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(54) Title: COMMUNICATION TRANSCEIVER FOR DIFFERENTIAL SIGNAL PROCESSING PROTOCOL AND METHOD FOR PROCESSING SIGNAL IN COMMUNICATION TRANSCEIVER FOR DIFFERENTIAL PROCESSING PROTOCOL

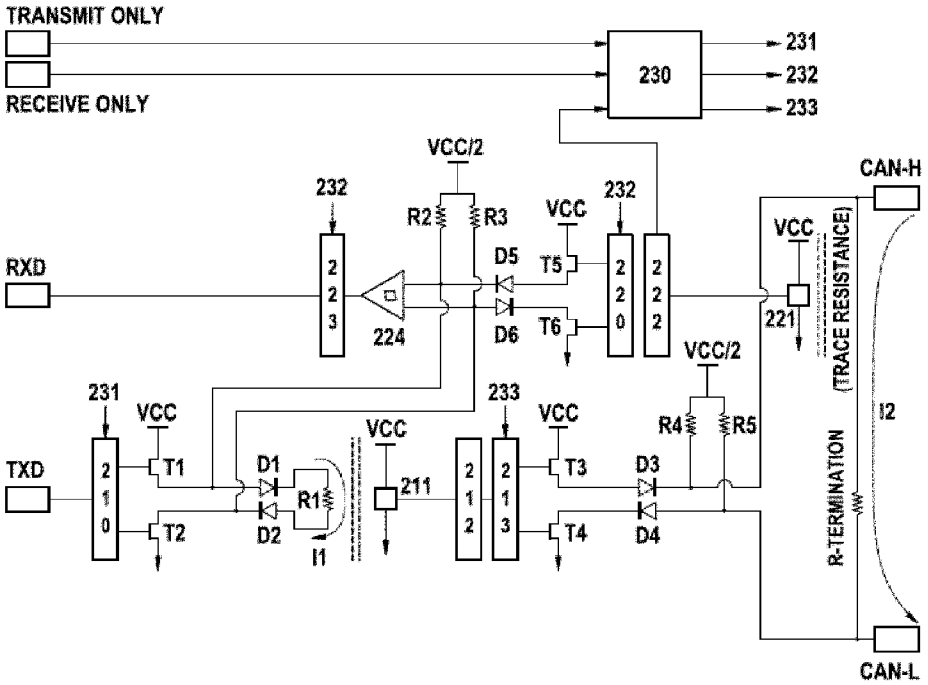


Fig. 2

(57) Abstract: A communication transceiver for differential signal processing protocol is disclosed. The communication transceiver includes a first driver unit for transmitter side, a second driver unit for receiver side, a first electrical isolation circuit for transmitter side, and a second electrical isolation circuit for receiver side, wherein the first electrical isolation circuit comprises the first driver unit which is configured to generate a first current flow upon receiving signal transmitted from TX interface pin, and a first non-contact-type current measurement sensor which is configured to trigger provision of differential signal upon sensing the first current flow, and the second electrical isolation circuit comprises a second non-contact-type current measurement sensor which is configured to sense a second current flow generated by signal transmitted from differential bus interface pins and trigger the second driver unit to provide

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signal to RX interface pin. A method for processing signals in communication transceiver for differential signal processing protocol is also disclosed.

Description

Communication Transceiver for Differential Signal Processing Protocol and Method for Processing Signal in Communication Transceiver for Differential Processing Protocol

FIELD OF THE INVENTION

The present invention is related to communication transceivers for differential signal processing protocol, in particular communication transceivers for differential signal processing protocol having an electrical isolation circuit, and methods for processing signals in communication transceiver for differential signal processing protocol.

BACKGROUND

Controller area networks (CAN), one of the differential signal processing protocols, are used in a number of industries, such as automotive, locomotive and industrial applications, for providing communication between devices. The CAN is often used to enable communication between various electronic control units and smart devices used in the afore-mentioned applications. A standard implementation of isolated CAN data link often includes a CAN controller, a CAN transceiver, an isolation module, and a power supply. Isolation module is typically located between a CAN controller and a CAN transceiver for the purpose of isolating control logic from noise, voltage surges, spikes, and so on.

FIG. 1 of US 2003/0123263 A1 discloses CAN data link including a CAN controller, a transceiver, and a transformer circuit connected between the CAN controller and the transceiver to provide electrical isolation, in which the transformer circuit with a particular design provides the requisite electrical isolation.

