(51) International Patent Classification:
H02J 1/00 (2006.01)  H02J 5/00 (2016.01)
G05F 1/10 (2006.01)  H01R 31/06 (2006.01)

(21) International Application Number:
PCT/EP2016/064587

(22) International Filing Date:
23 June 2016 (23.06.2016)

(25) Filing Language:
English

(26) Publication Language:
English

(30) Priority Data:
15 175987.5 9 July 2015 (09.07.2015)  EP

(71) Applicant: PHILIPS LIGHTING HOLDING B.V. [NL/NL]; High Tech Campus 45, 5656 AE Eindhoven (NL).

(72) Inventors: MISHRA, Priya, Ranjan; c/o High Tech Campus 5, 5656 AE Eindhoven (NL).
PANGULOORI, Rakeshbabu; c/o High Tech Campus 5, 5656 AE Eindhoven (NL).
BANALA, Sreenivasa, Chary; c/o High Tech Campus 5, 5656 AE Eindhoven (NL).


(54) Title: SELF-CONFIGURABLE POWER ADAPTER DEVICE

(57) Abstract: A self-configurable power adapter device is disclosed. The disclosed power adapter device is capable of converting power from a standard power delivery system into any of a plurality of powers having a plurality of power characteristics as required by a plurality of operational modes of an electrical appliance. The disclosed power adapter device provides output power that can be directly provided to the electrical appliance meeting the power requirements associated with an operational mode of the electrical appliance. The output power provided will have power characteristics configured based on the operational mode of the electrical appliance. The operational modes of the electrical appliance comprises wake-up mode, sleep mode and stand-by mode, and the power adapter device is adapted to provide a plurality of configurable voltage values based on the operational mode of the electrical appliance. Hence, the disclosed power adapter device eliminates the need for the additional internal power conversion mechanism in the electrical appliance. This could result in reducing the power losses in the power distribution architecture of the electrical appliance and power wastage. This could improve the overall efficiency.
Declarations under Rule 4.17:

— as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(H))

— as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(Hi))

Published:

— with international search report (Art. 21(3))
Self-configurable power adapter device

FIELD OF THE INVENTION

The present subject matter relates to electrical power conversion devices and more particularly to electrical power conversion devices whose output is self-configurable to adapt to the power requirements of an electrical appliance.

BACKGROUND OF THE INVENTION

Patent application US20070230227A1 discloses a variable power conversion device. The disclosed variable power conversion device is capable of providing output power at the output terminal. The output power at the output terminal provides a plurality of powers having a plurality of power characteristics and power levels that are appropriate for a plurality of types of electrical appliances. The output power from the variable power conversion device is not directly provided to the electrical appliance. The output power is provided to an internal power optimization circuit present in the electrical appliance. The internal power optimization circuit will further modify the power received from the disclosed variable power conversion device to make it suitable for use within the electrical appliance. This could result in power wastage.

GB2407717A discloses that a universal power supply that can read data from a consumer appliance and determine a voltage requirement and an amperage tolerance of the consumer appliance, and supply the required voltage at an amperage that does not exceeds the amperage tolerance. WO2009086567A1 discloses that power requirement of devices can be communicated to microprocessor. Based on the power requirement of each device, power control module instructs regulator to deliver the requested power output to the device through power lines.

SUMMARY OF THE INVENTION

Within electrical appliances, different power/voltage levels are required for different functions. During a normal operation, the input voltage is converted into different levels by using a plurality of conversion means. For example, in an intelligent lamp, the control MCU/IC often requires a 3.3V supply while another component such as the load
requires a 12V supply. The present solution is using one conversion means to provide the 12V voltage from input power, and using another conversion means such as a linear power supply to further convert the 12V voltage into the 3.3V voltage. During normal operation, the load consumes much power thus the power loss ratio of the another conversion means is small; however when the electrical appliance sleeps or stands by and the load is disabled, the power loss ratio of the another conversion means takes a large part.

Accordingly, it is an object of the present subject matter to provide an improved power adapter whose power output is self-configurable to adapt to the operation modes of the electrical appliance. The present subject matter is defined by the independent claims. The dependent claims define advantageous embodiments.

Accordingly, an improved power adapter device is disclosed. The disclosed power adapter device comprises an input for receiving an input power, and an output for providing an output power. A conversion device is provided for converting the input power into the output power. A processing device is coupled to receive information indicative of power requirements of an electrical appliance associated with respective operational modes of the electrical appliance to control the conversion device to provide directly the output power matching the power requirements of the electrical appliance, wherein the operational modes of the electrical appliance comprises wake-up mode, sleep mode and stand-by mode, and said processing device is adapted to provide a plurality of configurable voltage values based on the operational mode of the electrical appliance.

The processing device will establish a communication with the electrical appliance. The electrical appliance will communicate to the processing device, information indicative of the power requirements of the electrical appliance associated with an operational mode of the electrical appliance.

The processing device is adapted to control the conversion device based on the received information. The processing device ensures that the output power from the conversion device meets the power requirements of the operational mode of the electrical appliance.

