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(54) **DATA LINK THROUGH VEHICLE SAFETY SYSTEM**

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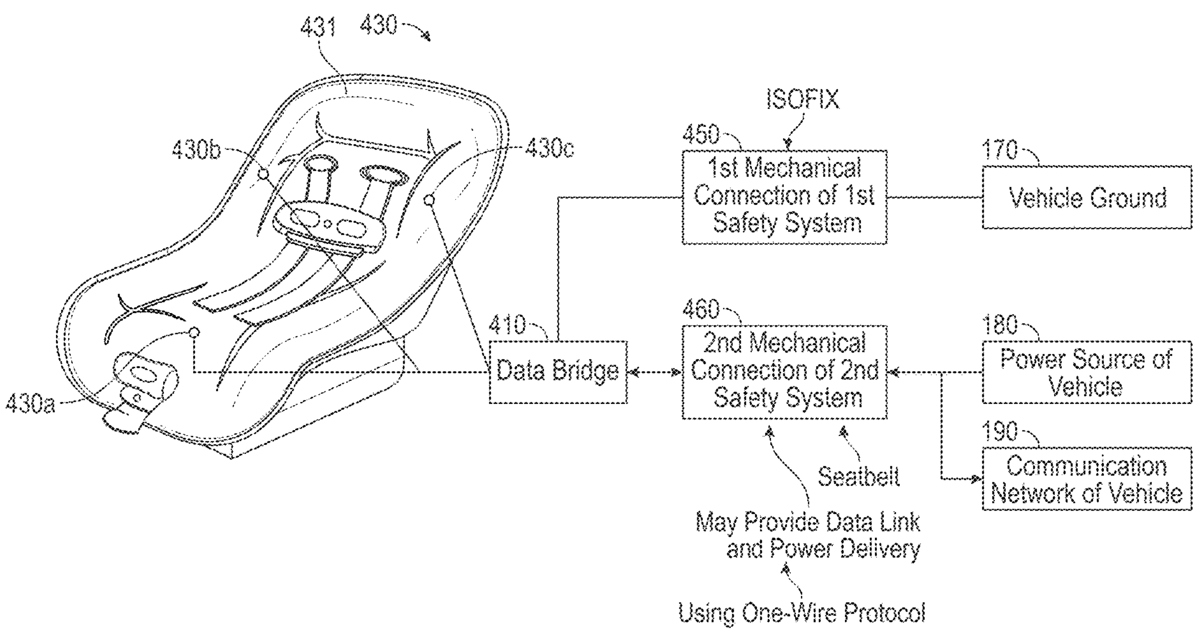
(57) **ABSTRACT**

A device including a transceiver and a first logic circuit electrically coupled to the transceiver. The device including a first electrical conductor electrically coupled to the transceiver and to a first mechanical connection of a first vehicle safety system of a vehicle. The first mechanical connection to provide a first electrical path to a ground of the vehicle. The device including a second electrical conductor electrically coupled to the transceiver and to a second mechanical connection of a second vehicle safety system of the vehicle. The second vehicle safety system separate from the first vehicle safety system. The second mechanical connection to provide a data link to communicate data with a communication network of the vehicle.



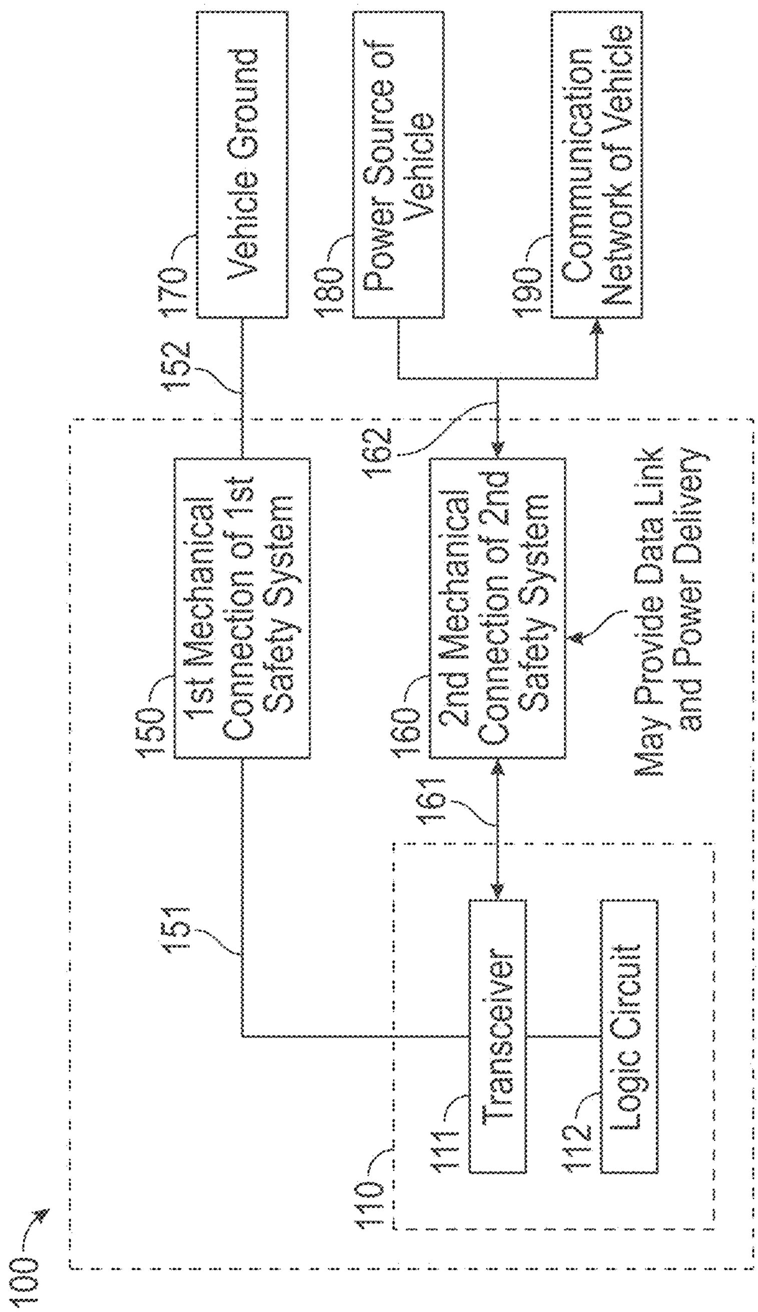

100
110
111
Transceiver
112
Logic Circuit
151
150
1st Mechanical Connection of 1st Safety System
152
170
Vehicle Ground
161
160
2nd Mechanical Connection of 2nd Safety System
162
May Provide Data Link and Power Delivery
180
Power Source of Vehicle
190
Communication Network of Vehicle

