

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
19 January 2006 (19.01.2006)

PCT

(10) International Publication Number
WO 2006/006116 A1

(51) International Patent Classification⁷: **G08C 17/00**

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(21) International Application Number:
PCT/IB2005/052212

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(22) International Filing Date: 4 July 2005 (04.07.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
04103280.6 9 July 2004 (09.07.2004) EP

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(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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Published:

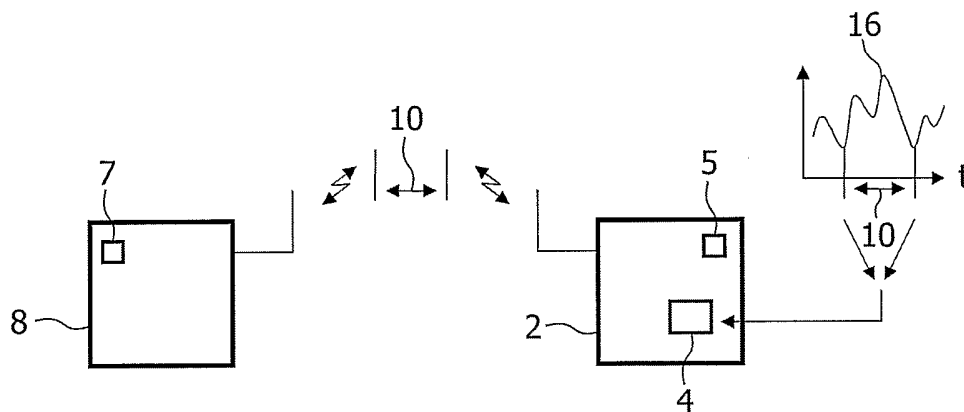
— with international search report

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: WIRELESS POWER SAVING DATA TRANSMISSION SYSTEM



(57) Abstract: The present invention relates to a wireless power saving data transmission system. Typical receivers of data transmission systems always have to be in a receiving mode that usually consumes more power than an idle mode if it has to be ensured that every transmitted information is received by the receiver. According to the present invention, a measurement interval is provided to the receiver to enable the receiver to switch into a receiving mode only for the time data is transmitted to the receiver. Advantageously, this saves energy in the receiver.

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Wireless Power Saving Data Transmission System

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The present invention relates to the field of data transmission systems. In particular, the present invention relates to a data transmission system, to a transmitter and to a receiver. In addition, the invention relates to a method for transmitting data within a data transmission.

10 Quite often a measurement has to be performed in a different location to where the results have to be presented. Also, it often appears that an actor needs to have impact on a remote system, for example, a switch for lights. For connecting the far-end devices and for transporting the information it is quite common to use cables. Wiring these systems entails many of disadvantages and is expensive. Therefore, in the past,
15 devices have been developed using wireless (e.g. radio, infrared or ultrasonic) transmission techniques to send information from a remote device to a receiver. Usually, receivers need continuous energy for the receiving mode since they always have to be able to receive the sent information. In contrast to this continuous operation of the receiver, the transmitter is operated in a burst mode, allowing low energy
20 consumption. Both the transmitter and the receiver usually require a stand-alone power source.

It is an objective of the invention to reduce a power consumption of a
25 receiver of a data transmission system.

According to an aspect of the present invention in accordance with claim 1, the above object may be solved by a system comprising a transmitter, a receiver and a sensor, wherein the transmitter comprises the sensor. The sensor is adapted to perform a measurement within an interval and to provide information concerning this interval
30 via the transmitter to the receiver.

This enables the receiver to work in a burst mode. Information concerning the measurement interval may relate to the measurement interval itself and information on how to determine the measurement interval. Due to the fact that the receiver "knows" the measurement interval, when the next data is sent by the transmitter, the receiver may adopt its operation in accordance with this information concerning the interval to, for example, reduce its power consumption.

Combining the transmitter with the sensor makes it possible to use a variety of available sensors. Advantageously, existing sensors which are optimized with various measurement values can be used with minor adaptations. Further, advantageously by sending information concerning the measurement interval to the receiver, the present invention may allow, to provide the receiver with important information about characteristic parameters of the measuring process performed by the transmitter. Analyzing these parameters enables the receiver to use the same characteristics for receiving as the transmitter uses for sending. This could be an advantage if the transmitter is not sending data continuously. In other words, this means that if there is a duty ratio between sending data and not sending data it could be advantageous for the receiver performing switch on when the transmitter is sending data.

