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

(11) EP 3 333 817 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
13.06.2018 Bulletin 2018/24

(21) Application number: **16834801.9**

(22) Date of filing: **27.07.2016**

(51) Int Cl.:
G08B 17/00 *(2006.01)* ***G08B 17/06*** *(2006.01)*

(86) International application number:
PCT/JP2016/003466

(87) International publication number:
WO 2017/026098 (16.02.2017 Gazette 2017/07)

(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: **07.08.2015 JP 2015157699**

(71) Applicant: **Panasonic Intellectual Property Management Co., Ltd.**
Osaka-shi, Osaka 540-6207 (JP)

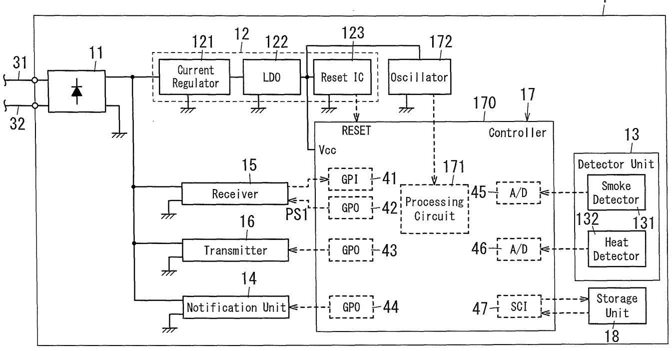
(72) Inventors:
- **OOI, Motohiro**
  Osaka-shi, Osaka 540-6207 (JP)
- **ITOU, Takasi**
  Osaka-shi, Osaka 540-6207 (JP)
- **GOSHONOO, Kazuhiko**
  Osaka-shi, Osaka 540-6207 (JP)
- **MIZUTA, Tomoaki**
  Osaka-shi, Osaka 540-6207 (JP)
- **LI, Ran**
  Osaka-shi, Osaka 540-6207 (JP)

(74) Representative: **Appelt, Christian W.**
Boehmert & Boehmert
Anwaltspartnerschaft mbB
Pettenkoferstrasse 22
80336 München (DE)

(54) AUTOMATIC FIRE ALARM SYSTEM CHILD MACHINE, AUTOMATIC FIRE ALARM SYSTEM, AND AUTOMATIC FIRE ALARM SYSTEM PARENT MACHINE

(57) An object of the present invention is to reduce power consumption. An automatic fire alarm system slave device (1) includes a receiver (15) and a controller (17). The receiver (15) is electrically connected to a pair of cables (31, 32) and receives a signal transmitted from a master device (2) by varying a voltage (VI) applied between the pair of cables (31, 32). The controller (17) switches a state of the receiver (15) to either a reception enabled state in which the receiver (15) is operating or a reception disabled state in which the receiver (15) stops operating. The controller (17) is configured to switch the state of the receiver (15) to either the reception enabled state or the reception disabled state by intermittently applying a power supply signal (PS1) to the receiver (15). The power supply signal (PS1) supplies power to operate the receiver (15).

FIG. 1



Printed by Jouve, 75001 PARIS (FR)

Description

Technical Field

[0001] The present invention generally relates to automatic fire alarm system slave devices, automatic fire alarm systems, and automatic fire alarm system master devices. More particularly, the present invention relates to an automatic fire alarm system slave device electrically connected to a pair of cables extended from a master device, an automatic fire alarm system including the automatic fire alarm system slave device, and an automatic fire alarm system master device.

Background Art

[0002] An automatic fire alarm system has been known in which a fire detector (functioning as a slave device) is connected to detector lines (which may be a pair of cables) extended from a fire receiver (functioning as a master device). One example of this is disclosed, for example, in Patent Literature 1. The fire receiver of this automatic fire alarm system is configured to output a control signal to the fire detector through the detector lines. Meanwhile, the fire detector is configured to perform operation in an abnormality detection mode on receiving the control signal from the fire receiver.

[0003] There has been increasing demand for reducing the power consumption of known automatic fire alarm systems like this.

Citation List

Patent Literature

[0004] Patent Literature 1: JP 2002-8154 A

Summary of Invention

[0005] It is therefore an object of the present invention to provide an automatic fire alarm system slave device, automatic fire alarm system, and automatic fire alarm system master device, all of which contribute to reducing power consumption.

[0006] An automatic fire alarm system slave device according to an aspect of the present invention includes a receiver and a controller. The receiver is electrically connected to a pair of cables and configured to receive a signal from a master device, which is also electrically connected to the pair of cables. The signal is transmitted from the master device by varying a voltage applied between the pair of cables. The controller is configured to switch a state of the receiver to either a reception enabled state in which the receiver is operating or a reception disabled state in which the receiver stops operating. The controller is configured to switch the state of the receiver to either the reception enabled state or the reception disabled state by intermittently applying a power supply signal to the receiver. The power supply signal supplies power to operate the receiver.

[0007] An automatic fire alarm system according to another aspect of the present invention includes the automatic fire alarm system slave device described above, and a master device. The master device is electrically connected to a pair of cables and configured to apply a voltage between the pair of cables. The master device includes a transmitter configured to transmit a signal to the automatic fire alarm system slave device by varying a voltage applied between the pair of cables.

[0008] An automatic fire alarm system master device according to still another aspect of the present invention is designed to be used in the automatic fire alarm system described above.

Brief Description of Drawings

[0009]

FIG. 1 is a block diagram illustrating a general configuration for an automatic fire alarm system slave device according to an embodiment of the present invention;
FIG. 2 is a block diagram illustrating a general configuration for an automatic fire alarm system according to the embodiment;
FIG. 3 is a schematic circuit diagram illustrating a receiver in the automatic fire alarm system slave device according to the embodiment;
FIG. 4 is a block diagram illustrating a general configuration for a first variation of a controller in the automatic fire alarm system slave device according to the embodiment;
FIG. 5 is a block diagram illustrating a general configuration for the first variation of the controller with an oscillator built in a microcomputer in the automatic fire alarm system slave device according to the embodiment;
FIG. 6A is a block diagram illustrating a general configuration for a second variation of a controller in the automatic fire alarm system slave device according to the embodiment;
FIG. 6B illustrates how a processing circuit changes its state in the automatic fire alarm system slave device according to the embodiment;
FIG. 7 illustrates a first exemplary operation of the automatic fire alarm system slave device according to the embodiment;
FIG. 8 illustrates a second exemplary operation of the automatic fire alarm system slave device according to the embodiment; and
FIG. 9 illustrates a third exemplary operation of the automatic fire alarm system slave device according to the embodiment.

Description of Embodiments

[0010] A slave device 1 for an automatic fire alarm system 100 according to an exemplary embodiment includes a receiver 15 and a controller 17 as shown in FIGS. 1 and 2. The receiver 15 is electrically connected to a pair of cables 31, 32 and receives a signal from a master device 2, which is also electrically connected to the pair of cables 31, 32. The signal is transmitted from the master device 2 by varying a voltage (hereinafter referred to as a "standby voltage") V1 applied between the pair of cables 31, 32. The controller 17 switches a state of the receiver 15 to either a reception enabled state in which the receiver 15 is operating or a reception disabled state in which the receiver 15 stops operating. The controller 17 is configured to switch the state of the receiver 15 to either the reception enabled state or the reception disabled state by intermittently applying a power supply signal PS1 to the receiver 15. The power supply signal PS1 supplies power to operate the receiver 15.

[0011] Meanwhile, an automatic fire alarm system 100 according to this embodiment includes a slave device 1 and a master device 2 configured to apply a voltage between the pair of cables 31, 32 as shown in FIG. 2. The master device 2 includes a transmitter 24, which is electrically connected to the pair of cables 31, 32 and configured to transmit a signal to the slave device 1 by varying a voltage between the cables 31, 32.

[0012] Furthermore, a master device 2 for the automatic fire alarm system 100 according to this embodiment is designed to be used in the automatic fire alarm system 100 of this embodiment as shown in FIG. 2.

[0013] The slave device 1 for the automatic fire alarm system 100, the master device 2 for the automatic fire alarm system 100, and the automatic fire alarm system 100 according to this embodiment will be described in detail. Note that the configuration to be described below is only a non-limiting exemplary embodiment of the present invention. Although the present invention will be described with reference to such exemplary embodiments, those embodiments should not be construed as limiting but numerous modifications or variations can be readily made by those skilled in the art depending on their design choice or any other factor without departing from the true spirit and scope of the invention as defined by the appended claims. In the drawings, the dotted arrows indicate signal flows.

[0014] In the following description, an automatic fire alarm system 100 according to this embodiment is supposed to be used in a multi-family dwelling house (i.e., what is called a "mansion" in Japan). Naturally, however, the automatic fire alarm system 100 of this embodiment does not have to be used in a multi-family dwelling house, but may also be used in any of various other types of buildings including business facilities, hospitals, hotels, and multi-tenant buildings.

