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(54) **SYSTEM AND METHOD FOR PROCESSING MEASUREMENTS, MEASUREMENT UNIT, AND METHOD FOR CONNECTING SUBSTATION TO REMOTE CONTROL CENTER**

(57) The invention relates to a system for processing measurements within a substation. The system comprises a first measurement unit and a second measurement unit, each configured for measuring a characteristic of an energy flow, and for providing a sensor signal. The system also comprises a time indicator for providing a time reference signal and a data processing unit connected to the at least one measurement unit for receiving the respective sensor signal of the at least one measurement unit. Each measurement unit is connected to the time indicator, and each measurement unit is configured to provide its sensor signal indicative of the measured characteristic together with a timestamp indicating the time at which a measurement corresponding to the measured characteristic was taken on the basis of the time reference signal. The data processing unit synchronizes the measurements. Also claimed are measurement units and related methods.

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# SYSTEM AND METHOD FOR PROCESSING MEASUREMENTS, MEASUREMENT UNIT, AND METHOD FOR CONNECTING A SUBSTATION TO A REMOTE CONTROL CENTER

The invention relates to a system for processing measurements within a substation, the system comprising at least one first measurement unit and at least one second measurement unit, each measurement unit being configured for measuring a different characteristic of an electric energy flow in the substation, and for providing a sensor signal indicative of the measured characteristic, a time indicator for providing a time reference signal, and a data processing unit communicatively connected to the at least one measurement unit for receiving the respective sensor signal of the at least one measurement unit.

Such a system in itself is known and is marketed by the applicant under the name SASensor, and is used in e.g. substations of electricity grids. A description of such a system is given in relation to figure 1 below. The system is used to measure characteristics of an electric energy flow. In the known system, the measurements are taken using sensors. The sensors pass the signal to a network switch, which is provided with a time reference signal. The switch is outfitted with a synchronization module, which records the time of arrival of each signal from the sensors. Based on the time of arrival, the measurements are then synchronized by software installed on the switch.

Synchronization is important, since it allows associating measurements taken at substantially the same time to be used as input for analysis or decision making. As a rudimentary example, power may normally be calculated using the voltage and current measurements. However, if the moment at which the voltage measurement deviates from the moment at which the current measurement was taken, the calculated power becomes nondescriptive of any physical quantity.

Although the system described in the preamble performs satisfactory to a certain extent, there remains a need for improvement, particularly in improving synchronization.

The invention therefore has as its object to provide a system for providing synchronized measurements, which allows more accurately synchronizing measurements.

The object is achieved using a system according to the preamble, wherein each measurement unit is communicatively connected to the time indicator for receiving the time reference signal, wherein each measurement unit is configured to provide its sensor signal indicative of the measured characteristic together with a timestamp indicating the time at which a measurement of the characteristic was taken on the basis of the time reference signal, wherein the data processing unit is configured to:

- process one or more measured characteristics from the at least one first measurement unit with one or more measured characteristics from the at least one second measurement unit of which

corresponding measurements were taken within a predefined time period from each other, based on the timestamps provided with each of said measured characteristics, and to

- provide an information signal indicative of the processing of the one or more measured characteristics.

By connecting the measurement units to the time indicator, a system global time is available to each measurement unit. Accordingly, the, for example each, measurement may be provided with a timestamp, which indicates the moment at which the measurement was taken, based on the system global time, i.e. based on the time reference signal. As such, the measurement is provided with a timestamp locally where the measurement is taken. As a result, any delay in transmitting and/or receiving of the sensor's output, does not influence the timestamping of the measurement. Accordingly, the timestamp more accurately describes the moment at which the measurement was taken. By passing the measurements, for instance as values, to the processing unit along with their timestamps, the processing unit may synchronize messages based on their relatively accurate timestamp. Since the timestamp more accurately represents the time at which measurements were taken, the synchronization is more accurate as well.

Accordingly, the system may be configured and suitable for providing synchronized measurements within a substation.

It is noted that since the measurements are timestamped locally, the location at which they are processed and/or synchronized is no longer relevant. It therefore becomes principally possible to process the measurements elsewhere in the substation, or even outside of the substation. As an added advantage, it becomes possible to synchronize measurements of a relatively large amount of measurement units, even when the measurement units are not close together.

Locally timestamping the measurements may herein be understood as providing the measurements with timestamps at the location at which the measurements were taken, for instance within a single device, e.g. in a housing.

Synchronization herein may comprise combining one or more values from the at least one first measurement unit with one or more values from the at least one second measurement unit that were taken within a predefined time period from each other, based on the timestamps provided with each of said values.

The time at which measurements were taken may be evaluated based on the timestamp provided with each respective measurement.

The timestamp may be embodied as a digital signal representing the time at which the measurement was taken. A timestamp may be provided for each measurement in the sensor signal. The timestamp may be generated based on the time reference signal at the moment the measurement was taken, or shortly thereafter, for instance when a measurement controller (see below) processes the measurement. Preferably, the time stamping is implemented in compliance

with the standardized Precision Time Protocol (PTP), IEEE 1588v2, where PTP is defined in accordance with the power utility profile, IEC/IEEE 61850-9-3. PTP is commonly known to the skilled person (see for instance https://en.wikipedia.org/wiki/Precision_Time_Protocol).

In particular, the timestamp may be generated based on a local clock which is synchronized using the clock signal, preferably in compliance with PTP. The timestamp may be a PTP timestamp.

Synchronization via the clock signal may take place based on a sync and/or follow up message sent by e.g. the time indicator, followed by a delay request and respond sent respectively received by the measurement unit, in particular by the measurement controller (see below) thereof. For example, respective synchronization steps based on the PTP standard can be implemented.

The sensor signal may comprise packages which each include data indicative of a measured characteristic and of a time at which the corresponding measurement was taken. The data indicative of said time is referred to as the timestamp.

It is noted that although the invention is described in relation to a substation, it is possible to apply the invention to any other energy installation or other part of an electric power grid that requires or benefits from synchronized measurements. As an example, measurements across different substations may be synchronized using the system as described herein, even if the substations are in different geographical locations, such as neighboring towns.

As an additional advantage, the system may be easily expandable or reconfigurable. In particular, it is not necessary to change, remove or add hardwired connections for each measurement unit when adding, removing or changing a measurement unit. In fact, it may be sufficient to communicatively connect for instance a new measurement unit to the processing unit.

The measurement units may be housed in a housing. The housing may be different and separate from the housing of other units of the system, such as the processing unit. The measurement units may be arranged at a distance from some or all other units of the system, such as the processing unit. The connection between the measurement units and the processing unit may be made over a network, for instance a communication network, a computer network, e.g. including respective wired and/or wireless communication lines, such as ethernet cables or glass fibre cables. Information may be sent using a suitable protocol over the communication lines from the measurement unit to the processing unit. As an example the connection may be made over the internet.

