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- (71) **Applicant:** HEWLETT PACKARD ENTERPRISE DEVELOPMENT LP [US/US]; 11445 Compaq Center Drive West, Houston, TX 77070 (US).
- (72) **Inventors:** WANG, Han; 11445 Compaq Center Drive W., Houston, Texas 77070 (US). RAYMOND, Patrick A.; 11445 Compaq Center Drive W., Houston, Texas 77070 (US). FRANZ, John; 11445 Compaq Center Drive W., Houston, Texas 77070 (US).
- (74) **Agents:** ADEKUNLE, Olaolu Olubunmi et al.; Hewlett Packard Enterprise, 3404 E. Harmony Road, Mail Stop 79, Fort Collins, CO 80528 (US).
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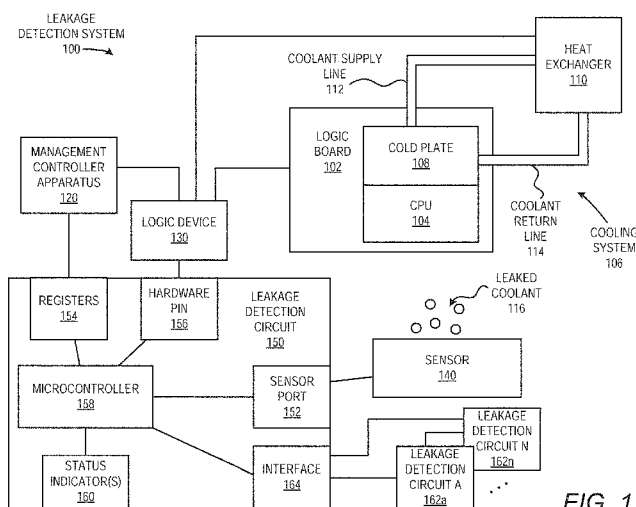


FIG. 1

(57) **Abstract:** According to an example, a leakage detection system for a logic board may include a management controller apparatus that is to determine whether to shut down either or both of a cooling system for the logic board and the logic board based upon a read value of a register bit in the register of a leakage detection circuit and whether a communication is received from a logic device regarding receipt of a leakage detected signal by the logic device from the leakage detection circuit.



LEAKAGE DETECTION FOR A LOGIC BOARD

BACKGROUND

[0001] Computers and other computing devices are being assembled with ever-increasing densities of heat generating components, such as integrated circuits, processors, multiple core processors, and graphics processing units, to meet ever-increasing demands for computing power and speed. Conventional techniques for removing the heat generated by these components include the use of heat sinks and fans. However, those conventional techniques often provide insufficient levels of cooling, particularly when the components are densely packed together. Another type of cooling system uses liquid coolant to cool the heat generating components and may be more effective at dissipating heat from the components than cooling systems that employ air-cooling techniques.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] Features of the present disclosure are illustrated by way of example and not limited in the following figure(s), in which like numerals indicate like elements, in which:

[0003] FIG. 1 is a simplified block diagram of a leakage detection system for a logic board, according to an example of the present disclosure;

[0004] FIG. 2 is a block diagram of a management controller apparatus of the leakage detection system depicted in FIG. 1, according to an example of the present disclosure; and

[0005] FIG. 3 shows a flow diagram of a method for detecting and responding to a detected leak, according to an example of the present disclosure.

DETAILED DESCRIPTION

[0006] For simplicity and illustrative purposes, the present disclosure is described by referring mainly to an example thereof. In the following description, numerous specific details are set forth in order to provide a thorough understanding of the present disclosure. It will be readily apparent however, that the present disclosure may be practiced without limitation to these specific details. In other instances, some methods and structures have not been described in detail so as not to unnecessarily obscure the present disclosure. As used herein, the terms “a” and “an” are intended to denote at least one of a particular element, the term “includes” means includes but not limited to, the term “including” means including but not limited to, and the term “based on” means based at least in part on.

[0007] Additionally, It should be understood that the elements depicted in the accompanying figures may include additional components and that some of the components described in those figures may be removed and/or modified without departing from scopes of the elements disclosed herein. It should also be understood that the elements depicted in the figures may not be drawn to scale and thus, the elements may have different sizes and/or configurations other than as shown in the figures.

[0008] Disclosed herein are a leakage detection system for a logic board, a management controller apparatus to detect and respond to a detected leak, and a method for detecting and responding to a detected leak. The leakage detection system may include the management controller apparatus, a logic device that is connected to the management controller apparatus, a sensor that is sensitive to moisture, and a leakage detection circuit. The leakage detection circuit may include a sensor port connected to the sensor, a register, a hardware pin physically linked to the logic device, and a microcontroller to detect when moisture, e.g., from a leak from a cooling system, has contacted the sensor. In addition, the microcontroller is to, in response to a determination that moisture has been detected, set a bit in the register to a value to indicate that moisture has been detected and output a leakage detected signal to the logic device through

the hardware pin. The management controller apparatus is to determine whether to shut down either or both of a cooling system for the logic board and the logic board based upon a read value of the register bit and whether a communication is received from the logic device regarding receipt of the leakage detected signal.

