(12) STANDARD PATENT APPLICATION (11) Application No. **AU 2018203426 A1**
(19) AUSTRALIAN PATENT OFFICE

(54) Title
ELECTRICITY METER

(51) International Patent Classification(s)
G01R 22/06 (2006.01)

(21) Application No: **2018203426** (22) Date of Filing: **2018.05.15**

(43) Publication Date: **2019.12.05**
(43) Publication Journal Date: **2019.12.05**

(71) Applicant(s)
EMBERTEC PTY LTD

(72) Inventor(s)
Gatto, Riccardo

(74) Agent / Attorney
Collison & Co, Gpo Box 2556, Adelaide, SA, 5001, AU

(56) Related Art
US 2008/0046205 A1
US 2008/0294452 A1
US 2006/0071812 A1
US 2005/0237221 A1
US 2014/0344796 A1

2018203426 15 May 2018

ABSTRACT

A meter for measuring electricity use including digital memory which stores configuration data describing the installation of the meter and communication means which receives the configuration data for storage in the digital memory and transmits the configuration data retrieved from the digital memory. The meter may include separate communication interfaces adapted to receive the configuration data and to transmit the configuration data.

2018203426 15 May 2018

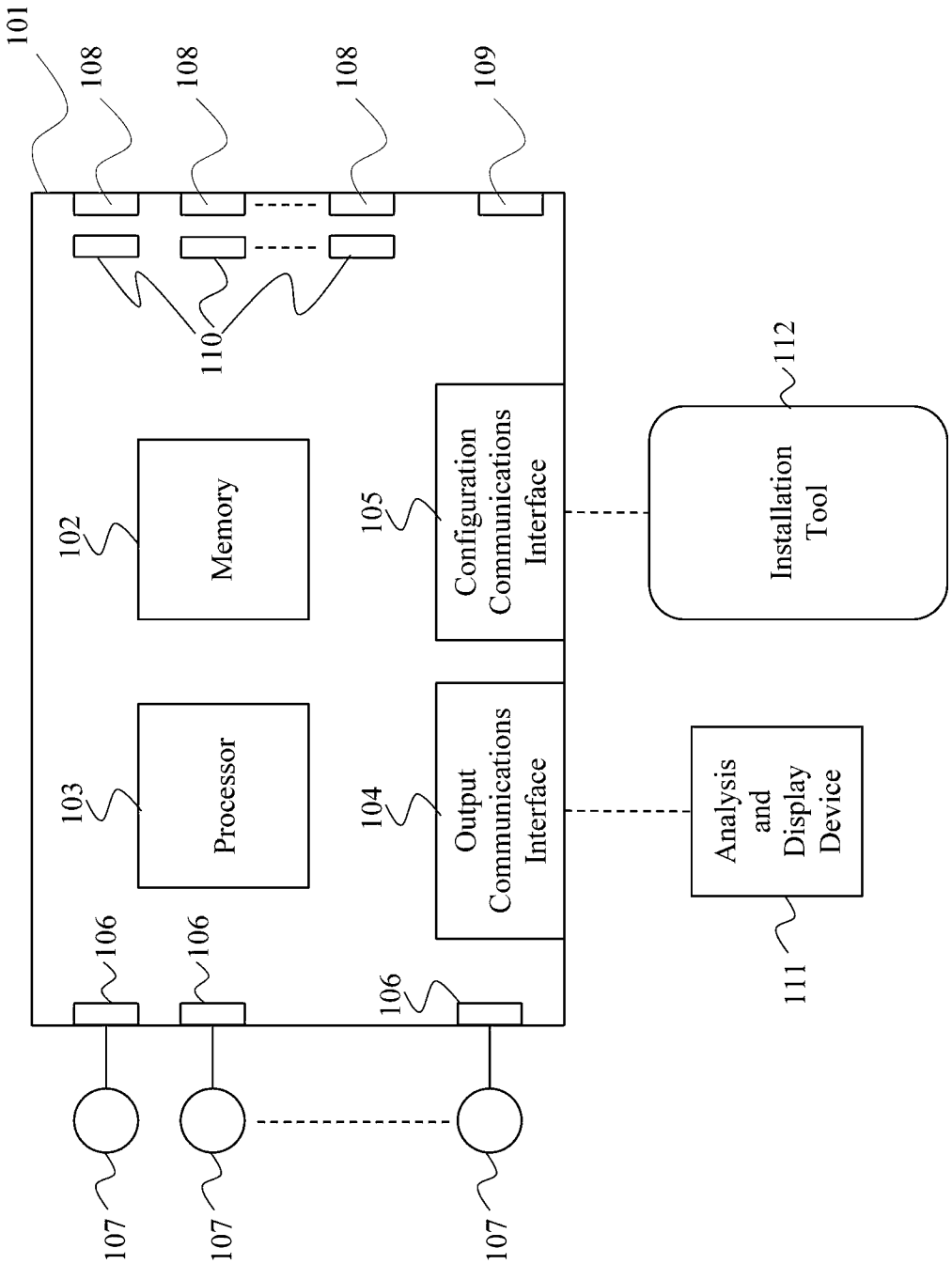

Figure 1

2018203426 15 May 2018

ELECTRICITY METER

TECHNICAL FIELD

[0001] The present invention relates to the field metering of electricity usage, in particular for energy demand management and control of energy demand.

BACKGROUND ART

[0002] Increasing electricity prices and environmental concerns have led to greater interest on the part of consumers of electricity in reducing electricity consumption in general, and reducing reliance on expensive electricity from the public grid in particular.

