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Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
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(54) Title: SYSTEM FOR REMOTE READING, DATA PROCESSING, AND MANAGEMENT OF THE CONSUMPTION OF ELECTRIC ENERGY

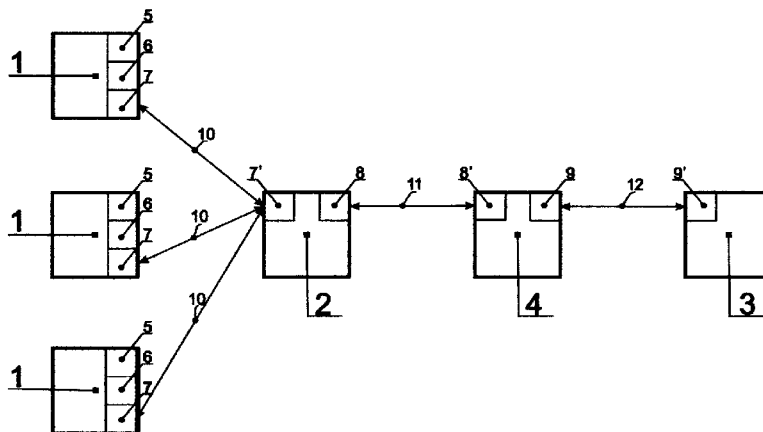


Fig. 2/3

(57) Abstract: The described system comprises end devices (1) in the form a single-phase or three- phase electric energy meter that measures the consumption and the parameters of electric energy and, through power lines communication (PLC) over the existing power distribution grid or through wireless communications transmits the readings to an intermediate communication unit (2,4) or directly to the control Center (3). The combination of wired and wireless communication technologies allows optimized use of the existing telecommunication infrastructures and minimizes the initial investment cost. The instruments of the system and the direct energy-use management allow localization of the losses and their minimization or elimination, as well as improving the efficiency of the system, optimizing and minimizing the operation cost.

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System for remote reading, data processing, and management of the consumption of electric energy

FIELD OF THE INVENTION

The utility model pertains to a system for remote reading, data processing, and management of the consumption of electric energy to be used both in industrial and residential applications. On the basis of data analysis and processing, the system shall be able to send signals to the electric energy consumption metering and control units according to predefined criteria.

The system shall therefore be used in all fields that require transmission of metering data, information about the states of devices, about the values of parameters monitored by all kinds of measuring devices, management of control and actuating mechanisms incorporated in metering devices, transmission and processing of reading data and remote control of processes.

BACKGROUND OF THE INVENTION

Known is a system for remote reading of electric energy as disclosed in patent **US2004/0059585 A1**, which comprises of an end-point unit that is an electromechanical electric meter connected through either telephone wired or wireless communication lines to the World Wide Web and the Internet to transmit the data to a control center. The control center consists of a communications server, a database to store the readings and configurations of the end devices, and a user module providing the users at the utility company with access to the data to be analyzed, processed and exported to other systems.

The electromechanical meter converts analog information to digital data that is transmitted to the control center. The mechanical movement of the disk is proportional to the current in the phase circuit, the voltage and the used electric energy respectively.

When the determined time for transmission of data to the center comes, the meter dials-up the center via built-in modem using the subscriber's telephone line and, when connection is established, sends data to the center which in turn sends data to the meter (if any) such as configuration and subscription rates.

In this way the system is used for remote reading of electric meters through the public telephone network and over the Internet.

Known are standards for power line communications (IEC 61334) and for energy metering (IEC 62056 DLMS/COSEM).

Furthermore, known are entirely electronic energy meters with incorporated relays and differential current relays and sensors.

SUMMARY OF THE INVENTION

The objective is to build a system for remote reading, data processing, and management of the consumption of electric energy that would avoid the drawbacks of the existing such systems like the need for telephone lines available at the reading spot, which makes the latter inapplicable in certain cases. In the same time, the existing infrastructure (power distribution grid) is put to profit making the building and maintenance of the system easier and more efficient and minimizing the cost.

