

**POWER MONITORING DEVICE AND POWER MONITORING SYSTEM USING THE
SAME**

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Korean Patent Application No. 10-2021-0008079, filed on January 20, 2021, which is hereby incorporated by reference as if fully set forth herein.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present disclosure relates to a power monitoring device and a power monitoring system using the same, and more particularly, to a power monitoring device and a power monitoring system using the same for ensuring communication stability by connecting a power monitoring device used while being connected to a bus-way and a server via multiple networks.

Discussion of the Related Art

[0003] The race-way or the bus-way means a power distribution method that is recently and frequently used. This race-way or bus-way method refers to a method in which a bus or a race to which power is supplied is standardized in a predetermined form, and devices are connected to these ways and used.

[0004] This distribution method is mainly used in a computer system that operates a server device using a plurality of racks, but recently, is also frequently used in a place that requires distribution of a large amount of current, such as a clean room, a factory, or a research institute, or includes a computer system provided therein for an operation.

[0005] In this distribution method, a device that receives power through a distribution way is directly connected to the distribution way, but in general, the device is connected to the distribution way using a tab detachable to a slot provided in the distribution way. In particular, the tab is not only used for simply connecting the distribution way and the device, but is also mainly used in the form of a tap-off box to which a device for monitoring and power supply control is connected recently. Thus, the tab includes the device for monitoring and control and includes a communication device for connection between these devices and the server.

[0006] Thus, high communication stability is required for a measuring device and a control device provided in the tap-off box. However, due to increase in the complexity of devices connected to the distribution way, the devices are operated while such communication stability is not ensured, and thus, there is a problem an effect of accidents or failures greatly affects operations of other devices.

[0007] 【Cited Reference】

[0008] 【Patent Document】

[0009] (Patent Document 1) Korean Utility Model Publication
No. 20-0412122 (Registered on March 16, 2006) "Bus-way system"

SUMMARY OF THE INVENTION

[0010] An object of the present disclosure is to provide a power monitoring device for a bus-way and a power monitoring system using the same for ensuring communication stability by connecting a power monitoring device and a server through multiple networks.

[0011] According to an aspect of the present disclosure, a power monitoring device includes a terminal unit including a voltage measuring terminal unit connected to one or more voltage measuring devices or a current measuring terminal unit connected to one or more current measuring devices and configured to output measurement data containing voltage data from the voltage measuring terminal unit or current data from the current measuring terminal unit, a device communication unit provided to transfer the measurement data to an external device and including a first port configured to perform any one of data reception from the external device and data transmission to the external device and a second port configured to perform a remaining one of the data reception and the data transmission,

and a power supply including a plurality of input terminals, each of which is connected to an external power source, for supplying power supplied from an outside to the device communication unit.

[0012] The external device may be any one of another power monitoring device, a gateway, or a monitoring server.

[0013] The device communication unit may relay data of the other power monitoring device connected to the first port or may be directly connected to the gateway by the first port and transfers own measurement data or the measurement data transferred from the power monitoring device connected to the second port to the gateway, or may relay data of the other power monitoring device connected to the second port or may be directly connected to the gateway by the second port and may transfer own measurement data or the measurement data transferred from the power monitoring device connected to the first port to the gateway.

[0014] In the power supply, the plurality of input terminals may be connected to different external power sources, respectively.

[0015] Any one of the plurality of input terminals may be connected to the gateway and may receive power from the gateway.

[0016] According to another aspect of the present disclosure, a power monitoring system includes a plurality of power

monitoring devices configured to collect measurement data, a gateway multiply connected to the plurality of power monitoring devices, and a monitoring server connected to the gateway through a plurality of lines to receive the measurement data.

[0017] The plurality of power monitoring devices may be connected to each other via different serial communication, and each of a first device and a last device of the plurality of power monitoring devices connected by serial communication may be connected to the gateway.

[0018] The power monitoring device may be provided in a tap-off box.

[0019] The tap-off box may include a plug head connected to a bus-way to which power is supplied, a circuit breaker for relay between the plug head and a device for receiving power, and a measuring device connected between the circuit breaker and the device, configured to generate measurement data, and including a voltage measuring device or a current measuring device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] FIG. 1 is a schematic diagram showing the configuration of a power monitoring system according to the present disclosure.

[0021] FIG. 2 is a diagram showing another form of FIG. 1.

[0022] FIG. 3 is a diagram showing an example of a bus-way applied to a power monitoring system.

[0023] FIGS. 4 to 7 are example diagrams for explaining occurrence of an accident due to communication failure.

[0024] FIG. 8 is an example diagram showing an outer appearance of the gateway of FIGS. 1 to 3.