Implementation of the CAN isolation module between a CAN controller and a CAN transceiver, however, often accompanies technical issues. For instance, the CAN

isolation module, in particular capacitive isolation circuits, may require too many wires and frequent switching, which may create high frequency interference or noise coupling. Such interference or noise coupling may result in loss of data and/or erroneous data. Also, the CAN isolation module in prior art is typically located in between a CAN controller and a CAN transceiver as a separate module, and hence, technical limit as to size reduction of CAN data link may exist.

Hence, isolated CAN designs which can address one or more of the above-described problems are desired in the art.

SUMMARY OF THE INVENTION

An aspect of the present invention concerns a communication transceiver for differential signal processing protocol. In the present invention, the communication transceiver comprises at least a first driver unit for transmitter side, a second driver unit for receiver side, a first electrical isolation circuit for transmitter side, and a second electrical isolation circuit for receiver side. In the present invention, the first electrical isolation circuit may comprise the first driver unit which is configured to generate a first current flow upon receiving signal transmitted from TX interface pin, and a first non-contact-type current measurement sensor which is configured to trigger provision of differential signal upon sensing the first current flow. In the present invention, the second electrical isolation circuit may comprise a second non-contact-type current measurement sensor which is configured to sense a second current flow generated by signal transmitted from differential bus interface pins and trigger the second driver unit to provide signal to RX interface pin. In the present invention, the differential bus interface pins and micro-controller interface pins (TX and RX interface pins) may be galvanically isolated by having an isolation between the first non-contact-type current measurement sensor and the first current flow and between the second non-contact-type current measurement sensor and the second current flow. In the present invention, at least one of the first and second non-contact-type current measurement sensors may be shielded from an external electromagnetic interference. In the present invention, the non-contact-type current measurement sensor may be a Hall effect sensor. In the present invention, the

communication transceiver may further comprise at least one slope control unit which is configured to detect edges of output of the first or second non-contact-type current sensor. In the present invention, the communication transceiver may further comprise at least one mode control unit which is configured to determine a mode of the communication transceiver. In the present invention, the communication transceiver may further comprise a third control unit at transmitter side which is configured to control the provision of differential signal upon sensing the first current flow by the first non-contact-type current measurement sensor. In the present invention, the slope control unit may be connected to the first non-contact-type current measurement sensor and the third driver unit. In the present invention, the slope control unit may be configured to detect transmission signal sensed by the first non-contact-type current measurement sensor and, in turn, to send a signal to the mode control unit to disable at least one driver unit at receiver side. In the present invention, the slope control unit may be connected to the second non-contact-type current measurement sensor and the second driver unit. In the present invention, the slope control unit may be configured to detect differential signal sensed by the second-non-contact-type current measurement sensor and, in turn, to send a signal to the mode control unit to disable at least one driver unit at transmitter side. In the present invention, the communication transceiver may be selected from a controller area network (CAN) transceiver, two-wired Ethernet transceiver or Flexray transceiver, in particular a CAN transceiver.

Another aspect of the present invention concerns a method for processing transmission signal to differential signal in communication transceiver for differential signal processing protocol. In the present invention, such method for processing transmission signal to differential signal may comprise receiving signal transmitted from TX interface pin at a first driver unit connected to the TX interface pin; enabling, by the first driver unit, a first set of switches connected to the first driver unit to generate a first current flow in a first trace resistance connected to the first set of switches, upon the receipt of signal transmitted from TX interface pin; sensing the first current flow by a first non-contact-type current measurement sensor which is in vicinity to and electrically isolated from the first trace resistance; and enabling, by a third driver unit connected to the first non-contact-type current measurement

sensor, a third set of switches connected to the third driver unit to provide signals to differential bus interface pins, respectively, upon sensing the first current flow.

Further aspect of the present invention concerns a method for processing differential signal to receiving signal in communication transceiver for differential signal processing protocol. In the present invention, such method for processing differential signal to receiving signal may comprise generating a second current flow at a second trace resistance connected to differential bus interface pins upon receiving signals from the differential bus interface pins; sensing the second current flow by a second non-contact-type current measurement sensor which is in vicinity to and electrically isolated from the second trace resistance; and enabling, by a second driver unit connected to the second non-contact-type current measurement sensor, a second set of switches connected to the second driver unit to provide signal to RX interface pin, upon sensing the second current flow.

