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(54) Title: SYSTEM, APPARATUS AND METHOD FOR DETECTING A SHORT-CIRCUIT IN A WIRE

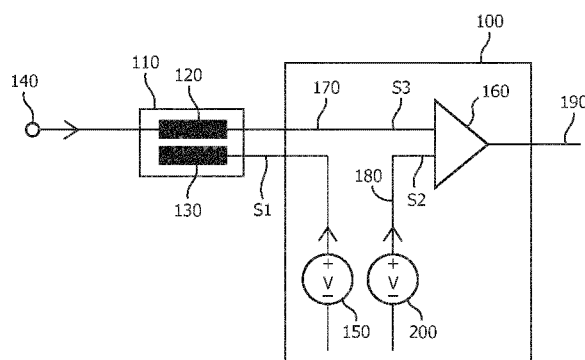


FIG. 1

(57) Abstract: The invention relates to a system (100) intended to be connected to a wire (110) comprising a signal line (120) and a shield line (130), a first end of said signal line (120) being intended to be connected to a signal source (140). The system (100) comprises a signal generator (150) intended to be connected to said shield line (130), an amplifier (160) having a first input (170), a second input (180) and an output (190); said first input (170) being connected to a second end of said signal line (120), a voltage generator (200) connected to said second input (180). The amplifier (160) is adapted to deliver on the output (190), a voltage difference between the voltage of said second input (180) and the voltage of said first input (170). A substantially large amplitude voltage delivered at said output (190) reflects a short-circuit between said signal line (120) and said shield line (130). The invention also relates to a corresponding method of detecting a short-circuit occurring between the signal line (120) and the shield line of a wire.

SYSTEM, APPARATUS AND METHOD FOR DETECTING A SHORT – CIRCUIT IN A WIRE

FIELD OF THE INVENTION

The invention relates to the field of measurement of electrical signals, in particular to a system for detecting a short-circuit occurring between a signal line and a shield line of a wire used during measurement.

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BACKGROUND OF THE INVENTION

Measuring electrical signals is done in various fields. For example, in the medical field, Electrocardiography (ECG) is an interpretation of the electrical activity of the heart captured by skin electrodes and externally recorded by an electrocardiograph, and the whole process is a non-invasive recording process.

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Measuring electrical signals is often done via a sensor connected to a (lead) wire, the wire being used to conduct electrical signal to the device in charge of measuring/analysing the signal. A lead wire usually includes two metal lines: one is a signal line and the other is a shield line. The signal line and the shield line are separated by an insulating layer, so that the signal line and the shield line cannot electrically contact with each other.

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During an electrocardiographic examination, lead wires are used to connect the electrocardiograph and the skin electrodes to a patient. The lead wire is often twisted by the various manipulations of the practitioner or the movement of the patient being examined, resulting in that the insulating layer between the signal line and the shield line may sometimes break. Therefore, a short-circuit occurs between the signal line and the shield line, the lead wires is thus referred to as a shorted lead wire. The shorted lead wire may cause incorrect measured signal, with possible negative consequences on the analysis of the signal.

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There are known solutions to detect a short-circuit in a lead wire. They consist to remove lead wires from the source of signal, run service procedures (not in normal ECG acquisition procedure) to check voltage levels on the lead wire has been wrong. Therefore, those known solutions cannot be used during real time, such as for example during ECG acquisition. Moreover, those solutions do not always allow detecting intermittent short-circuit, as the lead wire might not short-circuit during the service test.

OBJECT AND SUMMARY OF THE INVENTION

It is an object of the invention to propose an improved system to detect short-circuit in a wire between a signal line and a shield line. The invention is defined by the independent claims. The dependent claims define advantageous embodiments.

The system according to the invention is intended to be connected to a wire comprising a signal line and a shield line, a first end the signal line being intended to be connected to a signal source.

The system according to the invention comprises:

- a signal generator intended to be connected to the shield line;
- an amplifier having a first input, a second input and an output; the first input being connected to a second end of the signal line;
- a voltage generator connected to the second input.

The amplifier is adapted to deliver on the above-mentioned output a voltage difference between the voltage of the second input and the voltage of the first input. A substantially large amplitude voltage delivered at the output reflects a short-circuit occurring between the signal line and the shield line.

With this invention, detection of short-circuit in the wire between the signal line and the shield line can be done during the data measurement/acquisition is ongoing, for example during ECG measurement/acquisition. In other words, short-circuit in the wire can be detected at any time during data measurement/acquisition. Therefore, it does not require an extra separate short-circuit detection procedure, and it does not require the source of signal, for example delivered by patients or from various sensors, to be removed during detection.

The invention also relates to an apparatus comprising a system according to the invention.

To this end, the apparatus further comprises a display connected to the output of the system, and wherein the display is adapted to visualize the signal of the output.