[0009] As discussed in greater detail herein, the management controller apparatus may not determine that a leak has been detected unless the management controller apparatus determines that the register bit has been set to the second value and the communication regarding receipt by the logic device has been received. In other words, if one of these conditions is not met, the management controller apparatus may determine that a leak has not occurred and may thus not take any damage prevention or mitigation actions. Thus, if one of these conditions occurred due to an error in either or both of the leakage detection circuit and the logic device, and thus did not occur in response to an actual detected leak, the management controller apparatus may not take the damage prevention or mitigation actions. By not taking these actions each time that one of the conditions occur, the management controller apparatus may save time and valuable resources as the shutting down and re-starting of the cooling system and/or logic board may be relatively costly in terms of time and resource availability.

[0010] Through implementation of the features disclosed herein, cooling systems that use liquid coolants may be implemented to cool electronic components with a relatively lower risk of damage caused by leakage in the cooling systems as well as a relatively lower risk of unnecessary shutdowns.

[0011] With reference first to FIG. 1, there is shown a simplified block diagram of a leakage detection system 100 for a logic board 102, according to an example of the present disclosure. The logic board 102 depicted in FIG. 1 may be a system board, a motherboard, or other type of logic board found, for instance, in a computer system, a server, a blade server, or the like. In this regard, the logic board 102 may include a central processing unit (CPU) 104 as well as other components (not shown). The CPU 104 may represent a single processing unit, multiple processing units, a multiple core processing unit, or the like.

[0012] As also shown in FIG. 1, the CPU 104, and in other examples, other components on the logic board 102, may be cooled through operation of a liquid coolant-based cooling system 106. The cooling system 106 may include a cold plate 108 that may be in thermal contact with the CPU 104 to absorb and dissipate heat generated by the CPU 104. Particularly, the cold plate 108 may receive a chilled or cooled coolant, which may be in liquid form, from a heat exchanger 110 via a coolant supply line 112 and heat from the CPU 104 may be conducted into the coolant, thereby cooling the CPU 104, while heating the coolant. The heated coolant, which may be in liquid or gaseous form following absorption of the heat, may then be returned to the heat exchanger 110 via a coolant return line 114 where the heated coolant may be cooled and supplied back into the cold plate 108. The coolant may be any suitable cooling fluid, such as, water, alcohol, refrigerant, or the like.

[0013] The heat exchanger 110 may include, for instance, a refrigeration-based heat exchanger, a liquid-to-air heat exchanger, a liquid-to-liquid heat exchanger, or other type of heat exchanger. The cooling system 106 may also include a pump (not shown) that is to apply pressure on the coolant to cause the coolant to flow through the cooling system 106, which may be formed in a closed loop. The heat exchanger 110 may also be positioned at a location away from the logic board 102. For instance, the logic board 102 may be housed within a server chassis and the heat exchanger 110 may be positioned in an electronics rack in which the server chassis is housed. In another example, the heat exchanger 110 may be positioned outside of the electronics rack or outside of a data center in which the electronics rack is housed. Although not shown, the heat exchanger 110 may also supply coolant to cold plates provided on other logic boards, for instance, all of the logic boards housed in a plurality of server chassis of an electronics rack.

[0014] Although the cold plate 108 and the lines 112, 114 are intended to be hermetically sealed and to thus prevent leakage of the coolant, coolant may nevertheless leak out from the cold plate 108 and/or the lines 112, 114. The leaked coolant is represented as reference numeral 116. According to an example, the leakage detection system 100 is to detect the leaked coolant 116

and to take measures to avoid or mitigate damage to the logic board 102, including the CPU 104 and other components on the logic board 102, that may be caused by the leaked coolant 116. That is, the leakage detection system 100 may determine that a leak has occurred relatively quickly after the leak has occurred and may shut down either or both of the cooling system 110 and the logic board 102. Although particular reference is made herein to the detection of leaked coolant 116, it should be understood that the leakage detection system 100 may detect other forms of moisture, such as condensation, spilled liquids, etc.

[0015] According to an example, however, the leakage detection system 100 may not automatically shut down the cooling system 106 and/or the logic board 102 when a leak has been detected. Instead, the leakage detection system 100 may require a confirmation that a leak has been detected, for instance, to minimize false positive readings. In one regard, therefore, the leakage detection system 100 may prevent the unnecessary shutdown of the cooling system 106 and/or the logic board 102. In one regard, shutting down of the cooling system 106 and/or the logic board 102 unnecessarily may be costly both in terms of the time required to perform the shutdown and the time required to re-start after the shutdown, and thus, the leakage detection system 100 disclosed herein may reduce or prevent the occurrence of these costly shutdowns.

[0016] As shown, the leakage detection system 100 may include a management controller apparatus 120, a logic device 130, a sensor 140, and a leakage detection circuit 150. The leakage detection circuit 150 is depicted as including a sensor port 152 that is connected to the sensor 140, registers 154, a hardware pin 156, and a microcontroller 158. The management controller apparatus 120, the logic device 130 and/or the leakage detection circuit 150 may be positioned externally to the logic board 102. For instance, the logic board 102 may be housed within a server chassis and the management controller apparatus 120, the logic device 130 and/or the leakage detection circuit 150 may be positioned in another server chassis, mounted separately on an electronics rack, or the like. In another example, the management controller apparatus 120, the

logic device 130, the sensor 140, and/or the leakage detection circuit 150 may be mounted on or otherwise form part of the logic board 102.

[0017] The management controller apparatus 120, which may be a circuit, may monitor the physical state of the components on the logic board 102 through receipt of sensor data over, for instance, over an I²C bus. By way of particular example, the management controller apparatus 120 is a baseboard management controller of the logic board 102. The logic device 130, which may also be a circuit, may be a complex programmable logic device (CPLD) and may control various hardware components in the logic board 102 including the shutdown of the cooling system 106 and/or the logic board 102.