One or more aspects of the present invention may bring about one or more advantages. According to one or more aspects of the present invention, a communication transceiver for differential signal processing protocol, in particular CAN transceiver, wherein an isolation module is integrated therein can be provided. In addition, one or more aspects of the present invention can provide isolation for the communication transceiver with small size, hence allowing larger freedom of design and/or possible cost reduction for the products in which the communication transceiver is integrated. Further, one or more aspects of the present invention may provide a simple and/or stable isolation for differential signal communication network data link. Still further, one or more aspects of the present invention may provide an effective isolation for the communication transceiver utilizing non-contact-type current measurement sensor. One or more aspects of the present invention may also provide an isolated differential signal communication network design, in particular CAN design, which is compatible with industrial standards, such as ISO standard, in particular ISO 11898, and SAE J2284.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a schematic diagram of the CAN transceiver according to an embodiment of the present invention.

FIG. 2 illustrates a schematic diagram of an electrical circuit of the CAN transceiver according to an embodiment of the present invention.

FIG. 3 illustrates a schematic diagram of the CAN transceiver with arrangement of pins according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, communication transceiver for differential signal processing protocol and method for processing signals in the communication transceiver according to the present invention will be described by referencing to a CAN transceiver according to an exemplary embodiment of the present invention with reference to the drawings.

As used in the present invention, the singular forms “a”, “an”, and “the” are intended to include the plural referents unless the context clearly indicates otherwise. For example, reference to “a data” includes references to one or more types of data or information.

The expression “configured to” used in various implementations of the present invention may be interchangeably used with "suitable for", "having the capacity to", "designed to", "adapted to", "made to", or "capable of" according to a situation, for example. The term “configured to” may not necessarily mean “specifically designed to” in terms of hardware. Instead, the expression “a device configured to” in some situations may mean that the device and another device or part are “capable of” carrying out a function.

FIG. 1 illustrates a schematic diagram of the CAN transceiver according to an embodiment of the present invention. The CAN transceiver (100) according to the present invention may comprise, at transmitter side, a first driver unit (110), a first

electrical isolation circuit (111), and a third driver unit (112). The CAN transceiver (100) according to the present invention may comprise, at receiver side, a second driver unit (120) and a second isolation circuit (121). The CAN transceiver (100) may further comprise a mode control unit (130). In the present invention, the mode control unit (130) may enable the CAN transceiver to operate in certain mode(s), such as transmit-only mode and receive-only mode through TO and RO pins, respectively.

Details of working principles of the CAN transceiver according to an embodiment of the present invention is given referring to FIG. 2 which illustrates a schematic diagram of an electric circuit of the CAN transceiver according to an embodiment of the present invention.

At the transmitter side, the first driver unit (210) may be connected to, at one end, TXD pin of the transceiver (micro-controller side) and, at the other end, a first set of switches (T1, T2). In the present invention, the first set of switches (T1, T2) may be a pair of switches. Signal may be provided from a micro-controller to TXD pin, and in turn, the first driver unit (210) may receive the signal. Upon receiving the signal from TXD pin, the first driver unit (210) may enable the first set of switches (T1, T2) so to generate a first current flow (i1). According to an embodiment of the present invention, the first current flow (i1) can be generated at a first trace resistance (R1) which is connected to the first set of switches (T1, T2) by enabling the first set of switches (T1, T2). The first isolation circuit at least comprises a first non-contact-type current measurement sensor (211) to sense the first current flow (i1) as generated. Particular examples of the non-contact-type current measurement sensor (211) include Hall effect sensors, inductive sensors and fiber optic current sensors, but the present invention is not limited thereto. In the present invention, the first non-contact-type current measurement sensor (211) may be located in vicinity to the first trace resistance (R1), while maintaining a certain distance from the first trace resistance (R1) so that it can sense the first current flow (i1) while creating an electrical isolation or galvanic isolation from the first trace resistance side. In the present invention, the first non-contact-type current measurement sensor (211) may be shielded against external electromagnetic

