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(54) **SYSTEMS AND METHODS FOR PROVIDING AN ELECTRONICS HOUSING WITH WIRELESS COVERAGE IN OPPOSITE DIRECTIONS**

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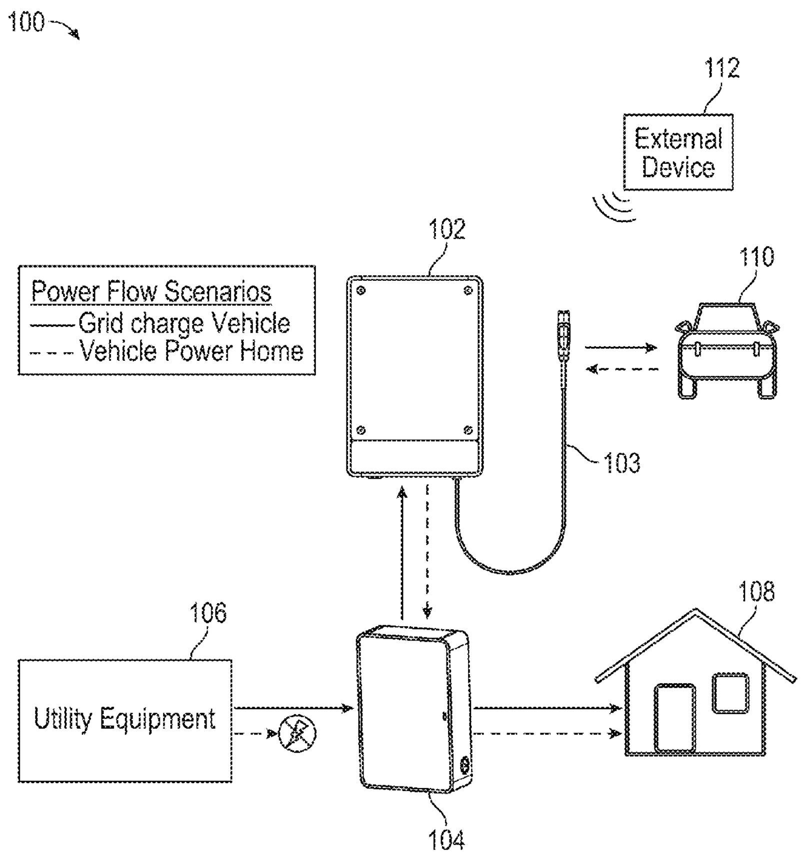
(57) **ABSTRACT**

An apparatus includes an electronics housing having a bottom and a side that at least partially form a cavity having an opening. An electronics housing cover is coupled to the electronics housing and at least partially covers the opening of the cavity. A portion of the electronics housing cover extends beyond the side of the electronics housing. A first antenna is disposed adjacent to the bottom and external to the cavity of the electronics housing. A second antenna is disposed adjacent to the side and external to the cavity of the electronics housing. A first signal passing in a first direction is capable of being received at the second antenna without passing through the electronics housing and is not capable of being received at the first antenna without passing through the electronics housing. A second signal passing in a second direction opposite the first direction is capable of being received at the first antenna without passing through the electronics housing.



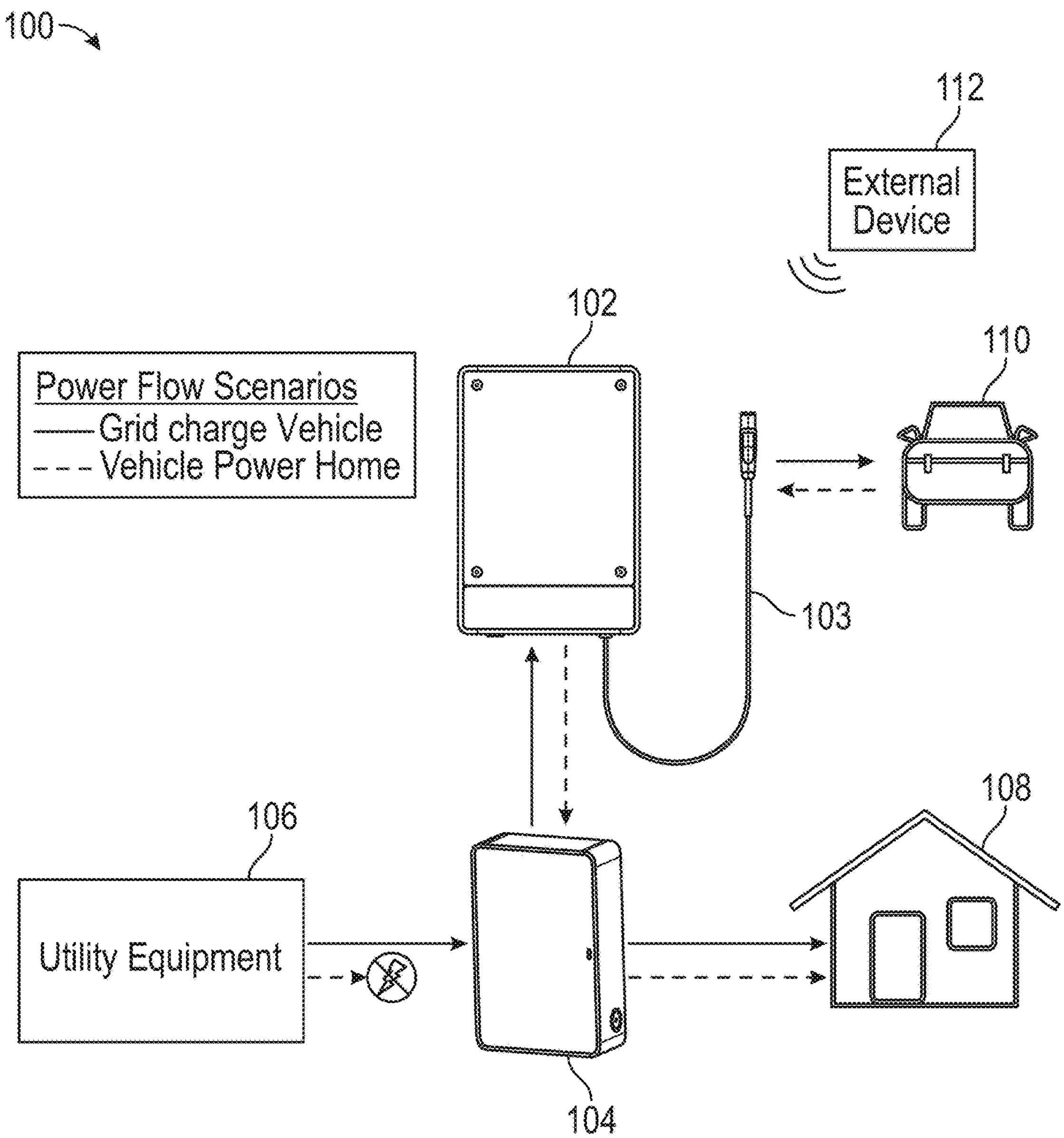

100
112
External Device
102
110
Power Flow Scenarios
Grid charge Vehicle
Vehicle Power Home
103
106
108
Utility Equipment
104

FIG. 1

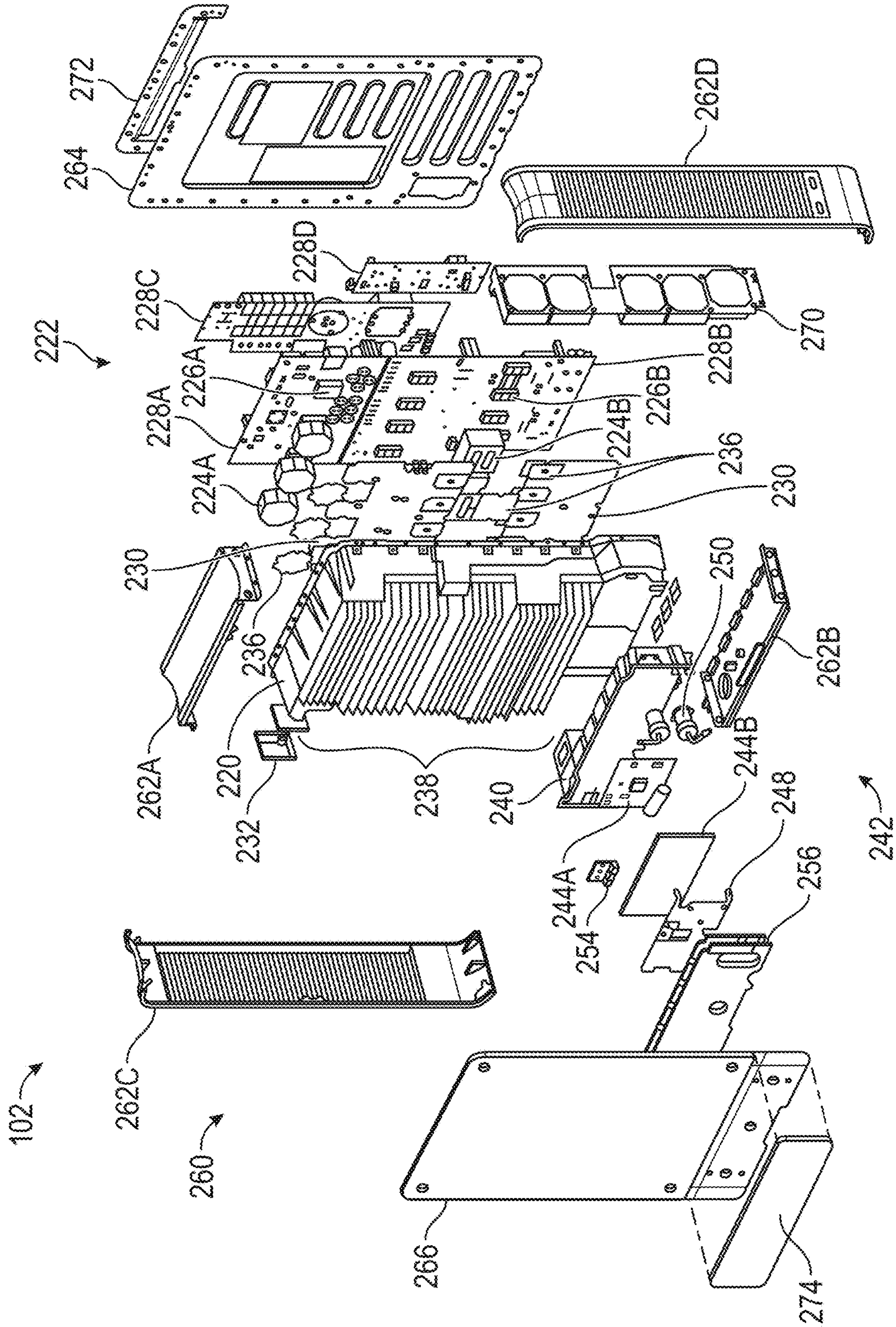

102
260
262C
262A
220
232
238
240
236
230
224A
228A
226A
222
228C
228D
264
272
262D
270
228B
226B
224B
236
230
250
262B
244B
244A
254
248
256
242
266
274

FIG. 2

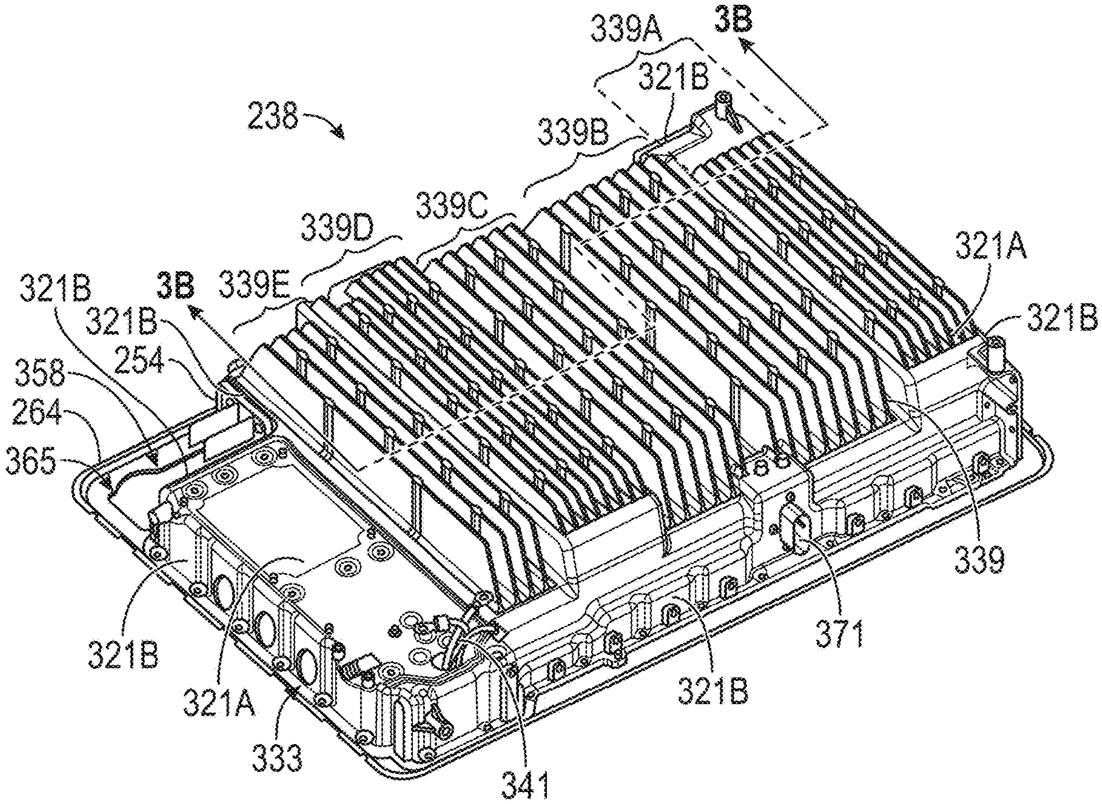

3B
339A
321B
238
339B
339C
339D
339E
3B
321B
321B
254
358
264
365
321A
321B
339
371
321B
321B
321A
333
341

FIG. 3A

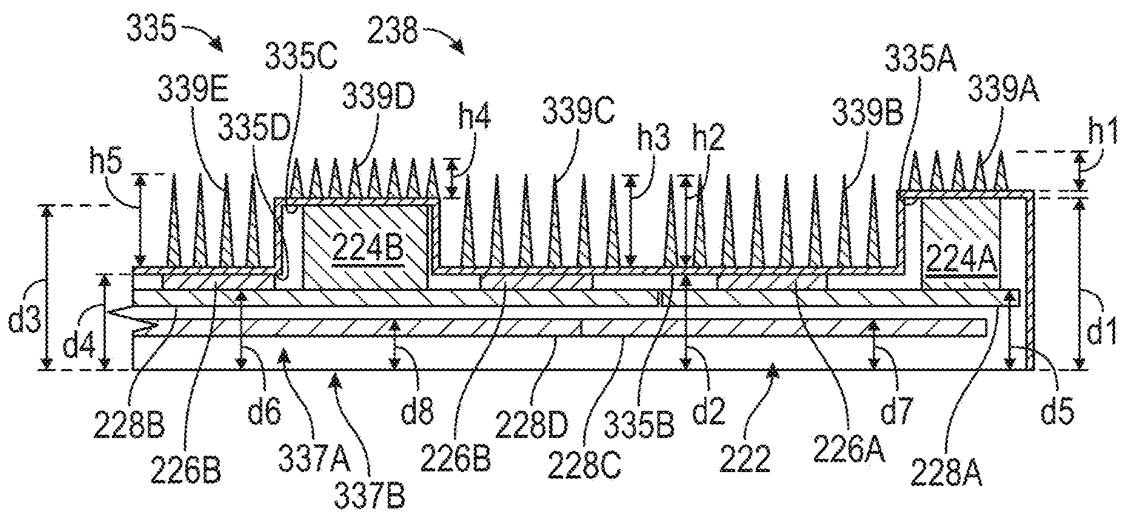

335
238
335C
335A
339E
339D
339C
339B
339A
335D
h4
h3
h2
h1
h5
224B
224A
d3
d4
d1
228B
d6
d8
228D
335B
d2
d7
d5
226B
337A
226B
228C
222
226A
228A
337B