The measured characteristics may be represented in the sensor signal as values indicative of the measurement taken. The representation may be analog or digital. The timestamps may accordingly be provided together with each such value, the timestamp corresponding to the time at which the measurement corresponding to said value was taken.

The characteristics of the energy flow being different may be understood as that they represent a different physical quantity, or the same physical quantity but for another part of the energy network. As an example, one measurement unit may relate to a voltage, while another measurement unit may relate to a current. As another example, one measurement unit may relate to a current in a part of the electricity network, such as a bay, and another measurement unit may relate to a current in another part of the electricity network, such as another bay.

Bays may in this application be defined as separately powered parts of the electricity network. In practice, bays correspond to geographical locations such as a collection of energy consumers. In particular, a bay may correspond to a neighbourhood or district. A bay may be represented within the substation by a single connection or a combination of outgoing connections at the medium voltage level.

The medium voltage level is a concept known to the person skilled in the art, and may for the purpose of this application relates to voltages of over 1000 V alternating current. Additionally or alternatively, the maximum voltages within the medium voltage range may be 70 kV alternating current, 60 kV alternating current, or 25 kV alternating current, or any other value as used in the field.

The processing unit may be a merging unit. A merging unit is a subsystem of a substation protection, automation, and control (PAC) system. A merging unit is most often realized as a device where the current and/or voltage measurements are directly connected to physical ports of the device. An example merging unit is described in US 2014/0074415 A1.

The processing unit may have the functionality of a Logical Device Merging Unit (LDMU) configured according to the International Electrotechnical Commission (IEC), IEC 61850 standard. The processing unit may be configured in accordance with the standards for instrument transformers IEC 6189-13 and IEC 61869-9. Accordingly, the processing of the measured values may be the processing as defined in these protocols.

The information signal may be compliant to a configurable IEC 61850-9-2 sampled measured values (SMV) communication protocol.

The information may be used as input for a application functionalities in a substation Protection, Automation and Control (PAC) system.

Since the system may be used to at least partly automate a substation, the present invention relates to the field of substation automation and in particular to the functionality as defined for standalone merging units as well as the digital interface for instrument transformers.

The present invention further relates to the time coherent combining (i.e. synchronization) of current and/or voltage measured data on an independent hard- and software platform.

Communicatively connected may herein be understood as being connected following the Time Sensitive Networking (TSN) technology as defined by the IEEE802.1Q standard.

Providing the timestamp may take place in accordance with the Precision Time Protocol (PTP) as defined in IEC 61588 and IEEE 1588v2.

The substation may be a distribution substation, for instance used for transforming power from a transmission system (at a relatively high voltage) to a distribution system (at a relatively low voltage. An example of a distribution substation is given by Wikipedia at https://en.wikipedia.org/wiki/Electrical_substation.

The application may be concerned with substation at the high and medium voltage range, e.g. with voltages of over 1,000 V of alternating current.

In an embodiment of the system, each measurement unit comprises:

- a sensor configured for providing an analog signal corresponding to the measured characteristic;
- an analog-digital converter communicatively connected to the sensor for receiving the analog signal, and configured for providing a digital signal corresponding to the analog signal; and
- a measurement controller communicatively connected to the analog-digital converter for receiving the digital signal, and communicatively connected to the time indicator for receiving the time reference signal,

wherein the measurement controller is configured to provide the sensor signal based on the digital signal and the time reference signal.

The sensor, analog-digital converter and the measurement controller may be arranged together in a housing.

The controller being configured to provide the sensor signal based on the digital signal and the time reference signal may have the advantage that the sensor signal is provided with the timestamp relatively close to the sensor. Accordingly, delay that could otherwise influence the timestamping, is compensated for.

In another embodiment of the system, the system further comprises:

- a control module communicatively connected to the data processing unit for receiving the information signal,

wherein the control module is configured to provide a command signal to at least one substation actuator, such as a switching device e.g. a circuit breaker, based on the information signal.

The control module being configured to provide a command signal based on the information signal allows basing the control on the more accurately synchronized measurements. This may be particularly advantageous when such control includes protection functions or other safety-critical decisions.

In particular, the control module may be an IED (Intelligent Electronic Device), for instance as defined in IEC 61850.

The control module may be implemented on or in the processing unit, particularly as a software module. As such, the control module may share hardware with the processing unit, thereby reducing the different hardware units needed, and reducing the need to communicate between separate hardware units, thereby removing delays in the communication process.

In this application, software may include (the programming / implementation of) an FPGA (Field Programmable Gate Array).

In another embodiment of the system, the system may further comprise a network switch,

wherein the at least one measurement unit, the time indicator, the data processing unit and optionally the control unit are communicatively connected to each other via the switch.

Using the network switch, all respective system components may be connected communicatively to each other. Moreover, the system may be easily expandable via the switch.

In particular, the data processing unit is separate from the switch, i.e. it is a separate physical device, connected to the switch via e.g. cabling or wirelessly. Even if no switch is used, the data processing unit may similarly be a separate physical device than the measurement units.

As compared to the prior art system described above, the system as described in this application has the advantage that the switch need not perform any timestamping functionality. As such, a relatively simple type of switch can be used, such as a commercial off the shelf product, preferably compliant with the PTP protocol. The prior art system required custom functionality from the switch thereby limiting the options in selecting hardware for the system, possibly incurring additional costs and increasing dependence on a particular supplier. Now that timestamping is performed at the measurement unit, the switch can be free of such functionality.

As an alternative to using the switch, the respective system components may be connected via any other suitable means or directly.

The system may further include an instrument transformer for each measurement unit, wherein each instrument transformer is configured for providing a secondary electric energy flow isolated from a primary electric energy flow in a substation, wherein each measurement unit is connected to its corresponding instrument transformer for measuring a characteristic of the secondary electric energy flow. The instrument transformer may be an instrument transformer as defined in IEC 61869.

Using instrument transformers measurements can be taken from a secondary electric energy flow. By using instrument transformers, it therefore is possible to measure characteristics of the primary energy flow, without actually having to measure directly any quantity of the primary electric energy flow. In particular when using instrument transformers already present in a substation (or other energy installation), the system of this embodiment may be implemented easily, as no interface needs to be made to the primary electric energy flow.

The characteristic of the electric energy flow may be a current and/or a voltage. In particular, the characteristic of one measurement unit is a current, whereas the characteristic of another measurement unit is a voltage. As such, current and voltage measurements may be processed, e.g. combined, in power readings.