[0015] The automatic fire alarm system 100 of this embodiment has basically the same configuration as a general automatic fire alarm system. The automatic fire alarm system 100 is configured to detect the outbreak of a fire using the slave device 1 and make the slave device 1 notify the master device 2 of the outbreak of the fire (make a fire notification). The slave device 1 does not have to have such a configuration for detecting the outbreak of a fire but may also have a configuration including an emergency transmitter. As used herein, the "emergency transmitter" refers to a device with a press button, which may be manually pressed by a person who has detected a fire to notify the master device 2 of the outbreak of the fire.

[0016] Furthermore, the automatic fire alarm system 100 of this embodiment also has a coordination capability of coordinating other related devices, including smoke prevention and exhaustion systems and emergency broadcasting systems, with this automatic fire alarm system 100 when the master device 2 receives a notification that those related devices should be coordinated with the system 100 (i.e., a coordination instruction) from the slave device 1. This allows the automatic fire alarm system 100 of this embodiment to control a fire door of the smoke prevention and exhaustion system and give notification of the outbreak of a fire by either sounding an audio alarm or announcing a voice message from emergency broadcasting system.

[0017] The automatic fire alarm system 100 of this embodiment is based on a P-type (proprietary-type) automatic fire alarm system. Also, the automatic fire alarm system 100 of this embodiment is supposed to use existent cabling as it is and replace the master device 2 and a plurality of slave devices 1 of a P-type automatic fire alarm system installed in a multi-family dwelling house. Alternatively, the automatic fire alarm system 100 of this embodiment may also be adopted as an automatic fire alarm system to be newly introduced.

[0018] The configurations of the master device 2 and the plurality of slave devices 1 will be described in detail. In the following description, the configuration of only one of the plurality of slave devices 1 will be described and description of the other slave devices 1 will be omitted herein, because those other slave devices 1 have the same configuration as the one slave device 1.

<Configuration of master device>

[0019] The master device 2 is a P-type receiver to receive a fire notification and a coordination instruction from the slave device 1. The master device 2 may be installed in, for example, a building manager room of a building (e.g., a multi-family dwelling house).

[0020] As shown in FIG. 2, the master device 2 includes an application unit 21, a resistor 22, a receiver 23, a transmitter 24, a display unit 25 to display various kinds of information thereon, an interface unit 26 to accept a user's manipulation and input, and a controller 27 to control all of these components. Also, the master device 2 is electrically connected to the pair of cables 31, 32.

[0021] The application unit 21 applies a predetermined voltage between the pair of cables 31, 32. In this embodiment, the voltage applied by the application unit 21 between the pair of cables 31, 32 is supposed to be DC 24 V as an example. Note that this value is only an example and should not be construed as limiting.

[0022] The resistor 22 is connected between the application unit 21 and at least one of the two cables 31, 32. In the example illustrated in FIG. 1, the resistor 22 is inserted between one cable 31 (with the higher potential) of the two cables 31, 32 and the application unit 21. However, this is only an example. Alternatively, the resistor 22 may be inserted between the other cable 32 (with the lower potential) and the application unit 21. Still alternatively, the resistor 22 may also be inserted between each of the two cables 31, 32 and the application unit 21.

[0023] The resistor 22 has two functions, namely, a first function of transforming a current flowing through the resistor 22 into a potential difference (voltage) between both terminals of the resistor 22 by a voltage drop and a second function of limiting the amount of the current flowing through the pair of cables 31, 32 when the cables 31, 32 are short-circuited with each other. In short, the resistor 22 has both the first function as a current-voltage transformer and the second function as a current limiter. In this embodiment, the resistor 22 is supposed to have a resistance value of 470 Ω as an example. Note that this value is only an example and should not be construed as limiting.

[0024] The receiver 23 is electrically connected between the resistor 22 and the pair of cables 31, 32. The receiver 23 receives a signal S2, which is transmitted from the slave device 1, based on the voltage (hereinafter referred to as a "standby voltage") V1 between the pair of cables 31, 32. Specifically, when the slave device 1 pulls in the current flowing through the pair of cables 31, 32, the current value of the current flowing through the resistor 22 varies, thus causing a variation in the standby voltage V1 as will be described later. The receiver 23 receives the signal S2 transmitted from the slave device 1 by detecting the voltage value of this standby voltage V1. In addition, the receiver 23 also receives the fire notification and coordination instruction transmitted from the slave device 1 by detecting the voltage value of the standby voltage V1.

[0025] The transmitter 24 is electrically connected between the resistor 22 and the pair of cables 31, 32. The transmitter 24 transmits a signal S1 to the slave device 1 by varying the amount of the current flowing between the pair of cables 31, 32. Specifically, when the transmitter 24 pulls in the current flowing from the application unit 21 toward the resistor 22, the standby voltage V1 varies. That is to say, the transmitter 24 transmits the signal S1 to the slave device 1 by varying the standby voltage V1 by pulling in the current flowing from the application unit 21 toward the resistor 22.

[0026] In the master device 2 of this embodiment, the controller 27 may control the transmitter 24 to alternately switch the voltage value of the standby voltage V1 between a first level and a second level (which is lower than the first level), for example, thereby transmitting the signal S1 to the slave device 1.

[0027] The display unit 25 may include an LED (light emitting diode) and a liquid crystal display, an organic electroluminescent display, or any other type of display, for example. Under the control of the controller 27, the display unit 25 displays some kind of information represented by the data included in the signal S2 received from the slave device 1. For example, the display unit 25 may display an alert to the outbreak of a fire or indicate what floor the fire has broken out on. Also, if identification information (such as the address) unique to the slave device 1 that has detected a fire is available, the display unit 25 may also display the site of installation of the slave device 1.

[0028] The controller 27 includes, as its major component, a microcomputer and performs a desired function by executing a program stored in a memory. Note that the program may be written in the memory in advance but may also be provided by being stored on some storage medium such as a memory card or be downloaded through a telecommunications line.

[0029] The master device 2 applies a voltage from the application unit 21 to the pair of cables 31, 32 as described above. This allows the master device 2 to serve as a power supply that operates the entire automatic fire alarm system 100 including the slave device 1 connected between the pair of cables 31, 32.

[0030] The master device 2 further includes an emergency power supply 28 including a storage battery in order to provide emergency power that would allow the automatic fire alarm system 100 to operate safely even in cases of a power failure. The master device 2 may use, as its mains power supply, a utility power supply, a non-utility generation facility, or any other power source. The application unit 21 automatically switches the power sources from the mains power supply to the emergency power supply 28 when the mains power supply causes a power failure, and automatically switches the power sources from the emergency power supply 28 to the mains power supply when the mains power supply recovers from the power failure.

<Configuration of slave device>

[0031] The slave device 1 includes a diode bridge 11, a power supply unit 12, a detector unit 13, a notification unit 14, a receiver 15, a transmitter 16, a controller 17, and a storage unit 18 as shown in FIGS. 1 and 2.

[0032] The diode bridge 11 has its input terminals electrically connected to the pair of cables 31, 32 and has one of its output terminals electrically connected to the power supply unit 12, the notification unit 14, the receiver 15, and the transmitter 16.

[0033] The power supply unit 12 generates power to operate the slave device 1 by being supplied with power from the pair of cables 31, 32. The power supply unit 12 includes a current regulator 121, a low drop-out (LDO) regulator 122, and a reset IC (integrated circuit) 123. The current regulator 121 is electrically connected to the pair of cables 31, 32 to regulate the upper limit of the current flowing through the pair of cables 31, 32.

[0034] The low drop-out regulator 122 has its input terminal electrically connected to the output terminal of the current regulator 121 and has its output terminal electrically connected to the reset IC 123, the controller 17, and an oscillator 172 (to be described later). The low drop-out regulator 122 operates so as to narrow the difference between the voltage input to its input terminal and the voltage output from its output terminal. The output voltage of the low drop-out regulator 122 is supplied as an operating voltage for the controller 17 to a power supply terminal (designated by Vcc in FIG. 1) of the controller 17.

[0035] The reset IC 123 monitors the output voltage of the low drop-out regulator 122, thereby monitoring the input voltage applied to the controller 17. On sensing that the voltage value of the input voltage has fallen out of a required range to operate the controller 17, the reset IC 123 applies a reset signal to the reset terminal (designated by RESET in FIG. 1) of the controller 17, thereby resetting (or initializing) the controller 17.

[0036] The detector unit 13 detects a variation in smoke concentration, temperature, or the concentration of a gas such as carbon monoxide, for example, thereby detecting the outbreak of a fire or smoke. In the slave device 1 of this embodiment, the detector unit 13 includes a smoke detector 131 for detecting the outbreak of smoke or detecting a variation in the concentration of smoke, and a heat detector 132 for detecting a variation in temperature. On detecting the outbreak of a fire based on the detection results obtained by the smoke detector 131 and the heat detector 132, the detector unit 13 transmits a detection signal to the controller 17. The detector unit 13 is controlled by the controller 17.

[0037] The notification unit 14 includes a buzzer, an LED (light emitting diode), or any other suitable device and is configured to notify people around the site in question of the outbreak of a fire. The notification unit 14 is also controlled by the controller 17.

