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

(11) EP 2 818 441 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
31.12.2014 Bulletin 2015/01

(51) Int Cl.:
B66B 5/00 *(2006.01)*

(21) Application number: **13174335.3**

(22) Date of filing: **28.06.2013**

(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

(71) Applicant: **Kone Corporation**
00330 Helsinki (FI)

(72) Inventors:
- **Aitamurto, Juha-Matti**
  05800 Hyvinkää (FI)
- **Hovi, Antti**
  05810 Hyvinkää (FI)

(74) Representative: **Papula Oy**
P.O. Box 981
00101 Helsinki (FI)

(54) **An earthquake sensor device of an elevator system**

(57) According to one aspect there is provided a method for providing testing status information of an earthquake sensor. The method comprises initiating testing with the earthquake sensor of an elevator system; and causing transmission of testing status information from the earthquake sensor to an elevator control system of the elevator system. According to another aspect there is provided a method for processing testing status information of an earthquake sensor. The method comprises receiving testing status information from the earthquake sensor to an elevator control system of an elevator system; and determining, with the elevator control system, operability of the earthquake sensor and the connection between the earthquake sensor and the elevator control system based on the received testing status information.

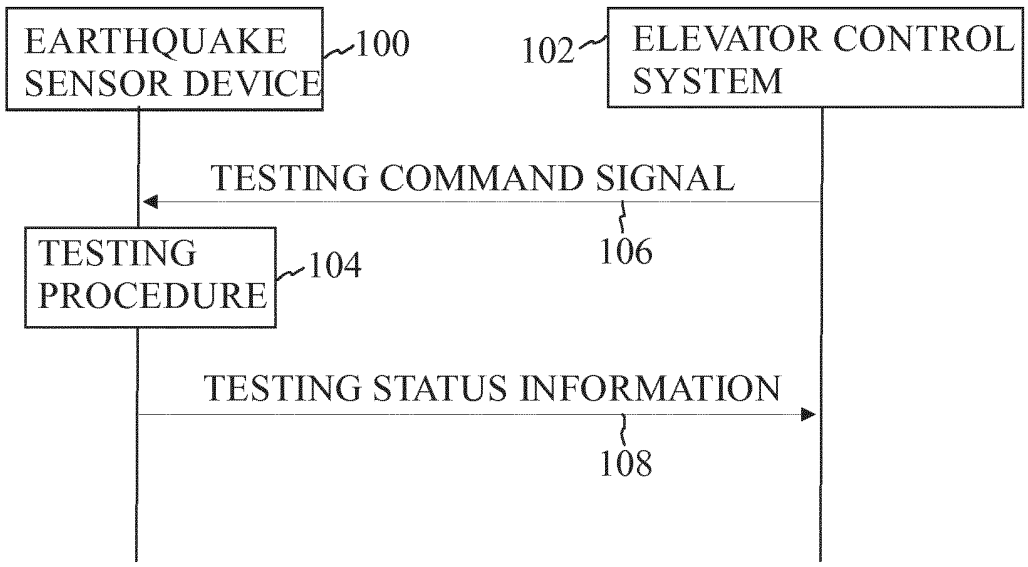

FIG. 1A

EP 2 818 441 A1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to elevator systems. Especially, the invention relates to earthquake sensors in the elevator systems.

DESCRIPTION OF THE RELATED ART

[0002] Modern elevator systems are equipped with sensors which are configured to identify an earthquake emergency situation. In an earthquake emergency return mode upon activation of primary and/or secondary wave seismic sensors, all cars stop at the nearest floor, and park there with the doors open to facilitate the safe evacuation of passengers.

[0003] Although the frequency of earthquakes is low in most parts of the world, the sensors sensing an earthquake in an elevator system need to be continuously operational. Some earthquake sensors include internal monitoring functions in order to make sure that they are operational. A drawback of such sensors is that they are not able to detect defects in the connection between the earthquake sensor and the elevator control system. For example, one or more of the following defects may remain undetected:

- the microcontroller of an earthquake sensor becoming completely inactive
- defect in a power supply of the earthquake sensor
- seizure of the output signal of the earthquake sensor to a permanent state
- earth fault in a signal wire
- short-circuit from the signal wire to unfamiliar potential
- open circuit in the signal wire
- seizure of the output signal of the elevator control to a permanent state.

[0004] Based on the above, there is a need for a solution which would remove or alleviate one or more of the above drawbacks.