disturbances. Upon sensing the first current flow (i1), the first non-contact-type current measurement sensor (211) may trigger provision of CAN-H and CAN-L signal to CAN-H pin and CAN-L pin, respectively. According to an embodiment of the present invention, the first non-contact-type current measurement sensor (211) may be connected to a third driver unit (213) which is, at the other end, connected to a third set of switches (T3, T4), and such provision of CAN-H and CAN-L signal may be activated by enabling the third set of switches (T3, T4). In the present invention, the third set of switches (T3, T4) may be a pair of switches. The first isolation circuit may further comprise a first slope control unit (212) which is configured to detect edges (the rising edge and falling edge) of output of the first non-contact-type current sensor (211). According to an embodiment of the present invention, the first slope control unit (212) may be connected to, at one end, the first non-contact-type current measurement sensor (211) and, at the other end, the third driver unit (213). Although it is not indicated in the drawing, in the present invention, the first slope control unit (212) may further be connected to a mode control unit (230). According to an embodiment of the present invention, the first slope control unit (212) may be configured to detect a signal from the first non-contact-type current measurement sensor (211) and, in turn, to send a signal to the mode control unit (230) so that the mode control unit (230) can enable the CAN transceiver to operate only in a particular mode. For instance, if the TXD signal from the first non-contact-type current measurement sensor (211) is sensed, the slope control unit (212) may send a signal to the mode control unit (230) to disable at least one driver unit at receiver side (e.g. by disabling one or both the second and fourth driver units via 232).

At the receiver side, a second current flow (i2) may be generated by signals from CAN-H and CAN-L pins. In the present invention, the second current flow (i2) may be generated at a second trace resistance which is connected to CAN-H and CAN-L pins upon receiving signals from CAN-H and CAN-L pins, the second trace resistance being near R-termination. In the embodiment, the R-termination is a termination resistance which is selected to match the differential line impedance. The second isolation circuit at least comprises a second non-contact-type current measurement sensor (221) to sense the second current flow (i2) as generated. Particular examples of the non-contact-type current measurement sensor (221)

include Hall effect sensors, inductive sensors and fiber optic current sensors, but the present invention is not limited thereto. In the present invention, the second non-contact-type current measurement sensor (221) may be located in vicinity to the second trace resistance, while maintaining a certain distance from the second trace resistance so that it can sense the second current flow (i2) while creating an electrical isolation or galvanic isolation from the second trace resistance side. In the present invention, the second non-contact-type current measurement sensor (211) may be shielded against external electromagnetic disturbances. Upon sensing the second current flow (i2), the second non-contact-type current measurement sensor (221) may trigger provision of a signal to RXD pin. According to an embodiment of the present invention, the second non-contact-type current measurement sensor (221) may be connected to the second driver unit (220) which is, at the other end, connected to a second set of switches (T5, T6), and such provision of the signal to RXD pin may be activated by enabling the second set of switches (T5, T6). The second isolation circuit may further comprise a second slope control unit (222) to control which is configured to detect edges (the rising edge and falling edge) of output of the second non-contact-type current sensor (221). According to an embodiment of the present invention, the second slope control unit (222) may be connected to, at one end, the second non-contact-type current measurement sensor (221) and, at the other end, the second driver unit (220). In the present invention, the second slope control unit (222) may further be connected to the mode control unit (230). According to an embodiment of the present invention, the second slope control unit (222) may be configured to detect CAN-H and CAN-L signal (e.g. by sensing the same via the second non-contact-type current measurement sensor (221)) and, in turn, to send a signal to the mode control unit (230) so that the mode control unit (230) can enable the CAN transceiver to operate only in a particular mode. For instance, if the CAN-H and CAN-L signal is sensed, the second slope control unit (222) may send a signal to the mode control unit (230) to disable at least one driver units at transmitter side (e.g. by disabling one or both the first and third driver units via 231 and 233). The fourth driver unit (223) may exist between the second set of switches (T5, T6) and RXD pin.

The principles of electrical isolation and signal processing applied in the CAN transceiver according to the present invention may be applied in communication transceivers for differential signal processing protocol in general. Hence, still further aspect of the present invention concerns a communication transceiver for differential signal processing protocol, comprising a first driver unit for transmitter side, a second driver unit for receiver side, a first electrical isolation circuit for transmitter side, and a second electrical isolation circuit for receiver side, wherein the first electrical isolation circuit comprises the first driver unit which is configured to generate a first current flow upon receiving signal transmitted from TX interface pin, and a first non-contact-type current measurement sensor which is configured to trigger provision of differential signal upon sensing the first current flow, and the second electrical isolation circuit comprises a second non-contact-type current measurement sensor which is configured to sense a second current flow generated by signal transmitted from differential bus interface pins and trigger the second driver unit to provide signal to RX interface pin.