The objective is attained using a system that includes end devices, which may be electric meters (either single-phase or three-phase), street lighting controllers, large load controllers, etc. The end device measures the consumption and the parameters of the electric energy and uses power lines communications (PLC) or wireless communications to transmit such data to an intermediate communications device or directly to the control center.

The system for remote reading, data processing, and management of the consumption of electric energy is shown in the following preferred embodiments:

One of the preferred embodiments of the system for remote reading, data processing, and management of the consumption of electric energy involves end devices with incorporated modems connected through communications means to a control center. The modems at the end devices are equipped with built-in relay for remote on/off switch, a differential current sensor and a digital or analog signal processing, transmitting and receiving unit, which is a modem. The communications means contains at least one data transceiver whereas the control center contains a modem for communication.

In another preferred embodiment of the system for remote reading, data processing, and management of the consumption of electric energy, the end devices are connected to at least one data receiver and transmitter over a low-voltage grid. Between the control center and the data receiver/transmitter there is a second data receiver/transmitter and the connection between the two data transceivers is established over a medium-voltage grid. In this case, the second data transceiver is equipped with incorporated communication modems and the connection between the data transceiver and the control center is achieved through a local area network.

In the third embodiment of the system for remote reading, data processing, and management of the consumption of electric energy, the end devices are connected to at least one of the units that receive and transmit data over the low-voltage grid, the connection between the data transceiver and the control center being achieved through a mobile communications network.

The end device, which may be a single-phase or three-phase electronic energy meter, a street lighting controller, a large loads controller or a similar device, measures the consumption and the parameters of the electric energy and may accommodate access control elements (such as a meter cover opening sensor) and consumption control elements (like a differential current sensor). Depending on the selected embodiment, the end device is equipped with a modem for wired or wireless communication with the intermediate communication unit or directly with the control center. The communication unit is equipped with incorporated modems for wired or wireless communication, or a combination of these two, to connect with the end devices from one side, and from the other side with the control center. The communication unit receives and transmits data

between the end devices and the control center and provides multiplexing of the numerous low-speed connections with the end devices over the existing power lines into a high-speed connection with the control center. The control center accommodates communication modules that may vary in type to support different communication interfaces (wired or wireless) and in number depending on the number of the end devices and intermediate communication units in the system, database for storage of the data from the end devices and an user module for access, processing and analysis of the data and control of the system.

The system in accordance with the invention provides two-way communication in real time between the control center and the end devices. The system users, such as the power utility companies, have immediate access to "screenshot/still" of the information over the whole system, in other words to information about the parameters and the status of the system at a given moment. The system extremely facilitates the making of decisions about the management of the infrastructure by the power utility company.

The proposed solution allows avoiding the restrictions of the existing similar systems such as the need for availability of telephone lines, which in some cases requires the building of additional infrastructure and in other cases makes them inapplicable. In the same time, the use of the existing infrastructure (power lines) is optimized and the cost of external services (telephone and internet services or mobile communications) and the dependence from the providers of such services is minimized. The use of intermediate communication units that concentrate the data from a large number of end devices minimizes the load of the communication modules at the control center and allows the system to be extended to cover millions of end devices.

The incorporation of a relay switch allows individual subscribers to be connected to or disconnected from the power distribution system as needed. On the basis of the information about the consumption and the parameters of electric energy it is possible for an operator or for the system itself using predefined criteria set forth by the utility company or by the end user to undertake actions for connection or disconnection. This from one side allows quicker and more flexible reaction on the part of the utility company, and improves the services they provide to the client. On the other side, it eliminates the need for a utility company employee to visit the residence and cuts expenses, especially in the case where the metering board is not readily accessible (e.g. mounted on a pole) and requires the use of lifting platforms.

Furthermore, the relay switch provides protection for the client from the power distribution network and for the power distribution network from the client in the case of failures or emergency situations. This guarantees the quality of the service provided to the client and additionally extends the capabilities of the power utility company.