SUMMARY

[0005] According to a first aspect there is provided a method for providing testing status information of an earthquake sensor. The method comprises initiating testing with the earthquake sensor of an elevator system; and causing transmission of testing status information from the earthquake sensor to an elevator control system of the elevator system.

[0006] In one embodiment the method further comprises initiating the testing with the earthquake sensor in response to receiving a testing command from the elevator control system.

[0007] In one embodiment the method further comprises initiating the testing with the earthquake sensor within a predetermined time frame.

[0008] In one embodiment the communication between the earthquake sensor and the elevator control system is performed via serial communication.

[0009] In one embodiment the transmitting comprises transmitting testing status information from the earthquake sensor to the elevator control system via pulse width modulation periodicity changes. In one embodiment the initiating comprises initiating the testing with the earthquake sensor in response to receiving a testing command from the elevator control system after identifying a change in impedance in a pulse width modulation output.

[0010] In one embodiment the testing status information indicates at least one of the following: device operational, and an internal failure.

[0011] In one embodiment the method comprises causing transmission of a signal indicating a secondary wave to the elevator control system; receiving a resetting signal from the elevator control system; and resetting the earthquake sensor device.

[0012] According to another aspect there is provided a method for processing testing status information of an earthquake sensor. The method comprises receiving testing status information from the earthquake sensor to an elevator control system of an elevator system, and determining, with the elevator control system, operability of the earthquake sensor and the connection between the earthquake sensor and the elevator control system based on the received testing status information.

[0013] In one embodiment the method further comprises causing transmission of a testing command to the earthquake sensor prior to receiving the testing status information. In one embodiment the transmission is triggered after a predetermined time frame expires.

[0014] In one embodiment the communication between the elevator control system and the earthquake sensor is performed via serial communication.

[0015] In one embodiment the receiving comprises receiving testing status information from the earthquake sensor via pulse width modulation periodicity changes.

[0016] In one embodiment the method further comprises causing transmission of a testing command to the earthquake sensor from the elevator control system by changing impedance of a pulse width modulation input.

[0017] In one embodiment the testing status information indicates at least one of the following: device operational, and an internal failure.

[0018] In one embodiment the method further comprises receiving a signal indicating a secondary wave from the earthquake sensor device; and causing transmission of a resetting signal to the earthquake sensor.

[0019] According to another aspect there is provided a method for determining operational status of an earthquake sensor. The method comprises expecting, with an elevator control system, to receive testing status information from the earthquake sensor within a predeter-

mined time frame; and determining, with the elevator control system, the earthquake sensor to be operationally faulty when receiving no testing status information from the earthquake sensor within the predetermined time frame.

[0020] According to another aspect there is provided an earthquake sensor for providing testing status information to an elevator system. The earthquake sensor comprises means for initiating testing with the earthquake sensor of the elevator system; and a transmitter configured to transmit testing status information from the earthquake sensor to an elevator control system.

[0021] In one embodiment the earthquake sensor comprises a receiver configured to receive a testing command from the elevator control system, wherein the means for initiating are configured to initiate the testing in response to the testing command.

[0022] In one embodiment the means for initiating are configured to initiate the testing with the earthquake sensor within a predetermined time frame.

[0023] In one embodiment the communication between the earthquake sensor and the elevator control system is performed via serial communication.

[0024] In one embodiment the transmitter is configured to transmit the testing status information from the earthquake sensor to the elevator control system via pulse width modulation periodicity changes.

[0025] In one embodiment the initiating means are configured to initiate the testing in response to receiving a testing command from the elevator control system after identifying a change in impedance in a pulse width modulation output.

[0026] In one embodiment the testing status information indicates at least one of the following: device operational, and an internal failure.

[0027] According to another aspect there is provided an elevator control system for processing testing status information of an earthquake sensor. The elevator control system comprises a receiver configured to receive testing status information from the earthquake sensor, and means for determining operability of the earthquake sensor based on the received testing status information.

[0028] In one embodiment the elevator control system comprises a transmitter configured to transmit a testing command to the earthquake sensor prior to receiving the testing status information.

[0029] In one embodiment the transmission is triggered after a predetermined time frame expires.

[0030] In one embodiment the communication between the elevator control system and the earthquake sensor is performed via serial communication.

[0031] In one embodiment the receiver is configured to receive the testing status information from the earthquake sensor via pulse width modulation periodicity changes.