One or more general and particular description provided in the above as to the CAN transceiver of the present invention may be applicable to the aspect of the present invention concerning the communication transceiver for differential signal processing protocol, *mutatis mutandis*, by, for instance, replacing CAN transceiver with communication transceiver for differential signal processing protocol, CAN-H and CAN-L signal with differential signal, CAN-H and CAN-L pins with differential bus interface pins, RXD pin with RX interface pin, RXD signal with receiving signal, TXD pin with TX interface pin, and/or TXD signal with transmission signal, as necessary. The communication transceiver can be selected from various types of differential signal communication network transceiver, such as CAN (e.g. CAN partial networking, CAN flexible data rates) transceiver, two-wired Ethernet transceiver or Flexray transceiver.

The communication transceiver according to the present invention may be advantageously used for processing transmission signal to differential signals. Hence, another aspect of the present invention concerns a method for processing transmission signal to differential signals in communication transceiver for

differential signal processing protocol. The method for processing transmission signal to differential signal may comprise receiving signal transmitted from TX interface pin at a first driver unit connected to the TX interface pin; enabling, by the first driver unit, a first set of switches connected to the first driver unit to generate a first current flow in a first trace resistance connected to the first set of switches, upon the receipt of signal transmitted from TX interface pin; sensing the first current flow by a first non-contact-type current measurement sensor which is in vicinity to and electrically isolated from the first trace resistance; and enabling, by a third driver unit connected to the first non-contact-type current measurement sensor, a third set of switches connected to the third driver unit to provide signals to differential bus interface pins, respectively, upon sensing the first current flow.

One or more general and particular description provided in the above as to the CAN transceiver of the present invention may be applicable to the aspect of the present invention concerning the method for processing transmission signal to differential signals, *mutatis mutandis*.

The communication transceiver according to the present invention may also be advantageously used for processing differential signals to receiving signal. Hence, further aspect of the present invention concerns a method for processing differential signals to receiving signal in communication transceiver for differential signal processing protocol. The method for processing differential signals to receiving signal may comprise generating a second current flow at a second trace resistance connected to differential bus interface pins upon receiving signals from the differential bus interface pins; sensing the second current flow by a second non-contact-type current measurement sensor which is in vicinity to and electrically isolated from the second trace resistance; and enabling, by a second driver unit connected to the second non-contact-type current measurement sensor, a second set of switches connected to the second driver unit to provide signal to RX interface pin, upon sensing the second current flow.

One or more general and particular description provided in the above as to the CAN transceiver of the present invention may be applicable to the aspect of the present

invention concerning the method for processing CAN-H and CAN-L signal to RXD signal, *mutatis mutandis*.

While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it should be understood that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims. Therefore, the technical protection scope of the present invention should be defined by the following claims and their equivalents.

List of Reference Signs

100 – CAN transceiver
110 – First driver unit
111 – First isolation circuit
112 – Third driver unit
120 – Second driver Unit
121 – Second isolation circuit
130 – Mode control unit

210 – First driver unit
211 – First non-contact-type current measurement sensor
212 – First slope control unit
213 – Third driver unit
220 – Second driver unit
221 – Second non-contact-type current measurement sensor
222 – Second slope control unit
223 – Fourth driver unit
224 – Comparator
230 – Mode control unit
231 – Enable/disable first driver unit
232 – Enable/disable second driver unit
233 – Enable/disable third driver unit

Patent claims

1. A communication transceiver for differential signal processing protocol, comprising:
a first driver unit for transmitter side,
a second driver unit for receiver side,
a first electrical isolation circuit for transmitter side, and
a second electrical isolation circuit for receiver side,
wherein the first electrical isolation circuit comprises the first driver unit which is configured to generate a first current flow upon receiving signal transmitted from TX interface pin, and a first non-contact-type current measurement sensor which is configured to trigger provision of differential signal upon sensing the first current flow, and
the second electrical isolation circuit comprises a second non-contact-type current measurement sensor which is configured to sense a second current flow generated by signal transmitted from differential bus interface pins and trigger the second driver unit to provide signal to RX interface pin.

2. The communication transceiver according to claim 1, wherein the differential bus interface pins and micro-controller interface pins (TX and RX interface pins) are galvanically isolated by having an isolation between the first non-contact-type current measurement sensor and the first current flow and between the second non-contact-type current measurement sensor and the second current flow.

3. The communication transceiver according to claim 1 or 2, wherein at least one of the first and second non-contact-type current measurement sensors is shielded from an external electromagnetic interference.

4. The communication transceiver according to any one of claims 1 to 3, wherein the non-contact-type current measurement sensor is a Hall effect sensor.

