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- (71) **Applicant:** HEWLETT PACKARD DEVELOPMENT COMPANY, L.P. [US/US]; 11445 Compaq Center Drive West, Houston, Texas 77070 (US).
- (72) **Inventor; and**
- (71) **Applicant (for US only):** ATKINSON, Lee [US/US]; 11445 Compaq Center Drive West, Houston, Texas 77070 (US).
- (74) **Agents:** GALLERT, Scott et al.; Hewlett Packard Company, Intellectual Property Administration, 3404 East Harmony Road, Mail Stop 35, Fort Collins, Colorado 80528 (US).
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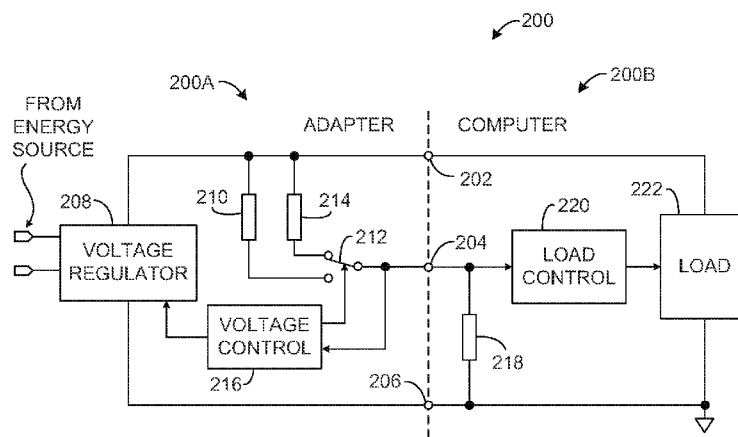
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(54) **Title:** POWER SUPPLY VOLTAGE AND LOAD CONSUMPTION CONTROL

**FIG. 2**

(57) **Abstract:** Examples of electronic circuits and methods are provided. A power adapter is coupled to load device such that a power node and a signal node and a ground node are common to both entities. A supply voltage is regulated and provided by the power adapter to the load device in accordance with a voltage sensed at the signal node. Electrical current drawn by the load device is limited in accordance with a voltage sensed at the signal node.

POWER SUPPLY VOLTAGE AND LOAD CONSUMPTION CONTROL

BACKGROUND

[0001] Electrical power adapters are used to convert alternating-current into regulated direct-current for use with laptop computers, cellular telephones and other load devices. A load device draws current provided by the adapter. The present teachings address the foregoing concerns.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] The present embodiments will now be described, by way of example, with reference to the accompanying drawings, in which:

[0003] FIG. 1 depicts a diagrammatic view of a system according to one example;

[0004] FIG. 2 depicts a schematic diagram of circuitry according to one example;

[0005] FIG. 3 is a flow diagram depicting a method according to one example;

[0006] FIG. 4 depicts a table of illustrative resistor values according to one example;

[0007] FIG. 5 depicts a table of illustrative resistor values according to another example; and

[0008] FIG. 6 depicts a schematic diagram of circuitry according to another example.

DETAILED DESCRIPTION

INTRODUCTION

[0009] Examples of electronic circuits and corresponding methods are provided. A power adapter is coupled to load device such that a power node and a signal node and a ground node are common to both entities. A regulated supply voltage is provided by the power adapter to the load device in accordance with a voltage sensed at the signal node. Electrical current drawn by the load device is limited in accordance with a voltage sensed at the signal node.

[0010] In one embodiment, an electronic circuit includes a power circuit having one or more resistors either directly or selectively coupled to a signal node. The power circuit also includes a voltage controller to detect a voltage at the signal node and to provide a corresponding voltage control signal. The power circuit includes a voltage regulator to provide a supply voltage to a power node in accordance with the voltage control signal. The electronic circuit also includes a load circuit to be removably coupled to the signal node and the power node. The load circuit includes a programming resistor coupled between the signal node and a ground node. The load circuit also includes a load controller to sense a voltage at the signal node and to provide a corresponding load control signal.

[0011] In another embodiment, a system includes a computer including a load controller. The system also includes a power adapter having a power node

and a signal node and a ground node each to be disconnectably coupled to the computer. The power adapter is configured to detect a voltage at the signal node and to provide a corresponding supply voltage at the power node. The load controller is configured to detect a voltage at the signal node and to provide a load control signal. The load control signal causes the computer to limit current drawn from the power adapter.

[0012] In yet another embodiment, a method includes coupling one or more resistors within an adapter, one at a time, into series relationship with a programming resistor within a load entity. The method also includes sensing one or more voltages at a signal node common to the adapter and the load entity. The method further includes providing a regulated source voltage from the adapter to the load entity in accordance with at least one of the sensed voltages. The method also includes limiting electrical current drawn by the load entity in accordance with at least one of the sensed voltages.