[0018] The sensor 140 may be sensitive to moisture. For instance, the sensor 140 may include cables or wires whose electrical resistance (or equivalently, conductance) may change when contacted by moisture as may occur when there is a leak in the cooling system 106. By way of the example, the sensor 140 may be formed of electrically conductive material, such as, copper, aluminum, etc. Additionally, the sensor 140 may be positioned at a location with respect to the logic board 102 at which coolant from the cooling system 106 may collect. For instance, in an example in which the logic board 102 is housed in a server chassis, the sensor 140 may be positioned at a bottom-most interior surface of the server chassis or a drip pan dedicated to the server chassis. In other examples, the leakage detection system 100 may include a plurality of sensors 140, in which the sensors 140 may be positioned at multiple locations with respect to the logic board 102 to enable detection of leakages in a relatively faster manner. For instance, the sensors 140 may be positioned around the periphery of the logic board 102.

[0019] In operation, the microcontroller 158 may continuously send a current to the sensor 140 and may measure the resistance level of the current flow through the sensor 140. When leaked coolant 116, or moisture from another source, contacts the sensor 140, the microcontroller 158 may detect a change in the resistance level of the sensor 140. According to an example, the microcontroller 158 may determine whether the change in resistance level

exceeds a predetermined threshold resistance level change, which may be set at a level to substantially prevent false detections. For instance, the predetermined threshold resistance level change may be set to account for changes in humidity of ambient airflow around the sensor 140.

[0020] In response to a determination that a detected resistance level change does not exceed the predetermined threshold resistance level change, the microcontroller 158 may continue detecting the resistance level of the sensor 140. However, in response to a determination that a detected resistance level change does exceed the predetermined threshold resistance level change, the microcontroller 158 may determine that a leak has been detected. In response to this determination, the microcontroller 158 may set a bit in the registers 154 that may cover leakage status and may currently be set to a first value, to a second value. The first value may correspond to an indication that an appreciable amount of moisture has not contacted the sensor 140, while the second value may correspond to an indication that an appreciable amount of moisture has contacted the sensor 140. That is, the first value may correspond to an indication that a leakage has not been detected and the second value may correspond to an indication that a leakage has been detected. The registers 154 may also cover other types of data, for instance, vendor identification, microcontroller type, readiness status, input validity, sensor installation, failures, control status of the leakage detection circuit 150, etc.

[0021] The microcontroller 158 may further output a leakage detected signal to the logic device 130 through the hardware pin 156, in which the hardware pin 156 is physically linked to the logic device 130. For instance, when the microcontroller 158 determines that a leak has been detected, the microcontroller 158 may pull the hardware pin 156 to have the logic LOW to indicate to the logic device 130 that a leakage in the cooling system 106 has been detected.

[0022] According to an example, the microcontroller 158 may nominally maintain a logic HIGH signal with the logic device 130 and may pull the logic HIGH signal to the logic LOW signal when a leakage is detected. The logic

device 130 may thus be immediately informed of a detected leakage through the change in the logic signal from the hardware pin 156. The logic device 130 may also output a communication to the management controller apparatus 120 to inform the management controller apparatus 120 that the logic device 130 has received the leakage detected signal from the leakage detection circuit 150.

[0023] The microcontroller 158 may further activate or change a status indicator 160 or a plurality of status indicators 160. The status indicator(s) 160 may be light emitting diodes (LEDs) that the microcontroller 158 may activate or deactivate to indicate that a leakage has been detected. In addition, the microcontroller 158 may maintain the status indicator(s) at a standard operational condition, i.e., emitting light at a particular color, when no leakage has been detected.

[0024] The management controller apparatus 120 may periodically read the registers 154 through, for instance, an Ethernet connection with the leakage detection circuit 150. During the periodic reading, the management controller apparatus 120 may determine that the register bit covering leakage status has been set to the second value. Based upon the receipt of the communication from the logic device 130 that the logic device 130 has received the leakage detected signal from the leakage detection circuit 150 and the determination that the register bit covering leakage status has been set to the second value, the management controller apparatus 120 may determine that a leakage has occurred and that either or both of the cooling system 106 and the logic board 102 are to be shut down.

[0025] According to an example, the management controller apparatus 120 may only determine that the leakage has been detected if the management controller apparatus 120 both reads that the register bit covering leakage status in the registers 154 is at the second level and the management controller apparatus 120 has received the communication from the logic device 130 that the logic device 130 has received the leakage detected signal from the leakage detection circuit 150. Thus, for instance, the management controller apparatus 120 may not determine that a leakage has been detected if one of these conditions is not

met. That is, if the management controller apparatus 120 determines after reading the registers 154 a predetermined number of times, which may be set as desired or needed, either that only one of the conditions is met or that both conditions are not met, the management controller apparatus 120 may determine that leakage has not been detected. Instead, the management controller apparatus 120 may determine that an error condition has occurred.

[0026] In one regard, therefore, the management controller apparatus 120 may implement a verification process prior to causing the cooling system 106 and/or the logic board 102 to be shutdown. By way of particular example, the management controller apparatus 120 may prevent the shutdown in the event that the register bit covering leakage status was improperly set to the second value. As another example, the management controller apparatus 120 may prevent the shutdown in the event that the signal communicated across the hardware pin 156 was improperly pulled to the logic LOW. Accordingly, for instance, the management controller apparatus 120 may reduce or minimize the number of false positives in the detection of leakages.