It is noted that although a current or voltage, or other quantity, of the secondary electric energy flow may be measured, the measurement may still be indicative of a corresponding quantity of the primary electric energy. The relation between the corresponding quantities of the primary and secondary electric energy flows may be defined by the instrument transformers used. As such, a characteristic of the secondary electric energy flow may correspond to the same characteristic of the primary electric energy flow.

Further, measurements of currents and voltages may be taken for every bay powered by the substation. Accordingly, a total power throughput of the substation may be calculated based on the measurements.

In particular, the data processing unit may be configured to calculate a value indicative of the power and/or other functions related to the electric domain based on the processed measured characteristics.

The calculated value may benefit from the increased accuracy in synchronization, and therefore may more accurately reflect the quantity of which it is indicative.

The invention also relates to a measurement unit, configured for use in a system according to any of the preceding claims, wherein the measurement unit comprises:

- a measurement interface for measuring a characteristic of an electric energy flow;
- an input for receiving a time reference signal; and
- an output for providing a sensor signal indicative of the measured characteristic,

wherein the measurement unit is configured to provide as its sensor signal the measured characteristic together with a timestamp indicating the time at which a measurement corresponding to the measured characteristic was taken on the basis of the time reference signal.

The measurement unit providing the value together with a timestamp allows synchronizing the measured value with other measurement values more accurately. Since the timestamping takes place by the measurement unit, there is little to no influence of delay, because the timestamp is applied locally in the measurement unit.

In an embodiment, the measurement unit comprises either:

- a sensor comprising the measurement interface, configured for providing an analog signal corresponding to the measured characteristic;
- an analog-digital converter communicatively connected to the sensor for receiving the analog signal, and configured for providing a digital signal corresponding to the analog signal; and

- a measurement controller comprising the input and the output, communicatively connected to the analog-digital converter for receiving the digital signal,

or:

- a sensor comprising the measurement interface, configured for providing a digital, preferably binary, signal corresponding to the measured characteristic; and

- a measurement controller comprising the input and the output, communicatively connected to the sensor for receiving the digital signal;

wherein the measurement controller is configured to provide the sensor signal at the output based on the digital signal and the time reference signal received at the input.

The measurement controller may allow timestamping the measured value at the location at which it was taken, thereby removing or minimizing the influence of delays.

The sensor, optionally the analog-digital converter and the measurement controller may be part of the same physical device, and may for instance be arranged together in a single housing. The measurement unit may be connected to other components of the system via e.g. cables and/or wirelessly.

It is noted that the measurement unit as described herein may allow synchronizing measurements of different measurement units at a distance of the measurement unit without losing accuracy for the synchronization.

The invention also relates to a method of connecting a substation to a remote control center, the method comprising

a) providing a system as described herein;

b) arranging each measurement unit of the system for measuring a desired characteristic of an electric energy flow of the substation; and

c) communicatively connecting the processing unit and optionally the control module to the remote control center.

By using a system as described herein, the measurements made may be synchronized more accurately, possibly at a distance from the measurement location. Accordingly, the remote control center is provided with a more accurate representation of the actual electric energy flow in the system, and may be able to perform more accurate analysis or make better decisions.

In particular, step b) comprises arranging each measurement unit to measure a secondary electric energy flow provided by an existing instrument transformer.

By using an existing instrument transformer, substations or other electric energy installations may be retrofitted without access to the primary electric energy flow. As such, the retrofitting may be performed relatively easily and/or without significant safety risks or significant measures to prevent such risks.

The invention also relates to a method of processing measurements within a substation, said method comprising:

a) generating a time reference signal;

b) measuring at least two different characteristics of an electric energy flow in the substation, and providing at least two corresponding sensor signals, each indicative of the respective measured characteristic and of a time at which a measurement of said characteristic was taken, based on the time reference signal;

c) processing the at least two sensor signals by combining one or more measured characteristics from the at least two sensor signals corresponding to measurements taken within a predefined time period from each other, based on the timestamps provided with each of said measured characteristics; and

d) providing an information signal indicative of the combination of the one or more values.

By providing the sensor signals with timestamps indicating the time at which the measurement was taken, the measured values may be synchronized, for instance at a different location. Since the timestamp is provided locally, i.e. at the moment and place the measurement was taken, any delays in transmitting the sensor signal do not influence the timestamping process. Accordingly, the synchronization may be more accurate since it is based on the timestamps accompanying the measurements, which are in itself more accurate by removal of e.g. such delays.

The method may be used to provide synchronized measurements within a substation.

Step b) of the method may be performed by a measurement unit, preferably one as described above.

A first characteristic that is measured in accordance with the method may pertain to a first bay powered by the substation. A second characteristic measured in accordance with the method may pertain to a second bay powered by the substation. Thus, the measurements may pertain to different bays, and may optionally be measured at different locations.

The invention will be further elucidated with reference to the attached drawings, in which:

Figure 1 schematically shows a prior art system for providing synchronized measurements;

Figure 2 schematically shows a system for providing synchronized measurements;

Figure 3A schematically shows a measurement unit;

Figure 3B schematically shows operations performed by the measurement unit of figure 3A;

Figure 4 schematically shows a method of connecting a substation to a command and control center; and

Figure 5 schematically shows a method of providing synchronized measurements.

Throughout the figures, like elements will be referred to using like reference numerals.

Figure 1 shows a prior art system 1 for providing synchronized messages in a substation or other electric energy installation. The system 1 includes sensors 2-1 - 2-4 for taking measurements in a substation. For instance, a sensor 2-1 may measure a voltage, and other sensors 2-2 – 2-4 may each measure a current, for instance of different bays powered by the substation. The measured values are provided via sensor signals 4 to a network switch 3, which includes a processing module 5. The processing module 5 provides the measured values received using the sensor signals 4 with timestamps at the time of arrival, and synchronizes them accordingly. Using the synchronized values, an information signal 6 is provided to a command and control center 7. The information signal may for instance include power data or other data relating to the electric domain.