[0003] There have been considerable efforts directed toward energy efficiency measures, both reducing electricity consumption, and directing consumption away from peak grid demand times.

[0004] There has also been considerable installation of behind the meter electricity generation and storage, including solar photo-voltaic generation and battery storage.

[0005] For optimum efficiency, these measures are best implemented with effective, real time monitoring of electricity usage, storage and generation occurring within the premises.

[0006] Electricity usage is generally measured by a meter placed in the premises where consumption occurs. These meters are provided by the utility supplying the electricity to the premises, and are designed to be read primarily by the utility. The meter may be an analogue meter, able to be read only visually.

[0007] More recently, digital electronic meters have been provided, which may be read electronically, outputting readings as a data stream. However, these meters are still largely intended to be read only by the supply utility. In general, the utility cannot or will not supply real time output data from such meters to the electricity consumer in the premises.

[0008] This has led to the installation, by consumers, of submeters which enable measurement of electricity usage and generation. Such submeters may measure a number of components of electricity usage, storage and generation across different electrical circuits, major appliances, solar PV and batteries.

2018203426 15 May 2018

[0009] These submeters may be associated with home energy management systems which analyse electricity usage, and direct energy efficiency measures. Where there are numerous elements to measure, installation of the submeter, and configuration of the energy management system may be complex.

DISCLOSURE OF THE INVENTION

[0010] In one form of this invention a there is proposed a meter for measuring electricity use including digital memory adapted to store configuration data describing the installation of the meter and communication means adapted to receive said configuration data for storage in the digital memory and to transmit said configuration data retrieved from the digital memory.

[0011] In preference the communication means includes a first communication interface adapted to receive said configuration data and a second communication interface adapted to transmit said configuration data.

[0012] T In preference the first communication interface and the second communication interface use the same communication protocol.

[0013] In preference the first communication interface and the second communication interface use different communication protocols.

[0014] In preference one or both of the first communication interface and the second communication interface are adapted to communicate with the public internet.

[0015] In preference the first communication interface is an IrDA interface and the second communication interface is a ZigBee interface.

[0016] In an embodiment the meter further includes an installation tool having a user interface adapted to permit a user to input the configuration data to be received by the meter and a tool communication interface able to communicate with the communication means.

[0017] The installation tool may include a tool communication interface adapted to communicate with the first communication interface to communicate the configuration data to be received by the meter.

2018203426 15 May 2018

[0018] The invention may also be said to lie in an installation tool for use with the meter including a user interface adapted to permit a user to input the configuration data to be received by the meter and a tool communication interface able to communicate with the communication means.

[0019] In a further form the invention may be said to be a system for installation of an energy usage monitoring device, the system including a meter for measuring, or when used for measuring, electricity use including digital memory adapted to store configuration data describing the installation of the meter and communication means adapted to receive said configuration data for storage in the digital memory and to transmit said configuration data retrieved from the digital memory, wherein the energy usage monitoring device is adapted to receive the configuration data from the communication means.

[0020] In preference, the system includes an installation tool having a user interface adapted to permit a user to input the configuration data to be received by the meter and a tool communication interface able to communicate with the communication means.

[0021] In preference the communication means includes a first communication interface adapted to receive said configuration data and a second communication interface adapted to transmit said configuration data, the first communication interface adapted to receive the configuration data from the tool communication interface and the second communication interface adapted to transmit the configuration data to the energy usage monitoring device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] Figure 1 is a block diagram representation of a meter after the invention.

[0023] Figure 2 is a block diagram of an energy usage monitoring system incorporating the invention.

[0024] Figure 3 is a diagrammatic representation of an installation tool of the invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0025] Now referring to the illustrations and in particular to Figure 1, there is shown a block diagram representation of electricity submeter incorporating the invention.

2018203426 15 May 2018

[0026] There is a meter 101 which is installed in a premises having an electricity supply from a grid. The meter includes memory 102 and a processor 103. The meter 101 also includes a Configuration Communications Interface 105 and an Output Communications Interface 104.

[0027] The meter also includes at least one current sensor electrical connection point 106 which allows the electrical connection of at least one current sensor, in the illustrated embodiment, a current clamp 107. There is also provided an active connector 108 for connection to the active conductor of the electricity supply associated with the current clamp 107, and a neutral connector for connection to the neutral point of the electricity supply. The meter also includes a voltage sensor 110, which is in electrical connection with the active connector 108 and the neutral connector 109. This allows for the measurement of the voltage of the electrical supply associated with the measured current.

[0028] Current clamp 107 is device which encircles an electrical conductor and measures the current flowing therein by the transformer effect. Current clamp 107 provides an electrical signal which is proportional to the current flowing in the conductor around which it is installed.

[0029] The processor 103 receives the electrical signal from the clamp 107 and the output of the voltage sensor 110. The processor uses these inputs to calculate the power being used by the circuit the conductor of which is surrounded by the clamp 107.

[0030] The processor communicates the calculated circuit power to an external analysis and display device 111 via the Output Communications Interface 104.

[0031] In general, there will be provided multiple current clamps 107, each with an associated active connector 108 and voltage sensor 110. These may be connected to measure current in a variety of circuits, supplying electricity to a variety of household appliances. This allows for power usage of each of these circuits to be monitored. Data describing the power in each of the circuits is displayed by the analysis and display device 111.

[0032] In order for the data displayed by the analysis and display device 111 to be useful, it is necessary for said device to have configuration data describing the usage of each monitored circuit. Where this information is provided to the device 111 by process which

2018203426 15 May 2018

is independent of the installation of the meter 101, there is increased scope for errors wherein the configuration data provided to the device 111 regarding the installation of the current clamps 107 or the use of the respective circuits is not accurate.

