(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 257 718 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
20.12.2017 Bulletin 2017/51

(51) Int Cl.:
B61L 19/06 *(2006.01)* ***B61L 27/00*** *(2006.01)*
B61L 7/08 *(2006.01)*

(21) Application number: **17169357.5**

(22) Date of filing: **03.05.2017**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **05.05.2016 NL 2016734**
02.05.2017 NL 2018835

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(54) **RELAY HOUSE OR RELAY BOX CABINET WITH ETHERCAT SYSTEM**

(57) System or method of wired data transfer, under real-time conditions, from a large number of digital and/or analog sensors, to a central unit for processing and/or storing those data, such as a DPU or DAQD, the sources and the central unit are close to each other and form a system, inside a relay house or a relay box cabinet, which system is operatively associated with a railway. For example, a relay house or relay box cabinet with EtherCat system.

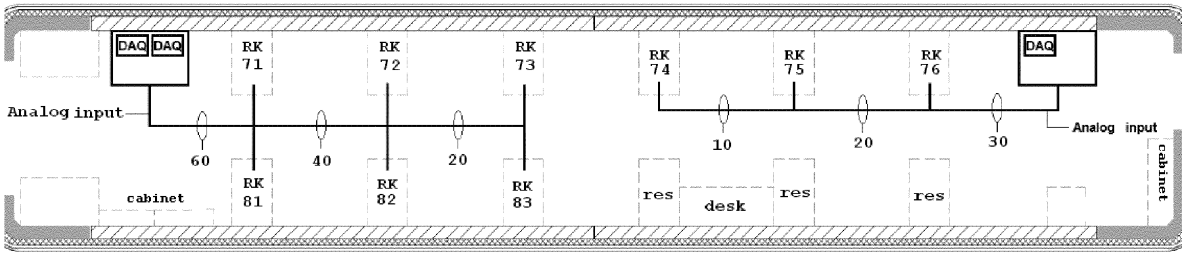


Fig. 3

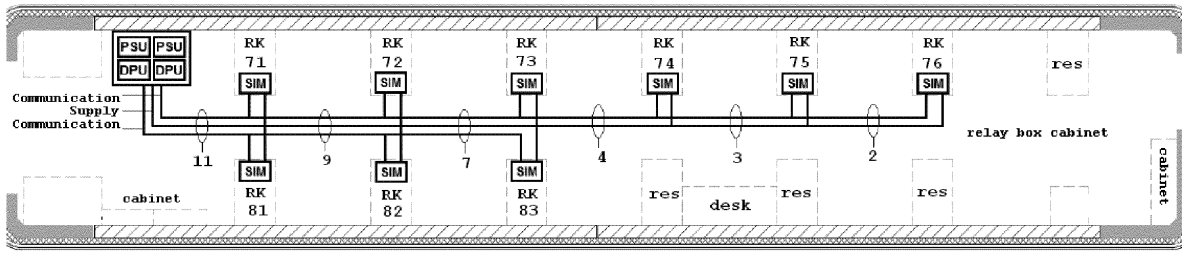


Fig. 4

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Description

[0001] Relay house or relay box cabinet with EtherCat system.

[0002] This invention relates to the wired transfer of data under real-time conditions, from a large number of digital and/or analog measuring data providing sources, such as digital and/or analog sensors, to a central unit for processing and/or storage of such data, such as a DPU (data processing unit), or a DAQD (data acquisition device), wherein the sources and the central unit are located close to each other and form a system, preferably within a relay housing or a relay box cabinet (hereinafter also referred to as "housing"),which system is operatively associated with a railway, for example, is arranged adjacent to a railway. Other railway applications are also conceivable, for train, tram or metro, for passenger and freight transport, preferably with an overhead line over the railway line for the electric power supply of the train locomotive. The system preferably fits within a ground surface being a maximum of 100 or 50 or 25 meters long and up to 100 or 50 or 25 or 15 meters in width, and/or can be located indoor or outdoor.

[0003] It should be understood that "digital" also means a digital analog-like signal having the function to present only two states, e.g. "on" and "off" or "in" and "out", which states are usually substantially different from each other and/or provide substantially different sensor signals, for example, "0 V", and "24 V". In general, such a sensor signal is as an analog signal applied to a digital input of the data-processing unit, and is at or after the digital input signal digitized by an A/D converter in order to be further processed as "real" digital signal by the digital working computer processor. In contrast to "digital", "analog" means an analog signal that has the function of presenting many states, which usually differ little from one another and/or lead to slightly differing sensor signals, for example a stepless between a minimum and maximum fluctuating value such as a temperature or a current or voltage level. Generally, such a sensor signal is presented as an analog signal to an analog input of a data processing unit and at or after that analog input, the signal is made digital by an A/D converter to be processed as digital signal by the digitally operating computer processor.