According to another exemplary embodiment of the present invention as set forth in claim 2, the receiver has two modes. The two modes are a receiving mode and a sleep mode. The difference between both these modes is that the power consumption in the receiving mode is higher than the power consumption in the sleep mode.

Advantageously, the receiver switches between these modes controlled by the measurement interval received from the transmitter. Exploiting the knowledge about the time when data is sent by the receiver may minimize the power consumption of the receiver.

Claims 3 and 4 provide further advantageous exemplary embodiments of the present invention. By adjusting the measurement intervals, it is possible to prevent collisions that may be accrued if other data transmission systems are used at the same time or the data transmission system comprises more than one transmitter.

According to another exemplary embodiment of the present invention as set forth in claim 5, the transmitter is adapted to transmit a data package containing data relating to a measurement of the sensor more than once. The resending of the data package could be repeated with a variable time gap.

5 By repeating the sent information several times, advantageously, the probability that the data transmission is not disturbed is increased.

According to another exemplary embodiment of the present invention as set forth in claim 6 the receiver is able to scan activity from the transmitter.

Advantageously, the receiver may recognize the measurement interval sent from the
10 transmitter.

According to another exemplary embodiment of the present invention as set forth in claim 7, a data transmission unit is provided, further comprising a power unit, for operating at least one of the transmitter and the receiver, wherein the power unit is adapted to generate the energy from environmental energy. An available
15 environmental energy may be, for example, heat, pressure, vibration, light or movement. This energy may be transformed into energy, which is necessary to operate at least one of the transmitter and the receiver.

Using a power unit for supplying the energy for operating at least one of the transmitter and the receiver with environmental energy may advantageously obviate
20 a separate power source for at least one of the transmitter and the receiver. Thus, no extra effort for changing the power source such as a battery is required.

According to another exemplary embodiment of the present invention as set forth in claim 8, a transmitter is provided comprising a sensor for performing a measurement. The sensor is adapted to perform the measurement with a measurement
25 interval and the transmitter is adapted to send information concerning the measurement interval to a receiver. Sending information concerning the measurement interval may be an advantage as the duration of the measurement, for example, may be a designated parameter for the whole measuring process.

According to another exemplary embodiment of the present invention as set forth in claim 9, a transmitter is provided adapted to manipulate the measurement
30 interval referring to different methods. The variation of the measurement interval,

advantageously, could be used to minimize interference by signals transmitted by other transmitters.

According to another exemplary embodiment of the present invention as set forth in claim 10, a transmitter is provided adapted to resend data packages.

5 An advantage of repeating the information may be that in the case of lost information, the same information is resent at a later time. Advantageously, the time after that the information is repeated may be varied.

 According to another exemplary embodiment of the present invention as set forth in claim 11, a transmitter is provided further comprising a power unit for
10 operating the transmitter, wherein the power unit is adapted to gather energy from environmental energy. Environmental energy could be for example heat, pressure, vibration, light and movement. Using environmental energy could make the transmitter independent of consumable energy.

 According to another exemplary embodiment of the present invention as
15 set forth in claim 12, a receiving unit is provided comprising a receiver adapted to receive a measurement interval. Receiving the measurement interval, advantageously, may enable the receiver to determine the time when information is sent from a transmitter. This can enable the receiver to activate its receiving mode just at the time when the information (i.e. the data package) is sent.

20 According to another exemplary embodiment of the present invention as set forth in claim 13, a receiver is provided using a receiving mode and a sleep mode. The receiver further comprising a power unit for operating the receiver, wherein the power unit is adapted to gather energy from environmental energy. Environmental
25 energy could be for example heat, pressure, vibration, light and movement. In the sleep mode, the power consumption of the receiver is minimized compared to the receiving mode. Differentiating between the sleep mode and the receiving mode, the receiver, advantageously, may save energy. Using environmental energy may make the receiver independent of consumable energy. In combination with the power savings reached by using a sleep mode in idle times, a better energy management of the receiver may be
30 provided.

 According to another exemplary embodiment of the present invention as set forth in claim 14, a method for transmitting data within a data transmission system

is provided. The transmission system comprises a transmitter and a receiver. The transmitter comprises a sensor for performing a measurement. Depending on the characteristics of a measurement, a particular measurement interval may be set-up. The transmitter pre-selects the measurement interval (e.g. in accordance with preset
5 parameters) and performs the measurement with the sensor within the pre-selected measurement interval. The transmitter decides if information about the measurement interval together with the measurement values have to be transmitted. The transmitter then sends the measurement values and if required the information concerning the pre-selected measurement interval to the receiver, e.g. to indicate when measurement values
10 are available. Then the transmitter waits until the next measurement has to be performed.

