

POWER MANAGEMENT SYSTEM

Technical Field

[0001] Various embodiments relate to a power management system and a method for
5 managing a supply of power to electronic devices, such as laptop computers.

Background

[0002] Electronic devices, such as laptop computers, typically use DC power supplied
from a transformer connected to a conventional AC power supply. Electrical connector
10 devices such as an attach-type electrical connector using a magnet or a USB-C connector
can be used for connecting the electronic devices to the transformer which is connected to
a conventional AC power supply. The electrical connector device can have a plurality of
electrical pins/electrical terminals to engage with the electrical pins/electrical terminals of
an electrical connector in the electronic devices to establish electrical connections and
15 connecting the electronic devices to the power supply. The power of the electrical
connector device can span a wide range of values.

[0003] Therefore, there exists a need for providing a solution to manage the supply of
power to the electronic devices especially when the power of the electrical connector
device is high.

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Summary

[0004] According to a first aspect of the present disclosure, a power management system
for use in a connector device configured for connecting an electronic device to a power
supply is provided. The power management system may comprise a switch configured to
25 connect the electronic device and the power supply, wherein the electronic device
receives power from the power supply when the switch is turned on; a controller
connected to the switch; and a detection pin configured to send a signal to the controller
when the detection pin is connected with a detection terminal of a connector in the
electronic device, wherein the controller is configured to turn on the switch when the
30 controller receives the signal from the detection pin and determines that the received
signal is within a pre-determined range.

[0005] According to a second aspect of the present disclosure, a connector device configured for connecting an electronic device to a power supply is provided. The connector device may comprise a power management system, and a power terminal and a ground terminal connected to the power management system. The power management system may comprise a switch configured to connect the electronic device and the power supply, wherein the electronic device receives power from the power supply when the switch is turned on; a controller connected to the switch; and a detection pin configured to send a signal to the controller when the detection pin is connected with a detection terminal of a connector in the electronic device, wherein the controller is configured to turn on the switch when the controller receives the signal from the detection pin and determines that the received signal is within a pre-determined range. The power terminal and the ground terminal may be configured to connect to a respect electrical terminal of a plurality of electrical terminals of the connector in the electronic device to establish an electrical connection.

[0006] According to a third aspect of the present disclosure, a power adapter configured for connecting an electronic device to a power supply is provided. The power adapter may comprise a connector device and a transformer. The connector device may comprise a power management system, and a power terminal and a ground terminal connected to the power management system. The power management system may comprise a switch configured to connect the electronic device and the power supply, wherein the electronic device receives power from the power supply when the switch is turned on; a controller connected to the switch; and a detection pin configured to send a signal to the controller when the detection pin is connected with a detection terminal of a connector in the electronic device, wherein the controller is configured to turn on the switch when the controller receives the signal from the detection pin and determines that the received signal is within a pre-determined range. The power terminal and the ground terminal may be configured to connect to a respect electrical terminal of a plurality of electrical terminals of the connector in the electronic device to establish an electrical connection. The transformer may be configured to convert an AC power input from the power supply to a DC power output.

[0007] According to a fourth aspect of the present disclosure, a method for controlling a supply of power from a power supply to an electronic device is provided, the method being carried out by a power management system for use in a connector device configured for connecting the electronic device to the power supply, the power management system comprising a switch, a controller and a detection pin, the method can
5 comprise: sending, by the detection pin, a signal to the controller when the detection pin is connected with a detection terminal of a connector in the electronic device; and turning on, by the controller, the switch when the controller receives the signal from the detection pin and determines that the received signal is within a pre-determined range, wherein the
10 switch is configured to connect the electronic device and the power supply, and wherein the electronic device receives power from the power supply when the switch is turned on.

Brief Description of the Drawings

[0008] In the drawings, like reference characters generally refer to like parts throughout
15 the different views. The drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the disclosure. In the following description, various embodiments of the disclosure are described with reference to the following drawings, in which:

[0009] FIG. 1A shows a connector device having a first connector which is connected to
20 a second connector.

[0010] FIG. 1B shows a connector device having a first connector which is separated from a second connector.

[0011] FIG. 2 shows a perspective view of an example connector device comprising a first connector and a second connector.

25 [0012] FIG. 3A shows a top perspective view of the first connector of FIG. 2.

[0013] FIG. 3B shows an exploded view of the first connector of FIG.2.

[0014] FIG. 4A shows a top perspective view of the second connector of FIG.2.

[0015] FIG. 4B shows a bottom perspective view of the second connector of FIG.2.

[0016] FIG. 5 shows a side view of the first connector and the second connector which
30 are connected with each other.

[0017] FIG. 6 shows a power management system comprised in and/or for use in the connector device according to various embodiments.

[0018] FIG. 7A shows a power management system comprised in and/or for use in the connector device according to various embodiments.

5 [0019] FIG. 7B shows a power management system comprised in and/or for use in the connector device according to various embodiments.