FIG. 1

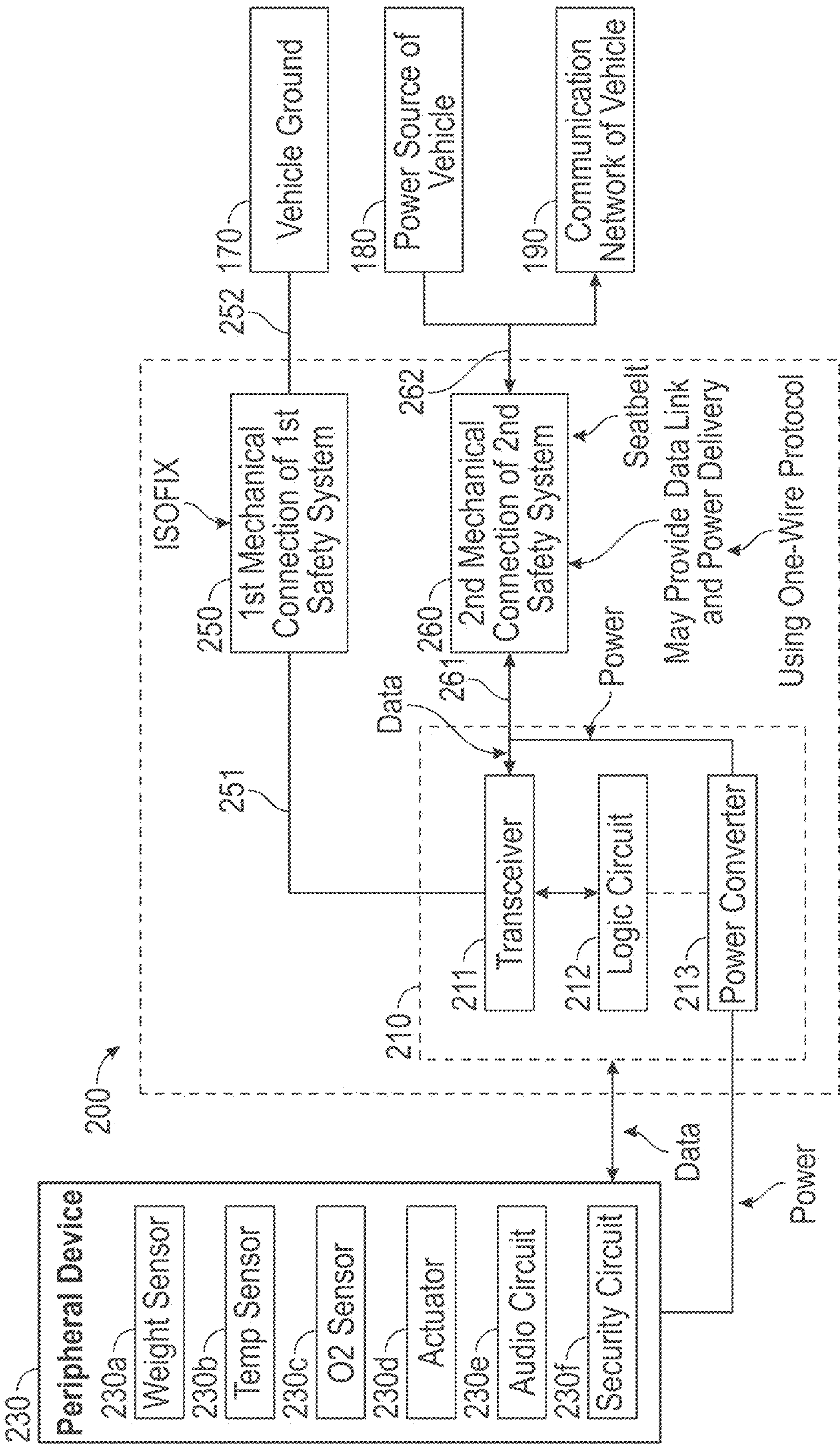
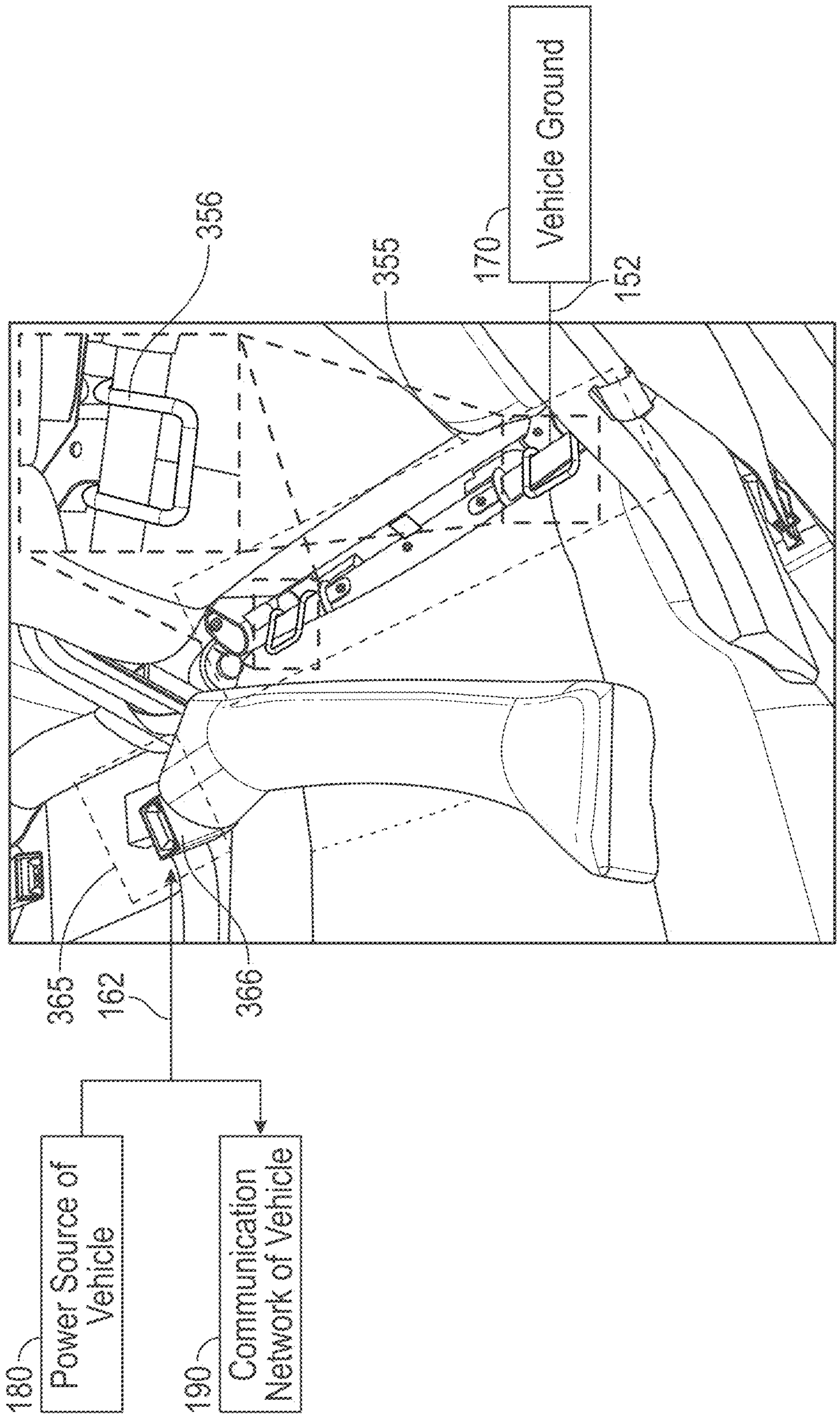
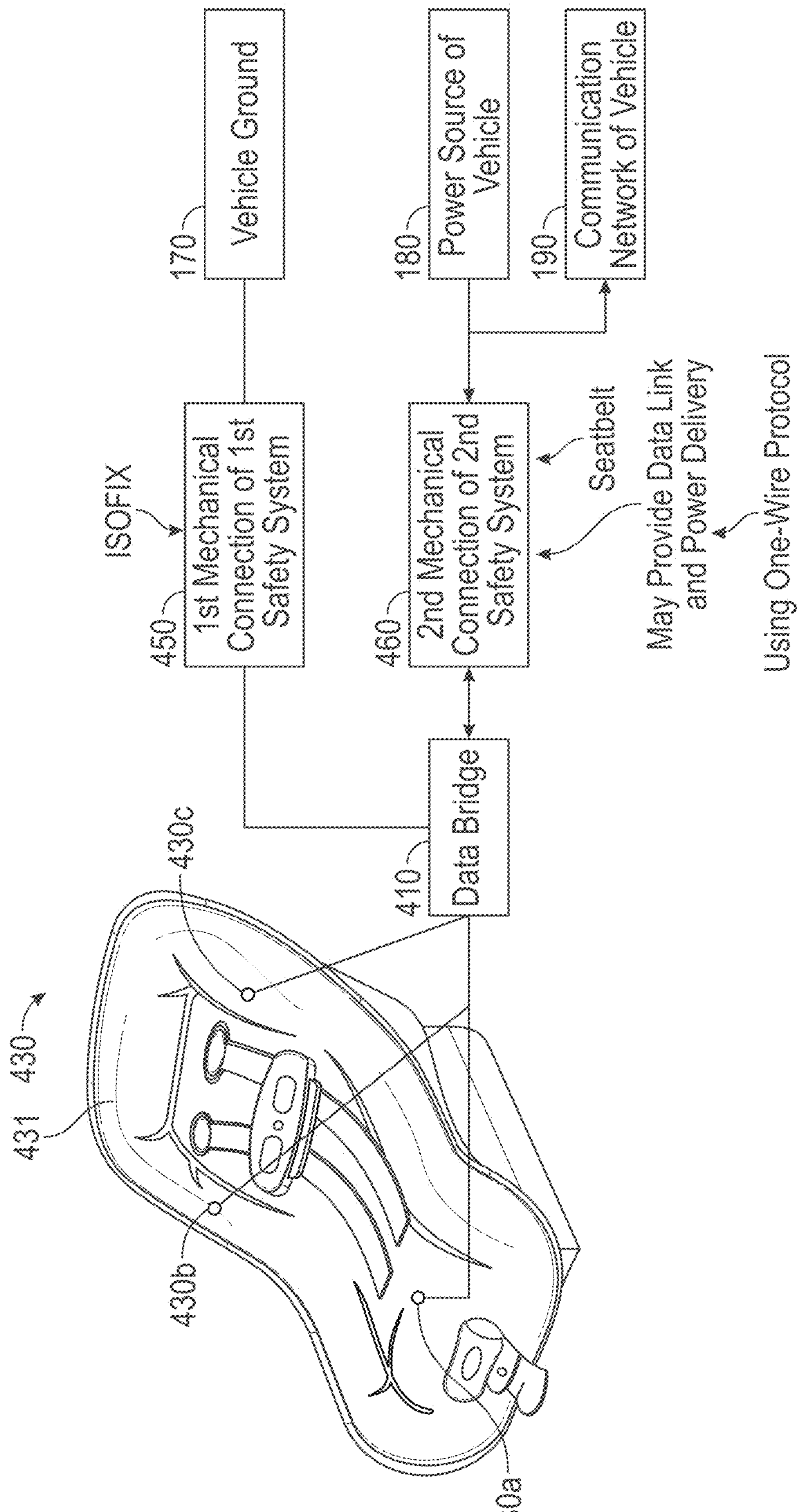

200
170
Vehicle Ground
180
Power Source of Vehicle
190
Communication Network of Vehicle
252
262
ISOFIX
250
1st Mechanical Connection of 1st Safety System
260
2nd Mechanical Connection of 2nd Safety System
Seatbelt
May Provide Data Link and Power Delivery
Using One-Wire Protocol
261
Data
Power
251
210
211
Transceiver
212
Logic Circuit
213
Power Converter
Data
Power
230
Peripheral Device
230a
Weight Sensor
230b
Temp Sensor
230c
O2 Sensor
230d
Actuator
230e
Audio Circuit
230f
Security Circuit

FIG. 2



356
355
170
Vehicle Ground
152
365
162
366
180
Power Source of Vehicle
190
Communication Network of Vehicle

FIG. 3



170
Vehicle Ground
180
Power Source of Vehicle
190
Communication Network of Vehicle
ISOFIX
450
1st Mechanical Connection of 1st Safety System
460
2nd Mechanical Connection of 2nd Safety System
Seatbelt
May Provide Data Link and Power Delivery
Using One-Wire Protocol
410
Data Bridge
430
431
430a
430b
430c