[0038] The receiver 15 receives the signal S1 transmitted from the master device 2 by detecting a variation in standby voltage V1. Specifically, when the master device 2 pulls in the current flowing through the pair of cables 31, 32, the current value of the current flowing through the resistor 22 varies, thus causing a variation in the standby voltage V1. The receiver 15 detects the voltage value of the output voltage of the diode bridge 11, corresponding to this standby voltage VI, thereby receiving, as a received signal, the signal S1 transmitted from the master device 2.

[0039] With this regard, a specific exemplary circuit configuration for the receiver 15 will be described. As shown in FIG. 3, the receiver 15 includes a filtering capacitor 151, resistors 152, 153, a semiconductor device 154, and a pull-up resistor 155. The receiver 15 operates using, as a power source, the power supply signal PS1 applied by the controller 17.

[0040] The semiconductor device 154 is implemented as an npn bipolar transistor, for example, but may naturally be implemented as any other type of semiconductor device such as a MOSFET (metal-oxide-semiconductor field-effect transistor). The emitter of the semiconductor device 154 is electrically connected to a circuit ground (i.e., the lower-potential output terminal of the diode bridge 11). The base of the semiconductor device 154 is electrically connected to one (e.g., the cable 31 in this embodiment) of the two cables 31, 32 via the diode bridge 11, the capacitor 151, and the resistor 153. The collector of the semiconductor device 154 is configured to receive a power supply signal PS1 via the pull-up resistor 155. The connection node 15A between the capacitor 151 and the resistor 153 is configured to receive the power supply signal PS1 via the resistor 152.

[0041] The connection node 15A is electrically connected to one (e.g., the cable 31 in this embodiment) of the two cables 31, 32 via the capacitor 151. The potential at the connection node 15A varies as the standby voltage V1 varies. The semiconductor device 154 is used in a so-called "open collector" mode. The collector-emitter voltage of this semiconductor device 154 is the voltage V2 of the received signal.

[0042] Next, it will be described how the receiver 15 operates. In the following description, the receiver 15 is supposed to be provided with the power supply signal PS1 from the controller 17. When the voltage value of the standby voltage V1 has a first level, the potential at the connection node 15A is higher than the threshold value VBE of the semiconductor device 154. In this case, the semiconductor device 154 turns ON, thus making the voltage V2 of the received signal low. On the other hand, when the voltage value of the standby voltageV1 has a second level, the potential at the connection node 15A is lower than the threshold value VBE of the semiconductor device 154. In this case, the semiconductor device 154 turns OFF, thus making the voltage V2 of the received signal high. Note that VBE herein stands for the base-emitter voltage of the semiconductor device 154.

[0043] In this manner, in the receiver 15, the ON/OFF state of the semiconductor device 154 changes as the standby voltage V1 varies. Thus, the receiver 15 receives, as a received signal, the signal S1 transmitted from the master device 2.

[0044] The transmitter 16 is electrically connected to the pair of cables 31, 32 via the diode bridge 11. The transmitter 16 transmits a signal S2 to the master device 2 by varying the amount of the current flowing through the pair of cables 31, 32. Specifically, when the transmitter 16 pulls in the current flowing through the pair of cables 31, 32, the standby voltage V1 varies. That is to say, the transmitter 16 transmits the signal S2 to the master device 2 by varying the voltage V1 between the pair of cables 31, 32 (i.e., the standby voltage VI) by pulling in the current flowing between the pair of cables 31, 32.

[0045] The controller 17 includes, as its major component, a microcomputer 170 and performs a desired function by executing a program stored in a memory. Note that the program may be written in the memory in advance but may also be provided by being stored on some storage medium such as a memory card or be downloaded through a telecommunications line. Note that the major component of the controller 17 is not limited to the microcomputer 170 but may also be an FPGA (field-programmable gate array), for example.

[0046] The controller 17 includes a GPI (general purpose input) terminal 41, GPO (general purpose output) terminals 42-44, A/D (analog to digital) terminals 45, 46, and an SCI (serial communication interface) terminal 47. The controller 17 extracts data from the received signal applied to the GPI terminal 41. Also, the controller 17 outputs the power supply signal PS1 from the GPO terminal 42 to the receiver 15. The controller 17 further outputs a control signal from the GPO terminal 43 to the transmitter 16, thereby controlling the operation of the transmitter 16. Furthermore, the controller 17 outputs a control signal from the GPO terminal 44 to the notification unit 14 to control the operation of the notification unit 14.

[0047] The controller 17 obtains a detection value of the smoke detector 131 that has been input to the A/D terminal 45. For example, a voltage signal varying with the concentration of smoke may be input to the A/D terminal 45. The controller 17 also obtains a detection value of the heat detector 132 that has been input to the A/D terminal 46. For example, a voltage signal varying with the temperature of the environment surrounding the heat detector 132 may be input to the A/D terminal 46. The controller 17 either retrieves or rewrites, via the SCI terminal 47, data stored in the storage unit 18.

[0048] The controller 17 further includes a processing circuit 171 for performing processing (program) in response to a clock signal. In this embodiment, the processing circuit 171 may be a CPU (central processing unit). The clock signal supplied to the processing circuit 171 is generated by the oscillator 172, which may include a crystal oscillator, for example. Naturally, the oscillator 172 may have any configuration for generating a clock signal to be supplied to the processing circuit 171 and does not have to have such a configuration including a crystal oscillator. In the slave device 1 of this embodiment, the oscillator 172 is provided separately from the microcomputer 170. Alternatively, the oscillator 172 may be built in the microcomputer 170.

[0049] The controller 17 controls the receiver 15 and the transmitter 16. Specifically, the controller 17 instructs the receiver 15 to receive a signal S1 such as a synch signal transmitted from the master device 2. In addition, the controller 17 is provided with the output of the detector unit 13 at regular intervals, and determines that a fire has broken out on sensing that the output of the detector unit 13 has exceeded a first reference value. Furthermore, the controller 17 instructs the transmitter 16 to regulate the amount of the current to be pulled in out of the current flowing through the pair of cables 31, 32, thus changing the standby voltage V1 to a fire notification level. This allows the controller 17 to transmit a fire notification to the master device 2. In this case, the controller 17 instructs the notification unit 14 to notify people around the site in question of the outbreak of a fire.

[0050] Also, the controller 17 determines that when the output of the detector unit 13 exceeds a second reference value (which is greater than the first reference value), other devices should be coordinated with this system 100. In that case, the controller 17 instructs the transmitter 16 to regulate the amount of the current to be pulled in out of the current flowing through the pair of cables 31, 32, thus changing the standby voltage V1 to a coordination instruction level (which is less than the fire notification level). This allows the controller 17 to transmit the coordination instruction to the master device 2.

[0051] Furthermore, the controller 17 instructs the transmitter 16 to alternately change the voltage value of the standby voltage V1 between the first level and the second level, thereby transmitting the signal S2 to the master device 2. The signal S2 includes information (identification information) to identify the device that has issued the fire notification on the slave device 1 basis, information for use to conduct an automatic test, and various other kinds of information. Exemplary items of the automatic test include items of a "keep alive" test and a self-diagnosis test of the slave device 1.

[0052] The storage unit 18 stores at least identification information (such as an address) assigned in advance to the slave device 1. That is to say, a unique piece of identification information has been assigned in advance to each of the plurality of slave devices 1 included in the automatic fire alarm system 100 of this embodiment. Those pieces of identification information are registered with the master device 2 in association with the respective sites of installation (e.g., room numbers) of the plurality of slave devices 1.

<Receiver>

[0053] In the automatic fire alarm system 100 of this embodiment, the master device 2 regularly transmits a synch signal to the plurality of slave devices 1 that are connected to the same line (i.e., the pair of cables 31, 32). The synch signal is a signal for use to define a timing for each of the slave devices 1 to conduct an automatic test or a timing for the slave device 1 to communicate with the master device 2.

[0054] In this case, when the semiconductor device 154 is ON in the receiver 15, a current flows mainly through the resistor 153 and the pull-up resistor 155. On the other hand, when the semiconductor device 154 is OFF in the receiver 15, a current flows mainly through the capacitor 151 via the resistor 152. That is to say, the receiver 15 continues to consume power because a current flows not only while the receiver 15 is receiving the signal S1 from the master device 2 but also while the receiver 15 is not receiving the signal S1. Thus, if the receiver 15 is continues to operate in order to wait for the signal S1 (serving as a synch signal in this embodiment) to be transmitted from the master device 2, power is wasted while the signal S1 is not being received, thus causing an increase in power consumption, which is not beneficial.

[0055] In addition, allowing the receiver 15 to continue to operate in every slave device 1 belonging to the automatic fire alarm system 100 of this embodiment would have a current pulled in the receiver 15 from the pair of cables 31, 32, thus causing a drop in standby voltage V1. In that case, even though no fire has actually broken out, the standby voltage V1 could reach the fire notification level and the slave device 1 might notify the master device 2 of the outbreak of a fire by mistake.

[0056] In view of this consideration, in the slave device 1 of this embodiment, the controller 17 is configured to switch the state of the receiver 15 to either a reception enabled state or a reception disabled state by intermittently applying the power supply signal PS1, which supplies power to operate the receiver 15, to the receiver 15. As used herein, the reception enabled state refers to a state where the receiver 15 is operating by being provided with the power supply signal PS1, while the reception disabled state refers to a state where the receiver 15 stops operating by being provided with no power supply signal PS1.