Advantageously, the transmitter discloses information that could be required for identifying the measurement interval.

According to another exemplary embodiment of the present invention as
15 set forth in claim 15, a method for controlling switching between a receiving mode and a sleep mode, on the basis of the information concerning the measurement interval, is provided. Advantageously, the receiver could be switched from the power consuming receiving mode into a less power consuming sleep mode. The benefit of switching is to reduce the power consumption required by the receiving process.

20 It may be seen as the gist of an exemplary embodiment of the present invention that a transmitter comprising a sensor pre-selects a measurement interval for performing a measurement and transmits information concerning the measurement interval to a receiver for, e.g. indicating the time when measurement values are available. This could enable a receiver to only use its power consuming receiving mode
25 at the time when it is needed to receive the measurement values from the transmitter.

These and other aspects of the present invention will become apparent from and elucidated with reference to the embodiments described hereinafter.

Exemplary embodiments of the present invention will be described in the following with reference to the following drawings:

- Fig. 1 shows a schematic representation of an exemplary embodiment of the present invention.
- Fig. 2 shows a simplified time diagram of a signal exchange between transmitter and receiver according to an exemplary embodiment of the present invention.
- Fig. 3 shows a simplified time diagram of a modification of the measurement interval with pseudo-random sequence according to an exemplary embodiment of the present invention.
- Fig. 4 shows the simplified representation of a switching between receiving and sleeping mode of the receiver according to an exemplary embodiment of the present invention.
- Fig. 5 shows a flow chart of a method for transmitting data within a data system according to an exemplary embodiment of the present invention.
- Fig. 6 shows a flow chart of a method for receiving data within a data system according to an exemplary embodiment of the present invention.

Fig. 1 shows a schematic representation of an exemplary embodiment of the present invention. In Fig. 1, reference numeral 16 could be any time dependent characteristic of a value that has to be measured. The transmitter 2 comprises a sensor 4 and a measurement interval 10 may be defined wherein the sensor measures the value of the measurand 16. The transmitter could be controlled by a small microprocessor which controls pre-selecting the measurement interval 10, digitalizing the values of the measurement and the transmitting of the measurement results. A clock for the microprocessor may be produced by a quartz oscillator that could operate at the frequency of, for example, 32768 Hz. Modulating the information within the transmission enables the transmitter to send information concerning the measurement interval and the measurement values on the air to the receiver 8. Information concerning the measurement interval may relate to any kind of information allowing to identify the interval. This may be duration, frequency, repetition interval, next point

in time when a measurement is performed, starting point and endpoint of a particular interval, interval shift etc. Within the receiver 8, the information concerning the measurement interval 10 can be used to control the switching between a receiving 46 and a sleeping mode 48. The sleeping mode 48 is less power consuming than the receiving mode. The use of the information of the measurement interval 10 and switching into the receiving mode 46 only in the time when information is sent from the transmitter to the receiver 8 enables the receiver 8 to save energy. In other words the receiver 8 only has to be in the receiving mode 46 while a burst 6 is sent by the transmitter 2. The information concerning the measurement interval 10 can be transmitted from the transmitter 2 to the receiver 8 at regular periods, for example, after each 10th measurement, to ensure that in case of interruptions the receiver still gets the information about the measurement interval 10. The sensor 4 may also be a switch, e.g. a light switch, which opposite to a sensor 4 may delivers non periodic signals. In this case there is no regular information sent from the transmitter 2 to the receiver 8 and thus a reference pulse may be transmitted from the transmitter 2 to the receiver 8, even if there are no measurement values available, to adapt the measurement interval 10 in the receiver 8. This reference pulse may be a keep-alive message for the system, providing information concerning the measurement interval 10 to the receiver 8, that the receiver 8 may remains being able to determine the measurement interval.

Alternatively to transmitting information concerning the measurement interval 10 from the transmitter 2 to the receiver 8, the receiver 8 may determine the measurement interval 10 by itself by measuring the signals sent from the transmitter 2 to the receiver 8, i.e. by scanning the traffic on the transmission channel. The power, needed to operate the transmitter 2 and the receiver 5, is provided by a power unit 5 for the transmitter 2 and a power unit 7 for the receiver. Both of these power units may transform environmental energy such as heat, pressure, vibration, light or movement into energy, which may be used by the transmitter 2 or the receiver 8. Also, such a power unit may be provided in the transmitter and the receiver only.