FIG. 3B

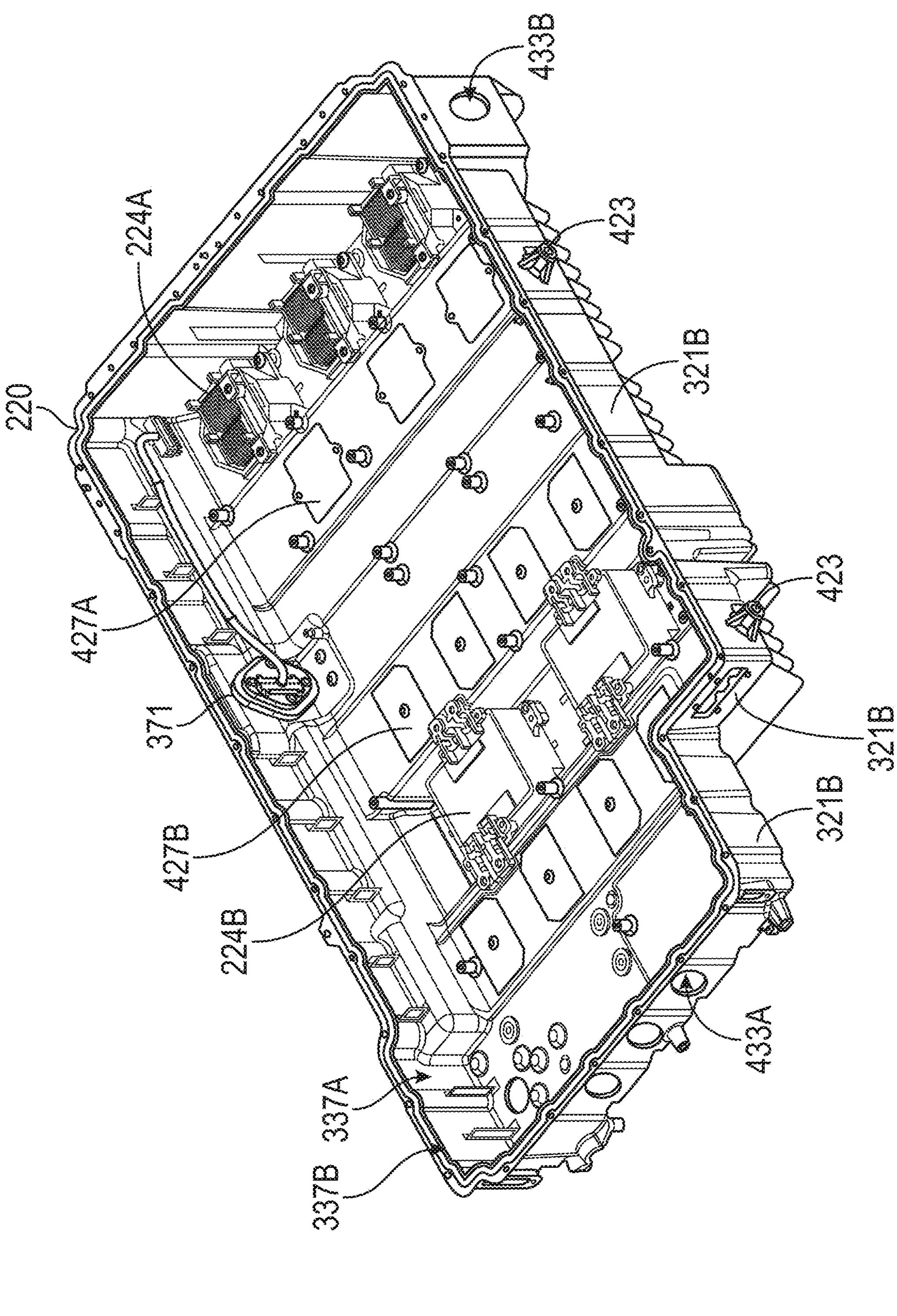

433B
224A
423
220
321B
427A
423
371
321B
427B
321B
224B
433A
337A
337B

FIG. 4A

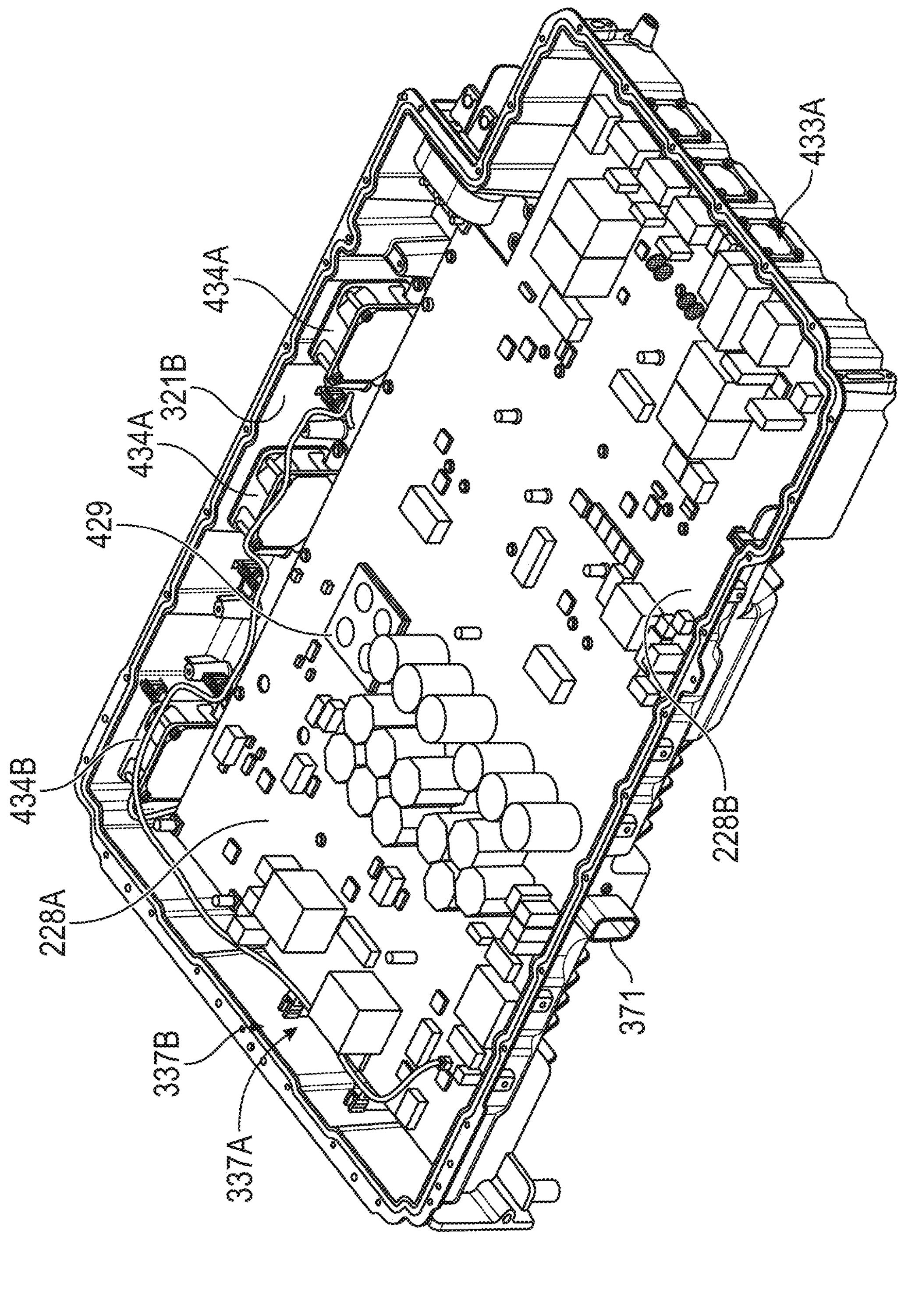


FIG. 4B

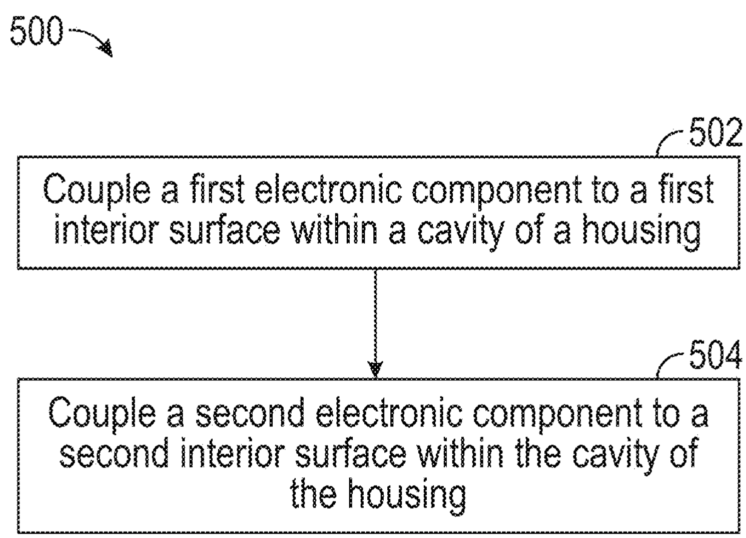

500
502
Couple a first electronic component to a first interior surface within a cavity of a housing
504
Couple a second electronic component to a second interior surface within the cavity of the housing

FIG. 5

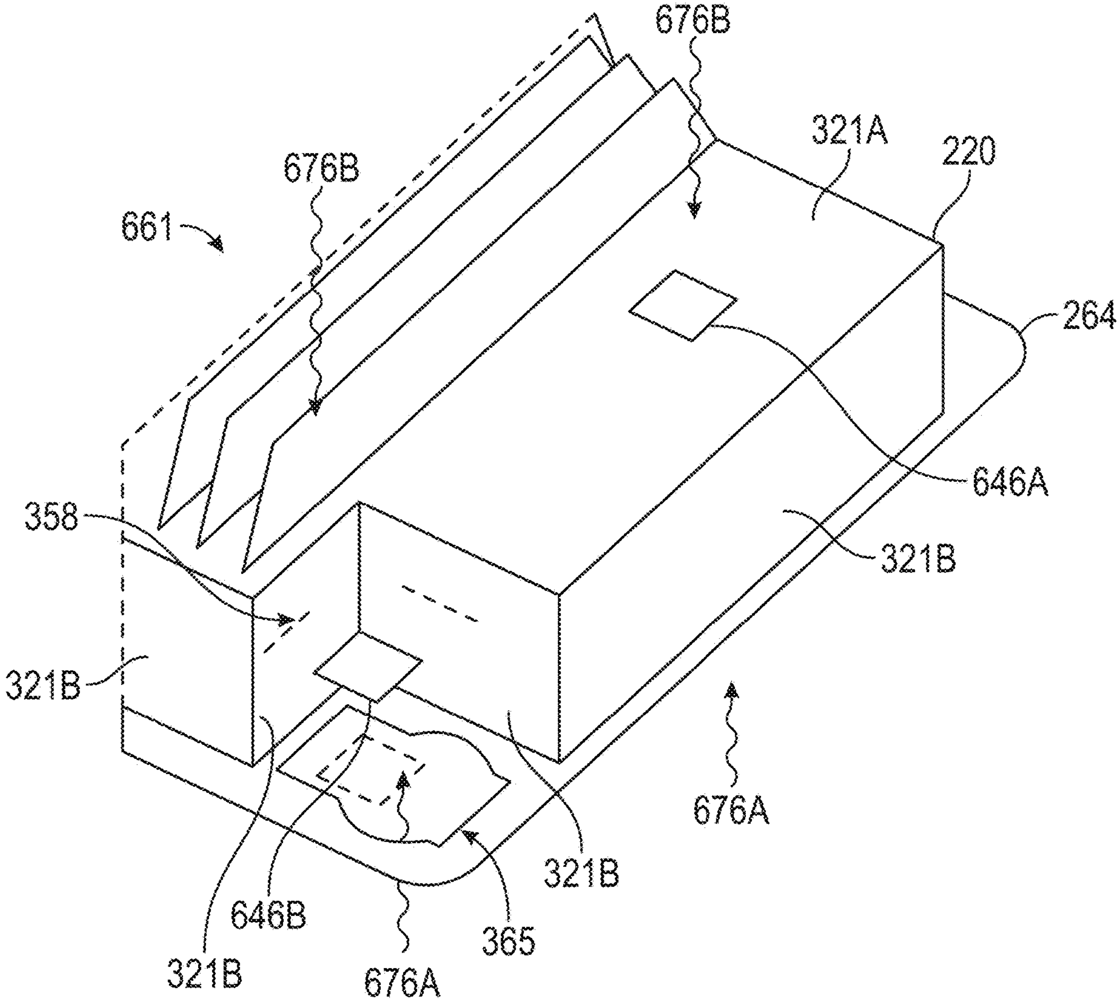

676B
676B
321A
220
661
264
646A
358
321B
321B
321B
676A
321B
646B
365
321B
676A

FIG. 6A

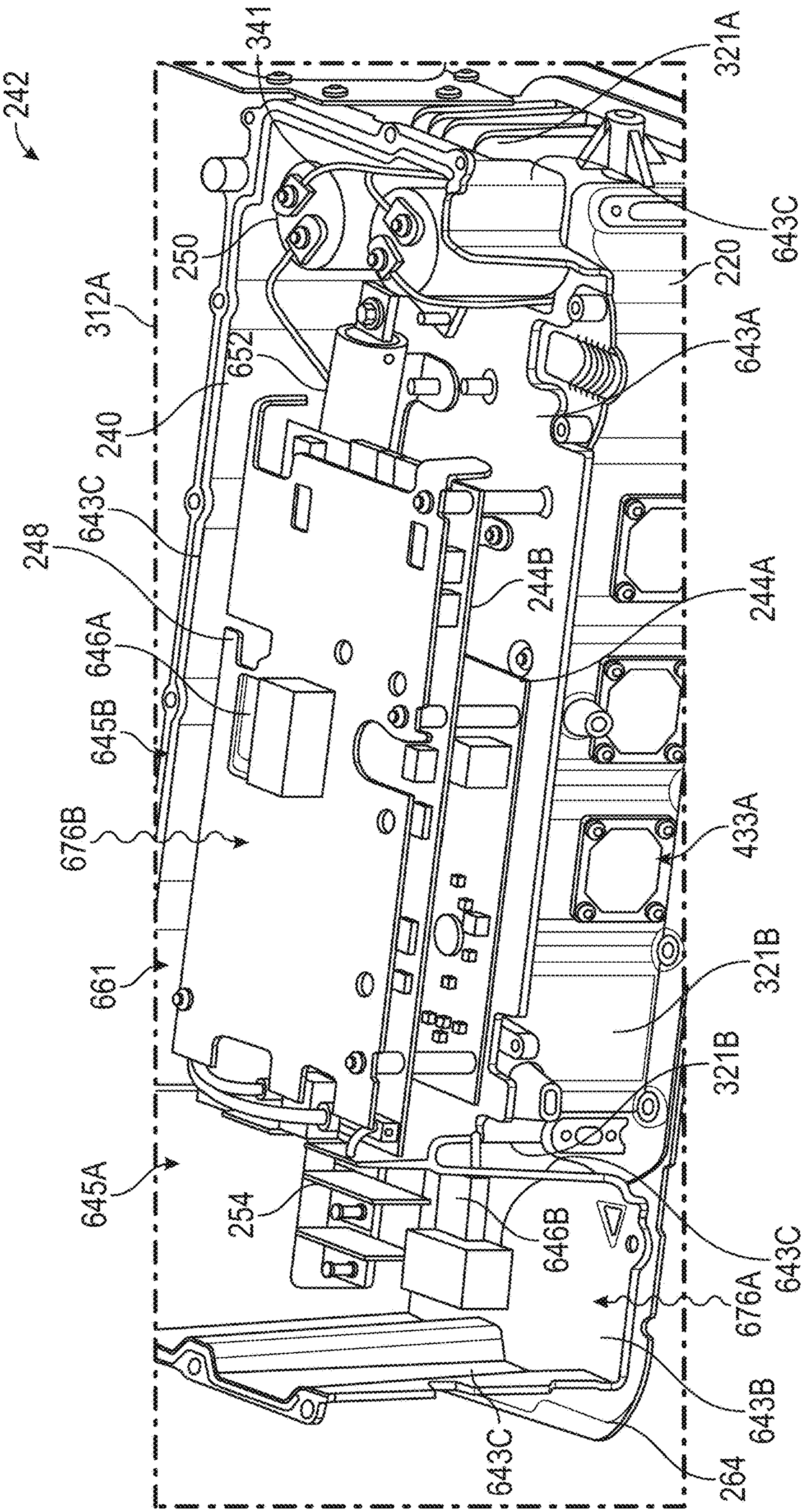

242
341
321A
250
312A
643C
220
652
643A
240
643C
248
244B
646A
244A
645B
676B
433A
661
321B
321B
645A
254
646B
643C
676A
643C
643B
264