FIG. 4

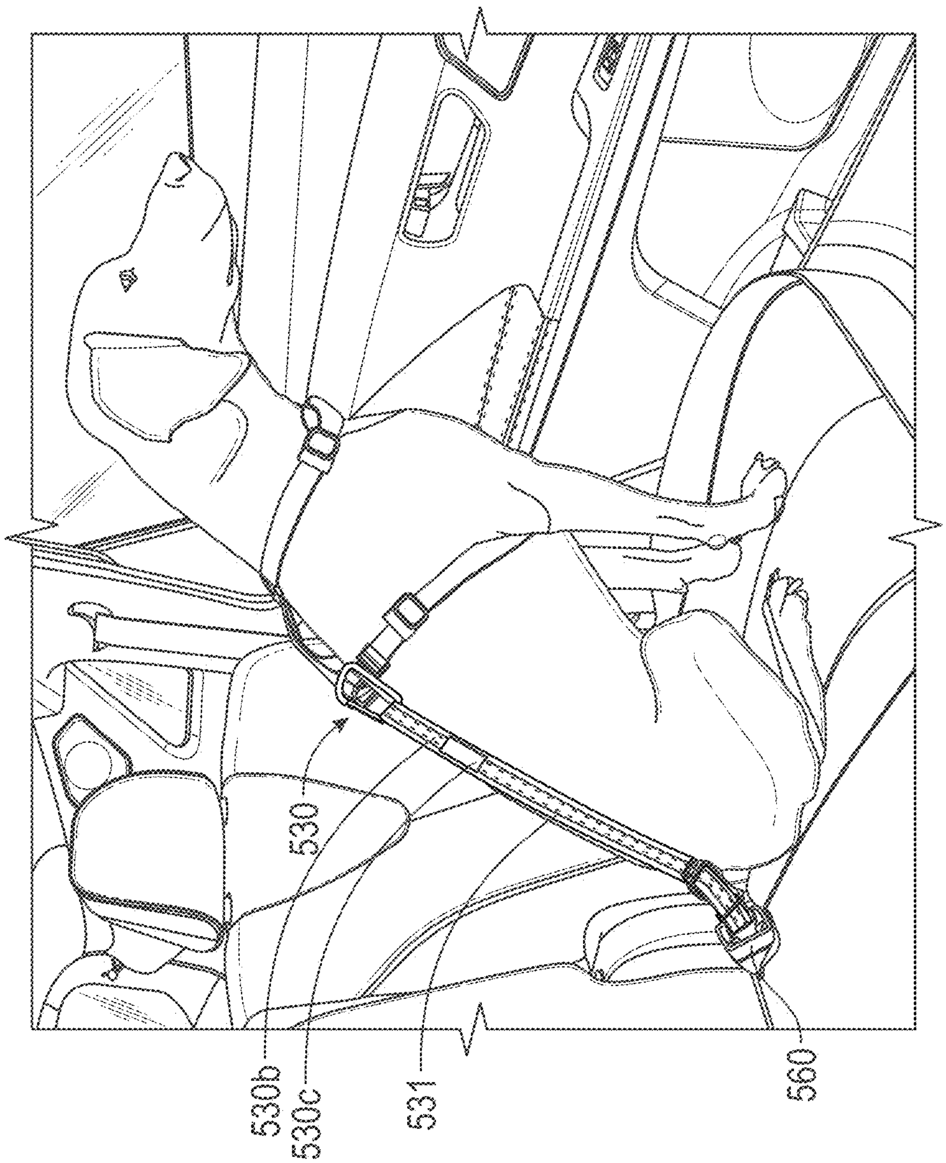


FIG. 5

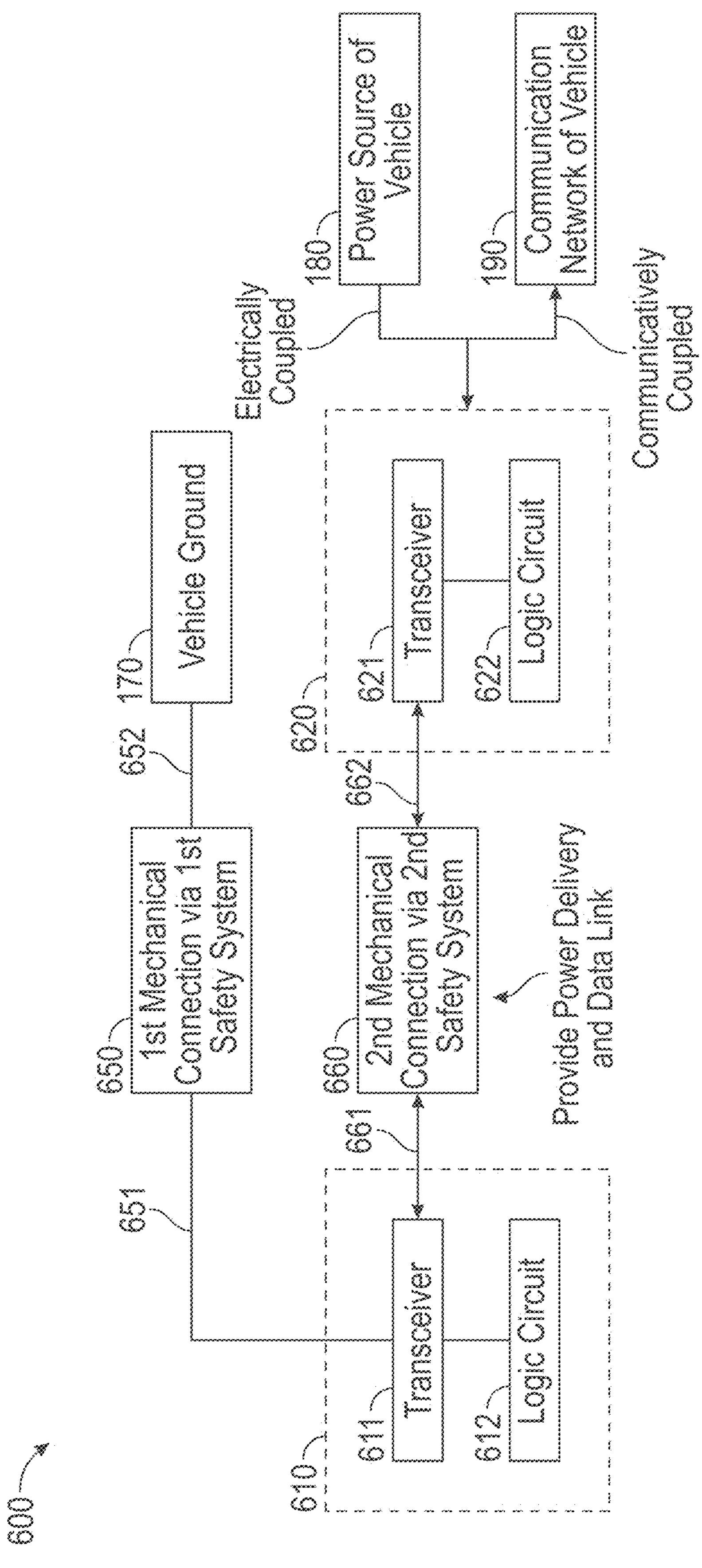
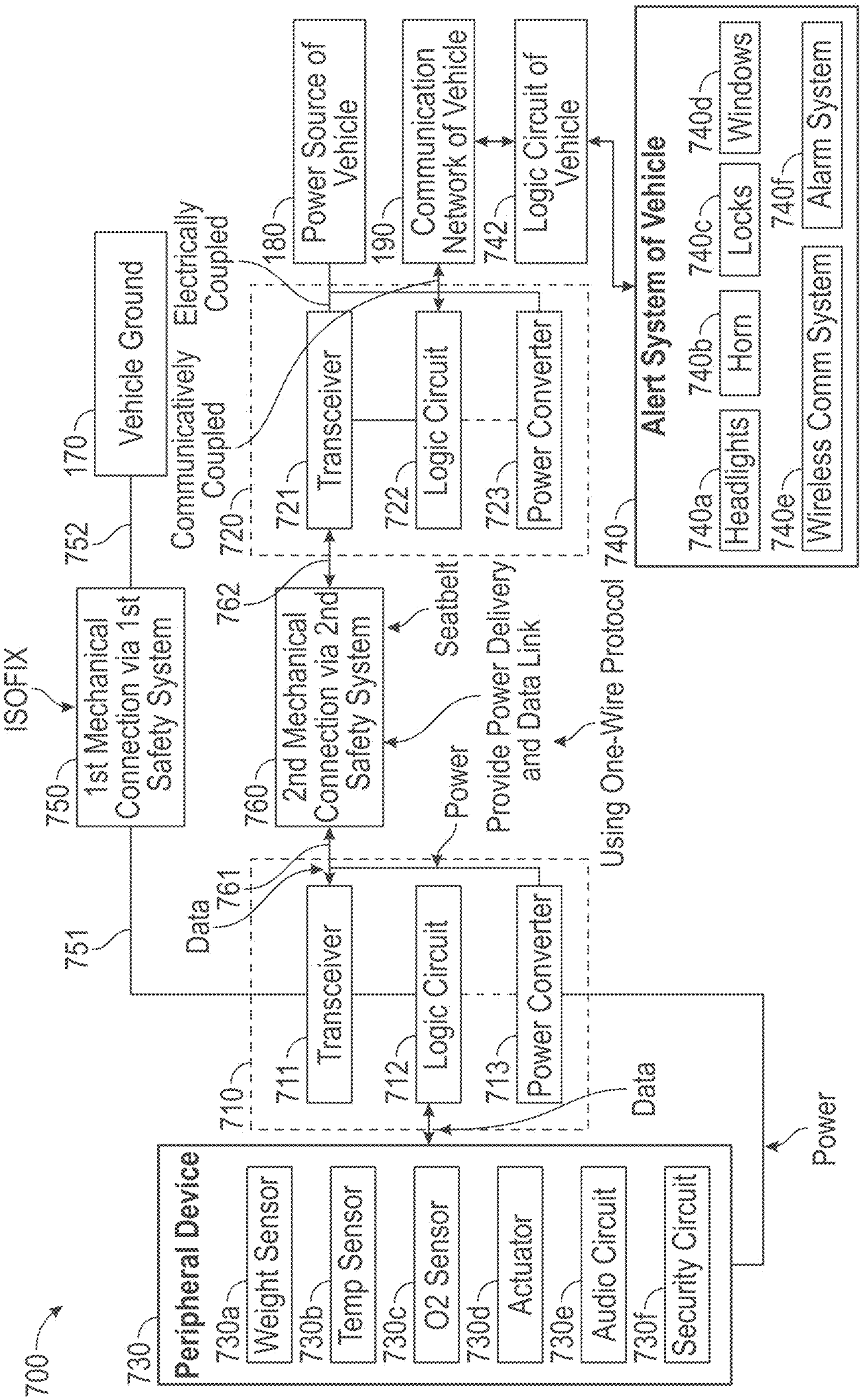