Fig. 2 shows a simplified time diagram of a signal exchange between transmitter 2 and receiver 8 according to an exemplary embodiment of the present invention. In Fig. 2, time diagrams are shown of the transmitting side 20 and of the receiving side 22. It shows a pre-selected measurement interval 10. The information

concerning this measurement interval 10 is transferred to the receiver 8 and used by the receiver 8 to identify the time when data is transmitted from the transmitter 2 to the receiver 8. Thus, the receiver 8 receives the measurement values 24 transmitted by the transmitter 2. The duration 6 and the content of the sent 18 and received 24 data packages may be identical on the transmitting 20 and receiving 22 side. Subsequent measurement values 26 are sent to the receiver 8 periodically with a predefined period 10. As the receiver 8 knows the time when the measurement values arrive (i.e. are sent), it switches into the receiving mode and receives the measurement values 28. This cycle is periodically repeated as long as the measurement takes place. Advantageously, a delay 12 may be used by the transmitter before the measurement value 18, 26 is sent to the receiver. This delay 12 also could be derived from a random number or random number sequence. By using such a random delay in advance of starting each transmission cycle or in advance of each measurement interval 10 or in advance of each single transmission of a data package 18, 26, collisions with data sent simultaneously from other transmitters may be prevented. A prerequisite for executing this method of synchronization may be that the receiver 8 has the information from the transmitter 2 concerning the manipulation of the measurement interval 10. To increase the probability that the receiver 8 gets the information sent by the transmitter 2, it may be an advantage to repeat the information 18 several times. It is possible to repeat the measurement with a constant delay 14 derived by a pseudo-random number or else the delay 14 may be derived by a pseudo-random sequence (e.g. generated by a Feedback Shift Register). In any case, the information about delay 14 may be transmitted to the receiver 8 so that it may adapt its receiving interval.

Fig. 3 shows a simplified time diagram of a modification of the measurement interval with a pseudo-random sequence according to an exemplary embodiment of the present invention. The figure shows the time diagram for the transmitter 30 and the time diagram for the receiver 32. The figure shows three subsequent measurement values on the transmitter side 34, 38 and 42 and on the receiver side 36, 40 and 44. The measurement interval 10 is adapted with the value derived from a pseudo-random sequence. Using this variation between subsequent transmitted data package decreases the probability of senders operating at the same time.

Fig. 4 shows a simplified diagram for using a sleep mode in the receiver according to an exemplary embodiment of the present invention. The figure shows the measurement interval 10 defining the point in time when the measurement values are gathered. The duration for the data packages 6 may depend on the duration when the receiver has to be active. For preventing collisions, a delay 12 derived from a pseudo-random number can be used. The receiver has two operation modes. It has a receiving mode 46 and less power consuming sleep mode 48. Advantageously, it can be switched between both these modes since the receiver 8 only has to be in the receiving mode 46 more or less exactly at the time when the measurement values are sent by the transmitter 2. At other times, the receiver 8 can be in the sleep mode 48. For example, for the measurement of temperature, the measurement could be performed every 60s so that the measurement period 10 equals 60s. Assuming the burst duration 6 for transmitting the measurement values from the transmitter to the receiver to be 0.5ms and assuming a certain gap of 3ms to ensure that the receiver will receive all relevant information, the savings would be 1/17 000.

Fig. 5 shows a flow chart of a method for transmitting data within a data transmission system according to an exemplary embodiment of the present invention. The flow chart shows in a first step S1 that a measurement interval is pre-selected. In step S2, the measurement itself is performed and the measurement values are gathered by the sensor 4. In the next step S21 a decision is made if it is necessary to transmit the information concerning the measurement interval 10, which may be required from time to time, e.g. after each 10th cycle, to inform the receiver 8 about the actual parameters the transmitter 2 is using for the measurement interval 10. In case a transmission of the actual parameters for the measurement interval 10 is required, the information concerning the selected measurement interval 10 and the measurement values are transmitted from the transmitter 2 to the receiver 8, as depicted in step S3. Otherwise step S31 is executed and solely the measurement values are transmitted. Independent of what decision was made in step S21, a wait cycle is performed in step S32. The duration of the wait cycle may depend on the time when the next measurement has to be performed and therefore it may depend on the measurement interval 10 in combination with possible random delays, according to the chosen transmission strategy. After the wait cycle the method is repeated beginning with step S2.