Figure 2 shows a system 11 for processing measurements, for instance for providing synchronized measurements, which is provided with measurement units 12-1 – 12-4. Details of the measurement units 12-1 – 12-4 (collectively referred to as 12) are provided below in relation to figure 3A. The system 11 further includes a time indicator 18 which provides a time reference signal 19. As an example, the time indicator comprises a GPS receiver. The system 11 is configured to pass the time reference signal 19, preferably via a network switch 13 to each measurement unit 12, for example by communication lines 19'. The measurement units 12 are each configured to provide a sensor signal 14 which is indicative not only of a measured value, but also of a timestamp indicating the time at which the measurement of said value was taken, based on the time reference signal. The system 11 further includes a data processing unit 15, which in this example is separate from the network switch 13. The data processing unit is embodied as a server configured to run software for providing the required functionalities. The server is placed at a distance from the switch 13 and the measurement units 12. The data processing unit 15 is configured to receive measurement data 14' from the measurement units 12-1 – 12-4, which includes the sensor signals 14 and thus the measured values with corresponding timestamps. The data processing unit 15 is configured to process or combine values from different measurement units taken at about the same time, i.e. the data processing unit 15 synchronizes the measurements. Synchronization is based on the timestamp provided with each measurement value. It is noted the data processing unit 15 is separate from, and at a distance from, the measurement units 12. This is made possible by timestamping the measured values locally at the measurement units 12, so that a delay in transmitting the measured values to the data processing unit 15 does not influence the time synchronization performed by the data processing unit 15. The data processing unit 15 is further

configured to provide an information signal 20 which includes a combination of at least some of the processed, e.g. combined or synchronized, values. The data processing unit 15 is configured to pass the information signal 20 to a control module 21, which in the current example is an IED. The control module is configured to provide a command signal 22 to substation actuators (not shown). As such, the control module 21 may perform safety checks and issue commands accordingly. The data processing unit 15 is also configured to pass the information signal 20 to a protocol converter 23 which is configured to allow communication 24 between a remote control center 17 and the system 11. Although the control module 21 is shown herein as a separate physical device, the control module 21 may also be implemented as software on the data processing unit 15.

Figure 3A shows a measurement unit 12 including an input 25 and an output 26. At the input 25 a time reference signal can be received by a measurement controller 29. The measurement controller 29 also comprises the output 26. It is configured to provide a sensor signal at the output 26. The sensor signal is indicative of a measured value and a timestamp indicating the time at which a measurement corresponding to said measured value was taken. The timestamp is based on the time reference signal received at the input 25. The analog sensor 27 is configured to generate a measured value, for instance by measuring a characteristic of a primary or secondary electric energy flow. The sensor 27 is configured to provide an analog signal 30 to an analog-digital converter 28, which in turn is configured to provide a digital signal 31 to the measurement controller 29. Accordingly, the measurement controller 29 is configured to receive information on the measured value via the digital signal 31 and on the time via the time reference signal received at the input 25, and has this information available at the suitable moment. Further, the measurement controller 29 is configured to provide measured values with timestamps as described above. The measurement unit 12 is provided as a stand alone device with a physical interface comprising the input 25 and output 26. The sensor 27, analog-digital converter 28 and measurement controller 29 are provided in a housing 32. It is noted that instead of an analog sensor 27 and analog-digital converter 28 a digital sensor could be used.

Figure 3B shows the steps performed by the measurement unit 12 of figure 3A. The measurement unit 12 receives in a first step 101, at the input of the measurement controller 29, a time reference signal. Then, in a second step 102, a measurement is taken by the sensor 27. A digital signal is created corresponding to the measurement, and passed to the measurement controller 29. The measurement controller 29 combines, in a third step 103, each measurement with a timestamp, the timestamp indicates the time at which the measurement was taken. Finally, in a fourth step 104, the measurement controller 29 provides at the output 26 a sensor signal which reflects the measured value and the corresponding timestamp. It is noted that steps 101 and 102 may be performed in an alternative order, and or at least partially simultaneously.

Figure 4 shows a method 200 of connection a substation to a remote control center. The method includes a first step 201 of providing a system as described herein, for instance in correspondence with figure 2. In a second step 202, the method includes arranging each measurement unit of the system for measuring a desired characteristic of an electric energy flow of the substation. In a final step 203, the processing unit and optionally the control module of the system are connected communicatively with the remote control center. In the second step 202, the measurement units are arranged to measure a secondary electric energy flow provided by existing instrument transformers.

Figure 5 shows a method 300 of providing synchronized measurements within a substation. The method comprises a first step 301 of generating a time reference signal. The method 300 further includes a second step 302 of measuring at least two different characteristics of an electric energy flow in the substation, and providing at least two corresponding sensor signals, each indicative of a value representing the respective measured characteristic and of a time at which a measurement corresponding to said value was taken, based on the time reference signal. A third step 303 comprises processing the at least two sensor signals by combining one or more values from the at least two sensor signals corresponding to measurements taken within a predefined time period from each other, based on the timestamps provided with each of said values. A final and fourth step 304 includes providing an information signal indicative of the combination of the one or more values. As an example, the second step 302 may be performed using the measurement unit described with respect to figure 3A.

Although the invention has been described above with reference to specific examples and embodiments, the invention is not limited thereto, the scope the invention being determined by the claims.

# Conclusies

1. Systeem voor het verwerken van metingen binnen een substation, het systeem omvattende:

-ten minste een eerste meeteenheid en ten minste een tweede meeteenheid, waarbij elke meeteenheid is geconfigureerd voor het meten van een verschillende kenmerk van een elektrische energiestroom in het substation, en voor het verschaffen van een sensorsignaal dat indicatief is voor het gemeten kenmerk;

-een tijdindicator voor het verschaffen van een tijdreferentiesignaal; en

-een gegevensverwerkingseenheid die communicatief is verbonden met de ten minste ene meeteenheid voor het ontvangen van het respectieve sensorsignaal van de ten minste ene meeteenheid,

met het kenmerk, dat

elke meeteenheid communicatief is verbonden met de tijdindicator om het tijdreferentiesignaal te ontvangen,

waarbij elke meeteenheid is geconfigureerd om zijn sensorsignaal indicatief van het gemeten kenmerk samen met een tijdstempel welke de tijd aangeeft waarop een meting van het kenmerk is genomen op de basis van het tijdreferentiesignaal, te verschaffen,

waarbij de gegevensverwerkingseenheid is geconfigureerd om:

-een of meer gemeten kenmerken van de ten minste ene eerste meeteenheid te verwerken met een of meer gemeten kenmerken van de ten minste ene tweede meeteenheid waarvan corresponderende metingen zijn genomen binnen een voorafbepaalde tijdperiode van elkaar, gebaseerd op de tijdstempels voorzien met elk van genoemde gemeten kenmerken, en om

-een informatiesignaal te voorzien dat indicatief is voor de verwerking van de een of meer gemeten kenmerken.