[0057] That is to say, the receiver 15 is allowed to receive the signal S1 by operating while being provided with the power supply signal PS1 from the controller 17. On the other hand, the receiver 15 is not allowed to receive the signal S1 while being provided with no power supply signal PS1 from the controller 17, because the receiver 15 does not operate during such a period. Nevertheless, since no current flows, almost no power is consumed.

[0058] Therefore, the controller 17 allows the receiver 15 to operate only when necessary (e.g., while receiving a synch signal) and to stop operating when not necessary. That is to say, in the slave device 1 of this embodiment, the receiver 15 does not always wait for the signal S1 (serving as a synch signal in this embodiment) to be transmitted from the master device 2. This reduces the power consumption significantly.

<First variation of controller>

[0059] A first variation of the controller 17 for the slave device 1 of this embodiment will be described. According to the first variation, the controller 17 is configured to switch a state of the processing circuit 171 to either a processing enabled state or a processing disabled state by intermittently applying a clock signal to the processing circuit 171. As used herein, the processing enabled state refers to a state where the processing circuit 171 is operating responsive to a clock signal applied, while the processing disabled state refers to a state where the processing circuit 171 stops operating with no clock signal applied.

[0060] That is to say, the controller 17 may allow the processing circuit 171 to operate only when processing needs to be performed by the processing circuit 171 and stop operating the processing circuit 171 when processing need not be performed by the processing circuit 171. This configuration allows for reducing not only the power consumed by the receiver 15 but also the power consumed by processing circuit 171 as well.

[0061] This first variation may be implemented by providing a timer 173 for the controller 17 as shown in FIG. 4, for example. A clock signal generated by the oscillator 172 is input to the timer 173. The timer 173 supplies the clock signal to the processing circuit 171 at regular intervals by keeping time. Thus, the controller 17 is allowed to switch the state of the processing circuit 171 to either the processing enabled state or the processing disabled state.

[0062] In the slave device 1 of this embodiment, the timer 173 is built in the microcomputer 170. Alternatively, as well as the oscillator 172, the timer 173 may also be provided separately from the microcomputer 170. Still alternatively, the controller 17 may also be configured such that an oscillator 172 functioning as the timer 173 is built in the microcomputer 170 as shown in FIG. 5. According to this configuration, the oscillator 172 supplies a clock signal to the processing circuit 171 at regular intervals by using the function of the built-in timer 173.

<Second variation of controller>

[0063] A second variation of the controller 17 for the slave device 1 of this embodiment will be described. According to the second variation, the controller 17 is configured to switch the state of the processing circuit 171 to either a first state or a second state. As used herein, the first state refers to a state where the processing circuit 171 is supplied with a first clock signal. The second state refers to a state where the processing circuit 171 is supplied with a second clock signal. The second clock signal has a longer clock cycle than the first clock signal.

[0064] That is to say, the controller 17 may allow the processing circuit 171 to operate responsive to the first clock signal (at normal rates) in a normal state, and to operate responsive to the second clock signal (at lower rates) when performing lighter load processing such as waiting for a synch signal. This configuration allows the processing circuit 171 to operate responsive to the second clock signal (at lower rates) as needed, thus reducing the power consumption of the processing circuit 171 compared to a situation where the processing circuit 171 is allowed to operate continuously responsive to the first clock signal (at normal rates).

[0065] This second variation may be implemented by providing a frequency divider 174 for the controller 17 as shown in FIG. 6A, for example. The frequency divider

174 receives a clock signal generated by the oscillator 172 (e.g., the first clock signal in this embodiment). Then, in response to a request received from the processing circuit 171, the frequency divider 174 performs either processing of passing the clock signal supplied from the oscillator 172 (i.e., the first clock signal) to the processing circuit 171 as it is without subjecting the clock signal to frequency division (or multiplication) or processing of supplying a second clock signal to the processing circuit 171 after subjecting the clock signal to frequency division. This allows the controller 17 to switch the state of the processing circuit 171 to either the first state or the second state.

[0066] Optionally, the controller 17 may also be implemented as a combination of the first and second variations. That is to say, the controller 17 may also be configured to switch the state of the processing circuit 171 to one of a first state, a second state, or a processing disabled state as shown in FIG. 6B. On the drawings to be referred to in the following description, namely, in FIG. 6B and FIGS. 7-9, "enable" indicates the processing enabled state of the processing circuit, "disable" indicates the processing disabled state of the processing circuit, "enable (first state)" indicates that the processing circuit is in the processing enabled state and the first state, and "enable (second state)" indicates that the processing circuit is in the processing enabled state and the second state.

[0067] This configuration may be implemented by providing the timer 173 and the frequency divided 174 for the controller 17, for example. In that case, the timer 173 and the frequency divider 174 may be either provided separately from, or built in, the microcomputer 170.

<First exemplary operation>

[0068] Next, it will be described with reference to FIG. 7, as a first exemplary operation, how the slave device 1 of this embodiment operates in a situation where the slave device 1 receives the synch signal. On the drawings to be referred to in the following description, namely, FIGS. 7-9, "enable" indicates the reception enabled state of the receiver, "disable" indicates the reception disabled state of the receiver, "H" denotes a high level of the synch signal, and "L" denotes a low level thereof. In this embodiment, the high level may be a first level voltage value of the standby voltage V1 and the low level may be a second level voltage value of the standby voltage V2, for example.

[0069] In this first exemplary operation, the controller 17 switches the state of the receiver 15 to the reception enabled state during a period in which the synch signal is being transmitted from the master device 2 and switches the state of the receiver 15 to the reception disabled state during the other periods. That is to say, the receiver 15 operates to receive the synch signal while the synch signal is being transmitted from the master device 2 but stops operating during the other periods. Thus, this first exemplary operation allows the receiver 15 to reduce the power consumption, compared to a situation where the receiver 15 is allowed to operate continuously.

[0070] In addition, the controller 17 switches the state of the processing circuit 171 to the second state during a period in which the synch signal is being transmitted from the master device 2 and switches the state of the processing circuit 171 to the first state during the other periods. That is to say, the processing circuit 171 operates responsive to the second clock signal (at lower rates) while the synch signal is being transmitted from the master device 2 but operates responsive to the first clock signal (at normal rates) during the other periods. Thus, this first exemplary operation allows the processing circuit 171 to reduce the power consumption, compared to a situation where the processing circuit 171 is allowed to operate continuously responsive to the first clock signal (at normal rates).

[0071] Note that the "period during which the synch signal is being transmitted" is not herein limited to, and does not have to be identical with, the very period during which the synch signal is being transmitted. That is to say, the "period during which the synch signal is being transmitted" may be a period including, and somewhat longer than, that period.

[0072] Optionally, if the slave device 1 of this embodiment has transmitted either a fire notification or a coordination instruction to the master device 2, then the controller 17 may maintain the receiver 15 in the reception enabled state until the fire notification or the coordination instruction stops being transmitted. Such a configuration allows the slave device 1 to communicate in real time with the master device 2 in case of emergency such as the outbreak of a fire.

<Second exemplary operation>

[0073] Next, it will be described with reference to FIG. 8, as a second exemplary operation, how the slave device 1 of this embodiment operates in a situation where the slave device 1 receives the synch signal. In this second exemplary operation, the controller 17 alternately switches the state of the receiver 15 from the reception enabled state to the reception disabled state, and vice versa, a number of times (e.g., twice in this embodiment) every minimum bit width W1 of a synch signal transmitted from the master device 2, unlike the first exemplary operation. That is to say, the receiver 15 does not operate continuously but operates intermittently during the period in which the synch signal is being transmitted from the master device 2.

[0074] According to this configuration, the controller 17 acquires the synch signal by making sampling a number of times every minimum bit width W1 of the synch signal. Thus, this configuration allows the receiver 15 to reduce the power consumption, compared to a situation where the receiver 15 is allowed to operate continuously during the period in which the synch signal is being transmitted from the master device 2.

[0075] Alternatively, the controller 17 may also acquire the synch signal by making sampling only once every minimum bit width W1 of the synch signal. That is to say, the controller 17 may also be configured to alternately switch the state of the receiver 15 from the reception enabled state to the reception disabled state, or vice versa, every minimum bit width W1 of the synch signal.

<Third exemplary operation>

[0076] Next, it will be described with reference to FIG. 9, as a third exemplary operation, how the slave device 1 of this embodiment operates in a situation where the slave device 1 receives the synch signal. In this third exemplary operation, the controller 17 switches the state of the processing circuit 171 into the processing enabled state (e.g., the second state in this embodiment) when the state of the receiver 15 is the reception enabled state, and also switches the state of the processing circuit 171 into the processing disabled state when the state of the receiver 15 is the reception disabled state. That is to say, the processing circuit 171 operates responsive to the second clock signal (at lower rates) while the receiver 15 is operating, and stops operating during the other periods. In other words, the processing circuit 171 operates intermittently, not continuously.