Fig. 6 shows a flow chart of a method for receiving data within a data system according to an exemplary embodiment of the present invention. In a first step S4, an evaluation, based on the information concerning the measurement interval, is made if the receiver 8 actually has to be in the receiving mode 46 or sleep mode 48. If no data is transmitted, the receiver 8 will stay in its idle mode 48 or sleep mode. If the transmitter 2 sends data, the receiver 8 switches in step S5 into the receiving mode 46, receives the data, processes the data and may determine the time, when the receiver 8 has to return in the receiving mode the next time. Afterwards the method is repeated beginning with step S4.

10 It should be noted that the term "comprising" does not exclude other elements or steps and the "a" or "an" does not exclude a plurality and that a single processor or system may fulfill the functions of several means recited in the claims. Also elements described in association with different embodiments may be combined.

15 It should also be noted that the present invention may be used in any application requiring a wire based or wireless transmission of measurement data such as, e.g. pulse measurement devices, temperature sensors, window watchers and movement sensors.

20 It should also be noted that any reference signs in the claims shall not be construed as limiting the scope of the claims.

CLAIMS:

1. A data transmission system, comprising:
a transmitter (2);
a receiver (8); and
a sensor (4);
- 5 wherein the transmitter (2) comprises the sensor (4);
wherein the sensor (4) is adapted to perform a measurement with a measurement interval (10);
wherein the transmitter (2) is adapted to send information concerning the measurement interval (10) to the receiver (8).
- 10
2. The data transmission system of claim 1,
wherein the receiver (8) has a receiving mode (46) for receiving data from the transmitter (2) and a sleep mode (48) where a power consumption of the receiver (8) is minimized; and
- 15 wherein the receiver (8) is adapted to control a switching between the receiving mode (46) and the sleep mode (48) on the basis of the measurement interval (10).
3. The data transmission system of claim 2,
wherein the transmitter (2) is adapted to adjust the measurement interval (10) on the
- 20 basis of a pseudo-random number.
4. The data transmission system of claim 2,
wherein the transmitter is adapted to vary the measurement interval (10) during operation.

5. The data transmission system of claim 1,
wherein the transmitter (2) is adapted to transmit a data package containing data relating to a measurement of the sensor (4) to the receiver (8);
- 5 wherein the transmitter (2) is adapted to perform at least one resending of the data package to the receiver (8);
wherein the transmitter (2) is adapted to vary a time period (14) between a preceding transmission of the data package and a subsequent transmission of the data package.
- 10 6. The data transmission system of claim 2,
wherein the receiver (8) is adapted to perform a scanning with respect to whether the transmitter (2) performs a data transmission; and
wherein the receiver (8) is adapted to adjust the measurement interval on the basis of the scanning.
- 15 7. The data transmission system of claim 1,
further comprising a power unit for operating at least one of the transmitter and the receiver,
wherein the power unit is adapted to generate energy from environmental energy
- 20 selected from the group comprising heat, pressure, vibration, light and movement.
8. A transmitter for communication with a receiver, the transmitter comprising: a sensor (4) for performing a measurement;
wherein the sensor (4) is adapted to perform the measurement with a measurement
- 25 interval (10); and
wherein the transmitter (2) is adapted to send information concerning the measurement interval (10) to the receiver (8).
9. The transmitter of claim 8,
- 30 wherein the transmitter (2) is adapted to vary the measurement interval (10).

10. The transmitter of claim 8,
wherein the transmitter (2) is adapted to transmit a data package containing data relating to a measurement of the sensor (4) to the receiver (8);
wherein the transmitter (2) is adapted to perform at least one resending of the data
5 package to the receiver (8); and
wherein the transmitter (2) is adapted to vary a time period (14) between a preceding transmission of the data package and a subsequent transmission of the data package.
11. The transmitter of claim 8,
10 further comprising a power unit for operating the transmitter,
wherein the power unit is adapted to generate energy from environmental energy selected from the group comprising heat, pressure, vibration, light and movement.
12. A receiving unit for receiving results of a measurement from a
15 transmitter with a sensor, wherein the sensor performs the measurement with a measurement interval, wherein the receiving unit comprises:
a receiver (8);
wherein the receiver (8) is adapted to receive information concerning the measurement interval (10).
20
13. The receiving unit of claim 12,
wherein the receiver (8) has a receiving mode (46) for receiving data from the transmitter (2) and a sleep mode (48) where a power consumption of the receiver (8) is minimized; and
25 wherein the receiver (8) is adapted to control a switching between the receiving mode (46) and the sleep mode (48) on the basis of the measurement interval (10); and
wherein the receiver further comprises a power unit for operating the receiver;
wherein the power unit is adapted to generate energy from environmental energy selected from the group comprising heat, pressure, vibration, light and movement.