FIRST ILLUSTRATIVE SYSTEM

[0013] Reference is now directed to FIG. 1, which depicts a diagrammatic view of a system 100. The system 100 is illustrative and non-limiting with respect to the present teachings. Thus, other systems can be configured and/or operated in accordance with the present teachings.

[0014] The system 100 includes a laptop computer (laptop) 102. The laptop 102 can be defined by any such device that includes electronic circuitry according to the present teachings. The laptop 102 receives voltage-regulated, direct-current (DC) power from an electrical adapter (power adapter, or power circuit) 104 by way of a connecting cable 106. In turn, the electrical adapter 104

is connected to a source 108 of alternating-current (AC) power. The electrical adapter 104 includes circuitry according to the present teachings.

[0015] Illustrative operation of the system 100 is as follows: the electrical adapter 104 receives AC power from the source 108. The electrical adapter 104 assumes a first mode during which a first voltage signal is detected by the electrical adapter 104 and correlated to a voltage requirement of the laptop (i.e., load device) 102. The electrical adapter 104 then provides regulated DC power of the corresponding voltage to the laptop 102 by way of the connecting cable 106.

[0016] The electrical adapter 104 assumes a second mode during which a second voltage signal is detected by circuitry of the laptop 102 and correlated to operate according to a maximum power (or electrical current) capacity for the electrical adapter 104. The power rating can optionally be a continuous operating maximum or a temporary (e.g., ten seconds, etc.) operating maximum. The determined power rating is then used by the laptop 102 in regulating its own operations (i.e., current draw) to within the power output capability or limit of the electrical adapter 104.

FIRST ILLUSTRATIVE EMBODIMENT

[0017] FIG. 2 is a schematic diagram depicting circuitry 200 according to an embodiment of the present teachings. The circuitry 200 is illustrative and non-limiting in nature. Other circuitry consistent with the present teachings is also contemplated. The circuitry 200 includes a portion 200A that is provided (i.e., supported or housed) within an electrical adapter (ADAPTER), and a portion 200B that is provided within a laptop computer (COMPUTER). Thus, the circuitry

200 is as depicted when an electrical adapter (e.g., 104) is (removably) coupled to a laptop computer (e.g., 102) or other load device in accordance with the present teachings.

[0018] The circuitry portions 200A and 200B are referred to as “compatible” with each other by virtue of their cooperative configurations. Thus, the electrical adapter portion 200A is compatible with the laptop computer (or load) portion 200B, and vice versa.

[0019] The circuitry 200 includes a power node 202, a signal node 204 and ground node 206. During normal operation, a regulated direct-current voltage is provided between the nodes 202 and 206. The adapter portion 200A includes a voltage regulator 208 to provide a selectable (adjustable), regulated supply voltage between the power node 202 and the ground node 206. The voltage regulator 208 is controllably adjusted by way of voltage control signal described hereinafter. The voltage regulator 208 can be defined, at least in part, by a switching-type regulator, a linear-type regulator, or other suitable voltage control circuitry. The voltage regulator 208 is configured to be coupled to a source of electrical energy such as a line-level utility supply (e.g., one-hundred twenty volts AC).

[0020] The adapter portion 200A also includes a resistor 210 coupled (or connected) to the power node 202. The resistor 210 is also referred to as a biasing resistor 210 for purposes herein. The biasing resistor 210 can be selectively coupled to the signal node 204 by way of a switch 212. In one example, the biasing resistor 210 is characterized by an electrical resistance of 10.0K Ohms. Other suitable resistance values can also be used.

[0021] The adapter portion 200A also includes a resistor 214 coupled (or connected) to the power node 202. The resistor 214 is also referred to as a power capacity resistor 214 or power resistor 214 for purposes herein. The power capacity resistor 214 can be selectively coupled to the signal node 204 by way of the switch 212. The power capacity resistor 214 is characterized by an electrical resistance value that corresponds to a power provisioning capacity or current supplying capacity of the adapter portion 200A. Illustrative resistance values and corresponding electrical adapter (e.g., 104) capacities are described hereinafter.

[0022] The adapter portion 200A further includes a voltage controller 216. The voltage controller 216 is configured to detect (monitor, or sense) a voltage signal present at the signal node 204 and to correlate that signal with a voltage requirement of the laptop computer 200B. The voltage controller 216 is also configured to provide a voltage control signal to the voltage regulator 208 causing it to provide a supply voltage at the node 202 corresponding (equal, or about equal) to the voltage requirement of the laptop computer 200B. Furthermore, the voltage controller 216 is configured to selectively control the switch 212 so as to selectively couple either the biasing resistor 210 (i.e., first mode) or the power capacity resistor 214 (i.e., second mode) to the signal node 204.

[0023] The voltage controller 216 can be defined by or include any suitable electronic constituency. Without limitation, the voltage controller 216 can be at least partially defined by an application specific integrated circuit (ASIC), a microcontroller, a microprocessor, analog or digital or hybrid circuitry, and so on. Other elements or configurations can also be used.