[0020] FIG. 8 shows an example of a power management system comprised in and/or for use in a connector device.

10 [0021] FIG. 9 shows another example of a power management system comprised in and/or for use in a connector device.

Detailed Description

15 [0022] The following detailed description refers to the accompanying drawings that show, by way of illustration, specific details, and embodiments in which the disclosure may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the disclosure. Other embodiments may be utilized, and structural, logical, optical and electrical changes may be made without departing from the scope of the disclosure. The various embodiments are not necessarily mutually exclusive, as some embodiments can be combined with one or more other embodiments to form
20 new embodiments.

[0023] Embodiments described in the context of one of the methods or devices are analogously valid for the other methods or devices. Similarly, embodiments described in the context of a method are analogously valid for a device, and vice versa.

25 [0024] Features that are described in the context of an embodiment may correspondingly be applicable to the same or similar features in the other embodiments. Features that are described in the context of an embodiment may correspondingly be applicable to the other embodiments, even if not explicitly described in these other embodiments. Furthermore, additions and/or combinations and/or alternatives as described for a feature in the context of an embodiment may correspondingly be applicable to the same or
30 similar feature in the other embodiments.

[0025] It should be understood that the terms “on”, “over”, “top”, “bottom”, “down”, “side”, “back”, “left”, “right”, “front”, “back”, “lateral”, “side”, “up”, “down”, “vertical”, “horizontal” etc., when used in the following description are used for convenience and to aid understanding of relative positions or directions, and not intended to limit the orientation of any device, or structure or any part of any device or structure. In addition, the singular terms “a”, “an”, and “the” include plural references unless context clearly indicates otherwise. Similarly, the “or” is intended to include “and” unless the context clearly indicates otherwise.

[0026] It will be further understood that the terms “comprise” (and any form of comprise, such as “comprises” and “comprising”), “have” (and any form of have, such as “has” and “having”), “include” (and any form of include, such as “includes” and “including”), and “contain” (and any form of contain, such as “contains” and “containing”) are open-ended linking verbs. As a result, a method or device that “comprises,” “has,” “includes” or “contains” one or more steps or elements possesses those one or more steps or elements, but is not limited to possessing only those one or more steps or elements. Likewise, a step of a method or an element of a device that “comprises,” “has,” “includes” or “contains” one or more features possesses those one or more features, but is not limited to possessing only those one or more features. Furthermore, a device or structure that is configured in a certain way is configured in at least that way, but may also be configured in ways that are not listed.

[0027] Approximating language, as used herein throughout the specification and claims, may be applied to modify any quantitative representation that could permissibly vary without resulting in a change in the basic function to which it is related. Accordingly, a value modified by a term or terms, such as “about,” “substantially”, is not limited to the precise value specified but within tolerances that are acceptable for the operation of the embodiment for an application for which it is intended. In some instances, the approximating language may correspond to the precision of an instrument for measuring the value.

[0028] The term “exemplary” may be used herein to mean “serving as an example, instance, or illustration”. Any aspect or design described herein as “exemplary” is not necessarily to be construed as preferred or advantageous over other aspects or designs.

[0029] The terms “at least one” and “one or more” may be understood to include a numerical quantity greater than or equal to one (e.g., one, two, three, four, [...], etc.). The term “a plurality” may be understood to include a numerical quantity greater than or equal to two (e.g., two, three, four, five, [...], etc.). The phrase “at least one of” with regard to a group of elements may be used herein to mean at least one element from the group consisting of the elements. For example, the phrase “at least one of” with regard to a group of elements may be used herein to mean a selection of: one of the listed elements, a plurality of one of the listed elements, a plurality of individual listed elements, or a plurality of a multiple of listed elements.

[0030] The words “plural” and “multiple” in the description and the claims expressly refer to a quantity greater than one. Accordingly, any phrases explicitly invoking the aforementioned words (e.g., “a plurality of (objects)”, “multiple (objects)”) referring to a quantity of objects expressly refer to more than one of the said objects. The terms “group (of)”, “set (of)”, “collection (of)”, “series (of)”, “sequence (of)”, “grouping (of)”, etc., and the like in the description and in the claims, if any, refer to a quantity equal to or greater than one, i.e. one or more.

[0031] The term “first”, “second”, “third” detailed herein are used to distinguish one element from another similar element and may not necessarily denote order or relative importance, unless otherwise stated.

[0032] As used herein, the phrase of the form of “at least one of A or B” may include A or B or both A and B. Correspondingly, the phrase of the form of “at least one of A or B or C”, or including further listed items, may include any and all combinations of one or more of the associated listed items.

[0033] FIG. 1A shows a connector device 10 having a first connector 12 (e.g., a plug 12) which is connected to a second connector 14 (e.g., a receptacle 14). The second connector 14 may be part of an electronic device 30. FIG. 1B shows a connector device 10 having a first connector 12 which is separated from the second connector 14. The first connector 12 and the second connector 14 can be connected to each other to establish an electrical connection between the first connector 12 and the second connector 14.

