

SMART SOCKET

FIELD

This invention relates to a smart socket, and in particular to a smart socket for connecting an electrical appliance to an alternating current (AC) electrical power supply.

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BACKGROUND

Plug-in electrical appliances draw electricity from a municipal power supply in order to perform their functions or to be charged. The amount of electrical power consumed by electrical appliances is of interest because costs arising from their use can form a significant portion of household and corporate expenses and also because of environmental concerns. At present, residential, commercial and industrial users of electrical appliances typically come to know of their electrical power consumption only when they receive their electricity bills at the end of the month. However, while total power consumption may be known, the electricity bill is not able to provide information on what appliances are using how much power that contribute to the total power consumption. It would thus be desirable to be able to track the amount of electrical power consumed by individual items of electrical appliances during use, so that adjustments may be made to their usage patterns, or appliances that may be consuming too much electricity may be replaced, in order to monitor and reduce power consumption overall.

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SUMMARY

According to a first aspect, there is provided a smart socket configured to be in electrical connection with an alternating current (AC) power supply and to electrically connect an electrical appliance with the AC power supply, the electrical appliance provided with an electrical plug, the electrical plug having a live pin and a neutral pin configured to be inserted into the smart socket, the smart socket comprising: a housing having at least one opening for insertion of a live wire and a neutral wire into the housing, the live wire and the neutral wire configured to be in electrical communication with the AC power supply, the housing further comprising a live opening for insertion of the live pin into the housing and a neutral opening for insertion of the neutral pin into the housing, a live conductor provided in the housing to electrically connect the live pin with the live wire within the housing; a neutral conductor provided in the housing to electrically connect the neutral pin with the neutral wire within the housing; a current sensor; a metering chip in the housing to obtain data including voltage of the AC power supply and current from the current sensor when the live pin and the neutral pin have been inserted into the housing and the electrical appliance is in electrical connection with the AC power supply; and a communication module in the housing to transmit the data from the

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metering chip to a communication gateway.

The current sensor may comprise a current sensing portion provided on one of: the live conductor and the neutral conductor.

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The current sensing portion may be integral with the one of: the live conductor and the neutral conductor.

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The current sensing portion may comprise a length of a metal along the live conductor or the neutral conductor.

The metal may be a manganese-copper alloy.

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The smart socket may further comprise wiring provided at each end of the length of the current sensing portion to obtain a potential difference across the current sensing portion for obtaining the current.

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The smart socket may further comprise a contact switch provided in the housing adjacent one of: the live opening and the neutral opening, the contact switch configured to be moved into electrical contact with one of: the live conductor and the neutral conductor by one of: the live pin and the neutral pin respectively upon insertion of the live pin and the neutral pin into the live opening and the neutral opening respectively, wherein power is supplied from the AC power supply to the metering chip only when the contact switch is in contact with one of: the live conductor and the neutral conductor.

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The communication gateway may be remotely accessible via an application module installed in a smart device to allow retrieval and display of the data and to allow turning off and on of the power supply from the AC power supply to the electrical appliance.

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The communication module may be configured to function as a node of a communication mesh to receive data from and transmit data to other nodes in the communication mesh including the communication gateway.

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The communication module may comprise a Bluetooth low-energy module and the communication gateway may comprise a Bluetooth gateway.

The data may further include active power, reactive power, power factor, frequency, kilowatt hour (kWh), and kilo volt amperes reactive hours (kvarh).

BRIEF DESCRIPTION OF FIGURES

- 5 In order that the invention may be fully understood and readily put into practical effect there shall now be described by way of non-limitative example only exemplary embodiments of the present invention, the description being with reference to the accompanying illustrative drawings. FIG. 1 is a front view of a smart socket.
- FIG. 2 is a back view of the smart socket of FIG. 1.
- 10 FIG. 3 is a front view of an interior of the smart socket of FIG. 1.
- FIG. 4 is a close up view of a live conductor of the smart socket of FIG. 3.
- FIG. 5 is a schematic illustration of multiple units of the smart socket of FIG. 1 forming a mesh network with a remotely accessible communication gateway.
- FIG. 6a is a cross-sectional bottom view of an electrical plug partially inserted into the smart
- 15 socket of FIG. 1.
- FIG. 6b is a cross-sectional bottom view of an electrical plug fully inserted into the smart socket of FIG. 1.

