



- (51) International Patent Classification:
G11C 5/14 (2006.01) *G11C 16/06* (2006.01)
- (21) International Application Number:
PCT/US2015/027028
- (22) International Filing Date:
22 April 2015 (22.04.2015)
- (25) Filing Language: English
- (26) Publication Language: English
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- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,

HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- as to the identity of the inventor (Rule 4.17(i))
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))

Published:

- with international search report (Art. 21(3))

(54) Title: STATUS SIGNAL COMBINED ONTO POWER VOLTAGE

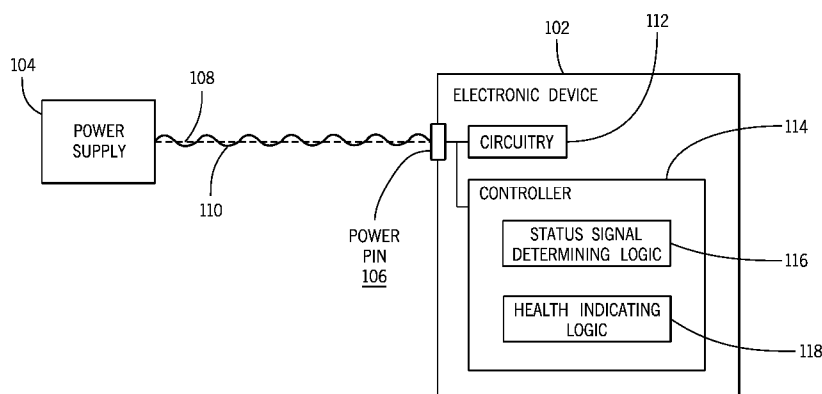


FIG. 1

(57) Abstract: An electronic device includes a power pin to receive a power voltage from a power supply. A controller is to determine whether a status signal combined onto the power voltage is received through the power pin, and indicate a health of the power supply based on the determining.

STATUS SIGNAL COMBINED ONTO POWER VOLTAGE

Background

[0001] A system can include a storage device to store data. Examples of storage devices include disk-based storage devices, solid state persistent storage devices, memory devices, and so forth. Requests can be submitted to a storage device to access data in the storage device. The access of data can include reading data stored in the storage device, or writing data into the storage device.

Brief Description Of The Drawings

[0002] Some implementations are described with respect to the following figures.

[0003] Fig. 1 is a block diagram of an example arrangement including a power supply and an electronic device, according to some implementations.

[0004] Fig. 2 is a block diagram of an example power supply controller according to some implementations.

[0005] Fig. 3 is a flow diagram of a process of an electronic device according to some implementations.

[0006] Fig. 4 is a schematic diagram of components in an electronic device according to further implementations.

[0007] Fig. 5 is a state diagram of a power supply controller according to further implementations.

[0008] Fig. 6 is a schematic diagram of components of a power supply according to further implementations.

Detailed Description

[0009] A memory module can include volatile memory and non-volatile memory to store data. A volatile memory can refer to a storage medium that loses stored

data (stored in the storage medium) in response to power being removed from the storage medium. A non-volatile memory can refer to a storage medium that maintains stored data (stored in the storage medium of the non-volatile memory) persistent even when power is removed from the storage medium of the non-volatile memory.

[0010] A memory module can be powered by an external power supply (a power supply that is external of the memory module). This external power supply can be a backup power supply that can temporarily power the memory module when primary power is lost. In some examples, the backup power supply can include a battery. In other examples, the backup power supply can include capacitor(s).

[0011] Primary power can be provided by a primary power supply, such as an AC adapter that is plugged into a wall outlet. In other examples, a primary power supply can include a battery or other type of power source.

[0012] The backup power supply is provided to protect against loss of data in the memory module, particularly data stored in the volatile memory of the memory module. In response to loss of primary power from the primary power supply, the backup power supply can provide power to the memory module for a time duration during which the memory module can save data in volatile memory to non-volatile memory in a data backup operation.

[0013] In some cases, a memory module may not have an input signal pin that is available to allow the backup power supply to provide an indication of a health status of the backup power supply to the memory module. Failure to provide an indication of the health status of the backup power supply to the memory module can result in data loss if primary power is lost and it turns out that the backup power supply does not have sufficient power to power the memory module after the primary power loss. For example, if the backup power supply does not have sufficient power to allow the memory module to copy data in volatile memory to non-volatile memory, then data in the volatile memory may be lost due to loss of primary power.

[0014] Although reference is made to the presence of a primary power supply and a backup power supply in some implementations of the present disclosure, it is noted that in other implementations, just one power supply for supplying power to a memory module is used.

[0015] In accordance with some implementations of the present disclosure, a health status signal regarding a health status of a power supply (e.g. backup power supply, a primary power supply, etc.) can be provided to a memory module (or more generally, an electronic device) without the use of a dedicated signal pin at the memory module (or electronic device). Although reference is made to memory modules in the ensuing discussion, it is noted that techniques or mechanisms according to some implementations can be applied to other types of electronic devices, such as processors, microcontrollers, and so forth.

[0016] In some implementations, the health status signal regarding a health status of a power supply can be modulated onto a power voltage that is provided by the power supply to the memory module. A health status of a power supply can refer to a condition of the power supply that can affect the power supply's ability to supply power to another device. For example, the health status can include a normal status (corresponding to a condition of the power supply in which the power supply is able to provide sufficient power to another device) and an abnormal status (corresponding to a condition of the power supply in which the power supply is unable to supply sufficient power to another device).

[0017] Although reference is made to a normal status and an abnormal status of a power supply, it is noted that in other examples, more than two health statuses of the power supply can be indicated by a health status signal.