Correspondingly, the present application also discloses an electrical appliance, wherein the electrical appliance is adapted to a plurality of configurable voltage values based on operational modes of the electrical appliance, said operational modes comprises wake-up mode, sleep mode and stand-by mode, the electrical appliance comprising: an internal power conversion mechanism; said electrical appliance (120) is adapted to: feed the voltage values for the wake-up mode to an internal power conversion mechanism; and feed the voltage
values for the sleep mode and the stand-by mode without passing the internal power conversion mechanism.

The essence of embodiments of the invention is that during the sleep mode or the stand-by mode, the power adapter device provides a specific voltage and the electrical appliance feeds this specific voltage without passing the internal power conversion mechanism. In such a case, the power loss on the internal power conversion mechanism is avoided. In other words, the output power from the conversion device is directly provided to the electrical appliance without any further modifications.

In particular, the internal power conversion mechanism is a switching mode power supply, and the output of the internal power conversion mechanism is adapted for low drop out regulators and/or an extra switching mode power supply, and the voltage values for the sleep mode and the stand-by mode is directly appropriate to the low drop out regulators and/or the extra switching mode power supply. In this embodiment, the power loss on the switching mode power supply as the internal power conversion mechanism is prevented.

More specifically, said voltage values for sleep mode and stand-by mode is lower than the voltage values for wake-up mode. This is advantageous since the function component for stand-by and sleep normally requires a lower supply voltage.

The disclosed power adapter device is thereby configured to provide a plurality of power characteristics during a plurality of operational modes (e.g., wake-up mode, sleep mode and stand-by mode) of the electrical appliance, each operational mode having a plurality of power characteristic requirements.

The disclosed power adapter device will obtain the power requirements of the electrical appliance whenever its operational mode is changed (i.e., from one operational mode to another operational mode). The disclosed power adapter device reconfigures its output power to meet the power requirements of the changed operational mode.

One possible way to obtain the operational mode of the electrical appliance could be based on a trigger from a user either manually or remotely. This could be implemented in real time but with a delay (e.g., the delay could range from 100 milliseconds to 1 - 5 seconds). The delay could vary from one electrical appliance to another electrical appliance. The delay generally depends on the characteristics of the particular electrical appliance.

In real situation, whenever the electrical appliance wants to change its operational mode (based on user triggered event or self-decision), it will communicate the intended operational mode change to the power adapter device. The electrical appliance will
continue to operate in the previous operational mode during the transition period. The
electrical appliance will change over to the intended operational mode once the voltage
characteristic or current characteristic or power characteristic changes.

The disclosed power adapter device is capable of converting power from a
standard power delivery system into any of a plurality of powers having a plurality of power
characteristics as required by a plurality of operational modes of the electrical appliance.

The disclosed power adapter device is not only capable of providing power
having a plurality of power characteristics, but has built-in intelligence that allows the power
adapter device to automatically reconfigure its output power based on the power
requirements of an operational mode of the electrical appliance. This allows a plurality of
power characteristics to be provided corresponding to a plurality of operational modes of the
electrical appliance.

The disclosed power adapter device is intelligent and self-configurable. The
disclosed power adapter device can reconfigure a particular power characteristic based on
a. the received information associated with the operational mode of the electrical
appliance
b. information that can be deduced or determined regarding the operational mode
power requirements of the electrical appliance

The prior art electrical appliances include their own internal power conversion
mechanism, although the output power provided from the power adapter device to the
electrical appliance is intended to have the proper power characteristics and to be of the
proper power level so as to be appropriate for the operation of the electrical appliance. The
prior art power adapter devices are configured to meet the maximum voltage and the
maximum current requirements of the electrical appliances. Additional internal power
conversion mechanisms are required in order to supply power to a plurality of functional
blocks of the electrical appliance, to operate the electrical appliance in a plurality of
operational modes. These additional power conversion mechanisms further modify the
received power to make it appropriate for internal use within the electrical appliance. These
additional power conversion mechanisms are generally provided in the form of a voltage
regulator circuit. This could often result in power dissipation, power wastage and further
could result in low efficiency.

The disclosed power adapter device provides output power that can be
supplied directly to the electrical appliance meeting the power requirements of the
operational mode of the electrical appliance. The output power provided will have power
characteristics configured based on the operational mode. Hence, the disclosed power adapter device eliminates the need for the additional internal power conversion mechanisms in the electrical appliance. This could result in reducing the power losses in the electrical appliance and power wastage. This in turn could improve the overall efficiency.

As an exemplary scenario, in the prior art power adapter devices, the output voltage of the power adapter device is fixed at 18 volts. This is converted to a plurality of voltages (e.g., 12.0 Volts, 10.0 Volts, 8.0 Volts, 5.0 Volts and 3.3 Volts etc., in the electrical appliance) which could result in power wastage and low efficiency (if only lower voltages are required). The disclosed power adapter device varies the output voltage which is fixed at 18.0 volts to a plurality of configurable voltage values based on the operational mode of the electrical appliance.

- if the operational mode requires 3.8 volts, the output voltage of the power adapter device could be close to the operational mode requirement (e.g., 4.0 Volts) instead of 18.0 volts

- if the operational mode requires 5.8 Volts, the output voltage of the power adapter device could be close to the operational mode requirement (e.g., 6.0 Volts) instead of 18.0 volts

This could result in power savings and improved efficiency. This could eliminate the need for an additional internal power conversion mechanism in the electrical appliance.