2. Systeem volgens de voorgaande conclusie, waarbij elke meeteenheid omvat:

-een sensor geconfigureerd om een analoog signaal te leveren dat overeenkomt met het gemeten kenmerk;

-een analoog-digitaal omzetter welke communicatief aan de sensor is verbonden om het analoge signaal te ontvangen, en geconfigureerd om een digitaal signaal te leveren dat overeenkomt met het analoge signaal; en

-een metingcontroller welke communicatief is verbonden met de analoog-digitaal omzetter om het digitale signaal te ontvangen, en communicatief verbonden met de tijdindicator om het tijdreferentiesignaal te ontvangen, waarbij de metingcontroller is geconfigureerd om het sensorsignaal te voorzien gebaseerd op het digitale signaal en het tijdreferentiesignaal.

3. Systeem volgens een der voorgaande conclusies, verder omvattende:

-een controlmodule welke communicatief is verbonden met de gegevensverwerkingseenheid om het informatiesignaal te ontvangen, waarbij de controlmodule is geconfigureerd om een stuursignaal te voorzien aan ten minste een substationactuator, om een schakelinrichting bijv. circuitbreker, gebaseerd op het informatiesignaal.

4. Systeem volgens de voorgaande conclusie, waarbij de controlmodule een softwaremodule is welke op de gegevensverwerkingseenheid is geïmplementeerd.

5. Systeem volgens een der voorgaande conclusies, verder omvattende:

-een netwerkswitch,

waarbij de ten minste ene meeteenheid, de tijdindicator, de gegevensverwerkingseenheid en optioneel de controleenheid communicatief zijn verbonden aan elkaar via de switch.

6. Systeem volgens een der voorgaande conclusies, verder een instrumenttransformator omvattende voor elke meeteenheid, waarbij elke instrumenttransformator is geconfigureerd om een secondaire elektrische energiestroom te voorzien welke van een primaire elektrische energiestroom is geïsoleerd in een substation, waarbij elke meeteenheid is verbonden aan zijn corresponderende instrumenttransformator om een kenmerk van de secondaire elektrische energiestroom te meten.

7. Systeem volgens een der voorgaande conclusies, waarbij het kenmerk een stroom en/of spanning is.

8. Systeem volgens een er voorgaande conclusies, waarbij de gegevensverwerkingseenheid is geconfigureerd om een waarde te berekenen die indicatief is voor het vermogen gebaseerd op de verwerkte een of meer gemeten kenmerken.

9. Meeteenheid, geconfigureerd voor gebruik in een systeem volgens een der voorgaande conclusies, waarbij de meeteenheid omvat:

-een metinginterface voor het meten van een kenmerk van een elektrische energiestroom;

-een ingang voor het ontvangen van een tijdreferentiesignaal; en

-een uitgang voor het voorzien van een sensorsignaal dat indicatief is voor het gemeten kenmerk,

waarbij de meeteenheid is geconfigureerd om als zijn sensorsignaal het gemeten kenmerk te leveren samen met een tijdstempel dat de tijd aangeeft waarop een meting die met het gemeten kenmerk overeenkomt is genomen op de basis van het tijdreferentiesignaal.

10. Meeteenheid volgens de voorgaande conclusie, waarbij de meeteenheid omvat:

of

-een sensor omvattende de metinginterface, geconfigureerd om een analoog signaal te leveren dat met het gemeten kenmerk overeenkomt;

-een analoog-digitaal omzetter welke communicatief is verbonden met de sensor om het analoge signaal te ontvangen, en geconfigureerd om een digitaal signaal te leveren dat overeenkomt met het analoge signaal; en

-een metingcontroller welke de ingang en uitgang omvat, communicatief verbonden met de analoog-digitaal omzetter om het digitale signaal te ontvangen,

of:

-een sensor omvattende de metinginterface, geconfigureerd om een digitaal, bij voorkeur binair, signaal te leveren dat met het gemeten kenmerk overeenkomt; en

-een metingcontroller welke de ingang en uitgang omvat, communicatief verbonden met de sensor om het digitale signaal te ontvangen;

waarbij de metingcontroller is geconfigureerd om het sensorsignaal op de uitgang te leveren gebaseerd op het digitale signaal en het op de ingang ontvangen tijdreferentiesignaal.

11. Werkwijze voor het verbinden van een substation aan een regelcentrale op afstand, de werkwijze omvattende:

a) voorzien van een systeem volgens een der voorgaande conclusies;

b) configureren van elke meeteenheid van het systeem om een gewenst kenmerk van een elektrische energiestroom van het substation te meten; en

c) communicatief verbinden van de verwerkingseenheid en optioneel de controlmodule aan de regelcentrale op afstand.

12. Werkwijze volgens een der voorgaande conclusies, waarbij stap b) omvat het inrichten van elke meeteenheid om een secundaire elektrische energiestroom te meten welke door een bestaande instrumenttransformator wordt voorzien.

13. Werkwijze voor het verwerken van metingen binnen een substation, de werkwijze bijvoorbeeld gebruikmakende van een systeem volgens een der conclusies 1-8, de werkwijze omvattende:

a) genereren van een tijdreferentiesignaal;

b) meten van ten minste twee verschillende kenmerken van een elektrische energiestroom in het substation, en het voorzien van ten minste twee overeenkomstige sensorsignalen, elk indicatief van een respectief gemeten kenmerk van een tijd waarop een meting die overeenkomt met genoemd gemeten kenmerk is genomen, gebaseerd op het tijdreferentiesignaal;

c) verwerken van de ten minste twee sensorsignalen door een of meer gemeten kenmerken van de ten minste twee sensorsignalen die overeenkomen met metingen genomen binnen een voorafbepaalde tijdperiode van elkaar te combineren, gebaseerd op de tijdstempels die met elk van genoemde kenmerken zijn voorzien; en

d) voorzien van een informatiesignaal dat indicatief is van de combinatie van de een of meer waarden.

14. Werkwijze volgens de voorgaande conclusie, waarbij stap b) wordt uitgevoerd door een meeteenheid, bij voorkeur een volgens conclusie 9 of 10.

15. Werkwijze volgens een der conclusies 13-14, waarbij een eerste kenmerk gerelateerd is aan een eerste compartiment dat door het substation wordt gevoed, en waarbij een tweede kenmerk gerelateerd is aan een tweede compartiment dat door het substation wordt gevoed.