FIG. 6B

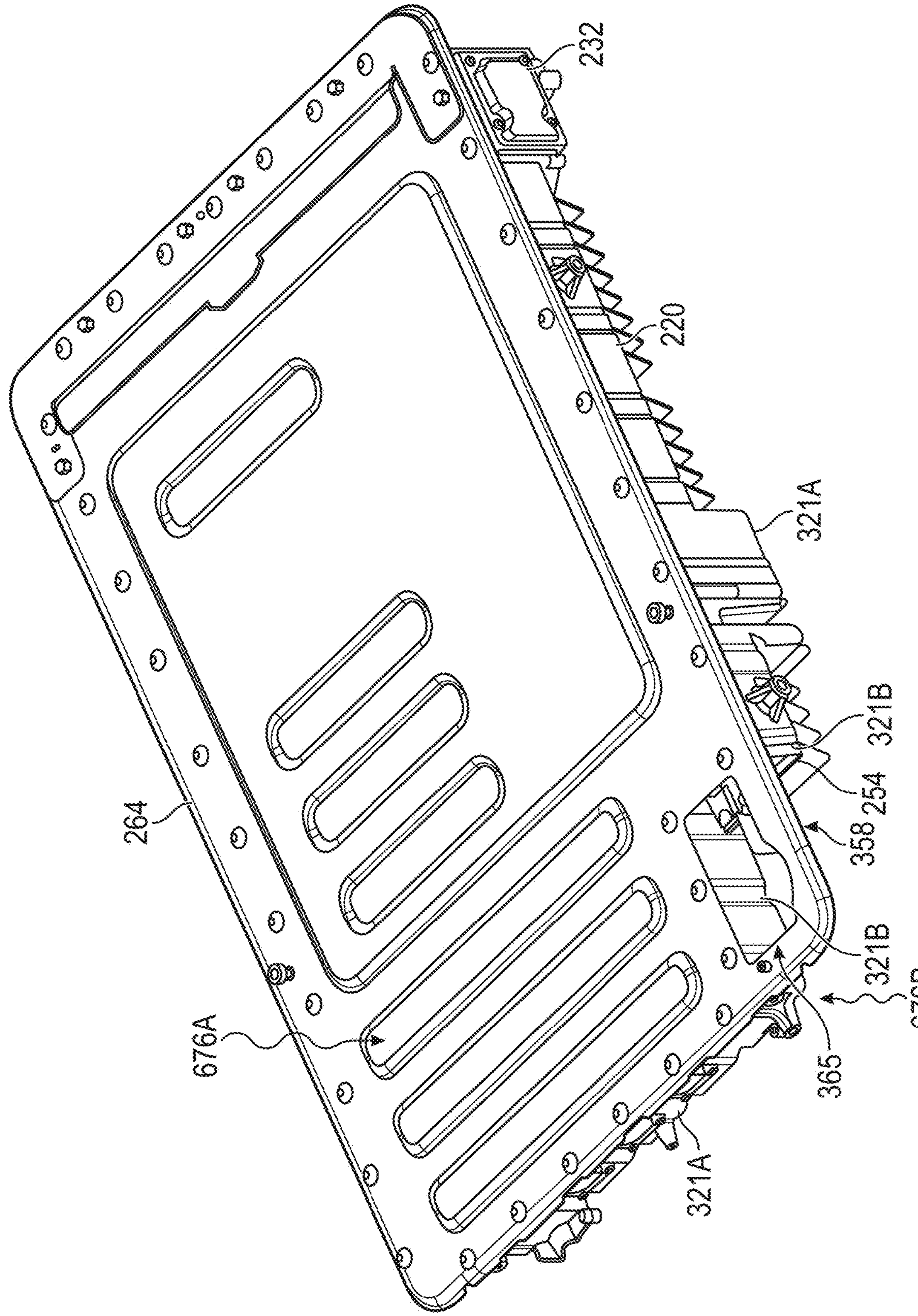


FIG. 7A

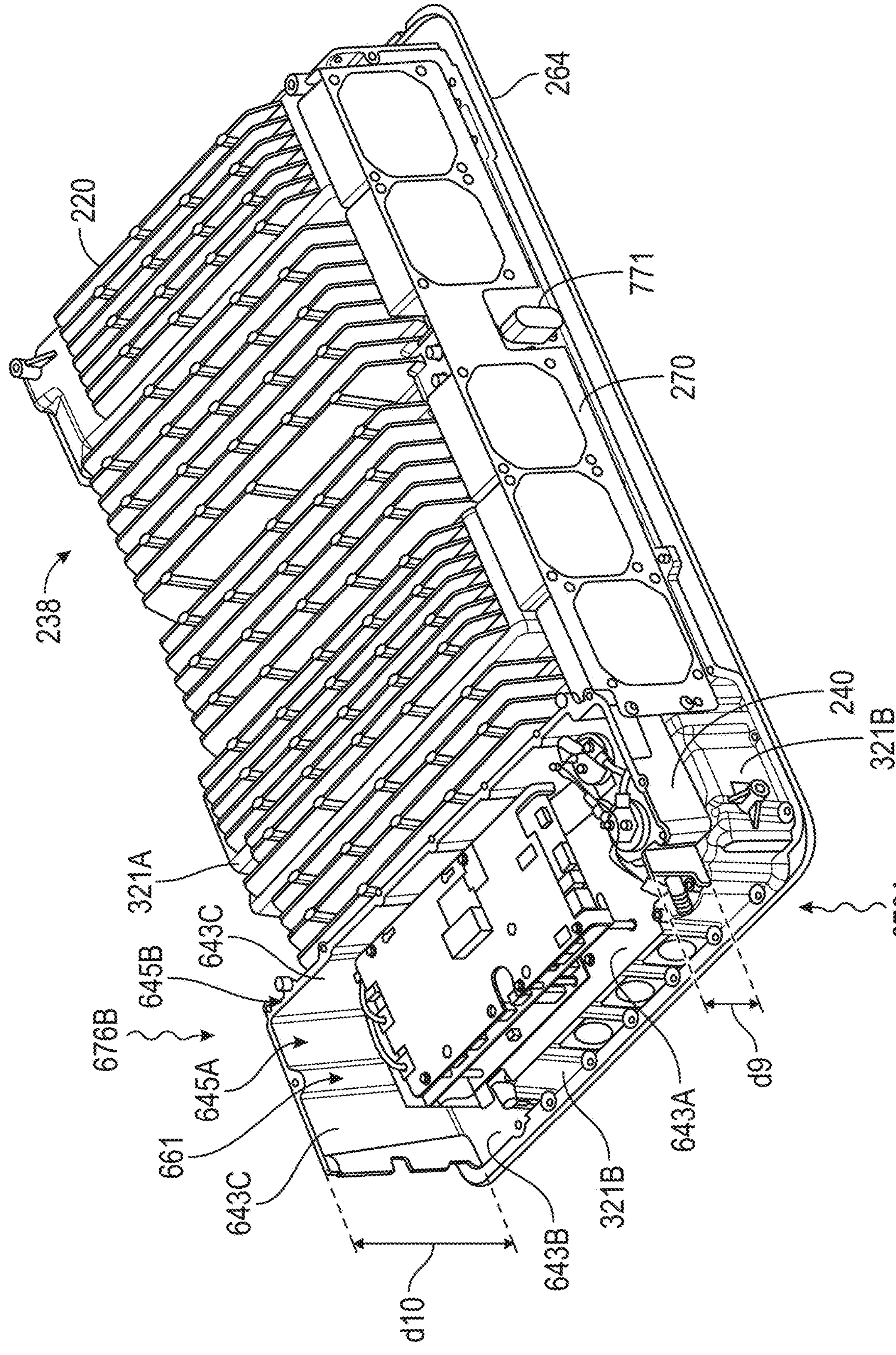

264
220
771
270
238
240
321B
321A
643C
645B
676A
676B
645A
661
643C
643A
d9
321B
643B
d10

FIG. 7B

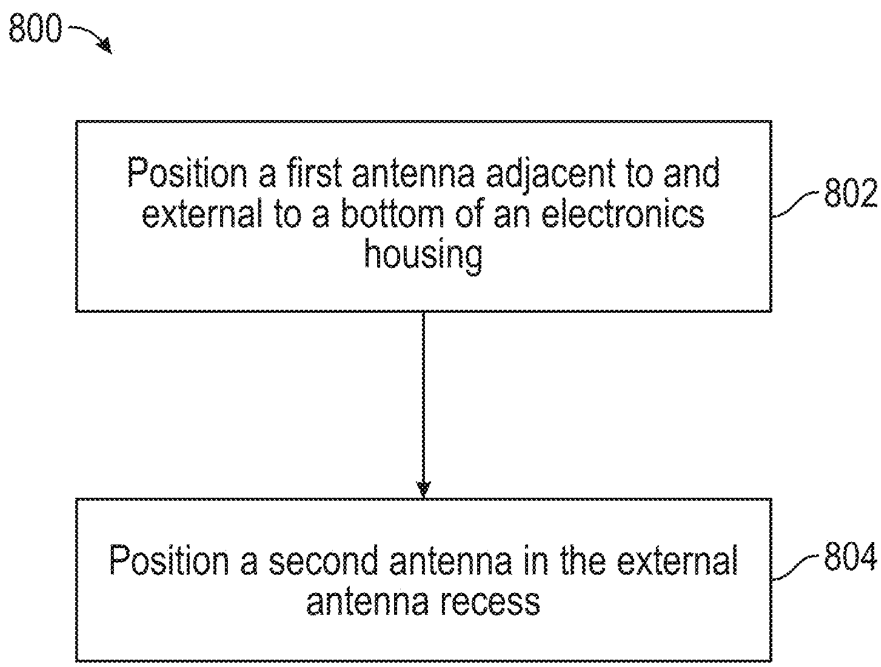

800
Position a first antenna adjacent to and external to a bottom of an electronics housing
802
Position a second antenna in the external antenna recess
804