[0024] The computer portion 200B of the circuitry 200 includes a resistor 218 that is connected between the signal node 204 and the ground node 206. The resistor 218 is also referred to as a programming resistor 218 for purposes herein. The programming resistor 218 is characterized by an electrical resistance value that corresponds to a voltage requirement of the computer portion (i.e., load entity or device) 200B.

[0025] The computer portion 200B also includes a load controller 220. The load controller 220 is configured to detect a voltage signal present at the signal node 204 and to correlate that signal with a power (or current) provisioning capacity of the adapter portion 200A. The load controller 220 is also configured to provide a load control signal causing a load device (entity, or circuitry) 222 to limit its power consumption (i.e., current draw) from the adapter portion 200A in accordance with the adapter capacity. The load controller 220 is configured such that the power capacity signal is detected when the power capacity resistor 214 is coupled to the signal node 204. (i.e., during the second mode).

[0026] The load controller 220 can be defined by or include any suitable electronic constituency. Without limitation, the load controller 220 can be at least partially defined by an application specific integrated circuit (ASIC), a microcontroller, a microprocessor, analog or digital or hybrid circuitry, and so on. Other elements or configurations can also be used.

[0027] The computer portion 200B further includes the load device 222 introduced above. The load device 222 is coupled to receive operating power from the power node 202 and the ground node 206. The load device 222 can be variously defined and can include a motherboard of a laptop computer, a

peripheral or peripherals of a computer, an electronic display, data acquisition circuitry, control instrumentation, and so on. Other load devices 222 can also be defined and used. The load device 222 is configured to perform various operations in accordance with its respective normal functions. The load device 222 is also configured to control (throttle, or modulate) its operations, or intensities of those operations, in accordance with the load control signal from the load controller 220. Electrical current draw (power consumption) by the load device 222 is thus limited or constrained within the power provisioning capacity of the adapter portion 200A.

[0028] The circuitry 200 includes resistors 210, 214 and 218 as described above, the respective resistive values of which serve to establish (communicate, or program) required voltage and power capacity parameters for normal operations of the adapter portion 200A and the computer portion 200B, respectively. However, the present teachings also contemplate that respective elements characterized by electrical impedance (i.e., resistance and/or reactance) can also be used to establish operating parameters for the adapter portion 200A and the computer portion 200B. Thus, inductors, capacitors or other elements – as well as resistors – can also be used in functions analogous those of resistors 210, 214 and/or 218.

FIRST ILLUSTRATIVE METHOD

[0029] FIG. 3 is a flow diagram depicting a method according to one embodiment of the present teachings. The method of FIG. 3 includes particular operations and order of execution. However, other methods including other operations, omitting one or more of the depicted operations, and/or proceeding in

other orders of execution can also be used according to the present teachings. Thus, the method of FIG. 3 is illustrative and non-limiting in nature. Reference is also made to FIGs. 1-2 in the interest of understanding the method of FIG. 3.

[0030] At 300, an electrical adapter is connected to a load device. For purposes of illustrative and non-limiting example, it is assumed that the adapter 104 is connected to the laptop 102 by way of the cable 106. In another scenario, the load device can be a cellular telephone, video gaming console, etc. The power node 202, the signal node 204 and the ground node 206, respectively, are now electrically common to both the adapter 104 and the laptop 102.

[0031] At 302, the electrical adapter is connected to a source of electrical energy. For purposes of the ongoing example, the electrical adapter 104 is connected (i.e., plugged in) to the electrical source 108. The electrical adapter 104 is now coupled to provide regulated direct-current energy to the laptop 102 once electrical parameters have been communicated there between.

[0032] At 304, a biasing resistor is switched into series relationship with a programming resistor. For purposes of the example, the voltage controller 216 causes the switch 212 to couple the biasing resistor 210 to the signal node 204 and into series-circuit relationship with the programming resistor 218. A voltage divider is thus defined. The adapter 104 and the laptop computer 102 are operating in a "first mode" with respect to communicating with each other.

[0033] At 306, a voltage at the signal node is sampled. For purposes of the present example, a voltage across the programming resistor 218, which is present at the signal node 204, is sampled by the voltage controller 216. The

voltage controller 216 digitally quantifies this voltage signal. The switch (or relay) 212 is in a "first mode" state during this step.

[0034] At 308, the sensed voltage is correlated to a voltage requirement of the load device. For purposes of the present example, the voltage controller 216 evaluates the digital quantification of the signal sampled at step 306 and determines that an operating voltage of nineteen volts (i.e., 19.0 Volts) is required by the laptop 102. The voltage controller 216 can make such determination by way of a lookup table, a predetermined mathematical function, or by another suitable technique.

[0035] At 310, a power capacity resistor is switched into series relationship with the programming resistor. For purposes of the present example, the voltage controller 216 causes the switch 212 to couple the power capacity resistor 214 to the signal node 204 and into series-circuit relationship with the programming resistor 218, defining a voltage divider. The adapter 104 and the laptop computer 102 are thus operating in a "second mode" with respect to communicating with each other.