[0004] By "wired data transfer" is preferably meant that communication between the components of the system is via wiring, so preferably there is no wireless and/or radio communication.

[0005] This document focuses primarily on a system placed in a house, such as a relay house or relay cabinet, thus an indoor system. The features disclosed in this context are also applicable to the alternative outdoor system, or a system under a covering.

[0006] The system, for example, placed in a house, usually contains a large number of more than ten or a hundred galvanic relays for example, a railway security system. For example, of the type of security relay (so-called B relay, e.g. B1 relay). The house is for example part of a railroad application dedicated to the management and control of turnouts and crossings, or track occupancy report. The house includes, for example, at least ten of each of one or more of a level crossing relay, voltage monitoring relay, control relay, monitoring relay, track repeat relay (TPR) or track relay (the TR, or the so-called B2-Vane relay is a widely used track relay, the track relay indicates whether a train is located in the relevant track section).

[0007] In addition, the house comprises galvanic features, such as supply cables, to feed the galvanic current (in language typical in the field "motor current") to electric motors for adjusting switch blades and/or switch frogs or to move barriers of railway crossings.

[0008] A B-Relay is a relay with a security function in a railway security system (including NX safety). B relays have a very high degree of reliability, and operate for decades, provided they are regularly revised. Important features of B relays are that they for sure loose contact when the coil is not energized, and the normally closed break contacts ("back contact") open before make contacts ("front contact") are closed. There exist several types of B-relay, with specific properties. The most common type is the 56001-783Gr1. This relay has two coils that operate on 12V DC, four switch contacts ("full contacts"), two make contacts and one break contact. Furthermore, there are B-relays which engage with a delay, disengage with a delay, are suitable for large currents etc. Another type of B-relay is the track relay (TR). This relay is a part of a track circuit, and is "on" when a track section is unoccupied, and falls off as the track section is occupied by a train. With B relays, especially the B2 vane relay B2 (the "track relay"), a movable element (with the B2 relay, the "vane"), which is susceptible to magnetism and a reset force, such as gravity are often used so that in the absence of the magnetic field generated by one or more coils of the B-relay, this element is no longer held in an extended position by the magnetic field and moves due to the reset force, such as gravity, causing the B relay switches. A so-called B1 relay is usually equipped with a reset spring.

[0009] A safety relay is supplied by the manufacturer in a sealed container. The rear wall of the casing is equipped with contact ports that correspond to contact plugs (so-called terminals) which project from a contact block in the relay box. A B relay is mounted by pressing his back against the contact block so that the terminals are inserted into the contact ports so the B relay, via to the terminals connected wires, is electrically connected to the relevant circuit in which the B relay must be included. If the housing after delivery by the factory is modified or damaged or the seal becomes broken, the product is rejected.

[0010] The housing includes many digital and/or analog sensors, e.g., at least fifty or a hundred, with which inside the house, the operation of the relays (for example, the relay position) in the housing and of the electric mo-

tors (for example, the motor current) outside the house is monitored. In addition, the housing contains temperature sensors, preferably of the NTC type. The signals of all these sensors are to be transferred to a central collection point (in other words: central unit) in the housing, over the measurement signal cables. Typically the relay position is detected by a digital sensor (as a rule, supplies a digital-like analog signal) and the motor current and the temperature are detected by an analog sensor. Each sensor obtains a number of times per second a measurement (this is also known as "sampling rate"), and sends the measurement data to the central assembly point.

[0011] It is usual, for example, due to regulations, that each measuring signal by its own, separate power - or measuring wire is transferred to the central assembly point, so that there are large amounts of separate current wires in the cable ducts having a length of usually more than 5 m and in some cases more than 10 or 20 meters, with a length of the order of 30 meters or more being no exception. Power leads that are no longer used due to a repair or modification may, in some cases, because of regulations, not deleted from the cable channel. Due to repairs and modifications usually power wires or cables are added to the cable duct so that, especially when no longer used power wires can not be removed, it becomes increasingly full and eventually overflowing. In some cases, when a repair or modification occurs, a power wire must be replaced by a power cable so that a repair or modification is permanently visible. Since a power cable is stranded, as a rule, while a power wire is single core, and usually not all conductors of the power cable will be used (often is used only one or two of the typically at least four conductors of the power cable), increasing the overcrowd of the cable channel.

[0012] It should be clear that for each measuring signal two conductors or power wires are usually required.

[0013] Preferably, the power cables or wires extend between a frame and the central assembly point within the space in the housing in which the frames and the central assembly point are located, and/or are positioned in a cable duct.

[0014] An alternative to the use of cable ducts is to place the power cables under the floor of the space in which the frames are located, for example in a basement. For example, power cords or wires are led through the bottom of the frame into the basement and come up again at or below the system cabinet.