[0018] "Modulating" a health status signal onto a power voltage can refer to combining (such as by addition) the health status signal with the power voltage. A power voltage refers to an output voltage generated by a power supply that is coupled to a power voltage input of a device to supply power to the device. The power voltage is received through a power pin of the memory module. By

modulating the health status signal onto the power voltage, the health status signal can also be received by the memory module through the power pin, so that a separate dedicated signal pin at the memory module does not have to be used for the memory module to receive the health status signal.

[0019] By using the power pin of the memory module (or other electronic device) to communicate a health status signal of an external power supply, more efficient usage of the pins of the memory module (or other electronic device) can be achieved, since a pin does not have to be dedicated to communication of the health status signal.

[0020] Fig. 1 is a block diagram of an example arrangement that includes an electronic device 102 that is powered by a power supply 104. An example of the electronic device 102 is a memory module. A memory module can include one or multiple memory devices, such as dynamic random access memory (DRAM) devices, static random access memory (SRAM) devices, flash memory devices, memristor devices, and so forth. In some examples, a memory module can be in the form of a dual inline memory module (DIMM) or other type of memory module. In further examples, a memory module can refer to an individual memory chip.

[0021] Although just one electronic device 102 is depicted in Fig. 1, it is noted that in other example arrangements, multiple electronic devices can be powered by the power supply 104. In this case, the power supply 104 can be considered a central power supply to provide power to multiple electronic devices (e.g. multiple memory modules).

[0022] As depicted in Fig. 1, the electronic device 102 has a power pin 106 to receive a power voltage 108 output by the power supply 104. In some examples, the power supply 104 is also able to generate a health status signal 110 that is combined with the power voltage 108 (for example, the health status signal 110 is modulated onto the power voltage 108). As depicted in Fig. 1, both the power voltage 108 and the health status signal 110 are received through the power pin 106 of the electronic device 102. In this manner, a separate dedicated signal pin does

not have to be provided at the electronic device 102 to receive the health status signal 110.

[0023] The electronic device 102 includes circuitry 112 that is powered by the power voltage 108 received through the power pin 106. In examples where the electronic device 102 includes a memory module, the circuitry 112 powered by the power voltage 108 can include a volatile memory and a non-volatile memory. The circuitry 112 can also include other circuitry, including control circuitry for controlling access of the volatile memory and/or the non-volatile memory, a voltage regulator to regulate the power voltage received through the power pin 106, and so forth.

[0024] In other types of electronic devices, the circuitry 112 can include any electronic component that can operate using the power voltage 108 supplied by the power supply 104.

[0025] The electronic device 102 further includes a controller 114, which is coupled to the power pin 106. The controller 114 includes a status signal determining logic 116 to determine whether the health status signal 110 is combined with the power voltage 108 that is received through the power pin 106. The controller 114 further includes a health indicating logic 118 to indicate a health of the power supply 104 based on the determining performed by the status signal determining logic 116. In some examples, presence of the health status signal 110 indicates a first health status of the power supply 104. Lack of presence of the health status signal 110 indicates that the power supply 104 has a second, different health status. For example, the first health status can be a status indicating that the power supply 104 is able to supply sufficient power to the electronic device 102. In examples where the electronic device 102 includes a volatile memory and non-volatile memory, the power supply 104 being at the first health status can mean that the power supply 104 is able to supply sufficient power to allow a backup operation to be performed to back up data in the volatile memory of the electronic device 102 to the non-volatile memory, such that data of the volatile memory is not lost in case of power failure. On the other hand, if the power supply 104 is at the second health status, then that is an indication that the power supply may not provide sufficient

power to support the backup operation from the volatile memory to the non-volatile memory.

[0026] In some implementations, a change of the health status of the power supply 104 from the first health status to the second health status can trigger application of a process according to a predetermined policy, such as any or some combination of the following: perform an immediate backup operation to save data from volatile memory to non-volatile memory of the electronic device 102, disable previously enabled triggers for specified actions, or enable triggers for specified actions.

[0027] In some examples, the health status signal 110 modulated onto the power voltage 108 is an oscillating signal that has a specified frequency. In other examples, other types of health status signals can be employed.

[0028] In the foregoing implementations, presence of the health status signal 110 on the power voltage 108 indicates a first health status of the power supply 104, while absence of the health status signal 110 on the power voltage 108 indicates the second health status of the power supply 104. In other examples, different characteristics of the health status signal can be used for indicating different health statuses of the power supply 104. For example, the health status signal 110 having a first characteristic indicates that the power supply 104 has a first health status, while the health status signal 110 having a second different characteristic indicates a second health status of the power supply 104. The characteristic of the health status signal 110 that can be varied for indicating different health statuses of the power supply 104 can be a frequency of the health status signal 110. For example, a first frequency of the oscillating health status signal 110 indicates the first health status, while a second, different frequency of the oscillating health status signal 110 indicates a second, different health status. In further examples, more than two characteristics of the health status signal 110 can be used for indicating more than two health statuses of the power supply 104.

[0029] In some examples, the status signal determining logic 116 and/or the health indicating logic 118 can be implemented as hardware circuitry in the controller 114. In other examples, the status signal determining logic 116 and/or the health indicating logic 118 can be implemented as machine-readable instructions (software or firmware) that can be executed by physical processing circuitry of the controller 114. The controller 114 can include any of the following: a microcontroller, an application-specific integrated circuit (ASIC) device, a programmable gate array, a microprocessor, or any other physical processing device.

[0030] Fig. 2 is a block diagram of a power supply controller 202, which can be part of the power supply 104 of Fig. 1, or can be separate from the power supply 104. The power supply controller 202 is used to perform control tasks for the power supply 104.