DETAILED DESCRIPTION

- 20 Exemplary embodiments of a smart socket 10 will be described below with reference to FIGS. 1 to 6b. The same reference numerals are used throughout the figures for the same or similar parts.

- 25 In this application, the term “electrical appliance” is used to refer to any device that draws electricity from a municipal power supply in order to perform its function or to be charged.

- In general, the smart socket 10 is provided to be in electrical connection with an alternating current (AC) power supply and to electrically connect an electrical appliance (not shown) with the AC power supply. The electrical appliance is typically provided with an electrical plug 90
- 30 (FIG. 6) that comprises a live pin 93 and a neutral pin 94 that are configured to be inserted into the smart socket 10. The electrical plug 90 may also comprise an earth pin 95 for improved safety. The smart socket 10 may be provided in various different configurations, for example, as a wall socket (also known as electrical outlet) that is fixed to a wall of a building, or in a moveable power strip (also known as extension strip) that comprises one or more units of the smart socket
- 35 10 for use with multiple electrical appliances, the power strip having a flexible cable terminating

in an electrical plug for connection with a wall socket.

As shown in FIG. 1, the smart socket 10 comprises a housing 20. The housing 20 comprises a live opening 23 for insertion of the live pin 93 of an electrical plug 90 (FIG. 6) into the housing 20 and a neutral opening 24 for insertion of the neutral pin 94 of the electrical plug 90 into the housing 20. In some configurations, the housing 20 may further comprise an earth opening 25 for insertion of the earth pin 95 of the electrical plug 90 into the housing 20. Preferably, the live opening 23, neutral opening 24 and earth opening 25 are provided on a face plate 21 of the housing 20.

As shown in FIG. 2, the housing 20 also has at least one opening 29 for insertion of a live wire and a neutral wire (not shown) into the housing 20. The at least one opening 29 is preferably provided on a backing box 22 of the housing 20 that assembles with the face plate 21 to close the housing 20. In an exemplary embodiment, the face plate 21 and the backing box 22 may be assemble using screws (not shown) through corresponding screw holes 28 provided in the backing box 22 and in the face plate 21. The live wire and the neutral wire are configured to be in electrical communication with the AC power supply. Where the smart socket 10 has the configuration of a wall socket, the live wire and the neutral wire would comprise the live wire and the neutral wire provided in a mains cable of the AC power supply. Where the smart socket 10 is provided as one or more units in a power strip, the live wire and the neutral wire would comprise a live wire and a neutral wire of the flexible cable of the power strip. Where the power strip comprises more than one smart socket 10, the multiple sockets 10 of the power strip preferably share a single housing 20. The at least one opening 29 also allows insertion of an earth wire into the housing 20. Where an earth wire is provided, a conductive bridge 35 may be provided to connect the earth wire to the screws connecting the face plate 21 with the backing box 22 for safety.

As shown in FIG. 3, the smart socket 10 further comprises a live conductor 30 provided in the housing 20 to electrically connect the live pin 93 of the electrical plug 90 with the live wire within the housing 20 when the live pin 93 has been fully inserted into the live opening 23. A neutral conductor 40 is also provided in the housing 20 to electrically connect the neutral pin 94 of the electrical plug 90 with the neutral wire within the housing 20 when the neutral pin 94 has been fully inserted into the neutral opening 24. An earth conductor 50 may also be provided in the housing 20 to electrically connect the earth pin of the electrical plug 90 with the earth wire within the housing 20 when the earth pin has been fully inserted into the earth opening 25.

The smart socket 10 includes a metering chip 60 provided in the housing 20, as shown in FIG. 3. The metering chip 60 is configured, to obtain data including voltage of the AC power supply and current drawn when the live pin 93 and the neutral pin 94 of the electrical plug 90 have been inserted into the housing 20 and the electrical appliance is in electrical connection with the AC power supply. To that end, a current sensor 61 is provided in the smart socket 10. In an exemplary embodiment, the current sensor 61 comprises a sensing portion 61 provided on the live conductor 30, as can be seen in FIGS. 3 and 4. The current sensing portion 61 is preferably integrally formed with the live conductor 30, and may comprise a length of a metal 61 along the live conductor 30. The material of the metal of the current sensing portion 61 may comprise a manganese copper alloy having a weight percentage ratio 25% manganese and 75% copper. Wiring (not shown) is also provide in the housing 20 that connect the live conductor 30 and the neutral conductor 40 to the metering chip 60 in order for the metering chip 60 to be powered by the AC power supply and obtain the voltage of the AC power supply during use of an appliance that has been plugged into the smart socket 10.