[0027] In the event that the management controller apparatus 120 determines that one of the above-identified conditions has occurred without the other condition having occurred, the management controller apparatus 120 may output an indication to a user that there may be an error in the leakage detection circuit 150. The indication may be a communication of an error message that may be displayed on a display. In addition, or alternatively, the indication may be a change in the status indicator(s) 160 of the leakage detection circuit 150.

[0028] In the event that the management controller apparatus 120 determines that a leakage has been detected, i.e., that both of the conditions discussed above have been met, the management controller apparatus 120 may cause either or both of the cooling system 106 and the logic board 102 to be shutdown. The shutting down of the cooling system 106 may include, for instance, deactivating a pump or other mechanism in the cooling system 106 to cease or reduce the flow of coolant through the cooling system 106. The shutting down of the logic board 102 may include ceasing the supply of power to the logic

board 102 such that the components on the logic board 102 that require power stop operating.

[0029] According to a first example, and as shown in FIG. 1, the management controller apparatus 120 may communicate an instruction to the logic device 130 to cause the logic device 130 to shut down the cooling system 106 and/or the logic board 102. In another example, the management controller apparatus 120 may communicate instructions to a controller (not shown) of the cooling system 106 to shut down the flow of coolant and/or may communicate instructions or otherwise control a power supply to the logic board 102 to cease delivery of power to the logic board 102. In a further example, the management controller apparatus 120 may communicate an indication that a leakage has been detected to a higher level management system (not shown), for instance, a chassis level or a rack level management system, and the higher level management system may shut down the cooling system 106 and/or the logic board 102.

[0030] In the third example, the higher level management system may stop the flow of coolant for a plurality of logic boards 102 and may also stop operations of the plurality of logic boards 102. In one regard, therefore, detection of a leakage around one logic board may automatically cause damage prevention measures to be taken in and around other logic boards, for instance, logic boards that neighbor the logic board for which a leakage was detected to have occurred.

[0031] According to a further example, a leakage detection circuit 162a-162n may be provided for each of a plurality of other logic boards (not shown), which may be similar to the logic board 102. The variable “n” may be an integer value equal to or greater than one. In addition, each of the leakage detection circuits 162a-162n may include all of the same elements as those depicted as being contained in the leakage detection circuit 150. As shown, the leakage detection circuit 150 may be in communication with each of the other leakage detection circuits 162a-162n through an interface 164 and the other leakage detection circuits 162a-162n may be in communication with each other through respective interfaces on the leakage detection circuits 162a-162n. In this

example, when one of the leakage detection circuits 150 detects that a leak has occurred, that leakage detection circuit 150 may output an indication to the other leakage detection circuits 162a-162n that a leak has been detected.

[0032] In addition, each of the other leakage detection circuits 162a-162n may set a bit in their respective registers 154 that may cover leakage status and may currently be set to a first value, to a second value and may output a leakage detected signal to a respective logic device 130 through the hardware pin 156. In this regard, the management controller apparatuses 120 in respective leakage detection systems containing the other leakage detection circuits 162a-162n may determine that a leak has been detected and may output signals to cause other cooling systems 106 and/or logic boards 102 to be shut down in any of the manners described above. Thus, for instance, if one of the leakage detection circuits 162a fails to correctly detect a leakage, another leakage detection circuit 162b that may be positioned beneath the leakage detection circuit 162a, for instance, at the bottom of an electronics rack, may correctly detect the leak. The leakage detection circuits 162a-162n may thus provide backup protection to the leakage detection circuit 150.

[0033] With reference now to FIG. 2, there is shown a block diagram 200 of the management controller apparatus 120 depicted in FIG. 1, according to an example. As shown in FIG. 2, the management controller apparatus 120 may include a first connector 202 that is to be connected to the registers 154 in a leakage detection circuit 150. The first connector 202 may be an Ethernet port such that the management controller apparatus 120 may communicate with the leakage detection circuit 150 through use of Ethernet protocols. In other examples, the first connector 202 may be another type of port and the management controller apparatus 120 may communicate with the leakage detection circuit 150 through other suitable protocols. For instance, the management controller apparatus 120 may communicate with the leakage detection circuit 150 through a communication bus, e.g., I²C. The second connector 204 may be a hardware pin that is to be physically linked to the logic device 130.

[0034] The management controller apparatus 120 is also depicted as including a processor 206 and a machine-readable storage medium 210. The processor 206 may be any of a central processing unit (CPU), a semiconductor-based microprocessor, an application specific integrated circuit (ASIC), and/or other hardware device suitable for retrieval and execution of instructions stored in the machine-readable storage medium 210. The processor 206 may fetch, decode, and execute instructions, such as instructions 212-218 stored on the machine-readable storage medium 210, to read a register bit in the registers 212, determine whether a communication from a logic device 130 has been received 214, determine whether a leak has been detected 216, and cause damage prevention measures to be taken 218. As an alternative or in addition to retrieving and executing instructions, the processor 206 may include one or more electronic circuits that include electronic components for performing the functionalities of the instructions 212-218. These processes are described in detail below with respect to FIG. 3.