FIG. 8

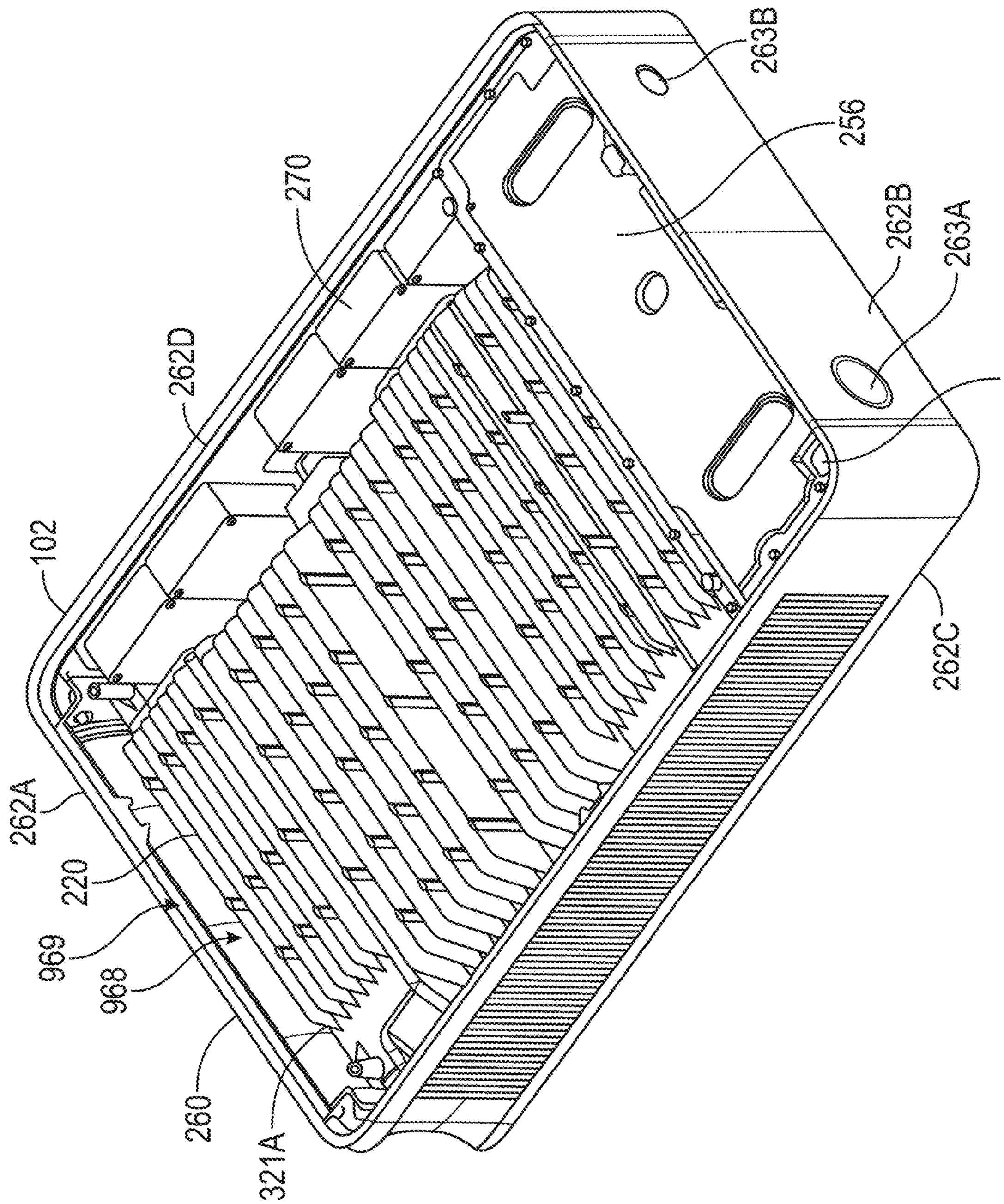

102
262A
220
969
968
260
321A
270
262D
256
263B
262B
263A
240
262C

FIG. 9

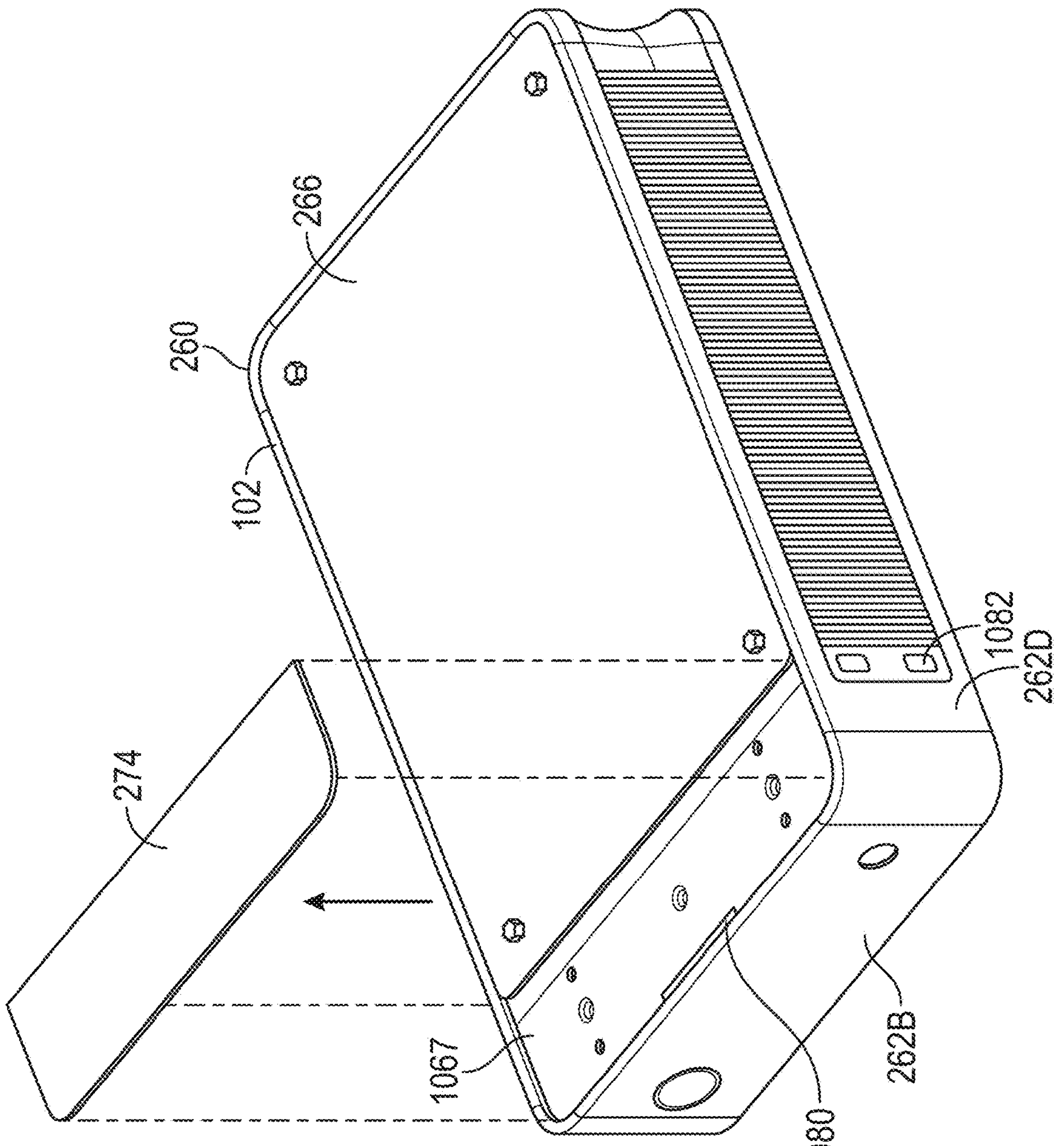


FIG. 10

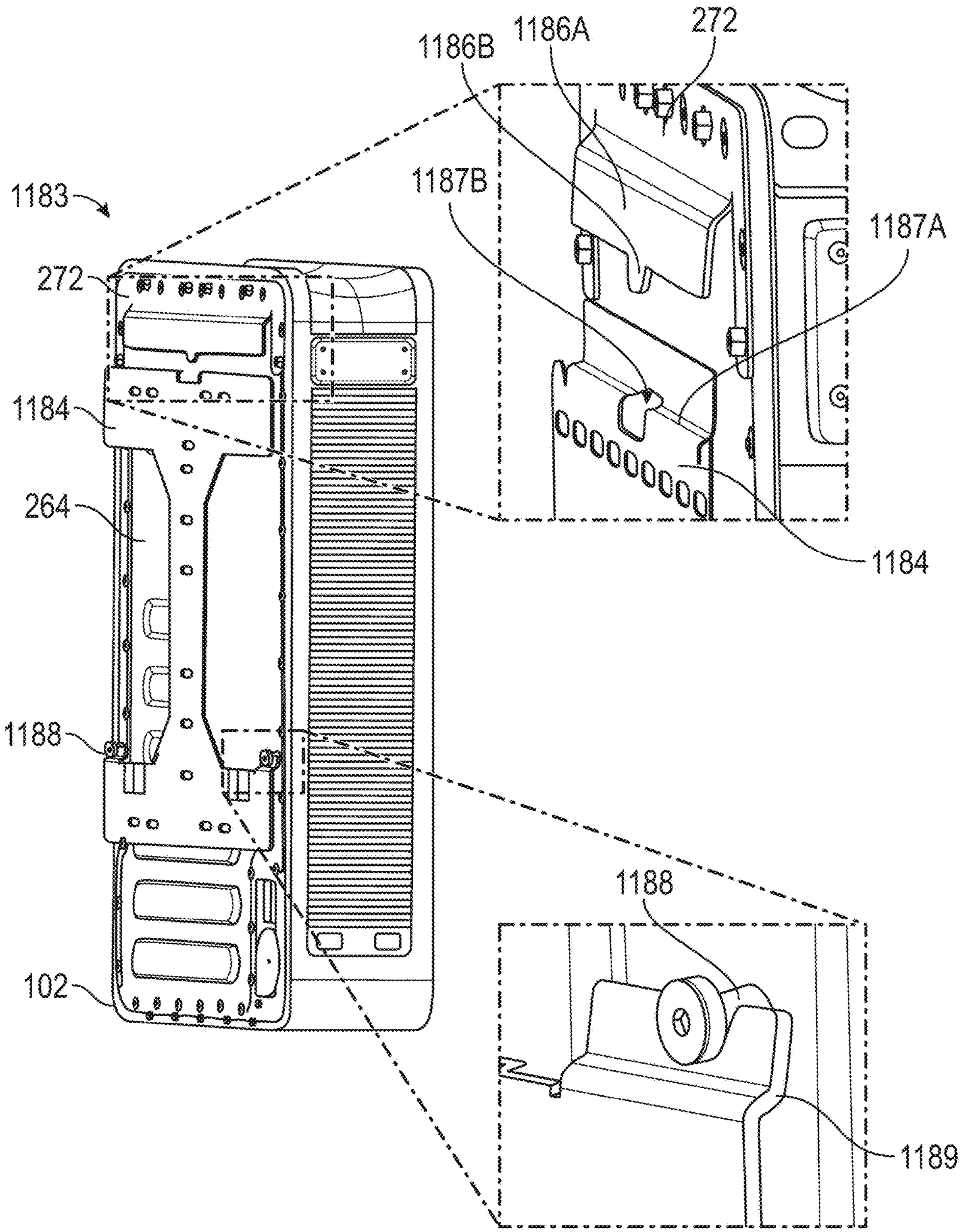

1183
272
1184
264
1188
102
1186B
1186A
272
1187B
1187A
1184
1188
1189

FIG. 11

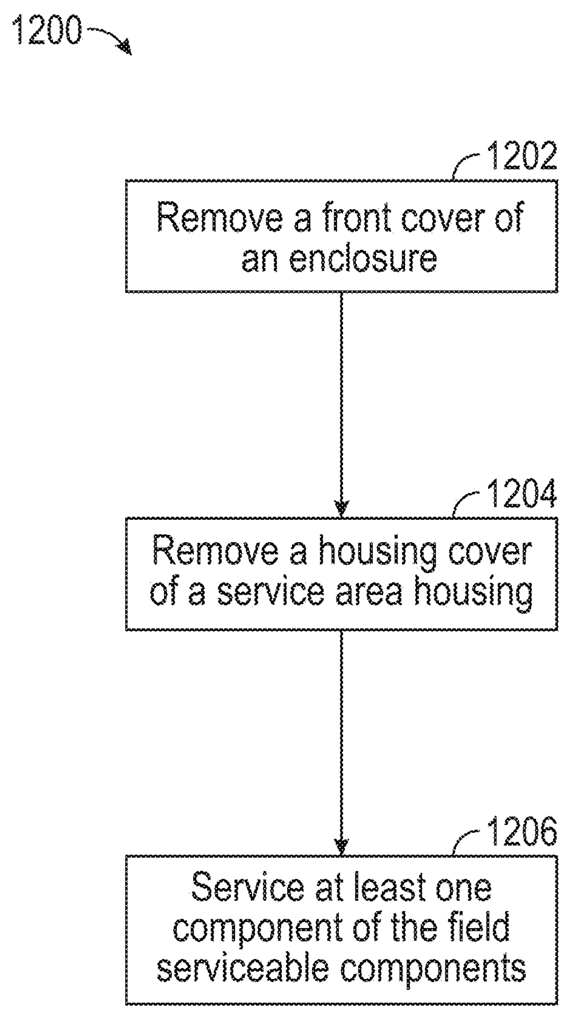

1200
1202
Remove a front cover of an enclosure
1204
Remove a housing cover of a service area housing
1206
Service at least one component of the field serviceable components

FIG. 12

SYSTEMS AND METHODS FOR PROVIDING AN ELECTRONICS HOUSING WITH WIRELESS COVERAGE IN OPPOSITE DIRECTIONS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This Patent Application claims priority to U.S. Provisional Patent Application No. 63/708,533, filed on Oct. 17, 2024, and entitled "Bidirectional Charging Systems and Methods." The disclosure of the prior Application is considered part of and is incorporated by reference into this Patent Application.

INTRODUCTION

[0002] The present disclosure is directed to systems and methods for a vehicle charging system, and more particularly to systems and methods for bi-directional charging of a vehicle.

SUMMARY

[0003] A vehicle charging system may provide power to a vehicle, such as to charge a battery of the vehicle. The power may be received from a power source, such as an electrical grid that distributes power from a power company, and may also be used to power an external system, such as a home. Different power support scenarios may affect operation of the vehicle charging system. Some power companies may have electricity rates that vary by a time of day and/or a day of the week. Energy arbitrage techniques may be used to offset the variable rates. For example, it may be cheaper to charge a battery of the vehicle at night (e.g., when rates may be cheaper) and, if possible, use power from the battery of the vehicle during the day (e.g., when rates may be more expensive) instead of the electrical grid. Some power companies receive grid support from their customers. A customer may provide power that is generated on their property, or otherwise available on-site, to the electrical grid to support grid energy usage. When power from the electrical grid is down, the vehicle and the home may no longer receive power. The vehicle charging system and devices that are powered through the home may remain offline or unusable until power to the grid is restored, which may require several days. An auxiliary power system, such as a backup generator, may be used to provide power in such scenarios. However, auxiliary power systems may require any one or combination of additional equipment that can be costly to install and maintain, equipment that is noisy when in operation, modification to a home's existing electrical infrastructure, or additional space for the equipment's footprint. Thus, a means for enabling bi-directional power flow between a vehicle and other systems and/or sources that accommodates different power support scenarios is needed.

[0004] In one approach, a system for managing power flow is provided. The system may have cooling requirements that affect the system's size or footprint. Cooling systems, such as external heat sinks or liquid cooling systems, may be used to remove heat generated by the system. While this approach may satisfy cooling requirements, it may add bulk to the system and/or require maintenance of another system.

[0005] In another approach, wireless communication with the system may be affected by a material or layout of components of the system. The components may attenuate, degrade, or block wireless signals from reaching the system. Wireless communication may be affected by a surrounding environment. The environment may be indoors or in a home, where walls or other material may attenuate, degrade, or block the wireless signals. Since communication with the system may not be consistent, the system may not provide reliable management of power flow.

[0006] In another approach, the system may be difficult to service or maintain. Specialized tooling may be required to access or remove components of the system, which may require additional inventory and cost. Components that do not need to be serviced may need to be removed to access components that require servicing. The entire system or subsystem may need to be removed and/or replaced to when servicing. Although the system may be serviced, the servicing may result in the system being unavailable for an undesirable amount of time. If components cannot be accessed on site, then replacement of the system may be required.

[0007] Accordingly, there is a need to provide a system for enabling bi-directional power flow that satisfies cooling requirements while accounting for maintenance costs and footprint constraints, provides consistent wireless communication, and may be serviced on-site, such as at a residential location.

[0008] To help address these problems, systems and methods are provided herein for providing consistent communication with a system for managing power flow. The system may include a housing and two antennas. One of the antennas may receive a signal from a first direction and the other may receive a signal from an opposite second direction. Thus, the system may wirelessly communicate with other systems without components of the system attenuating, degrading, or blocking communication.

[0009] In some embodiments, an apparatus comprises an electronics housing having a bottom and a side. The bottom and the side at least partially form a cavity having an opening. The apparatus further comprises an electronics housing cover coupled to the electronics housing. The electronics housing cover at least partially covers the opening of the cavity. A portion of the electronics housing cover extends beyond the side of the electronics housing. The apparatus further comprises a first antenna disposed adjacent to the bottom and external to the cavity of the electronics housing. The apparatus further comprises a second antenna disposed adjacent to the side and external to the cavity of the electronics housing. A first signal passing in a first direction is capable of being received at the second antenna without passing through the electronics housing. The first signal passing in the first direction is not capable of being received at the first antenna without passing through the electronics housing. A second signal passing in a second direction opposite the first direction is capable of being received at the first antenna without passing through the electronics housing.

[0010] In some embodiments, an apparatus comprises an electronics housing having a bottom and a plurality of sidewalls. The plurality of sidewalls form an external antenna recess. The apparatus further comprises an electronics housing cover coupled to a recess sidewall of the plurality of sidewalls of the electronics housing. A portion of the electronics housing cover extends over the external antenna recess. The apparatus further comprises a first antenna disposed adjacent to and external to the bottom of the electronics housing. The apparatus further comprises a second antenna disposed in the external antenna recess. A first signal passing in a first direction is capable of being received at the second antenna without passing through the electronics housing. The first signal passing in the first direction is not capable of being received at the first antenna without passing through the electronics housing. A second signal passing in a second direction opposite the first direction is capable of being received at the first antenna without passing through the electronics housing.

[0011] In some embodiments, a method comprises positioning a first antenna adjacent to and external to a bottom of an electronics housing. The electronics housing comprises the bottom and a plurality of sidewalls. The plurality of sidewalls form an external antenna recess. An electronics housing cover is coupled to a recess sidewall of the plurality of sidewalls of the electronics housing. A portion of the electronics housing cover extends over the external antenna recess. The method further comprises positioning a second antenna in the external antenna recess. A first signal passing in a first direction is capable of being received at the second antenna without passing through the electronics housing. The first signal passing in the first direction is not capable of being received at the first antenna without passing through the electronics housing. A second signal passing in a second direction opposite the first direction is capable of being received at the first antenna without passing through the electronics housing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The present disclosure, in accordance with one or more various embodiments, is described in detail with reference to the following figures. The drawings are provided for purposes of illustration only and merely depict typical or example embodiments. These drawings are provided to facilitate an understanding of the concepts disclosed herein and should not be considered limiting of the breadth, scope, or applicability of these concepts. It should be noted that for clarity and ease of illustration, these drawings are not necessarily made to scale.

[0013] FIG. **1** is a schematic illustration of a power management system, in accordance with embodiments of the disclosure;

[0014] FIG. **2** is an exploded illustration of a bi-directional charger, in accordance with embodiments of the disclosure;

[0015] FIG. **3**A is a schematic illustration of an electronics housing, in accordance with embodiments of the disclosure;

[0016] FIG. **3**B is a schematic offset section cutaway illustration of the electronics housing in FIG. **3**A, in accordance with embodiments of the disclosure;

[0017] FIGS. **4**A and **4**B are schematic illustrations of an electronics housing, in accordance with embodiments of the disclosure;

[0018] FIG. **5** is a flowchart of an illustrative process for installing electronic components in an electronics housing, in accordance with embodiments of the disclosure;

[0019] FIGS. **6**A and **6**B are schematic illustrations of an arrangement of components of antenna system of a bi-directional charger, in accordance with embodiments of the disclosure;

[0020] FIGS. **7**A and **7**B are schematic illustrations of an antenna system of a bi-directional charger, in accordance with embodiments of the disclosure;

[0021] FIG. **8** is a flowchart of an illustrative process for installing an antenna system in a bi-directional charger, in accordance with embodiments of the disclosure;

[0022] FIG. **9** is a schematic illustration of components within an enclosure of a bi-directional charger, in accordance with embodiments of the disclosure;

[0023] FIG. **10** is a schematic illustration of an enclosure of a bi-directional charger enclosure, in accordance with embodiments of the disclosure;

[0024] FIG. **11** is a schematic illustration of a mounting system for a bi-directional charger, in accordance with some embodiments of this disclosure; and

[0025] FIG. **12** is a flowchart of an illustrative process for servicing components of a bi-directional charger, in accordance with embodiments of the disclosure.

DETAILED DESCRIPTION

[0026] A vehicle charging system is provided that includes systems, components, and/or assemblies that enable bi-directional (BiDi) power flow between a vehicle, a power source, and/or an external system. In one approach, the vehicle charging system includes a BiDi charger that includes any of an enclosure and component layout that increases serviceability, an electronics housing having dual purpose functionality as a structural chassis for the BiDi charger and a cooling system for the BiDi charger, an antenna system, and a mounting system. Such features may improve serviceability and reduce a size or footprint of the vehicle charging system as discussed below.

[0027] In one approach, the vehicle charging system enables home backup power by enabling power to flow from a vehicle to an external system. In some embodiments, the external system includes any one or combination of a building and associated electrical infrastructure, a branch circuit, an appliance, heating and/or cooling systems, electrical devices (e.g., phone, computer, modem, router, television, gaming console, etc.), lighting, another vehicle, a main panel, a subpanel, a breaker box, or an electrical grid, to name a few examples.

[0028] In some embodiments, a BiDi thermal architecture is presented. An exterior of the electronics enclosure has heat dissipating sections. A cavity of the electronics housing may contain any one or combination of electronic components that are sensitive to handling or a surrounding environment, high-voltage electronic components, high-tolerance electronic components, electronic components having a high-tolerance interface, or electronic components that are not accessed on-site for maintenance or field repairs. Each of the electronic components, or subsets of the electronic components, may generate different amounts of heat and have different cooling requirements. The electronics system may include several items that form a cooling system for the BiDi charger. The electronics housing may include different heat dissipating sections that are thermally coupled to the electronic components. Each of the heat dissipating sections may accommodate the various cooling requirements of electronic components that are thermally coupled thereto. The heat dissipating sections may include heat dissipating structures that increase an area of the heat dissipating sections that is available for heat transfer. In some embodiments, an internal airflow generating stir device moves air around the cavity to promote heat transfer. In some embodiments, an airflow generating venting device moves outside air through the cavity and out a vent opening to remove heat from within the cavity. In some embodiments, an external airflow generating assembly moves air over a surface of the heat dissipating sections to remove heat. The dual-purpose functionality of the electronics enclosure may reduce complexity, size, weight, or manufacturing costs when compared to conventional charger systems, which may use bulky external heat sinks or a separate or standalone liquid cooling system. The thermal architecture of the electronics enclosure may increase reliability by reducing components or optimizing thermal pathways for heat removal. The thermal architecture of the electronics enclosure may increase a useable lifespan of electronics of the electronics enclosure by reducing operating temperatures.

[0029] In some embodiments, an architecture for a BiDi antenna system is presented. The electronics housing may not allow signals to reliably travel through. A first antenna and a second antenna may be positioned at different locations inside the enclosure to ensure coverage from in front of the system and behind the system. For example, if the first antenna is positioned adjacent to a front of the electronics housing, the first antenna may not receive signals from behind the system. The second antenna may be placed adjacent to a side of the electronics housing, which may be perpendicular to the front, to remediate this "dead zone" in coverage. The second antenna may receive signals from behind the housing, and in some instances, from in front of the system too. A backplate of the enclosure may include a cutout adjacent to the second antenna to facilitate reception of the signals from behind the housing.

[0030] In some embodiments, a BiDi enclosure packaging configuration is presented. The enclosure restricts access to components arranged within, which prevent a technician or user from accessing high-voltage components. Systems and components within the enclosure are laid out in a manner that allows easier access to field serviceable components and hinders access to non-field serviceable components. The field serviceable components may be easily removed from the enclosure or grouped in a service area housing that can be accessed using standard tools or hardware. The non-field serviceable components may be contained within the electronics housing, which may be coupled to the backplate of the enclosure and not easily removed or opened with standard tools or hardware.