[0034] As shown in FIG. 1A and FIG. 1B, the connector device 10 can be configured to connect an electronic device 30 (e.g., a laptop computer) to a power supply 20. For

example, the first connector 12 may be connectable to a power supply 20, and the second connector 14 may be positioned in an electronic device 30 (e.g., a laptop computer 30) having a housing and internal electronics. The first connector 12 may be connectable to a power supply 20 via a transformer 40. The first connector 12 may comprise a transformer
5 40 for converting AC input from the conventional AC power supply 20 to DC output. In some embodiments, the connector device 10 may comprise the first connector 12 and the second connector 14. The connector device 10 may be part of a power adapter 50 for connecting the electronic device 30 to a conventional AC power supply 20. The power adapter 50 can have a transformer 40 connected to the connector device 10, and the
10 transformer 40 can be configured to convert an AC power input from the power supply 20 to a DC power output. The power adapter 50 may have an output voltage of 5V, 9V, 12V, 20V, 28V, 36V or 48V. However, other values of the output voltage may be possible in accordance with various embodiments.

[0035] For example, the power adapter 50 may have an input voltage range of 100V to 240V, an input current range of less than 4.5A and an input frequency of 50 Hz to 60 Hz,
15 and an output voltage of 19.5V +/- 5%, an output current of 16.92A and a power of 330W. The power adapter 50 may have an input voltage range of 100V to 240V, an input current range of less than 3.6A and an input frequency of 50 Hz to 60 Hz, and an output voltage of 19.5V, an output current of 11.8A and a power of 230W. The power adapter
20 50 may have an input voltage range of 100V to 240V, an input current range of less than 1.5A and an input frequency of 50 Hz to 60 Hz, and an output voltage of 5V / 9V / 15V / 20V, an output current of 3A / 5A and a power of 100W. The power adapter 50 may have an input voltage range of 100V to 240V, an input current range of less than 2A and an input frequency of 50 Hz to 60 Hz, and an output voltage of 20V, an output current of
25 3.25A and a power of 65W. However, the power adapter 50 may not be limited to the aforementioned values or ranges for voltage, current, frequency, and power.

[0036] The first connector 12 may include a plurality of electrical terminals, which are preferably biased towards a corresponding plurality of terminals positioned on the second connector 14.

30 [0037] The first connector 12 may include at least one power terminal and at least one ground terminal. The first connector 12 may further include a detection pin.

[0038] The second connector 14 may be configured to receive the first connector 12 so as to establish an electrical connection. The second connector 14 may include a receptacle configured to receive the first connector 12. The second connector 14 may include a plurality of electrical terminals and at least one detection terminal.

5 [0039] The plurality of electrical terminals of the second connector 14 may be configured to contact with the at least one power terminal and the at least one ground terminal of the first connector 12 so as to establish the electrical connection between the first connector 12 and the second connector 14, when the first connector 12 and the second connector 14 are connected with each other.

10 [0040] The detection pin of the first connector 12 may be configured to contact the at least one detection terminal of the second connector 14 when the first connector 12 is received in and connected with the second connector 14.

[0041] FIG. 2 shows a perspective view of an example connector device 10 comprising a first connector 12 which can be connected to a second connector 14 in an electronic device 30, according to various embodiments. FIG. 3A shows a top perspective view of the first connector 12 of FIG. 2. FIG. 3B shows an exploded view of the first connector 12 of FIG. 2. The first connector 12 may include a first magnetic element 16. The first magnetic element 16 of the first connector 12 may be made of a ferromagnetic material capable of being attracted by magnets. The first connector 12 may include a first and second power terminal 132 and a first and second ground terminal 134.

[0042] The first connector 12 may further include a detection pin 130 disposed between a second power terminal 132 and a second ground terminal 134. The detection pin 130 may be configured to connect with a detection terminal 138 (or a pair of detection terminals 138) of the second connector 14 and send a signal when the first connector 12 is received in and connected with the second connector 14. Likewise, it should be appreciated that the detection pin 130 of the first connector 12 may be disposed beside the second power terminal 132 and the second ground terminal 134, for example, to the right side of the second power terminal 132 or to the left side of the second ground terminal 134.

[0043] FIG. 4A shows a top perspective view of the second connector 14 of FIG.2. FIG. 4B shows a bottom perspective view of the second connector 14 of FIG.2. The second connector 14 may be configured to receive the first connector 12 so as to establish an

electrical connection between the first connector 12 and the second connector 14. The second connector 14 may include a receptacle 14a configured to receive the first connector 12.