[0077] This configuration allows the processing circuit 171 to reduce the power consumption, compared to a situation where the processing circuit 171 is allowed to operate continuously during the period in which the synch signal is transmitted from the master device 2. Note that the processing circuit 171 just needs to operate while the receiver 15 is operating, and therefore, may operate responsive to the first clock signal (at normal rates).

[0078] In addition, since the processing circuit 171 just needs to operate at least while the receiver 15 is operating, the operating period W2 of the receiver 15 does not have to agree with the operating period W3 of the processing circuit 171. In this embodiment, the operating period W3 of the processing circuit 171 is longer than the operating period W2 of the receiver 15.

[0079] As can be seen from the foregoing description, a slave device (1) for an automatic fire alarm system (100) according to a first aspect of the present invention includes a receiver (15) and a controller (17). The receiver (15) is electrically connected to a pair of cables (31, 32) and configured to receive a signal from a master device (2) that is also electrically connected to the pair of cables (31, 32). The signal is transmitted from the master device (2) by varying a voltage (VI) applied between the pair of cables (31, 32). The controller (17) is configured to switch a state of the receiver (15) to either a reception enabled state in which the receiver (15) is operating or a reception disabled state in which the receiver (15) stops operating. The controller (17) is configured to switch the state of the receiver (15) to either the reception enabled state or the reception disabled state by intermittently applying a power supply signal (PS1) to the receiver (15). The power supply signal (PS1) supplies power to operate the receiver (15).

[0080] In a slave device (1) for an automatic fire alarm system (100) according to a second aspect of the present invention, which is dependent on the first aspect, the controller (17) is configured to switch the state of the receiver (15) to the reception enabled state during a period in which a synch signal is being transmitted from the master device (2) and switch the state of the receiver (15) to the reception disabled state during the other periods.

[0081] In a slave device (1) for an automatic fire alarm system (100) according to a third aspect of the present invention, which is dependent on the first or second aspect, the controller (17) includes a processing circuit (171) configured to perform processing responsive to a clock signal. The controller (17) is configured to switch a state of the processing circuit (171) to either a processing enabled state in which the processing circuit (171) is operating or a processing disabled state in which the processing circuit (171) stops operating by intermittently applying the clock signal to the processing circuit (171).

[0082] In a slave device (1) for an automatic fire alarm system (100) according to a fourth aspect of the present invention, which is dependent on the third aspect, the controller (17) is configured to switch the state of the processing circuit (171) to either a first state in which a first clock signal is applied to the processing circuit (171) or a second state in which a second clock signal, having a longer cycle time than the first clock signal, is applied to the processing circuit (171).

[0083] In a slave device (1) for an automatic fire alarm system (100) according to a fifth aspect of the present invention, which is dependent on the fourth aspect, the controller (17) is configured to switch the state of the processing circuit (171) to the second state during a period in which a synch signal is being transmitted and switch the state of the processing circuit (171) to the first state during the other periods.

[0084] In a slave device (1) for an automatic fire alarm system (100) according to a sixth aspect of the present invention, which is dependent on any one of the first to fifth aspects, the controller (17) is configured to alternately switch the state of the receiver (15) from the reception enabled state to the reception disabled state, and vice versa, a number of times every minimum bit width (W1) of a synch signal transmitted from the master device (2).

[0085] In a slave device (1) for an automatic fire alarm system (100) according to a seventh aspect of the present invention, which is dependent on the sixth aspect, the controller (17) is configured to switch the state of a processing circuit (171), performing processing responsive to a clock signal, to a processing enabled state in which the processing circuit (171) is operating when the receiver (15) is in the reception enabled state, and also switch the state of the processing circuit (171) to a processing disabled state in which the processing circuit (171) stops operating when the receiver (15) is in the reception disabled state.

[0086] An automatic fire alarm system (100) according to an eighth aspect of the present invention includes: the slave device (1) of the automatic fire alarm system (100) according to any one of the first to seventh aspects; and a master device (2) electrically connected to a pair of cables (31, 32) and configured to apply a voltage between the pair of cables (31, 32). The master device (2) includes a transmitter (24) configured to transmit a signal to the automatic fire alarm system slave device (1) by varying a voltage applied between the pair of cables (31, 32).

[0087] A master device (2) for an automatic fire alarm system (100) according to a ninth aspect of the present invention is designed to be used in the automatic fire alarm system (100) according to the eighth aspect.

[0088] The slave device (1) for an automatic fire alarm system (100), the automatic fire alarm system (100), and the master device (2) for the automatic fire alarm system (100) all contribute to reducing power consumption.

Reference Signs List

[0089]

100	Automatic Fire Alarm System
1	Slave Device
15	Receiver
17	Controller
171	Processing Circuit
2	Master Device
24	Transmitter
32, 32	Pair of Cables
PS1	Power Supply Signal
W1	Minimum Bit Width

Claims

1. An automatic fire alarm system slave device comprising:

    a receiver electrically connected to a pair of cables and configured to receive a signal from a master device that is also electrically connected to the pair of cables, the signal being transmitted from the master device by varying a voltage applied between the pair of cables; and
    a controller configured to switch a state of the receiver to either a reception enabled state in which the receiver is operating or a reception disabled state in which the receiver stops operating,
    the controller being configured to switch the state of the receiver to either the reception enabled state or the reception disabled state by intermittently applying a power supply signal to the receiver, the power supply signal supplying power to operate the receiver.

2. The automatic fire alarm system slave device of claim 1, wherein
    the controller is configured to switch the state of the receiver to the reception enabled state during a period in which a synch signal is being transmitted from the master device and switch the state of the receiver to the reception disabled state during the other periods.

3. The automatic fire alarm system slave device of claim 1 or 2, wherein
    the controller comprises a processing circuit configured to perform processing responsive to a clock signal,
    the controller is configured to switch a state of the processing circuit to either a processing enabled state in which the processing circuit is operating or a processing disabled state in which the processing circuit stops operating by intermittently applying the clock signal to the processing circuit.

4. The automatic fire alarm system slave device of claim 3, wherein
    the controller is configured to switch the state of the processing circuit to either a first state in which a first clock signal is applied to the processing circuit or a second state in which a second clock signal, having a longer cycle time than the first clock signal, is applied to the processing circuit.

5. The automatic fire alarm system slave device of claim 4, wherein
    the controller is configured to switch the state of the processing circuit to the second state during a period in which a synch signal is being transmitted from the master device and switch the state of the processing circuit to the first state during the other periods.

6. The automatic fire alarm system slave device of any one of claims 1 to 5, wherein
    the controller is configured to alternately switch the state of the receiver from the reception enabled state to the reception disabled state, and vice versa, a number of times every minimum bit width of a synch signal transmitted from the master device.

7. The automatic fire alarm system slave device of claim 6, wherein
    the controller is configured to switch the state of a processing circuit, performing processing responsive to a clock signal, to a processing enabled state in which the processing circuit is operating when the receiver is in the reception enabled state, and also switch the state of the processing circuit to a processing disabled state in which the processing circuit stops operating when the receiver is in the reception disabled state.

8. An automatic fire alarm system comprising:

the automatic fire alarm system slave device of any one of claims 1 to 7; and
a master device electrically connected to a pair of cables and configured to apply a voltage between the pair of cables,
the master device including a transmitter configured to transmit a signal to the automatic fire alarm system slave device by varying a voltage applied between the pair of cables.