[0015] The components to be monitored, as well as the associated sensors inside the house are in frames, for example racks or relay cabinets.

[0016] The object of the invention is for the system, preferably inside a relay or relay box casing, one or more of: increase the safety and/or reliability of the monitoring of the to be monitored components, such as relays, and power supply cables for electric drive motors of rail switches; more efficient use of the in the data processing participating hardware such as data processing devices and data-carrying conductors; low energy consumption; robust system; after being put in operation of the system inside the house, easy to repair and/or modify while retaining performance and properties; low cost of construction; less sensitive to one or more of interference, crosstalk, mechanical vibrations, temperature fluctuations; take into account existing regulations; another, implicit or explicit, object disclosed herein.

[0017] To this end, it is proposed a system, for example, inside the housing, arranged to do the signal transfer by wire through an intermediate station, preferably a plurality of intermediate stations, wherein preferably a first group of a plurality of, preferably, at least ten sensors is data communicating connected to a first intermediate station, via electric wires or cables, and a second group of a plurality of, preferably at least sensors is data communicating connected to a second intermediate station and the first and second intermediate station are communicating connected to the central assembly point via power lines or - cables, in which the sensors preferably belong to either the first or the second group. Preferably, the housing comprises intermediate stations (also called "module") of at least two types, and/or at least two or three or four or five intermediate stations. The first and second intermediate stations are separate and preferably located at a mutual distance, preferably at least 1 meter.

[0018] An intermediate station preferably comprises one or more of: an A/D converter for digitizing the signals originating from the connected sensors; an Ethernet like output which is by a wire or cable data communicating connected to the central assembly point; an electrical processor for processing the data from the sensors; means for real time transmission of data to the central assembly point, for example, EtherCat like; means for receiving by wire of analog data from the sensors and transmitting by wire of the on the received analog data based digital data to the central assembly point; is associated with a single frame; is placed in or on a frame; is or is not the only intermediate station of the frame associated with it (for example, a minimum of two or three or four intermediate stations in the same frame).

[0019] Preferably, for at least one or two or three intermediate stations the length of the one or more cables or wires for data communication with the central assembly point is at least 5 or 10 or 20 meters.

[0020] Another advantage is that the number of power cables or wires for data communications which runs to the central assembly point from the intermediate stations, can be significantly less, in many cases less than one-half or one-quarter.

[0021] The invention may optionally increase the flexibility in the design of the equipment to be installed in the house.

[0022] Preferably, at least one or two separate measuring leads extend to the associated intermediate station from each sensor. By using the invention it becomes possible, to limit the number of current wires or cables, for

example in cable ducts, so that fewer or smaller ducts suffice, which reduces the space demand inside the housing. Cable ducts, for example, run from the central assembly point, such as a system cabinet, towards the sensors. For the measurement cables or wires which extend in the direction of the duct from the sensors, is sufficient space present in the frames (e.g. rack, or a relay box) in which the sensors are located. These measuring cables are connected to a module and from the module a smaller number, or a single communication cable, extends in the direction of the cable duct. By placing a module in the frame, the measurement cables remain within the frame and the number of cables (communication cables) running from the frames to the central assembly point can be significantly limited.

[0023] For example, a module is a Sensor Interface Module (abbreviated: SIM) or Digital Input Module (abbreviated: DIM). To a SIM are connected to measuring leads or wires originating from analog sensors, which supply analogue measuring signals to the SIM. To a DIM are connected measuring leads or wires originating from digital sensors, which deliver digital measuring signals to the DIM.

[0024] As a result, it becomes possible to accommodate a part of the functionality which according to prior art technology is incorporated into a system cabinet, in a rack of a relay housing or in a relay box of a relay cabinet, which functionality is preferably housed in one or more modules.

[0025] With the invention, a space saving can be realized in the house, for example, less wall space is required. For example, system cabinets are less required, which, moreover, can be made smaller. System cabinets usually occupy wall space, however, wall space in a house is limited.

[0026] In the central assembly point, for example, the system cabinet, there are preferably one or more, for example, a minimum of two or three, Data Processing Units (abbreviated: DPU), and optionally one or more Power Supply Units (abbreviated: PSU). The DPU receives signals via the communication cables from the S IM and the DIM. The PSU provides the galvanic power supply f or one or more of SIM, DIM and DPU. This feed is preferably supplied from the PSU via a star network. Preferably, each module or central collection point (e.g. DPU) has its own power supply, which is connected to a PSU.

[0027] Preferably, a module or a DPU comprises one or more of an FPGA (Field Programmed Gate Array), CPU (Central Processing Unit) or microcontroller and computer memory, which are mutually connected operatively for data transfer. The FPGA is a hardware-programmable computer component and provides fast data processing, thus relieving the CPU.