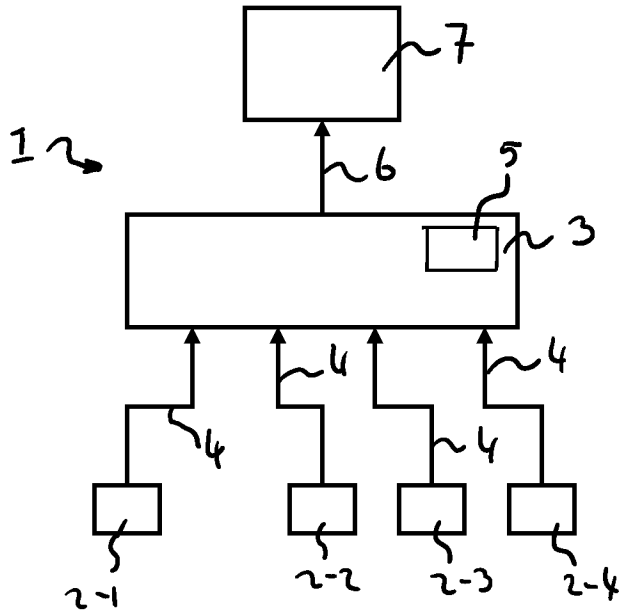
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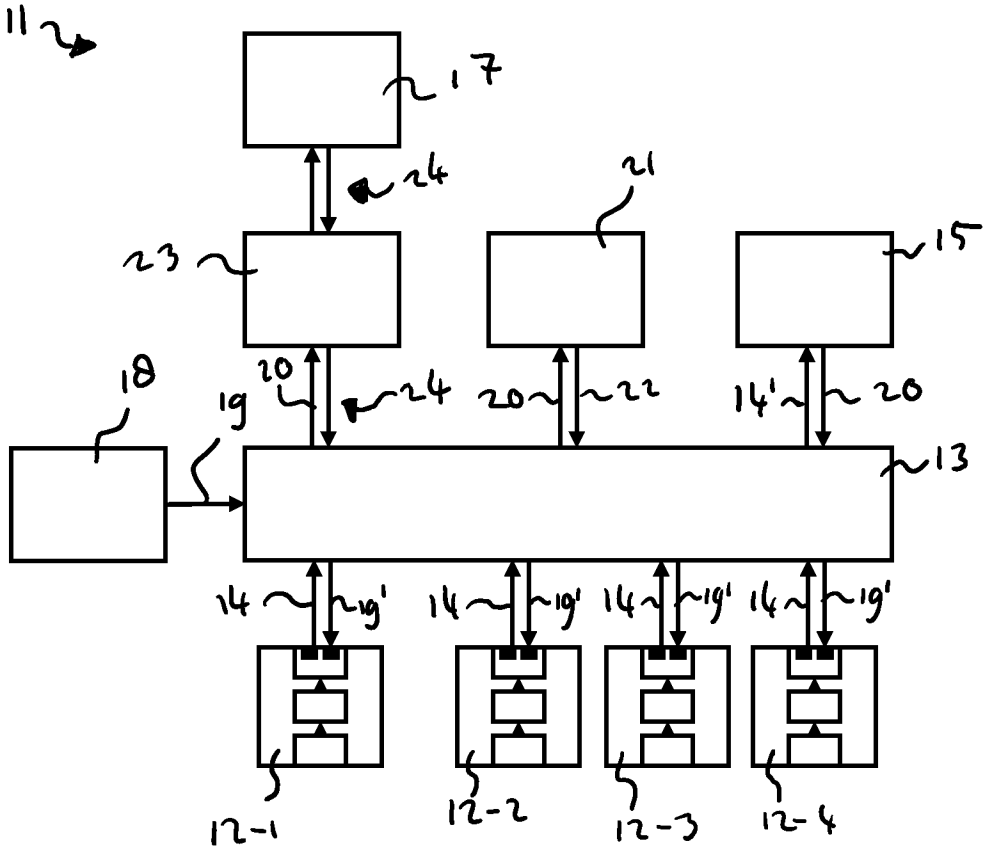
**Fig. 1**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12-4