[0031] The power supply controller 202 receives, at an input 204, an input power voltage 206, which can be from a power source. This power source can be a primary power supply (in examples where the power supply 104 is a backup power supply). The power supply controller 202 includes a detector 208 to check for presence of the input power voltage 206 and to check a charge of the power supply 104. For example, the power supply 104 can include a battery and/or a capacitor (or a set of batteries and/or capacitors). Checking the charge of the power supply 104 can thus refer to checking a charge of the battery(ies) and/or the capacitor(s), for the purpose of determining whether the battery(ies) and/or the capacitor(s) has (have) sufficient energy to provide power to the electronic device 102 for a sufficiently long duration such that a specified operation can be performed. In some examples, this specified operation includes a backup operation of data from the volatile memory to the non-volatile memory of the electronic device 102. In other examples, this specified operation can include another type of operation at the electronic device 102.

[0032] The detector 208 provides an active indication 210 to a combiner 212 of the power supply controller 202, in response to the detector 208 detecting that the input power voltage 206 is present (has been received at the input 204) and that the

charge of the power supply 104 is above a threshold. In response to the active indication 210, the combiner 212 can combine a health status signal (e.g. 110), provided by a health status signal source 214, onto an output power voltage (e.g. 108) provided through an output 205. For example, the combiner 212 can be a modulator to combine the health status signal 110 with the input power voltage 206 to produce the output power voltage 108 with the health status signal 110 modulated onto the output power voltage 108, which is supplied to one or multiple devices.

[0033] In some examples, the health status signal source 214 can be an oscillator that outputs an oscillating signal having a specified frequency for use as the health status signal 110. In other examples, the health status signal source 214 can be an oscillator that is controllable to output oscillating signals of different frequencies, where these different frequencies can be used to indicate respective different statuses of the power supply 104.

[0034] In response to either (1) the charge of the power supply 104 is not above the threshold, or (2) the input power voltage 206 is not present, the detector 208 does not provide the active indication 110 (or can provide a different indication, such as an inactive indication). In response to lack of the active indication 110 or to an inactive indication, the combiner 212 does not modulate the health status signal 110 onto the output power voltage 108.

[0035] Fig. 3 is a flow diagram of a process performed by the electronic device 102 (and more specifically, by the controller 114 in the electronic device 102 of Fig. 1), according to some implementations. The electronic device 102 receives (at 302) a power voltage (e.g. 108 in Fig. 1) through a power pin (e.g. 106) of the electronic device 102 from a power supply (e.g. 104) that is external of the electronic device 102.

[0036] The electronic device 102 checks (at 304) for a status signal (e.g. health status signal 110 in Fig. 1) modulated onto the power voltage that is received through the power pin. The electronic device 102 indicates (at 306) a health of the power supply based on the checking. For example, in response to detecting that the

status signal is modulated onto the power voltage, then the electronic device 102 indicates a first health status of the power supply 104. In response to detecting that the status signal is not modulated onto the power voltage, the electronic device 102 indicates a second, different health status of the power supply 104.

[0037] In other examples, the checking (at 304) can check for different characteristics of the status signal. For example, in response to detecting a first characteristic (e.g. first frequency) of the status signal, the electronic device 102 indicates a first health status of the power supply 104. In response to detecting a second, different characteristic (e.g. second frequency) of the status signal, the electronic device 102 indicates a second health status of the power supply 104.

[0038] Fig. 4 is a schematic diagram of components in the electronic device 102, according to further implementations. In the example of Fig. 4, the status signal determining logic 116 of Fig. 1 can be implemented with a filter 402, while the health indicating logic 118 can be implemented with an arrangement of components that includes resistors R1, R2, and R3, a diode D1, a comparator 404, inverters 406 and 408, and AND gates 410 and 412. Although a specific arrangement of components is shown in Fig. 4, it is noted that in other examples, a different arrangement of components can be employed.

[0039] In Fig. 4, VSAFE corresponds to the power voltage 108 received by the electronic device 102 in Fig. 1. The filter 402 can be a high-pass filter that is used for detecting presence of the health status signal 110 that is modulated onto VSAFE. The power voltage VSAFE is a DC voltage, such that the filter 402 would filter out this DC voltage. The filter 402 can provide an output signal 403, which can have an active state to indicate that the health status signal 110 on VSAFE has been detected by the filter 402, and an inactive state to indicate that the filter 402 does not detect the health status signal 110 on VSAFE. In some examples, the active state of the detect signal 403 can be a high ("1") state, while the inactive state of the detect signal 403 can be low ("0") state. In other examples, the active state can be a low state, and the inactive state can be a high state.

[0040] The detect signal 403 is provided to one input of the AND gate 410, and to the input of the inverter 408. The output of the inverter is fed to one input of the AND gate 412.

[0041] The other inputs of the AND gates 410 and 412 receive an output of the comparator 404. The comparator 404 is used to determine whether the power voltage VSAFE is above a specified threshold. One input of the comparator 404 is connected between resistors R2 and R3, while the other input of the comparator 404 is connected between the resistor R1 and the diode D1. R2 and R3 are connected between VSAFE and a reference voltage (e.g. ground), and R1 and D1 are connected between VSAFE and the reference voltage. The voltage at the node between R1 and D1 is compared by the comparator 404 to the voltage at the node between R2 and R3, for determining whether VSAFE is above the specified threshold.

[0042] If the power voltage VSAFE is above the threshold, then the comparator 404 outputs a signal having an active state. However, if the power voltage VSAFE is not above the threshold, then the comparator 404 outputs a signal having an inactive state.

[0043] Thus, according to Fig. 4, if both the health status signal 110 is present, and VSAFE is above the threshold, then the AND gate 410 sets a power good signal (e.g. VSAFE_GOOD) to an active state to indicate that the power supply voltage supplied by the power supply 104 is "good." In other words, the power supply 104 is in a condition in which sufficient power is provided and which has sufficient charge to support a target operation (e.g. a backup operation) in case of power failure. The power good signal enables the controller 114 of the electronic device 102 to perform a backup operation if triggered. The power good signal (e.g. VSAFE_GOOD) is deactivated to an inactive state in response to either VSAFE not being present or the health status signal 110 not being detected by the filter 402.