[0025] FIG. 9 is a perspective view of a front surface of a power monitoring device.

[0026] FIG. 10 is a perspective view of a rear surface of a power monitoring device.

[0027] FIG. 11 is an example diagram showing the configuration of a tap-off box.

[0028] FIG. 12 is an example diagram for explaining use of a power monitoring device when 3-phase power is supplied to the device.

[0029] FIG. 13 is an example diagram for explaining use of a power monitoring device when single-phase power is supplied to the device.

DETAILED DESCRIPTION OF THE INVENTION

[0030] Exemplary embodiments of the present disclosure are described in detail so as for those of ordinary skill in the art to easily implement the present disclosure with reference to the accompanying drawings. It should be noted that reference

numbers of components in the accompanying drawings use the same reference numbers as much as possible when indicating the same components in other drawings. In the description of the present disclosure, certain detailed explanations of related known functions or known configurations are omitted when it is deemed that they may unnecessarily obscure the essence of the present disclosure. In addition, some features presented in the drawings are enlarged, reduced, or simplified for ease of description, and the drawings and components thereof are not necessarily drawn to scale. However, those skilled in the art will readily understand these details.

[0031] FIG. 1 is a schematic diagram showing the configuration of a power monitoring system according to the present disclosure. FIG. 2 is a diagram showing another form of FIG. 1. FIG. 3 is a diagram showing an example of a bus-way applied to a power monitoring system.

[0032] Referring to FIGS. 1 to 3, a power monitoring system 10 according to the present disclosure may include a power monitoring device 51, a gateway 40, and a power monitoring server 30. The power monitoring system 10 may further include an operating computer.

[0033] As shown in FIG. 3, the power monitoring system 10 may be configured in conjunction with a bus-way system. Here, for convenience of description, in addition to a bus-way, only

an example in which the power monitoring system 10 is associated with a bus-way distribution system will be described.

[0034] However, needless to say, the following description may also be applied to a switchboard system using another method or a general method without being limited to a bus-way distribution system.

[0035] A bus-way system 90 may include a bus-way 92 that is a distribution way for supplying power to a device (not shown) for receiving power and a power supply 91 for supplying power to the plurality of bus-ways 92.

[0036] The power supply 91 may receive power from an external power source or an uninterruptible power supply devices and may supply the power to the bus-way 92. The power supply 91 may include devices such as a circuit breaker, a disconnecter, a power meter, and a transformer.

[0037] The bus-way 92 may configure a distribution way between the power supply 91 and the devices. The bus-way 92 may be configured for each rack in which a plurality of devices is accommodated, and the plurality of bus-ways 92 may be provided in a space in which a plurality of racks are arranged in such a way that the plurality of racks share one bus-way 92.

[0038] The bus-way 92 may be formed of a conductor in the form of a rod or a rail and may include a slot formed therein for attaching and detaching a plug head 81 of a tap-off box 80.

[0039] The power monitoring device 51: 51a to 51n may monitor power branched from the bus-way 92 and supplied to a device to collect measurement data and may transfer the collected measurement data to the power monitoring server 30 through the gateway 40. Here, the measurement data may be data such as voltage data, current data, power data, temperature data, whether leakage current is present, and the amount of leakage current. The measurement data may be digital data converted from a measurement value, but in the present disclosure, the measurement data may mean including the measured analog type measurement value. To this end, the power monitoring device 51 may include a terminal unit, a device communication unit and a power supply. The terminal unit, the device communication unit, and the power supply will be described in more detail with reference to other drawings.

[0040] The power monitoring device 51 may be connected to a measuring device for generating measurement data in order to collect the measurement data, and to this end, may include a terminal unit including a plurality of connection terminals. Here, the measuring device may be a voltmeter, an ammeter, a wattmeter, or a thermometer, and the power monitoring device 51 may be connected to a plurality of measuring devices.

[0041] The plurality of power monitoring devices 51 may be provided, and the plurality of power monitoring devices 51 may

be communicatively connected to each other through a device communication unit. In this case, connection between the power monitoring devices 51 may be achieved via serial communication. In particular, the power monitoring device 51 according to the present disclosure may dually connected to the gateway 40 through both ends of the power monitoring devices 51 connected via serial communication.