600
610
611
Transceiver
612
Logic Circuit
651
661
650
1st Mechanical Connection via 1st Safety System
660
2nd Mechanical Connection via 2nd Safety System
Provide Power Delivery and Data Link
652
662
170
Vehicle Ground
620
621
Transceiver
622
Logic Circuit
Electrically Coupled
Communicatively Coupled
180
Power Source of Vehicle
190
Communication Network of Vehicle

FIG. 6



700
730
Peripheral Device
730a Weight Sensor
730b Temp Sensor
730c O2 Sensor
730d Actuator
730e Audio Circuit
730f Security Circuit
Data
Power
710
711 Transceiver
712 Logic Circuit
713 Power Converter
751
Data
761
Power
750 1st Mechanical Connection via 1st Safety System
ISOFIX
752
170 Vehicle Ground
760 2nd Mechanical Connection via 2nd Safety System
Provide Power Delivery and Data Link
Using One-Wire Protocol
Seatbelt
762
720
721 Transceiver
722 Logic Circuit
723 Power Converter
Communicatively Coupled
Electrically Coupled
180 Power Source of Vehicle
190 Communication Network of Vehicle
742 Logic Circuit of Vehicle
740
Alert System of Vehicle
740a Headlights
740b Horn
740c Locks
740d Windows
740e Wireless Comm System
740f Alarm System

FIG. 7

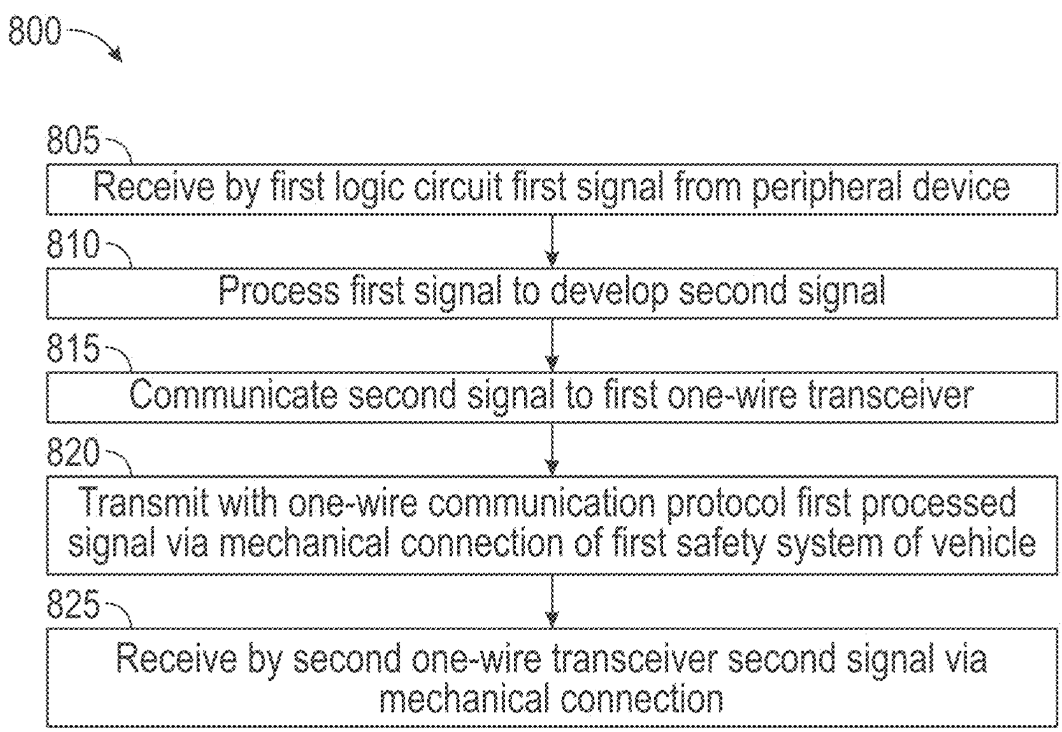

800
805
Receive by first logic circuit first signal from peripheral device
810
Process first signal to develop second signal
815
Communicate second signal to first one-wire transceiver
820
Transmit with one-wire communication protocol first processed signal via mechanical connection of first safety system of vehicle
825
Receive by second one-wire transceiver second signal via mechanical connection

FIG. 8

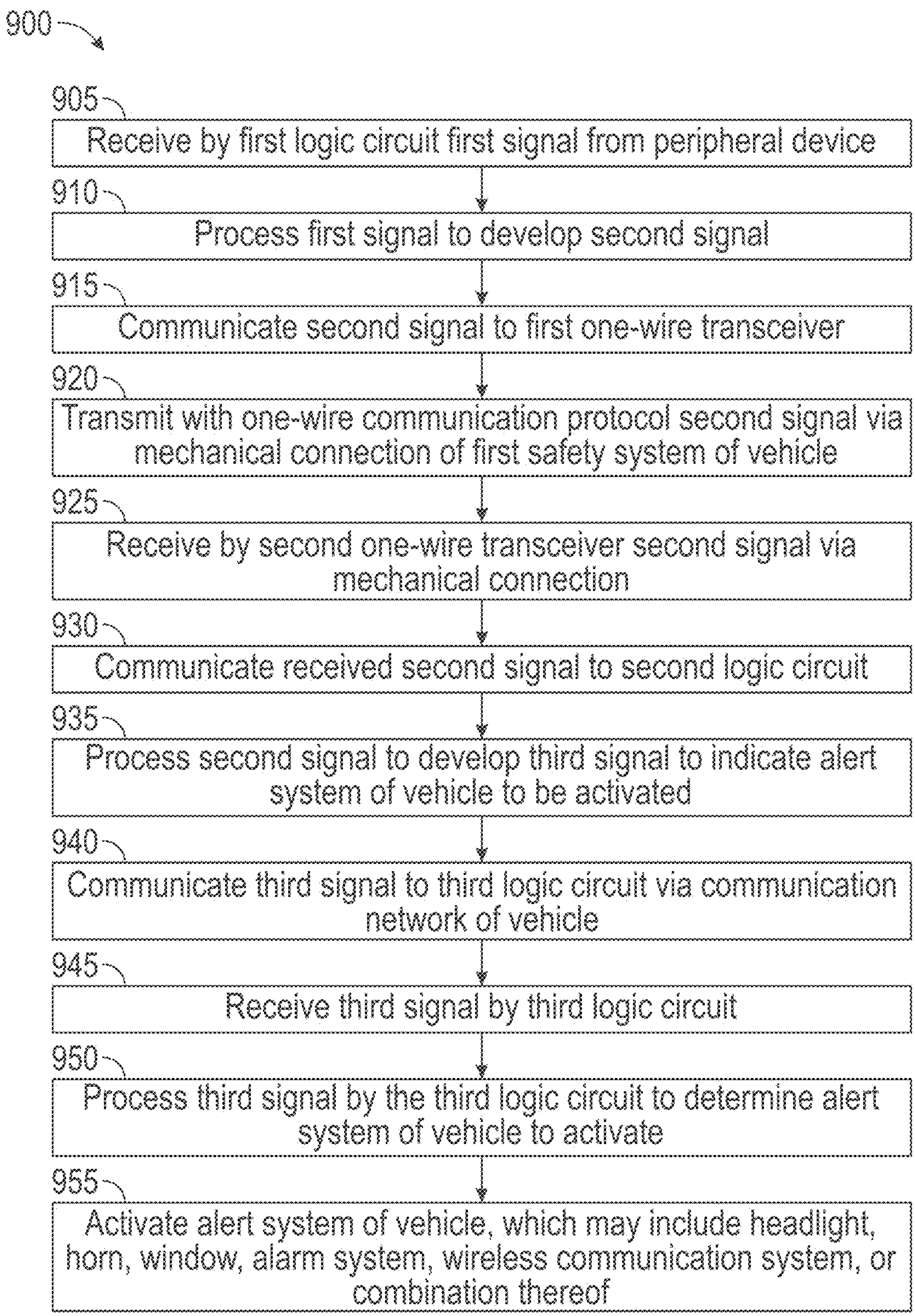

900
905
Receive by first logic circuit first signal from peripheral device
910
Process first signal to develop second signal
915
Communicate second signal to first one-wire transceiver
920
Transmit with one-wire communication protocol second signal via mechanical connection of first safety system of vehicle
925
Receive by second one-wire transceiver second signal via mechanical connection
930
Communicate received second signal to second logic circuit
935
Process second signal to develop third signal to indicate alert system of vehicle to be activated
940
Communicate third signal to third logic circuit via communication network of vehicle
945
Receive third signal by third logic circuit
950
Process third signal by the third logic circuit to determine alert system of vehicle to activate
955
Activate alert system of vehicle, which may include headlight, horn, window, alarm system, wireless communication system, or combination thereof

FIG. 9

DATA LINK THROUGH VEHICLE SAFETY SYSTEM

PRIORITY

[0001] This application claims priority to U.S. Provisional Application No. 63/554,030 filed Feb. 15, 2024, the entire contents of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to providing a data link through a mechanical connection of a vehicle safety system.

BACKGROUND

[0003] Many vehicles include mechanical connections as part of the vehicles safety systems that can be used to secure occupants within the vehicle. One example is a seatbelt system of a vehicle. Another example is a separate system such as an ISOFIX system including connections that may be used, e.g., as attachment points to secure a child's car seat in a vehicle independent of the seatbelt system. While ISOFIX refers to an international standard for such systems and connections, similar standards may be referred to by different names in different regions, e.g., Lower Anchors and Tethers for Children (LATCH) and Lower Universal Anchorage System (LUAS). Systems such as ISOFIX, LATCH, and LUAS may be referred to herein simply as ISOFIX, without limitation to any of those particular standards. ISOFIX connections and seatbelt connections typically include two components. ISOFIX connections typically include metal bars accessible through the back seat of a vehicle and useable as anchorage points and metal clasps for attaching to those anchorage points. ISOFIX connections are typically used to mechanically couple children's car seats to the vehicle. Seatbelt connections typically include a metal tongue that is inserted into a buckle that includes metal components to secure the tongue in place. Many vehicles also include an existing data network that connects through an onboard computer. The onboard computer may control various systems within the vehicle.

