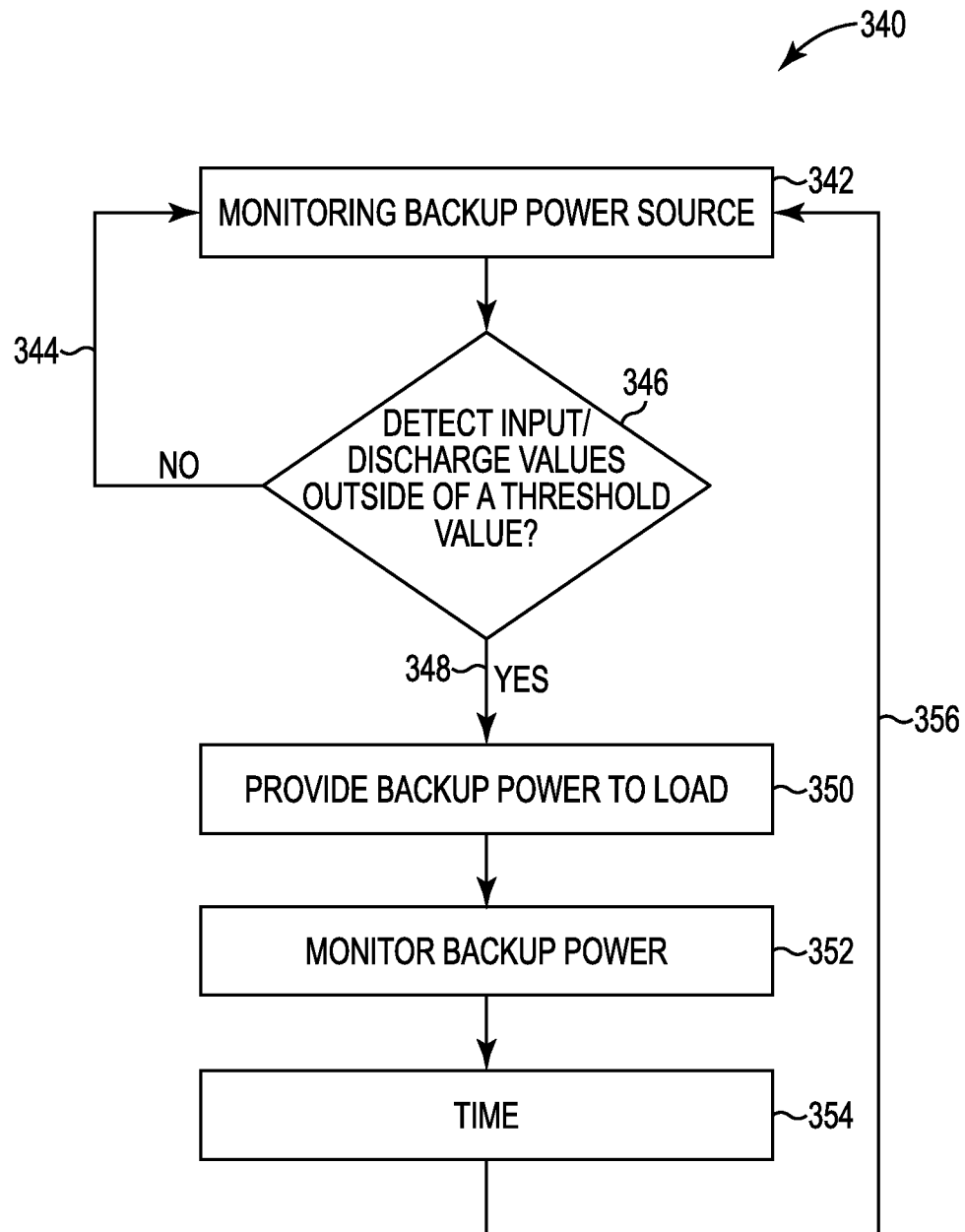
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**Fig. 1**