In an embodiment, the power requirements of the electrical appliance, is at least one of

- a voltage characteristics
- a current characteristics
- an average power characteristic

This embodiment has the advantage that the disclosed power adapter device could suit a broad range of power needs of a plurality of types of electrical appliances.

An exemplary scenario, wherein the power requirement of the electrical appliance is voltage characteristic could be as follows. Certain electrical appliances generally go through multiple operational modes in their use cycle. Each operational mode requires a plurality of operational voltages. Further, many modern electrical appliances are remote controlled either through mobile or internet protocols. They are always in power ON condition. Generally, the electrical appliance is in sleep mode and periodically awake. In
such a condition, the electrical appliance is operated at very low voltages just sufficient to recognize triggers.

An exemplary scenario, wherein the power requirement of the electrical appliance is current characteristic could be as follows. Certain electrical appliances, such as LED lamps, have current characteristic and the voltage depends on the operational current. Hence, the power adapter voltage follows the electrical appliance current dependent voltage characteristic.

An exemplary scenario, wherein the power requirement of the electrical appliance is average power characteristic could be as follows. Many electrical appliances need a plurality of operating power, irrespective of operating voltage and operating current (provided they are in the defined range) and could be in pulse form. In such a condition, the disclosed power adapter device has the capability to adapt to the pulse information, and the power adapter voltage or the power adapter current or both follow the pulse information provided by the electrical appliance.

In a still further embodiment, the conversion device comprises
- an AC-DC power factor conversion module
- a DC-DC regulation module and an associated feedback controller

The AC-DC power factor conversion module is configured to convert input voltage to multiple DC voltage levels or DC current levels. The DC-DC regulation module and the associated feedback controller aids the electrical appliance to update the voltage level, the current level and the power level in a plurality of operational modes.

In a still further embodiment, the processing device comprises
- a communication module
- a processor associated with memory configured to generate programmable reference for the conversion device.

This embodiment has the advantage that it ensures the output power from the conversion device meets the power characteristic requirements of a plurality of operational modes of the electrical appliance.

In a still further embodiment, the communication module employs at least one of:
- a serial communication mode
- a power line communication mode
- a wireless communication mode
- a near filed communication mode
- an RF mode
- an optical communication mode
- an illumination based communication mode
to obtain the power requirements of the electrical appliance. This embodiment enables the
use of a plurality of communication modes to obtain the operational mode of the electrical
appliance.

Certain electrical appliances may be integrated with internal battery bank. The
disclosed power adapter device has built-in intelligence to smartly decide to operate the
electrical appliance on the output power provided by the internal battery bank or on the
output power provided by the power adapter device. This decision could be based on
efficiency associated with a particular operational mode of the electrical appliance.

In a still further embodiment, the power adapter device comprises a switching
module. The switching module is configured to determine whether providing power to the
electrical appliance by an internal battery bank is efficient and if so provide output power
directly from the internal battery bank.

Generally, the electrical appliances with in-built battery are designed to
operate on a plurality of operational modes. In certain operational modes wherein the battery
power is insufficient, power will be supplied directly from the disclosed power adapter
device. This condition could arise due to the change of current and voltage characteristic of
the electrical appliance based on the internal battery status of charge i.e., bulk charging mode,
absorption mode or trickle charge mode.

In a still further embodiment, the power adapter device is disposed on a
molded modular switch. The disclosed power adapter device is integrated with switches and
sockets. This embodiment has the advantage that the disclosed power adapter device could
conform to the DC grid architecture which specifies that there is no need of power
optimization circuits or Switching Mode Power Supplies (SMPS) in individual electrical
appliances.

This embodiment has the further advantage that the output power will only be
available at the input of the electrical appliance connected to the socket. Hence, this could
prevent the risk of exposure of human beings to dangerous DC voltages under DC grid
architectures where the power distributed is above 60 V DC.

A method of supplying power to an electrical appliance using a power adapter
device is disclosed. The method comprises:
- a step of providing an input for receiving an input power, and an output for providing an output power;
- a step of providing a conversion device for converting the input power into the output power; and
- a step of providing a processing device coupled to receive information indicative of power requirements of an electrical appliance associated with respective operational modes of the electrical appliance to control the conversion device to provide directly the output power matching the power requirements of the electrical appliance, wherein the operational modes of the electrical appliance comprises wake-up mode, sleep mode and stand-by mode, and said processing device is adapted to provide a plurality of configurable voltage values based on the operational mode of the electrical appliance;

providing voltage values for wake-up mode to a switching mode power supply of the electrical appliance, providing output of the switching mode power supply to additional internal power conversion mechanisms, and providing output of the additional internal power conversion mechanisms to functional blocks of the electrical appliance;

providing voltage values for sleep mode and stand-by mode directly to the additional internal power conversion mechanisms without passing said switching mode power supply.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiment(s) described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned aspects, features and advantages will be further described, by way of example only, with reference to the accompanying drawings, in which the same reference numerals indicate identical or similar parts, and in which:

Fig. 1 schematically shows a power adapter device according to an embodiment of the present subject matter;

Fig. 2 schematically shows a conversion device according to an embodiment of the present subject matter;

Fig. 3 schematically shows a processing device according to a further embodiment of the present subject matter;

Fig. 4 schematically shows a state machine diagram according to an embodiment of the present subject matter;
Fig. 5 schematically shows a power adapter device according to a further embodiment of the present subject matter;

Fig. 6 schematically shows a power adapter device disposed on a molded modular switch according to a still further embodiment of the present subject matter; and

Fig. 7 schematically shows an exemplary flow chart illustrating a method of supplying power to an exemplary electrical appliance, using a power adapter device according to an embodiment of the present subject matter.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Referring now to Fig. 1, the power adapter device 100 comprises

1. an input 102 for receiving an input power 104
2. an output 108 for providing an output power 106
3. a conversion device 110
4. a processing device 112

The input 102 provides input power 104 to the power adapter device 100. The power adapter device provides first output power 106 at the output 108 to the electrical appliance 120.

The input 102 providing input power 104 to the power adapter device 100 can be any of a variety of standard and specialized power sources. Typically, the power source could be a standard power delivery system that provides power to wall sockets/outlets in homes or businesses.

The conversion device 110 is coupled to the input 102. The conversion device is configured to convert the input power 104 into the output power 106.

The processing device 112 is configured to establish a communication with the electrical appliance 120. The electrical appliance will communicate to the processing device information 130 indicative of the power requirements of the electrical appliance associated with an operational mode of the electrical appliance.

The electrical appliance could be (not limited to)

a) point of care health care devices and hand held diagnostic devices (BP monitor, digital thermometer, glucometer etc.)
b) personal care appliances (electric shavers, trimmers, hair cutters, tooth brushes, hair straighteners etc.)
c) entertainment appliances including toys, music players etc.
d) lighting appliances/light source drivers
e) communication equipment, mobile phones etc.
f) smart devices
g) audio-visual devices
h) computing devices and peripherals
i) battery chargers
j) hand held kitchen appliances such as hand blenders, hand mixers

The processing device 112 is adapted to control the conversion device based on the received information. The processing device ensures that the output power from the conversion device meets the power requirements of the operational mode of the electrical appliance. The output power from the conversion device is directly provided to the electrical appliance without any further modifications.

The electrical appliance 120 is configured not to further modify the first output power 106 to meet the power requirements of the electrical appliance, associated with the operational mode of the electrical appliance.

In particular, the output power 106 provided by the conversion device could take any of a plurality of power levels and power characteristics including for example,

a) powers having a plurality of voltage levels
b) powers having a plurality of current levels
c) powers having a plurality of power values
d) powers having a plurality of pulse voltage and pulse current values with a plurality of rising and falling characteristic

The disclosed power adapter device is thereby configured to provide a plurality of power characteristics during a plurality of operational modes (e.g., wake-up mode, sleep mode and stand-by mode) of the electrical appliance 120, each operational mode having a plurality of power characteristic requirements.

The disclosed power adapter device will obtain the power requirements of the electrical appliance whenever its operational mode is changed (i.e., from one operational mode to another operational mode). The disclosed power adapter device reconfigures its output power to meet the power requirements of the changed operational mode.

One possible way to obtain the operational mode of the electrical appliance could be based on a trigger from a user either manually or remotely. This could be implemented in real time but with a delay (e.g., the delay could range from 100 milliseconds to 1 - 5 seconds). The delay could vary from one electrical appliance to another electrical
appliance. The delay generally depends on the characteristics of the particular electrical appliance.

In real situation, whenever the electrical appliance wants to change its operational mode (based on user triggered event or self-decision), it will communicate the intended operational mode change to the power adapter device. The electrical appliance will continue to operate in the previous operational mode during the transition period. The electrical appliance will change over to the intended operational mode once the voltage characteristic or current characteristic or power characteristic changes.

The disclosed power adapter device 100 is capable of converting power from a standard power delivery system into any of a plurality of powers having plurality of power characteristics as required by a plurality of operational modes of the electrical appliance 120.

The disclosed power adapter device 100 is not only capable of providing power having a plurality of power characteristics, but has built-in intelligence that allows the power adapter device to automatically reconfigure its output power based on the power requirements of an operational mode of the electrical appliance. This allows a plurality of power characteristics to be supplied corresponding to a plurality of operational modes of the electrical appliance.

The disclosed power adapter device is intelligent and self-configurable. The disclosed power adapter device can reconfigure a particular power characteristic based on:

a. the received information 130 associated with the operational mode of the electrical appliance 120

b. information that can be deduced or determined regarding the operational mode power requirements of the electrical appliance 120

The prior art electrical appliances include their own internal power conversion mechanism, although the output power provided from the power adapter device to the electrical appliance is intended to have the proper power characteristics and to be of the proper power level so as to be appropriate for the operation of the electrical appliance. The prior art power adapter devices are configured to meet the maximum voltage and the maximum current requirements of the electrical appliances. Additional internal power conversion mechanisms are required in order to supply power to a plurality of functional blocks of the electrical appliance, to operate the electrical appliance in a plurality of operational modes. These additional power conversion mechanisms further modify the received power to make it appropriate for internal use within the electrical appliance. These additional power conversion mechanisms are generally provided in the form of a voltage...
regulator circuit. This could often result in power dissipation, power wastage and further could result in low efficiency.