[0032] In one embodiment the elevator control system comprises a transmitter configured to transmit a testing command to the earthquake sensor by changing impedance of a pulse width modulation input.

[0033] In one embodiment the testing status information indicates at least one of the following: device operational, and an internal failure.

[0034] In one embodiment the receiver is configured to receive a signal indicating a secondary wave from the earthquake sensor device, and the transmitter is configured to transmit a resetting signal to the earthquake sensor after detecting the secondary wave.

[0035] According to another aspect there is provided a system comprising an earthquake sensor device according to claim 18 and an elevator control system according to claim 19.

BRIEF DESCRIPTION OF THE DRAWINGS:

[0036]

The accompanying drawings, which are included to provide a further understanding of the invention and constitute a part of this specification, illustrate embodiments of the invention and together with the description help to explain the principles of the invention. In the drawings:

Figure 1A is a flow diagram illustrating initiating testing with an earthquake sensor of an elevator system according to one embodiment of the invention.

Figure 1B is a flow diagram illustrating initiating testing with an earthquake sensor of an elevator system according to another embodiment of the invention.

Figure 2 illustrates examples of pulse width modulation signals according to one embodiment of the invention.

Figure 3 illustrates examples of identification signals according to one embodiment of the invention.

DETAILED DESCRIPTION

[0037] Reference will now be made in detail to the embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

[0038] Figure 1A is a flow diagram illustrating initiating testing with an earthquake sensor of an elevator system according to one embodiment of the invention.

[0039] In the arrangement of Figure 1A, an elevator system is equipped with a sensor or sensors which identify an earthquake emergency situation. If an earthquake is detected, a special emergency procedure is executed by the elevator system. Figure 1A provides a solution for testing the operability of the earthquake sensor and the connection between an earthquake sensor device 100 and elevator control system 102. The elevator control system 102 is configured to send a testing command signal 106 to the earthquake sensor device 100. In re-

sponse to receiving the testing command signal 106, the earthquake sensor device 104 executes a testing procedure 104 and provides the elevator control system 102 with testing status information.

[0040] In one embodiment, testing status codes and a testing status relating to each code have been stored in the elevator control system 102. When the elevator control system 102 receives testing status information comprising a testing status code, it is able to determine the actual meaning of the testing status code. In another embodiment, the earthquake sensor device 100 may send testing status information that itself includes a description relating to the testing status. Thus, the elevator control system need not store any additional information to be used to interpret the testing status information.

[0041] By executing the above signaling, the elevator control system 102 receives a confirmation that the earthquake sensor device 100 and the connection between the earthquake sensor device 100 and the elevator control system 102 are operational.

[0042] In one embodiment of Figure 1A, the communication between the earthquake sensor device 100 and the elevator control system 102 is performed via serial communication.

[0043] In one embodiment of Figure 1A, the earthquake sensor 100 identifies an impedance change by measuring current in a pulse width modulation (PWM) output. The testing status information 108 may be transmitted to the elevator control system 102 via pulse width modulation (PWM) periodicity changes. Examples of PWM signals are presented in Figure 2.

[0044] In one embodiment of Figure 1A, the elevator control system 102 sends to the earthquake sensor 100 a separate testing signal 106, and the earthquake sensor 100 responds to the testing signal with a separate testing status signal 108.

[0045] In one embodiment, several signaling methods disclosed above may be used concurrently. This provides an enhanced monitoring possibility of the operability of the earthquake sensor device.

[0046] Figure 1B is a flow diagram illustrating initiating testing with an earthquake sensor device 100 of an elevator system according to another embodiment of the invention. The embodiment of Figure 1B differs from the embodiment of Figure 1A in that the elevator control system 102 does not transmit a testing command signal to the earthquake sensor device 100. The earthquake sensor device 100 is configured to initiate the testing procedure 110 independently and provides results of the testing to the elevator control system 102 with the testing status information signaling 112. In one embodiment, the earthquake sensor device 100 is configured to transmit the testing status information within a predetermined time frame.

[0047] If the elevator control system 102 notices that is has not received any testing status information signaling from the earthquake sensor 100 within a predetermined time frame, it may deduce that the earthquake sensor device 100 is faulty and is not operational. The predetermined time frame may be configured to be any time interval, for example, 6 hours, 12 hours or 24 hours. The elevator control system 102 may also trigger a transmission of a separate testing command signal to the earthquake sensor 100 in order to verify whether the earthquake sensor device 100 is operational or not.