This apparatus is advantageous because it allows to trigger a warning (visual, sound...) indicating that a short-circuit has been detected in the wire. The user can thus replace the damaged wire.

The invention also relates to a method implementing various steps of a system according to the invention.

To this end, the method according to the invention comprises the steps of:

- applying a first voltage signal to the shield line;
- calculating a voltage difference signal between the voltage of a second end of the signal line and a second voltage signal;
- detecting substantially large voltage amplitude of the output signal reflecting a short-circuit occurring between the signal line and the shield line,

Detailed explanations and other aspects of the invention will be given below.

BRIEF DESCRIPTION OF THE DRAWINGS

Particular aspects of the invention will now be explained with reference to the embodiments described hereinafter and considered in connection with the accompanying drawings, in which identical parts or sub-steps are designated in the same manner:

Fig.1 depicts a schematic diagram of a system in accordance with an embodiment of the present invention;

Fig.2 depicts a schematic diagram of an apparatus comprising a system according to the present invention;

Fig.3 depicts a flow chart of a method in accordance with the present invention.

The same reference numbers are used to denote similar parts throughout the Figures.

DETAILED DESCRIPTION OF THE INVENTION

Fig.1 depicts a schematic diagram of a system in accordance with an embodiment of the present invention.

According to an embodiment of a first aspect of the invention, there is provided a system 100 for detecting a short-circuit occurring between a signal line 120 and a shield line 130 of a wire 110.

The wire 110 includes the signal line 120 and the shield line 130. There is an insulating layer (not shown), such as a rubber layer, covering the signal line 120, between the signal line 120 and the shield line 130.

A first end of the signal line 120 is intended to be connected to a signal source 140. At this first end, the shield line 130 is disconnected. .

For example, if the measurement is done in the context of ECG data acquisition, the signal source 140 is generated by human body of the patient, and the wire is contacted to the human body through electrodes.

A second end of the wire 110 is connected to the system 100.

The system 100 according to the invention comprises an amplifier 160, a voltage generator 200 and a signal generator 150.

At the second end of the wire 110, the signal line 120 is connected to the first input 170 of the amplifier 160. The shield line 130 is connected to the signal generator 150 in the system 100.

The amplifier 160 has the first input 170 connecting to the second end of the signal line 120 and has the second input 180 connecting to the voltage generator 200. The amplifier 160 has an output 190. The output 190 is also the output of system 100.

The output 190 corresponds to the difference of the first input 170 and the second input 180, possibly multiplied by a given amplifying factor.

The signal source 140 preferably generates electronic signal of low amplitude. For example, signal source 140 may deliver signals having amplitude in the order of the millivolt or lower.

For example, if the measurement is done in the context of ECG data acquisition, the signal source 140 generates ECG signal, which corresponds to the electrical impulses generated by the heart (polarization and depolarization of cardiac tissue) as detected by electrodes attached to the surface of the skin. ECG signal is a physiological signal often in the range [0; 1mV] in amplitude.

The signal generator 150 generates a signal which is applied to the shield line 130. The signal could be a continuous (DC) voltage signal, an alternating (AC) voltage signal or a waveform signal.

The voltage of the signal generator 150 has noticeable difference with the voltage of the input 170. For example, the ratio between the voltage of the signal generator 150 and the voltage of the first input 170 is larger than two.

The voltage generator 200 is preferably adapted to generate a fixed voltage value. For a given amplifier 160, it has power supply range as $[V1; V2]$. $V1$ and $V2$ are chosen from a few millivolts to a few volts. The voltage generated by the voltage generator 200 is in the range $[V1; V2]$ in amplitude.

When no short-circuit exists in the lead wire, the amplifier 160 receives the signal source, such as ECG signal, which is amplified. When the signal measured at output 190 is much larger than the normal ECG signal range, such as, for example two times larger, it can be considered that there is a short-circuit between the signal line 120 and the shield line 130.

Fig.2 depicts a schematic diagram of an apparatus 300 according to the present invention. The apparatus 300 is intended to be connected to a wire 110 comprising a signal line 120 and a shield line 130, a first end of said signal line 120 being intended to be connected to a signal source 140.

The apparatus 300 is aimed to detecting a short-circuit occurring between a signal line 120 and a shield line 130 of a wire 110.

To this end, the apparatus 300 comprises a system 100 as described previously, the system 100 being intended to be connected to the wire 110. The apparatus 300 also comprises a display 310 connected to the output 190 of the system 100. The display 310 is adapted to visualize the signal of the output 190

During normal data acquisition, the output 190 is within normal ECG range. When a short-circuit occurs between the signal line 120 and the shield line 130, the output 190 becomes out of normal ECG range, as described above, which can be easily noticed in the ECG waveform as “non-operable” ECG. Therefore, the visualization of large amplitude output 190 on the display 310 allows to visualize that a short-circuit occurred between the signal line 120 and the shield line 130.