[0004] People often leave children and pets in vehicles unattended, which can lead to tragic consequences. Every year children die from heat exposure in hot vehicles. While there have been attempts to develop car seats with sensors to monitor conditions of seated children, such car seats or other devices may not be able to reliably warn others of unsafe conditions, especially when the vehicle is turned off.

[0005] Examples of the present disclosure may address one or more of these issues.

SUMMARY

[0006] Aspects and examples of the present disclosure provide a robust data link to a vehicle's data network and onboard computer. In some examples the data link may be used to monitor conditions of occupants in the vehicle and to initiate corrective actions.

[0007] One aspect may include a device. For example, the device may include a transceiver and a first logic circuit electrically coupled to the transceiver. The device may include a first electrical conductor electrically coupled to the transceiver and to a first mechanical connection of a first vehicle safety system of a vehicle. The first mechanical connection may provide a first electrical path to a ground of the vehicle. The device may include a second electrical conductor electrically coupled to the transceiver and to a second mechanical connection of a second vehicle safety system of the vehicle. The second vehicle safety system may be separate from the first vehicle safety system. The second mechanical connection may provide a data link to communicate data with a communication network of the vehicle.

[0008] Another aspect may include a method. For example, the method may include receiving by a first logic circuit a first signal from a peripheral device. The method may include processing by the first logic circuit the first signal to develop a second signal and communicating the second signal to a first one-wire transceiver. The method may include transmitting with a one-wire communication protocol the second signal via a mechanical connection of a first safety system of a vehicle. The method may include receiving by a second one-wire transceiver the second signal via the mechanical connection.

[0009] Another aspect may include a system. For example, the system may include a first data bridge including a first transceiver and a first logic circuit. The system may include a first mechanical connection electrically coupled to the first data bridge and a vehicle ground via a first vehicle safety system of a vehicle. The system may include a second data bridge including a second transceiver and a second logic circuit. The second data bridge may be electrically coupled to a power source of the vehicle and communicatively coupled to a communication network of the vehicle. The system may include a second mechanical connection electrically coupled to the first data bridge and the second data bridge via a second vehicle safety system of the vehicle separate from the first vehicle safety system. The second mechanical connection may provide an electrical path for power delivery from the power source of the vehicle and a data link for data communication with the communication network of the vehicle via the second data bridge.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The figures illustrate aspects of data link circuits and systems of the present disclosure.

[0011] FIG. **1** illustrates a data link circuit.

[0012] FIG. **2** illustrates a data link circuit and peripheral device.

[0013] FIG. **3** illustrates mechanical connections to vehicle safety systems.

[0014] FIG. **4** illustrates a car seat peripheral device.

[0015] FIG. **5** illustrates a pet tether peripheral device.

[0016] FIG. **6** illustrates a data link system.

[0017] FIG. **7** illustrates a data link system and peripheral device.

[0018] FIG. **8** illustrates a method of using a data link circuit.

[0019] FIG. **9** illustrates a method of using a data link system.

[0020] The reference number for illustrated elements that appears in multiple different figures has the same meaning across the multiple figures, and the mention or discussion herein of any illustrated element in the context of any particular figure also applies to each other figure, if any, in which that same illustrated element is shown. In some figures, certain elements may be omitted for clarity when discussing aspects or examples of other elements.

DESCRIPTION

[0021] Aspects of the present disclosure include providing two-way data communication and power through the mechanical connections of a vehicles safety system, e.g., a vehicle's ISOFIX and seatbelt connections, without limitation. One mechanical connection may be used to provide an electrical ground, and another can be used to provide a data and power connection, e.g., via a one-wire connection and protocol. As an example, an ISOFIX connection may be used to provide the electrical ground and a seatbelt connection may be used to provide data and power. As another example, a seatbelt connection may be used to provide the electrical ground and an ISOFIX connection may be used to provide data and power.

[0022] Referring to FIG. **1**, there is provided an illustration of data link circuit **100**. Data link circuit **100** may include data bridge **110**. Data bridge **110** may include transceiver **111** and logic circuit **112**. Transceiver **111** may be communicatively coupled to logic circuit **112** to transmit data signals between logic circuit **112** and transceiver **111**. Transceiver **111** may be electrically coupled to a first mechanical connection **150** of a first vehicle safety system of the vehicle via first electrical conductor **151**. First mechanical connection **150** may be electrically coupled via fourth electrical conductor **152** to vehicle ground **170**, which may be a ground of the vehicle. Electrical conductors **151** and **152** and first mechanical connection **150** may provide a first electrical path to a ground of the vehicle such as vehicle ground **170**. Transceiver **111** may be electrically coupled to a second mechanical connection **160** of a second vehicle safety system of the vehicle via a second electrical conductor **161**, where the second vehicle safety system is separate from the first vehicle safety system. The second electrical conductor **161** and second mechanical connection **160** may provide a data link to communicate data with a communication network **190** of the vehicle via third electrical conductor **162** electrically coupled to second mechanical connection **160**. In some examples, electrical conductors **161** and **162** and second mechanical connection **160** may also provide a second electrical path for power delivery from a power source **180** of the vehicle.

[0023] There are various ways components may be electrically coupled and communicatively coupled within the scope of the present disclosure. Components may be electrically coupled by any suitable electrical conductor for transferring power, e.g., pins, wires, busses, vias, or other electrical pathways, without limitation. Components may be communicatively coupled by any suitable mechanism for transferring signals. In some examples, components may be communicatively coupled by electrically coupling the components. In other examples, components may be communicatively coupled by a wireless connection, e.g., WiFi, Bluetooth, cellular, or any other suitable wireless mechanism or protocol.

[0024] In some examples, the first mechanical connection **150** may be an ISOFIX connection and the first vehicle safety system may be an ISOFIX system. In some examples, the second mechanical connection **160** may be a seatbelt connection and the second vehicle safety system may be a seatbelt system. In other examples, the first mechanical connection **150** may be a seatbelt connection and the first vehicle safety system may be a seatbelt system. In yet other examples, the second mechanical connection **160** may be an ISOFIX connection and the second vehicle safety system may be an ISOFIX system. The physical contact of metallic components of first mechanical connection **150** and second mechanical connection **160** may provide electrical coupling between the mating parts of those mechanical connections. As one example, an ISOFIX connection may include an anchor point (e.g., a metal bar behind the seat cushion, without limitation) and a mechanical attachment (e.g., a clasp, hook, or latch, without limitation) that may be connected to the anchor point to form a mechanical connection, e.g., first mechanical connection **150**. First electrical conductor **151** may be coupled to the mechanical attachment that may be connected to the anchor point. In some examples, the anchor point may be electrically coupled to the vehicle ground **170** (e.g., by attaching fourth electrical conductor **152** to the anchor point and to vehicle ground **170**). By connecting the mechanical attachment to the anchor point, an electrical path through first mechanical connection **150** to vehicle ground **170** may be created. As another example, a seatbelt connection may include a metal tongue that is inserted into a buckle to form a mechanical connection, e.g., second mechanical connection **160**. Metal components within the buckle may secure the tongue in place and also electrically couple the tongue to the buckle. Second electrical conductor **161** may be electrically coupled to the seatbelt tongue, and third electrical conductor **162** may be electrically coupled to the metallic component of the seatbelt buckle that physically contacts the tongue. By connecting the metallic tongue and buckle components, an electrical path through mechanical connection **160** may be created and used to transfer power and data as described herein. Third electrical conductor **162** may be provided woven into seatbelt fabric, or may be provided as a border on one or more edges of the seatbelt fabric, without limitation. Second electrical conductor **161** may be similarly provided, or may be provided as additional connector arranged to mate with the buckle.

[0025] In some examples, transceiver **111** of data bridge **110** may send and receive data to, and from, communication network **190** of the vehicle through third electrical conductor **162**, second mechanical connection **160**, and electrical conductor **161** using a one-wire (or single-wire) connection and protocol, e.g., a Local Interconnect Network (LIN) connection and protocol. In some examples, data bridge **110** may send and receive data to, and from, communication network **190** of the vehicle and receive power from power source **180** of the vehicle through the second mechanical connection **160** and electrical conductor **161** using a one-wire (or single-wire) connection and protocol, e.g., a LIN-over-DC-powerline (DC-LIN) connection and protocol. Transceiver **111** may be a DC-LIN transceiver to transmit and receive data over a DC powerline. In some examples, communication network **190** of the vehicle may be a controller area network (CAN), local area network (LAN), Ethernet network, wireless network (e.g., WiFi or Bluetooth, without limitation), or any other suitable communications network for communicating data within a vehicle.

[0026] Transceiver **111** may be any suitable transceiver that transmits and receives data over a one-wire connection such as electrical conductor **161** via second mechanical connection **160**. In some examples, transceiver **111** may also receive and transmit power over a one-wire connection such as electrical conductor **161** via second mechanical connection **160**. Examples of transceiver **111** may include LIN transceivers and DC-LIN transceivers, without limitation. In some examples, data bridge **110** may provide power to, and communicate data with, a connected device as described with respect to FIG. **2**. Power source **180** of the vehicle may be any suitable power source for providing power to data bridge **110**, e.g., a battery, an alternator, an inverter, or a converter, without limitation. In some examples, power source **180** provides DC power, e.g., 12V DC power, without limitation.

[0027] Logic circuit **112** may process data signals received by transceiver **111** and may process data signals received from a connected device (not shown) to be transmitted by transceiver **111**, e.g., to communication network **190** of the vehicle. Logic circuit **112** may be implemented in any suitable manner, such as by a processor, microcontroller (MCU), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), a programmable logic device (PLD), state machine, reprogrammable logic or hardware, analog circuitry, digital circuitry, digital logic, instructions for execution by a processor, or any suitable combination thereof, without limitation. In some examples, logic circuit **112** may receive and process data from multiple sources.