[0035] The machine-readable storage medium 210 may be any electronic, magnetic, optical, or other physical storage device that contains or stores executable instructions. Thus, the machine-readable storage medium 210 may be, for example, Random Access Memory (RAM), an Electrically Erasable Programmable Read-Only Memory (EEPROM), a storage device, an optical disc, and the like. In some implementations, the machine-readable storage medium 210 may be a non-transitory machine-readable storage medium, where the term “non-transitory” does not encompass transitory propagating signals. As described in detail below, machine-readable storage medium 210 may be encoded with a series of executable instructions 212-218 to detect and respond to a detected leak.

[0036] Also shown in FIG. 2 is a data store 220 in communication with the logic board 102. The data store 220 may be a data storage device to which data from the logic board 102 may be stored. The data store 220 may be, for instance, a flash memory device, and either may be mounted on the logic board 102 or may be a separate device from the logic board 102. In any regard, according to an example, the processor 206 may execute the instructions 218 to cause data

contained in the logic board 102, for instance, data stored in a CPU RAM, to be backed up in the data store 220 prior to causing either or both of the cooling system 106 for the logic board 102 and the logic board 102 to be shut down.

[0037] With reference now to FIG. 3, there is shown a flow diagram of a method 300 for detecting and responding to a detected leak, according to an example. It should be understood that the method 300 depicted in FIG. 3 may include additional operations and that some of the operations described therein may be removed and/or modified without departing from the scope of the method 300. The description of the method 300 is made with reference to the features depicted in FIGS. 1 and 2 for purposes of illustration and thus, it should be understood that the method 300 may be implemented in apparatuses having architectures different from those shown in FIGS. 1 and 2.

[0038] Generally speaking, the processor 206 of the management controller apparatus 120 may implement or execute the instructions 212-218 stored on the machine-readable storage medium 210 to perform the method 300.

[0039] At block 302, the processor 206 may execute the instructions 212 to read a register bit of a leakage detection circuit 150, in which a microcontroller 158 of the leakage detection circuit 150 is to set the register bit to a first value when a leak is not detected and to a second value when a leak is detected. At block 304, the processor 206 may execute the instructions 214 to determine whether a communication from a logic device 130 has been received, in which the logic device 130 is to send the communication in response to receipt of a leakage detected signal from the leakage detection circuit 150.

[0040] At block 306, the processor 206 may execute the instructions 216 to determine whether a leak has been detected based upon the read value of the register bit and whether the communication from the logic device 130 has been received. As discussed above, the processor 206 may determine that a leak has been detected only when the processor 206 determines that both the register bit is set to the second value and the communication from the logic device 130 has been received.

[0041] At block 308, the processor 206 may execute the instructions 218 to cause either or both of a cooling system 106 for a logic board 102 and the logic board 102 to be shut down in response to a determination that a leak has been detected to have occurred. The processor 206 may directly communicate instruction signals to the cooling system 106 and/or the logic board 102 to cause either or both of the cooling system 106 for the logic board 102 and the logic board 102 to be shut down. In another example, the processor 206 may communicate an instruction to the logic device 130, and the logic device 130 may cause either or both of the cooling system 106 for a logic board 102 and the logic board 102 to be shut down. In a further example, the processor 206 may communicate an instruction to a higher level controller, and the higher-level controller may cause either or both of the cooling system 106 for a logic board 102 and the logic board 102 to be shut down.

[0042] Some or all of the operations set forth in the method 300 may be contained as utilities, programs, or subprograms, in any desired computer accessible medium. In addition, the method 300 may be embodied by computer programs, which may exist in a variety of forms both active and inactive. For example, they may exist as machine readable instructions, including source code, object code, executable code or other formats. Any of the above may be embodied on a non-transitory computer readable storage medium.

[0043] Examples of non-transitory computer readable storage media include computer system RAM, ROM, EPROM, EEPROM, and magnetic or optical disks or tapes. It is therefore to be understood that any electronic device capable of executing the above-described functions may perform those functions enumerated above.

[0044] Although described specifically throughout the entirety of the instant disclosure, representative examples of the present disclosure have utility over a wide range of applications, and the above discussion is not intended and should not be construed to be limiting, but is offered as an illustrative discussion of aspects of the disclosure.

[0045] What has been described and illustrated herein is an example of the

disclosure along with some of its variations. The terms, descriptions and figures used herein are set forth by way of illustration only and are not meant as limitations. Many variations are possible within the spirit and scope of the disclosure, which is intended to be defined by the following claims -- and their equivalents -- in which all terms are meant in their broadest reasonable sense unless otherwise indicated.

What is claimed is:

1. A leakage detection system for a logic board, said system comprising:
 - a management controller apparatus;
 - a logic device connected to the management controller apparatus;
 - a sensor that is sensitive to moisture; and
 - a leakage detection circuit having:
 - a sensor port connected to the sensor;
 - a register;
 - a hardware pin physically linked to the logic device; and
 - a microcontroller to detect when moisture has contacted the sensorand wherein, in response to a determination that moisture has been detected, to set a bit in the register to a value to indicate that moisture has been detected, and to output a leakage detected signal to the logic device through the hardware pin; and
 - wherein the management controller apparatus is to determine whether to shut down either or both of a cooling system for the logic board and the logic board based upon a read value of the register bit and whether a communication is received from the logic device regarding receipt of the leakage detected signal.
2. The leakage detection system according to claim 1, wherein the logic device is to send the communication regarding receipt of the leakage detected signal to the management controller apparatus responsive to receipt of the leakage detected signal from the leakage detection circuit and wherein the management controller apparatus is to determine that either or both of the cooling system and the logic board are to be shut down in response to the detected value of the register bit indicating that moisture has been detected and receipt of the communication from the logic device.
3. The leakage detection system according to claim 2, wherein the management controller apparatus is to cause either or both of the cooling system and the logic board to be shut down.