[0033] It is desirable for the configuration data to be provided by the installer of the meter, typically a qualified electrician. However, the analysis and display device may be secured for use only by the premises occupier, or may require additional setup parameters to be entered, unrelated to the configuration data. The device 111 may be located remotely from the meter 101. An electrician must be paid, at a relatively high hourly rate for any work undertaken, including entry of configuration data. It may thus be uneconomic or inconvenient for the installer to directly enter configuration data into the analysis and display device.

[0034] There is provided an installation tool 112 which communicates with the meter 101 via the Configuration Communications Interface 105.

[0035] The installation tool 112 is used by the installer to input the description of the circuit associated with each of the clamps 107. This configuration data is communicated to the meter 101 via the Configuration Communications Interface 105. The configuration data is stored in memory 102.

[0036] This configuration data is then made available to the analysis and display device 111. This configures the device 111 with data describing the function of the circuit monitored by each of the clamps 107. The device 111 displays the data collected by each clamp 107 with appropriate description. The device 111 uses the configuration data to analyse the power usage data of the clamps 107 transmitted by the processor 103 appropriately for the function of the circuit monitored by the respective clamp 107.

[0037] Referring now to Figure 2, which is a block diagram of an energy usage monitoring system for a household, there is a grid electricity supply having an active conductor 250 and a neutral conductor 252. There is a main switchboard meter 255 which measures electricity supplied to the household for the purposes of billing by the grid supplier. There is a main switch 256 which allows the household circuits to be isolated from the grid supply.

2018203426 15 May 2018

[0038] This grid supply provides electricity for the electrical loads of the household including air conditioner 282, pool pump 281 and general lighting and appliances load 280.

[0039] There is installed in the household a submeter 201. The submeter 201 includes processor 203 and memory 202. The submeter 201 further includes Configuration Communications Interface 205 and an Output Communications Interface 204.

[0040] The submeter 201 monitors the electrical power in at least some electrical circuits supplying electrical loads in the household. This requires measurement of the voltage and current in each monitored circuit.

[0041] The total power supplied to the household from the grid flows through circuit 245. The current flowing in this circuit is monitored by current clamp 240 which is installed around the conductor of the circuit 245. Voltage clamp 240 is connected to the submeter 201 via current sensor electrical connection point 230. The voltage is monitored by a connection of the active conductor 250 to active connector 270. Signals from the current clamp 240 and the active connector 270 are applied to the processor 203. The processor analyses these signals to calculate the power flowing to the entire household via circuit 245.

[0042] The submeter 201 may also determine the power flowing in sub-circuits which supply electricity to individual loads in the premises. Sub-circuit 246 supplies electricity to pool pump 281. This sub-circuit branches off from the main circuit after the point at which current clamp 240 is attached to the main circuit 245. The current flowing in sub-circuit 246 is monitored by current clamp 241. The voltage is monitored by a connection of the active conductor 250 to active connector 271. Signals from the current clamp 241 and the active connector 271 are applied to the processor 203. The processor analyses these signals to calculate the power flowing in circuit 246, and hence the energy consumption of the pool pump 281.

[0043] Sub-circuit 247 supplies electricity to air conditioner 282. Again, this sub-circuit branches off from the main circuit after the point at which current clamp 240 is attached to the main circuit 245, and is a separate sub-circuit from the sub-circuit feeding the pool pump. The current flowing in sub-circuit 247 is monitored by current clamp 242. The voltage is monitored by a connection of the active conductor 250 to active connector 272.

2018203426 15 May 2018

Signals from the current clamp 242 and the active connector 272 are applied to the processor 203. The processor analyses these signals to calculate the power flowing in circuit 247, and hence the energy consumption of the air conditioner 282.

[0044] There is provided analysis and display hub device 211. In embodiments, the functionality of the analysis and display device 211 may range from simple display of the power measurements made by the sub-meter 201 up to sophisticated home energy hub functionality including control of appliances.

[0045] The hub 211 is in data communication with the submeter 201 using output communication channel 220 via Output Communications Interface 204. Processor 203 calculates the power in each monitored circuit and communicates this data to the hub device using output communication channel 220 via Output Communications Interface 204.

[0046] Output communication channel 220 may be provided using any convenient carrier or protocol, including without limitation, Zigbee, wi-fi, and wired ethernet connections.

[0047] In a preferred embodiment, the hub 211 has a connection to an external processor, an Intelligent Power Manager (IPM) 262, in the illustrated embodiment this connection being provided by the public internet 261.

[0048] The IPM 262 is a remote computer processor which is in communication with one or more hub devices situated at one or more households. Data from the sub-meter 201 is transmitted via the hub device 211 and the internet connection 261 to the IPM 262. The IPM 262 is able to record and analyse data on electricity consumption from a household, or in an embodiment, a large number of households.

[0049] There is an internet access device 263, which may be, without limitation, a mobile phone or a personal computer.

[0050] The internet access device 263 provides a user interface for the IPM 262, which in an embodiment is provided by running an internet browser which displays a user interface from the IPM 262. In other embodiments, the internet access device may run an App which provides the user interface locally, to display information from the IPM 262.

2018203426 15 May 2018

[0051] The IPM 262 also records, where available, information regarding the make-up of the households, the appliances in each household, and the geographic location of each household.

[0052] The IPM 262 monitors and tracks the energy usage patterns of a particular household and compares this data to similar sized homes preferably in real time, or at intervals significantly less than the household electricity billing interval, to provide the basis for householders to compare their energy usage with that of others during particular time periods.