DESCRIPTION OF THE DRAWINGS

An illustrative embodiment of the system of the utility model is given on the attached figures, where:

Figure 1: Block diagram of remote metering system that uses the low-voltage lines of the power distribution grid and mobile communications network;

Figure 2: Block diagram of remote metering system that uses the low-voltage and medium-voltage lines of the power distribution grid;

Figure 3: Block diagram of Remote metering system that uses mobile communications network;

ILLUSTRATIVE EMBODIMENTS OF THE UTILITY MODEL

The following illustrative embodiments of the system for remote reading, data processing, and management of the consumption of electric energy are shown:

In the first illustrative embodiment of the System for remote reading, data processing, and management of the consumption of electric energy shown on fig. 1, the end devices with incorporated modems are connected through communication means to the control center 3. The modems at the end devices 1 accommodate switch relays 5 for remote switching on or off; differential current sensor 6 and device for processing, transmitting and receiving digital or analog signal 7. The communication means contains a device for receiving and transmitting data 2, the control center 3 contains communication modem and the connection between the device for receiving and transmitting data 2 and the control center 3 has communication modem 13'.

In the second embodiment of the system for remote reading, data processing, and management of the consumption of electric energy shown on fig.2 the end devices 1 are connected to at least one device for receiving and transmitting data 2 over low-voltage grid 10. Between the control center 3 and the data transceiver 2 is located second data transceiver 4 and the communication between the two data transceivers 2 and 4 is achieved over the medium-voltage grid 11. In this situation, the second data transceiver 4 accommodates incorporated communications modems 8' and 9, and the communication between the data transceiver 4 and the control center 3 is achieved over local area network 12.

In the third embodiment of the system for remote reading, data processing, and management of the consumption of electric energy shown on fig.3 the end devices 1 are connected to least one of the data transceivers 2 over low-voltage grid 10 whereas the communication between the data transceiver 2 and the control center 3 is achieved through mobile communications network 14.

FIELDS OF APPLICATION OF THE UTILITY MODEL

The electric energy metering, data processing and use management system is designed to measure the consumption of electric energy and measure the parameters of the supplied energy on the basis of data analysis and processing whereas the system sends signals to the electric energy metering and control devices in accordance with criteria set forth in advance.

Where the configured reading period occurs, e.g. each 15 minutes, the end device 1 that may be an electric meter records the reading in its internal memory and using the incorporated modem 7 for communication over the low-voltage power distribution grid 10 transmits the recorded data to the transceiver 2 located at the transformer station. Thus the data transceiver 2 is able to collect the data from all electric meters 1 powered from

the transformer station that measure the electric energy used by clients of the low-voltage grid. After that, the data transceiver 2 sends via its incorporated modem for communication over the medium-voltage grid 8 over the existing medium-voltage power distribution grid 11 data received from the electric meters to the second device 4 located at the substation. The substation is in continuous communication with the headquarters of the power utility company where the control center 3 is located (hired lines, optical fiber cables or Ethernet). The second data transceiver 4 on the medium-voltage grid collects data from several transceivers 2 on the low-voltage grid (for example from all kiosk switchgears powered from the substation) and sends it via the modem 9 to the control center 3 through the local area network of the power utility company 12. In this way, data is transmitted using exclusively the existing infrastructure without need for service providers cost.

In the case the power utility company does not own the substation or the medium-voltage grid 8, the data transceiver on the low-voltage grid 2 may use a GPRS mobile communications modem 13 to connect directly to the control center 3 over mobile communications network 14. In this way, at the price of one service provided by the mobile communications network may be controlled hundreds of end devices communicating with the relevant data transceivers and, in the case of failure in the mobile communications network, a simple replacement of the SIM card would help solve the problem.