[0028] The central assembly point of the state of the art is a so-called data logger. Depending on the required number of measurement channels (signal inputs) for temperature, analog and digital measurement signals, a type of data logger was selected. Well-known examples of types of data logger are as follows (in parentheses the number of signal inputs): K-logger2020 (2 temperature, 20 analog, 20 digital); G-logger3060 (2 temperature, 30 analog, 60 digital); G-logger6060 (4 temperature, 60 analog, 60 digital); G-logger30120 (2 temperature, 30 analog, 120 digital).

[0029] According to the present invention preferably a module of either analog or digital type, i.e., configured to receive either analog or digital measurement signals, is optionally in combination with one or more inputs for temperature measurement signals. Temperature measurement signals are typically analog signals, however, relatively weak in the case of, for example, an NTC temperature sensor, so that a separate input for the temperature sensor is more suitable. Using analog and digital modules enables further hardware savings within the house, for example, by reducing the number of unused signal inputs.

[0030] Preferably, the housing of one module type, for example digital type, contains at least two, three or four times as many modules as the other module type, for example, analog type.

[0031] For the hardware according to the invention preferably one or more of the following applies: DPU (for example, type MSOM) is connected to m ax. 6 S IM or max. 12 DIM or up to 8 combined SIM and DIM; SIM (for example, type EAI 10): 1 input temperature/10 analogue inputs; DIM (for example, type EDI10) : 10 digital inputs; PSU 60W (for example, UN type 60W) is connected to feed max 5 S IM or DIM or 12 DPU ,or up to 3 combined SIM and DIM and DPU; PSU 150W (for example, UN type 150W) is connected to feed max. 13 SIM or DIM or 30 or DPU or up to 10 combined SIM and DIM and DPU.

[0032] The system according to the invention is preferably adapted for a sample frequency of at least 1Ks/s (1,000 samples per second) or 1, 5ks/s or 2Ks/s per channel and/or for a minimum of 50 or 60 channels. Thus, at 2Ks/s per channel and 66 channels, the system processes 132,000 samples per second. Preferably, each connected sensor has its own channel. The inventor was surprised to have managed to develop a system that, by means of wired communication, allows for real-time transmission of data from the sensors via the intermediate stations to the central assembly point, preferably wherein each sensor performs continuous measurements, per second at least 1000 or 1500 or 1750 or 2000 measurement samples (also called "sampling rate") and this number of samples arrives in real time at the central assembly point, where it is processed, in which all this data is transmitted through wiring. This was, because of the large number of sensors, the high sampling rate and the distance traveled by the data from the frames to the central assembly point, assumed impossible.

[0033] In a preferred embodiment, the system comprises means for, under real-time conditions:

- at the intermediate stations generating of digital

measurement data from the at the input received measuring signals from the sensors;
- transmit these digital measurement data via the output to the input of the central assembly point;
- processing these digital measurement data in the central assembly point.

[0034] For the system according to the invention preferably one or more of the following is applicable: the scanning engine (e.g. EtherCAT) runs on top priority; using the raw EtherCAT interface for more influence on the performance; use of as little as possible overhead for the data, preferably 16bits raw per channel, rather than double (64 bit) per channel; of the dual core CPU is a single core assigned to the EtherCAT processing; the EtherCAT processing has a high priority on the allocated core.

[0035] A module is preferably configured as a slave, and the DPU as a master.

[0036] As a rule, the frames form rows with mutual spacing so that a mechanic can navigate between the frames to access the components in the frames for, for example, repair work. A frame may be composed of side by side, for example separate frame parts, such as racks or cabinets. For example, the house contains at least 3 or 4 or 5 rows of frames and/or a frame is composed of at least 3 or 4 or 5 frame sections next to each other. A frame may or may not be grounded. For example, a relay box is usually grounded and a rack is not grounded. As a rule, components in the frames, such as relays, sensors, interfaces (e.g. DIM or SIM), are not grounded.

[0037] Preferably, for the monitoring the measuring wire or cable of the system is connected to a free contact of the component to be monitored, for example, B-relay, and/or the component to be monitored is associated with a separate sensor of the system.

[0038] In one embodiment, a relay, for example track relay TR, is monitored by a torque measurement, for example by current clips.

[0039] The invention is in a preferred embodiment based on the understanding of making the signals derived from the sensors as closely as possible to the sensors, preferably in or at the frames, digital by using an A/D converter. Alternatively or in combination with this, the invention is based on the understanding of providing a modular design for the equipment directly connected to the sensors by a module exclusively with inputs for digital or digital like analog signals and a module with analog signal inputs.

[0040] The accompanying drawing shows in top view the layout of a housing, wherein is shown in:

Fig. 1 a prior art relay house;
Fig. 2 a relay house according to the invention;
Fig. 3 a prior art relay cabinet; and
Fig. 4 a relay cabinet according to the invention.