[0036] At 312, a voltage at the signal node is sampled. For purposes of the present example, a voltage present at the signal node 204 is sampled by the load controller 220 and is digitally quantified. The switch (or relay) 212 is maintained in a "second mode" state during this step.

[0037] At 314, the sensed voltage is correlated to a power capacity of the electrical adapter. For purposes of the present example, the load controller 220 evaluates the digital quantification of the signal sampled at step 312 and determines that the adapter 104 can provide ninety watts (i.e., 90.0 Watts) of

power. The load controller 220 can make such determination by way of a lookup table, a predetermined mathematical function, or by another suitable technique.

[0038] At 316, the adapter is operated to provide the voltage required by the load device. For purposes of the present example, the voltage controller 216 provides a voltage control signal to the voltage regulator 208, causing it to provide a regulated nineteen volts DC between the power node 202 and the ground node 206.

[0039] At 318, the load device is operated in accordance with the power capacity of the adapter. For purposes of the present example, the load controller 220 provides a load control signal to the load device 222 causing it to throttle or limit normal operations so as to consume ninety watts (or less) from the adapter 104. Such wattage limitations can also be considered (or implemented) in terms of limiting instantaneous current draw (e.g., $90.0 \text{ Watts} / 19.0 \text{ Volts} = 4.73 \text{ Amps}$ (approx.) current limit).

[0040] The foregoing method is illustrative of any number of devices and methods contemplated by the present teachings. In general, and without limitation, an electrical adapter is connected to a computer or other load, and to a source of electricity. Circuitry within the electrical adapter and the load device now share a number of electrical nodes in common. A switching element couples a biasing resistor of the adapter into series with a programming resistor of the load device. A voltage present on a signal node is digitally quantified and correlated to a voltage requirement of the load device.

[0041] The switching element then couples a power capacity resistor into series with the programming resistor and a voltage present on the signal node is

digitally quantified and correlated to a power provisioning capacity of the electrical adapter. The electrical adapter provides regulated electrical voltage consistent with the requirements of the load device. In turn, the load device limits or throttles its respective normal operations in accordance with the power capacity of the electrical adapter.

ILLUSTRATIVE PROGRAMMING RESISTOR VALUES

[0042] Reference is made now to FIG. 4, which depicts a table 400 including illustrative and non-limiting examples of programming resistor values correlated to respective voltage requirements of a load device (e.g., 102). For example, a programming resistor (e.g., 218) having a value of 4.7K Ohms is correlated to a voltage requirement of 5.0 volts. In another example, a programming resistor having a value of 33K Ohms is correlated to a voltage requirement of 15.0 volts. Other resistance values correlated to other respective voltages can also be used.

ILLUSTRATIVE POWER CAPACITY RESISTOR VALUES

[0043] Attention is turned now to FIG. 5, which depicts a table 500 including illustrative and non-limiting examples of power capacity resistor values correlated to respective power provisioning capacities of an electrical adapter (e.g., 104). For example, a power capacity resistor (e.g., 214) having a value of 10K Ohms is correlated to a power capacity of 15.0 Watts. In another example, a power capacity resistor having a value of 47K Ohms is correlated to a power capacity of 70.0 Watts, and so on. Other resistance values correlated to other respective power (or current) capacities can also be used.

SECOND ILLUSTRATIVE EMBODIMENT

[0044] FIG. 6 is a schematic diagram depicting circuitry 600 according to another embodiment of the present teachings. The circuitry 600 is illustrative and non-limiting in nature. Other circuitry consistent with the present teachings is also contemplated. The circuitry 600 includes a portion 600A that is provided (i.e., supported or housed) within an electrical adapter (ADAPTER), and a portion 600B that is provided within a laptop computer (COMPUTER). Thus, the circuitry 600 is as depicted when an electrical adapter (e.g., 104) is (removably) coupled to a laptop computer (e.g., 102) or other load device in accordance with the present teachings.

[0045] The circuitry portions 600A and 600B are referred to as “compatible” with each other by virtue of their cooperative configurations. Thus, the electrical adapter portion 600A is compatible with the laptop computer (or load) portion 600B, and vice versa.

[0046] The circuitry 600 includes a power node 602, a signal node 604 and ground node 606. During normal operation, a regulated direct-current voltage is provided between the nodes 602 and 606. The adapter portion 600A includes a voltage regulator 608 to provide a selectable (adjustable), regulated supply voltage between the power node 602 and the ground node 606. The voltage regulator 608 is controllably adjusted by way of voltage control signal described hereinafter. The voltage regulator 608 can be defined, at least in part, by a switching-type regulator, a linear-type regulator, or other suitable voltage control circuitry. The voltage regulator 608 is configured to be coupled to a source of electrical energy such as a line-level utility supply (e.g., one-hundred twenty volts AC).