[0048] The solutions disclosed in Figures 1A and 1B make it possible to identify various fault situations in the earthquake sensor device and in the connection between the earthquake sensor device and the elevator control system.

[0049] Figure 2 illustrates examples of signals transmitted using pulse width modulation according to one embodiment of the invention. Figure 2 represents exemplary signals that an earthquake sensor device may provide during a testing procedure or during its normal operational mode.

[0050] The signal 200 indicates that the earthquake sensor device is operational. The signal 202 indicates that a primary wave has been detected. The signal 204 indicates that a secondary wave has been detected. The signal 206 indicates that internal tests are active. The signal 208 indicates that an internal failure has occurred. In one embodiment, during a testing procedure the earthquake sensor device may transmit the signal 200 or 208 to the elevator control. The signal 208 provides an example of a possible signal for providing further information to the elevator control about the operability of the earthquake sensor device. The signal may mean, for example, that an internal error has occurred during the testing procedure and that the earthquake sensor is not fully operational. It is possible to provide further indications about the operability of the earthquake sensor or its connection interface towards the elevator control system by changing the pulse width modulation of the signals and thus providing more identifiable states. When using one signal wire, it is also possible to use, for example, Manchester coding in providing status information about the earthquake sensor device.

[0051] Figure 3 illustrates examples of signals from an earthquake sensor device to an elevator control system according to one embodiment of the invention. In this embodiment, the earthquake sensor indicates its status to the elevator control with one signal. The time during which the signal is zero determines the status of the earthquake device. In Figure 3, the signal 300 indicates that the earthquake sensor device is operational. The signal 302 indicates that internal tests are active. The signal 308 indicates that an internal failure has occurred. Additional states may be indicated by using different zero signal lengths.

[0052] During a normal operational mode of the earthquake sensor device, the signal 304 may be used to indicate that a primary wave has been detected. Similarly, the signal 306 may be used to indicate that a secondary wave has been detected.

[0053] Furthermore, as already disclosed above, any

of the above disclosed techniques for transmitting testing status information between the earthquake sensor device and the elevator control system may be used to transmit signals from the earthquake sensor device to the elevator control system relating to the normal operational mode of the earthquake sensor device, for example, signals indicating the primary or secondary wave. In one embodiment, status codes and a status relating to each code have been stored in the elevator control system. When the elevator control system receives status information comprising a status code, it is able to determine the actual meaning of the status code. In another embodiment, the earthquake sensor device may send status information that itself includes a description relating to the status. Thus, the elevator control system need not store any additional information to be used to interpret the status information.

[0054] In another embodiment of the invention, binary coding may also be used to transmit information from an earthquake sensor device to elevator control. The amount of bits used in the coding determines the number of different states that can be indicated. If two bits are used, a bit combination (1,1) may indicate that the earthquake sensor device is operational. A bit combination (1,0) may indicate that internal tests are active in the earthquake sensor device. A bit combination (0,1) may indicate that the earthquake sensor device has detected a primary wave. A bit combination (0,0) may indicate that the earthquake sensor device has detected a secondary wave or that an internal failure has occurred. By using more bits it is possible to indicate more states of the earthquake sensor device to the elevator control system.

[0055] By using any of the above techniques for transmitting information between an earthquake sensor device and an elevator control system it is possible to identify fault situations with the earthquake sensor device and/or in its connection interface towards elevator control system, and the elevator control system is constantly aware of the operability of the earthquake sensor device. Furthermore, if the elevator control system does not receive a status report from the earthquake sensor device within a predetermined time frame, the elevator control system is able determine that the earthquake sensor is malfunctioning.

[0056] Furthermore, in one embodiment, any of the above disclosed signal transmission techniques or other appropriate signal transmission techniques may be used to transmit a reset signal from the elevator control system to the earthquake sensor device after detecting the secondary wave signal from the earthquake sensor device. By using the remote reset possibility it is possible to return an elevator back to its normal operating mode easier and faster without a need to make the reset manually at the location of the earthquake sensor device.

[0057] The earthquake sensor device and the elevator control system disclosed above comprise the necessary means for implementing the functions disclosed above. These means may comprise, for example, at least one processor, at least one memory for storing information which may comprise a computer program or programs to be executed by the at least one processor, and a signaling interface or interfaces to enable communication between the earthquake sensor device and the elevator control system. The signaling interface may be a wired interface or wireless communication interface.