**Fig. 2**

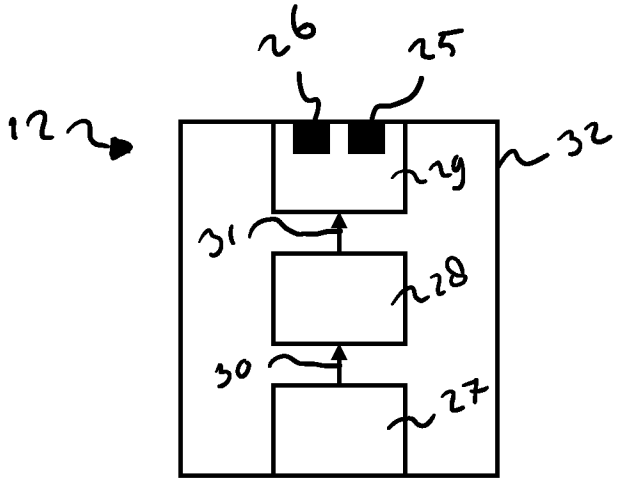


Fig. 3A

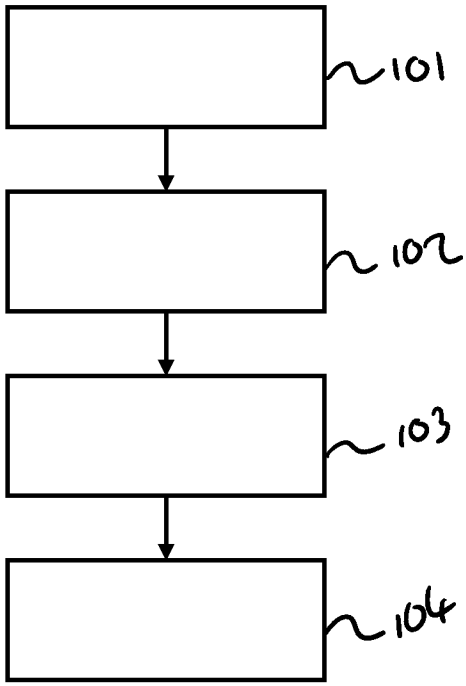


Fig. 3B

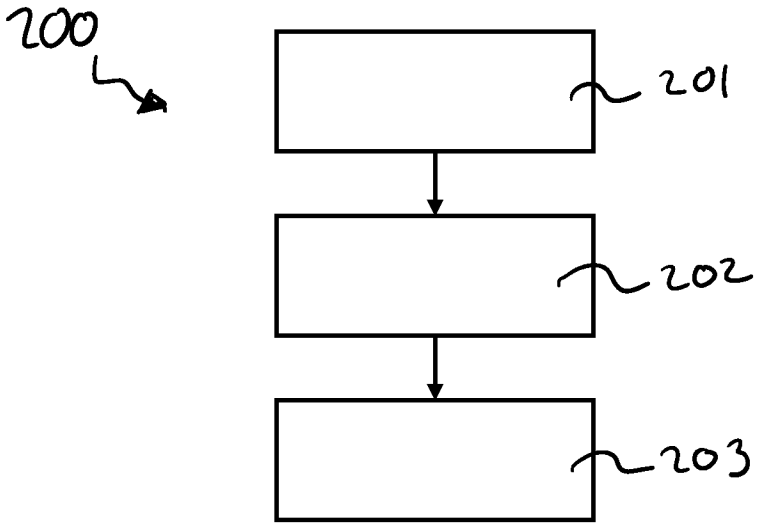


**Fig. 4**

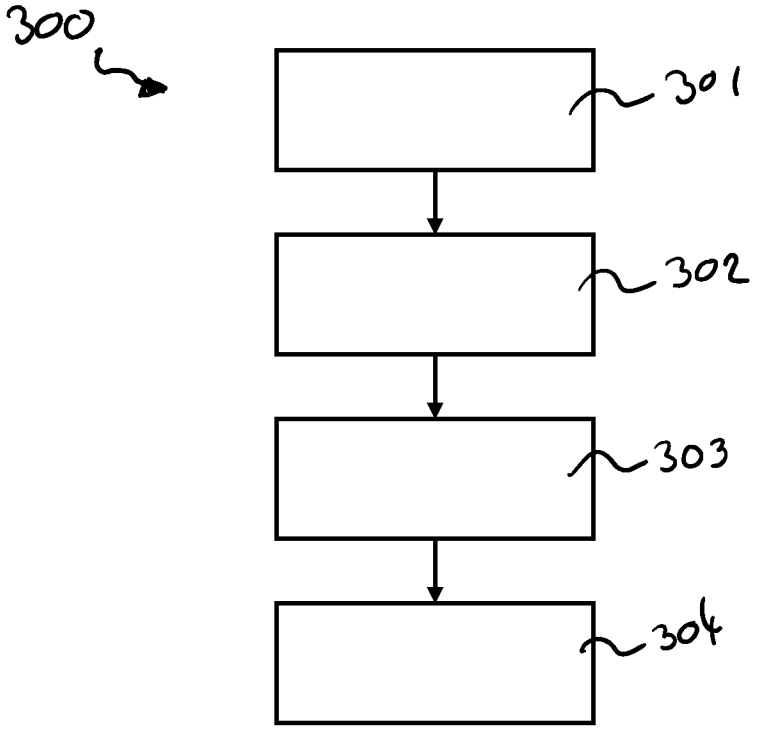


**Fig. 5**

# SAMENWERKINGSVERDRAG (PCT)

## RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

| IDENTIFICATIE VAN DE NATIONALE AANVRAGE | KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE |
|---|---|
| | |
| Nederlands aanvraag nr.<br>**2029344** | Indieningsdatum<br>**07-10-2021** |
| | Ingeroepen voorrangsdatum |
| Aanvrager (Naam)<br>**Alliander N.V.** | |
| Datum van het verzoek voor een onderzoek van internationaal type<br>**18-12-2021** | Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr.<br>**SN80226** |

**I. CLASSIFICATIE VAN HET ONDERWERP** (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

**Zie onderzoeksrapport**

**II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK**

Onderzochte minimumdocumentatie

| Classificatiesysteem | Classificatiesymbolen |
|---|---|
| **IPC** | **Zie onderzoeksrapport** |

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

| | | | |
|---|---|---|---|
| **III.** | ☐ | **GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES** | (opmerkingen op aanvullingsblad) |
| **IV.** | ☐ | **GEBREK AAN EENHEID VAN UITVINDING** | (opmerkingen op aanvullingsblad) |

# ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
**NL 2029344**

A. CLASSIFICATIE VAN HET ONDERWERP
**INV. H02J13/00 G01R19/25**
**ADD.**

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte miminum documentatie (classificatie gevolgd door classificatiesymbolen)
**H02J G01R**

Onderzochte andere documentatie dan de mimimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
**EPO-Internal, WPI Data**

C. VAN BELANG GEACHTE DOCUMENTEN

| Categorie ° | Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages | Van belang voor conclusie nr. |
|---|---|---|
| X | US 2018/348267 A1 (YANG QIAOYIN [US] ET AL) 6 december 2018 (2018-12-06) | 1-7,9-15 |
| Y | * figuren 2,3 * | 8 |
| | * alinea [0017] - alinea [0018] * | |
| | * alinea [0029] * | |
| | * alinea [0035] - alinea [0037] * | |
| | * alinea [0039] - alinea [0048] * | |
| | ----- | |
| X | US 2010/002348 A1 (DONOLO MARCOS A [US] ET AL) 7 januari 2010 (2010-01-07) | 1,9,11, 13 |
| | * figuren 1,3,4,22 * | |
| | * alinea [0034] - alinea [0036] * | |
| | * alinea [0106] * | |
| | * alinea [0109] - alinea [0110] * | |
| | * alinea [0112] - alinea [0114] * | |
| | * alinea [0294] * | |
| | ----- | |
| | -/-- | |

[X] Verdere documenten worden vermeld in het vervolg van vak C.

[X] Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

° Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

| Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid | Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type |
|---|---|
| **21 juni 2022** | |

| Naam en adres van de instantie | De bevoegde ambtenaar |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016 | **Martin, Raynald** |

1

# ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
**NL 2029344**

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN

| Categorie ° | Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages | Van belang voor conclusie nr. |
|---|---|---|
| X | US 2013/307331 A1 (BERGGREN BERTIL [SE] ET AL) 21 november 2013 (2013-11-21)<br>* figuur 1 *<br>* alinea [0041] - alinea [0045] *<br>* alinea [0048] *<br>* alinea [0052] * | 1,9,11, 13 |
| X | US 2012/089262 A1 (WANG ZHAO [CN] ET AL) 12 april 2012 (2012-04-12)<br>* figuren 1-3 *<br>* alinea [0024] - alinea [0030] * | 1,9-11, 13 |
| X<br>Y | US 2009/099798 A1 (GONG YANFENG [US] ET AL) 16 april 2009 (2009-04-16)<br>* figuren 2,3 *<br>* alinea [0022] - alinea [0023] *<br>* alinea [0052] - alinea [0054] * | 1,9,11, 13<br>8 |

# ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek

**NL 2029344**

| In het rapport genoemd octrooigeschrift | Datum van publicatie | Overeenkomend(e) geschrift(en) | Datum van publicatie |
|---|---|---|---|
| US 2018348267 A1 | 06-12-2018 | GEEN | |
| US 2010002348 A1 | 07-01-2010 | GEEN | |
| US 2013307331 A1 | 21-11-2013 | CN 102044870 A | 04-05-2011 |
| | | EP 2312719 A1 | 20-04-2011 |
| | | US 2011093124 A1 | 21-04-2011 |
| | | US 2013307331 A1 | 21-11-2013 |
| US 2012089262 A1 | 12-04-2012 | CN 102484394 A | 30-05-2012 |
| | | EP 2294675 A1 | 16-03-2011 |
| | | US 2012089262 A1 | 12-04-2012 |
| | | WO 2010118550 A1 | 21-10-2010 |
| US 2009099798 A1 | 16-04-2009 | US 2009099798 A1 | 16-04-2009 |
| | | WO 2009048964 A1 | 16-04-2009 |

# WRITTEN OPINION

| File No. | Filing date *(day/month/year)* | Priority date *(day/month/year)* | Application No. |
|---|---|---|---|
| SN80226 | 07.10.2021 | | NL2029344 |

International Patent Classification (IPC)
INV. H02J13/00 G01R19/25

Applicant
Alliander N.V.