[0047] The adapter portion 600A also includes a resistor 610 coupled (or connected) to the power node 602. The resistor 610 is also referred to as a power capacity resistor 610 for purposes herein. The power capacity resistor 610 is coupled (or connected) to the signal node 604. The power capacity resistor 610 is characterized by an electrical resistance value that corresponds to a power provisioning capacity or current supplying capacity of the adapter portion 600A. Various suitable resistance values can also be used for the power capacity resistor 610 such as, without limitation, those described above in regard to Table 500.

[0048] The adapter portion 600A further includes a voltage controller 612. The voltage controller 612 is configured to detect (monitor, or sense) a voltage signal present at the signal node 604 and to correlate that signal with a voltage requirement of the laptop computer 600B. The voltage controller 612 is also configured to provide a voltage control signal to the voltage regulator 608 causing it to provide a supply voltage at the node 602 corresponding (equal, or about equal) to the voltage requirement of the laptop computer 600B.

[0049] The voltage controller 612 can be defined by or include any suitable electronic constituency. Without limitation, the voltage controller 612 can be at least partially defined by an application specific integrated circuit (ASIC), a microcontroller, a microprocessor, analog or digital or hybrid circuitry, and so on. Other elements or configurations can also be used.

[0050] The computer portion 600B of the circuitry 600 includes a resistor 614 that is connected between the signal node 604 and the ground node 606. The resistor 614 is also referred to as a programming resistor 614 for purposes

herein. The programming resistor 614 is characterized by an electrical resistance value that corresponds to a voltage requirement of the computer portion (i.e., load entity or device) 600B. Various suitable resistance values can also be used for the programming resistor 614 such as, without limitation, those described above in regard to Table 400.

[0051] The computer portion 600B also includes a load controller 616. The load controller 616 is configured to detect a voltage signal present at the signal node 604 and to correlate that signal with a power (or current) provisioning capacity of the adapter portion 600A. The load controller 616 is also configured to provide a load control signal causing a load device 618 to limit its power consumption (i.e., current draw) from the adapter portion 600A in accordance with the adapter capacity. The load controller 616 is configured such that the power capacity signal is detected when the power capacity resistor 610 is coupled to the signal node 604. Optionally, the load controller 616 is also coupled to monitor a voltage present at the power node 602 and to modulate the load control signal accordingly.

[0052] The load controller 616 can be defined by or include any suitable electronic constituency. Without limitation, the load controller 616 can be at least partially defined by an application specific integrated circuit (ASIC), a microcontroller, a microprocessor, analog or digital or hybrid circuitry, and so on. Other elements or configurations can also be used.

[0053] The computer portion 600B further includes the load device 618 introduced above. The load device 618 is coupled to receive operating power from the power node 602 and the ground node 606. The load device 618 can be

variously defined and can include a motherboard of a laptop computer, a peripheral or peripherals of a computer, an electronic display, data acquisition circuitry, control instrumentation, and so on. Other load devices 618 can also be defined and used. The load device 618 is configured to perform various operations in accordance with its respective normal functions. The load device 618 is also configured to control (throttle, or modulate) its operations, or intensities of those operations, in accordance with the load control signal from the load controller 618. Electrical current draw (power consumption) by the load device 618 is thus limited or constrained in accordance with the power provisioning capacity of the adapter portion 600A.

[0054] In general, the foregoing description is intended to be illustrative and not restrictive. Many embodiments and applications other than the examples provided would be apparent to those of skill in the art upon reading the above description. The scope of the invention should be determined, not with reference to the above description, but should instead be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. It is anticipated and intended that future developments will occur in the arts discussed herein, and that the disclosed systems and methods will be incorporated into such future embodiments. In sum, it should be understood that the invention is capable of modification and variation and is limited only by the following claims.

CLAIMS

What is claimed is:

1. An electronic circuit, comprising:

a power circuit having one or more resistors either directly or selectively coupled to a signal node, the power circuit including a voltage controller to detect a voltage at the signal node and to provide a corresponding voltage control signal, the power circuit including a voltage regulator to provide a supply voltage to a power node in accordance with the voltage control signal; and

a load circuit to be removably coupled to the signal node and the power node, the load circuit including a programming resistor coupled between the signal node and a ground node, the load circuit including a load controller to sense a voltage at the signal node and to provide a corresponding load control signal.

2. The electronic circuit according to claim 1, the programming resistor characterized by an electrical resistance correlated to a voltage required by a load device including the load circuit.

3. The electronic circuit according to claim 2, the voltage controller and the voltage regulator respectively such that the supply voltage is in accordance with the voltage required by the load device.

4. The electronic circuit according to claim 1, at least one of the resistors of the power circuit characterized by an electrical resistance correlated to a power capacity of the power circuit.

5. The electronic circuit according to claim 4, the load controller such that electrical current drawn by a load entity is limited in accordance with the power capacity of the power circuit.