[0041] Fig. 1-4 illustrate frames in which are placed relays, and from the frames run communication cables or wires to the system cabinets placed against the wall. A bundle of communication cables is represented by a single straight line, and a line associated with the number indicates the number of conductors in the bundle.

[0042] The number of frames, therein contained to be monitored components and therewith associated sensors for providing the measurement signals for monitoring is similar to Figures 1 and 2, respectively, Figures 3 and 4.

[0043] In the case of FIGS. 1 and 3 a much larger number of cores arrives at the system cabinets in comparison with Fig. 2 and 4. Thus, the drawing gives an impression of the reduction in wires or cables which run inside the housing.

[0044] Fig. 2 and 4 show that frames are equipped with modules of type SIM and DIM. All with the respective frame associated sensors are connected via measuring lines data communicating to the with the frame associated modules. The modules are connected via communication cables to the equipment (DPU) in the system cabinets. The PSU present within the system cabinets provides the electrical power to the measurement and data processing equipment within the system cabinets and frames.

[0045] In Fig. 1 and 2, the cables extending between the frames and the system cabinet are located in a cable duct in the above ground space in which the frames and system cabinet are located. In Figures 3 and 4, these power cables run underground in a basement and the frames and system cabinet are above ground. In Figures 3 and 4, only analogue measurement signals are collected from track relay, so that only type of SIM modules are placed.

[0046] All the described or in the drawing illustrated features form either alone or in any combination of one or more such features the subject of this invention.

Claims

1. System or method for wired data transmission, at real time conditions, from a plurality of digital and/or analogue measurement data providing sources, such as digital and/or analogue sensors to a central unit to process and/or store said data, such as a DPU (data processing unit) or a DADQ (data acquisition device), wherein the sources and the central unit are at a short mutual distance and provide a system, preferably within a relay house or relay box cabinet, which system is operatively associated with a railway, e.g. is provided at a side of the railway; preferably fitting within a ground surface which is up to 100 or 50 or 25 meter long and up to 100 or 50 or 25 or 15 meter wide, and/or is located indoor or outdoor; the system is adapted to allow the signal transmission to take place by wire through an intermediate station or in different words module, preferably a plurality of modules, wherein preferably a first group of

a plurality of, preferably, at least ten sensors is data communicating connected to a first module via electric wires or cables, and a second group of a plurality of, preferably at least ten sensors is data communicating connected to a second module and the first and second modules are data communicating connected to the central unit via power lines or cables, in which the sensors preferably belong to either the first or the second group.

2. System or method according to claim 1, the housing comprises modules of at least two types and/or the first and second modules are separate and preferably located at a mutual distance, preferably at least 1 meter.

3. System or method as claimed in claim 1 or 2, the housing contains one or more frames or racks containing the sensors, for a module one or more of the following applies: is associated with a single frame; is placed in or at a frame; may or may not be the only module of the frame associated therewith; for example, at least tw o or three or four modules at the same frame.

4. System or method according to any of claims 1-3, the measuring wires leading from the sensors in the direction of the central unit are connected to a module at or in the frame, and from this module runs a single communication cable in the direction of the central unit.

5. System or method according to any of claims 1-4, a part of the functionality is, rather than in a system cabinet, housed in a rack of a relay housing or in a relay box of a relay box cabinet, which functionality is preferably incorporated into one or more s modules.

6. System or method according to any of claims 1-5, with one or more of a Field Programmed Gate Array (FPGA), Central Processing Unit (CPU) or microcontroller and computer memory, which are operatively connected for data transfer.

7. System or method according to any of claims 1-6, the housing contains from one module type, for example, digital type, at least two, three, or four times as many modules than from the other module type, for example, analog type.

8. System or method according to any of claims 1-7, adapted for a sample frequency of at least 2Ks/s (1,000 samples per second) per channel, and for a minimum of 60 channels, with for each connected sensor its own channel.

9. System or method according to any of claims 1 to 8, the sampling rate of each sensor is at least 2000 samples per second and the length of the from the frame the central unit leading data cables is at least 5 meters.

10. System or method according to any of claims 1-9, and one or more of the following is applicable: the scanning engine (e.g. EtherCAT) runs on top priority; use of the raw Ethercat interface for more control over performance; use as little as possible overhead for data, preferably 16bits raw per channel instead of double (64 bits) per channel; of the dual core CPU is one core assigned to the Ethercat processing; the EtherCAT processing has a high priority on the assigned core; a module is configured as slave and the central unit as a master.

11. System or method according to any of claims 1-10, for the frames one or more of the following applies: forming rows with mutual spacing so that a mechanic can move between the frames in order to gain access to the components in the frames, for example, for repair; is made up of juxtaposed, for example, separate frame parts, such as shelves or relay boxes; the housing contains at least 3 or 4 or 5 rows of frames; a frame is composed of at least 3 or 4 or 5 frame parts adjacent to each other; is or is not grounded; a relay cabinet is indeed and a rack is not grounded; components placed in the frames, for instance, relays, sensors, modules, are not grounded.