[0042] In detail, the plurality of power monitoring device 51: 51a to 51n may be connected to a lower part of one gateway 40: 40a to 40n via serial communication. In this case, a first device 51a and a last device 51n of the power monitoring device 51 configuring serial communication may be connected to a gateway 40a through different communication lines 70a and 70b, and may be connected to the gateway 40a in the form of a loop or a ring as such. Here, for convenience of description, among serial communication lines 70 for connecting the gateway 40 and the power monitoring devices 51, a line for connecting the gateway 40a and a first power monitoring device 51a may be defined as a first communication line 70a, a line for connecting the gateway 40a and an n^{th} power monitoring device 51n may be defined as a second communication line 70b, and a line for connecting the power monitoring devices 51a to 51n to each other may be defined as a common line 70c. This is for convenience of explanation and is not necessarily divided as such, and the

first and n^{th} power monitoring devices 51a also refer to devices connected to the first communication line 70a and the second communication line 70b for convenience, and the present disclosure is not limited thereto.

[0043] To this end, the device communication unit of the power monitoring device 51 may include first and second ports for serial communication. That is, the first port may be connected to the gateway 40 through the power monitoring device 51 of a former stage or the first communication line 70a, and the second port may be connected to the gateway 40 through the power monitoring device 51 of a latter stage or the second communication line 70b. That is, when the first port is allocated for communication with the gateway 40, the second port may be used for communication, that is, data reception and transmission with the power monitoring device 51 of the latter stage, and when the second port is allocated for communication with the gateway 40, the first port may be used for data reception and transmission with the power monitoring device 51 of the former stage. Here, when an accident such as disconnection does not occur, the first port and the second port may remain usable, but priority may be assigned to any one of the first communication line 70a and the second communication line 70b and may be operated. That is, when an accident does not occur, the power monitoring devices 51 may perform data

reception and transmission with the gateway through the power monitoring device 51 of the former stage.

[0044] That is, when the first port is used to transmit measurement data to the gateway 40, the second port may be used to receive measurement data from another power monitoring device 51, and when the second port is used to transmit measurement data to the gateway 40, the first port may be used to receive measurement data from the power monitoring device 51 of the former stage. Although, according to the present disclosure, only the case in which the power monitoring device 51 collects measurement data and transfers the measurement data to the gateway 40 has been described above, when data for control is transmitted to the power monitoring device 51 from the gateway 40, this may be achieved using a reverse method of the method of transferring measurement data, which may be easily understood by one of ordinary skill in the art and thus a detailed description thereof will be omitted.

[0045] The power monitoring device 51 may receive power for an operation from the outside and may include a power supply therefor. The power supply may include a plurality of input terminals for connection with an external power source. The input terminal may be provided in a plural number and may be separated from other input terminals to receive external power. The plurality of input terminals may each be connected to

different external power sources to receive power from different power sources. For example, any one of the plurality of input terminals may be connected to the power supply of the gateway 40 to receive power. Here, all the plurality of input terminals may be connected to the power supply of the gateway 40, and in this case, may be connected to different output terminals provided in the power supply of the gateway 40.

[0046] The gateway 40 may relay connection between the power monitoring server 30 and the power monitoring device 51. The gateway 40 may supply power for an operation of the power monitoring device 51.

[0047] In detail, the gateway 40 may receive the measurement data from the power monitoring device 51 and may transfer the measurement data to the power monitoring server 30. Here, it may be possible to transfer control data to the power monitoring device 51 from the power monitoring server 30.

[0048] That is, the gateway 40 may be multiply connected to the power monitoring server 30 and the power monitoring device 51.

[0049] First, as described above, the gateway 40 may be connected to the power monitoring device 51 of a first group including the plurality of power monitoring devices 51 through the first and second communication lines 70a and 70b. In this case, the gateway 40 may communicate with the power monitoring

device 51 through a communication line to which priority is assigned among the first and second communication lines 70a and 70b, and when the corresponding communication line is damaged or disconnected or the common line 70c is damaged, the gateway 40 may perform using the second communication line 70b or may receive measurement data using the first and second communication lines 70a and 70b together.

[0050] Here, when measurement data is received through any one of the communication lines 70a and 70b to which priority is assigned normally, the other one of the communication lines 70a and 70b may be used to check connection stability or to confirm data receipt. That is, a test signal may be transferred to the power monitoring device 51 through the first communication line 70a, and whether the test signal is output to the second communication line 70b through the last power monitoring device 51n may be checked to check a connection status between the gateway 40 and the power monitoring devices 51.

[0051] The gateway 40 may be multiply connected to the server 30. To this end, the gateway 40 and the server 30 may be connected to each other by a network separated from a plurality of independent LANs 60: 60a and 60b. As such, even if communication failure of any one of the LANs 60a and 60b for connecting the gateway 40 and the server 30 occur, connection

with the server 30 may be maintained through the other one of the LANs 60a and 60b.