6. The electronic circuit according to claim 1, each of the resistors of the power circuit connected to the power node.

7. The electronic circuit according to claim 1, the resistors of the power circuit including a biasing resistor, the voltage controller to cause the biasing resistor to be coupled to the signal node while the voltage controller is detecting the voltage corresponding to the voltage control signal.

8. The electronic circuit according to claim 1, the resistors of the power circuit including a power capacity resistor, the voltage controller to cause the power capacity resistor to be coupled to the signal node while the load controller is sensing the voltage corresponding to the load control signal.

9. A system, comprising:

a computer including a load controller; and

a power adapter having a power node and a signal node and a ground node each to be disconnectably coupled to the computer, the power adapter to detect a voltage at the signal node and to provide a corresponding supply voltage at the power node, the load controller to detect a voltage at the signal node and to provide a load control signal causing the computer to limit current drawn from the power adapter in accordance therewith.

10. The system according to claim 9, the computer including a voltage programming resistor connected to the signal node, the voltage programming resistor connected to either the power node or the ground node.

11. The system according to claim 9, the power adapter including a current capacity resistor, the power capacitor resistor being coupled to the signal node at least during the detection of the voltage corresponding to the load control signal.

12. The system according to claim 11, the computer including a voltage programming resistor, the current capacity resistor and the voltage programming resistor coupled to define a voltage divider between the power node and the ground node during the detection of the voltage corresponding to the load control signal.

13. The system according to claim 9, the power adapter including a biasing resistor, the computer including a voltage programming resistor, the biasing resistor and the voltage programming resistor coupled to define a voltage divider between the power node and the ground node during the detection of the voltage corresponding to the supply voltage.

14. The power adapter according to claim 9, the power adapter configured to be coupled to a source of alternating-current electrical energy, the power adapter including a voltage regulator to provide the supply voltage at the power node.

15. A method, comprising:

coupling one or more resistors within an adapter one at a time into series relationship with a programming resistor within a load entity;

sensing one or more voltages at a signal node common to the adapter and the load entity;

providing a regulated source voltage from the adapter to the load entity in accordance with at least one of the sensed voltages; and

limiting electrical current drawn by the load entity in accordance with at least one of the sensed voltages.

16. The method according to claim 15 further comprising removably coupling the adapter to the load entity.

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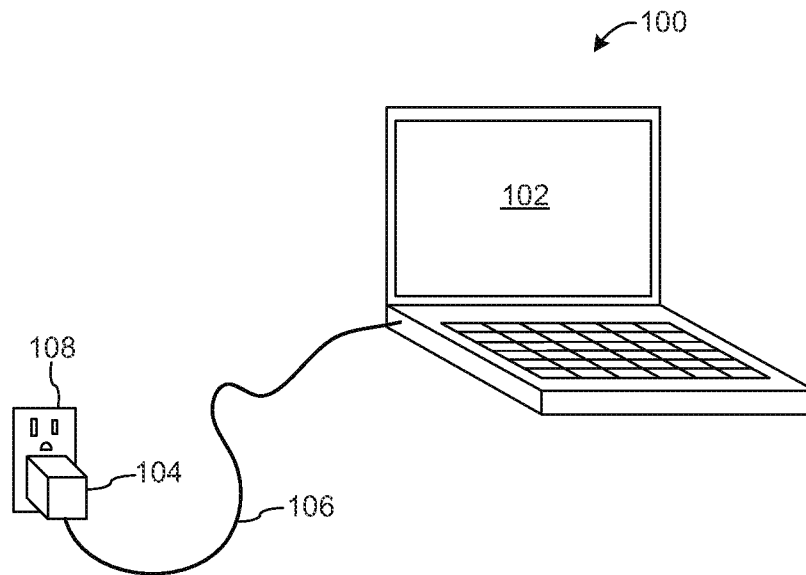