[0028] Referring to FIG. **2**, there is provided an illustration of data link circuit **200**. Descriptions of like numbered elements as shown in FIG. **1** and previously described are not repeated for brevity. Data link circuit **200** may include data bridge **210**. Data bridge **210** may include transceiver **211** and logic circuit **212**. Transceiver **211** may be communicatively coupled to logic circuit **212** to transmit data signals between logic circuit **212** and transceiver **211**. Transceiver **211** may be electrically coupled to a first mechanical connection **250** of a first vehicle safety system of the vehicle via first electrical conductor **251**. First mechanical connection **250** may be electrically coupled to vehicle ground **170** via fourth electrical conductor **252**. Electrical conductors **251** and **252** and first mechanical connection **250** may provide a first electrical path to a ground of the vehicle such as vehicle ground **170**. Transceiver **211** may be electrically coupled to a second mechanical connection **260** of a second vehicle safety system of the vehicle via a second electrical conductor **261**, where the second vehicle safety system is separate from the first vehicle safety system. The second electrical conductor **261** and second mechanical connection **260** may provide a data link to communicate data with a communication network **190** of the vehicle via third electrical conductor **262**. In some examples, second electrical conductor **261** and second mechanical connection **260** may also provide a second electrical path for power delivery from a power source **180** of the vehicle. Data bridge **210** may also include power converter **213** electrically coupled to the second electrical conductor **261**. Power converter **213** may be electrically coupled to one or more peripheral devices, such as peripheral device **230**, to provide power to the one or more peripheral devices. Logic circuit **212** may be communicatively coupled to peripheral device **230** to communicate data with peripheral device **230**. Peripheral device **230** may include one or more sensors, e.g., weight sensor **230***a*, temperature sensor **230***b*, or oxygen (O2) sensor **230***c*, without limitation. In some examples, peripheral device may also include actuator **230***d*, audio circuit **230***e*, and security circuit **230***f*. Although one peripheral device **230** is shown in FIG. **2**, in some examples, additional peripheral devices may also be included.

[0029] Data bridge **210** may implemented similar to data bridge **110**, as described above with the addition of power converter **213**. Transceiver **211** may be implemented similar to transceiver **111**, as described above. Logic circuit **112** may implemented similar to logic circuit **112**, as described above. Electrical conductors **251**, **252**, **261**, and **262** may be implemented similar to electrical conductors **151**, **152**, **161**, and **162**, respectively, as described above. First mechanical connection **250** may be implemented similar to first mechanical connection **150**, as described above. Second mechanical connection **260** may be implemented similar to second mechanical connection **160**, as described above, and may provide a data link to communicate data with communication network **190** of the vehicle and deliver power to data bridge **210** from power source **180** of the vehicle. Data may be communicated through second mechanical connection **260** and electrical conductors **261** and **262** using a one-wire protocol, e.g., LIN or DC-LIN, without limitation.

[0030] Power converter **213** may be any suitable power converter to convert power received from a power source such as vehicle power source **180** at one voltage to another voltage. In some examples, power converter **213** may be a DC-DC power converter and may convert DC power at one voltage, e.g., 12V, to another DC voltage, e.g., 5V, 3.3 V, or 1.8V, without limitation. In other examples, power converter **213** may be an AC-DC power converter to convert AC power at one voltage, e.g., 120V, to a DC voltage, e.g., 12V, 5V, 3.3 V, or 1.8V, without limitation. In other examples, power converter **213** may be a DC-AC power converter (which may also refer to as an inverter) to convert DC power at one voltage to an AC voltage. In some examples, power converter **213** may provide power to one or more peripheral devices, such as peripheral device **230**. In some examples, peripheral device **230** may include an internal power source such as a battery (not shown). In some examples, power converter **213** may provide power at an appropriate voltage for other components of data bridge **210**, e.g., to logic circuit **212** as indicated by the dashed line between power converter **213** and logic circuit **212**, which may be used to electrically couple power converter **213** and logic circuit **212**.

[0031] In some examples, peripheral device **230** may be a portable computing device, e.g., a smart phone, a tablet, a laptop, without limitation. In some examples, peripheral device **230** may be used to monitor the health condition of an occupant of the vehicle. In some examples, peripheral device **230** may receive power from vehicle power source **180** and communicate data with vehicle communication network **190** via data bridge **210** of data link circuit **200**. In some examples, peripheral device **230** may include sensors, e.g., one or more of sensors **230***a*-**230***c*, to monitor a condition of an occupant (e.g., a person or an animal) of the vehicle. In some examples, as described with reference to FIG. **4**, peripheral device **230** may include a car seat to secure the occupant within the vehicle. In some examples, as described with reference to FIG. **5**, the occupant may be a pet and peripheral device **230** may include a pet tether to secure the occupant within the vehicle. Weight sensor **230***a* may be used to determine if an occupant is present in a seat of the vehicle. In some examples, a logic circuit such as logic circuit **212** may receive signals from weight sensor **230***a* and determine the signals indicate an occupant is present. A logic circuit such as logic circuit **212** may receive signals from temperature sensor **230***b* and determine the signals indicate the temperature of an occupant is outside of a normal healthy range, e.g, below 97° F. or above 100° F. for a human occupant. In some examples, temperature sensor **230***b* may be similarly used to determine if the temperature within the vehicle is above or below a threshold value indicating the occupant of the vehicle is in an unsafe condition. A logic circuit such as logic circuit **212** may receive signals from oxygen sensor **230***c* and determine the signals indicate the oxygen level of an occupant is outside of a normal healthy range. In some examples, oxygen sensor **230***c* may be similarly used to determine if the oxygen level within the vehicle is below a threshold value indicating the occupant of the vehicle is in an unsafe condition. In response to determining that an occupant is in a hazardous condition, a logic circuit such as logic circuit **212** may send a signal to actuator **230***d* to take corrective action. For example, actuator **230***d* may comprise a fan that may be activated to reduce the temperature condition of an occupant or an oxygen disperser that may be activated to increase the oxygen level in the vehicle, without limitation. Audio circuit **230***e* may include a microphone, a speaker, or a combination thereof. In some examples, a logic circuit such as logic circuit **212** may receive signals from audio circuit **230***e* and determine the signals indicate an occupant is present and whether the occupant is in audible distress. In some examples, audio circuit **230***e* may be used to communicate with the occupant or to provide an audible alert indicating to others that the occupant is in distress. In some examples, security circuit **230***f* may include data encryption and decryption features to provide data security during data communication with other components such as logic circuit **212**. Security circuit **230***f* may also include authentication features to authenticate connected components and prevent unauthorized use of data link circuit **200**. In some examples, peripheral device **230** may also include radio frequency (RF) interfaces to communicate with other components wirelessly, e.g., via Bluetooth, WiFi, cellular (e.g., GSM, 3G, 4G, 5G), without limitation. In some examples, peripheral device **230** may also include cable interfaces to communicate with other components via wired connections, e.g., serial or USB without limitation. In some examples, data bridge **210** may be separate from peripheral device **230**. In other examples, data bridge **210** may be integrated with peripheral device **230**.

[0032] In some examples, peripheral device **230** may include a logic circuit (not shown) separate from logic circuit **212** to receive signals from sensors (e.g., sensors **230***a*-**230***c*) and process those signals to determine information about the condition of an occupant and communicate that information to logic circuit **212**. In that situation, the optional logic circuit of peripheral device **230** may send processed signals to logic circuit **212** for further processing and potential corrective action. In some examples, logic circuit **212** may communicate data via transceiver **211**, electrical conductor **261**, second mechanical connection **260**, and electrical conductor **262** to communication network **190** of the vehicle. In some examples, the vehicle may include a logic circuit (not shown) separate from logic circuit **212** and the logic circuit of the vehicle may determine appropriate corrective actions, which may include activating an alert system of the vehicle as described below.

[0033] Referring to FIG. **3**, an illustration of mechanical connections to vehicle safety systems is provided. A vehicle may include a first safety system in the form of an ISOFIX system **355**. ISOFIX system **355** may include ISOFIX anchors **356** that may be used to make a mechanical connection such as first mechanical connections **150** and **250** as previously described. The vehicle may include a second safety system in the form of a seatbelt system **365**. Seatbelt system **365** may include seatbelt buckle **366** that may be used to make a mechanical connection, such as second mechanical connections **160** and **260** as previously described. In some examples, ISOFIX anchors **356** may be electrically coupled to a vehicle ground, such as vehicle ground **170**, via an electrical conductor, such as fourth electrical conductor **152**, as previously described. In some examples, seatbelt buckles **366** may be electrically coupled to a power source of the vehicle, such as vehicle power source **180**, via an electrical conductor such as third electrical conductor **162**, as previously described. In some examples, seatbelt buckles **366** may be communicatively coupled to a communication network of the vehicle, such as vehicle communication network **190**. In some examples, communicative coupling may be provided by an electrical conductor, such as third electrical conductor **162**, as previously described.

[0034] Referring to FIG. **4**, an illustration of peripheral device **430** is provided. Peripheral device **430** may be implemented similar to peripheral device **230**. Peripheral device **430** may comprise car seat **431**. Car seat **431** may include weight sensor **430***a*, temperature sensor **430***b*, oxygen sensor **430***c*, or any combination thereof. Weight sensor **430***a* may be implemented similar to weight sensor **230***a* as described above. Temperature sensor **430***b* may be implemented similar to temperature sensor **230***b* as described above. Oxygen sensor **430***c* may be implemented similar to oxygen sensor **230***c* as described above. Data bridge **410** may be implemented similar to data bridge **110** and **210** as previously described. First mechanical connection **450** may be implemented similar to first mechanical connection **150** and **250**, as described above. Second mechanical connection **460** may be implemented similar to second mechanical connection **160** and **260**, as described above, and may provide a data link to communicate data with communication network **190** of the vehicle and deliver power to data bridge **410** from power source **180** of the vehicle. Data may be communicated through second mechanical connection **460** using a one-wire protocol, e.g., LIN or DC-LIN, without limitation. In some examples, data bridge **410** may be separate from peripheral device **430**. In other examples, data bridge **410** may be integrated with peripheral device **430**. In some examples car seat **431** may be used to secure an occupant within the vehicle using first mechanical connection **450**, second mechanical connection **460**, or a combination thereof. Although car seat **431** is illustrated as a child car seat, in some examples, car seat **431** may be a passenger seat of the vehicle.