5. The communication transceiver according to any one of claims 1 to 4, further comprising at least one slope control unit which is configured to detect edges of output of the first or second non-contact-type current sensor.

6. The communication transceiver according to any one of claims 1 to 5, further comprising at least one mode control unit which is configured to determine a mode of the communication transceiver.

7. The communication transceiver according to claim 6, further comprising a third control unit at transmitter side which is configured to control the provision of differential signal upon sensing the first current flow by the first non-contact-type current measurement sensor.

8. The communication transceiver according to claim 7, wherein the slope control unit is connected to the first non-contact-type current measurement sensor and the third driver unit.

9. The communication transceiver according to any one of claims 6 to 8, wherein the slope control unit is configured to detect transmission signal sensed by the first non-contact-type current measurement sensor and, in turn, to send a signal to the mode control unit to disable at least one driver unit at receiver side.

10. The communication transceiver according to claim 6, wherein the slope control unit is connected to the second non-contact-type current measurement sensor and the second driver unit.

11. The communication transceiver according to claim 10, wherein the slope control unit is configured to detect differential signal sensed by the second non-contact-type current measurement sensor and, in turn, to send a signal to the mode control unit to disable at least one driver unit at transmitter side.

12. The communication transceiver according to any one of claims 1 to 11, wherein the communication transceiver is selected from a controller area network (CAN) transceiver, two-wired Ethernet transceiver or Flexray transceiver.

13. A method for processing transmission signal to differential signals in communication transceiver for differential signal processing protocol, comprising:

receiving signal transmitted from TX interface pin at a first driver unit connected to the TX interface pin,

enabling, by the first driver unit, a first set of switches connected to the first driver unit to generate a first current flow in a first trace resistance connected to the first set of switches, upon the receipt of signal transmitted from the TX interface pin,

sensing the first current flow by a first non-contact-type current measurement sensor which is in vicinity to and electrically isolated from the first trace resistance, and

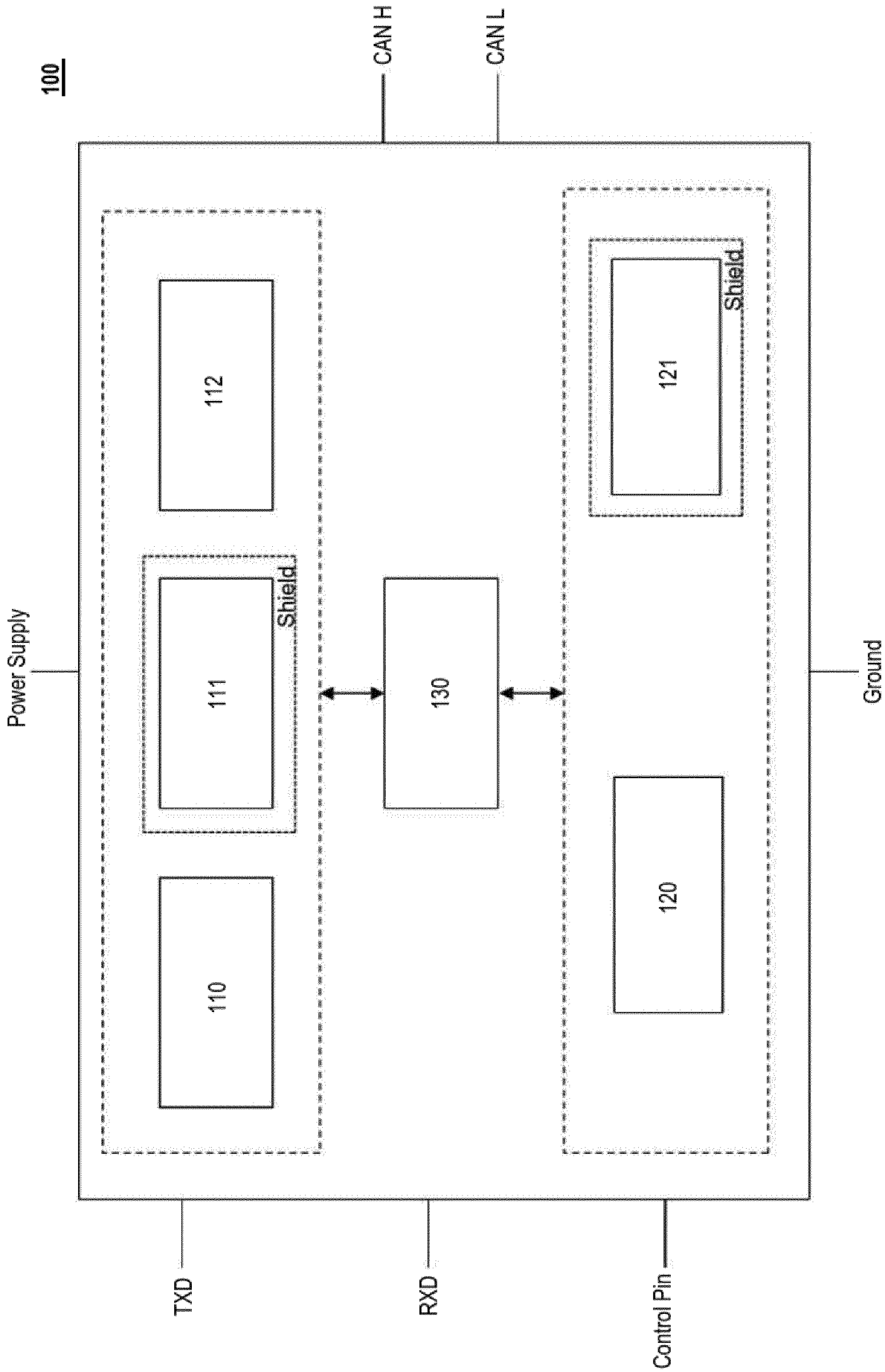
enabling, by a third driver unit connected to the first non-contact-type current measurement sensor, a third set of switches connected to the third driver unit to provide signals to differential bus interface pins, respectively, upon sensing the first current flow.