9. An automatic fire alarm system master device for use in the automatic fire alarm system of claim 8.

FIG. 1

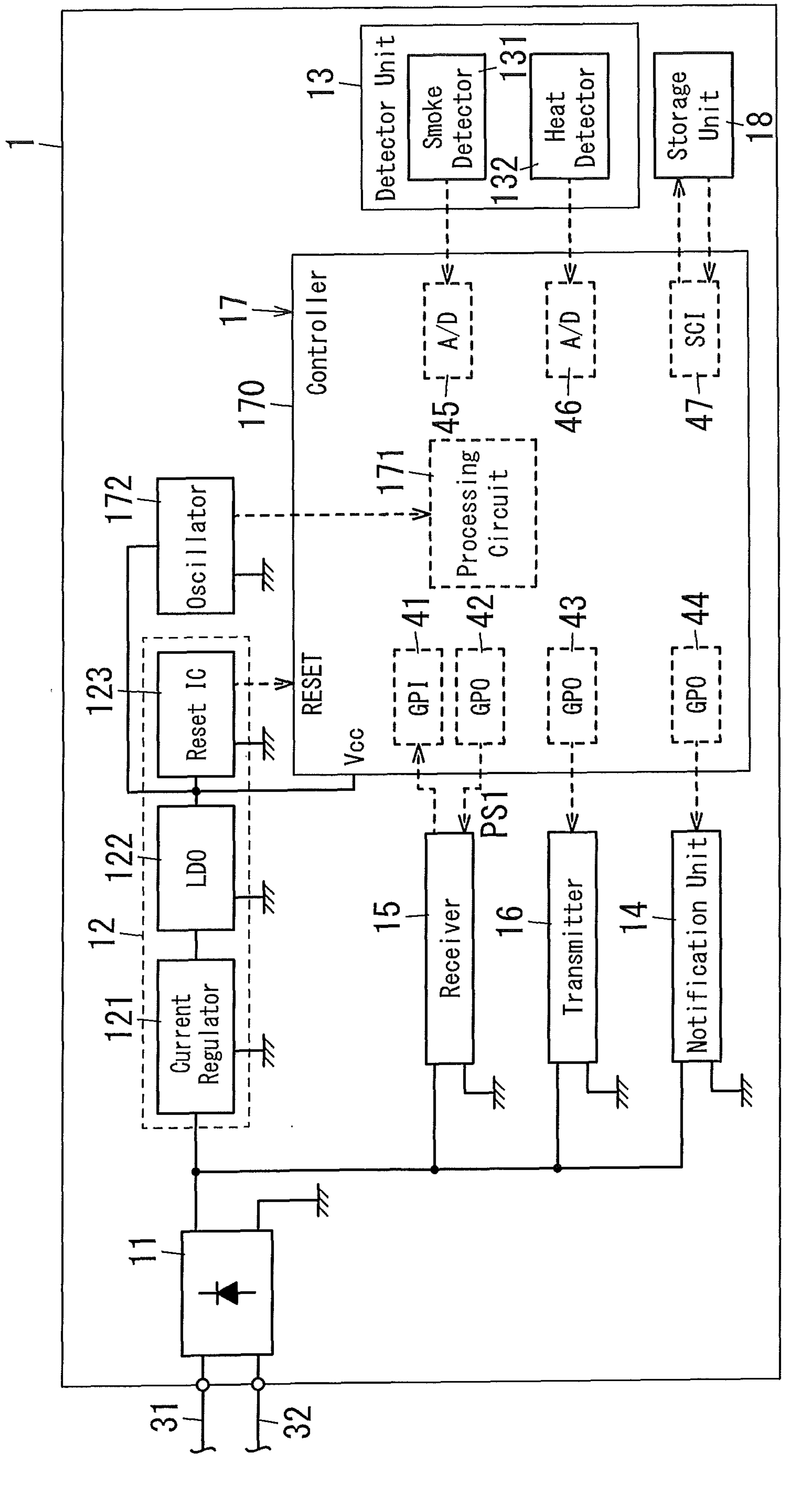

1
13
Detector Unit
Smoke Detector
131
Heat Detector
132
Storage Unit
18
17
Controller
170
A/D
45
A/D
46
SCI
47
171
Processing Circuit
172
Oscillator
123
Reset IC
RESET
Vcc
41
GPI
42
GPO
43
GPO
44
GPO
PS1
12
122
LDO
121
Current Regulator
15
Receiver
16
Transmitter
14
Notification Unit
11
31
32

FIG. 2

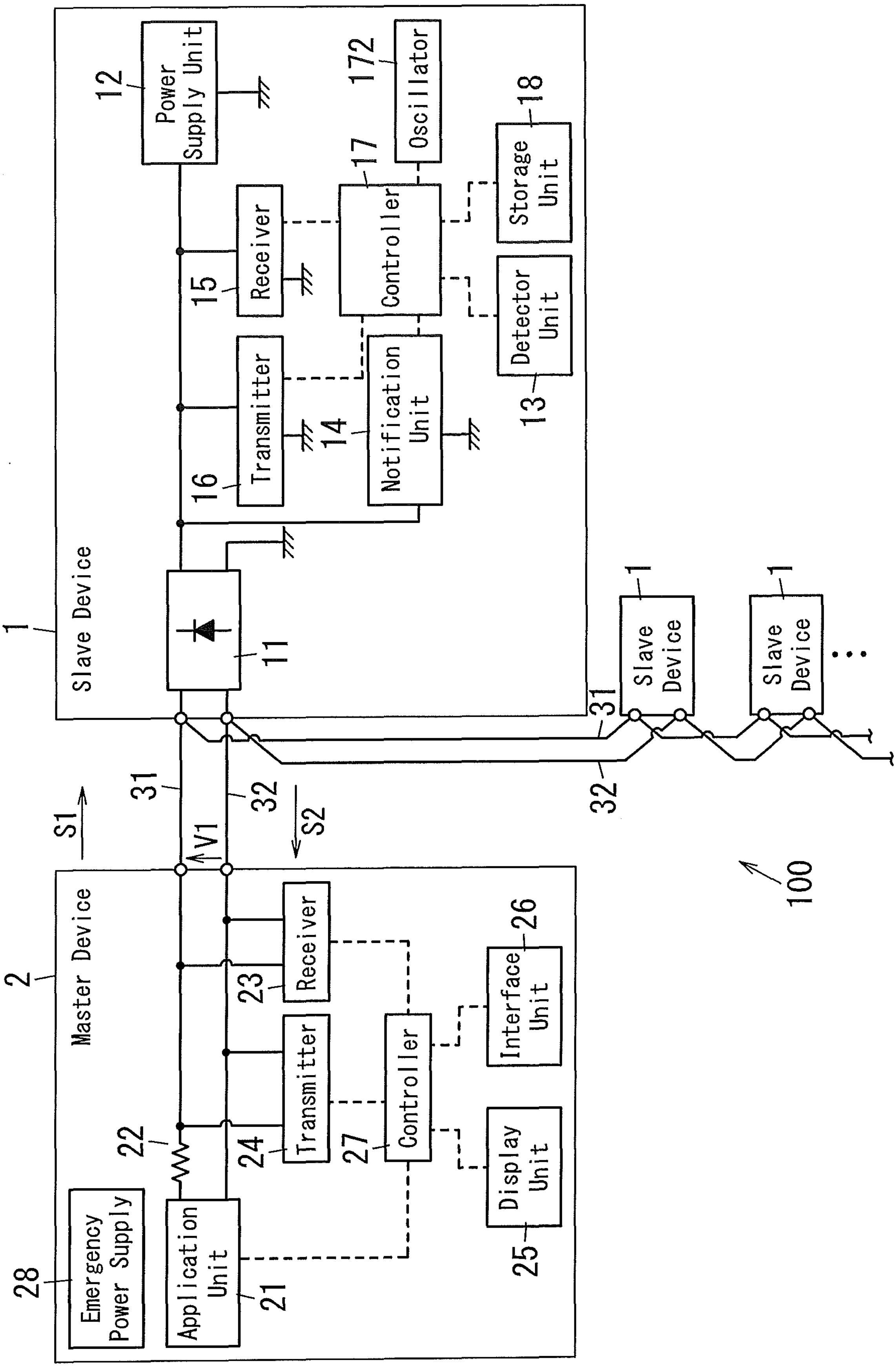

Slave Device
1
Power Supply Unit
12
Receiver
15
Transmitter
16
Controller
17
Oscillator
172
Storage Unit
18
Detector Unit
13
Notification Unit
14
11
31
32
S1
S2
V1
Slave Device
1
Slave Device
1
Master Device
2
Receiver
23
Transmitter
24
Controller
27
Interface Unit
26
Display Unit
25
22
Application Unit
21
Emergency Power Supply
28
100

FIG. 3

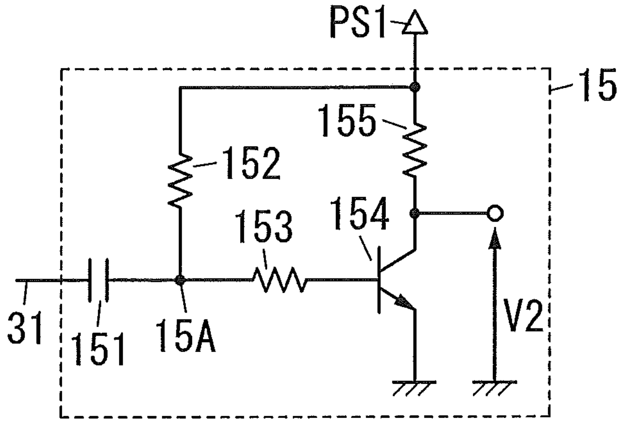


FIG. 4

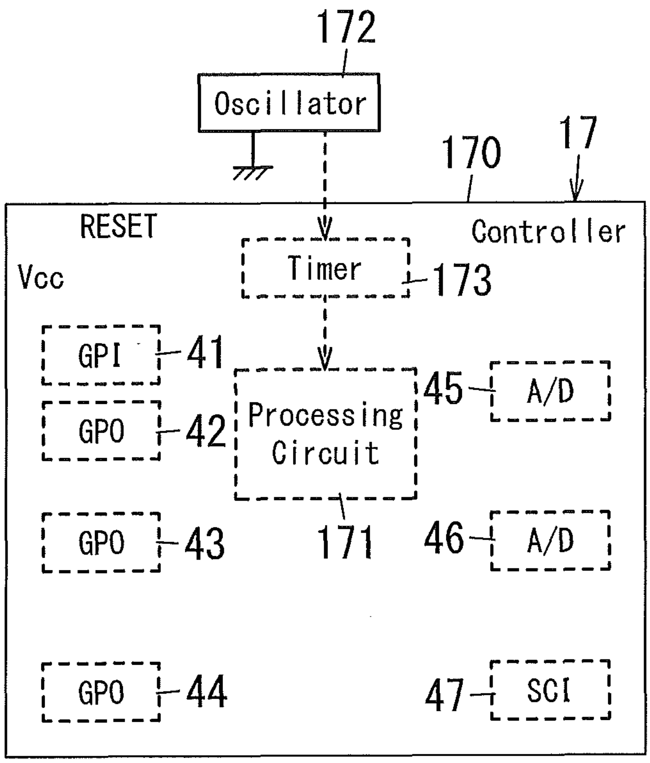

172
Oscillator
170
17
RESET
Controller
Vcc
Timer
173
GPI
41
GPO
42
Processing Circuit
45
A/D
GPO
43
171
46
A/D
GPO
44
47
SCI