[0058] It is obvious to a person skilled in the art that with the advancement of technology, the basic idea of the invention may be implemented in various ways. The invention and its embodiments are thus not limited to the examples described above, instead they may vary within the scope of the claims.

Claims

1. A method for providing testing status information of an earthquake sensor, the method comprising:

   initiating testing with the earthquake sensor of an elevator system; and
   causing transmission of testing status information from the earthquake sensor to an elevator control system of the elevator system.

2. The method according to claim 1, further comprising:

   initiating the testing with the earthquake sensor in response to receiving a testing command from the elevator control system.

3. The method according to claim 1, further comprising:

   initiating the testing with the earthquake sensor within a predetermined time frame.

4. The method according to any of claims 1 - 3, wherein the communication between the earthquake sensor and the elevator control system is performed via serial communication.

5. The method according to any of claims 1 - 4, wherein the transmitting comprises transmitting testing status information from the earthquake sensor to the elevator control system via pulse width modulation periodicity changes.

6. The method according to claim 5, wherein the initiating comprises initiating the testing with the earthquake sensor in response to receiving a testing command from the elevator control system after identifying a change in impedance in a pulse width modulation output.

7. The method according to any of claims 1 - 6, wherein the testing status information indicates at least one of the following:

- device operational
- an internal failure.

8. The method according to any of claims 1 - 7, further comprising:

causing transmission of a signal indicating a secondary wave to the elevator control system;
receiving a resetting signal from the elevator control system; and
resetting the earthquake sensor device.

9. A method for processing testing status information of an earthquake sensor, the method comprising:

receiving testing status information from the earthquake sensor to an elevator control system of an elevator system; and
determining, with the elevator control system, operability of the earthquake sensor and the connection between the earthquake sensor and the elevator control system based on the received testing status information.

10. The method according to claim 9, wherein the method further comprises:

causing transmission of a testing command to the earthquake sensor prior to receiving the testing status information.

11. The method according to claim 10, wherein the transmission is triggered after a predetermined time frame expires.

12. The method according to any of claims 9 - 11, wherein the communication between the elevator control system and the earthquake sensor is performed via serial communication.

13. The method according to any of claims 9 - 11, wherein the receiving comprises receiving testing status information from the earthquake sensor via pulse width modulation periodicity changes.

14. The method according to claim 13, further comprising:

causing transmission of a testing command to the earthquake sensor from the elevator control system by changing impedance of a pulse width modulation input.

15. The method according to any of claims 9 - 14, wherein the testing status information indicates at least one of the following:

- device operational
- an internal failure.

16. The method according to any of claims 9 - 15, further comprising:

receiving a signal indicating a secondary wave from the earthquake sensor device;
causing transmission of a resetting signal to the earthquake sensor.

17. A method for determining operational status of an earthquake sensor, the method comprising:

expecting, with an elevator control system, to receive testing status information from the earthquake sensor within a predetermined time frame; and
determining, with the elevator control system, the earthquake sensor to be operationally faulty when receiving no testing status information from the earthquake sensor within the predetermined time frame.

18. An earthquake sensor for providing testing status information to an elevator system, comprising means for performing the method of any of claims 1 - 8.

19. An elevator control system, comprising means for performing the method of any of claims 9 - 17.

20. An elevator system comprising an earthquake sensor according to claim 18 and an elevator control system according to claim 19.