[0044] If the power voltage VSAFE is not above the specified threshold, then the inverter 406 sets a signal VSAFE_NOT_PRESENT to an active state to indicate that the VSAFE power voltage is not present.

[0045] If VSAFE is above the specified threshold, but the health status signal 110 is not detected by the filter 402, then the AND gate 412 sets an INSUFFICIENT_VSAFE signal to an active state to indicate that even though VSAFE is above the specified threshold, the power supply 104 may not have sufficient charge to support a target operation (e.g. backup operation) at the electronic device 102 in case of power failure.

[0046] The electronic device 102 shown in Fig. 4 also includes a regulator 420, which outputs a regulated voltage in response to VSAFE. The regulator 420 can be part of the circuitry 112 of Fig. 1, in some examples.

[0047] Fig. 5 is a state diagram of a state machine, which can be used to implement the detector 208 of Fig. 2, according to some examples. The state machine of Fig. 5 includes two states: S1 and S2. In response to the input power voltage (206) being on, the state machine transitions to state S1. In state S1, the state machine provides a health status inactive indication to indicate that the health status signal 110 is not to be modulated onto the output power voltage 108.

[0048] On the other hand, in state S2, the state machine outputs a health status active indication (e.g. 210 in Fig. 2) to indicate that the health status signal 110 is to be modulated onto the output power voltage 108.

[0049] The state machine transitions from state S1 to state S2 in response to the battery or capacitor of the power supply 104 being fully charged.

[0050] Once at state S2, in response to the power supply charge falling below a threshold or in response to loss of the input power voltage (206), the state machine transitions from state S2 to state S1.

[0051] Fig. 6 is a schematic diagram of an example arrangement of the power supply 104 of Fig. 1, according to further implementations. The power supply 104 includes a power source 602, which can include a battery and/or a capacitor or a set of batteries and/or a set of capacitors.

[0052] A comparator 604 is used to detect presence of the input power voltage 206 to the power supply 104. The comparator 604 has one input connected between resistors R4 and R5, and another input connected between a resistor R6 and a diode D2. R4 and R5 are connected between the input power voltage 206 and a reference voltage, and R6 and D2 are connected between the input power voltage 206 and the reference voltage. The comparator 604 compares the voltage at the node between R4 and R5 to the voltage at the node between R6 and D2, to determine whether the input power voltage 206 is above a specified threshold.

[0053] The comparator 604 outputs a signal 606 that has an active state in response to detecting presence of the input power voltage 206 (*i.e.* the input power voltage 206 is above the specified threshold). The signal 606 is provided to one input of an AND gate 608.

[0054] A comparator 610 is used to determine whether the power source 602 is fully charged. One input of the comparator 610 is connected between a diode D3 and a resistor R7, where D3 and R7 are connected in series with the battery 602 between the input power voltage 206 and the reference voltage. The comparator 610 provides a measurement of the power source voltage to an input of another comparator 612. The other input of the comparator 612 is connected between a resistor R8 and a diode D4, which provides a threshold to which the measured power source voltage is compared by the comparator 612. If the power source voltage is above the threshold, the comparator 612 outputs a signal 614 set to an active state, which is provided to another input of the AND gate 608. A third input of the AND gate 608 receives an oscillating signal provided by an oscillator 616. This oscillating signal can be the health status signal 110 discussed above.

[0055] If the power source 602 is fully charged (as indicated by the signal 614 set to an active state), and the input power voltage 206 is present (indicated by the signal 606 set to an active state), then the AND gate 608 outputs the oscillating signal to an input of a modulator 618. The modulator 618 modulates the oscillating signal onto the input power voltage 206 to produce VSAFE with the oscillating signal modulated onto VSAFE.

[0056] A diode D5 is provided between the output of the modulator 618 and VSAFE, and a diode D6 is provided between a node of the power source 602 and VSAFE.

[0057] In examples according to Fig. 6, the AND gate 608 and the modulator 618 can form part of the combiner 212 of Fig. 2, while the resistors R4, R5, R6, R7, R8, diodes D2, D3, D4, and comparators 604, 610, 612, can form part of the combiner 212 of Fig. 2.

[0058] In other examples, other arrangements of components in the power supply 104 can be used.

[0059] In the foregoing description, numerous details are set forth to provide an understanding of the subject disclosed herein. However, implementations may be practiced without some of these details. Other implementations may include modifications and variations from the details discussed above. It is intended that the appended claims cover such modifications and variations.

What is claimed is:

- 1 1. An electronic device comprising:
2 a power pin to receive a power voltage from a power supply;
3 circuitry to be powered by the power voltage; and
4 a controller to:
5 determine whether a status signal combined onto the power voltage is
6 received through the power pin, and
7 indicate a health of the power supply based on the determining.
- 1 2. The electronic device of claim 1, wherein the power voltage being above a
2 threshold and the indicated health being a given health status enable the controller
3 to trigger saving of data from volatile memory to non-volatile memory in the
4 electronic device.
- 1 3. The electronic device of claim 1, wherein the controller is to activate a power
2 good signal indicating that the power voltage is sufficient to support a target
3 operation at the electronic device, in response to the power voltage being above a
4 threshold and determining that the status signal is received.
- 1 4. The electronic device of claim 3, wherein the controller is to deactivate the
2 power good signal in response to determining that the status signal has not been
3 received.
- 1 5. The electronic device of claim 1, wherein the controller is to indicate that the
2 power supply has a first health status in response to determining that the status
3 signal is received.

1 6. The electronic device of claim 5, wherein the controller is to indicate that the
2 power supply has a second health status in response to determining an absence of
3 the status signal on the power voltage, wherein the second health status is different
4 from the first health status.

1 7. The electronic device of claim 5, wherein the controller is to indicate that the
2 power supply has the first health status in response to determining that the status
3 signal has a first characteristic.