[0053] Data from the household on energy usage and the other data concerning household make-up which is of use to profile the energy usage of the household is encrypted and stored in the IPM 262.

[0054] The householder can then access their energy usage information from the IPM 262 via the internet access device 263 at any time to assess their energy usage over certain time periods, i.e. over the last hour, 24 hours, week, or month, as desired.

[0055] This information is displayed by the user interface on the internet access device 263.

[0056] The IPM 262 provides information concerning cost and budget to the household via the internet access device 263.

[0057] This requires that the IPM 262 have access to the tariff rate applicable to the household. Tariffs may not be constant over the day, week, month or any other time period. The applicable tariff details may be entered by a householder, or the details of the tariff may be acquired by the IPM 262 from an energy retailer supplying energy to the household.

[0058] Via the user interface of the internet access device 263, the householder can enter household description data, which describes the makeup of the household, details of the dwelling, and information about the appliances in use in the household.

[0059] In order for the information displayed on the internet access device 263 to be meaningful, information describing the way in which the submeter 201 has been wired must be communicated to the IPM 262. It is advantageous if the installation of the

2018203426 15 May 2018

submeter can be achieved by an electrician or other installer, without the need to interact with the user interfaces which may be provided by the IPM 262 and the internet access device, since these interfaces are optimised for ongoing household user use which adds complexity which is unnecessary for the installer and the installation process.

[0060] There is provided an installation tool 212 which communicates with the submeter 201 via the Configuration Communications Interface 205. The installation tool 212 includes a meter communication interface 221 which communicates with the Configuration Communications Interface 205. In a preferred embodiment this is an IrDA interface. This interface uses infra-red radiation to provide a communication channel which is short range and line of sight making for a very simple, reasonably secure communication channel. IrDA has the advantage that it is a wireless channel providing electrical separation between the submeter 201 and the installation tool 212. IrDA being line of sight and short range provides physical security for the channel, meaning that encryption and log in protection is not required. In other embodiments, and convenient wired or wireless protocol may be employed.

[0061] The installation tool 212 is used by the installer to input the description of the circuit associated with each of the clamps 240, 241 and 242. This configuration data is communicated to the meter 201 via the Configuration Communications Interface 205. The configuration data is stored in memory 202.

[0062] The submeter 201 communicates the power measurement which has been calculated for each circuit 245, 246, 247 to the installation tool 212. The installation tool 212 is able to display these measurement results, along with the identity of each circuit as provided in the configuration data, for each circuit being monitored.

[0063] Thus the outputs of the submeter 201 can be monitored at installation without the necessity for the hub device 211 being present. This is advantageous because it allows the installation of the submeter 201 and the provision of the hub device 211 to proceed independently.

[0064] During installation, the installer installs the submeter 201, and places current clamps around selected circuits. In the illustrated embodiment these circuits are the Whole of House circuit 245 supplying electricity to all loads in the household, the Pool circuit 246 supplying electricity to the swimming pool pump, the air-conditioning circuit supplying

2018203426 15 May 2018

electricity to an air-conditioning unit. Other loads which may have a supply circuit include, without limitation, hot water heaters and in-floor heating. Where a solar PV installation exists within the household, the electrical supply circuit from this installation may be monitored. This will of course monitor generation rather than consumption of electricity. A circuit supplying a storage battery may also be monitored, which monitors energy flows into and out of the battery.

[0065] During installation the hub 211 may not be configured or may be absent. Configuration of the hub unit, or of the IPM 262 via the hub unit may be impossible or inconvenient for the installer.

[0066] During installation, the installer uses the installation tool 212 to enter data describing which clamps have been applied to which circuits and the function of the loads supplied by those circuits. This data is transmitted to the submeter 201 via the IrDA interface 221 of the installation tool 212 and the Configuration Communications Interface 205 of the submeter 201. This configuration data is stored in the memory 202. Configuration data may include data which identifies the particular installation tool and/or the particular installer. General information including, without limitation, the date of installation, the company providing the installation, the GPS co-ordinates of the installation tool at the time of the installation, and any other data to identify the installer and the installation circumstance, may also be stored into the memory 202 by the installation tool. The processor 203 of the submeter 201 may also directly store information concerning the installation, for example the data and time, into the memory 202.

[0067] When the hub unit 211 is available, the hub unit 211 and the submeter processor 203 establish wireless output communication link 220.

[0068] The configuration data is then able to be downloaded from memory 202 using output communication channel 220 via Output Communications Interface 204 to the hub unit 211. The configuration data is then transmitted to the IPM 262 via the internet 261. The IPM 262 uses this configuration data in order to categorise the electricity flow data which is received from the submeter 201. The IPM is then able to analyse the electricity flow data with the information describing the use of each monitored circuit.

2018203426 15 May 2018

[0069] The IPM 262 is then able to display correctly described and analysed data on the internet access device 263, in the illustrated embodiment, a mobile phone.

[0070] In preferred embodiments, the meter is provided with multiple active connectors. Each active connector is associated with a respective current sensor electrical connection point. The current clamp connected to that current sensor electrical connection point is deployed to measure the current in a circuit supplied from the associated active conductor. This ensures that the correct voltage reference is used for each measured circuit. It also allows for use in a premises supplied with two or three phase electricity. In such an installation, there will be multiple active conductors coming into the premises from the supply grid, one for each phase. Any one active conductor supplying any phase can be connected to any active connector. The current clamp connected to the associated current sensor electrical connection point is deployed to measure the current in a circuit supplied by the phase of the associated active conductor. This allows for the measurement of the power consumed by devices powered by circuits connected to any of the phases.