FIG. 5

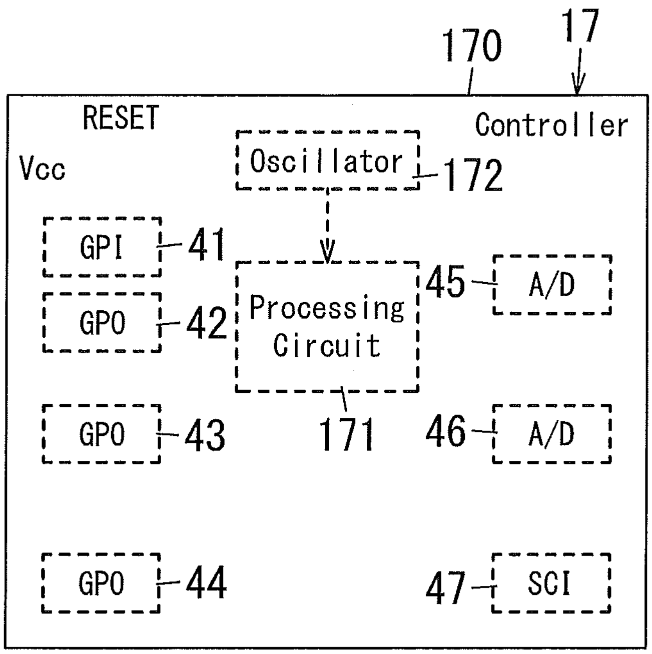

170
17
RESET
Controller
Vcc
Oscillator
172
GPI
41
GPO
42
Processing Circuit
45
A/D
GPO
43
171
46
A/D
GPO
44
47
SCI

FIG. 6A

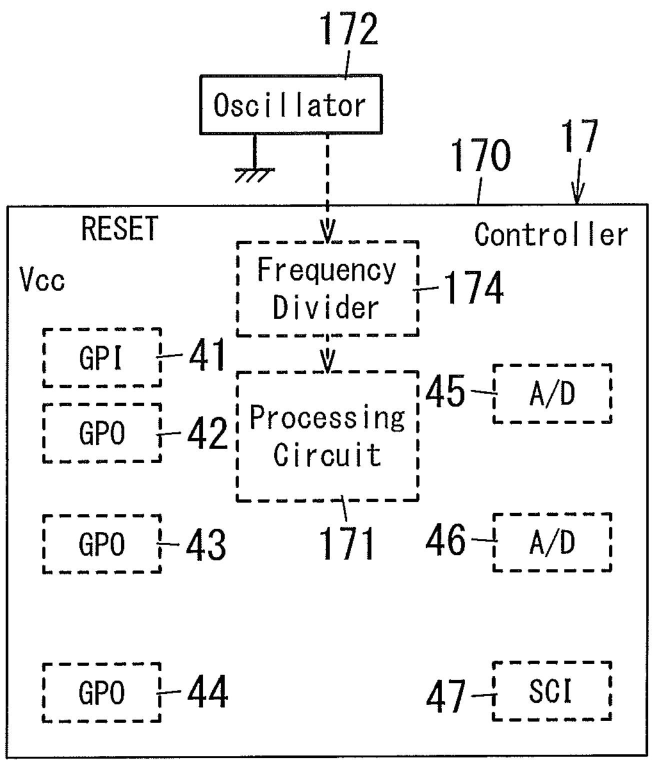

172
Oscillator
170
17
RESET
Controller
Vcc
Frequency Divider
174
GPI
41
GPO
42
Processing Circuit
45
A/D
GPO
43
171
46
A/D
GPO
44
47
SCI

FIG. 6B

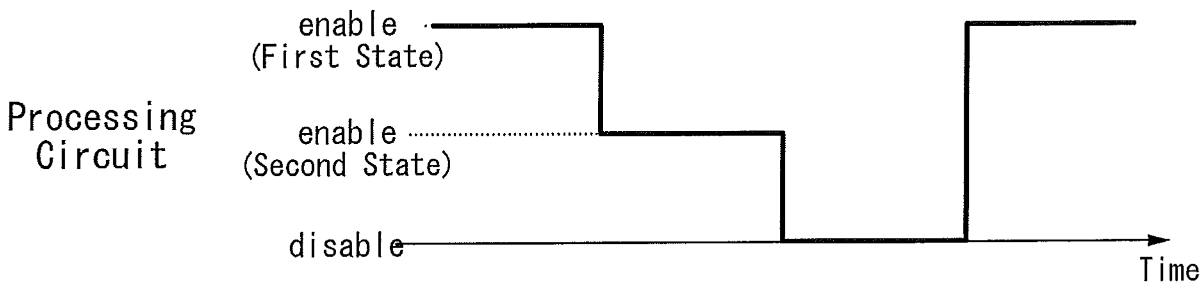

Processing Circuit
enable (First State)
enable (Second State)
disable
Time

FIG. 7

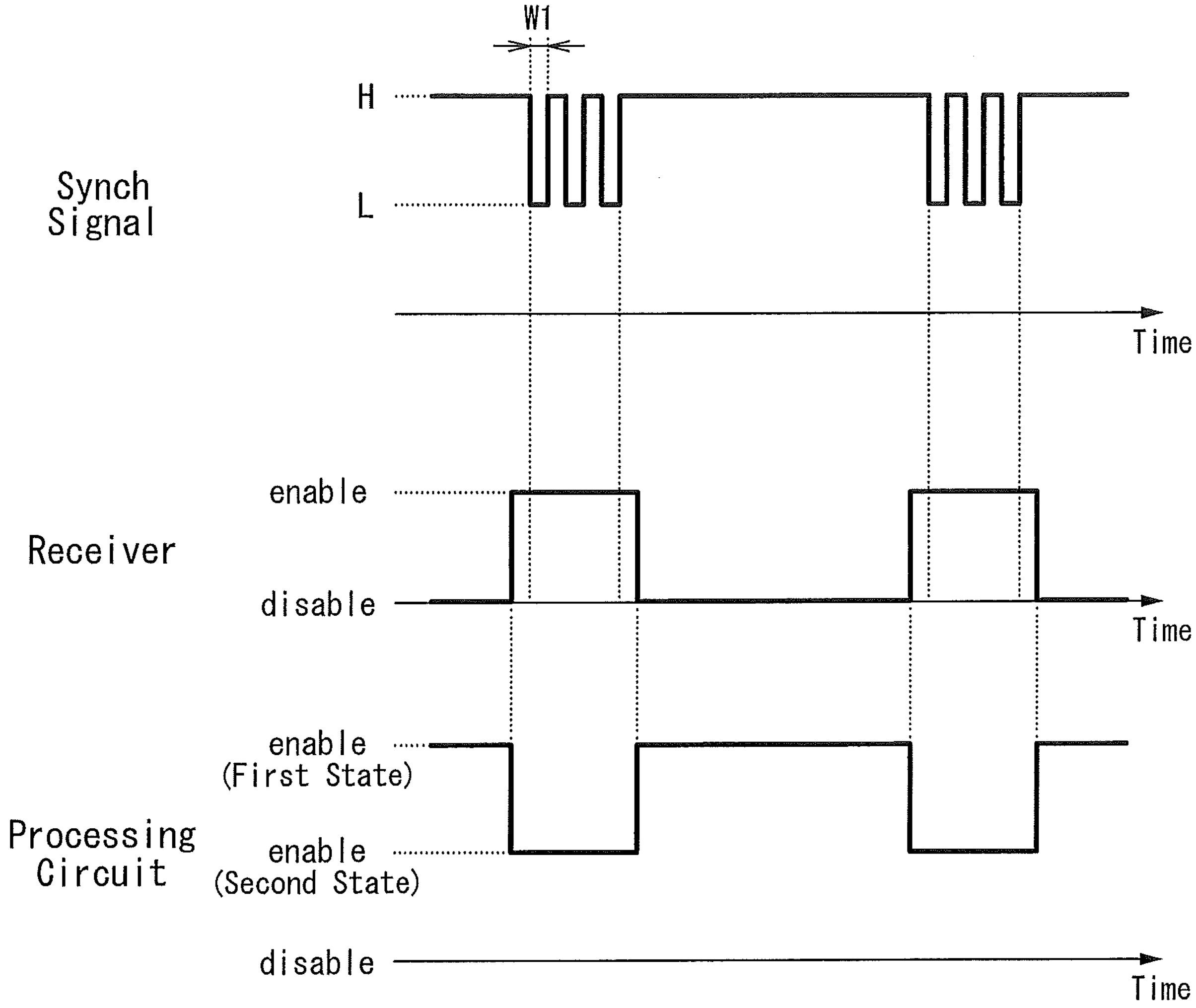

W1
H
L
Synch
Signal
Time
enable
Receiver
disable
Time
enable
(First State)
Processing
Circuit
enable
(Second State)
disable
Time