4. The leakage detection system according to claim 2, wherein the management controller apparatus is to determine that neither of the cooling system and the logic board are to be shut down in response to either:

the detected value of the register bit indicating that moisture has been detected without receipt of the communication from the logic device; or

receipt of the communication from the logic device without the detected value of the register bit indicating that moisture has been detected.

5. The leakage detection system according to claim 1, further comprising:

another leakage detection circuit that is to detect a leakage at a location other than at the logic board, wherein each of the leakage detection circuit and the another leakage detection circuit is to communicate an indication that moisture has been detected in response to a determination by the leakage detection circuit or the another leakage detection circuit that moisture has been detected.

6. The leakage detection system according to claim 5, wherein the leakage detection circuit, in response to receipt of the indication that moisture has been detected from the another leakage detection circuit, is to set the register bit to a value to indicate that moisture has been detected and to output a leakage detected signal to the logic device through the hardware pin.

7. The leakage detection system according to claim 5, wherein the leakage detection circuit is positioned to detect a leak occurring in a server chassis and wherein the another leakage detection circuit is positioned to detect a leak occurring in another server chassis or in a location beneath the server chassis.

8. The leakage detection system according to claim 1, further comprising:

a plurality of sensors that are sensitive to moisture, wherein the plurality of sensors are positioned at different logic boards, wherein the different logic boards are positioned in different server chassis; and

wherein the leakage detection circuit is to detect when moisture has

contacted any of the plurality of sensors and to set the register bit to a value to indicate that moisture has been detected and to output a leakage detected signal to the logic device through the hardware pin.

9. The leakage detection system according to claim 1, wherein the management controller apparatus is further to back up data from the logic board to a data store in response to a determination that the logic board is to be shut down and to shut down the logic board following the backing up of the data.

10. A management controller apparatus comprising:

a first connector to be connected to a register of a leakage detection circuit, wherein the leakage detection circuit is to set a register bit covering leakage status to a first value when a leak is not detected and to a second value when a leak is detected;

a second connector to be connected to a logic device, wherein the leakage detection circuit is to output a leakage detected signal to the logic device in response to a determination that a leak has been detected; and

a processor to read the register bit of the leakage detection circuit through the first connection and to receive a communication from the logic device through the second connection, wherein the processor is to determine whether a leak has been detected to have occurred based upon the read value of the register bit and whether the communication from the logic device has been received.

11. The management controller apparatus according to claim 10, wherein the processor is further to determine that a leak has been detected to have occurred when the value of the register bit is the second value and the communication is received from the logic device, and wherein the processor is to cause either or both of a cooling system for a logic board and the logic board to be shut down in response to a determination that a leak has been detected to have occurred.

12. The management controller apparatus according to claim 10, wherein the processor is further to determine that a leak has not been detected to have

occurred when either:

the value of the register bit is the second value and the communication has not been received; or

the value of the register bit is the first value and the communication has been received.

13. The management controller apparatus according to claim 10, wherein the processor is further to back up data from the logic board in response to a determination that a leak has been detected to have occurred and to shut down the logic board following the backing up of the data.

14. A method for detecting and responding to a detected leak, said method comprising:

reading, by a processor of a management controller apparatus, a register bit of a leakage detection circuit, wherein the leakage detection circuit is to set the register bit to a first value when a leak is not detected and to a second value when a leak is detected;

determining, by the processor, whether a communication from a logic device has been received, wherein the logic device is to send the communication in response to receipt of a leakage detected signal from the leakage detection circuit; and

determining, by the processor, whether a leak has been detected based upon the read value of the register bit and whether the communication from the logic device has been received.