[0044] The second connector 14 can include a second magnetic element 18 disposed adjacent to the receptacle 14a of the second connector 14. The second magnetic element 18 of the second connector 14 may include a pair of magnets 18, for example, permanent magnets (preferably rare earth magnets) or electromagnets, and the first magnetic element 16 of the first connector 12 may include a ferromagnetic material capable of magnetic attraction to the pair of permanent magnets 18 of the second connector 14.

[0045] The second connector 14 may include four pairs of electrical terminals 136. Each of the four pairs of electrical terminals 136 may be configured to contact with one of the first, second power terminals 132 and the first, second ground terminals 134 of the first connector 12 so as to establish the electrical connection between the first connector 12 and the second connector 14.

[0046] The second connector 14 may include a detection terminal 138. The detection pin 130 of the first connector 12 may be configured to connect with the detection terminal 138 of the second connector 14 (e.g. at the received position) and send a signal that the first connector 12 is connected with the second connector 14. It should be appreciated that the detection terminal 138 of the second connector 14 may include a pair of detection terminals 138 configured to be in contact with a top and a bottom of the detection pin 130 of the first connector 12, respectively. That is, the detection pin 130 of the first connector 12 may be sandwiched by the pair of detection terminals 138 of the second connector 14 at the received position such that the first connector 12 is in electrical connection with the second connector 14.

[0047] FIG. 5 shows a side view of the first connector 12 and the second connector 14 which are connected with each other to establish an electrical connection between the first connector 12 and the second connector 14. When the first connector 12 and the second connector 14 are connected with each other, the power terminals 132 and the ground terminals 134 of the first connector 12 may engage the electrical terminals 136 of the second connector 14, the detection pin 130 of the first connector 12 may engage the detection terminals 138 of the second connector 14. To maintain the connection, the first

magnetic element 16 of the first connector 12 and the second magnetic element 18 of the second connector 14 may magnetically couple together and hold the first connector 12 to the receptacle 14a of the second connector 14.

[0048] FIG. 6, FIG. 7A, FIG. 7B respectively show a power management system 100
5 comprised in and/or for use in the connector device 10 according to various embodiments. The power management system 100 can comprise a switch 110, a controller 120 connected to the switch 110, and the detection pin 130.

[0049] The switch 110 can be configured to connect the electronic device 30 and the power supply 20. In some embodiments, the switch 110 can be configured to connect the
10 electronic device 30 to the power supply 20 via a transformer 40. When the switch 110 is turned on, the electronic device 30 can receive power from the power supply 20, for example, for charging the electronic device 30. The electronic device 30 cannot receive power from the power supply 20 when the switch 110 is turned off. In one embodiment, the switch 110 can comprise a transistor. In another embodiment, the switch 110 can
15 comprise a plurality of transistors connected in parallel.

[0050] When a first connector 12 in the connector device 10 is not connected with a second connector 14 in the electronic device 30, the switch 110 is turned off and the electronic device 30 cannot receive power from the power supply 20, for example, for charging the electronic device 30.

[0051] The detection pin 130 can be configured to send a signal to the controller 120
20 when the detection pin 130 is connected with a detection terminal 138 of a second connector 14 in the electronic device 30.

[0052] The controller 120 can be configured to turn on the switch 110 when the controller 120 receives the signal from the detection pin 130 and determines that the
25 received signal is within a pre-determined range.

[0053] As mentioned above, the detection pin 130 can be configured to send a signal to the controller 120 when the detection pin 130 is connected with a detection terminal 138 of a second connector 14 in the electronic device 30. When the controller 120 further determines that the received signal is within a pre-determined range, the controller 120
30 can turn on the switch 110. The controller 120 can be an integrated circuit (IC) 120.

However, when the controller 120 determines that the received signal is not within a pre-determined range, the controller 120 can keep the switch 110 turned off.

[0054] For example, when the connector device 10 is not properly connected to the electronic device 30 such that the detection pin 130 is not properly connected (e.g., partially connected, not fully connected) with the detection terminal 138 of the second connector 14 in the electronic device 30, the controller 120 can detect that the signal received from the detection pin 130 by the controller 120 is not within a pre-determined range, the controller 120 can keep the switch 110 turned off.

[0055] For example, when a mismatched power adapter 50 or a mismatched connector device 10 is connected to the electronic device 30, the controller 120 can detect that the signal received from the detection pin 130 is not within a pre-determined range and keep the switch 110 turned off.

[0056] When the connector device 10 is properly connected to the electronic device 30 such that the detection pin 130 is properly connected with the detection terminal 138 of the second connector 14 in the electronic device 30 and the power adapter 50/the connector device 10 connected to the electronic device 30 matches the electronic device 30, the controller 120 can detect that the signal received from the detection pin 130 is within a pre-determined range and turn on the switch 110. When the switch 110 is turned on, the electronic device 30 can receive power from the power supply 20, for example, for charging the electronic device 30.

[0057] In some embodiments, the controller 120 can be configured to determine a power required by the electronic device 30 based on the signal received from the detection pin 130. For example, the controller 120 can be configured to turn on the switch 110 when the received signal is within a pre-determined range to deliver the required power to the electronic device 30.