FIG. 8

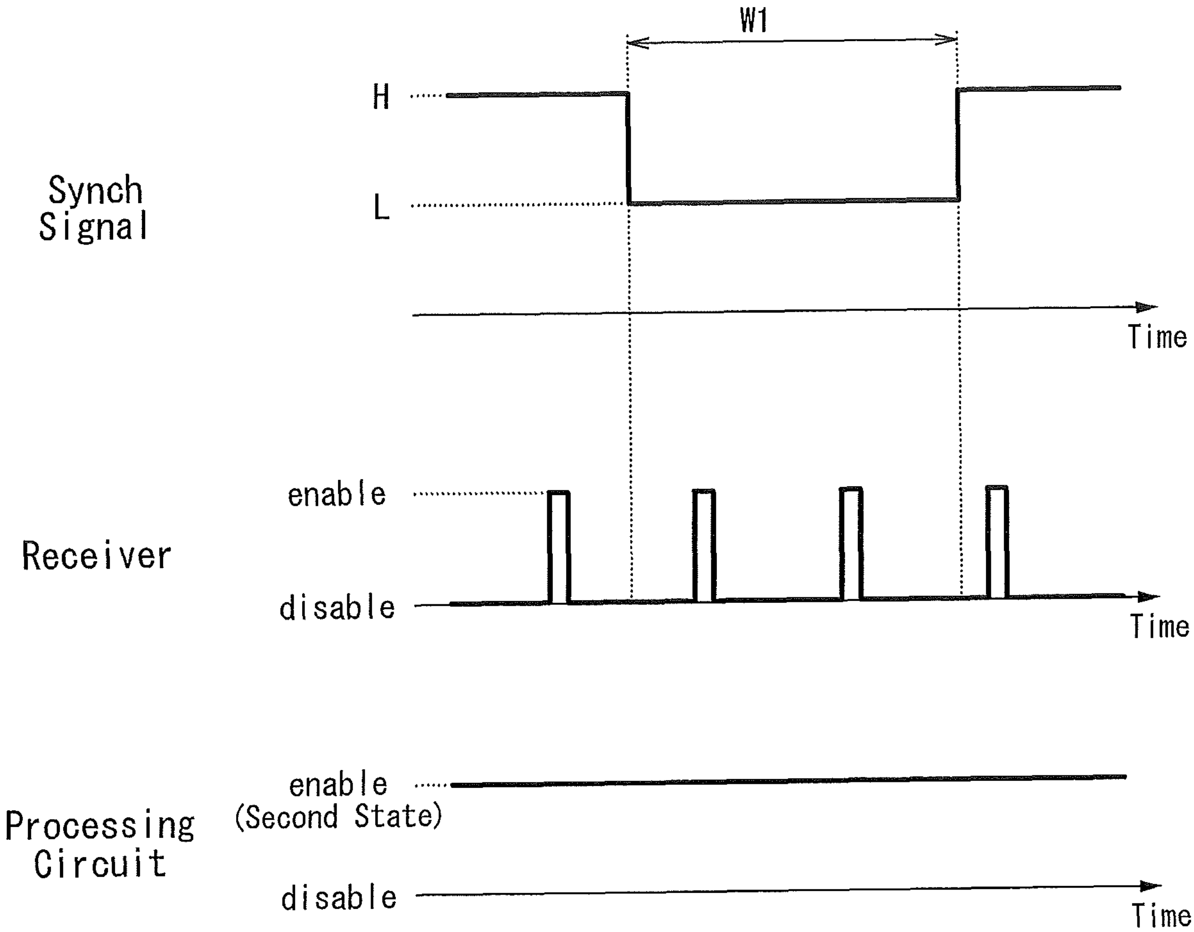
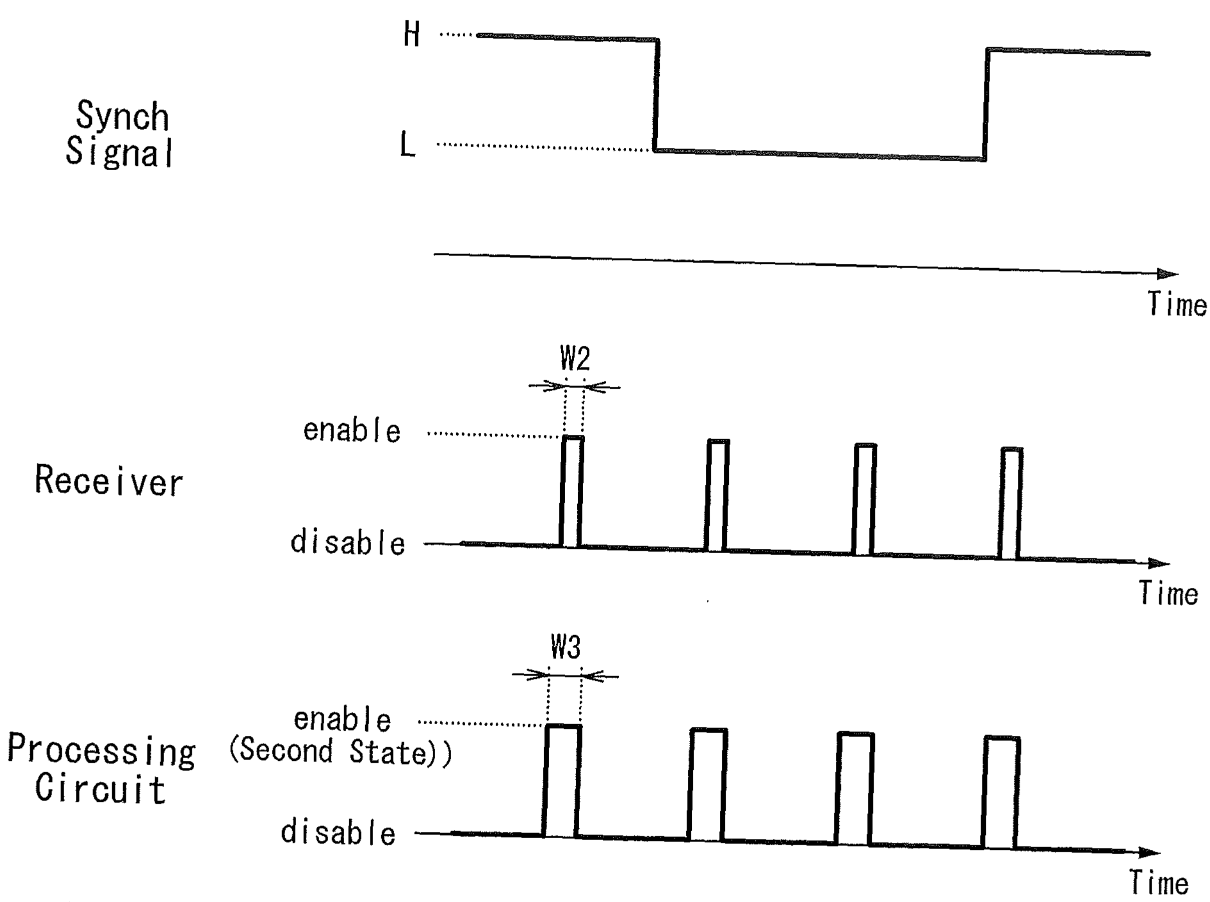

W1
H
L
Synch
Signal
Time
enable
Receiver
disable
Time
enable
(Second State)
Processing
Circuit
disable
Time

FIG. 9


H
L
Synch Signal
Time
W2
enable
Receiver
disable
Time
W3
enable
(Second State))
Processing Circuit
disable
Time

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2016/003466

A. CLASSIFICATION OF SUBJECT MATTER
G08B17/00(2006.01)i, *G08B17/06*(2006.01)i

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)
G08B17/00, G08B17/06

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2016
Kokai Jitsuyo Shinan Koho	1971-2016	Toroku Jitsuyo Shinan Koho	1994-2016

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 35376/1983(Laid-open No. 142889/1984) (Hochiki Corp.), 25 September 1984 (25.09.1984), page 6, line 3 to page 13, line 2; fig. 3 (Family: none)	1-4,8,9 5-7
Y	WO 2006/131998 A1 (Matsushita Electric Works, Ltd.), 14 December 2006 (14.12.2006), paragraphs [0011] to [0012], [0029] to [0054]; fig. 4 to 6 & EP 1855260 A1 paragraphs [0011] to [0012], [0029] to [0054]; fig. 4 to 6	1-4,8,9

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 October 2016 (06.10.16)	18 October 2016 (18.10.16)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/003466

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 11-175863 A (Nittan Co., Ltd.), 02 July 1999 (02.07.1999), paragraphs [0019] to [0026]; fig. 4 to 7 (Family: none)	3,4

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2002008154 A **[0004]**