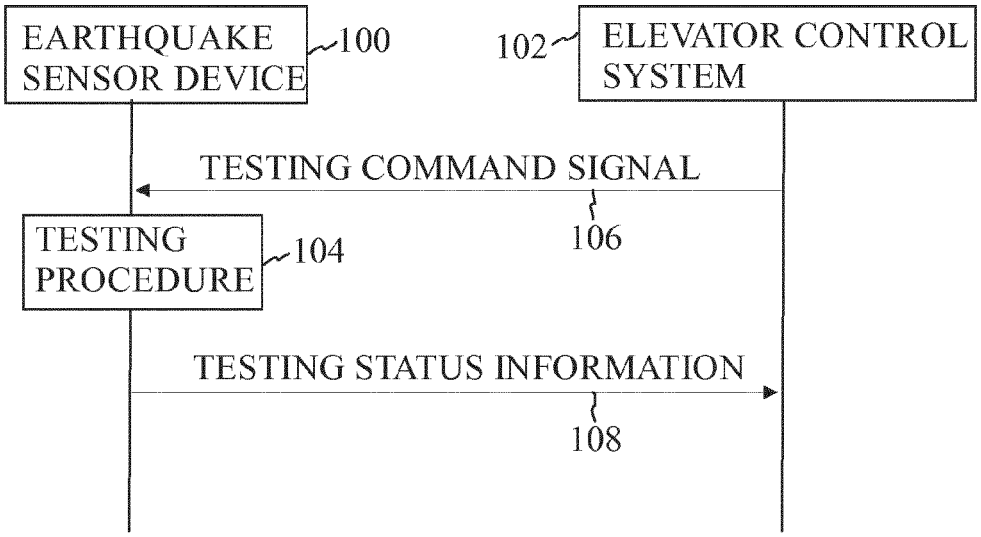
EARTHQUAKE SENSOR DEVICE
100
102
ELEVATOR CONTROL SYSTEM
TESTING COMMAND SIGNAL
106
TESTING PROCEDURE
104
TESTING STATUS INFORMATION
108

FIG. 1A

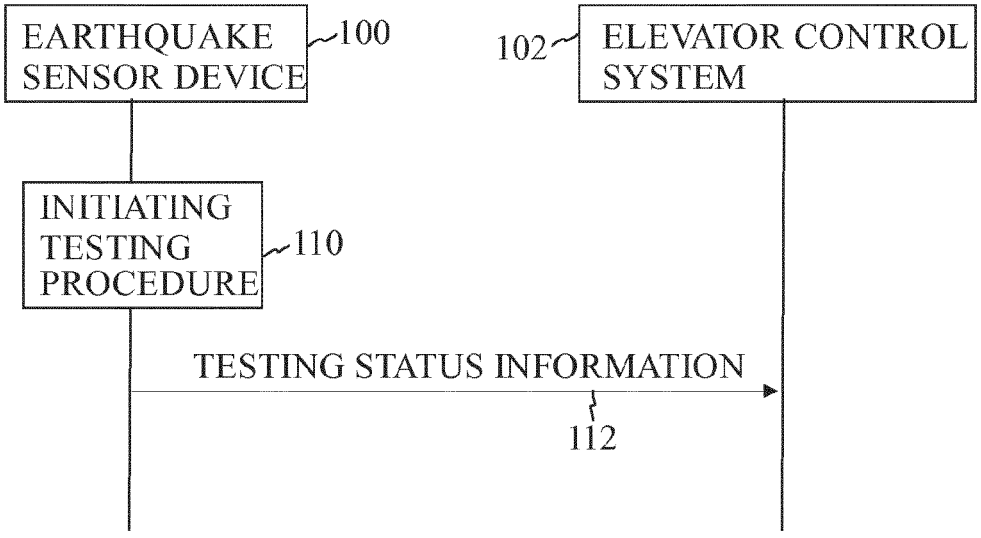
EARTHQUAKE SENSOR DEVICE
100
102
ELEVATOR CONTROL SYSTEM
INITIATING TESTING PROCEDURE
110
TESTING STATUS INFORMATION
112