[0058] The power management system 100 can comprise a temperature sensing element 150 (see, e.g. FIG. 7A, FIG. 7B) connected to the controller 120. The temperature sensing element 150 can be configured to detect an internal temperature of the detector device 10, and turn off the controller 120 and therefore turn off the switch 110 when the internal temperature of the detector device 10 is higher than a pre-determined threshold value. The temperature sensing element 150 can comprise at least one Negative Temperature

Coefficient (NTC) thermistor which are resistors with a negative temperature coefficient. The resistance of the NTC thermistor may decrease with increasing temperature. When the internal temperature of the detector device 10 exceeds the pre-determined threshold value, the resistance of the NTC thermistor decreases below a threshold value such that the controller 120 is turned off. When the controller 120 is turned off, the switch 110 is turned off, and the electronic device 30 cannot receive power from the power supply 20, e.g., for charging the electronic device 30.

[0059] In some embodiments, the power management system 100 can comprise an indicator 140 (see, e.g., FIG. 7A) connected to the switch 110 for indicating that the switch 110 is turned on and the electronic device 30 receives power from the power supply 20. The indicator 140 can be configured to receive power from the power supply 20 when the switch 110 is turned on. The indicator 140 cannot receive power from the power supply 20 when the switch 110 is turned off. The indicator 140 can send visual signals when it receives power from the power supply 20. For example, the indicator 140 can be a light emitting diode (LED), which emits light when it receives power from the power supply 20.

[0060] As mentioned above, the switch 110 can be turned on by the controller 120 when the controller 120 receives the signal from the detection pin 130 and determines that the received signal is within a pre-determined range. Therefore, when the controller 120 receives the signal from the detection pin 130 and determines that the received signal is within a pre-determined range, the indicator 140 can receive power from the power supply 20 and send visual signals, for example, emit light, for indicating that the connector device 10 is properly connected to the electronic device 30 such that the detection pin 130 is properly connected with the detection terminal 138 of the second connector 14 in the electronic device 30 and the power adapter 50/the connector device 10 matches the electronic device 30. On the other hand, when the indicator 140 does not send visual signals, for example, emit light, it may indicate that the connector device 10 is not properly connected to the electronic device 30 or the power adapter 50/the connector device 10 mismatch the electronic device 30 so that a user may check the connection between the connector device 10 and the electronic device 30 and/or check if the power adapter 50/the connector device 10 matches the electronic device 30.

[0061] As mentioned above, the switch 110 can be turned off when the internal temperature of the detector device 10 is higher than a pre-determined threshold value. When the switch 110 is turned off, the indicator 140 cannot receive power from the power supply 20, and therefore, stop sending visual signals, for example, emitting light.
5 Therefore, the indicator 140 can be used for indicating that the internal temperature of the detector device 10 exceeds a pre-determined threshold value.

[0062] In some embodiments, the power management system 100 can comprise an indicator 140 (see, e.g., FIG. 7B) connected to the controller 120 for indicating that the switch 110 is turned on and the electronic device 30 receives power from the power
10 supply 20. The indicator 140 may receive power from the controller 120 and show indication (e.g., emit green light) when the controller 120 detects that a voltage ($V_{ID_adapter}$) at a detection pin connecting terminal 122 is within the pre-determined range.

[0063] FIG. 8 shows an example of a power management system 100 comprised in and/or for use in a connector device 10 for connecting an electronic device 30 to a power
15 supply 20, directly or via a transformer 40. The power management system 100 comprises a switch 110, a controller (Integrated Circuit, IC) 120 and a detection pin 130.

[0064] As shown in the example of FIG. 8, the switch 110 comprises two N-type metal-oxide-semiconductor field-effect transistors (MOSFETs) 112 connected in parallel. Compared to one MOSFET, the two MOSFETs connected in parallel may help to reduce
20 a thermal dissipation. The switch 110 connects the electronic device 30 and a power supply 20 (not shown) directly or via a transformer 40 (not shown). The power management system 100 receives an input voltage (VO_in) from the power supply 20 or the transformer 40. When the switch 110 is turned on, the electronic device 30 can receive power from the power supply 20, and receive an output voltage (VO_out) from
25 the power management system 100. When the switch 110 is turned off, the electronic device 30 cannot receive power from the power supply 20.