A potential difference across the current sensing portion 61 may be obtained by providing current sensing wiring 62 (FIG. 3) at each end of the current sensing portion 21 leading to the metering chip 60, so that current passing through the live conductor 30 may be computed from the obtained potential difference and a known resistance of the current sensing portion 61. From the obtained voltage of the AC power supply and the computed current, other data such as active power, reactive power, power factor, frequency, kilowatt hour (kWh), and kilo volt amperes reactive hours (kvarh) may be computed and obtained by the metering chip 60. In an alternative configuration, the current sensing portion may be provided on the neutral conductor 40 instead of the live conductor 30. Besides manganese copper alloy, other materials may be used that will allow a potential difference to be measured.

Data from the metering chip 60 is transmitted by the smart socket 10 to a communication gateway 71 via a communication module 70 provided in the housing 20. As shown in FIG. 5, the communication module 70 may be configured to function as a node 72 of a mesh network 73 to receive data from and transmit data to other nodes 72 in the mesh network 73, including the communication gateway 71. The communication gateway 71 is configured to be remotely accessible via an application module installed in a smart device 200 to allow retrieval and display of the data and to allow turning off and on of the power supply from the AC power supply to the electrical appliance. The smart device 200 may comprise a cellular telephone, a tablet, a computer and so on.

Remote access to the communication gateway 71 may be via local access when the smart device 200 is connected to a same communication network as the communication gateway 71, for example when the communication gateway 71 and the smart device 200 are both connected to a same Wi-Fi network of a residence provided with one or more units of the smart socket 10.

5 Remote access to the communication gateway 71 may additionally or alternatively be via a remote cloud access 300. In an exemplary embodiment, the communication module 70 comprises a Bluetooth low-energy module and the communication gateway 71 comprises a Bluetooth gateway. In alternative embodiments, other communication modes such as Wi-Fi instead of Bluetooth may be used for data transmission. In further embodiments, the
10 communication gateway 71 may have a wired internet connection. In an example of use, individual apartments in an apartment block may each be provided with multiple smart sockets as that communicate with one communication gateway 71 provided in each apartment, wherein the communication gateways and multiple smart sockets provided in different apartments are configured not to interfere with each other, thereby preventing cross-communication of
15 communication gateways and smart sockets between different apartments.

As shown in FIG. 6, in an exemplary embodiment, the smart socket 10 preferably further comprises a contact switch 80 to turn on and off power supply to the metering chip 60. The contact switch 80 may be provided in the housing 20 adjacent the neutral opening 24, and may
20 comprise a resilient electrically conductive strip that, at rest, is in an open position (FIG. 6a) where the contact switch 80 is not in contact with the neutral conductor 40 when the electrical plug 90 is not fully inserted into the smart socket 10. In this way, the metering chip 60 would not draw additional power from the AC power supply when no electrical plug 90 is plugged into the smart socket 10. From the open position, the contact switch 80 is moved or deflected into a
25 closed position (FIG. 6b) by the neutral pin 94 upon complete insertion of the neutral pin 94 into the neutral opening 24 so that the contact switch 80 comes into electrical contact with the neutral conductor 40, thereby closing a circuit to supply power from the AC power supply to the metering chip 60. Movement of the contact switch 80 by the neutral pin 94 from the open position to the closed position preferably comprises elastic deformation of the contact switch 80
30 so that upon removal of the electrical plug 90 from the socket, the contact switch 80 springs back to the open position, thereby cutting off power to the metering chip 60. In an alternative embodiment, the contact switch 80 may be provided adjacent the live opening 23 instead of the neutral opening 24 in order to be pushed into contact with the live conductor 30 by the live pin 93 when the plug 90 is fully inserted into the socket 10 in order to supply power to the metering
35 chip 60.

The above disclosed smart socket 10 is therefore able to obtain power consumption data of an electrical appliance that is plugged into the smart socket 10 when power is being drawn from the AC power supply, and can transmit this data to a person or persons using a smart device that is provided with the application module for retrieving and viewing the data. In this way, users may make informed decisions to effect any changes to electrical appliance usage patterns or even to replace appliances that are consuming too much electricity, if necessary. As the smart socket 10 may be provided as a wall socket or on a power strip, the smart socket 10 may be readily provided anywhere within building to receive the plugs of electrical appliances that may be placed at locations of convenience to their users, without being restricted to be used with only appliances that can be positioned to be plugged into a wall socket.