[0031] FIG. **1** is a schematic illustration of a power management system **100**, in accordance with embodiments of the disclosure.

[0032] In some embodiments, the power management system **100** includes a BiDi charger **102** and an automatic grid disconnect (AGD) **104**. In some embodiments, the AGD **104** is electrically coupled to any one or combination of utility equipment **106**, an electrical infrastructure **108**, or the BiDi charger **102**. The BiDi charger **102** may be electrically coupled to a vehicle **110**. In some embodiments, the BiDi charger **102** includes a charging cable **103** that may be physically and/or electrically coupled to a vehicle **110** to provide power to the vehicle **110**. In some embodiments, an external device **112** communicates with any one or combination of the BiDi charger **102**, the AGD **104**, the utility equipment **106**, the electrical infrastructure **108**, or the vehicle **110**. In some embodiments, the external device **112** includes any one or combination of a smartphone, a desktop and/or laptop computer, a television, a smart appliance, a smart doorbell, a security system, a power and/or energy monitoring system, a server, or any other device that may communicate with the BiDi charger **102**, the AGD **104**, the utility equipment **106**, the electrical infrastructure **108**, or the vehicle **110**.

[0033] In some embodiments, the utility equipment **106** includes a power input from an electrical grid. In some implementations, the utility equipment **106** includes any one or combination or an electric meter, a service panel, a service drop, a service lateral, or a transformer. In some embodiments, the utility equipment **106** includes a battery or backup battery. In some embodiments, the utility equipment **106** includes any one or combination of a generator, solar power system, wind power system, or other power system, to name a few examples. In some embodiments, the electrical infrastructure **108** includes an electrical system that distributes power for a building, such as a home, plant, facility, or office, to name a few examples. In some embodiments, the electrical infrastructure **108** includes any one or combination of a main panel, circuit breaker, branch circuit, or electrical outlets, to name a few examples.

[0034] In some embodiments, the BiDi charger **102** is electrically coupled to a battery or power generating system of the vehicle **110**. In some embodiments, the vehicle **110** is an electric vehicle having a battery. In some embodiments, the vehicle **110** includes an internal combustion engine (e.g., gasoline, diesel, hydrogen, etc.) having a battery and/or alternator.

[0035] In some embodiments, the AGD **104** enables BiDi power transfer to/from the BiDi charger **102**. In some implementations, the AGD **104** provides power to the vehicle **110** (e.g., from the utility equipment **106**). In some implementations, the AGD **104** provides power to the electrical infrastructure **108** (e.g., from the vehicle **110** and/or the utility equipment **106**). The embodiment depicted in FIG. **1** includes two power flow scenarios. In a first scenario, the AGD **104** distributes power input from the utility equipment **106** to the BiDi charger **102** and the electrical infrastructure **108**. The BiDi charger **102** distributes power to the vehicle **110**. In a second scenario, there is no power input from the utility equipment **106**. The AGD **104** distributes power from the BiDi charger **102** to the electrical infrastructure **108**. The BiDi charger **102** receives power from the vehicle **110**.

[0036] FIG. **2** is an exploded illustration of the BiDi charger **102**, in accordance with embodiments of the disclosure.

[0037] The BiDi charger **102** may be used to accommodate different power support scenarios. In some embodiments, the BiDi charger **102** enables energy arbitrage techniques. In some implementations, the BiDi charger **102** charges a battery of a vehicle (e.g., the vehicle **110** in FIG. **1**) during a first time period (e.g., when rates are cheaper) and uses the battery to power an external system (e.g., the electrical infrastructure **108** in FIG. **1**) during a second time period (e.g., when rates are more expensive). In some embodiments, the BiDi system **102** provides grid support. In some implementations, the BiDi system **102** provides power to utility equipment (e.g., the utility equipment **106** in FIG. **1**). In some embodiments, the BiDi charger **102** reduces or eliminates power disruptions associated with conventional power supply methods for electrical infrastructure (e.g., the electrical infrastructure **108** in FIG. **1**). For example, the BiDi charger **102** may be used to provide power from the vehicle to the electrical infrastructure. As shown, the BiDi charger **102** includes an electronics housing **220**, service area housing **240**, an external airflow generating device **270**, and enclosure **260**.

[0038] In some embodiments, the electronics housing **220** houses electronic components **222**. In some embodiments, the electronic components **222** include any one or combination of a power factor correction (PFC) magnetics component **224**A, a direct current (DC) magnetics component **224**B, a first transistor **226**A, a second transistor **226**B, a first main power board (MPB1) **228**A, a second main power board (MPB2) **228**B, an input filter board (IFB) printed circuit board assembly (PCBA) **228**C, a power control center (PCC) PCBA **228**D, an insulating pad **230**, a weather-resistant cover **232**, an airflow generating stir device (e.g., airflow generating stir device **434**A in FIG. **4**B), or an airflow generating venting device (e.g., airflow generating venting device **434**B in FIG. **4**B). In some embodiments, an input terminal block **254** is coupled to, and/or at least partially disposed in, an opening of the electronics housing **220**. In some embodiments, an input terminal block **254** is partly disposed within a cavity (e.g., cavity **337**A in FIGS. **3**B-**4**B) of the electronics enclosure **220** and partly disposed external to the cavity. In some embodiments, the electronic components **222** include the input terminal block **254** or a portion thereof. In some embodiments, the input terminal block **254** provides input power to the electronic components **222**. In some embodiments, the input terminal block **254** includes terminals inside and outside of the electronics housing **220**. In some implementations, a ferrite core is arranged adjacent to or surrounding the terminals inside the electronics housing **220**. The ferrite core may reduce or suppress electromagnetic interference (EMI).

[0039] In some embodiments, the PFC magnetics component **224**A includes an alternating current (AC) magnetics component. In some embodiments, the PFC magnetics component **224**A includes any one or combination of a PFC inductor or PFC choke. In some embodiments, the PFC magnetics component **224**A boosts energy from an AC input to a DC bus.

[0040] In some embodiments, the DC magnetics component **224**B includes a transformer. In some implementations, the DC magnetics component **224**B includes a dual active bridge transformer. In some implementations, the DC magnetics component **224**B includes an air gap to prevent operation in saturation region. In some embodiments, the DC magnetics component **224**B transfers power from DC to DC. In some embodiments, the first transistor **226**A includes an insulated-gate bipolar transistor (IGBT). In some embodiments, the second transistor **226**B includes a MOSFET.

[0041] In some embodiments, any one or combination of the PFC magnetics component **224**A, DC magnetics component **224**B, first transistor **226**A, or second transistor **226**B are coupled to the electronics enclosure **220**. In some implementations, any one or combination of the PFC magnetics component **224**A, DC magnetics component **224**B, first transistor **226**A, or second transistor **226**B are directly coupled to the electronics enclosure **220**. In some examples, a thermal interface material (TIM) **236** is disposed between any one or combination of the PFC magnetics component **224**A, DC magnetics component **224**B, first transistor **226**A, or second transistor **226**B and the electronics enclosure **220** to promote heat transfer therebetween. In some embodiments, the TIM **236** provides a thermally conductive, electrically insulating layer. In some embodiments, the TIM **236** includes a silicone pad, or any other suitable thermally conductive material.

[0042] In some embodiments, the electronics housing **220** includes a contact surface (e.g., contact surfaces **427**A, **427**B in FIG. **4**A). In some implementations, the contact surface is formed in the electronics housing **220**, such as by any one or combination of machining, etching, blasting, sanding, or ablating, to name a few examples. The first transistor **226**A and/or the second transistor **226**B may couple to the electronics housing **220** via the contact surface. The contact surface may reduce or eliminate air gaps in the heat transfer path. In some embodiments, the electronics housing **220** includes heat dissipating sections **238** to remove heat generated by the electronic components **222**, such as discussed in relation to FIGS. **3**A-**4**B. In some embodiments, a heat flow path is formed from at least one of the PFC magnetics component **224**A, DC magnetics component **224**B, first transistor **226**A, or second transistor **226**B to at least one of the heat dissipating sections **238**.

[0043] In some embodiments, the PFC magnetics component **224**A and/or the first transistor **226**A are directly coupled to the MPB1 **228**A. In one example, the PFC magnetics component **224**A is mounted to the MPB1 **228**A without a wire harness. In some implementations, the TIM **236** is disposed between any of the PFC magnetics component **224**A or first transistor **226**A and the MPB1 **228**A. In some embodiments, the PFC magnetics component **224**A and/or the first transistor **226**A are part of the MPB1 **228**A. In one example, a replacement MPB1 **228**A may include the PFC magnetics component **224**A and/or the first transistor **226**A. In some embodiments, the MPB1 **228**A includes a current sensor feedback circuit and/or a current sensing circuit. In some embodiments, the MPB1 **228**A monitors and/or controls the airflow generating stir device. In some embodiments, the MPB1 **228**A is coupled to the electronics housing **220**. In some implementations, standoffs and/or fasteners are used to couple the MPB1 **228**A to the electronics housing **220**.

[0044] In some embodiments, the DC magnetics component **224**B and/or the second transistor **226**B are directly coupled to the MPB2 **228**B. In some implementations, the TIM **236** is disposed between any of the DC magnetics component **224**B or second transistor **226**B and the MPB2 **228**B. In some embodiments, the DC magnetics component **224**B and/or the second transistor **226**B are part of the MPB2 **228**B. In some embodiments, the MPB2 **228**B includes a current sensing circuit to sense transformer saturation. In some embodiments, the MPB2 **228**B includes heatsinks for power dissipation. In some embodiments, the MPB2 **228**B includes a relay circuit. In some embodiments, the MPB2 **228**B is coupled to the electronics housing **220**. In some implementations, standoffs and/or fasteners are used to couple the MPB2 **228**B to the electronics housing **220**.

[0045] In some embodiments, the insulating pad **230** is arranged between the electronics housing **220** and any one or more of the MPB1 **228**A or the MPB2 **228**B. In some embodiments, more than one insulating pad **230** is used. In some implementations, a separate insulating pad **230** is used for each of the MPB1 **228**A and the MPB2 **228**B. In some embodiments, the insulating pad **230** is attached to the electronics housing **220**. In some implementations, the insulating pad **230** is attached to the electronics housing **220**

using any one or combination of glue, adhesive, or sealant. In some embodiments, the insulating pad **230** forms cutouts to allow any one or combination of the PFC magnetics component **224**A, DC magnetics component **224**B, first transistor **226**A, or second transistor **226**B to directly couple to the electronics enclosure **220** without the insulating pad **230** therebetween. In some embodiments, the insulating pad **230** blocks or restricts heat transfer to portions of the electronics housing **220** in which is it attached, and promotes or concentrates heat transfer to the remaining portions of the electronics housing **220**.

[0046] In some embodiments, the weather-resistant cover **232** is coupled to an exterior of the electronics housing **220** to cover an opening (e.g., upper opening **433**B in FIG. **4**A) in the electronics housing **220**. In some implementations, the weather-resistant cover **232** forms a vent for air to move through the opening. In some implementations, the weather-resistant cover **232** prevents any one or combination of rain, moisture, or dust from entering the opening.

[0047] In some embodiments, the IFB PCBA **228**C is coupled to the input terminal block **254**. In some implementations, the IFB PCBA **228**C is directly coupled to the input terminal block **254**. In some embodiments, the IFB PCBA **228**C is coupled to the MPB1 **228**A through a board-to-board connector. In some embodiments, directly coupling the electronic components **222** to one another and/or to the electronics housing **220** minimizes thermal resistance and eliminates a need for intermediary thermal management components, such as standalone heat sinks or thermal pads.

[0048] In some embodiments, the PCC PCBA **228**D includes a microcontroller. In some implementations, the PCC PCBA **228**D includes an ARM microcontroller. In some embodiments, the PCC PCBA **228**D includes interface connectors to couple the PCC PCBA **228**D to the MPB1 **228**A and/or the MPB2 **228**B. In some implementations, a first one or more harnesses connect to the interface connectors of the PCC PCBA **228**D and to the MPB1 **228**A and/or the MPB2 **228**B. In some examples, the first one or more harnesses include any one or combination of a controller area network (CAN) harness, 24V harness, or power electronics module (PEM) harness. In some implementations, a second one or more harnesses connect to the interface connectors of the PCC PCBA **228**D and to the MPB1 **228**A.

[0049] In some embodiments, the service area housing **240** houses field serviceable components **242**. In some embodiments, the field serviceable components **242** include any one or combination of an integrated magnetic device (IMD) PCBA **244**A, a cluster control unit (CCU) PCBA **244**B, a first antenna (e.g., first antenna **646**A in FIGS. **6**A and **6**B), a second antenna (e.g., second antenna **646**B in FIGS. **6**A and **6**B), an antenna cover **248**, an electronic switch **250**, a fuse (e.g., fuse **652** in FIG. **6**B), or the input terminal block **254**. In some embodiments, the input terminal block **254** comprises an AC terminal block. In some embodiments, the electronic switch **250** comprises a contactor.

[0050] In some embodiments, the IMD PCBA **244**A includes an IMD circuit and/or integrated measurement relay (IMR) circuit. In some embodiments, the IMD PCBA **244**A places the boost converter on same functional block as IMD circuit. In some embodiments, the BiDi charger **102** is in a black start mode and the IMD PCBA **244**A upconverts voltage to start charging. In some implementations, the IMD PCBA **244**A upconverts 24 V to 500 V. In some implementations, the IMD PCBA **244**A may perform one or more operations, such as perform an isolation test, check impedance of cable to earth to make sure safe to charge, apply large enough voltage, or exceed the expected charge voltage. In some embodiments, the IMD PCBA **244**A controls the electronic switch **250**. In some embodiments, the IMD PCBA **244**A senses temperature. In some embodiments, the IMD PCBA **244**A includes an interface connector. In some implementations, the interface connectors enable a wire harness to connect the IMD PCBA **244**A to the CCU PCBA **244**B.

[0051] In some embodiments, the CCU PCBA **244**B includes an inter-integrated circuit (I2C) to support a programmable logic controller (PLC) chip for communication with the vehicle. In some embodiments, the CCU PCBA **244**B includes an interface connector.

[0052] In some embodiments, the field serviceable components **242** are intended to be serviced in the field or at a location of the BiDi charger **102**. In some embodiments, the electronic components **222** are not intended to be serviced in the field or at the location of the BiDi charger **102**. In some implementations, the electronic components **222** are intended to be serviced at a service or repair center. In some implementations, the electronic components **222** are referred to as non-field serviceable components.

[0053] In some embodiments, a service area cover **256** couples to the service area housing **240** to at least partially shield the field serviceable components **242**. In some implementations, fasteners couple the service area cover **256** to the service area housing **240**. In some examples, the fasteners are removed using standard tooling, such as a Phillips or flat-head screwdriver, hex key, wrench, or socket, to name a few examples, to ensure the field serviceable components **242** can be easily accessed for servicing. Servicing may include any one or combination of, for at least a portion of component, inspecting, removing, replacing, troubleshooting, performing measurements, downloading data from, uploading data to, adjusting, calibrating, adjusting, cleaning, or adding a material to, to name a few examples. In some implementations, a gasket or seal is disposed between the service area cover and the service area housing **240**. In some embodiments, the service area cover **256** is referred to as a service housing cover or a housing cover.

[0054] In some embodiments, at least one of the MPB1 **228**A, MPB2 **228**B, IFB PCBA **228**C, PCC PCBA **228**D, IMD PCBA **244**A, or CCU PCBA **244**B includes any one or combination of control circuitry, input/output (I/O) circuitry (e.g., or I/O path), or storage. In some embodiments, the control circuitry may be coupled to any one or combination of sensors, actuators, motors, interfaces, and any other suitable components to control the operations and/or functionality of the BiDi charger **102**. In some embodiments, the control circuitry monitors sensor signals, generates control signals, executes computer readable instructions, receives inputs, or a combination thereof. In some embodiments, the control circuitry provides power and/or a data connection to the at least one of the electronic components **222** and/or at least one of the field serviceable components **242**.

[0055] In some embodiments, at least one of the MPB1 **228**A, MPB2 **228**B, IFB PCBA **228**C, PCC PCBA **228**D, IMD PCBA **244**A, or CCU PCBA **244**B includes communications circuitry for communicating with other systems. In some implementations, the communications circuitry includes any of an antenna (e.g., the first and/or the second antenna), a transmitter, a receiver, a transceiver, transceiver circuitry or other circuitry, a modulator, a demodulator, or a signal processing unit, or any combination thereof, and may be configured to access the internet, a local area network, wide area network, Bluetooth-enabled device, near field communication (NFC)-enabled device, Wi-Fi enabled device, cellular (e.g., 2G/3G/4G/5G) enabled device, or any other suitable device using any suitable protocol. In some implementations, the communications circuitry is used to communicate (e.g., through the I/O circuitry) with any one or combination of an AGD (e.g., the AGD **104** in FIG. **1**), an external device (e.g., the external device **112** in FIG. **1**), a vehicle (e.g., the vehicle **110** in FIG. **1**), utility equipment (e.g., the utility equipment **106** in FIG. **1**), electrical infrastructure (e.g., the electrical infrastructure **108** in FIG. **1**), or another system (e.g., another vehicle or a server). In some implementations, the communications circuitry may communicate wirelessly and/or through a wired connection.