[0065] When a first connector 12 in the connector device 10 is not connected with a second connector 14 in the electronic device 30, the switch 110 is turned off and the electronic device 30 cannot receive power from the power supply 20, for example, for
30 charging the electronic device 30. When the detection pin 130 is connected with a detection terminal 138 of a second connector 14 in the electronic device 30, the detection

pin 130 sends a signal to the controller 120. When the connector device 10 is properly connected to the electronic device 30 such that the detection pin 130 of the first connector 12 is properly connected with the detection terminal 138 of the second connector 14 (e.g. at the received position) in the electronic device 30 and the power adapter 50/the connector device 10 matches the electronic device 30, the IC 120 can detect that a voltage ($V_{ID_adapter}$) at a detection pin connecting terminal 122 is within a pre-determined range and therefore a voltage (V_{gate}) at a gate terminal 124 of the IC 120 exceeds a threshold value such that the switch 110 connected to the gate terminal 124 of the IC 120 is turned on. The IC 120 determines that the signal received by the IC 120 from the detection pin 130 is within a pre-determined range when the voltage at the detection pin connecting terminal 122 of the IC 120 is within a pre-determined range. When the switch 110 is turned on, the electronic device 30 (e.g., a laptop 30) can receive power from the power supply 20, for example, for charging the electronic device 30.

[0066] When the connector device 10 is not properly connected to the electronic device 30, the detection pin 130 of the first connector 12 is not properly connected (e.g., partially connected) with the detection terminal 138 of the second connector 14 or when the power adapter 50/the connector device 10 mismatches the electronic device 30, the IC 120 can detect that a voltage ($V_{ID_adapter}$) at detection pin connecting terminal 122 is not within the pre-determined range and therefore a voltage (V_{gate}) at a gate terminal 124 of the IC 120 does not exceed the threshold value such that the switch 110 connected to the gate terminal 124 of the IC 120 is turned off. When the switch 110 is turned off, the electronic device 30 (e.g., a laptop 30) can not receive power from the power supply 20, for example, for charging the electronic device 30.

By way of example, the pre-determined range for the voltage ($V_{ID_adapter}$) detected at detection pin connecting terminal 122 may be set as from 0.457 V to 0.494 V for a connector device 10 with a power of 330W, wherein the resistance of the connector device external resistor (R_2) (or the resistance of the connector device 10) is 475 K Ohm, the voltage (VCC) at the VCC Pin 126 of the integrated circuit (IC) 120 is $5V \pm 0.1V$ and the resistance of the laptop resistor (or the internal resistance of the laptop 30) is 49.9K Ohm.

[0067] As shown in FIG.8, the power management system 100 can comprise a light emitting diode (LED) as indicator 140 connected to the switch 110 for indicating if the connector device 10 is properly connected to the electronic device 30 and if the power adapter 50/ the connector device 10 matches the electronic device 30. The indicator (LED) 140 receives a supply of power from the power supply 20 (not shown) and emits light when the switch 110 is turned on.

[0068] The power management system 100 can comprise a NTC thermistor 150 configured to detect an internal temperature of the detector device 10, and turn off the controller 120 and the switch 110 when the internal temperature of the detector device 10 is higher than a pre-determined threshold value .

[0069] FIG. 9 shows another example of a power management system 100 comprised in and/or for use in a connector device 10 for connecting an electronic device 30 to a power supply 20, directly or via a transformer 40. The power management system 100 may comprise a switch 110, a controller (Integrated Circuit, IC) 120 and a detection pin 130.

[0070] As shown in the example of FIG. 9, the switch 110 may comprise an N-type metal-oxide-semiconductor field-effect transistor (MOSFET) 112. The switch 110 may connect the electronic device 30 and a power supply 20 (not shown) directly or via a transformer 40 (not shown). The power management system 100 may receive an input voltage (VO_in) from the power supply 20 or the transformer 40. When the switch 110 is turned on, the electronic device 30 can receive power from the power supply 20, and receive an output voltage (VO_out) from the power management system 100. When the switch 110 is turned off, the electronic device 30 cannot receive power from the power supply 20.

[0071] When a first connector 12 in the connector device 10 is not connected with a second connector 14 in the electronic device 30, the switch 110 is turned off and the electronic device 30 cannot receive power from the power supply 20, for example, for charging the electronic device 30. When the detection pin 130 is connected with a detection terminal 138 of a second connector 14 in the electronic device 30, the detection pin 130 may send a signal to the controller 120. When the connector device 10 is properly connected to the electronic device 30 such that the detection pin 130 of the first connector 12 is properly connected with the detection terminal 138 of the second connector 14 (e.g.

at the received position) in the electronic device 30 and the power adapter 50/the connector device 10 matches the electronic device 30, the IC 120 can detect that a voltage ($V_{ID_adapter}$) at a detection pin connecting terminal 122 is within a pre-determined range and therefore a voltage (V_{gate}) at a gate terminal 124 of the IC 120 exceeds a threshold value such that the switch 110 connected to the gate terminal 124 of the IC 120 is turned on. The IC 120 may determine that the signal received by the IC 120 from the detection pin 130 is within a pre-determined range when the voltage at the detection pin connecting terminal 122 of the IC 120 is within a pre-determined range. When the switch 110 is turned on, the electronic device 30 (e.g., a laptop 30) can receive power from the power supply 20, for example, for charging the electronic device 30.