Whilst there has been described in the foregoing description exemplary embodiments of the present invention, it will be understood by those skilled in the technology concerned that many variations and combination in details of design, construction and/or operation may be made without departing from the present invention. For example, while the figures depict an exemplary smart socket having a Type G configuration as defined by the US Department of Commerce International Trade Administration (ITA), it should be appreciated that the smart socket may have a configuration of any other accepted type according to which countries the smart socket is intended to be used in.

CLAIMS

1. A smart socket configured to be in electrical connection with an alternating current (AC) power supply and to electrically connect an electrical appliance with the AC power supply,
5 the electrical appliance provided with an electrical plug, the electrical plug having a live pin and a neutral pin configured to be inserted into the smart socket, the smart socket comprising:
 - a housing having at least one opening for insertion of a live wire and a neutral wire into
10 the housing, the live wire and the neutral wire configured to be in electrical communication with the AC power supply, the housing further comprising a live opening for insertion of the live pin into the housing and a neutral opening for insertion of the neutral pin into the housing,
 - a live conductor provided in the housing to electrically connect the live pin with the live
15 wire within the housing;
 - a neutral conductor provided in the housing to electrically connect the neutral pin with the
20 neutral wire within the housing;
 - a current sensor;
 - a metering chip in the housing to obtain data including voltage of the AC power supply
and current from the current sensor when the live pin and the neutral pin have been
25 inserted into the housing and the electrical appliance is in electrical connection with the AC power supply;
 - a contact switch provided in the housing, the contact switch being not in electrical contact
with the live conductor or the neutral conductor when the electrical plug is not
inserted into the smart socket,
wherein the contact switch is configured to form electrical contact with one of: the
30 live conductor and the neutral conductor by one of: the live pin and the neutral pin respectively upon insertion of the live pin and the neutral pin into the live opening and the neutral opening respectively when the electrical plug is inserted into the smart socket, closing a circuit to supply power from the AC power supply to the metering chip, and
35 wherein the contact switch is configured to lose electrical contact with one of: the live conductor and the neutral conductor by one of: the live pin and the neutral pin respectively upon removal of the live pin and the neutral pin from the live opening and the neutral opening respectively when the electrical plug is removed from the smart socket, opening the circuit to cut power from the AC power supply to the metering chip; and

a communication module in the housing to transmit the data from the metering chip to a communication gateway.

2. The smart socket of claim 1, wherein the current sensor comprises a current sensing portion
5 provided on one of: the live conductor and the neutral conductor.
3. The smart socket of claim 2, wherein the current sensing portion is integral with the one of:
the live conductor and the neutral conductor.
- 10 4. The smart socket of claim 2, wherein the current sensing portion comprises a length of a
metal along the live conductor or the neutral conductor.
5. The smart socket of claim 3, wherein the metal is a manganese-copper alloy.
- 15 6. The smart socket of claim 2 or claim 3, further comprising wiring provided at each end of the
length of the current sensing portion to obtain a potential difference across the current sensing
portion for obtaining the current.
- 20 7. The smart socket of any one of the preceding claims, wherein the communication gateway is
remotely accessible via an application module installed in a smart device to allow retrieval
and display of the data and to allow turning off and on of the power supply from the AC
power supply to the electrical appliance.
- 25 8. The smart socket of any one of the preceding claims, wherein the communication module is
configured to function as a node of a communication mesh to receive data from and transmit
data to other nodes in the communication mesh including the communication gateway.
9. The smart socket of any one of the preceding claims, wherein the communication module
comprises a Bluetooth low-energy module and the communication gateway comprises a
30 Bluetooth gateway.
10. The smart socket of any one of the preceding claims, wherein the data further includes active
power, reactive power, power factor, frequency, kilowatt hour (kWh), and kilo volt amperes
reactive hours (kvarh).

11. The smart socket of any one of the preceding claims, wherein the contact switch includes a resilient electrically conductive strip and movement of the contact switch to close the circuit to supply power from the AC power supply to the metering chip or to open the circuit to cut power from the AC power supply to the metering chip includes elastic deformation of the contact switch.

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