[0056] In some embodiments, the I/O circuitry receives inputs and/or sends outputs. In some implementations, the I/O circuitry receives inputs from and/or sends outputs to at least one of the vehicle, the AGD, the utility equipment, the electrical infrastructure, the external device, sensors, or the communications circuitry. In some embodiments, the sensors include any one or combination of a temperature sensor, voltage sensor, current transformer, power meter, vibration sensor, or a load sensing device to monitor power or a temperature of the BiDi charger **102**. In some embodiments, the I/O circuitry includes, or replaces, the communications circuitry.

[0057] In some embodiments, the BiDi charger **102** includes one or more applications to control operations and/or functionality of the BiDi charger **102**. In some embodiments, the control circuitry executes a power control application to control power to or from any one or combination of the electronic components **222**, the field serviceable components **242**, the vehicle, or the AGD. In some embodiments, the control circuitry executes a temperature control application to regulate a temperature of the BiDi charger **102** by controlling power to or from any one or combination of the airflow generating stir device, the airflow generating venting device, or the external airflow generating assembly **270**. In some implementations, the temperature control application supports different cooling modes for controlling the fans, such as passive, active, and hybrid, to enable optimal thermal management under varying operating conditions.

[0058] In some embodiments, any one or combination of the control circuitry, I/O circuitry, or communications circuitry executes a communications application to communicate with any one or combination of the vehicle, the AGD, the utility, the electrical infrastructure, or the external device. In some embodiments, the control circuitry executes an input interface application to send or receive an input or output from a user interface. In some implementations, the user interface includes any one or combination of a status indicator light (e.g., light bar assembly **1080** in FIG. **10**), a button (e.g., user interface element **1082** in FIG. **10**), or the external device. In some embodiments, any of the applications, or a corresponding application, runs on the external device to communicate with the BiDi charger **102**. In some embodiments, the application communicates with the external device through a server. In some embodiments, the external device includes a screen, and the user interface includes a graphical user interface (GUI) of the application on the external device.

[0059] In some embodiments, the system includes storage. In some embodiments, the storage is an electronic storage device provided that is part of the control circuitry. As referred to herein, the phrase "electronic storage device" or "storage device" should be understood to mean any device for storing electronic data, computer software, or firmware, such as random-access memory, read-only memory, hard drives, optical drives, digital video disc (DVD) recorders, compact disc (CD) recorders, BLU-RAY disc (BD) recorders, BLU-RAY 3D disc recorders, digital video recorders (DVR, sometimes called a personal video recorder, or PVR), solid state devices, quantum storage devices, gaming consoles, gaming media, or any other suitable fixed or removable storage devices, and/or any combination of the same. The storage may be used to store various types of applications as well as data from sensors. In some implementations, nonvolatile memory is also used (e.g., to launch a boot-up routine and other instructions). In some implementations, cloud-based storage or server-based storage is used to supplement storage or instead of the storage.

[0060] In some implementations, the storage includes non-transitory memory with non-transitory instructions, that when executed, cause the execution of applications to control aspects of the accessories and/or performance characteristics of the vehicle. In one example, the control circuitry and I/O circuitry are part of the computer having the non-transitory memory. In some embodiments, the instructions are provided by the control circuitry through the I/O circuitry and/or communications circuitry.

[0061] In some embodiments, any one of combination of the MPB1 **228**A, MPB2 **228**B, IFB PCBA **228**C, or PCC PCBA **228**D is referred to as a board, circuit board, printed circuit board, or PCBA, to name a few examples. In some embodiments, any one of combination of the MPB1 **228**A, MPB2 **228**B, IFB PCBA **228**C, or PCC PCBA **228**D may provide functionality that is different than previously discussed. In some embodiments, any one of combination of the PFC magnetics component **224**A, DC magnetics component **224**B, first transistor **226**A, or second transistor **226**B may be referred to as a component, an electronic component, or an electrical component, to name a few examples. In some embodiments, any one of combination of the PFC magnetics component **224**A, DC magnetics component **224**B, first transistor **226**A, or second transistor **226**B may provide functionality that is different than previously discussed.

[0062] In some embodiments, the enclosure **260** includes a top ribbon **262**A, bottom ribbon **262**B, left-side ribbon **262**C, right-side ribbon **262**D, electronics housing cover **264**, and a removable front cover **266**. The enclosure forms an internal space (e.g., internal space **968** in FIG. **9**). In some embodiments, any one or combination of the electronics housing **220**, the service area housing **240**, or the external airflow generating assembly **270** are arranged within the internal space.

[0063] In some embodiments, the ribbons **262**A-**262**D are coupled to one another. In some implementations, the ribbons **262**A-**262**D are coupled together using any one or combination of glue, adhesive, sealant, or fasteners. In some embodiments, the ribbons **262**A-**262**D are not intended to be decoupled. In some implementations, the ribbons **262**A-**262**D are integrally formed. For example, two or more of the ribbons **262**A-**262**D may be machined out of a single billet of material, molded or printed as a single piece, welded or bonded together, or otherwise joined to together to function as a single article. In some embodiments, at least one of the ribbons **262**A-**262**D is removably coupled to the other ribbons **262**A-**262**D.

[0064] In some embodiments, the ribbons **262**A-**262**D are coupled to the electronics housing cover **264** and the front cover **266**. In some implementations, the ribbons **262**A-**262**D are coupled to the electronics housing cover **264** using any one or combination of glue, adhesive, sealant, or fasteners. In some embodiments, the electronics housing cover **264** couples to the electronics housing **220** to ensure the electronic components **222** cannot be easily accessed. In some embodiments, the electronics housing **220** is referred to as a body and the electronics housing cover **264** is referred to as a body cover. In some embodiments, the electronics housing **220** is referred to as a housing and the electronics housing cover **264** is referred to as a housing cover. In some implementations, the ribbons **262**A-**262**D are removably coupled to the electronics housing cover **264** to enable the electronics housing **220** to be removed for servicing. In some embodiments, the electronics housing cover **264** includes a mounting cleat **272** to couple the BiDi charger **102** to a surface, such as a wall, as discussed in relation to FIG. **11**.

[0065] In some embodiments, the front cover **266** is removably coupled to one or more of the ribbons **262**A-**262**D using any one or combination of glue, adhesive, sealant, or fasteners. In some implementations, at least one retention feature removably couples the front cover **266** to one or more of the ribbons **262**A-**262**D. For example, the retention features may include any one or combination of hooks, loops, magnetic features, slots, pins, buttons, snaps, or other fasteners. In some embodiments, a noise absorber material, such as a foam, fiberglass, wool, wood fiber, cotton, or polyester, is coupled to a surface of the front cover **266** that faces the electronics housing **220**. In some embodiments, a removable accent panel **274** is removably coupled to the front cover **266**. In some implementations, at least one retention feature removably couples the accent panel **274** to the front cover **266**. In some examples, a magnetic feature of the accent panel **274** engages a magnetic feature of the front cover **266** to hold the second removable panel to the frame. In some embodiments, the magnetic feature is any one of a magnet, magnetic material, or ferromagnetic material. In some implementations, the magnetic feature of the accent panel **274** is one of a magnet or ferromagnetic material and the magnetic material is the front cover **266** is one of the magnet or ferromagnetic material.

[0066] In some embodiments, the external airflow generating assembly **270** generates air movement to move air over an exterior surface of the electronics housing to remove heat. In some implementations, the external airflow generating assembly **270** moves air over the heat dissipating sections **238**. In some implementations, the external airflow generating assembly **270** pulls in air through venting features in the left-side ribbon **262**C and moves the air over the electronics enclosure **220** and out of venting features in the right-side ribbon **262**D. In some implementations, the venting features include any one or combination of openings, a mesh, a screen, slots, or louvers. In some implementations the airflow direction is reversed, and air is pulled through the right-side ribbon **262**D and moves the air out of the left-side ribbon **262**C. In some embodiments, the external airflow generating assembly **270** is electrically coupled to the field serviceable components **242** and/or the electronic components **222**. In some embodiments, the external airflow generating assembly **270** is field serviceable. In some implementations, the external airflow generating assembly **270** may be removed from the enclosure **260** to be serviced or replaced, such as discussed in relation to FIG. **9**.

[0067] In some embodiments, the BiDi charger **102** includes a cooling system to dissipate heat generated by the electronic components **222** and/or the field serviceable components **242**. In some implementations, the electronics enclosure **220** includes the cooling system or a portion of the cooling system. In some examples, the airflow generating venting device and/or the airflow generating stir device promotes dissipation and removal of heat from inside the cavity of the electronics enclosure **220** to an exterior or surroundings of the electronics enclosure **220**. The heat dissipating sections **238** and the external airflow generating assembly **270** dissipate heat from the exterior of the electronics enclosure **220**. A thermal architecture and cooling system of the electronics housing **220** is discussed in relation to FIGS. **3**A-**5**.

[0068] FIG. **3**A is a schematic illustration of the electronics housing **220**, in accordance with embodiments of the disclosure. FIG. **3**B is a schematic offset section cutaway illustration of the electronics housing **220** in FIG. **3**A, in accordance with embodiments of the disclosure. FIGS. **3**A and **3**B are herein described together for brevity.

[0069] In some embodiments, the electronics housing **220** has a bottom **321**A (oriented upwards in the views of FIGS. **3**A and **3**B) and a plurality of sides **321**B (FIG. **3**A) or sidewalls that form a cavity **337**A having an opening **337**B (FIG. **3**B). Each of the plurality of sides has a first end coupled to the bottom **321**A and a second end forming the opening **337**B. In the embodiment depicted in FIGS. **3**A and **3**B, the bottom **321**A has a non-planar, multi-leveled exterior surface and corresponding interior surface **335** (e.g., interior surfaces **335**A-**335**D) to accommodate a service area housing (e.g., the service area housing **240** in FIGS. **2**, **6**B, **7**B, and **9**), the electronic components **222** (FIG. **3**B), and the heat dissipating sections **238**. In some embodiments, there is a constant thickness between the exterior and the interior surfaces of the bottom **321**A. In some embodiments, there is a variable thickness between the exterior and the interior surfaces of the bottom **321**A.

[0070] In the embodiment depicted in FIG. **3**A, the electronics housing **220** has six sides **321**B and an external antenna recess **358**. The antenna recess **358** is external to the electronics housing **220** and forms a through-hole in, or recessed portion of, the electronics housing **220**. In an exemplary concept of a recessed portion, the recessed portion may be a concave indentation in an otherwise straight or convex profile. As shown, the antenna recess **358** is formed by two of the six sides **321**B that travel inward at a corner of the electronics housing **220**. In some embodiments, the sides **321**B may be referred to as sidewalls and the two sides **321**B that form the antenna recess **358** referred to as recess sidewalls. In some embodiments, the sides **321**B form an exterior profile of the electronics housing **220** and the electronics housing **220** forms the antenna recess **358** at least partially inward of the exterior profile. For example, the exterior profile may have a rectangular shape and the antenna recess **358** may be a portion of the rectangular shape that is removed. The portion may be partially inward of the exterior profile entirely within the exterior profile.

[0071] In some embodiments, the input terminal block **254** is arranged in the antenna recess **358**. The second ends of the six sides **321**B are level with one another such that they form a plane. In some embodiments, the two sides **321**B are referred to as recess sidewalls. The electronics housing cover **264** couples to the electronics housing **220** (e.g., to the sides **321**B). In some embodiments, the electronics housing cover **264** couples to the second ends of the plurality of sides **321**B. The electronics housing cover **264** at least partially covers the opening **337**B and extends beyond the sides **321**B to form a lip. A portion of the electronics housing cover **264** extends beyond the recess sidewalls and the portion forms a cutout **365**. In some embodiments, the cutout **365** is used to allow a signal to pass through the electronics housing cover **264**, such as discussed in relation to FIGS. **6**A-**7**.

[0072] Referring to FIG. **3**B, in some embodiments, the heat dissipating sections **238** include heat dissipating structures **339** (e.g., heat dissipating structures **339**A-**339**E in FIG. **3**B) that increase an area of the heat dissipating sections **238** available for heat transfer. The heat dissipating structures **339** may be coupled to or integrally formed with the exterior surface of the bottom **321**A. In the embodiment depicted in FIGS. **3**A and **3**B, the heat dissipating structures **339** are cooling fins that are integrally formed with the electronics housing **220**. For example, the electronics housing **220** and the heat dissipating structures **339** may be machined out of a single billet of material, molded or printed as a single piece, welded or bonded together, or otherwise joined to together to function as a single article. In some implementations, the electronics housing **220** is casted as one piece, which may allow space flexibility for the electronic components. In some implementations, each of the cooling fins extends in the same direction. In some implementations, cooling fins corresponding to one of the heat dissipating structures **339** extend in a different direction than cooling fins corresponding to at least one other heat dissipating structure **339**. The electronics housing **220** may have a dual purpose, such as a housing and a heat sink.

[0073] In the embodiment depicted in FIG. **3**B, the heat dissipating structures **339** include a first heat dissipating structure **339**A, a second heat dissipating structure **339**B, a third heat dissipating structure **339**C, a fourth heat dissipating structure **339**D, and a fifth heat dissipating structure **339**E. In some embodiments, the shape of at least a portion of the heat dissipating structures **339** may differ. For example, the shape may be any one or combination of triangular, rectangular, scalloped, or trapezoidal, to name a few examples. In some implementations, heat dissipating structures **339** include any one or combination of pin fins, louvered fins, corrugated fins, flat fins, inverted trapezoidal fins, ribs, a heat spreader, or a heat sink, to name a few examples. In some implementations, the heat dissipating structures **339** may have a fin surface of any one or combination of plain rectangular, plain triangular, wavy, offset strip, perforated, or louvered.

[0074] Referring again to FIG. **3**B, in some embodiments, the first heat dissipating structure **339**A has a first height (h**1**). The second heat dissipating structure **339**B has a second height (h**2**). The third heat dissipating structure **339**C has a third height (h**3**). The fourth heat dissipating structure **339**D has a fourth height (h**4**). The fifth heat dissipating structure **339**E has a fifth height (h**5**). In some embodiments, the first and fourth height are a same or substantially similar height, such as within 0.2 in of one another, within 0.15 in, within 0.1 in, within 0.05 in, or within 0.01 in. In some embodiments, the first and fourth height are a different height. In some embodiments, the second, the third, and the fifth height are a same or substantially similar height. In some embodiments, any of the second, the third, or the fifth height are a different height from another. In some embodiments, any one or combination of the second, the third, or the fifth height is a higher height than any one or combination of the first or fourth height.

[0075] Referring again to FIG. **3**B in some embodiments, the interior surfaces **335** of the bottom **321**A include a first interior surface **335**A corresponding to the first heat dissipating structure **339**A and respective heat dissipating section **238**, a second interior surface **335**B corresponding to the second and the third heat dissipating structure **339**B, **339**C and respective heat dissipating sections **238**, a third interior surface **335**C corresponding to the fourth heat dissipating structure **339**D and respective heat dissipating section **238**, and a fourth interior surface **335**D corresponding to the fifth heat dissipating structure **339**E and respective heat dissipating section **238**.

[0076] In some embodiments, any one or combination of PFC magnetics component **224**A, DC magnetics component **224**B, first transistor **226**A, second transistor **226**B, MPB1 **228**A, MPB2 **228**B, IFB PCBA **228**C, PCC PCBA **228**D is arranged in the cavity **337**A at different depths from the opening **337**B, such as at different depths from the second ends of the sides **321**B.

[0077] In the embodiment depicted in FIG. **3**B, there are at least two of the second transistors **226**B. The PFC magnetics component **224**A is coupled to the first interior surface **335**A at a first depth (d**1**). Each of the first transistor **226**A and a first of the two second transistors **226**B are coupled to the second interior surface **335**B at a second depth (d**2**). The DC magnetics component **224**B is coupled to the third interior surface **335**C at a third depth (d**3**). A second of the two second transistors **226**B is coupled to the fourth interior surface **335**D at a fourth depth (d**4**).

[0078] The MPB1 **228**A is coupled to the PFC magnetics component **224**A and the first transistor **226**A at a fifth depth (d**5**). The MPB2 **228**B is coupled to each of the two second transistors **226**B and the DC magnetics component **224**B at a sixth depth (d**6**). The IFB PCBA **228**C is arranged in the cavity **337**A such that a bottom surface of IFB PCBA **228**C that faces the second interior surface **335**B is arranged at a seventh depth (d**7**). In some embodiments, the IFB PCBA **228**C is coupled to the MPB1 **228**A and/or the MPB2 **228**B at the seventh depth. The PCC PCBA **228**D is arranged in the cavity **337**A such that a bottom surface of PCC PCBA **228**D that faces the second interior surface **335**B and/or the fourth interior surface **335**D is arranged at an eighth depth (d**8**). In some embodiments, the PCC PCBA **228**D is coupled to the MPB1 **228**A and/or the MPB2 **228**B at the eighth depth.