FIG. 1

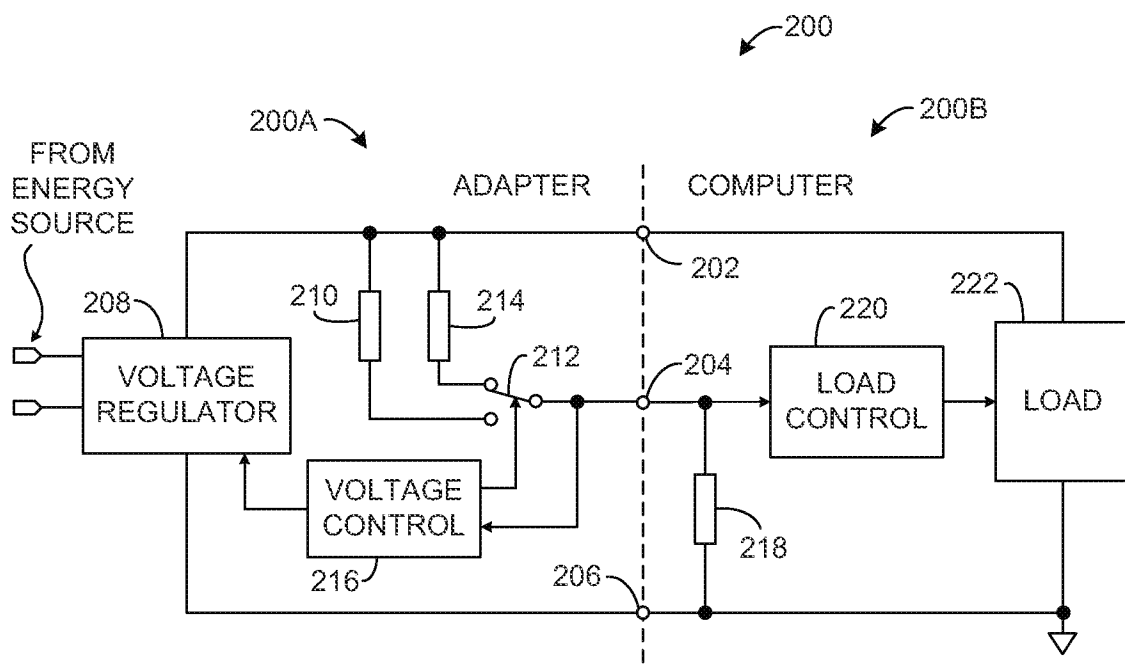


FIG. 2

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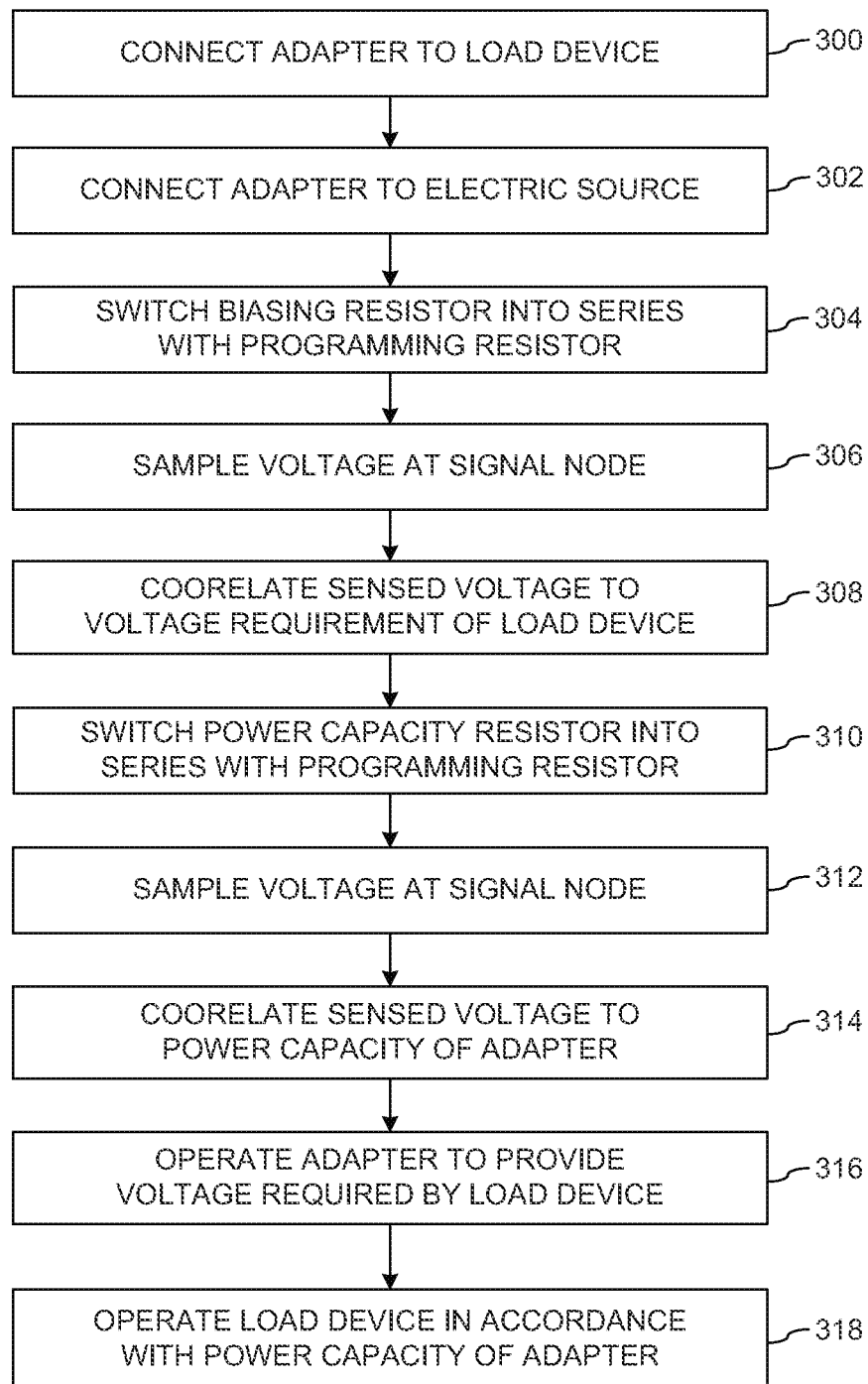