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the application
- ☒ Box No. VIII Certain observations on the application

| | Examiner |
|---|---|
| | Martin, Raynald |

Application number

# WRITTEN OPINION

NL2029344

## Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

## Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

| | | | |
|---|---|---|---|
| Novelty | Yes: | Claims | 8 |
| | No: | Claims | 1-7, 9-15 |
| Inventive step | Yes: | Claims | |
| | No: | Claims | 1-15 |
| Industrial applicability | Yes: | Claims | 1-15 |
| | No: | Claims | |

2. Citations and explanations

**see separate sheet**

# WRITTEN OPINION

## Box No. VII Certain defects in the application

see separate sheet

## Box No. VIII Certain observations on the application

see separate sheet

1 **Re Item VIII**

**Certain observations on the application**

1.1 The method claim 11 is defined as providing a system according to one of the previous claims, wherein the claims 9 and 10 are not defining such a system, thereby rendering the subject-matter of claim 11 unclear.

1.2 The method claim 12 is defined as being dependent of any of the preceding claims, wherein claims 1-10 are apparatus claims, thereby rendering the subject-matter of claim 12 unclear.

2 **Re Item V**

**Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

2.1 Reference is made to the following documents:

D1 US 2018/348267 A1 (YANG QIAOYIN [US] ET AL) 6 december 2018 (2018-12-06)

D2 US 2010/002348 A1 (DONOLO MARCOS A [US] ET AL) 7 januari 2010 (2010-01-07)

D3 US 2013/307331 A1 (BERGGREN BERTIL [SE] ET AL) 21 november 2013 (2013-11-21)

D4 US 2012/089262 A1 (WANG ZHAO [CN] ET AL) 12 april 2012 (2012-04-12)

D5 US 2009/099798 A1 (GONG YANFENG [US] ET AL) 16 april 2009 (2009-04-16)

2.2 The present application does not meet the criteria of patentability, because the subject-matter of claim 1 is not new.

2.2.1 D1 discloses (Fig.2 and 3) a system for processing measurements within a substation, the system comprising:

- at least one first measurement unit and at least one second measurement unit (RDAU 222, RDAU#1-RDAU#4 322, 324, 326, 328), each measurement unit being configured to measure a different characteristic of an electrical energy flow in the substation, and to provide a sensor signal indicative of the measured characteristic ([0043]);

- a time indicator for providing a time reference signal (352, [0044]); and
- a data processing unit communicatively connected to the at least one measurement unit for receiving the respective sensor signal from the at least one measurement unit (IED 342),

wherein

- each measurement unit is communicatively connected to the time indicator to receive the time reference signal (Fig.3, [0044]),
- each measurement unit is configured to provide its sensor signal indicative of the measured characteristic together with a time stamp indicating the time at which a measurement of the characteristic was taken on the basis of the time reference signal ([0040]),
- the data processing unit is configured to ([0047-0048]):
  - process one or more measured characteristics of the at least one first unit of measurement with one or more measured characteristics of the at least one second unit of measurement of which corresponding measurements have been taken within a predetermined time period of each other, based on the time stamps provided with each of said measured characteristics, and
  - to provide an information signal indicative of the processing of the one or more measured characteristics.

The subject-matter of claim 1 is therefore not new over D1.

2.3 The present application does not meet the criteria of patentability, because the subject-matter of claim 9 is not new.

2.3.1 D1 discloses (2 and 3) a measurement unit (RDAU 222, RDAU#1-RDAU#4 322, 324, 326, 328), configured for use in a system according to claim 1, wherein the measurement unit comprises ([0035-0036], [0040]):

- a measurement interface for measuring a characteristic of an electrical energy flow;
- an input for receiving a time reference signal; and
- an output for providing a sensor signal indicative of the measured characteristic,

wherein the measurement unit is configured to provide as its sensor signal the measured characteristic together with a time stamp indicating the time at which a measurement corresponding to the measured characteristic was taken on the basis of the time reference signal.

The subject-matter of claim 9 is therefore not new over D1.

2.4 The present application does not meet the criteria of patentability, because the subject-matter of claim 11 is not new.

2.4.1 D1 discloses (Fig.1A, 2 and 3, [0017-0022]) a method of connecting a substation (119, 141, 151, 190) to a remote control center (172), the method comprising:

(a) providing a system according to claim 1;

(b) configuring each measurement unit of the system to measure a desired characteristic of an electrical energy flow from the substation; and

(c) communicatively connecting the processing unit (IED 104, 106, 108, 115) and optionally the control module to the remote control center.

The subject-matter of claim 11 is therefore not new over D1.

2.4.2 Claim 13 is a method claim corresponding to apparatus claim 1 and its subject-matter is therefore as well not new over D1.

2.5 All the features of claims 1, 9, 11 and 13 are as well disclosed in D2-D5 and their subject-matter is therefore as well not new over these documents.

2.6 Dependent claims 2-8, 10, 12, 14 and 15 do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of novelty and/or inventive step, the reasons being as follows.

2.6.1 Claim 2: D1, [0035-0036], Fig.5.

2.6.2 Claims 3 and 4: D1, [0035-0037].

2.6.3 Claim 5: D1, Fig.2, [0037].

2.6.4 Claims 6 and 7: D1, F2 and 3, [0035], [0043].

2.6.5 Claim 8: D1, [0048] with D5, [0064].

2.6.6 Claim 10: D1, [0035-0036], Fig.5; D4, [0008].

2.6.7 Claim 12: D1, F2 and 3, [0035], [0043].

2.6.8 Claim 14: D1, [0017], [0046-0047].

3 **Re Item VII**

**Certain defects in the application**

3.1 The features of the claims are not provided with reference signs placed in parentheses.

3.2 The relevant background art disclosed in D1-D5 is not mentioned in the description, nor are these documents identified therein.