The disclosed power adapter device provides output power that can be directly provided to the electrical appliance meeting the power requirements of the operational mode of the electrical appliance. The output power provided will have power characteristics configured based on the operational mode. Hence, the disclosed power adapter device eliminates the need for the additional internal power conversion mechanism in the electrical appliance. This could result in reducing the power losses in the electrical appliance and power wastage thereby improving the overall efficiency.

As an exemplary scenario, in the prior art power adapter devices, the output voltage of the power adapter device is fixed at 18 volts. This is converted to a plurality of voltages (e.g., 12.0 Volts, 10.0 Volts, 8.0 Volts, 5.0 Volts and 3.3 Volts etc., in the electrical appliance) which could result in power wastage and low efficiency (if only lower voltages are required). The disclosed power adapter device varies the output voltage which is fixed at 18.0 volts to a plurality of configurable voltage values based on the operational mode of the electrical appliance.

As an exemplary scenario incorporating the subject matter,
- if the operational mode requires 3.8 Volts, the output voltage of the power adapter device could be close to the operating range (e.g., 4.0 Volts) instead of 18.0 volts
- if the operational mode requires 5.8 Volts, the output voltage of the power adapter device could be close to the operating range (e.g., 6.0 Volts) instead of 18.0 volts.

Generally electrical appliances will need different voltages for different operational modes. These different operational modes are invoked at different times or at the same time. Referring now to Fig. 1, in prior art power adapter devices $V_{prog}$ is fixed at 18.0 volts and a plurality of voltages are derived i.e., 12.0 V, 5.0, 3.3 V, 1.8 V and 1.2 V. This could result in poor efficiency if only lower voltages are required.

The disclosed power adapter device will vary $V_{prog}$ according to the power characteristic requirements of the operational mode of the electrical appliance 120. The switch position could be changed to reduce the losses based on the value of $V_{prog}$. The number of switches and the number of Switching Mode Power Supplies (SMPS) could be accordingly incorporated based on the operational mode requirements of the electrical appliance 120.

In an embodiment, time variable DC $V_{prog}$ could be supplied with micro-switches. This could reduce the number of Low Drop Out (LDO) regulators and SMPS in the
electrical appliance. In such a case, DC $V_{\text{prog}}$ values could be sequentially fetched to only those circuits which need power based on immediate operational mode requirements. This could result in saving of energy. The sequence and the different voltages could depend on the received information 130 indicative of the power requirements of the electrical appliance 120, associated with the operational mode of the electrical appliance. This could be useful for electrical appliances where two or three voltages are required for different operational modes at different times.

The power requirements of the electrical appliance 120 associated with the operational mode of the electrical appliance is at least one of

- a voltage characteristics
- a current characteristics
- an average power characteristic

This has the advantage that the disclosed power adapter device could suit to a broad range of power needs of a plurality of types of electrical appliances.

An exemplary scenario, wherein the power requirement of the electrical appliance is voltage characteristic could be as follows. Certain electrical appliances generally go through multiple operational modes in their use cycle. Each operational mode requires a plurality of operational voltages. Further, many modern electrical appliances are remote controlled either through mobile or internet protocols. They are always in power ON condition. Generally, the electrical appliance is in sleep mode and periodically awake. In such a condition, the electrical appliance is operated at very low voltages just sufficient to recognize triggers.

An exemplary scenario, wherein the power requirement of the electrical appliance is current characteristic could be as follows. Certain electrical appliances such as LED lamps, have current characteristic and the voltage depends on the operational current. Hence, the power adapter voltage follows the electrical appliance current dependent voltage characteristic.

An exemplary scenario, wherein the power requirement of the electrical appliance is average power characteristic could be as follows. Many electrical appliances need a plurality of power, irrespective of operating voltage and operating current (provided they are in the defined range) and could be in pulse form. In such a condition, the disclosed power adapter device has the capability to adapt to the pulse information, and the power adapter voltage or the power adapter current or both follow the pulse information provided by the electrical appliance.
Referring now to Fig. 2, the conversion device 110 comprises

1. an AC - DC power factor conversion module 110A
2. a DC - DC regulation module HOB and an associated feedback controller 110C

The AC - DC power factor conversion module is configured to convert input voltage to multiple DC voltage levels or DC current levels. The DC - DC regulation module and the associated feedback controller could aid the electrical appliance to update the voltage level, the current level and the power level in a plurality of operational modes.

In operation, the AC - DC power factor conversion module 110A converts the input AC power to the power adapter device to a constant intermediate DC voltage, while maintaining high power factor for the full range of input voltage i.e., -30% to + 20% of rated value and full range of load i.e., 10%> to 100% of rated value.

In DC - DC regulation module HOB, the intermediate DC voltage is converted to another DC voltage based on the received information 130, indicative of the power requirements of the electrical appliance 120 associated with the operational mode of the electrical appliance. This is enabled by the processor 112B, which in turn will provide a programmable reference value. A plurality of output values are obtained based on the plurality of programmable reference values.