[0072] When the connector device 10 is not properly connected to the electronic device 30, the detection pin 130 of the first connector 12 is not properly connected (e.g., partially connected) with the detection terminal 138 of the second connector 14 or when the power adapter 50/the connector device 10 mismatches the electronic device 30, the IC 120 can detect that a voltage ($V_{ID_adapter}$) at detection pin connecting terminal 122 is not within the pre-determined range and therefore a voltage (V_{gate}) at a gate terminal 124 of the IC 120 does not exceed the threshold value such that the switch 110 connected to the gate terminal 124 of the IC 120 is turned off. When the switch 110 is turned off, the electronic device 30 (e.g., a laptop 30) can not receive power from the power supply 20, for example, for charging the electronic device 30.

[0073] By way of example, the pre-determined range for the voltage ($V_{ID_adapter}$) detected at detection pin connecting terminal 122 may be set as from 0.16 V to 0.184 V for a connector device 10 with a power of 330W, wherein the resistance of the connector device external resistor (R_2) (or the resistance of the connector device 10) is 909 K Ohm, the voltage (VCC) at the VCC Pin 126 of the integrated circuit (IC) 120 is $3.3V \pm 0.231V$ and the resistance of the laptop resistor (or the internal resistance of the laptop 30) is 49.9K Ohm.

[0074] As shown in FIG.9, the power management system 100 may include a light emitting diode (LED) as an indicator 140 connected to the IC 120 for indicating if the connector device 10 is properly connected to the electronic device 30 and if the power adapter 50/ the connector device 10 matches the electronic device 30. The IC 120 may

control the indicator (LED) 140 to emit light continuously when the IC 120 detects that a voltage ($V_{ID_adapter}$) at the detection pin connecting terminal 122 is within the pre-determined range, and the IC 120 may control the indicator (LED) 140 to emit flashing light when the IC 120 detects that a voltage ($V_{ID_adapter}$) at the detection pin connecting terminal 122 is not within the pre-determined range.

[0075] As shown in FIG.9, the power management system 100 may include an NTC thermistor 150 configured to detect an internal temperature of the detector device 10, and turn off the controller 120 and the switch 110 when the internal temperature of the detector device 10 is higher than a pre-determined threshold value.

[0076] As shown in FIG.9, the power management system 100 may include a MOSFET Q3 connected to the VCC Pin 126 of the IC 120, and may include a diode D1 and a resistor R7 connected to the MOSFET Q3. When the first connector 12 is unplugged/disconnected from the second connector 14, the IC 120 may turn on the MOSFET Q3 and therefore the output voltage (VO_out) can rapidly discharge through the diode D1 and the resistor R7. This may help avoid arcing from occurring when the first connector 12 is unplugged/disconnected from the second connector 14.

[0077] As shown in FIG.9, the power management system 100 may include a first Zener diode ZD1 and a second Zener diode ZD2 for protecting other semiconductor devices in the power management system 100 against voltage surges. In some embodiments, the indicator 140 may be configured to flash or be turned off when some parts of the power management system 100 are damaged or the protection function of the first Zener diode ZD1 and/or the second Zener diode ZD2 is active.

[0078] Arcing can occur when connecting (inserting) a first connector in a connector device to a second connector comprised in and/or positioned in the electronic device, when the two connectors are not properly connected, e.g., partially connected, especially when the power of the connector device is relatively high. Therefore, charging the electronic device when the two connectors are not properly connected may cause damage to the electronic device. The switch 110 in the power management system 100 of the present disclosure is turned off such that the charging of the electronic device 30 is prevented when the first connector 12 of the connector device 10 is not properly connected with the second connector 14 in the electronic device 30. Therefore, the power

management system 100 of the present disclosure can help to avoid damage to the electronic device 30 due to the improper connection (e.g., partial connection) between the first connector 12 and the second connector 14.

[0079] In addition, charging an electronic device with a mismatched power adapter
5 and/or a mismatched connector device may also cause damage to the electronic device. The switch 110 in the power management system 100 of the present disclosure is turned off such that the charging of the electronic device 30 is prevented when the power adapter 50/connector device 10 mismatches with the electronic device 30. Therefore, the power management system 100 of the present disclosure can help to avoid damage to the
10 electronic device 30 due to a mismatch between the power adapter 50 (or the connector device 10) and the electronic device 30.

[0080] In addition, the switch 110 in the power management system 100 of the present disclosure is turned off such that the charging of the electronic device is prevented when an internal temperature of the detector device is higher than a pre-determined threshold
15 value. Therefore, the power management system 100 of the present disclosure can help to avoid damage to the electronic device 30 due to high internal temperature of the detector device 10.

[0081] While the disclosure has been particularly shown and described with reference to specific embodiments, it should be understood by those skilled in the art that various
20 changes in form and detail may be made therein without departing from the spirit and scope of the disclosure as defined by the appended claims. The scope of the disclosure is thus indicated by the appended claims and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced.