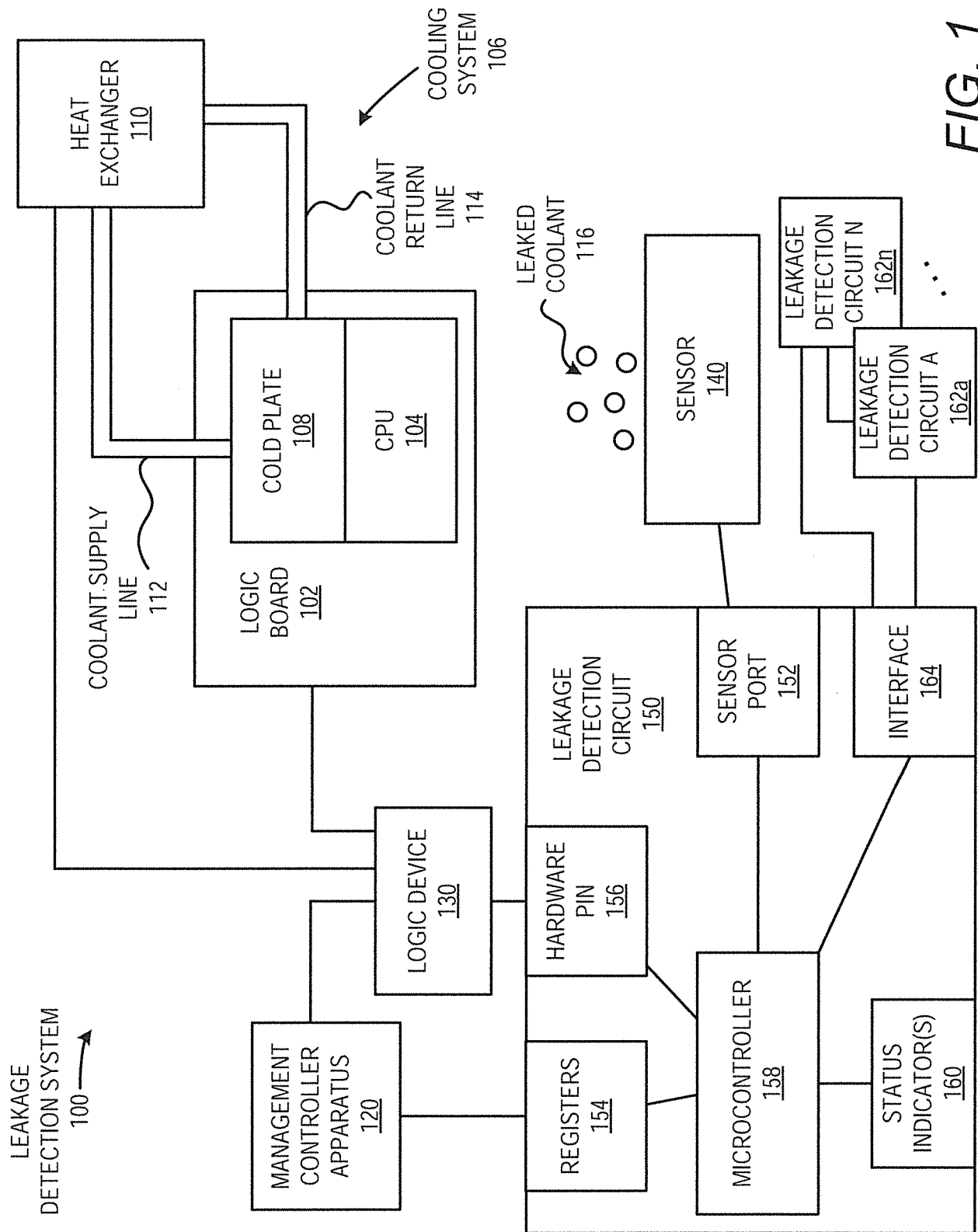
15. The method according to claim 14, further comprising:

determining, by the processor, that a leak has been detected to have occurred when the value of the register bit is read to be the second value and a determination is made that the communication is received from the logic device; and

causing, by the processor, either or both of a cooling system for a logic board and the logic board to be shut down in response to a determination that a

leak has been detected to have occurred.