Referring now to Fig. 3, the processing device 112 comprises

1. a communication module 112A
2. a processor 112B associated with memory 112C, the processor configured to generate programmable reference 112D for the conversion device 110

The communication module could be wireless (GPS, Wi-Fi, and Bluetooth, optical) or wired (serial communication, power line communication).

In operation, the communication module is configured to receive information from the electrical appliance 120 and process it. The processed information is fed to the processor 112B which is configured to generate a programmable reference value. The programmable reference value is fed to the conversion device 110. The conversion device 110 will generate a plurality of output values based on the plurality of programmable reference values.

Further, the communication module employs at least one of

- a serial communication mode
- a power line communication mode
- a wireless communication mode
- a near filed communication mode
- an RF mode
- an optical communication mode
- an illumination based communication mode
to obtain the power requirements of the electrical appliance. This embodiment enables the use of a plurality of communication modes to obtain the operational mode of the electrical appliance.

Referring now to Fig. 4,
1. reference numeral 402 represents state one, which is standby operational mode
2. reference numeral 404 represents state two, in which the power output of the power adapter device is configured to meet the power characteristic requirements of the operational mode of the electrical appliance 120
3. reference numeral 406 represents state three, in which the power output of the power adapter device is reconfigured to meet the power characteristic requirements of the changed operational mode of the electrical appliance 120

The disclosed power adapter device 100 is in standby operational mode initially until and unless the power adapter device 100 senses that the electrical appliance 120 is connected to it. This sensing could be
1. based on switching ON the electrical appliance connected to the power adapter device 100 or
2. based on the receipt of a trigger/external command communicated by the electrical appliance 120

If the power adapter device 100 receives a NO sensing signal 402b, then the power adapter device 100 will transition to state one i.e., 402 standby mode of operation.

If the power adapter device 100 receives a YES sensing signal 402a, then the power adapter device 100 will transition to state two i.e., 404 in which the power output of the power adapter device will be configured. This configuration could be based on the received information, the received information indicative of the power characteristic requirements of the electrical appliance 120 associated with the operational mode of the electrical appliance 120.

The electrical appliance 100 will signal the power adapter device when the operational mode of the electrical appliance is to be changed. If the power adapter device receives a YES signal 404a, then the power adapter device will transition to state three i.e., 406 in which the power output of the power adapter device will be reconfigured. This
reconfiguration will be based on the changed operational mode of the electrical appliance 120. The power adapter device 100 will reconfigure the output power characteristics to meet the power characteristic requirements of the electrical appliance 120 associated with the changed operational mode of the electrical appliance 120.

The above mentioned process of reconfiguring the output power characteristics is repeated whenever there is a change in the operational mode of the electrical appliance 120 i.e., the power adapter device receiving a YES signal 406a. At any point in time, if the power adapter device 100 receives a NO sensing signal 406b, then the power adapter device 100 will transition to state one i.e., 402 standby mode of operation.

Certain electrical appliances may be integrated with internal battery bank. The disclosed power adapter device has built-in intelligence to smartly decide to operate the electrical appliance on the output power provided by the internal battery bank or on the output power provided by the power adapter device. This decision could be based on the efficiency associated with a particular operational mode of the electrical appliance.

Generally, the electrical appliances with in-built battery are designed to operate on a plurality of operational modes. In certain operational modes wherein the battery power is insufficient, power will be supplied directly from the disclosed power adapter device. This condition could arise due to the change of current and voltage characteristic of the electrical appliance based on the internal battery status of charge i.e., bulk charging mode, absorption mode or trickle charge mode.

Referring now to Fig. 5, the power adapter device 100 comprises a switching module 502. The switching module 502 is configured to determine whether providing power to the electrical appliance 120 by an internal battery bank 204 is efficient. If so, the power adapter device will provide power directly from the internal battery bank 204. This enables the electrical appliance to receive output power 208 directly from the internal battery bank. Alternately, if the power is to be provided from the power adapter device 100, then the internal battery bank 204 is automatically configured to standby mode.

Electrical appliances integrated with internal battery bank needs battery management unit. The battery management unit ensures that battery is charged utilizing one of the modes such as constant current mode, constant voltage mode, boost mode, trickle mode at different state of charge level in order to keep the battery healthy and meet the stated life cycles. According to this embodiment, electrical appliance integrated with internal battery bank, communicates with the power adapter device and notifies that it is integrated.
with battery. The power adapter device reconfigures itself at different state of charge level and will supply optimized power. In case the power is to be provided from the power adapter device, then the battery bank is automatically put to standby mode.

Referring now to Fig. 6, the power adapter device is disposed on a molded modular switch 602. The disclosed power adapter device is integrated with switches and sockets. This embodiment has the advantage that the disclosed power adapter device could conform to the forthcoming DC grid architecture. The DC grid architecture specifies that there is no need of power optimization circuits or Switching Mode Power Supplies (SMPS) in individual electrical appliances.