[0052] The gateway 40 may be configured to supply external power to the power monitoring device 51. To this end, an output terminal for outputting power to the power monitoring device 51 may be provided in the gateway 40, and the output terminal may be provided in a plural number.

[0053] The power monitoring server 30 may connect the gateway 40 to an administrator terminal such as an operating computer 20, may transfer the measurement data transferred through the gateway 40 to the operating computer 20, and may transfer control data transferred from the operating computer 20 to the designated power monitoring device 51 via the gateway 40.

[0054] To this end, the power monitoring server 30 may be multiply connected to the gateway 40. The plurality of gateways 40: 40a to 40n may be connected to the power monitoring server 30 and may be connected to the gateways 40 by multiple networks, respectively. For example, when the network is configured by a LAN, the network may include a first LAN 60a and a second LAN 60b, and the gateways 40 may be doubly connected to the power monitoring server 30 through the first and second LANs 60a and 60b. In addition, the operating computer 20 and the power monitoring server 30 may also be dually connected through the first and second LANs 60a and 60b.

[0055] FIGS. 4 to 7 are example diagrams for explaining occurrence of an accident due to communication failure.

[0056] FIGS. 4 to 7 will now be described in more detail with reference to FIGS. 1 and 2, and as described above, the server 30 and the gateway 40, and the gateway 40 and the power monitoring device 51 may form multiple communication lines (or communication channels) to perform communication.

[0057] To this end, the server 30 and the gateway 40 may be connected through independent different networks, for example, a plurality of LANs 60.

[0058] The gateway 40 and the power monitoring device 51 may be connected to different power monitoring devices 51 belonging to one group through the plurality of communication lines 70a and 70b. In particular, the gateway 40 may be connected to the first power monitoring device 51a and the last power monitoring device 51n among the power monitoring devices 51 of one group, which are connected using a serial communication method, and may form connection in the form of a ring.

[0059] As such, even if any one of communication lines for connecting the power monitoring devices 51a to 51n or the device 51 is in a communication failure state, communication with the gateway 40 may be maintained through a different line, and connection stability of the gateway 40 and the power monitoring server 30 may be ensured.

[0060] For example, as shown in FIG. 4, when the first power monitoring device 51a, slave #01 and the second power monitoring device 51b, slave #02 are disconnected, the first power monitoring device 51a may be connected to the gateway 40a through the first communication line 70a, and the second power monitoring device to the other power monitoring devices 51b to 51n may be connected to the gateway 40a through the second communication line 70b to stably transfer measurement data to the power monitoring server 30.

[0061] As described above, in the power monitoring system 10 according to the present disclosure, connection between the gateway 40 and the power monitoring server 30 and connection between the power monitoring server 30 and the operating computer 20 may be multiply configured and may be achieved through a LAN. For example, these may be connected through the two independent LANs 60a and 60b.

[0062] As such, failure may occur at various locations in a network configured by the LAN 60. As shown in FIG. 5, failure may occur between the LAN 60 and the gateway 40. As shown in FIG. 6, failure may occur in the LAN 60 between the power monitoring server 30 and the operating computer 20, and as shown in FIG. 7, failure may also occur between the LAN 60 and the gateway 40.

[0063] In the power monitoring system according to the present disclosure, when failure in lines of the LAN 60 occurs in either line, the components may be connected through a LAN 60 of other lines that are doubly configured, thereby ensuring communication stability.

[0064] When the gateway 40 and the power monitoring device 51 are multiply connected to each other, each of the power monitoring devices 51 may include two identifications (IDs) in order to stably recognize a device. That is, there may be a plurality of IDs of respective IDs assigned to the first to n^{th} power monitoring devices 51 when the gateway 40 is connected to the power monitoring devices 51 using the first communication line 70a, and respective IDs assigned to the first to n^{th} power monitoring devices 51 when the gateway 40 is connected to the power monitoring devices 51 using the second communication line 70b. For example, when the gateway 40 is connected to the power monitoring devices 51 using the first communication line 70a, IDs of #1, #2 ... #n may be assigned to the power monitoring devices 51 in order, and when the gateway 40 is connected to the power monitoring devices 51 using the second communication line 70b, IDs of #n+1, #n+2... #2n may be assigned to the power monitoring devices 51 in reverse order to distinguish the two cases. As such, devices may be recognized as different devices according to a sequence of serial communication of the connected

communication line 70, and thus failure may be rapidly recognized and device crash may be prevented.

[0065] Conventionally, when the above accident occurs, the third power monitoring device 51c to the termination power monitoring device 51n may be disconnected from the gateway 40 and the power monitoring server 30, but according to the present disclosure, connection stability may be ensured by multiply connected communication lines.