[0071] The illustrated embodiments have shown the current sensors as current clamps. Other current sensing technologies may be used, including, without limitation, Hall effect devices and current shunts.

[0072] Referring now to Figure 3, there is shown an installation tool for use in configuring an electricity usage monitoring installation. There is a tablet computer 301, which provides processing and display functionality for the installation tool. The tablet computer 301 runs software to implement the functionality of the installation tool.

[0073] The tablet computer 301 includes a data connector, in the illustrated embodiment a USB connector 331. Other suitable data connectors may be provided.

[0074] There is provided a meter communication interface unit 302 for communication with an electricity usage monitoring meter. In the illustrated embodiment the interface 302 is an IrDA protocol interface. This provides short range wireless communication using infra-red signals. Other suitable wired or wireless connections may be employed.

[0075] The interface unit 302 includes data cable 303 and cable connector 332. The cable connector connects to the data connector 331 of the tablet computer 301 to provide data connection to the IrDA interface 302.

2018203426 15 May 2018

[0076] Figure 4 shows a diagram of an input screen of the installation tool of Figure 3.

[0077] The input screen allows an installer to nominate the use of each current clamp in a sub-meter installation. For each current clamp 401, the installer may choose from a list of available load descriptions 402. This description is then sent to the sub-meter as configuration data, to be recorded in memory by the sub-meter.

[0078] Figure 5 shows an output display of the installation tool of Figure 3. The installation tool receives data from the sub-meter showing the description 501 recorded by the sub-meter for the load which each current clamp is measuring. The current power measurement 502 for that load is displayed. This permits an installer to check that an installation has been performed correctly, without the need for a hub device and/or an IPM to be available at the time of installation.

[0079] In other embodiments, the installation tool may be provided as a purpose built display and processing unit, implementing the described functions of the installation toll via hardware or firmware.

[0080] In further embodiments, the IPM may not be provided, with the functionality of the IPM being provided by the hub device 211.

[0081] Although the invention has been herein shown and described in what is conceived to be the most practical and preferred embodiment, it is recognised that departures can be made within the scope of the invention, which is not to be limited to the details described herein but is to be accorded the full scope of the appended claims so as to embrace any and all equivalent devices and apparatus.

2018203426 15 May 2018

We Claim:

1. A meter for measuring electricity use including digital memory adapted to store configuration data describing the installation of the meter and a communication means adapted to receive said configuration data for storage in the digital memory and to transmit said configuration data retrieved from the digital memory.

2. The meter of claim 1 wherein the communication means includes a first communication interface adapted to receive said configuration data and a second communication interface adapted to transmit said configuration data.

3. The meter of claim 2 wherein the first communication interface and the second communication interface use the same communication protocol.

4. The meter of claim 2 wherein the first communication interface and the second communication interface use different communication protocols.

5. The meter of claim 2 wherein one or both of the first communication interface and the second communication interface are adapted to communicate with the public internet.

6. The meter of claim 2 wherein the first communication interface is an IrDA interface and the second communication interface is a ZigBee interface.

7. The meter of claim 1 further including an installation tool having a user interface adapted to permit a user to input the configuration data to be received by the meter and a tool communication interface able to communicate with the communication means.

8. The installation tool as in claim 7 having a tool communication interface adapted to communicate with the first communication interface to communicate the configuration data to be received by the meter.

9. An installation tool for use with the meter of claim 1 including a user interface adapted to permit a user to input the configuration data to be received by the meter and a tool communication interface able to communicate with the communication means.

10. A system for installation of an energy usage monitoring device, the system including a meter for measuring electricity use including digital memory adapted to store configuration data describing the installation of the meter and communication means

2018203426 15 May 2018

adapted to receive said configuration data for storage in the digital memory and to transmit said configuration data retrieved from the digital memory, wherein the energy usage monitoring device is adapted to receive the configuration data from the communication means.

11. The system of claim 10 further including an installation tool having a user interface adapted to permit a user to input the configuration data to be received by the meter and a tool communication interface able to communicate with the communication means.

12. The system of claim 11 wherein the communication means includes a first communication interface adapted to receive said configuration data and a second communication interface adapted to transmit said configuration data, the first communication interface adapted to receive the configuration data from the tool communication interface and the second communication interface adapted to transmit the configuration data to the energy usage monitoring device.