12. System or method according to any of claims 1-11, for monitoring the measuring wire is connected to a free contact of the component to be monitored, for example, B relay, and/or the component to be monitored is associated with a separate sensor of the system.

13. System or method according to any of claims 1-12, as close as possible to the sensors, preferably in or on the frames, digitizing by an A/D converter of the signals coming from the sensors.

14. System or method according to any of claims 1-13, including providing a modular design to the equipment that is directly connected to the sensors, by using an module exclusively having inputs for digital or digital-like analog signals, and a module with inputs for analog signals.

15. System or method according to any of claims 1-14, all to a respective frame associated sensors are via measuring lines data communicatively connected to the with the frame associated modules, these modules are connected via communication cables connected to the equipment (DPU) within the system cabinets, the PSU present in the system cabinets, provides the electric power supply to the measuring

and data processing equipment in the system cabinets, and optionally frames.

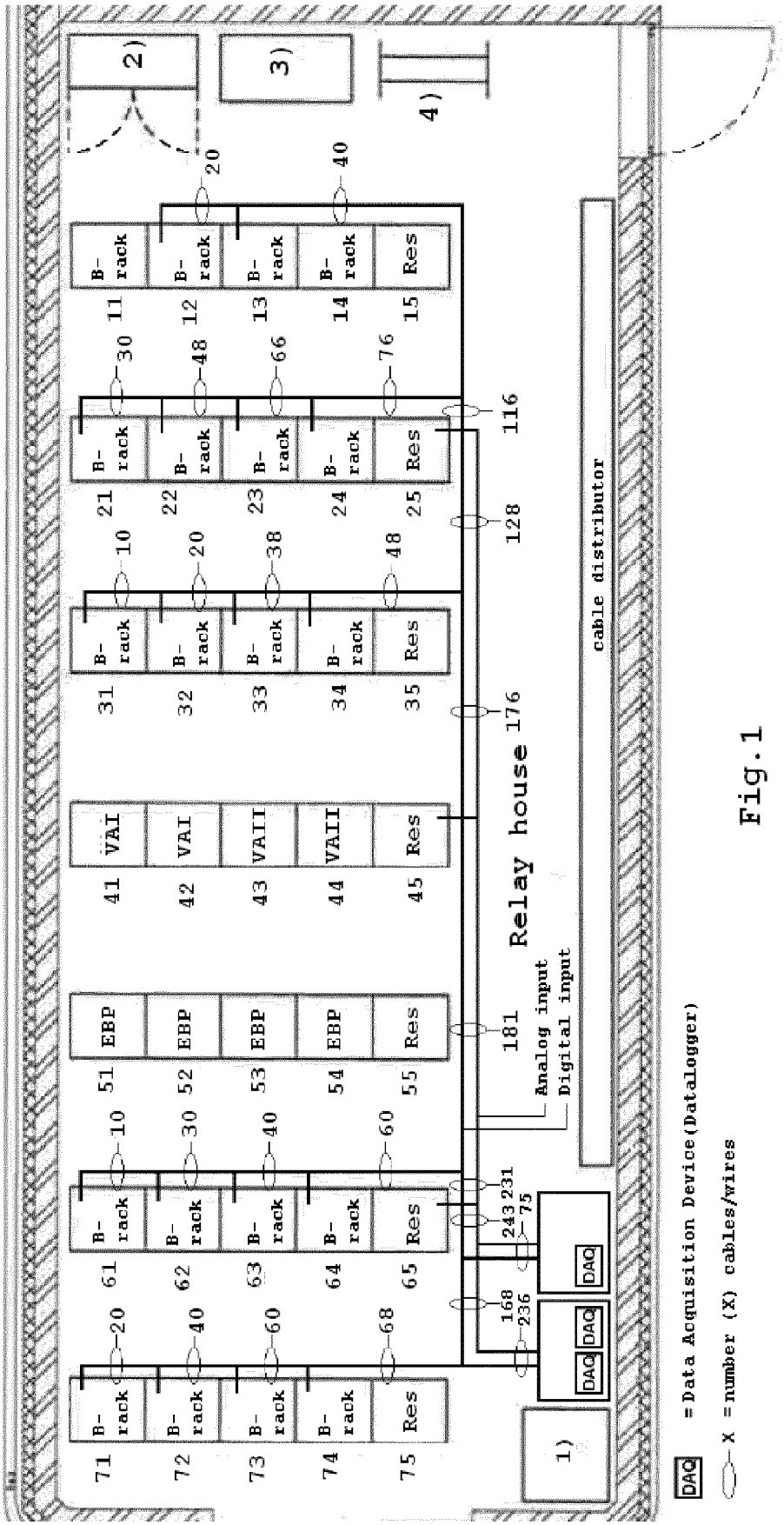

2)
3)
4)
1)
B-rack
Res
VAI
VAII
EBP
DAQ
Relay house
cable distributor
Analog input
Digital input
= Data Acquisition Device(Datalogger)
X = number (X) cables/wires