[0079] In some embodiments, the first and the third depth are a same or substantially similar depth, such as within 0.2 in of one another, within 0.15 in, within 0.1 in, within 0.05 in, or within 0.01 in. In some embodiments, the first and fourth height are a different depth. In some embodiments, the second and the fourth depth are a same or substantially similar depth. In some embodiments, the second and the fourth depth are a different depth. In some embodiments, the fifth and the sixth depth are a same or substantially similar depth. In some embodiments, the fifth and the sixth depth are a different depth. In some embodiments, the seventh and the eighth depth are a same or substantially similar depth. In some embodiments, the seventh and the eighth depth are a different depth.

[0080] In some embodiments, any one or combination of the first or the third depth is a deeper depth than any one or combination of the second, the fourth, the fifth, the sixth, the seventh, or the eighth depth. In some embodiments, any one or combination of the second or the fourth depth is a deeper depth than any one or combination of the fifth, the sixth, the seventh, or the eighth depth. In some embodiments, any one or combination of the fifth or the sixth depth is a deeper depth than any one or combination of the seventh or the eighth depth.

[0081] In some embodiments, the heights and depths are based on any one or combination of a stackup of the electronic components **222**, an amount of heat generated by the electronic components **222**, a TIM (e.g., the TIM **236** in FIG. **2**) used and/or whether a TIM is used, a material of the electronic components **222** and/or the electronics housing **220**, a process used to manufacture or treat the electronic components **222** and/or the electronics housing **220**, or a heat flux and/or thermal conductivity of the electronic components **222** and/or the electronics housing **220**. In some embodiments, a different TIM is used between at least one of the PFC magnetics component **224**A, DC magnetics component **224**B, first transistor **226**A, or second transistor **226**B and the electronics enclosure **220**. In some implementations, the different TIM has a different heat flux and/or thermal conductivity and is determined based at least in part on corresponding heat generated by the PFC magnetics component **224**A, DC magnetics component **224**B, first transistor **226**A, or second transistor **226**B.

[0082] In some embodiments, the electronics housing **220** and the heat dissipating structures **339** are configured based on the electronic components **222**. In the embodiment depicted in FIG. **3**B, the first transistor **226**A and the second transistor **226**B components generate more heat than the PFC magnetics component **224**A and the DC magnetics component **224**B. The second, the third, and the fifth heat dissipating structures **339**B, **339**C, **339**E, which form part of a heat flow path for, and dissipate heat generated by, the first transistor **226**A and the second transistor **226**B, have a higher height than the first and the fourth dissipating structures **339**A, **339**D, which form part of a heat flow path for, and dissipate heat generated by, the PFC magnetics component **224**A and the DC magnetics component **224**B. The higher height of the second, the third, and the fifth heat dissipating structures **339**B, **339**C, **339**E may increase the surface area and may dissipate heat faster than the first and the fourth dissipating structures **339**A, **339**D.

[0083] In some embodiments, the second interior surface **335**B includes two portions, each corresponding to one of the second and the third heat dissipating structure **339**B, **339**C. In some implementations, the two portions are at different depths. In some examples, one of the two portions is not at the second depth and the other of the two portions is at the second depth. In some embodiments, the first transistor **226**A and the first of the two second transistors **226**B are coupled to the second interior surface **335**B at a different depths, such as when the two portions are at different depths.

[0084] Referring to FIG. **3**A, in some embodiments, the electronics housing **220** includes a fan harness **271** on an exterior that is electrically coupled to the electronic components **222**. In some implementations, a harness or connector of an external airflow generating assembly (e.g., external airflow generating assembly **270** in FIGS. **2**, **7**B, and **9**) is coupled to a fan harness **371**. In some embodiments, a transition harness **341** travels through a transition opening in the bottom **321**A of the electronics housing **220**. In some implementations, the transition opening is in a lower portion of the bottom that is outside of the heat dissipating sections **238**. The lower portion may couple to a service area housing (e.g., the service area housing **240** in FIGS. **2**, **6**B, **7**B, and **9**). In some implementations, the transition harness **341** comprises a high voltage harness. In some implementations, the transition harness **341** connects to the MPB2 **228**B (FIG. **3**B) at one end and to an electronic switch (e.g., the electronic switch **250** in FIGS. **2** and **6**) at the other end. In some embodiments, the electronics housing **220** forms a lower opening **333** in the lower portion to allow airflow into the cavity **337**A.

[0085] In the embodiment depicted in FIG. **3**A, there are three lower openings **333**. In some embodiments, more or less may be used.

[0086] FIGS. **4**A and **4**B are schematic illustrations of the electronics housing **220**, in accordance with embodiments of the disclosure.

[0087] FIG. **4**A shows the cavity **337**A prior to installation of an insulating pad (e.g., the insulating pad **230** in FIG. **2**), a MPB1 (e.g., the MPB1 **228**A in FIGS. **2**, **3**B, and **4**B), and an MPB2 (e.g., the MPB2 **228**B in FIGS. **2**, **3**B, and **4**B). The electronics housing **220** includes a first transistor contact surface **427**A for a first transistor (e.g., the first transistor **226**A in FIGS. **2** and **3**B) and a second transistor contact surface **427**B for a second transistor (e.g., the second transistor **226**B in FIGS. **2** and **3**B). In some embodiments, a TIM (e.g., the TIM **236** in FIG. **2**) is coupled to or contacts at least one of the contact surfaces **427**A, **427**B. In some implementations, the contact surfaces **427**A, **427**B are referred to as TIM regions. In some embodiments, at least one of the contact surfaces **427**A, **427**B is created by removing material from the electronics housing **220**. In some implementations, the electronics housing **220** is machined, etched, blasted, ablated, or otherwise modified to create the contact surfaces **427**A, **427**B. In some embodiments, at least one of the contact surfaces **427**A, **427**B is created by adding material to the electronics housing **220**. In some implementations, the material is added to the electronics housing **220** by a deposition process such as plating, thermal spray, cold spray, printing, or vapor deposition, to name a few examples. In some implementations, the material may be fastened, glued, adhered, or otherwise attached to the electronics housing **220**. The added material may be similar to the material of the electronics housing **220**, have similar or different properties (e.g., thermal conductivity or resistivity).

[0088] The electronics housing **220** forms a lower opening **433**A (or, e.g., lower opening **333** in FIG. **3**A) and an upper opening **433**B. In some embodiments, a weather-resistant cover (e.g., the weather-resistant cover **232** in FIGS. **2** and **7**A) is coupled to an exterior of the electronics housing **220** at the upper opening **433**B. In some implementations, the weather-resistant cover forms a vent for air to exit the cavity **337**A through the upper opening **433**B and the vent. In some implementations, the weather-resistant cover prevents external environmental elements, such as rain, moisture, or dust, to name a few examples, from entering the cavity **337**A through the upper opening **433**B. In some implementations, the weather-resistant cover includes any one or combination of a passageway for air to move through, a mesh, screen, or filter to prevent dust and/or debris intrusion, a water repellent seal or port to prevent water intrusion, or a one-way valve to prevent air from outside the cavity **337**A from moving through the passageway. In some embodiments, the lower opening **433**A is used to move air into the cavity **337**A. In the embodiment depicted in FIG. **4**A, the lower opening **433**A includes a feature to prevent external environmental elements from entering the cavity **337**A through the lower opening **433**A. In some examples, the feature includes at least one of the features of the weather-resistant cover. In one example, the weather resistant cover is coupled to the exterior of the electronics housing **220** at the lower opening **433**A.

[0089] In some embodiments, an airflow generating venting device (e.g., airflow generating venting device **434**B in FIG. **4**B) is coupled to the electronics housing **220** at the upper opening **433**B. In some implementations, the airflow generating venting device is attached to an interior surface (e.g., the interior surface **335** in FIG. **3**B) of the electronics housing **220**. In some examples, the airflow generating venting device is attached to the interior surface of a side (e.g., the side **321**B in FIGS. **3**A, **4**A, **4**B, and **6**-**7**B) of the electronics housing **220**. In some implementations, the airflow generating venting device is attached to an exterior surface of the electronics housing **220**. The airflow generating venting device moves air out of the cavity **337**A through the upper opening **433**B. In some implementations, the air is heated air that is heated by the electronic components **222**. In some implementations, the airflow generating venting device pulls air into the cavity **337**A through the lower opening **433**A.

[0090] In some embodiments, the electronics housing **220** includes attach points **423**. In some implementations, the attach points **423** are on a side **321**B of the electronics housing **220** that is adjacent to a left-side ribbon (e.g., the left-side ribbon **262**C in FIGS. **2** and **9**) of an enclosure (e.g., the enclosure **260** in FIGS. **2**, **9**, and **10**). In some embodiments, transport hardware couples to the attach point **423**. In some implementations, the transport hardware includes a handle or a knob for moving or carrying a BiDi charger (e.g., the BiDi charger **102** in FIGS. **1**, **2**, and **9**-**11**). The transport hardware may be installed when the left-side ribbon is not coupled to the enclosure.

[0091] In the embodiment depicted in FIG. **4**A, there are three PFC magnetics components **224**A, two DC magnetics components **224**B, three first transistor contact surfaces **427**A (corresponding to three first transistors), and eight second transistor contact surfaces **427**B (corresponding to eight second transistors). In some embodiments, more or less may be used.

[0092] FIG. **4**B shows the embodiment of FIG. **4**A after installation of the MPB1 **228**A, the MPB2 **228**B, an airflow generating stir device **434**A, and the airflow generating venting device **434**B, amongst other components. FIG. **4**B also shows the cavity **337**A prior to installation of a IFB PCBA (e.g., the IFB PCBA **228**C in FIGS. **2** and **3**B) and a PCC PCBA (e.g., the PCC PCBA **228**D in FIGS. **2** and **3**B). In some embodiments, a busbar **429** couples and/or electrically couples the MPB1 **228**A to the MPB2 **228**B.

[0093] In some embodiments, any one or combination of the airflow generating stir device **434**A or airflow generating venting device **434**B are coupled to the electronics housing **220**. In some implementations, the airflow generating stir device **434**A and/or the airflow generating venting device **434**B are coupled to an interior of the electronics housing **220**. In some implementations, the airflow generating stir device **434**A and/or the airflow generating venting device **434**B are coupled to a side **321**B of the electronics housing **220**. In some examples, the side **321**B is adjacent to a left-side ribbon (the left-side ribbon **262**C in FIGS. **2** and **9**) of an enclosure (e.g., the enclosure **260** in FIGS. **2**, **9**, and **10**).

[0094] In some embodiments, the airflow generating stir device **434**A generates air movement to circulate and/or stir air around a space. In some implementations, the airflow generating stir device **434**A stirs air inside the cavity **337**A. In the embodiment depicted in FIG. **4**B, the airflow generating stir device **434**A includes a stir fan to move air around the cavity **337**A. In some embodiments, the airflow generating venting device **434**B generates air movement to move air into the cavity **337**A from outside of the cavity **337**A (e.g., through the lower opening **433**A) and/or to move air from inside the cavity **337**A to outside the cavity **337**A (e.g., through the upper opening **433**B). In some implementations, the airflow generating venting device **434**B moves heated air from inside the cavity **337**A, such as air that is heated by electronic components (e.g., the electronic components **222** in FIGS. **2** and **3**B), to outside the cavity **337**A and external to the electronics housing **220**. In some implementations, the airflow generating venting device **434**B moves air into, through, and out of the cavity **337**A to bring in air and remove heated air. In some embodiments, an airflow generating device or assembly (e.g., airflow generating stir device **434**A, airflow generating venting device **434**B, or external airflow generating assembly **270**) comprises any one or combination of a fan, blower, ventilator, propellor, or any device that may generate airflow, to name a few examples. In some embodiments, the use or inclusion of the airflow generating stir device **434**A and/or the airflow generating venting device **434**B is optional. For example, a layout or arrangement of the electronic components **222**, the TIM, and the heat dissipating sections **238** may create heat flow paths that dissipate heat generated from the electronic components **222** without the airflow generating stir device **434**A and/or the airflow generating venting device **434**B fan, such as through natural convection.

[0095] In some embodiments, standoffs are used to provide space or a gap between any one or combination of the MPB1 **228**A, the MPB2 **228**B, the IFB PCBA, or the PCC PCBA. The space or gap may promote air circulation within the cavity **337**A and/or air movement through the cavity **337**A. The air movement or circulation may improve heat transfer.

[0096] In the embodiment depicted in FIG. **4**B, there are two airflow generating stir devices **434**A and one airflow generating venting device **434**B. In some embodiments, more or less may be used.

[0097] FIG. **5** is a flowchart of an illustrative process **500** for installing electronic components (e.g., the electronic components **222** in FIGS. **2** and **3**B) in an electronics housing (e.g., the electronics housing **220** in FIGS. **2**, **4**A, **6**-**7**B, and **9**), in accordance with embodiments of the disclosure.

[0098] The process **500** begins at operation **502** with coupling a first electronic component (e.g., one of PFC magnetics component **224**A, DC magnetics component **224**B, first transistor **226**A, or second transistor **226**B in FIGS. **2**, **3**B, and **4**A) to a first interior surface (e.g., one of the interior surfaces **335**A-**335**D in FIG. **3**B) within a cavity (e.g., the cavity **337**A in FIGS. **3**B-**4**B) of a housing (e.g., the electronics housing **220** in FIGS. **2**, **4**A, **6**-**7**B, and **9**), such as described above with respect to FIGS. **2**, **3**B, and **4**A. In some embodiments, the housing includes a first heat dissipating structure (e.g., one of the heat dissipating structures **339**A-**339**E in FIGS. **3**A and **3**B) coupled to a first exterior surface of the housing. The first heat dissipating structure removes a first amount of heat. The housing further includes a second heat dissipating structure (e.g., a different one of the heat dissipating structures **339**A-**339**E in FIGS. **3**A and **3**B) coupled to a second exterior surface of the housing. The second heat dissipating structure removes a second amount of heat. The first interior surface is opposite the first exterior surface of the housing.

[0099] The process **500** continues to operation **504** with coupling a second electronic component (e.g., a different one of PFC magnetics component **224**A, DC magnetics component **224**B, first transistor **226**A, or second transistor **226**B in FIGS. **2**, **3**B, and **4**A) to a second interior surface (e.g., a different one of the interior surfaces **335**A-**335**D in FIG. **3**B) within the cavity of the housing, such as described above with respect to FIGS. **2**, **3**B, and **4**A. In some embodiments, the second interior surface is opposite the second exterior surface of the housing.

[0100] FIG. **5** is an illustrative example of a method, and other methods including fewer, additional, or alternative steps are possible consistent with this disclosure. Various modifications can be made to the process **500** in accordance with various embodiments disclosed herein. In some embodiments, process **500** is a manual process and at least one of its operations is performed by a user or operator. In some embodiments, process **500** is an automated process and at least one of its operations is performed using control circuitry.

[0101] In some embodiments, the BiDi charger **102** includes an antenna system (e.g., antenna system **661** in FIGS. **6**A, **6**B, and **7**B) to enable communication (e.g., BiDi communication) with the BiDi charger **102**. For example, the antenna system may communicate with an external device (e.g., the external device **112** in FIG. **1**) or system. In some implementations, the antenna system comprises a dual antenna system (e.g., first antenna **646**A and second antenna **646**B in FIGS. **6**A and **6**B). In some implementations, the antenna system enables compact packing of components (e.g., the electronic components **222** in FIGS. **2** and **3**B and/or the field serviceable components **242** in FIGS. **2** and **6**) of the BiDi charger. An architecture for a dual antenna system is discussed in relation to FIGS. **6**A-**8**.

[0102] FIGS. **6**A and **6**B are schematic illustrations of an arrangement of components of an antenna system **661** of a bi-directional charger (e.g., the BiDi charger **102** in FIGS. **1**, **2**, and **9**-**11**), in accordance with embodiments of the disclosure. FIGS. **6**A and **6**B show different view perspectives to facilitate discussion of the antenna system **661**.

[0103] FIG. **6**A shows a position of a first antenna **646**A and a second antenna **646**B in relation to the electronics housing **220** and the electronics housing cover **264**. In the depicted embodiment, some features, such as an input terminal bock (e.g., the terminal block **254** in FIGS. **2**, **3**A, **6**B, and **7**A) and lower openings (e.g., the lower opening **333**, **433**A in FIGS. **3**A, **4**A, **4**B, and **6**B), have been omitted to avoid overcomplicating the drawing.