2018203426 15 May 2018

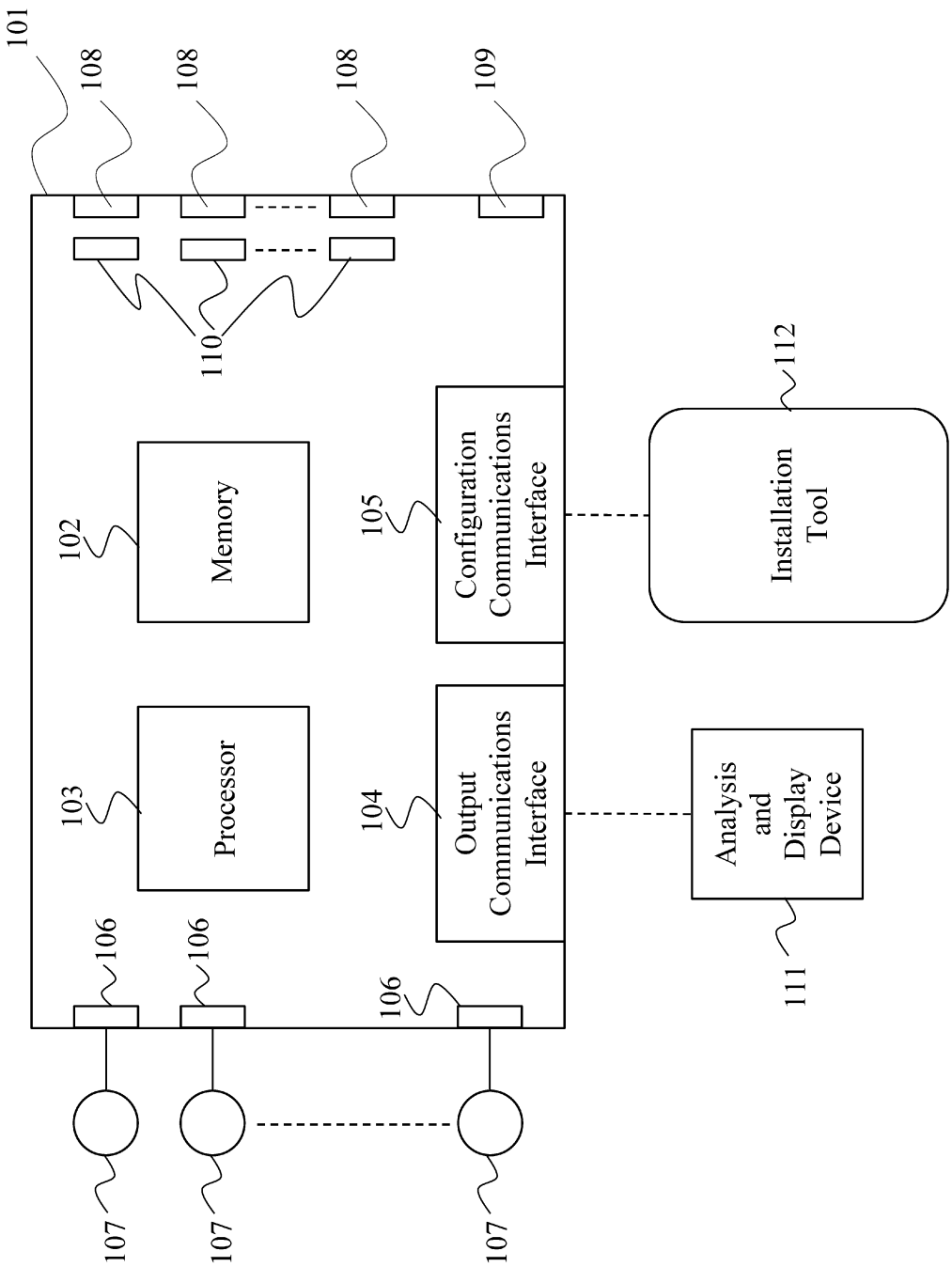

Figure 1

2018203426 15 May 2018

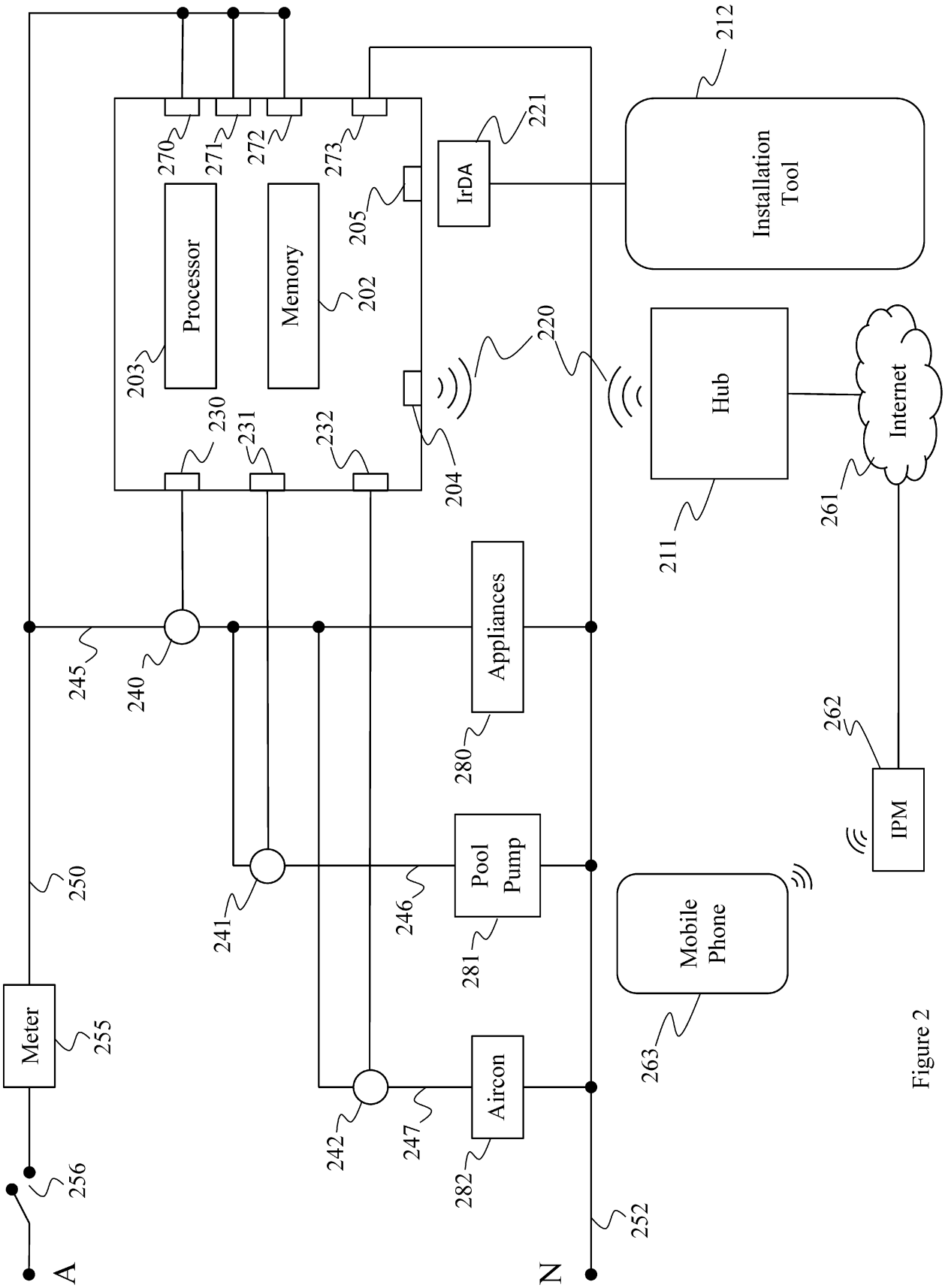