[0066] The second communication line 70b connected to the power monitoring devices 51 of one group may be connected different neighboring gateways 40 to respond to failure of the gateway 40.

[0067] FIG. 8 is an example diagram showing an outer appearance of the gateway of FIGS. 1 to 3.

[0068] Referring to FIG. 8, as described above, the gateway 40 may relay measurement data and control data and may also supply power to the power monitoring device 51.

[0069] For this function, the gateway 40 may be configured to be installed in the bus-way 92 or a rack and may include a device for connection with another device and an external power source.

[0070] In detail, FIG. 8A shows an example of a front surface of the gateway 40, FIG. 8B shows an example of first and third side surfaces of the gateway 40, FIG. 8C shows an example of a

second side surface of the gateway 40, FIG. 8D shows a fourth side surface of the gateway 40, and FIG. 8E shows an example of a front surface of the gateway 40. These arrangements and forms are proposed as examples, and the present disclosure is not limited thereto.

[0071] An interface for checking an operational status of a gateway or to directly perform setting may be provided on a front surface of the gateway 40. The interface may include a display panel 41 and a button 42 for input. In addition, an indicator lamp for expressing the operating status by lighting and color may be provided.

[0072] A component for connection with the power monitoring devices 51 may be provided on the second side surface. In detail, communication ports 43: 43a and 43b for connection with the first and second communication lines 70a and 70b may be provided on the second side surface. The communication ports 43 may be a serial communication port and may include a pair of Tx and Rx ports, respectively. The output terminals 44: 44a and 44b may be provided adjacent to the communication ports 43. The output terminal 44 may be connected to the aforementioned input terminal of the power monitoring device 51 to supply power.

[0073] A communication port for connection with the gateway 40 or another device may be provided on the fourth side surface. In detail, LAN ports 46 and 47 may be provided on the second

side surface, and the gateway 40 may be connected to the different LANs 60a and 60b. A separate communication port 45 for connection with another external device may be provided, and a serial communication port using a different method from a port installed on the second side surface may be provided. For example, the separate communication port 45 may be an RS 48 communication port, but the present disclosure is not limited thereto.

[0074] A device for fixing the gateway 40 to a structure such as a DIN-Rail may be provided on the rear surface. For example, a surface of the rear surface may be stepped to allow the DIN-Rail to be inserted, and a DIN-Rail fixer 48 may be provided at one side of the stepped portion.

[0075] Here, the corresponding DIN-Rail structure of the rear surface may be installed at the DIN-Rail, and the shape and coupling device of the structure may be changed when the structure is coupled to a general wall or other structures.

[0076] As described above, a communication port and a power output terminal for connection depending on a connection target may be separately provided in the gateway 40, but this is proposed as an example for the convenience of installation, and an outer appearance of the gateway 40 is not limited to the proposed form, and may be modified and changed.

[0077] FIGS. 9 and 10 are example diagrams showing an example of a power monitoring device. FIG. 9 is a perspective view of a front surface of a power monitoring device. FIG. 10 is a perspective view of a rear surface of a power monitoring device.

[0078] Referring to FIGS. 9 and 10, as described above, the power monitoring device may be connected to the gateway 40 to transfer measurement data and may also be connected to a measuring device in order to collect measurement data.

[0079] A component for this may be provided in the power monitoring device 51.

[0080] In detail, an indication device 57 such as a lighting device for intuitively checking an operation may be provided on one surface of the power monitoring device 51. The indication device 57 may be embodied as an LED device and may also be embodied using a known indication device.

[0081] The measuring device may include a temperature sensor, and an opening 58 for measuring the temperature of the temperature sensor may be provided on one surface of the measuring device. The temperature sensor may be omitted, and the opening for measuring temperature may be formed on a different surface, and the present disclosure is not limited to the proposal.

[0082] First and second ports 55 for serial connection may be provided in the power monitoring device 51. As described

above, the power monitoring device 51 may be connected to another power monitoring device 51 or the gateway 40 through the first and second ports 55.

[0083] A voltage measuring terminal 56 for connection with a voltage meter may be provided. A plurality of voltage meters (or voltmeters) may be provided, and the plurality of voltage measuring terminals 56 may be provided to the plurality of voltage meters, respectively. As another aspect, a current measuring terminal 53 may be provided and may be connected to a plurality of current measuring devices.

[0084] The current measuring terminal 53 and the voltage measuring terminal 56 may be provided in a plural number. The plurality of terminals 53 and 56 may be pre-allocated or configured to be used in combination depending on a value to be measured.