Fig.1

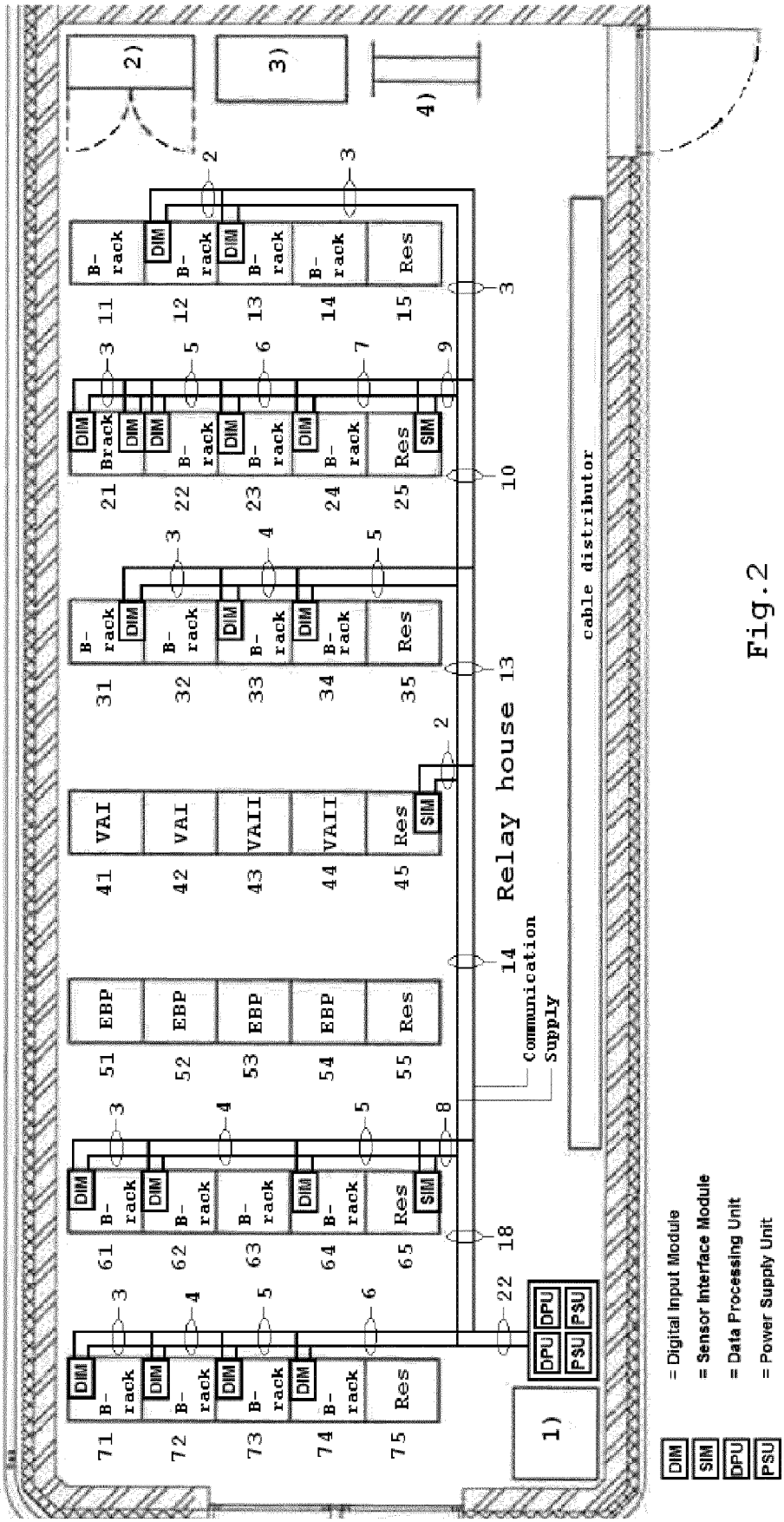

1)
2)
3)
4)
Relay house
cable distributor
Communication
Supply
B-rack
DIM
SIM
Brack
Res
VAI
VAII
EBP
DPU
PSU
= Digital Input Module
= Sensor Interface Module
= Data Processing Unit
= Power Supply Unit
= Number (X) cables