[0035] Referring to FIG. **5**, an illustration of peripheral device **530** is provided. Peripheral device **530** may be implemented similar to peripheral device **230**. Peripheral device **530** may comprise a pet tether **531**. Pet tether **531** may include temperature sensor **530***b* and oxygen sensor **530***c*, or any combination thereof. In some examples, pet tether **531** may include additional sensors. Temperature sensor **530***b* may be implemented similar to temperature sensor **230***b* as described above. Oxygen sensor **530***c* may be implemented similar to oxygen sensor **230***c* as described above. A first mechanical connection (not shown) may be implemented similar to first mechanical connection **150** and

250, as described above, which may include an ISOFIX connection. Second mechanical connection **560** may be implemented similar to second mechanical connection **160** and **260**, as described above, which may include a seatbelt connection. Pet tether **531** may comprise an electrical conductor woven into the pet tether fabric, or may be provided as a border on one or more edges of the pet tether fabric, without limitation, as described above in relation to third electrical conductor **162**. In some examples pet tether **531** may be used to secure an occupant within the vehicle, where the occupant is a pet. Pet tether **531** may be used to secure the pet using first mechanical connection **550**, second mechanical connection **560**, or a combination thereof.

[0036] Referring to FIG. **6**, an illustration of a data link system **600** is provided. Descriptions of like numbered elements as shown in FIG. **1** and previously described are not repeated for brevity. Data link system **600** may include a first data bridge **610**. First data bridge **610** may include a first transceiver **611** and a first logic circuit **612**. First transceiver **611** may be communicatively coupled to logic circuit **612** to transmit data signals between logic circuit **612** and first transceiver **611**. First transceiver **611** may be electrically coupled to a first mechanical connection **650** of a first vehicle safety system of the vehicle via first electrical conductor **651**. First mechanical connection **650** may be electrically coupled to vehicle ground **170** via fourth electrical conductor **652**. Electrical conductors **651** and **652** and first mechanical connection **650** may provide a first electrical path to a ground of the vehicle such as vehicle ground **170**. First transceiver **611** may be electrically coupled to a second mechanical connection **660** of a second vehicle safety system of the vehicle via a second electrical conductor **661**, where the second vehicle safety system is separate from the first vehicle safety system. Second mechanical connection **660** may be electrically coupled a second data bridge **620** via a third electrical conductor **662**. Second data bridge **620** may include a second transceiver **621** and a second logic circuit **622**. The second electrical conductor **661**, second mechanical connection **660**, and third electrical conductor **662** may provide a data link to communicate data with a communication network **190** of the vehicle via second data bridge **620**. In some examples, second electrical conductor **661**, second mechanical connection **660**, and third electrical conductor **662** may also provide a second electrical path for power delivery from a power source **180** of the vehicle via second data bridge **620**.

[0037] First and second data bridges **610** and **620** may be respectively implemented similar to data bridges **110**, **210**, and **410**, as described above. First and second transceivers **611** and **621** may be respectively implemented similar to transceivers **111** and **211**, as described above. First and second logic circuits **612** and **622** may be respectively implemented similar to logic circuits **112** and **212**, as described above. Electrical conductor **651** may be implemented similar to electrical conductors **151** and **251**, as described above. Electrical conductor **652** may be implemented similar to electrical conductors **152** and **252**, as described above. Electrical conductor **661** may be implemented similar to electrical conductors **161** and **261**, as described above. Electrical conductor **662** may be implemented similar to electrical conductors **162** and **262**, as described above. First mechanical connection **650** may be implemented similar to first mechanical connections **150**, **250**, and **450**, as described above. Second mechanical connection **660** may be implemented similar to second mechanical connections **160**, **260**, **460**, and **560**, as described above, and may provide a data link to communicate data with communication network **190** of the vehicle and deliver power to first data bridge **610** from power source **180** of the vehicle via second data bridge **620**.

[0038] Data link system **600** may include two data bridges, **610** and **620**, on either side of second mechanical connection **660**. Second data bridge **620** may be electrically coupled to vehicle power source **180**. Second data bridge **620** may be communicatively coupled to vehicle communication network **190**. Second transceiver **621** may communicate data with first transceiver **611** and deliver power to first transceiver **611** through second mechanical connection **660** using a one-wire connection and protocol, e.g., LIN or DC-LIN, without limitation. Second data bridge **620** may receive power from vehicle power source **180** of the vehicle. In some examples, second transceiver **621** may receive power directly from vehicle power source **180** and deliver power to first transceiver **611** via second mechanical connection **660**. In some examples, second data bridge **620** may include a power converter (not shown) that may convert power received from vehicle power source **180** from a first voltage level to a second voltage level before transceiver **621** receives power. Second transceiver **621** may then deliver power at the second voltage to first transceiver **611** via second mechanical connection **660**. The optional power converter for data bridge **620** may be implemented similar to power convert **213** as described above.

[0039] Referring to FIG. **7**, an illustration of data link system **700** is provided. Descriptions of like numbered elements as shown in FIG. **1** and previously described are not repeated for brevity. Data link system **700** may include a first data bridge **710** and second data bridge **720**. First data bridge **710** may include a first transceiver **711** and a first logic circuit **712**. First transceiver **711** may be communicatively coupled to first logic circuit **712** to transmit data signals between first logic circuit **712** and first transceiver **711**. First transceiver **711** may be electrically coupled to a first mechanical connection **750** of a first vehicle safety system of the vehicle, e.g., an ISOFIX connection of an ISOFIX system, via first electrical conductor **751**. First mechanical connection **750** may be electrically coupled to vehicle ground **170** via fourth electrical conductor **752**. Electrical conductors **751** and **752** and first mechanical connection **750** may provide a first electrical path to a ground of the vehicle such as vehicle ground **170**. First transceiver **711** may be electrically coupled to a second mechanical connection **760** of a second vehicle safety system of the vehicle, e.g., a seatbelt connection of a seatbelt system, via a second electrical conductor **761**, where the second vehicle safety system is separate from the first vehicle safety system. Second mechanical connection **760** may be electrically coupled a second data bridge **720** via a third electrical conductor **762**. Second data bridge **720** may include a second transceiver **721** and a second logic circuit **722**. The second electrical conductor **761**, second mechanical connection **760**, and third electrical conductor **762** may provide a data link to communicate data with a communication network **190** of the vehicle via second data bridge **720**. In some examples, second electrical conductor **761**, second mechanical connection **760**, and third electrical conductor **762** may also provide a second electrical path for power delivery from a power source **180** of the vehicle via second data bridge **720**.

[0040] First data bridge **710** may include first power converter **713** electrically coupled to the second electrical conductor **761**. First power converter **713** may be electrically coupled to one or more peripheral devices, such as peripheral device **730**, to provide power to the one or more peripheral devices. First logic circuit **712** may be communicatively coupled to peripheral device **730** to communicate data with peripheral device **730**. Peripheral device **730** may include one or more sensors, e.g., weight sensor **730***a*, temperature sensor **730***b*, or oxygen (O2) sensor **730***c*, without limitation. In some examples, peripheral device may also include actuator **730***d*, audio circuit **730***e*, and security circuit **730***f*. Although one peripheral device **730** is shown in FIG. **7**, in some examples, additional peripheral devices may also be included. Second data bridge **720** may include a second power converter **723** that may convert power received from vehicle power source **180** from a first voltage level to a second voltage level, which power at the second voltage level may be provided to second transceiver **721**. Second transceiver **721** may then deliver power at the second voltage to first transceiver **711** via second mechanical connection **760**.

[0041] First data bridge **710** and second data bridge **720** may be respectively implemented similar to data bridges **110**, **210**, **410**, **610**, and **620**, as described above. First and second transceivers **711** and **721** may be respectively implemented similar to transceivers **111**, **211**, **611**, and **621**, as described above. First and second logic circuits **712** and **722** may be respectively implemented similar to logic circuits **112**, **212**, **612**, and **622**, as described above. Electrical conductor **751** may be implemented similar to electrical conductors **151**, **251**, and **651**, as described above. Electrical conductor **752** may be implemented similar to electrical conductors **152**, **252**, and **652**, as described above. Electrical conductor **761** may be implemented similar to electrical conductors **161**, **261**, and **661**, as described above. Electrical conductor **762** may be implemented similar to electrical conductors **162**, **262**, and **662**, as described above. First mechanical connection **750** may be implemented similar to first mechanical connections **150**, **250**, **450**, and **650**, e.g., as an ISOFIX connection, as described above. Second mechanical connection **660** may be implemented similar to second mechanical connections **160**, **260**, **460**, **560**, and **660**, as described above, e.g., via a seatbelt, and may provide a data link to communicate data with communication network **190** of the vehicle and deliver power to first data bridge **710** from power source **180** of the vehicle via second data bridge **720**. Data may be communicated through second mechanical connection **760** using a one-wire protocol, e.g., LIN or DC-LIN, without limitation. Peripheral device **730** may be implemented similar to peripheral devices **230**, **430**, and **530**, as previously described. Components **730***a*-**730***f* may be respectively implemented similar to components **230***a*-**230***f*, as previously described.

[0042] Data link system **700** may include a third logic circuit **742** of the vehicle communicatively coupled to vehicle communication network **190**. Third logic circuit **742** may be implemented in any suitable manner, such as by a processor, microcontroller (MCU), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), a programmable logic device (PLD), state machine, reprogrammable logic or hardware, analog circuitry, digital circuitry, digital logic, instructions for execution by a processor, or any suitable combination thereof, without limitation. Data link system **700** may include alert system **740** of the vehicle, which may be used to provide alerts or take other corrective actions in response to signals received from either second logic circuit **722** or third logic circuit **742** via vehicle communication network **190**. Vehicle alert system **740** may include various vehicle subsystems, e.g., headlights **740***a*, horn **740***b*, door locks **740***c*, windows **740***d*, wireless communication system **740***e*, and alarm system **740***f*, without limitation. Wireless communication system **740***e* may be a standalone communication system or part of a vehicles emergency assistance system such as OnStar, without limitation. Wireless communication system **740***e* may be used to notify an owner of the vehicle or emergency services. Wireless communication system **740***e* may use wireless communication protocols, e.g., WiFi, Bluetooth, or cellular. Alarm system **740***f* may be a part of a vehicle security system, e.g., a theft protection system.