[0085] For example, the current measuring terminals 53 may separately provide to measure general current and leakage current. When eight current measuring terminals 53 are provided, in order to measure single-phase current, six terminals may be used to measure general current and two terminals may be used to measure leakage current. When the current measuring terminals 53 are used to measure 3-phase current, six terminals, three of which are combined, may be used to measure 3-phase current, and the other two may be used to measure leakage current.

[0086] Similarly, the voltage measuring terminal 56 may also be provided in a plural number and may be provided in a different number from the current measuring terminals 53. For example, seven voltage measuring terminals 56 may be provided and only some of these may be used to measure voltage. In particular, power consumption may be measured to measure voltage or current and may also indirectly check an on/off or active/inactive state of a device.

[0087] The current measuring terminal 53 and the voltage measuring terminal 56 may have a cover C. The cover C may be provided to cover or open some terminals that are not connected to a measuring device, may be provided for each terminal, or may be provided in such a way that a plurality of terminals share one cover C.

[0088] As another aspect, an accommodation part and a fixing device 54 may be coupled to a structure such as a DIN-Rail 99.

[0089] Although a power input terminal is not illustrated in FIGS. 9 and 10, a power input terminal may be provided on one surface similarly to the aforementioned terminals. In particular, the power input terminal may be provided in two or more, and one of the power input terminals may be connected to an output terminal of the aforementioned gateway 40. All the plurality of power input terminals may be connected to the output terminal of the gateway 40, but in this case, to ensure

operational stability, the power input terminals may be connected to different gateways 40 or may be separate power supplies. However, the present disclosure is not limited thereto.

[0090] As shown in FIGS. 9 and 10, the power monitoring device 51 may be used alone and may be connected to surrounding measuring device, or as shown in FIG. 3, the power monitoring device 51 may be configured and used in the form of a tap-off box.

[0091] FIG. 11 is an example diagram showing the configuration of a tap-off box.

[0092] FIG. 11A is an example diagram showing the internal configuration of each tap-off box. FIG. 11B is an example diagram showing the state in which power monitoring devices of tap-off boxes are connected via serial communication as shown in FIGS. 1 to 3.

[0093] The tap-off box may include a plug head 81 and a box 82, and the box 82 and the plug head 81 may be connected by a cable, or the plug head 81 may be coupled to one surface of the box 82.

[0094] A circuit breaker 98 that is connected to the plug head 81, connects a device for receiving power supplied from the bus-way 92 through the plug head 81, and blocks connection therebetween may be provided in the box 82. The circuit breaker

98 may be electrically connected to the plug head 81 outside the box 82.

[0095] Measuring devices 96 and 97, for example, a voltage measuring device 96 and a current measuring device 97 may be provided in engagement with a terminal of the circuit breaker 98. The measuring devices 96 and 97 may be disposed between power outlets provided in the circuit breaker 98 and the box 82.

[0096] The power monitoring device 51 may be disposed adjacent to the measuring devices 96 and 97.

[0097] As such, a tap-off box in which the circuit breaker 98, the measuring devices 96 and 97, and the power monitoring device 51 are installed may be provided in a plural number as shown in FIG. 11B. In this case, power monitoring devices 51: 51a, 51b, and 51c that are respectively provided in tap-off boxes 82: 82a, 82b, and 82c may be sequentially connected using a serial communication method, and a first device and a last device among the serially connected power monitoring devices 51 may be connected to the gateway 40.

[0098] Such a configuration of the tap-off box is only proposed as an example, and thus the present disclosure is not limited thereto, and features such as the form, arrangement, and type of the configuration may be changed depending on an installation place and a connected device.

[0099] FIGS. 12 and 13 are example diagrams for explaining connection between a measuring device and a power monitoring device, FIG. 12 is an example diagram for explaining use of a power monitoring device when 3-phase power is supplied to the device, and FIG. 13 is an example diagram for explaining use of a power monitoring device when single-phase power is supplied to the device.

[00100] Referring to FIGS. 12 and 13, as described above, the power monitoring device 51 according to the present disclosure may be connected to a measuring device by being coupled alone to a DIN-Rail or a rack or may also be included and used in a tap-off box.

[00101] The same power monitoring device 51 may be used in a 3-phase power system or may also be used in a single-phase power system. FIGS. 12 and 13 show this example.

[00102] When used in a 3-phase power system, the power monitoring device 51 may be used in the form shown in FIG. 12. In detail, a power monitoring device 51d may be connected to current measuring devices CT: CT1 to CT8 such as an ammeter and may be voltage measuring devices V: VN, and V1 to V6 such as a voltmeter.

[00103] Although the current measuring devices CT and the voltage measuring devices V are indicated in the power

monitoring device 51d in FIGS. 12 and 13, the drawings show input terminals connected to these devices.