Fig.2

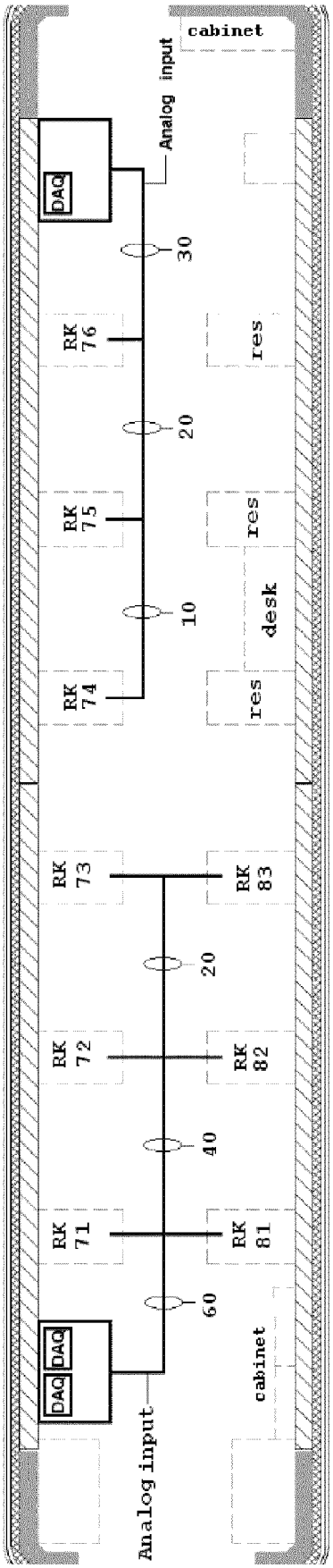

cabinet
Analog input
DAQ
30
RK 76
20
RK 75
res
10
RK 74
desk
res
RK 73
RK 83
20
RK 72
RK 82
40
RK 71
RK 81
60
DAQ
DAQ
Analog input
cabinet

Fig.3

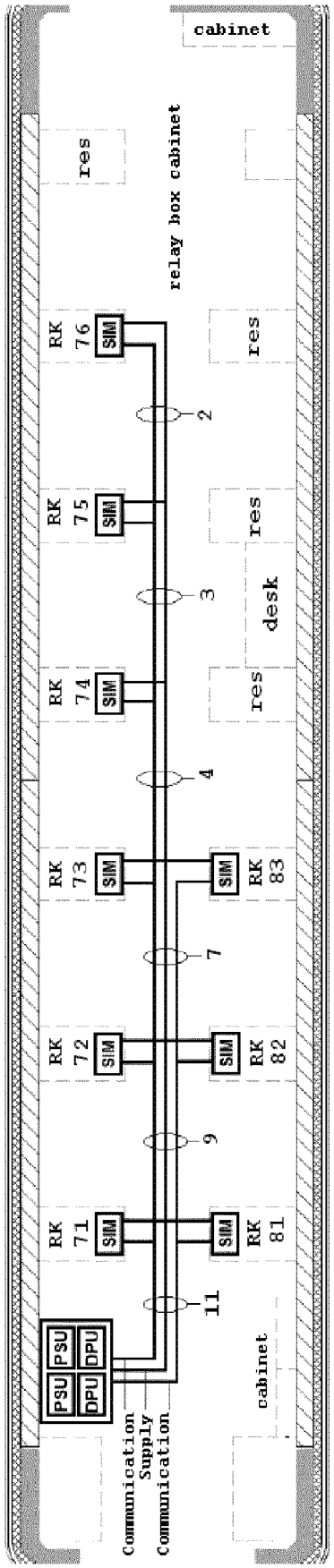

cabinet
relay box cabinet
res
RK 76
SIM
2
RK 75
SIM
3
RK 74
SIM
4
RK 73
SIM
RK 83
7
RK 72
SIM
RK 82
9
RK 71
SIM
RK 81
11
PSU
PSU
DPU
DPU
Communication
Supply
Communication
cabinet

Fig.4

Europäisches Patentamt
European Patent Office
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EUROPEAN SEARCH REPORT

Application Number
EP 17 16 9357

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	MICHIEL BLAAUBOER ET AL: "Reducing life Cycle costs of main line interlockings", SIGNAL + DRAHT, DVV, vol. 105, no. 11, 1 November 2013 (2013-11-01), pages 30-33, XP001584677, ISSN: 0037-4997 * page 30, paragraph 1 * * page 31, paragraph 4 - page 32, paragraph 6.3 * * figures 1-4 *	1-15	INV. B61L19/06 B61L27/00 B61L7/08
A	EP 2 549 620 A2 (SIEMENS SCHWEIZ AG [CH]) 23 January 2013 (2013-01-23) * paragraphs [0001], [0002], [0024] - [0035]; figures 1-7 *	1-15	
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Munich	9 November 2017	Massalski, Matthias

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EUROPEAN SEARCH REPORT

Application Number
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