[0043] An example operation of data link system **700** is provided for a scenario where a child has been left unattended in a vehicle and is experiencing a hazardous condition. For this example, peripheral device **730** may include a car seat and may be implemented similar peripheral device **430** including car seat **431**, as previously described, where sensors **730***a*, **730***b*, and **730***c* correspond to sensors **430***a*, **430***b*, and **430***c*, respectively. As an example, first logic circuit **712** may receive a signal, e.g., from weight sensor **730***a* indicating that an occupant is in the car seat. In some examples, first logic circuit **712** may receive a first signal from temperature sensor **730***b* indicating that the temperature inside the vehicle has exceeded a threshold value, e.g., 80° F., 90° F., or 100° F., without limitation. As another example, first logic circuit **712** may receive a first signal from temperature sensor **730***b* indicating that the body temperature of the occupant has exceeded a threshold value, e.g., 100° F., without limitation. As another example, logic circuit **712** may receive a signal, e.g., from oxygen sensor **730***c* indicating that an oxygen level (e.g., oxygen level of the occupant or inside the vehicle) is below a threshold value. First logic circuit **712** may process the first signal to develop a second signal for transmission via the second mechanical connection **760** which may provide a data link to vehicle communication network **190**. First logic circuit **712** may communicate the second signal to first transceiver **711**. First transceiver **711** may use a one-wire protocol to communicate the second signal through second mechanical connection **760** of the second safety system of the vehicle, which may be a seatbelt connection of a seatbelt system. The seatbelt system may be implemented similar to seatbelt system **365**, as previously described. The second signal may be received by second transceiver **721** and communicated to second logic circuit **722**. Second logic circuit **722** may process the second signal to develop a third signal to indicate to third logic circuit **742** that an alert system of the vehicle is to be activated. Second logic circuit **722** may communicate the third signal to third logic circuit **742** via vehicle communication network **190**. Third logic circuit **742** may process the third signal to determine which components of vehicle alert system **740** to activate. Third logic circuit **742** may then activate components of the vehicle alert system **740**. For example, third logic circuit **742** may cause the headlights **740***a* to flash, the horn **740***b* to blow, the windows

740*d* to roll down, the doors **740***c* to unlock, the alarm system **740***f* to activate, or any combination thereof. Third logic circuit **742** may also initiate communication via wireless communication system **740***e*, with an owner or operator of the vehicle to alert them of the presence of an occupant and the potentially hazardous conditions within the vehicle (e.g., high or low temperature, low oxygen level, without limitation). In some example, third logic circuit **742** may initiation communication with emergency services (e.g., 911 services) and may provide information regarding the detected hazardous condition and the location of the vehicle. In some examples, third logic circuit **742** may perform functions of second logic circuit **722**, e.g., processing the second signal to develop the third signal to indicate an alert system of the vehicle to be activated. In some examples, logic circuit **712** may initiate an alert, e.g., via audio circuit **730***e*, and may take corrective actions, e.g., via actuator **730***d*. In this manner, data link system **700** may be used to monitor the condition of an occupant of a vehicle and alert others and take corrective actions if it is determined the occupant may be in a hazardous condition.

[0044] Referring to FIG. **8**, a flowchart is provided of an example method **800** for using a data link circuit (e.g., data link circuit **100** or **200**) or a data link system (e.g., data link system **600** or **700**) in accordance with the present disclosure. In some examples, the method **800** may be executed with more or fewer operations than shown in FIG. **8**, and the operations shown in FIG. **8** may be optionally omitted, repeated, performed in a different order, performed in parallel, or recursively.

[0045] At **805**, a first logic circuit may receive a first signal from a peripheral device. At **810**, the first logic circuit may process the first signal to develop a second signal. At **815**, the first logic circuit may communicate the second signal to a one-wire transceiver. At **820**, the first one-wire transceiver may transmit, using a one-wire protocol (e.g., LIN or DC-LIN, without limitation), the second signal via a mechanical connection of a vehicle safety system (e.g., a seatbelt connection of a seatbelt system). At **825**, the second signal may be received by a second one-wire transceiver via the mechanical connection of the vehicle safety system.

[0046] Referring to FIG. **9**, a flowchart is provided of an example method **900** for using a data link circuit (e.g., data link circuit **100** or **200**) or a data link system (e.g., data link system **600** or **700**) in accordance with the present disclosure. In some examples, the method **900** may be executed with more or fewer operations than shown in FIG. **9**, and the operations shown in FIG. **8** may be optionally omitted, repeated, performed in a different order, performed in parallel, or recursively.

[0047] Blocks **905-925** of method **900** respectively correspond to blocks **805-825** of method **800** as described above and are not repeated for brevity. At **930**, the second one-wire transceiver may communicate the received second signal to a second logic circuit. At **935**, the second logic circuit may process the second signal to develop a third signal to indicate an alert system of the vehicle to be activated. At **940**, the third signal may be communicated to a third logic circuit via a communication network of the vehicle. At **945**, the third signal may be received by the third logic circuit. At **950**, the third signal may be processed by the third logic circuit to determine which alert system of the vehicle to activate. At **955**, the alert system may be activated, and may include flashing headlights, honking horn, activating windows, activating alarm system, wireless communication system, or a combination thereof.

[0048] While the present disclosure has been described herein with respect to certain illustrated examples, those of ordinary skill in the art will recognize and appreciate that the present invention is not so limited. Rather, additions, deletions, and modifications to the illustrated and described examples may be made without departing from the spirit and scope of the present disclosure and aspects hereinafter claimed along with their legal equivalents. In addition, features from one example may be combined with features of another example while still being encompassed within the scope of the present disclosure as contemplated and described.

What is claimed is:

1. A device comprising:

a transceiver;

a first logic circuit electrically coupled to the transceiver;

a first electrical conductor electrically coupled to the transceiver and to a first mechanical connection of a first vehicle safety system of a vehicle, the first mechanical connection to provide a first electrical path to a ground of the vehicle; and

a second electrical conductor electrically coupled to the transceiver and to a second mechanical connection of a second vehicle safety system of the vehicle, the second vehicle safety system separate from the first vehicle safety system, the second mechanical connection to provide a data link to communicate data with a communication network of the vehicle.

2. The device of claim **1**, wherein the second mechanical connection provides a second electrical path for power delivery from a power source of the vehicle, comprising a power converter electrically coupled to the second electrical conductor, the power converter to convert power received via the second electrical path at a first voltage to a second voltage.

3. The device of claim **2**, wherein the power converter is a DC-to-DC converter to provide DC power at the second voltage to one or more peripheral devices electrically coupled to the power converter.

4. The device of claim **1**, comprising one or more peripheral devices communicatively coupled to the first logic circuit, the one or more peripheral devices comprise one or more sensors to monitor a condition of an occupant of the vehicle.

5. The device of claim **4**, wherein the one or more sensors comprise a weight sensor, a temperature sensor, an oxygen sensor, or a combination thereof.

6. The device of claim **4**, wherein the one or more peripheral devices comprise a car seat to secure the occupant within the vehicle via the first mechanical connection, the second mechanical connection, or a combination thereof.

7. The device of claim **4**, wherein:

the occupant is a pet; and

the one or more peripheral devices comprise a pet tether to secure the pet within the vehicle via the first mechanical connection, the second mechanical connection, or a combination thereof.

8. The device of claim **3**, wherein the one or more peripheral devices comprise a portable computing device.

9. The device of claim **1**, wherein:
the first mechanical connection comprises an ISOFIX connection;
the first safety system is an ISOFIX system;
the second mechanical connection comprises a seatbelt connection; and
the second safety system is a seatbelt system.

10. The device of claim **1**, wherein the transceiver utilizes a one-wire communication protocol to communicate data via the data link of the second mechanical connection.

11. The device of claim **10**, wherein the one-wire communication protocol is a local interconnect network protocol.

12. A method comprising:
receiving by a first logic circuit a first signal from a peripheral device;
processing by the first logic circuit the first signal to develop a second signal;
communicating the second signal to a first one-wire transceiver;
transmitting with a one-wire communication protocol the second signal via a mechanical connection of a first safety system of a vehicle; and
receiving by a second one-wire transceiver the second signal via the mechanical connection.

13. The method of claim **12**, comprising:
communicating the received second signal to a second logic circuit; and
processing by the second logic circuit the second signal to develop a third signal, the third signal to indicate an alert system of the vehicle to be activated.

14. The method of claim **13**, comprising:
communicating the third signal to a third logic circuit via a communication network of the vehicle;
receiving by the third logic circuit the third signal;
processing by the third logic circuit the third signal to determine the alert system of the vehicle to be activated;
activating the alert system of the vehicle.

15. The method of claim **13**, wherein the alert system of the vehicle comprises a headlight, a horn, a window, an alarm system, a wireless communication system, or a combination thereof.

16. A system comprising:
a first data bridge comprising a first transceiver and a first logic circuit;
a first mechanical connection electrically coupled to the first data bridge and a vehicle ground via a first vehicle safety system of a vehicle;
a second data bridge comprising a second transceiver and a second logic circuit, the second data bridge electrically coupled to a power source of the vehicle and communicatively coupled to a communication network of the vehicle; and
a second mechanical connection electrically coupled to the first data bridge and the second data bridge via a second vehicle safety system of the vehicle separate from the first vehicle safety system, the second mechanical connection to provide an electrical path for power delivery from the power source of the vehicle and a data link for data communication with the communication network of the vehicle via the second data bridge.

17. The system of claim **16**, wherein:
the first mechanical connection comprises an ISOFIX connection;
the first safety system is an ISOFIX system;
the second mechanical connection comprises a seatbelt connection; and
the second safety system is a seatbelt system.

18. The system of claim **16**, comprising one or more sensors communicatively coupled to the first logic circuit of the first data bridge to monitor the physical condition of an occupant of the vehicle.

19. The system of claim **18**, comprising:
a third logic circuit of the vehicle communicatively coupled to the communication network of the vehicle; and
an alert system of the vehicle communicatively coupled to the third logic circuit.

20. The system of claim **18**, wherein the alert system of the vehicle comprises a headlight, a horn, a window, an alarm system, a wireless messaging system, or a combination thereof.

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