In the same time, two completely independent infrastructures for remote reading and management of energy consumption may be built managed by a single control center. For example, one electric energy metering system using power lines communications and another street lighting control system using wireless communications could be built. This would give a great advantage to large companies that supply and manage different energy resources and structures, which allows optimizing the investments, resources and maintenance cost. In rare cases of isolated reading premises where the existing infrastructure is absent or its use would prove inefficient the system could use a GPRS mobile data services modem 13 for direct communication with the control center 3.

The data from the electric energy meters shall be recorded and stored in the database of the control center. The user module shall grant access to this data to operators of the system for analysis, reference and export of data, as well as to the utility company's clients for verification of their use.

On the basis of the collected information may be undertaken steps by sending commands to actuators at the end devices or giving instructions to the maintenance staff for undertaking specific measures. The presence of an incorporated relay switch allows connection or disconnection of the subscriber to the power distribution grid as needed to assure direct energy use management.

The presence of an incorporated relay switch further allows protection of the user from the power transmission grid and protection of the power transmission grid from the user. The system provides the possibility to set forth criteria related to the quality of electric energy that the system will be able to monitor and undertake the relevant measures. This guarantees the high quality of the services provided to the subscriber and gives additional capacity to the power utility company.

In addition to electric energy meters and street lighting controllers, large load controllers could be used as end devices in the system. The power utility company could propose preferential prices for electric energy to the clients against their consent to connect their large loads (like a water heater or air conditioning system) to such a controller. In this way, the power utility company shall be able to disconnect certain loads within a given area at peak hours for a given period of time (the period of peak load) to prevent failures in the power supply system. This would not disturb in any way the comfort of the user or the quality of the services (the residence will still have power supply). This would allow the power utility company to take part to the national system for balancing the use of electric energy.

The installation of additional electric energy meters at key locations within the infrastructure would allow for comparison of the amounts of energy supplied and used, which is a powerful instrument to locate losses or thefts. Another such instrument is the use of end devices equipped with differential current sensors that, in the case of difference between the current flowing in the phase wire and the neutral wire (which is a symptom of irregularities and gives rise to suspicions on manipulation or attempted theft) will immediately send an alarm to the control center. This would give great possibilities to the power utility companies to minimize the loss of electric energy.

CLAIMS

1. System for remote reading, data processing, and management of the consumption of electric energy comprising end devices with incorporated modems, the end devices being connected through a communication means to a control center, characterized in that the modems in the end devices /1/ accommodate incorporated relay switches /5/ for remote connection and disconnection, a differential current sensor /6/ and a device for processing, transmission and receiving digital or analog signal /7/, whereas the communication unit contains at least one device for receiving and transmitting data /2/ and the control center /3/ contains a communications modem /13/.
2. System for remote reading, data processing, and management of the consumption of electric energy in accordance with claim 1 characterized in that the end devices /1/ are connected to at least one of the data transceivers /2/ over the low-voltage power distribution grid /10/, whereas between the control center /3/ and the data transceiver /2/ is located a second data transceiver /4/ the communication between the data transceivers /2/ and /4/ being achieved over the medium-voltage grid /11/, the data transceiver /4/ featuring incorporated communications modems /8', 9/, and the connection between the data transceiver /4/ and the control center /3/ is achieved over a local area network /12/.
3. System for remote reading, data processing, and management of the consumption of electric energy in accordance with claim 1 characterized in that the end devices /1/ are connected to the control center /3/ is through mobile communications network /14/ via modems 13 and 13'.