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14. A method for transmitting data within a data transmission system,
wherein the transmission system comprises:

a transmitter;

a receiver; and

5 wherein the transmitter comprises a sensor for performing a measurement;

wherein the method comprises the steps of:

pre-selecting a measurement interval in the transmitter;

performing a measurement with the sensor with the pre-selected measurement interval;

and

10 sending information concerning the pre-selected measurement interval from the
transmitter to the receiver.

15. The method of claim 15, further comprising the steps of:

controlling a switching between a receiving mode and a sleep mode on the basis of the

15 measurement interval;

wherein the receiving mode is for receiving data from the transmitter; and

wherein in the sleep mode, a power consumption of the receiver is minimized.

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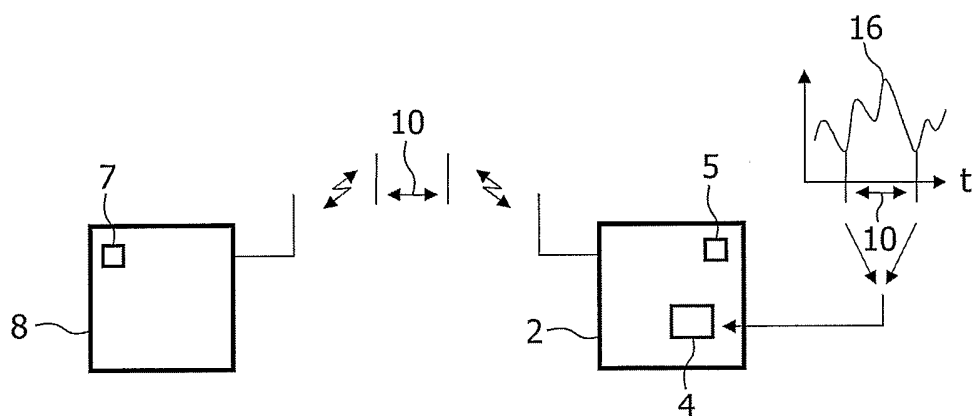