1 8. The electronic device of claim 7, wherein the controller is to indicate that the
2 power supply has a second health status in response to determining that the status
3 signal has a second characteristic different from the first characteristic, wherein the
4 second health status is different from the first health status.

1 9. The electronic device of claim 1, wherein the electronic device comprises a
2 memory module that includes the power pin, the circuitry, and the controller.

1 10. A controller for a power supply, comprising:
2 an input to receive an input power voltage;
3 a detector to check a charge of the power supply and to check for presence of
4 the input power voltage; and
5 a combiner to combine a health status signal onto an output power voltage of
6 the power supply in response to the detector indicating that the input power voltage
7 is present and the charge of the power supply is above a threshold.

1 11. The controller of claim 10, wherein the combiner is to prevent combining of
2 the health status signal onto the output power voltage in response to the detector
3 indicating either the charge of the power supply not being above the threshold or the
4 input power voltage not being present.

1 12. The controller of claim 10, wherein the detector is to check the charge of a
2 battery or capacitor of the power supply.

1 13. The controller of claim 10, further comprising an oscillator to produce an
2 oscillating signal, the health status signal comprising the oscillating signal.

1 14. A method of an electronic device, comprising:
2 receiving a power voltage through a power pin of the electronic device from a
3 power supply that is external of the electronic device;
4 checking for a status signal modulated onto the power voltage that is received
5 through the power pin, and
6 indicating a health of the power supply based on the checking.

1 15. The method of claim 14, further comprising applying a process according to a
2 predetermined policy in response to a change in the indicated health of the power
3 supply.