[00104] For this connection, the power monitoring device 51d according to the present disclosure may include a plurality of input terminals. For example, as shown in FIGS. 12 and 13, eight input terminals for inputting current data transferred from the current measuring devices CT and seven input terminals for inputting voltage data transferred from the voltage measuring devices V may be provided.

[00105] First, in FIGS. 12 and 13, a left side of the circuit breaker 98: 98a and 98b shows an input side to which for supplying power to the circuit breaker 98 from an external output source and a distribution way of the input side, and a right side of the circuit breaker 98 shows an output side connected to a device for receiving power and a distribution way of the output side.

[00106] When the power monitoring device 51d is used in the 3-phase power system, eight current input terminals may be provided to measure two sets, that is, two 3-phase distribution ways and leakage current. In this case, the distribution way may be configured as a 3-phase 4-wire system.

[00107] That is, eight input terminals and the current measuring devices CT may be connected to each other to connect the current measuring devices CT1 to CT3 and CT5 to CT7 for

measuring each 3-phase current and the current measuring devices CT4 and CT8 for measuring leakage current of each 3-phase distribution way.

[00108] To this end, the current measuring devices CT1 to CT3, and CT5 to CT7 may correspond to the distribution ways L1 to L3 to detect current of the distribution ways L1 to L3, respectively, and current measuring devices for measuring leakage current may correspond to the distribution ways L1 to L3 of four wires and a neutral wire N to detect 3-phase current and current of the neutral wire.

[00109] In this case, current data generated by each of the current measuring devices CT may contain identification codes for distinguishing between the current measuring devices CT and may transfer the current data to the power monitoring server 30. In addition, a packet of measurement data generated by the power monitoring device 51 may define a position of each of the current measuring devices CT, at which current data is to be recorded, and the size of the data, and accordingly, data of each of the current measuring devices CT may be separately recognized, which may be applied to voltage data in the same way.

[00110] The voltage measuring devices V1 to V6 and VN may also correspond to the distribution ways L1 to L3, and N, respectively, as shown in the drawings, to measure voltages of the phases L1 to L3 and voltage of the neutral wire N.

[00111] Although FIGS. 12 and 13 shows an example in which the current measuring devices CT are provided at an input side, the current measuring devices CT may be provided at an output side. In particular, the current measuring devices CT may be configured in such a way that the distribution ways L and N are branched to measure current of a distribution way distributed to each circuit breaker 98a or to measure current of a distribution way at an output side.

[00112] Although the voltage measuring device V is also provided at an input side, the voltage measuring devices V may be provided at an output side to allow the power monitoring server 30 or the operating computer 20 to recognize an operation of the circuit breaker. That is, like in the case in which voltage is detected in the state in which the circuit breaker 98 is set to be in an off-state or in the state in which the circuit breaker 98 is set to be in an on-state, measurement data of the voltage measuring devices V and state information of the circuit breaker 98 may be compared with each other to detect an operation of the circuit breaker 98. That is, the voltage measuring devices V may be provided at an output side to allow the power monitoring server 30 or the operating computer 20 to check whether the circuit breaker 98 is normally operated without a separate sensor for checking a general operation of

the circuit breaker 98, which is not capable of transferring the operation state to an external device.

[00113] In this way, it may be possible to measure current and voltage of a single-power system and to connect the measuring device therefor.

[00114] In the case of a single phase, it may be possible to measure current and voltage of four branch circuits through eight current input terminals and seven voltage input terminals as shown in the drawings. As such, when the four branch circuits are used, four circuit breakers 98b assigned to the respective branch circuits may be configured.

[00115] In this case, current measuring devices CT1, CT3, CT5, and CT7 for measuring single-phase current of each branch circuit and current measuring devices CT2, CT4, CT6, and CT8 for measuring leakage current of each branch circuit may be connected to a current input terminal of a power monitoring device 51e.

[00116] Similarly, voltage measuring devices V1, V2, V4, and V5 for measuring single-phase voltage of each branch circuit and the voltage measuring device VN for measuring voltage of a neutral wire may be installed at an output side of the circuit breakers 98b and may be connected to a voltage input terminal. In this case, the voltage of the neutral wire may be configured

to measure only the voltage of the neutral wire N of a main distribution way as shown in the drawings.

[00117] In the single-phase power system, the voltage measuring device VN may be configured for the circuit breakers 98b, and the power monitoring server 30 or the operating computer 20 may detect the operation state of the circuit breakers 98b.

[00118] According to the present disclosure, a power monitoring device and a power monitoring system using the same may ensure communication stability by connecting the power monitoring device and a server by a multiple network.