Figure 2

2018203426 15 May 2018

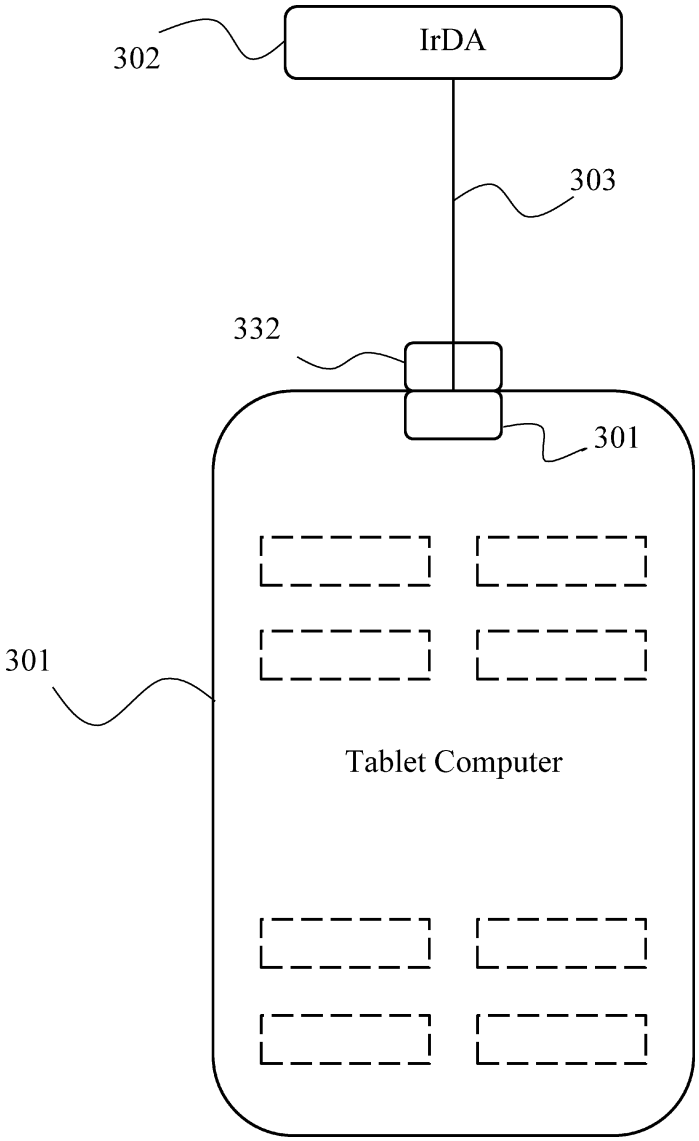

Figure 3

2018203426 15 May 2018