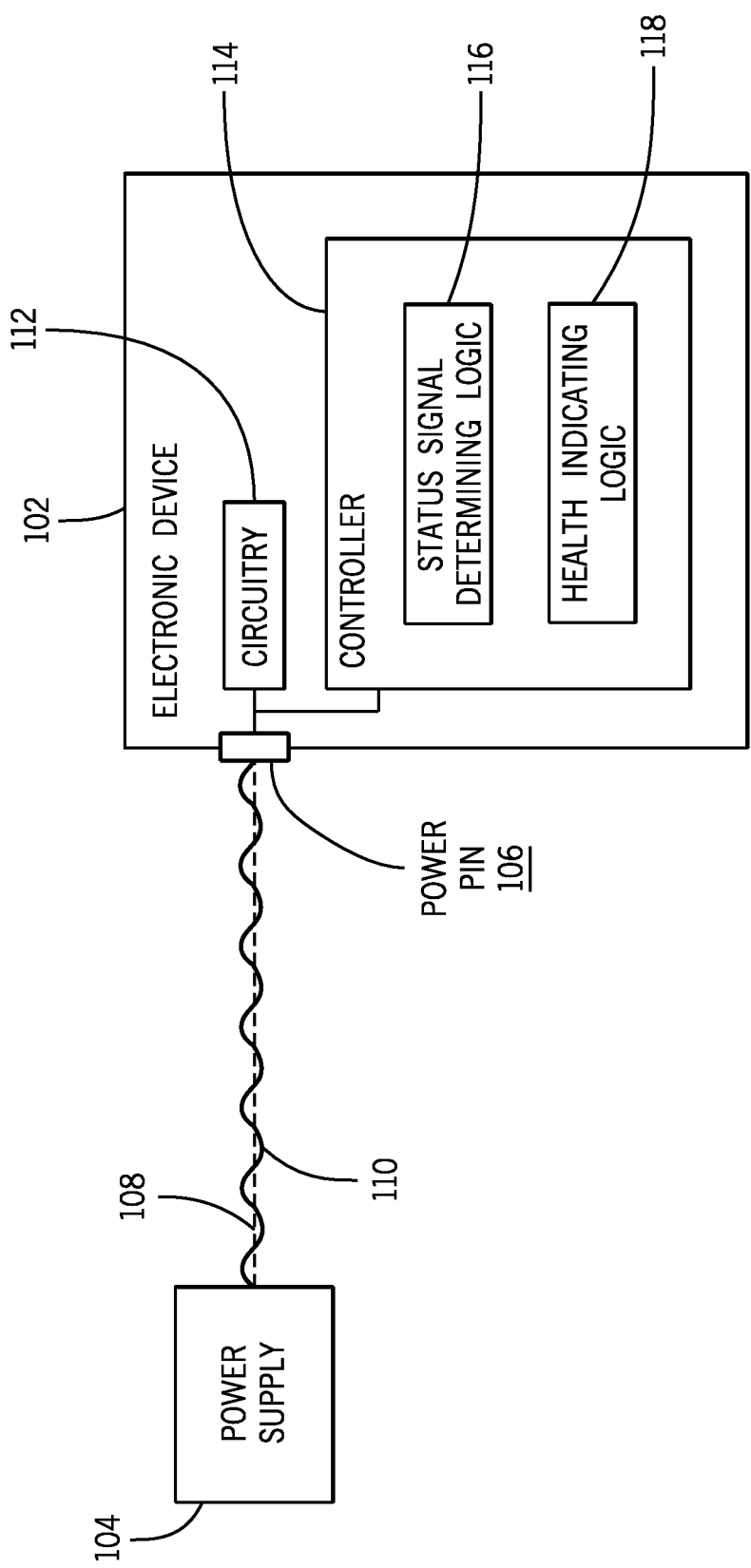


FIG. 1

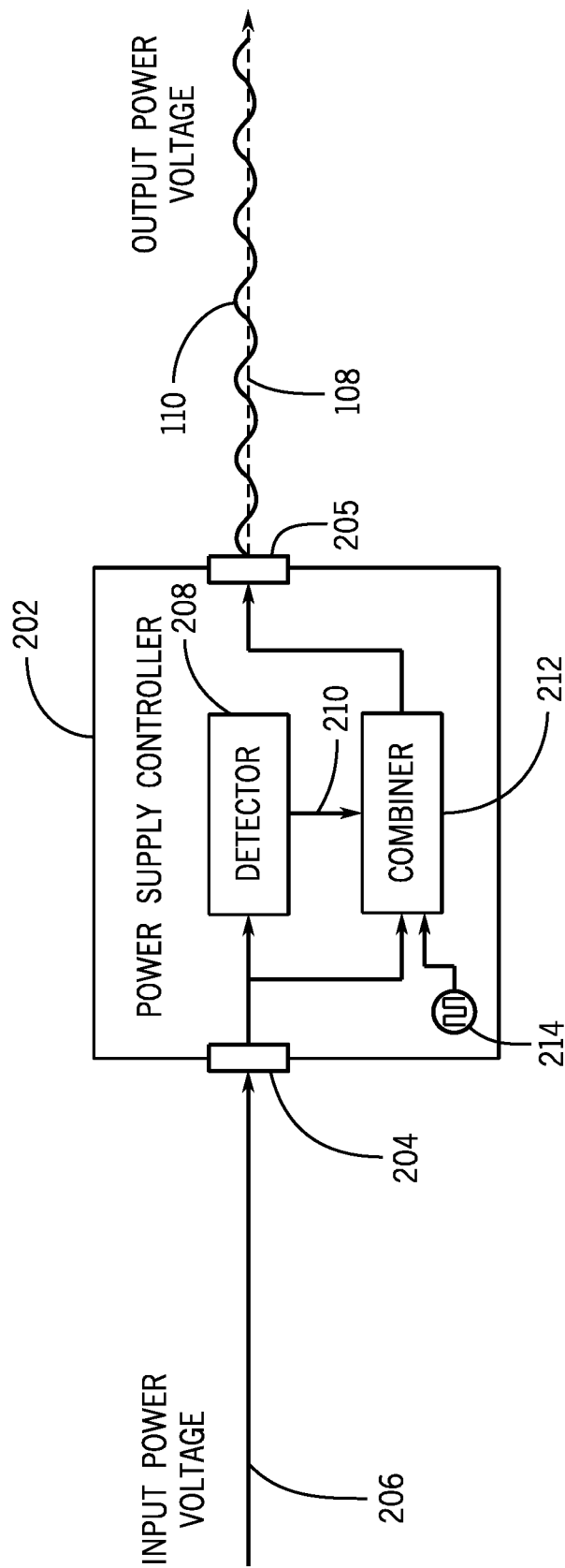


FIG. 2

3 / 6

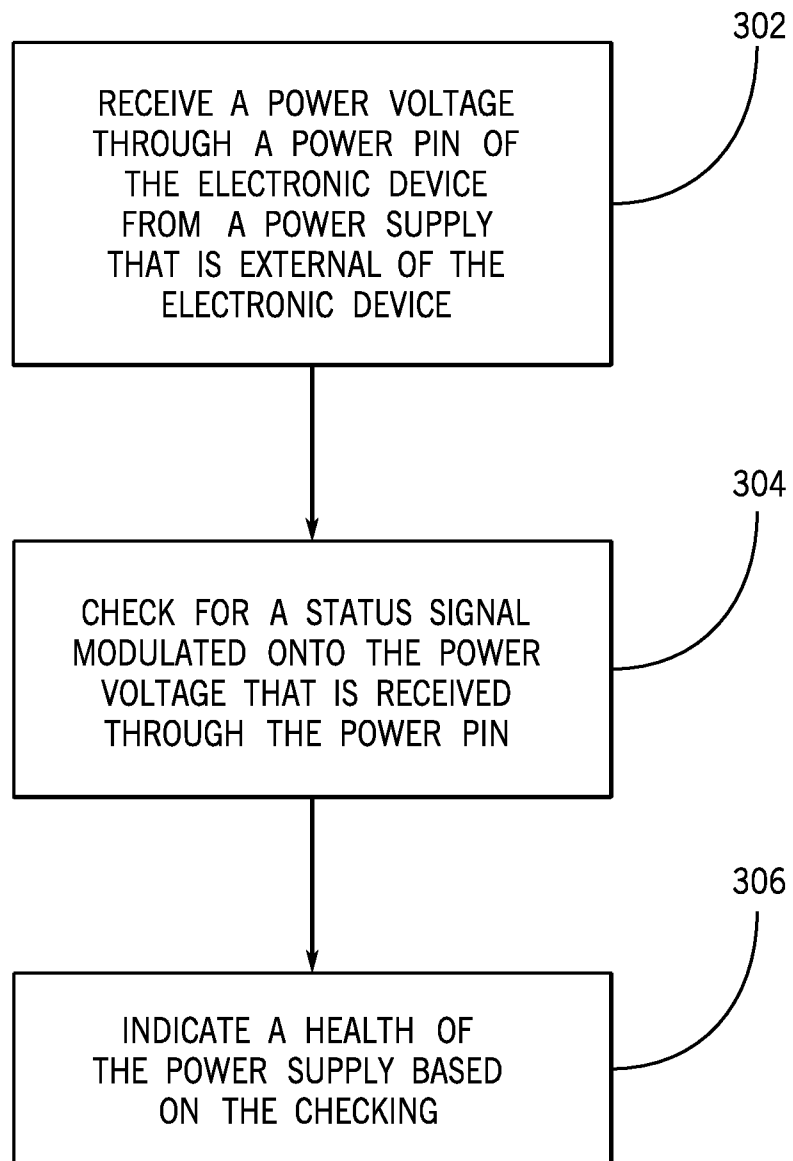


FIG. 3

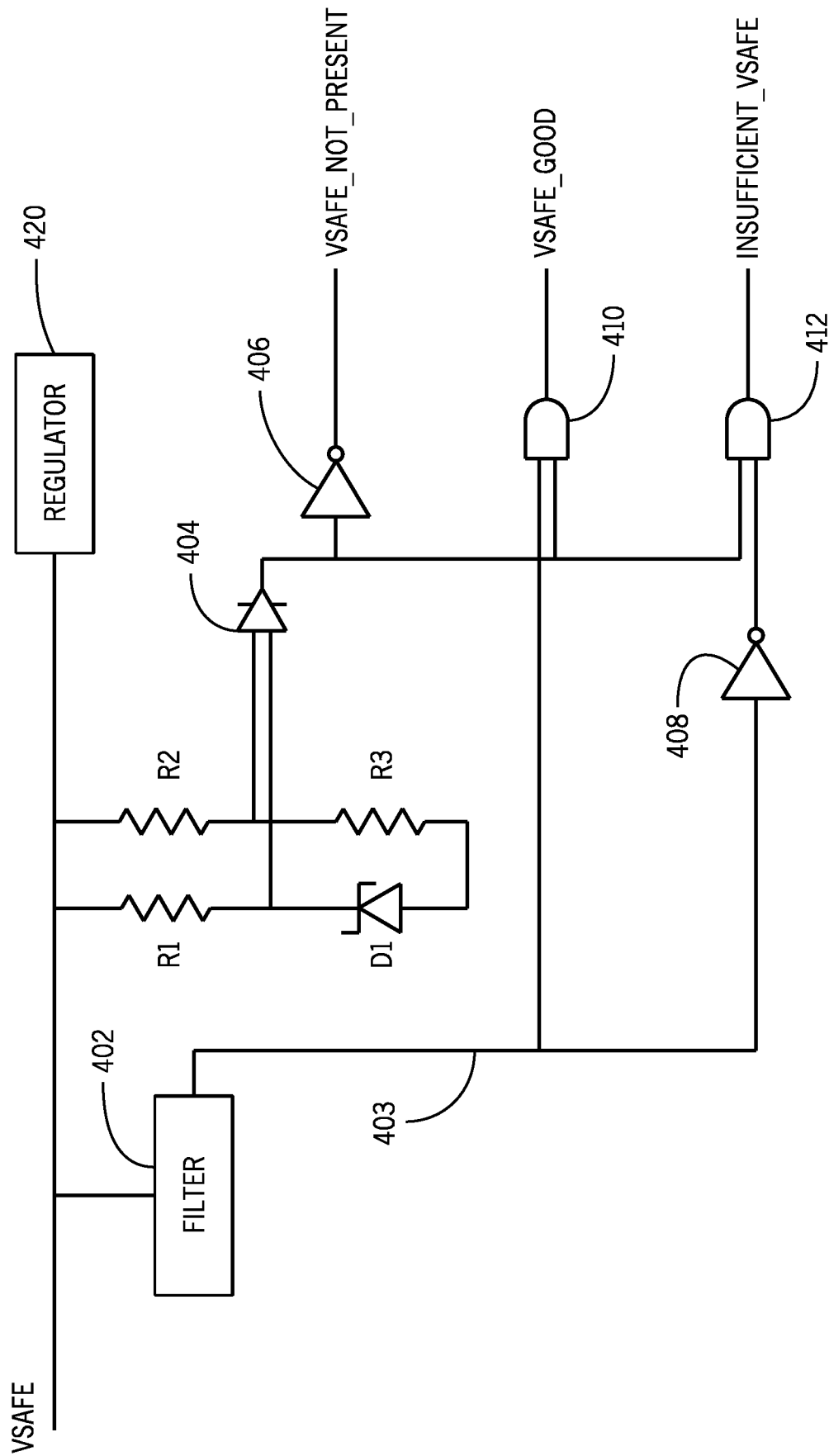


FIG. 4

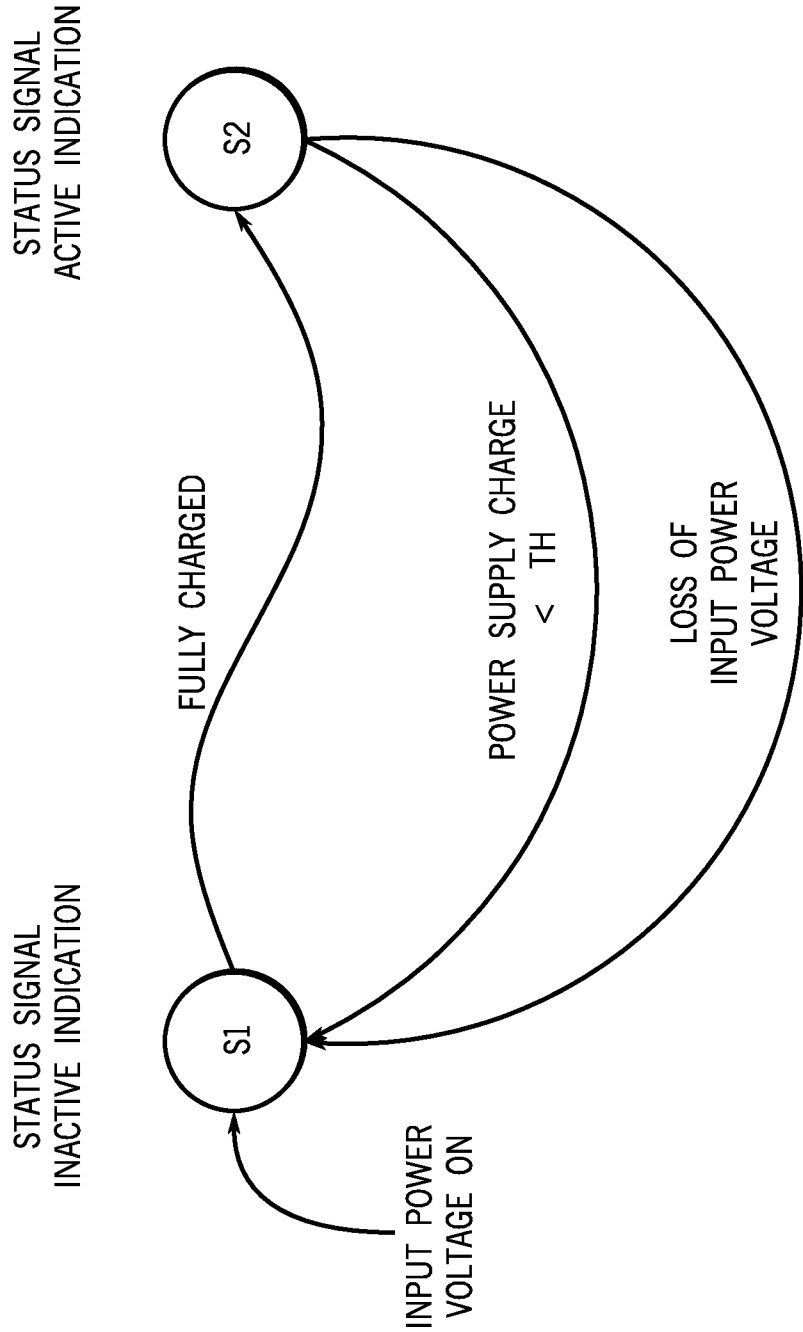


FIG. 5

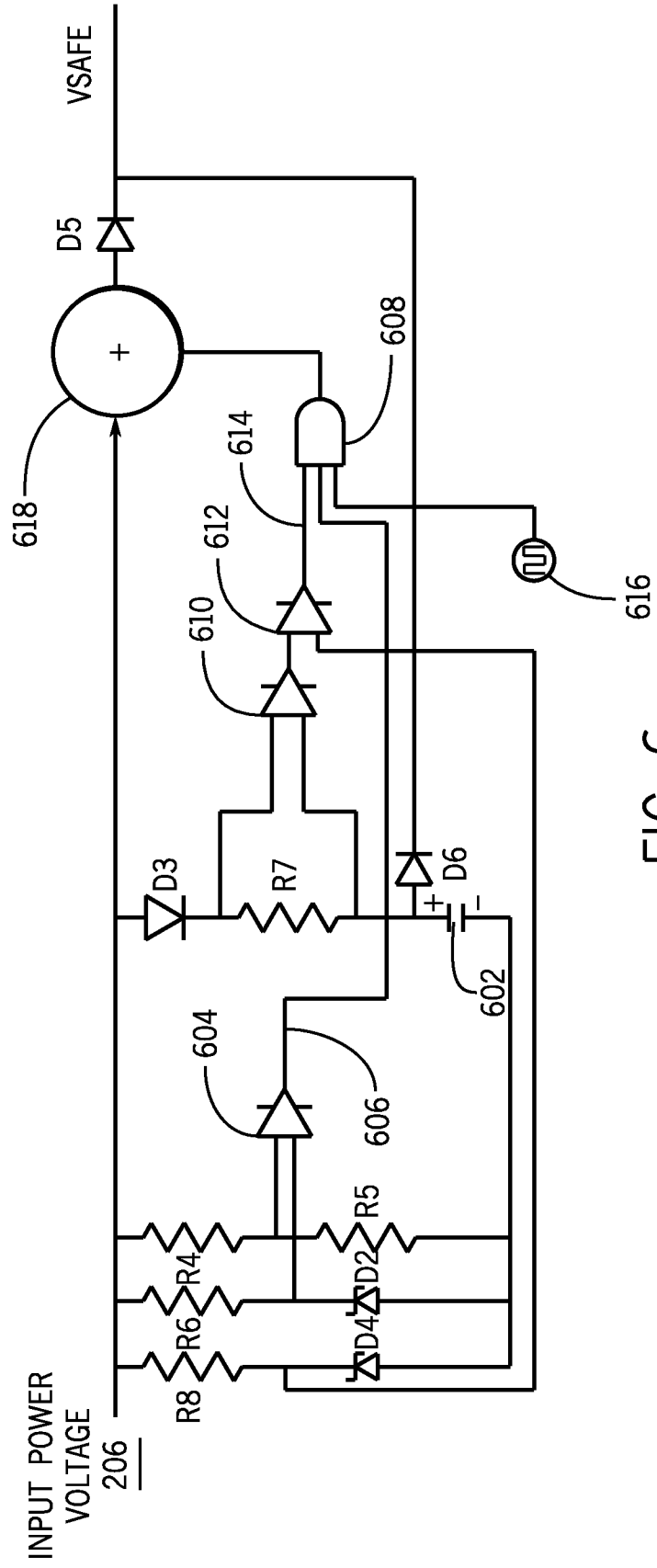


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/027028**A. CLASSIFICATION OF SUBJECT MATTER****G11C 5/14(2006.01)i, G11C 16/06(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)

G11C 5/14; G06F 19/00; G06F 12/16; H02J 7/00; G06F 12/00; G05F 1/10; G11C 8/02; G11C 16/06

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: power, pin, voltage, supply, controller, status, signal, health, saving, memory

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2013-0141035 A1 (CHING YU JHON TAM) 06 June 2013 See paragraphs [0023]-[0024], [0028], [0033]; and figures 1-3.	1-15
Y	US 2008-0015795 A1 (JAMES P. HOFMEISTER et al.) 17 January 2008 See paragraphs [0038]-[0039], [0042]; and figures 7, 10.	1-15
Y	US 2009-0235038 A1 (RONALD H. SARTORE) 17 September 2009 See paragraphs [0030], [0045]; and figure 1.	2,9
A	US 2006-0072369 A1 (RICHARD C. MADTER et al.) 06 April 2006 See paragraphs [0031]-[0033]; and figure 2.	1-15
A	US 2004-0103238 A1 (MEIR AVRAHAM et al.) 27 May 2004 See paragraphs [0042]-[0048]; and figure 1.	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

20 January 2016 (20.01.2016)

Date of mailing of the international search report

21 January 2016 (21.01.2016)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/027028

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