FIG. 1B

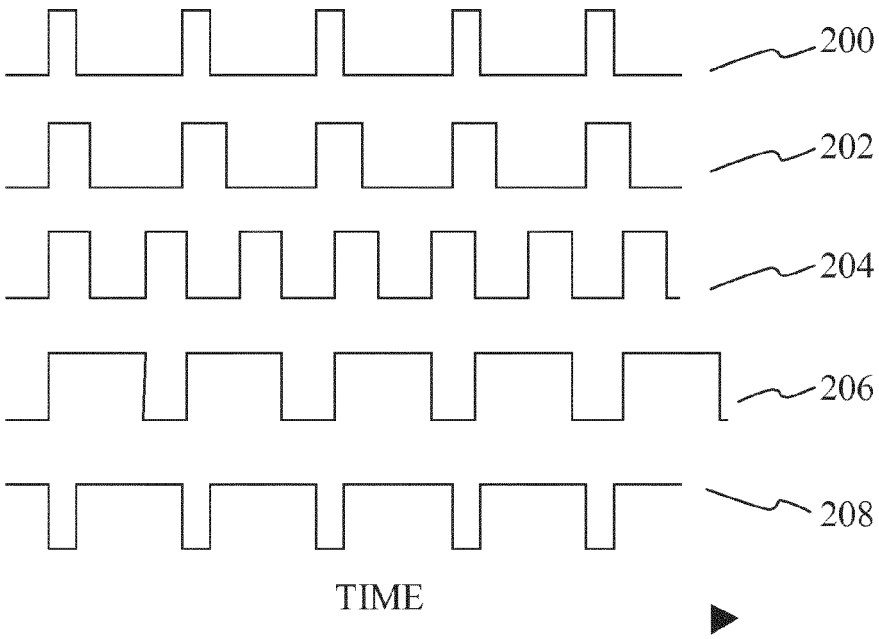

FIG. 2

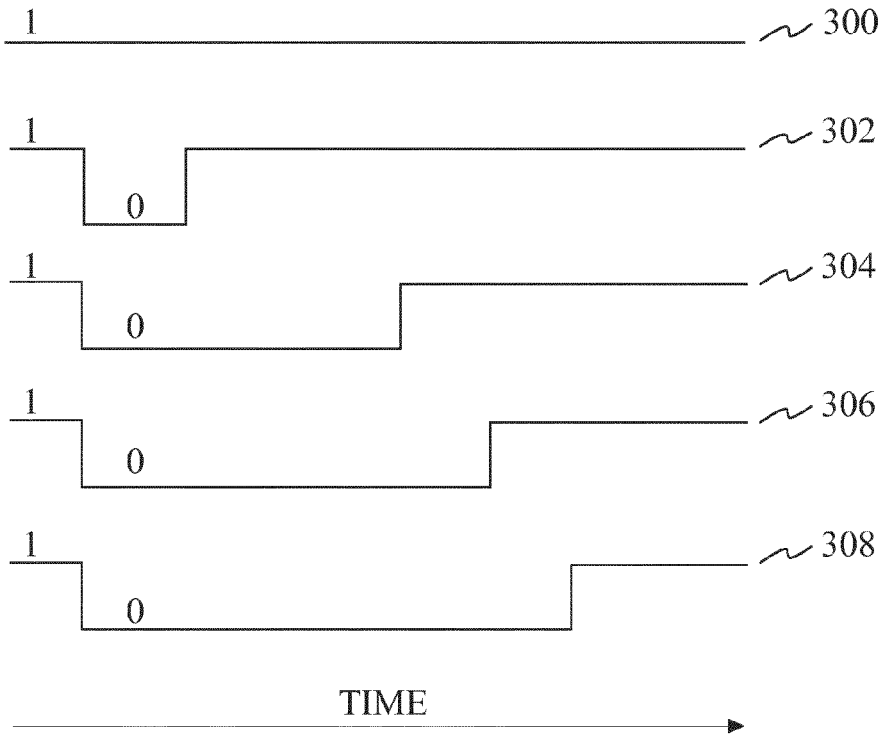

FIG. 3

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 13 17 4335

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 2010 222139 A (MITSUBISHI ELECTRIC CORP) 7 October 2010 (2010-10-07)	1-3, 7-11, 15-20	INV. B66B5/00
Y	* abstract; claims 1,2 * * paragraphs [0011] - [0016], [0034], [0035] *	4-6, 12-14	

X	WO 2011/161790 A1 (MITSUBISHI ELECTRIC CORP [JP]; YAMAGISHI KOJI [JP]) 29 December 2011 (2011-12-29)	1-3,7, 9-11,15, 17-20	
Y	* abstract; claim 1 * * paragraph [0014] *	4-6, 12-14	

Y	US 4 709 788 A (HARADA YUTAKA [JP]) 1 December 1987 (1987-12-01) * abstract *	4,12	

Y	CN 101 659 364 B (SHANGHAI STEP ELECTRIC CORP) 6 July 2011 (2011-07-06) * abstract *	5,6,13, 14	
	-----		TECHNICAL FIELDS SEARCHED (IPC)
			G01V B66B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	27 November 2013	Fernandes, Paulo

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 17 4335

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

27-11-2013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2010222139 A	07-10-2010	NONE	
WO 2011161790 A1	29-12-2011	NONE	
US 4709788 A	01-12-1987	CN 86104446 A	21-01-1987
		JP S624179 A	10-01-1987
		JP H0561190 B2	03-09-1993
		US 4709788 A	01-12-1987
CN 101659364 B	06-07-2011	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82