Fig.3 depicts a schematic diagram of a method in accordance with the present invention.

The method comprises:

- a step 401 applying a first voltage signal S1 to the shield line 130;
- 5 - a step 402 calculating a voltage difference signal between the voltage S3 of a second end of the signal line 120 and a second voltage signal S2;
- a step 403 detecting substantially large voltage amplitude of the output signal reflecting a short-circuit occurring between the signal line 120 and the shield line 130.

10 The step 401 is preferably adapted to generate the first signal as a signal chosen among a continuous voltage signal, an alternating voltage signal and a wave form signal.

The step 403 is preferably adapted to generate the second signal as a fixed voltage signal.

This invention applies, in particular, to any ECG applications including but not limited to cardiograph, Stress ECG and Holter ECG.

15 The above embodiments as described are only illustrative, and not intended to limit the technique approaches of the present invention. Although the present invention is described in details referring to the preferable embodiments, those skilled in the art will understand that the technique approaches of the present invention can be modified or equally displaced without departing from the spirit and scope of the technique approaches of the present invention, which will also fall into the protective scope of the claims of the present invention. In particular, although the invention has been described based on an ECG application, it can be applied to any other electrical measurement equipment. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. Any reference signs in the claims should not be construed as limiting the scope.

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CLAIMS:

1. A system (100) intended to be connected to a wire (110) comprising a signal line (120) and a shield line (130), a first end of said signal line (120) being intended to be connected to a signal source (140), said system (100) comprising:

- a signal generator (150) intended to be connected to said shield line (130);
- an amplifier (160) having a first input (170), a second input (180) and an output (190); said first input (170) being connected to a second end of said signal line (120);
- a voltage generator (200) connected to said second input (180);

wherein said amplifier (160) is adapted to deliver on said output (190), a voltage difference between the voltage of said second input (180) and the voltage of said first input (170);

wherein a substantially large amplitude, such as two times larger, voltage delivered at said output (190) reflects a short-circuit between said signal line (120) and said shield line (130).

2. A system as claimed in claim 1, wherein said signal generator (150) is chosen among a continuous voltage generator, an alternating voltage generator and a wave form generator.

3. A system as claimed in claim 1, wherein the ratio between a voltage of said signal generator (150) and the voltage of said first input (170) is larger than two, wherein no short-circuit occurs.

4. A system as claimed in claim 1, wherein said voltage generator (200) is adapted to generate a fixed voltage value.

5. An apparatus (300) intended to be connected to a wire (110) comprising a signal line (120) and a shield line (130), a first end of said signal line (120) being intended to be connected to a signal source (140), said apparatus (300) comprising:

- a system (100) as claimed in any one of claims 1 to 4, said system (100) being intended to be connected to said wire (110);
 - a display (310) connected to said output (190) of said system (100);
- wherein said display (310) is adapted to visualize the signal of said output (190).

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6. An apparatus as claimed in claim 5, wherein said apparatus (300) is chosen among the set of apparatus defined by electrocardiogram apparatus, electroencephalogram apparatus and electromyography apparatus.

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7. A method of detecting a short-circuit between a signal line (120) and a shield line (130) of a wire (110), a signal source (140) being connected to a first end of said signal line (120), said method comprising the steps of:

- applying (401) a first voltage signal (S1) to said shield line (130);
 - calculating (402) a voltage difference signal between the voltage (S3) of a
- second end of said signal line (120) and a second voltage signal (S2);
- detecting (403) substantially large voltage amplitude of said output signal reflecting a short-circuit occurring between said signal line (120) and said shield line (130).

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8. A method as claimed in claim 7, wherein said step 401 is adapted to generate said first signal as a signal chosen among a continuous voltage signal, an alternating voltage signal and a wave form signal.

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9. A method as claimed in claim 7, wherein said step 403 is adapted to generate said second signal as a fixed voltage signal.