14. A method for processing differential signal to receiving signal in communication transceiver for differential signal processing protocol, comprising:

generating a second current flow at a second trace resistance connected to differential bus interface pins upon receiving signals from the differential bus interface pins,

sensing the second current flow by a second non-contact-type current measurement sensor which is in vicinity to and electrically isolated from the second trace resistance, and

enabling, by a second driver unit connected to the second non-contact-type current measurement sensor, a second set of switches connected to the second driver unit to provide signal to RX interface pin, upon sensing the second current flow.


100
CAN H
CAN L
112
111
Shield
110
130
121
Shield
120
Power Supply
Ground
TXD
RXD
Control Pin

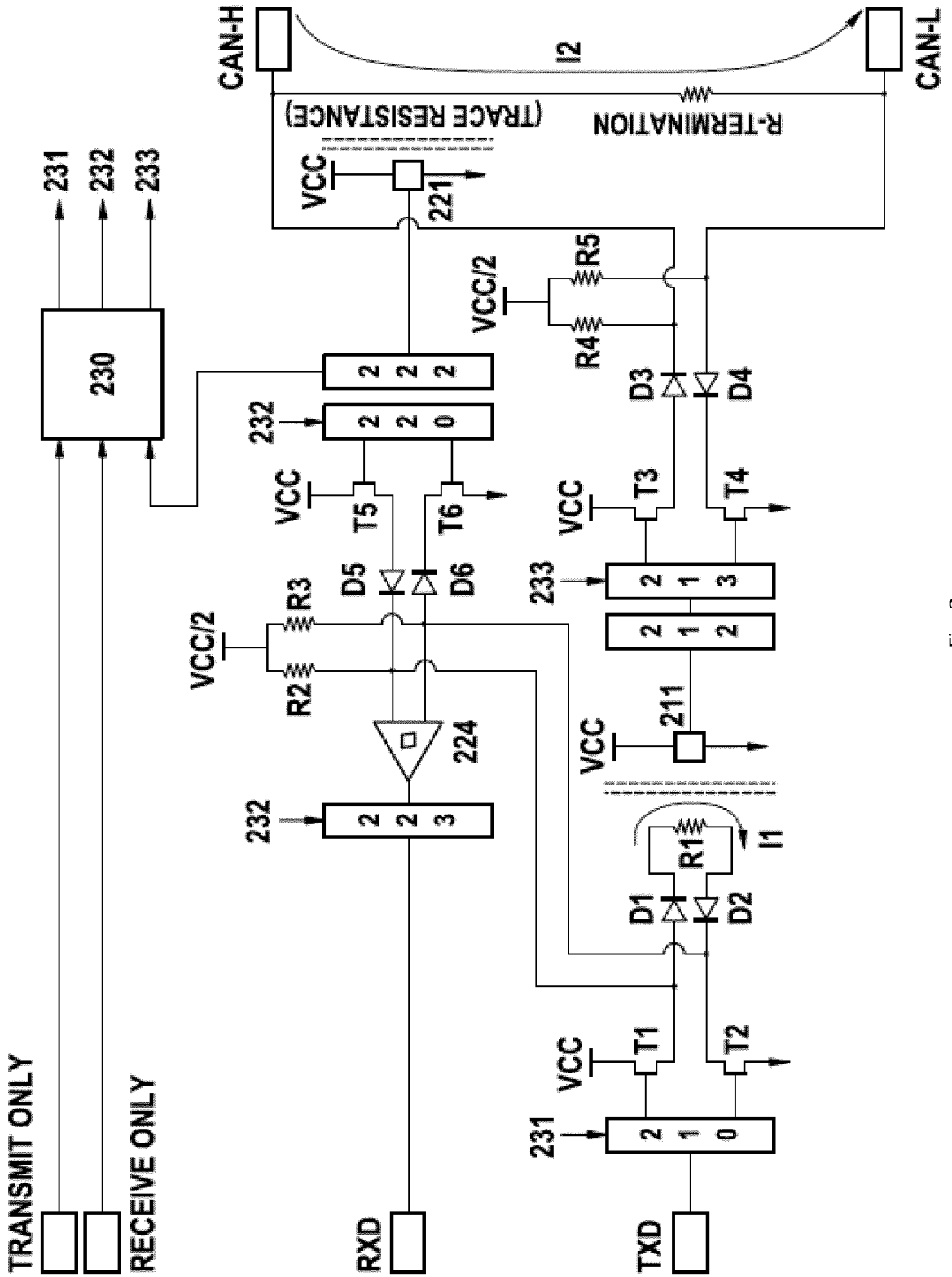

CAN-H
CAN-L
I2
R-TERMINATION
(TRACE RESISTANCE)
VCC
221
231
232
233
230
VCC/2
R5
R4
D3
D4
T3
T4
T5
T6
D5
D6
R3
R2
224
211
I1
R1
D1
D2
T1
T2
TRANSMIT ONLY
RECEIVE ONLY
RXD
TXD