FIG. 3

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400

PROGRAMMING RESISTOR	REQUIRED DEVICE VOLTAGE
4.7K OHMS	5 VOLTS
10K OHMS	9 VOLTS
22K OHMS	12 VOLTS
33K OHMS	15 VOLTS
47K OHMS	19 VOLTS

FIG. 4

500

POWER CAPACITY RESISTOR	ELECTRICAL ADAPTER CAPACITY
4.7K OHMS	5 WATTS
10K OHMS	15 WATTS
22K OHMS	20 WATTS
33K OHMS	40 WATTS
47K OHMS	70 WATTS

FIG. 5

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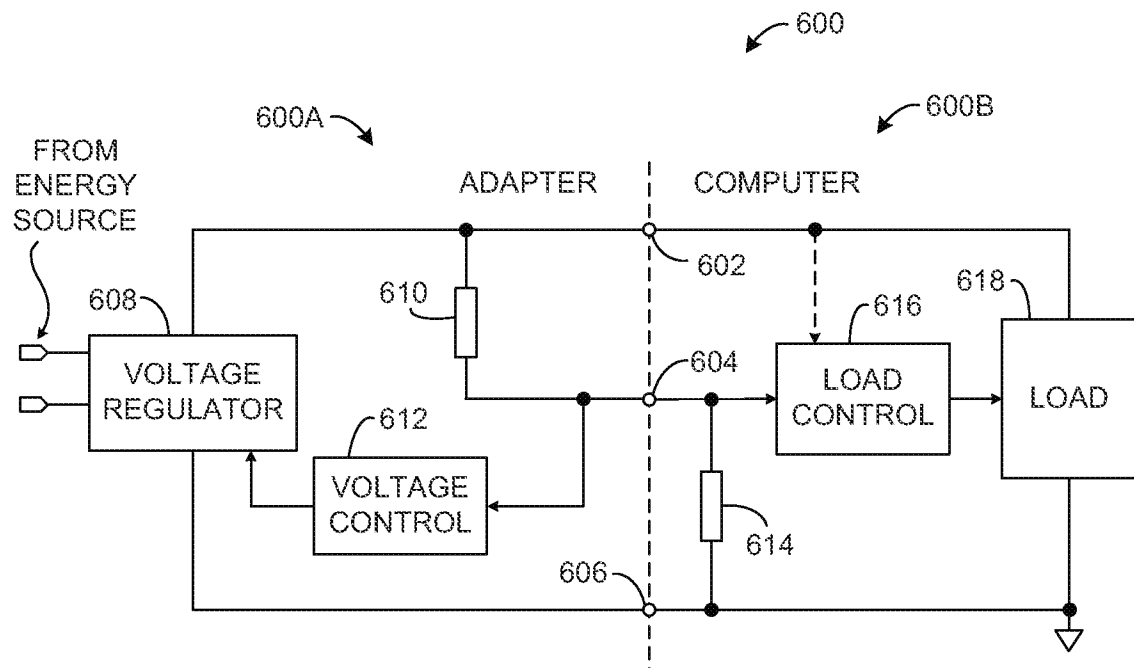


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/029255**A. CLASSIFICATION OF SUBJECT MATTER****H02M 7/00(2006.01)i, H05G 1/66(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)

H02M 7/00; H01H 47/00; H02J 7/00; H02J 17/00; H02J 9/00; G05F 3/16; H05G 1/66

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: adapter, resistor, node, load, limit, current

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2013-0038142 A1 (THOMAS PAUL SAWYERS) 14 February 2013 See paragraphs [0019]-[0026], claims 1,15 and figure 2.	1-16
A	US 2011-0156483 A1 (EFTIMIE CARAGHIORGHIOPOL et al.) 30 June 2011 See paragraphs [0017]-[0022], claims 1,14,19 and figure 1.	1-16
A	US 2009-0278407 A1 (DAVID JOHN TUPMAN et al.) 12 November 2009 See abstract, paragraphs [0038]-[0041] and figure 1A.	1-16
A	JP 2008-178194 A (SEIKO EPSON CORP. et al.) 31 July 2008 See abstract, claims 1,5,11 and figure 7.	1-16
A	US 2012-0161743 A1 (DER-HO CHI et al.) 28 June 2012 See paragraphs [0009]-[0016], claims 1,9 and figure 1.	1-16



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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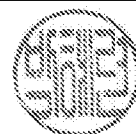
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City,
302-701, Republic of Korea

Facsimile No. +82-42-472-7140

Authorized officer

PARK, Hye Lyun

Telephone No. +82-42-481-3463



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2013/029255

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