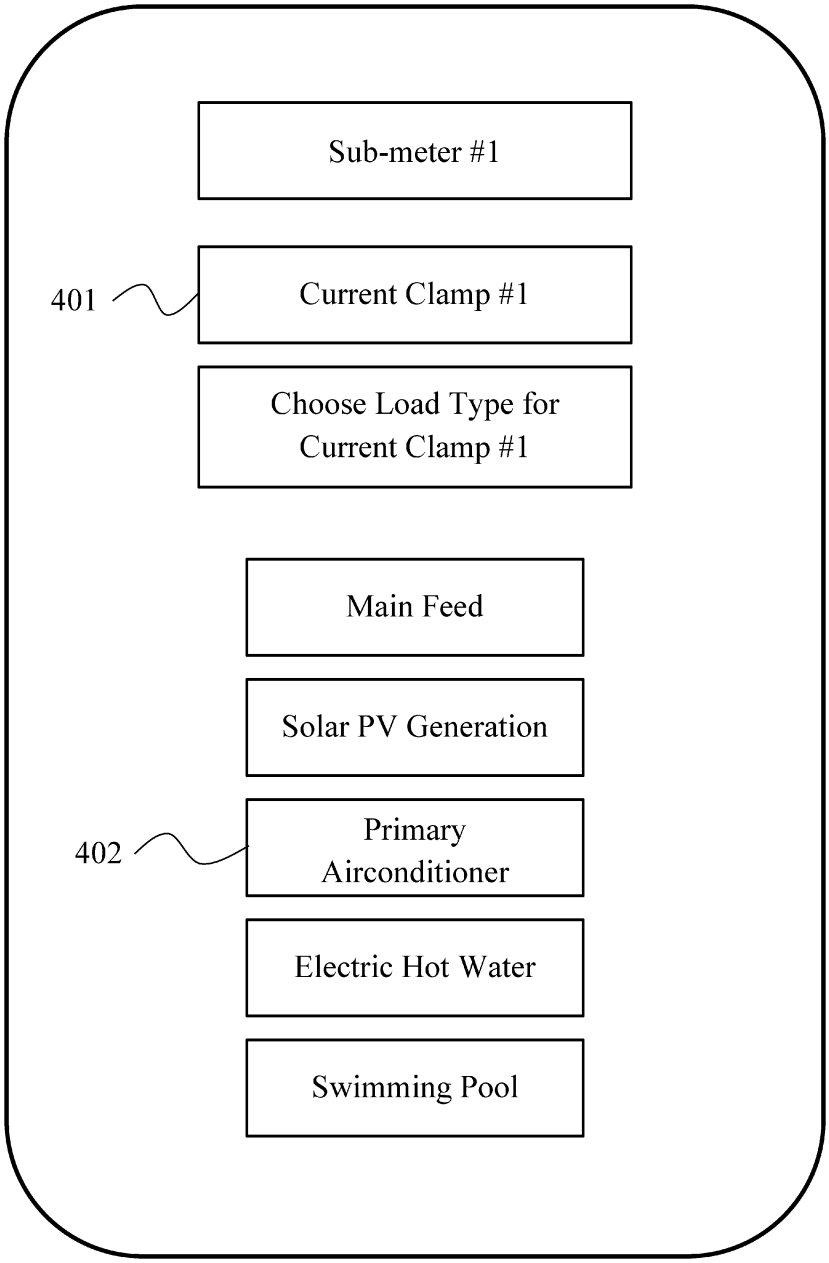

Figure 4

2018203426 15 May 2018

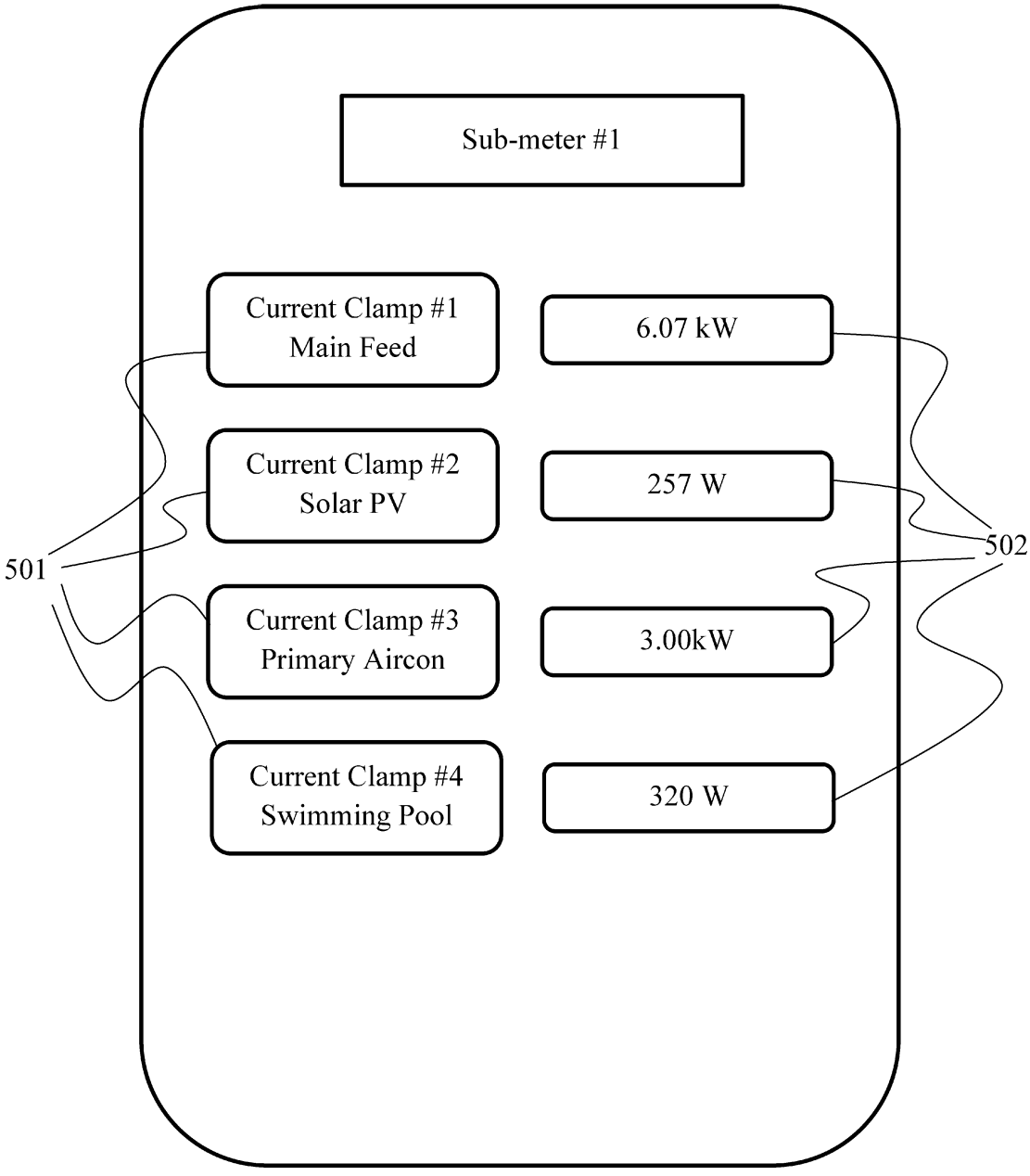

Figure 5