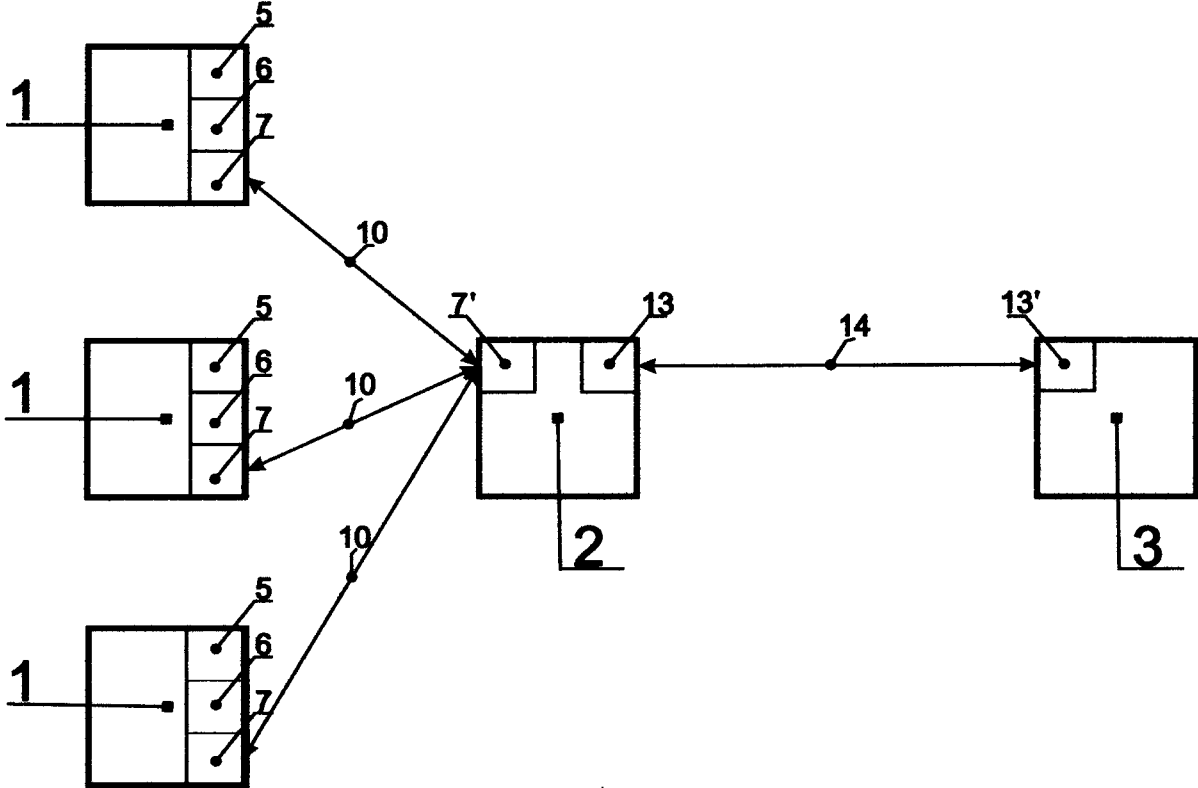


Fig. 1/3

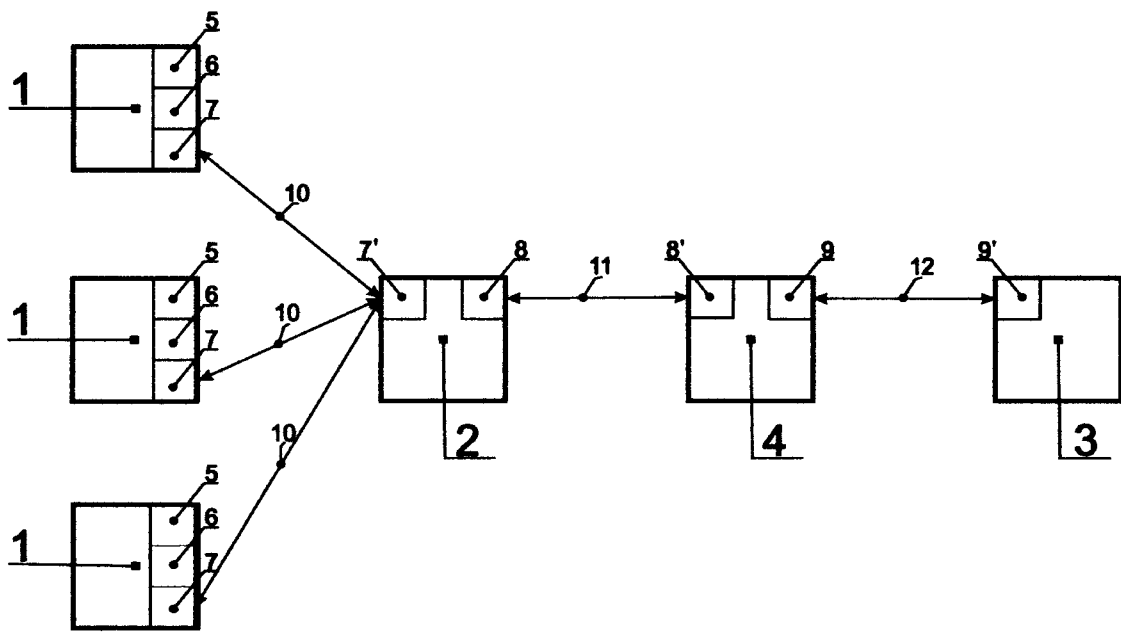


Fig. 2/3

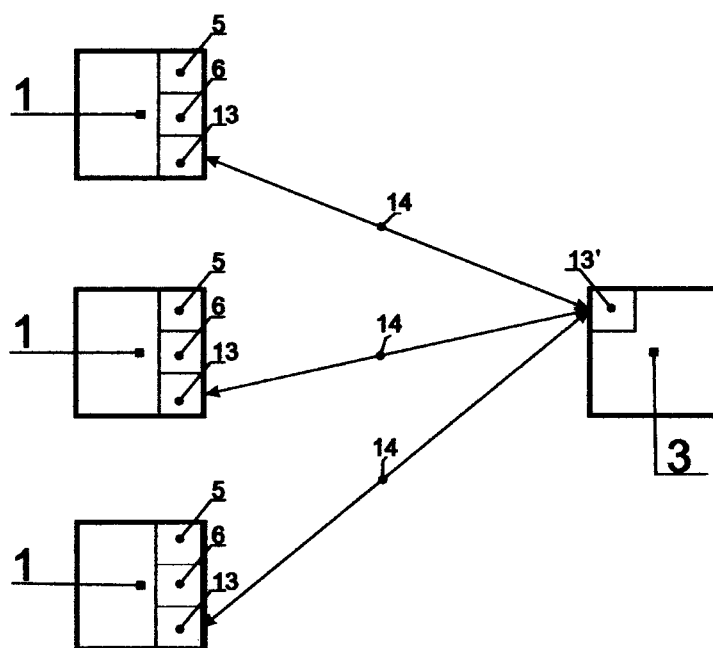


Fig. 3/3

INTERNATIONAL SEARCH REPORT

International application No
PCT/BG2011/000015

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01D4/00
ADD.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
G01D

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/061625 A1 (EHRKE LANCE A [US] ET AL) 1 April 2004 (2004-04-01)	1-3
Y	the whole document	1-3
X	EP 1 548 451 A2 (ENEL DISTRIBUZIONE SPA [IT]) 29 June 2005 (2005-06-29)	1-3
Y	the whole document	1-3
Y	US 6 239 722 B1 (COLTON LAURENCE JAY [US] ET AL) 29 May 2001 (2001-05-29) column 2 - column 7; figure 1	1-3
Y	US 2003/158677 A1 (SWARZTRAUBER SAYRE A [US] ET AL) 21 August 2003 (2003-08-21) abstract; figures 1-3	1-3
Y	US 4 749 992 A (FITZEMEYER EDWARD L [US] ET AL) 7 June 1988 (1988-06-07) column 2 - column 4; figures 1-4	1-3

Further documents are listed in the continuation of Box C.

See patent family annex.

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Date of the actual completion of the international search 16 December 2011	Date of mailing of the international search report 27/12/2011
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Kallinger, Christian
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/BG2011/000015

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