FIG.1

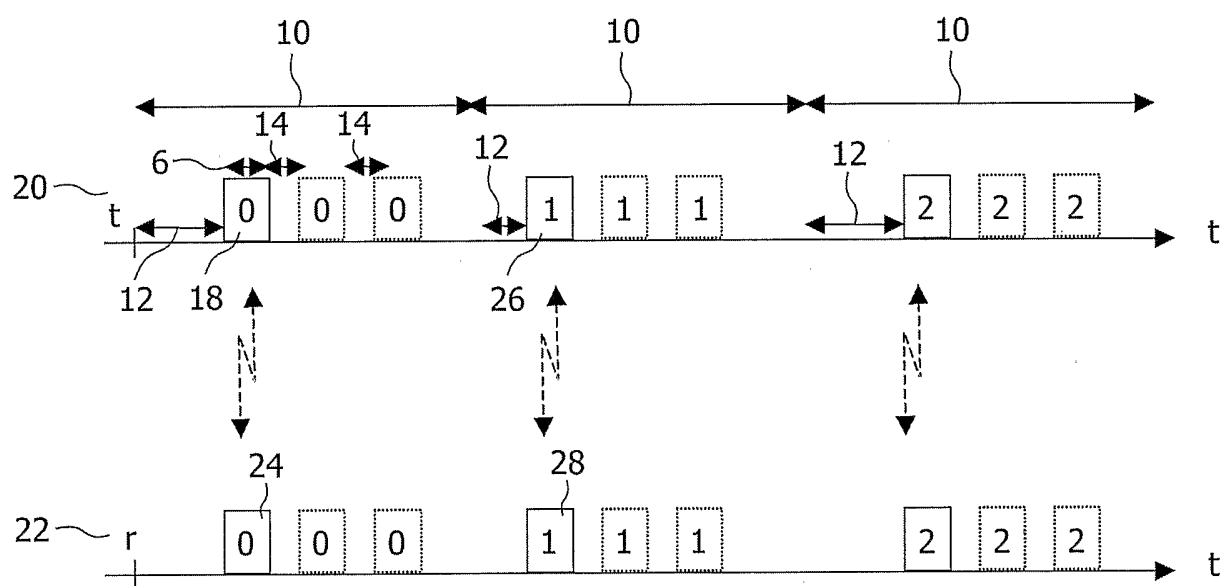


FIG.2

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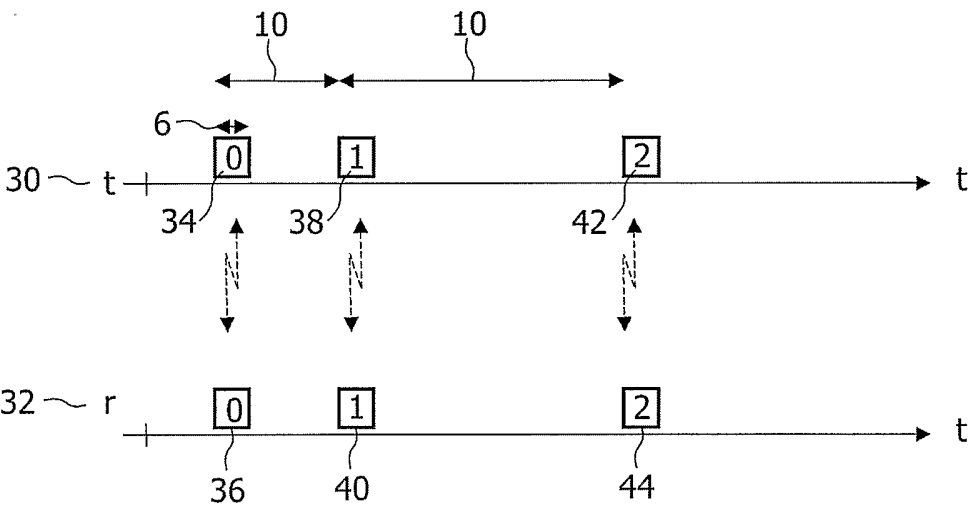


FIG.3

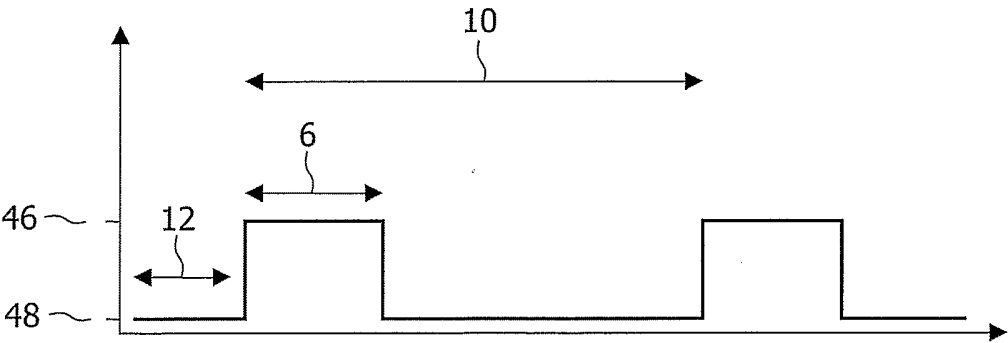


FIG.4

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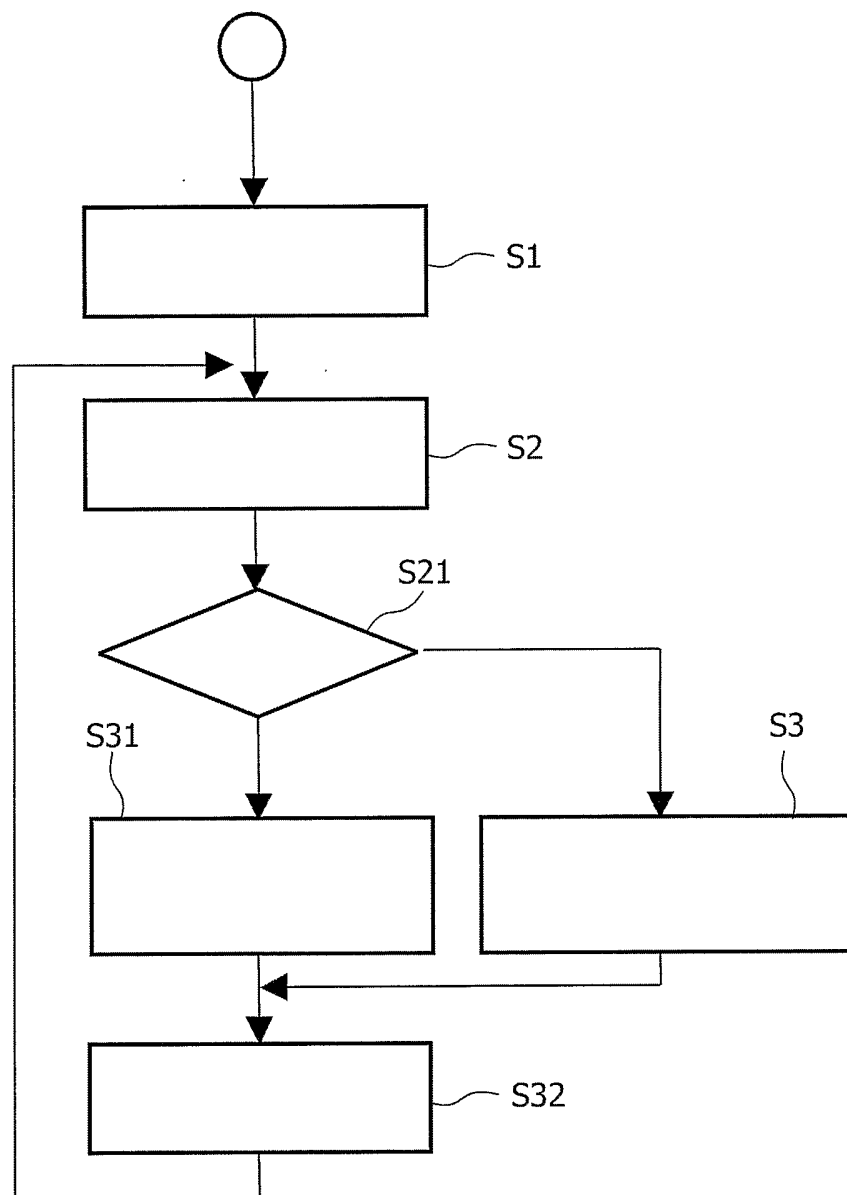