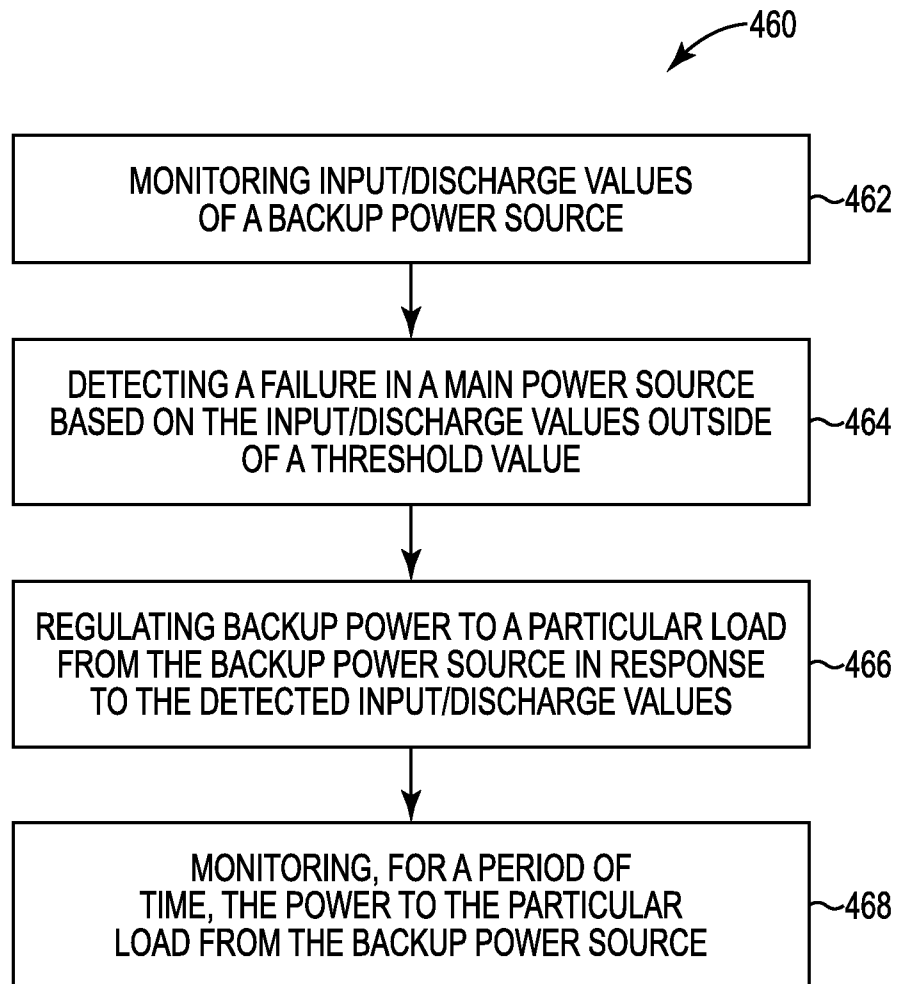
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**Fig. 2**

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**Fig. 3**

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**Fig. 4**

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/038323**A. CLASSIFICATION OF SUBJECT MATTER****G06F 1/30(2006.01)i, G06F 1/28(2006.01)i, G06F 1/26(2006.01)i**

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

B. FIELDS SEARCHEDMinimum documentation searched (classification system followed by classification symbols)
G06F 1/30; H02J 7/04; G06F 7/00; H02J 7/00; G08B 23/00; G06F 1/28; G06F 1/26Documentation 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 modelsElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: backup, power supply, monitor, detect, failure, discharge, input voltage**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2010-0295513 A1 (PETER MCCOLLUM et al.) 25 November 2010 See paragraphs [0010]-[0015], [0023]-[0029], [0035]; claim 17; and figure 4A.	1-15
A	US 2002-0027508 A1 (TSUTOMU BABA) 07 March 2002 See paragraphs [0010]-[0014]; and figure 3.	1-15
A	US 2009-0230917 A1 (YASUSHI KOJIMA et al.) 17 September 2009 See paragraphs [0008]-[0013]; and figure 5.	1-15
A	WO 2012-112308 A1 (CORAIID, INC.) 23 August 2012 See paragraphs [0008]-[0009]; and figure 5.	1-15
A	US 2003-0231003 A1 (GARY L. BALLARD et al.) 18 December 2003 See paragraphs [0016]-[0021]; and figure 1.	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search

28 March 2016 (28.03.2016)

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/038323

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010-0295513 A1	25/11/2010	US 8648568 B2 WO 2009-091395 A1	11/02/2014 23/07/2009
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