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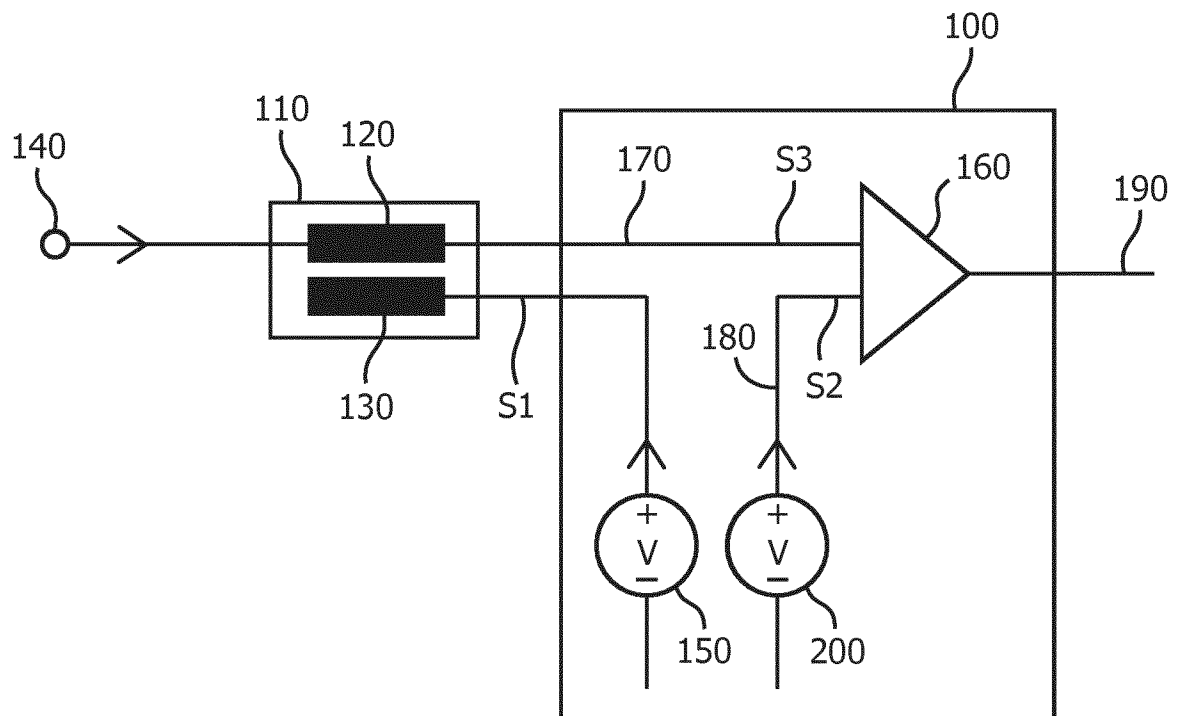


FIG. 1

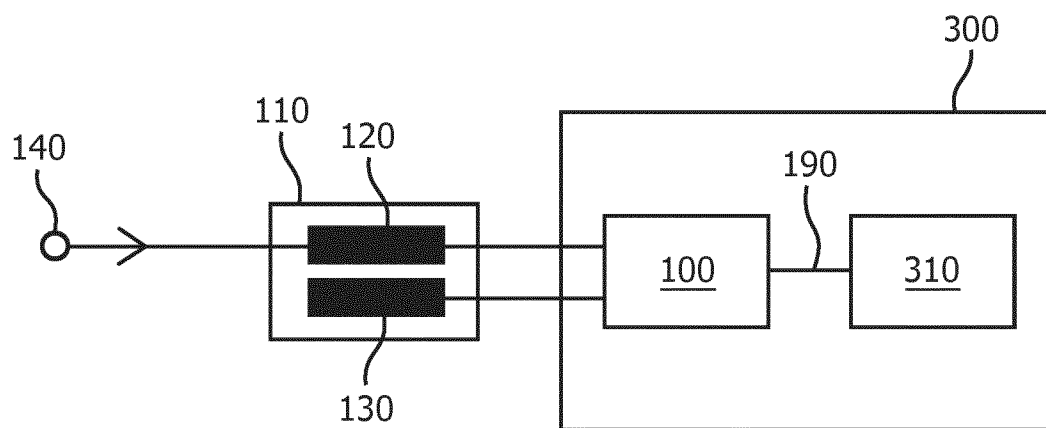


FIG. 2

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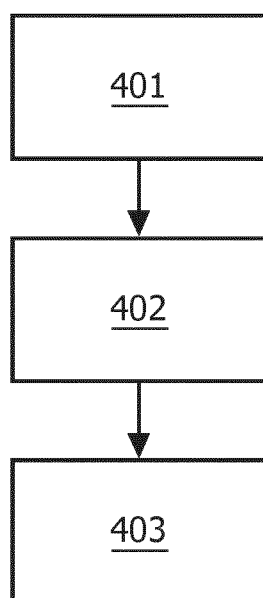


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER

INV. A61B5/04 G01R31/02
ADD. A61B5/0402 A61B5/0476 A61B5/0488

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)

A61B G01R

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP S63 157067 A (HITACHI CABLE; TAKIKAWA ENG KK) 30 June 1988 (1988-06-30)	1-4,7-9
Y	abstract figure 1	5,6
Y	----- US 2011/221449 A1 (MA XIANG [CN]) 15 September 2011 (2011-09-15) the whole document	5,6
A	----- US 6 395 974 B1 (ARGAUT PIERRE [FR] ET AL) 28 May 2002 (2002-05-28) abstract column 2, line 4 - line 49 figure 1	1-9
A	----- US 6 154 020 A (MOULTON GRANT [US]) 28 November 2000 (2000-11-28) the whole document	1-9



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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