[00119] While the present disclosure has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit. Accordingly, the scope of the present disclosure as defined by the following claims.

WHAT IS CLAIMED IS:

1. A power monitoring device comprising:

a terminal unit including a voltage measuring terminal unit connected to one or more voltage measuring devices or a current measuring terminal unit connected to one or more current measuring devices and configured to output measurement data containing voltage data from the voltage measuring terminal unit or current data from the current measuring terminal unit;

a device communication unit provided to transfer the measurement data to an external device and including a first port configured to perform any one of data reception from the external device and data transmission to the external device and a second port configured to perform a remaining one of the data reception and the data transmission; and

a power supply including a plurality of input terminals, each of which is connected to an external power source, for supplying power supplied from an outside to the device communication unit,

wherein the external device is any one of another power monitoring device, a gateway, or a monitoring server, and

wherein the device communication unit relays data of the other power monitoring device connected to the first port or,

is directly connected to the gateway by the first port and transfers own measurement data or the measurement data transferred from the power monitoring device connected to the second port to the gateway, or

relays data of the other power monitoring device connected to the second port or,

is directly connected to the gateway by the second port and transfers own measurement data or the measurement data transferred from the power monitoring device connected to the first port to the gateway.

2. The power monitoring device of claim 1, wherein, in the power supply, the plurality of input terminals are connected to different external power sources, respectively.

3. The power monitoring device of claim 2, wherein any one of the plurality of input terminals is connected to the gateway and receives power from the gateway.

4. A power monitoring system comprising:
a plurality of power monitoring devices configured to collect measurement data;

a gateway multiply connected to the plurality of power monitoring devices; and

a monitoring server connected to the gateway through a plurality of lines to receive the measurement data,

wherein the plurality of power monitoring devices are connected to each other via different serial communication, and

each of a first device and a last device of the plurality of power monitoring devices connected by serial communication is connected to the gateway.

5. The power monitoring system of claim 4, wherein the power monitoring device includes:

a terminal unit including a voltage measuring terminal unit connected to one or more voltage measuring devices or a current measuring terminal unit connected to one or more current measuring devices and configured to output measurement data containing voltage data from the voltage measuring terminal unit or current data from the current measuring terminal unit;

a device communication unit provided to transfer the measurement data from the terminal unit to an external device and including a first port configured to perform any one of data reception from the external device and data transmission to the external device and a second port configured to perform a remaining one of the data reception and the data transmission; and

a power supply including a plurality of input terminals, each of which is connected to an external power source, for supplying power supplied from an outside to the device communication unit.

6. The power monitoring system of claim 5, wherein the device communication unit relays data of another power monitoring device connected to the first port or is directly connected to the gateway by the first port and transfers own measurement data or the measurement data transferred from the power monitoring device connected to the second port to the gateway, or

relays data of the other power monitoring device connected to the second port or is directly connected to the gateway by the second port and transfers own measurement data or the measurement data transferred from the power monitoring device connected to the first port to the gateway.

7. The power monitoring system of claim 5, wherein the gateway includes a plurality of output terminals for outputting external power, and

wherein, in the power supply of the power monitoring device, the plurality of input terminals are connected to different output terminals of the gateway.

8. The power monitoring system of claim 5, wherein the gateway is connected to the power monitoring device by dual serial communication lines, and

wherein the monitoring server and the gateway are connected by dual LAN lines.

9. The power monitoring system of claim 5, wherein the power monitoring device is provided in a tap-off box.

10. The power monitoring system of claim 9, wherein the tap-off box includes:

a plug head connected to a bus-way to which power is supplied;

a circuit breaker for relay between the plug head and a device for receiving power; and

a measuring device connected between the circuit breaker and the device, configured to generate measurement data, and including a voltage measuring device or a current measuring device.

11. The power monitoring system of claim 5, wherein the current measuring terminal unit includes a plurality of input terminals connected to eight current measuring devices for receiving 3-phase current of two 3-phase distribution ways and

leakage current or receiving current of six single-phase distribution way and leakage current, and

wherein the voltage measuring terminal unit includes a plurality of input terminals connected to seven voltage measuring devices for receiving 3-phase voltage of two 3-phase distribution ways and voltage of a neutral wire or receiving voltage of six single-phase distribution ways and the voltage of the neutral wire.

12. The power monitoring system of claim 11, wherein the voltage measuring device connected to the voltage measuring terminal unit measures voltage of a distribution way of an output side of a circuit breaker connected to a device for receiving power and generates voltage data, and

wherein the monitoring server detects on/off of the circuit breaker based on the voltage data.