FIG.5

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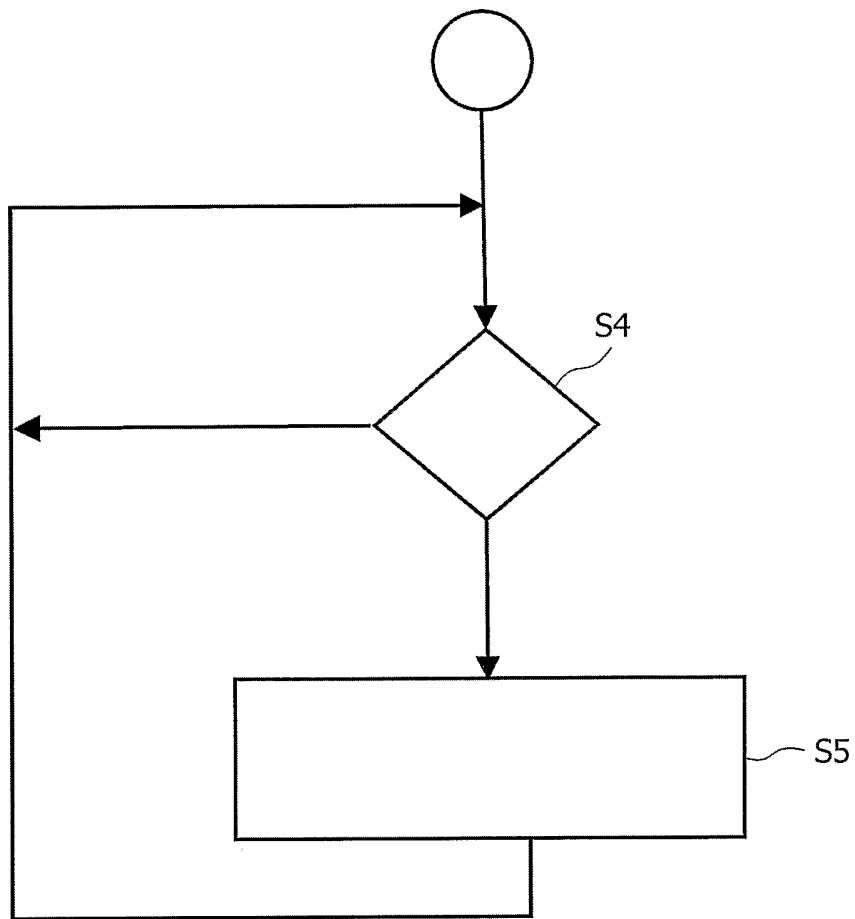


FIG.6

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB2005/052212

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G08C17/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G08C

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

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

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 469 989 B1 (ERNST GERHARD) 22 October 2002 (2002-10-22) column 5, line 26 - column 7, line 21 column 7, line 57 - column 9, line 13 -----	1-15
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☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Information on patent family members

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PCT/IB2005/052212

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