This embodiment has the further advantage that the output power will only be available at the input of the electrical appliance connected to the socket. Hence, this could prevent the risk of exposure of human beings to dangerous DC voltages under DC grid architectures where the power distributed is above 60 V DC

Referring now to Fig. 7, a method 700 of supplying power using a power adapter device is disclosed. The method comprises

- a step 702 of providing an input 102 for receiving an input power 104, and an output 108 for providing an output power 106;

- a step 704 of providing a conversion device 110 for converting the input power 104 into the output power 106; and

- a step 706 of providing a processing device 112 coupled to receive information 130 indicative of power requirements of an electrical appliance 120 associated with respective operational modes of the electrical appliance to control the conversion device to provide directly the output power 106 matching the power requirements of the electrical appliance 120.

The present subject matter discloses a power adapter device capable of converting power from a standard power delivery system into any of a plurality of powers having a plurality of power characteristics as required by a plurality of operational modes of the electrical appliance.

A few exemplary scenarios where the present subject matter could be used are illustrated below:

Example one:
Power adapter devices are configured to generally operate as voltage source with current limit. But, according to the present subject matter, the disclosed power adapter device can reconfigure itself as current source and drive LED type of current loads.

Currently, LED lamps have a problem. Different LED drivers are required to obtain different output power wattage from the LED i.e., when LED driver output needs to be changed from one dim level to another dim level. According to the present subject matter, the LED lamps connected to the power adapter device could be replaced with higher luminance/watt whenever new LEDs are available in the market without the need for changing the LED driver.

Example two:

Generally, electrical appliances will switch off many peripheral devices when in sleep mode in order to save power. The CPU and the associated control circuitry will operate even in the sleep mode at lower voltages e.g., 5.0 volt CPU in sleep mode may operate at 3.3 volts or 1.5 volts. At present, different power optimization circuits are needed for different operational modes. According to the present subject matter, the power adapter device could supply different voltages during wake-up and sleep mode.

Example three:

The disclosed power adapter device could be useful for kitchen appliances such as mixer grinders that need high power. The mixer grinder operates at different grinding speed and needs different input voltage. Currently available mixer grinders are provided with a chopper circuit to change the DC voltage across the motor. According to the present subject matter, different speed demand from the mixer grinder could be communicated to the disclosed power adapter device. The power adapter device could reconfigure its output power characteristic and could supply different voltages based on the selected speed. This could be implemented by providing a programming resistance on the mixer grinder that could notify the speed selection change to the disclosed power adapter device.

While the subject matter has been illustrated in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the subject matter is not limited to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art of practicing the claimed subject matter, from a study of the drawings, the
disclosure and the appended claims. Use of the verb "comprise" and its conjugates does not exclude the presence of elements other than those stated in a claim or in the description. Use of the indefinite article "a" or "an" preceding an element or step does not exclude the presence of a plurality of such elements or steps. The Figures and description are to be regarded as illustrative only and do not limit the subject matter. Any reference sign in the claims should not be construed as limiting the scope.
CLAIMS:

1. A power adapter device (100), comprising:
   - an input (102) for receiving an input power (104), and an output (108) for
     providing an output power (106);
   - a conversion device (110) for converting the input power (104) into the
     output power (106); and
   - a processing device (112) coupled to receive information (130) indicative of
     power requirements of an electrical appliance (120) associated with respective
     operational modes of the electrical appliance to control the conversion device to
     provide directly the output power (106) matching the power requirements of
     the electrical appliance (120), wherein the operational modes of the electrical
     appliance comprises wake-up mode, sleep mode and stand-by mode, and said
     processing device (112) is adapted to provide a plurality of configurable
     voltage values based on the operational mode of the electrical appliance (120).

2. The power adapter device as claimed in claim 1, wherein the voltage values
   for the wake-up mode is appropriate to an internal power conversion mechanism
   of the electrical appliance (120); and
   the voltage values for the sleep mode and the stand-by mode is appropriate to
   the electrical appliance without passing the internal power conversion mechanism.

3. The power adapter device as claimed in claim 2, wherein the internal power
   conversion mechanism is a switching mode power supply, and
   the output of the internal power conversion mechanism is adapted for low drop
   out regulators and/or an extra switching mode power supply, and the voltage values
   for the sleep mode and the stand-by mode is directly appropriate to the low drop
   out regulators and/or the extra switching mode power supply.

4. The power adapter device as claimed in claim 3, wherein the voltage values
   for sleep mode and stand-by mode is lower than the voltage values for wake-up mode.
5. The power adapter device as claimed in claim 2, wherein the conversion device (110) comprises
   - an AC - DC power factor conversion module (110A)
   - a DC - DC regulation module and an associated feedback controller (HOB).

6. The power adapter device as claimed in claim 5, wherein the processing device (112) comprises
   - a communication module (112A)
   - a processor (112B) with memory configured to generate programmable reference for the conversion device (110).

7. The power adapter device as claimed in claim 6, wherein the communication module (112A) employs at least one of
   - a serial communication mode
   - a power line communication mode
   - a wireless communication mode
   - a near filed communication mode
   - an RF mode
   - an optical communication mode
   - an illumination based communication mode
to obtain the power requirements of the electrical appliance.