Fig. 2

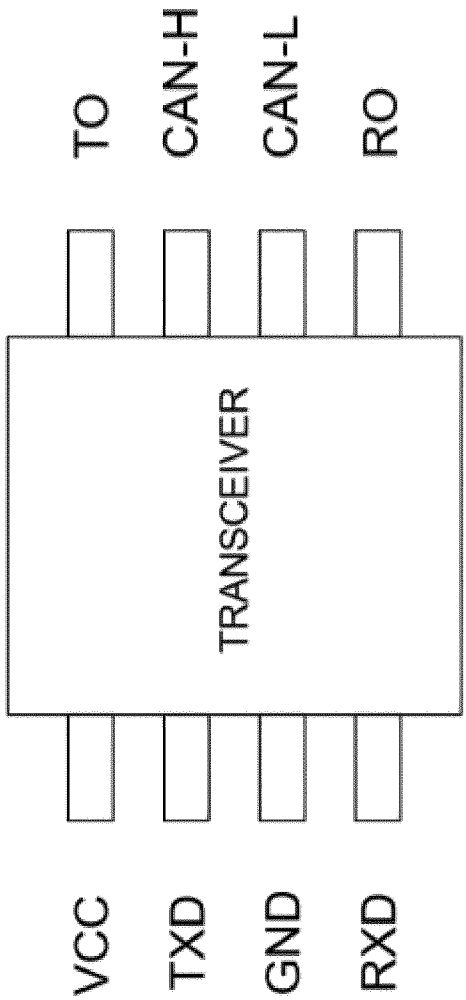


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/058448

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L25/02 H04B1/40 H03H11/32
ADD. H04B3/30 H04L25/08

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)
H04B H04L H03H

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, COMPENDEX, INSPEC, 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	US 2010/250820 A1 (GAALAAS ERIC [US] ET AL) 30 September 2010 (2010-09-30) paragraphs [0001], [0002] paragraph [0015] - paragraph [0082] figures 1-13	1-14
X	US 2001/008548 A1 (MILLER PETER [GB] ET AL) 19 July 2001 (2001-07-19) paragraph [0002] - paragraph [0004] paragraph [0010] - paragraph [0024] figure 1	1-14
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☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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30 April 2020	12/05/2020

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Information on patent family members

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