CLAIMS

1. A power management system for use in a connector device configured for connecting an electronic device to a power supply, the power management system comprising:
- 5 a switch configured to connect the electronic device and the power supply, wherein the electronic device receives power from the power supply when the switch is turned on;
- a controller connected to the switch; and
- 10 a detection pin configured to send a signal to the controller when the detection pin is connected with a detection terminal of a connector in the electronic device,
- wherein the controller is configured to turn on the switch when the controller receives the signal from the detection pin and determines that the received signal is within a pre-determined range.
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2. The power management system of claim 1, further comprising:
- an indicator connected to the switch, wherein the indicator is configured to receive power from the power supply when the switch is turned on.
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3. The power management system of claim 2, wherein the indicator is a light emitting diode (LED).
4. The power management system of claim 1, wherein the power management system is configured to determine a power required by the electronic device based on the signal received from the detection pin to deliver the required power to the electronic device.
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5. The power management system of claim 1, wherein the controller determines that the received signal is within a pre-determined range when a voltage at a detection pin connecting terminal of the controller is within a pre-determined range.
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- 5 6. The power management system of claim 5, wherein the voltage at the detection pin connecting terminal is within a pre-determined range when the detection pin is properly connected with a detection terminal of the connector in the electronic device and the connector device matches the electronic device.
- 10 7. The power management system of claim 5, wherein the switch is configured to be turned on when receiving a control voltage from the controller that is higher than a pre-determined threshold value when the voltage at the detection pin connecting terminal is within a pre-determined range.
- 15 8. The power management system of claim 1, wherein the switch comprises at least one transistor.
- 20 9. The power management system of claim 8, wherein the transistor is a metal-oxide-semiconductor field-effect transistor (MOSFET).
- 25 10. The power management system of claim 1, further comprising a temperature-sensing element configured to detect an internal temperature of the connector device, and turn off the controller and therefore turn off the switch when the detected internal temperature is higher than a pre-determined threshold value.
- 30 11. The power management system of claim 1, wherein the connector device is properly connected to the electronic device when the detection pin is properly connected with the detection terminal of the connector in the electronic device.
12. A connector device configured for connecting an electronic device to a power supply, the connector device comprising:
a power management system of any of claims 1 to 11; and
a power terminal and a ground terminal connected to the power management system, the power terminal and the ground terminal being

configured to connect to a respect electrical terminal of a plurality of electrical terminals of the connector in the electronic device to establish an electrical connection.

- 5 13. A power adapter configured for connecting an electronic device to a power supply, the power adapter comprising:
- a connector device of claim 12; and
 - a transformer connected to the connector device, wherein the transformer is configured to convert an AC power input from the power supply to a
- 10 DC power output.
14. A method for controlling a supply of power from a power supply to an electronic device, the method being carried out by a power management system for use in a connector device configured for connecting the electronic device to the power supply, the power management system comprising a switch, a controller and a
- 15 detection pin, the method comprising:
- sending, by the detection pin, a signal to the controller when the detection pin is connected with a detection terminal of a connector in the electronic device; and
- 20 turning on, by the controller, the switch when the controller receives the signal from the detection pin and determines that the received signal is within a pre-determined range,
- wherein the switch is configured to connect the electronic device and the power supply, and wherein the electronic device receives power
- 25 from the power supply when the switch is turned on.
15. The method of claim 14, further comprising:
- receiving, by an indicator connected to the switch, power from the power supply when the switch is turned on.
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16. The method of claim 15, wherein the indicator is a light emitting diode (LED).

17. The method of claim 14, further comprising:

determining, by the controller, a power required by the electronic device based on the signal received from the detection pin to deliver the required power to the electronic device.

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18. The method of claim 14, further comprising:

determining, by the controller, that the received signal is within a pre-determined range when a voltage at a detection pin connecting terminal of the controller is within a pre-determined range.

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19. The method of claim 18, wherein the voltage at the detection pin connecting terminal is within a pre-determined range when the detection pin is properly connected with the detection terminal of the connector in the electronic device and the connector device matches the electronic device.

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20. The method of claim 18, further comprising:

turning on the switch when the switch receives a control voltage from the controller that is higher than a pre-determined threshold value when the voltage at the detection pin connecting terminal is within a pre-determined range.

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21. The method of claim 14, where the switch comprises at least one transistor.

22. The method of claim 21, wherein the transistor is a metal-oxide-semiconductor field-effect transistor (MOSFET).

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23. The method of claim 14, further comprising:

detecting, by a temperature-sensing element, an internal temperature of the connector device; and

turning off the controller and therefore turning off the switch when the detected internal temperature is higher than a pre-determined threshold value.

- 5 24. The method of claim 14, wherein the connector device is properly connected to the electronic device when the detection pin is properly connected with the detection terminal of the connector in the electronic device.

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