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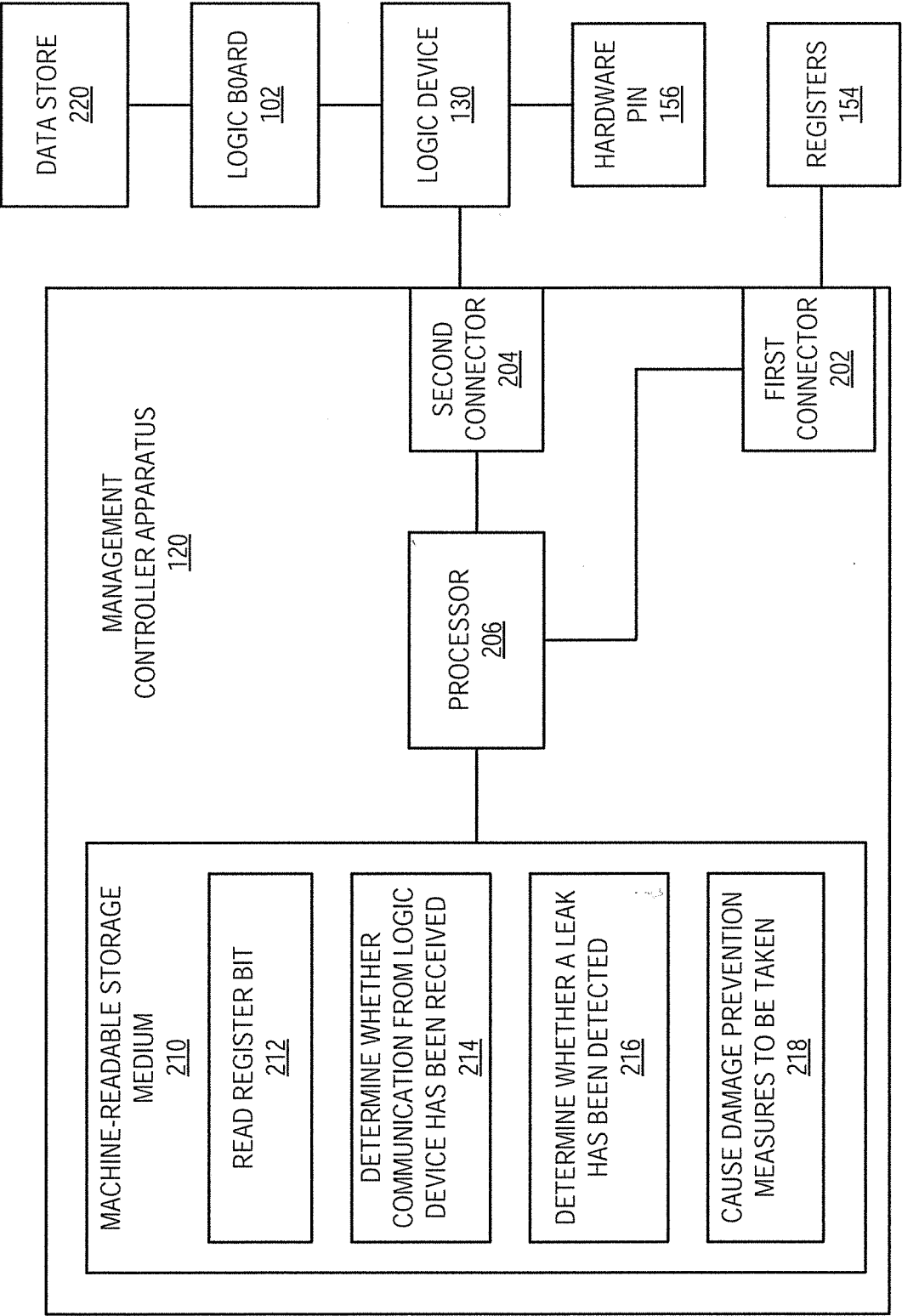
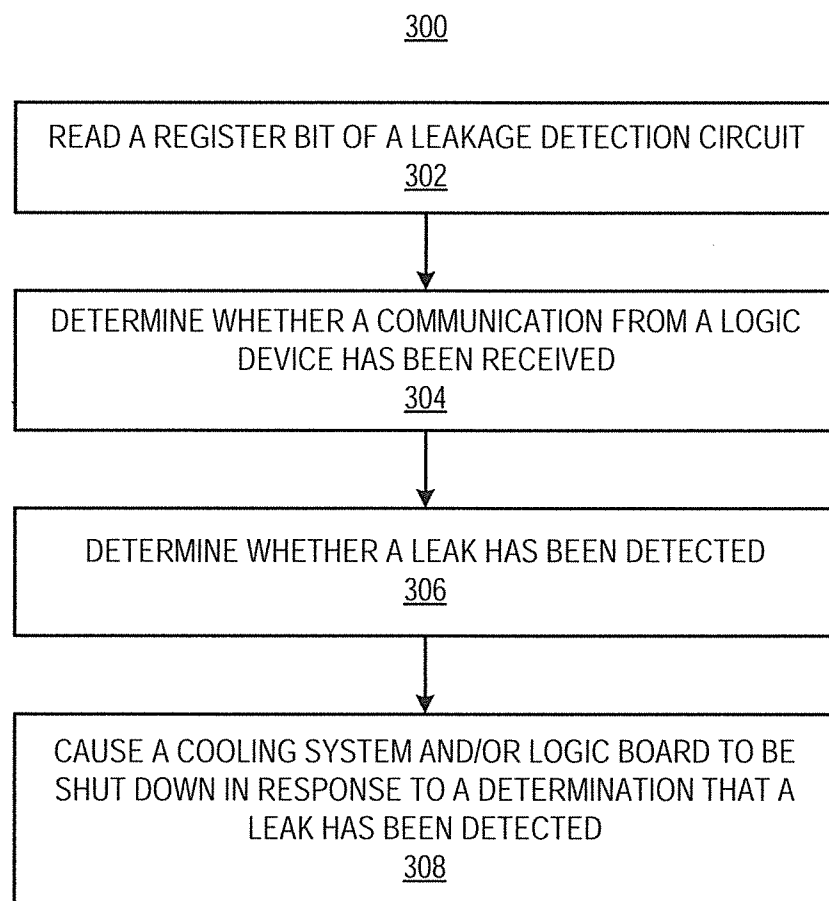


FIG. 2

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*FIG. 3*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/043288**A. CLASSIFICATION OF SUBJECT MATTER****G06F 1/20(2006.01)i, G06F 9/22(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 1/20; G01M 3/18; H04N 7/18; H05K 7/20; G08B 21/00; G01M 3/28; F25D 17/02; G06F 9/22

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

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

eKOMPASS(KIPO internal) & Keywords: logic board, leakage, detection, register, value, signal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2014-0266744 A1 (COOLIT SYSTEMS INC.) 18 September 2014 See paragraphs [0005], [0007], [0030], [0044]; claims 1, 4; and figures 7-8.	1-15
A	US 2007-0051166 A1 (KENNETH R. BAKER et al.) 08 March 2007 See paragraphs [0017]-[0018], [0026]; claim 1; and figures 1, 6.	1-15
A	US 2014-0251583 A1 (ASETEK A/S) 11 September 2014 See paragraphs [0005], [0021]; and figure 3.	1-15
A	US 2013-0063588 A1 (SUBHASH NEMANI et al.) 14 March 2013 See paragraphs [0011]-[0012]; and figure 1.	1-15
A	JP 2006-066703 A (TOSHIBA CORP.) 09 March 2006 See paragraphs [0019]-[0020]; and figure 7.	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

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"&" document member of the same patent family

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Name and mailing address of the ISA/KR

International Application Division
Korean Intellectual Property Office
189 Cheongsu-ro, Seo-gu, Daejeon Metropolitan City, 35208,
Republic of Korea

Facsimile No. +82-42-481-8578

Authorized officer

LEE, Dong Yun

Telephone No. +82-42-481-8734



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/043288

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US 2007-0051166 A1	08/03/2007	None	
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US 2013-0063588 A1	14/03/2013	CN 102998063 A EP 2570788 A1	27/03/2013 20/03/2013
JP 2006-066703 A	09/03/2006	None	