8. The power adapter device as claimed in claim 7, wherein the power adapter device (100) comprises a switching module (502) configured to determine whether providing power to the electrical appliance (120) by an internal battery bank (204) is efficient and if so provide output power (208) directly from the internal battery bank (204).

9. The power adapter device as claimed in any one of the preceding claims, wherein the power adapter device is disposed on a molded modular switch.

10. An electrical appliance (120), wherein the electrical appliance (120) is adapted to a plurality of configurable voltage values based on operational modes of the electrical
appliance, said operational modes comprises wake-up mode, sleep mode and stand-by mode, the electrical appliance (120) comprising:

an internal power conversion mechanism;

said electrical appliance (120) is adapted to:

feed the voltage values for the wake-up mode to an internal power conversion mechanism; and

feed the voltage values for the sleep mode and the stand-by mode without passing the internal power conversion mechanism.

11. The electrical appliance (120) according to claim 10, wherein the internal power conversion mechanism is a switching mode power supply, and the electrical appliance (120) further comprises:

low drop out regulators and/or an extra switching mode power supply coupled to the output of the internal power conversion mechanism, and

a switch adapted to:

connect the low drop out regulators and/or an extra switching mode power supply to the output of the internal power conversion mechanism during wake-up mode; and

connect the low drop out regulators and/or an extra switching mode power directly to the voltage values for the sleep mode and the stand-by mode without passing through the internal power conversion mechanism.

12. A method (700) of supplying power to an electrical appliance (120) using a power adapter device (100), the method comprising:

- a step (702) of providing an input (102) for receiving an input power (104), and an output (108) for providing an output power (106);

- a step (704) of providing a conversion device (110) for converting the input power (104) into the output power (106);

- a step (706) of providing a processing device (112) coupled to receive information (130) indicative of power requirements of an electrical appliance (120) associated with respective operational modes of the electrical appliance to control the conversion device to provide directly the output power (106) matching the power requirements of the electrical appliance (120), wherein the operational modes of the electrical appliance comprises wake-up mode, sleep mode and stand-by mode, and said processing
device (112) is adapted to provide a plurality of configurable voltage values based on the operational mode of the electrical appliance (120);

and

providing voltage values for wake-up mode to a switching mode power supply of the electrical appliance (120), providing output of the switching mode power supply to additional internal power conversion mechanisms, and providing output of the additional internal power conversion mechanisms to functional blocks of the electrical appliance (120);

providing voltage values for sleep mode and stand-by mode directly to the additional internal power conversion mechanisms without passing said switching mode power supply.

13. The method as claimed in claim 12, wherein said voltage values for sleep mode and stand-by mode is lower than the voltage values for wake-up mode.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
INV. H02J1/00 G05F1/10 H02J1/06 H02J5/00 H01R31/06
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H02J G05F H03J H01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched.

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

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>US 2010/156176 A (KIM DAE WON [KR] ET AL) 24 June 2010 (2010-06-24) paragraphs [0002], [0004], [0017], [0020], [0025], [2934], [0035], [0050], [0056]; figures 2, 4</td>
<td>1-13</td>
</tr>
<tr>
<td>A</td>
<td>GB 2 407 717 A (HEWLETT PACKARD DEVELOPMENT CO [US]) 4 May 2005 (2005-05-04) page 2, line 12 - line 19 page 3, line 19 - page 5, line 21; claim 8; figures 1, 2, 4</td>
<td>1-13</td>
</tr>
<tr>
<td>A</td>
<td>WO 2009/086567 A (GREEN PLUG [US]); PANIAGUA FRANK [US]; MOY PARAG [US]; YASSAE HOSSEIN) 9 July 2009 (2009-07-09) paragraphs [0024] - [0026], [0033], [0037]; figures 1, 3, 4</td>
<td>1-13</td>
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Further documents are listed in the continuation of Box C. See patent family annex.

*Special categories of cited documents:
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*D* document referring to an oral disclosure, use, exhibition or other means
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Date of the actual completion of the international search: 22 July 2016

Date of mailing of the international search report: 09/08/2016

Name and mailing address of the ISA:
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040
Fax: (+31-70) 340-3016

Authorized officer: Chaumeron, Bernard

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<th>Category</th>
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<th>Relevant to claim No.</th>
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<tr>
<td>A</td>
<td>US 2011/196547 A1 (PARK JONG S0O [KR] ET AL) 11 August 2011 (2011-08-11) paragraphs [0135], [0136], [0139], [0144], [0147], [0148]; figure 4</td>
<td>1-13</td>
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<td>US 2010156176 A1</td>
<td>24-06-2010</td>
<td>KR 20100073115 A</td>
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<td>US 2010156176 A1</td>
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<tr>
<td>GB 2407717 A</td>
<td>04-05-2005</td>
<td>DE 102004029942 A1</td>
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<td>GB 2407717 A</td>
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<td>US 2005083615 A1</td>
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<td>JP 2011509066 A</td>
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<td>US 2009177906 A1</td>
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<td>WO 2009086567 A1</td>
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<td>WO 2014149809 A2</td>
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<td>US 2011196547 A1</td>
<td>11-08-2011</td>
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