[0104] The electronics housing **220** includes the bottom **321**A and the sides **321**B. The bottom **321**A and the sides **321**B form a cavity (e.g., the cavity **337**A in FIGS. **3**B-**4**B) of the electronics housing **220** and two of the sides **321**B form the antenna recess **358**. When the electronics housing cover **264** is coupled to the electronics housing **220**, a portion of the electronics housing cover **264** extends beyond the sides **321**B of the electronics housing **220**. The first antenna **646**A is disposed adjacent to the bottom **321**A and external to the cavity of the electronics housing **220**. The second antenna **646**B is disposed adjacent to at least one of the sides **321**B (e.g., the two sides **321**B) and external to the cavity. In some embodiments, the second antenna **646**B is disposed adjacent to the electronics housing cover **264**. In some implementations, the second antenna **646**B is disposed adjacent to the cutout **365** of the electronics housing cover **264**. In the embodiment depicted in FIG. **6**A, dashed lines show orthogonal projections of the second antenna **646**B on the two sides **321**B and a dashed rectangle shows the orthogonal projection of the second antenna **646**B in the cutout **365**. In some embodiments, the second antenna **646**B is positioned such that at least one of the orthogonal projections is at a different location of the side **321**B or the electronics housing cover **264**.

[0105] The positions of the first and the second antenna **646**A, **646**B may affect communication with the BiDi charger. In the embodiment depicted in FIG. **6**A, the first and the second antenna **646**A, **646**B are arranged such that a first signal **676**A passing in a first direction is capable of being received at the second antenna **646**B without passing through the electronics housing **220**. In some embodiments, the first signal **676**A passes through the cutout **365** and the antenna recess **358** and is received at the second antenna **646**B. In some embodiments, the first signal **676**A is not capable of being received at the first antenna **646**A without passing through the electronics housing **220**. In some embodiments, the first signal **676**A must pass through the electronics housing **220** to be received at the first antenna **646**A. In some embodiments, the first signal **676**A is at least one of attenuated by the electronics housing **220** as it travels to the first antenna **646**A, degraded by the electronics housing **220** as it travels to the first antenna **646**A, or blocked by the electronics housing **220** from reaching the first antenna **646**A. In some embodiments, the first signal **676**A must pass through the electronics housing cover **264** and/or the cavity of the electronics housing **220** to be received at the first antenna **646**A. In some embodiments, the first signal **676**A is at least one of attenuated, degraded, or blocked by the electronics housing cover **264** and/or at least one electronic component (e.g., of the electronic components **222** in FIGS. **2** and **3**B) of the electronics housing **220** as it travels to the first antenna **646**A. Thus, if only one of the first or the second antenna **646**A, **646**B is used, then the BiDi charger may have difficulty communicating with other devices (e.g., the external device **112** in FIG. **1**) or systems (e.g., the AGD **104**, utility equipment **106**, electrical infrastructure **108**, or vehicle **110** in FIG. **1**).

[0106] In the embodiment depicted in FIG. **6**A, the first and the second antenna **646**A, **646**B are arranged such that a second signal **676**B passing in a second direction is capable of being received at the first antenna **646**A without passing through the electronics housing **220**. In some embodiments, the second direction is opposite the first direction. In some embodiments, the second signal **676**B is capable of being received at the second antenna **646**B. In some implementations, the second signal **676**B is capable of being received at the second antenna **646**B without passing through the electronics housing **220**. In some implementations, the second signal **676**B passes through the antenna recess **358** and is received at the second antenna **646**B. In some embodiments, the second signal **676**B is at least one of attenuated, degraded, or blocked by the electronics housing **220** (e.g., by the bottom **321**A and/or one of the sides **321**B) as it travels to the second antenna **646**B. Thus, if only one of the first or the second antenna **646**A, **646**B is used, then the BiDi charger may have difficulty communicating with other devices or systems. For example, the BiDi charger may be able to communicate with devices transmitting a signal in the second direction but not with devices transmitting a signal in the first direction.

[0107] In some embodiments, the second antenna **646**B is positioned closer to the electronics housing cover **264** or the cutout **365** thereof than what is shown in FIG. **6**A. In some implementations, positioning the second antenna **646**B closer to cutout **365** reduces or eliminates attenuation, degradation, or blocking of the first signal **676**A as it travels to the second antenna **646**B. In some implementations, positioning the second antenna **646**B closer to cutout results in attenuation, degradation, or blocking of the second signal **676**B by the electronics housing **220** as it travels to the second antenna **646**B.

[0108] In some embodiments, any one or combination of the bottom **321**A, the side **321**B, or the electronics housing cover **264** comprises a material that blocks, attenuates, or deprecates the first and/or the second signal **676**A, **676**B. In some implementations, any one or combination of the bottom **321**A, the side **321**B, or the electronics housing cover **264** comprises a metallic material. In some embodiments, at least a portion of the electronics housing cover **264** comprises a material that allows the first signal **676**A to be capable of being received at the second antenna **646**B without passing through the electronics housing **220**. In some implementations, the material is a non-metallic material. In some implementations, the second antenna **646**B is disposed adjacent to the portion of the electronics housing cover **264** that comprises the material.

[0109] In some embodiments, an orientation of the BiDi charger affects communication with the first and/or the second antenna **646**A, **646**B. In some implementations, the BiDi charger is mounted to a structure, such as a wall, which attenuates or degrades the first signal **676**A as it travels through the structure and towards the first or the second antenna **646**A, **646**B. In some examples, positioning the second antenna **646**B at any one or combination of adjacent to at least one side **321**B, external to the cavity, or in-line with the cutout **365** enables adequate communication with the BiDi charger via the second antenna **646**B. In some examples, the electronics housing **220** and/or the electronic components in combination with the structure attenuates or degrades the first signal **676**A to a signal loss value that is inadequate for communication with the BiDi charger via the first antenna **646**A. Thus, if the second antenna **646**B is not present and positioned as previously discussed, then communication with the BiDi charger may be impeded.

[0110] In some implementations, a wireless signal is attenuated or degraded based on a direction of the wireless signal. In some examples, a wireless signal passing in a third direction that is at an acute angle to the BiDi charger may be at least one of attenuated, degraded, or blocked by components of the BiDi charger as it travels to the first or the second antenna **646**A, **646**B. The components of the BiDi charger may include any one or combination of the electronics housing **220**, the electronics housing cover **264**, or an enclosure (e.g., the enclosure **260** in FIGS. **2**, **9**, and **10**), to name a few examples. The acute angle may be measure from a surface of a component of the BiDi charger. In some examples, positioning the first antenna **646**A at any one or combination of adjacent to the bottom **321**A or external to the cavity and/or positioning the second antenna **646**B at any one or combination of adjacent to at least one side **321**B, external to the cavity, or in-line with the cutout **365** enables adequate communication with the BiDi charger via the first or the second antenna **646**A, **646**B. Thus, if the first and the second antenna **646**A, **646**B are not present and positioned as previously discussed, then communication with the BiDi charger may be impeded.

[0111] FIG. **6**B shows the antenna system **661** positioned in the service area housing **240** of the BiDi charger. In some embodiments, the antenna system **661** includes the first antenna **646**A, the second antenna **646**B, and communications circuitry, such as the communications circuitry discussed in relation to FIG. **2**. In some embodiments, the CCU PCBA **244**B comprises the communications circuitry. In some embodiments, at least one of the first or the second antenna **646**A, **646**B is electronically coupled to the communications circuitry. In some embodiments, both the first and the second antenna **646**A, **646**B are used to communicate at a same time or during a same time period. In some embodiments, the first antenna **646**A is a primary antenna and/or a CCU antenna. In some embodiments, the second antenna **646**B is a secondary antenna. In some embodiments, the first and the second antenna **646**A, **646**B do not have an inherent priority, order, or rank. In some embodiments, one of the first or the second antenna **646**A, **646**B may be prioritized based on a request to establish communication with the BiDi charger or ongoing communication with the BiDi charger. In some embodiments, the communications circuitry receives at least one of the first or the second signal **676**A, **676**B. In some implementations, the communications circuitry controls the electronic switch **250** based at least in part on receiving the first and/or the second signal **676**A, **676**B. In some embodiments, the communications circuitry is external to the cavity of the electronics housing **220**. In some embodiments, the communications circuitry is disposed between the bottom **321**A and the first antenna **646**A. In some embodiments, the second antenna **646**B is disposed between the electronics housing cover **264** and the input terminal block **254**.

[0112] In some embodiments, the antenna system **661** is at least partially arranged in the service area housing **240**. In the embodiment depicted in FIG. **6**B, the service area housing **240** includes a first bottom **643**A, a second bottom **643**B, and a plurality of sides **643**C that at least partially form a compartment **645**A having an opening **645**B. The antenna system **661** is at least partially arranged in the compartment **645**A. In some embodiments, at least a portion of the field serviceable components **242** are arranged in the compartment **645**A.

[0113] Each of the plurality of sides **643**C has a first end coupled to at least one of the first or the second bottom **643**A, **643**B and a second end forming the opening **645**B. An interior surface of the first bottom **643**A is at a ninth depth (d**9**) from the opening **645**B and an interior surface of the second bottom **643**B is at a tenth depth (d**10**) from the opening **645**B. In some embodiments, the ninth and the tenth depths are measured from the second ends of the sides **643**C. In some embodiments, the tenth depth is deeper than the ninth depth.

[0114] In some embodiments, the first bottom **643**A is coupled to the bottom **643**A of the electronics housing **220**. The second bottom **643**B is arranged adjacent to the electronics housing cover **264**. In some embodiments, the second bottom **643**B is coupled to the electronics housing cover **264**. In some embodiments, the second bottom **643**B is arranged adjacent to, and/or coupled to, one of the sides **321**B of the electronics housing **220**. The first antenna **646**A is arranged in the compartment **645**A and disposed adjacent to the opening **645**B. The second antenna **646**B is arranged in the compartment **645**A and disposed adjacent to the second bottom **643**B. The first signal **676**A passes (e.g., in the first direction) through the second bottom **643**B and is capable of being received at the second antenna **646**B. In some embodiments, the second bottom **643**B is arranged in an antenna recess (e.g., the antenna recess **358** in FIGS. **3**A and **7**A) of the electronics housing **220**. The second antenna **646**B is arranged in the compartment **645**A and disposed adjacent to the second bottom **643**B. In some embodiments, the second antenna **646**B is coupled to the second bottom **643**B. In some embodiments, at least a portion of the service area housing **240** (e.g., the second bottom **643**B) comprises a non-metallic material. In some embodiments, at least a portion of the service area housing **240** (e.g., the second bottom **643**B) does not comprise a metallic material.

[0115] In the embodiment depicted in FIG. **6**B, a fuse **652** and/or the electronic switch **250** is coupled to the first bottom **643**A. The IMD PCBA **244**A is coupled to the first bottom **643**A. The CCU PCBA **244**B is coupled to the first bottom **643**A and/or the IMD PCBA **244**A. The antenna cover **248** is coupled to the CCU PCBA **244**B. In some implementations, standoffs and/or fasteners are used to couple any one or combination of the IMD PCBA **244**A, the CCU PCBA **244**B, or the antenna cover **248** to one another or to the service area housing **240**. In some implementations, the first antenna **646**A is coupled to the first antenna **646**A.

[0116] In some embodiments, the BiDi charger uses the antenna system **661** to enable a portion of communications, or all communications, with external systems and/or devices (e.g., any one or combination of the AGD **104**, the utility equipment **106**, the electrical infrastructure **108**, or the vehicle **110**, or the external device **112** in FIG. **1**). In some implementations, the communications application and/or the input interface application executes on the control circuitry to provide instructions to the control circuitry to send or receive data or information to the external systems or devices, such as discussed in relation to FIG. **2**.

[0117] In some embodiments, the antenna system **661** is arranged in an enclosure (e.g., the enclosure **260** in FIGS. **2**, **9**, and **10**).

[0118] In some embodiments, the antennas are used to send (or, e.g., transmit) and receive signals. Although the first and the second signal **676**A, **676**B are shown traveling towards the first and the second antenna **646**A, **646**B, respectively, at least one of the first or the second signal **676**A, **676**B may travel away from the first or the second antenna **646**A, **646**B.

[0119] In the embodiment depicted in FIG. **6**B, there are two electronic switches **250**. In some embodiments, more or less may be used. In the embodiment depicted in FIGS. **6**A and **6**B, there are two antennas (e.g., the first and the second antenna **646**A, **646**B). In some embodiments, more antennas may be used.

[0120] FIGS. **7**A and **7**B are schematic illustrations of the antenna system **661** of a BiDi charger (e.g., the BiDi charger **102** in FIGS. **1**, **2**, and **9-11**), in accordance with embodiments of the disclosure. As shown the electronics housing **220** is coupled to the electronics housing cover **264**.

[0121] FIG. **7**A shows the first and the second signals **676**A, **676**B in relation to a first orientation of the electronics housing **220**. A service area housing (e.g., the service area housing **240** in FIGS. **2**, **6**B, **7**B, and **9**) is omitted for clarity and ease of discussion. The first orientation is for illustrative purposes and does not necessarily reflect an orientation relating to the BiDi charger. In the first orientation, the electronics housing cover **264** faces upwards on the page. The first and the second signals **676**A, **676**B are shown in relation to the first orientation. The first signal **676**A passes through the cutout **365** of the electronics housing cover **264** and the antenna recess **358** of the electronics housing **220**, but does not pass through the electronics housing **220**, such as discussed in relation to FIG. **6**A. The weather-resistant cover **232** is coupled to an exterior of the electronics housing **220**.

[0122] FIG. **7**B shows the first and the second signals **676**A, **676**B in relation to a second orientation of the electronics housing **220**. The second orientation is for illustrative purposes and does not necessarily reflect an orientation relating to the BiDi charger. In the second orientation, the electronics housing cover **264** faces downwards on the page and the bottom **321**A of the electronics housing **220** faces upwards. The first and the second signals **676**A, **676**B are shown in relation to the second orientation. The first bottom **643**A of the service area housing **240** is at the ninth depth and the second bottom **643**B is at the tenth depth. The external airflow generating assembly **270** is arranged adjacent to one of the sides **321**B of the electronics housing **220** and electrically coupled to the fan harness **371**. The external airflow generating assembly **270** moves air across the bottom **321**A of the electronics housing **220** to remove heat from the heat dissipating sections **238**. In some embodiments, the external airflow generating assembly **270** moves heated air that is evacuated from a cavity (e.g., the cavity **337**A in FIGS. **3**B-**4**B) of the electronics housing **220**, such as discussed in relation not FIG. **4**B, away from the electronics housing **220**. In some embodiments, the external airflow generating assembly **270** is coupled to an exterior of the electronics housing **220**.

[0123] In some embodiments, the external airflow generating assembly **270** includes an external fan assembly to move air over the exterior of the electronics housing **220**. In the embodiment depicted in FIG. **7**B, the external airflow generating assembly **270** includes five fans. In some embodiments, more or less may be used.

[0124] As discussed in relation to FIGS. **6**A-**7**B, the wireless signals (e.g., the first and the second signal **676**A, **676**B) pass in a direction. In some embodiments, each of the wireless signals may not technically pass in a single direction. The wireless signals may comprise electromagnetic waves that oscillate as they travel through space. For example, a wireless signal may change direction as it propagates according to a wave pattern having a wavelength, frequency, amplitude, and/or speed. However, for illustrative purposes, the direction that each wireless signal passes may be considered the overall direction that it propagates. In some embodiments, communication with the BiDi charger is BiDi. For example, the BiDi charger receives the first signal **676**A passing in the first direction. The first signal **676**A may be sent from an external device or system. The BiDi charger may send or transmit a signal to the device that passes in a direction opposite of the first direction.

[0125] FIG. **8** is a flowchart of an illustrative process **800** for installing an antenna system (e.g., the antenna system **661** in FIGS. **6**A, **6**B, and **7**B) in a BiDi charger (e.g., the BiDi charger **102** in FIGS. **1**, **2**, and **9**-**11**), in accordance with embodiments of the disclosure.

[0126] The process **800** begins at operation **802** with positioning a first antenna (e.g., the first antenna **646**A in FIGS. **6**A and **6**B) adjacent to and external to a bottom (e.g., the bottom **321**A in FIGS. **3**A, **6**-**7**B, and **9**) of an electronics housing (e.g., the electronics housing **220** in FIGS. **2**, **4**A, **6**-**7**B, and **9**), such as described above with respect to FIG. **6**A. In some embodiments, the electronics housing comprises the bottom and a plurality of sidewalls (e.g., the sides **321**B in FIGS. **3**A, **4**A, **4**B, and **6**-**7**B). The sidewalls form an external antenna recess (e.g., the antenna recess **358** in FIGS. **3**A and **7**A). An electronics housing cover (e.g., the electronics housing cover **264** in FIGS. **2**, **3**A, **6**-**7**B, and **11**) is coupled to a recessed sidewall (e.g., a side **321**B forming an antenna recess **358** in FIGS. **3**A and **7**A) of the sidewalls. A portion of the electronics housing cover extends over the external antenna recess.

[0127] The process **800** continues to operation **804** with positioning a second antenna (e.g., the second antenna **646**B in FIGS. **6**A and **6**B) in the external antenna recess, such as described above with respect to FIGS. **6**A, **6**B, and **7**B. A first signal (e.g., the first signal **676**A in FIGS. **6**A-**7**B) passing in a first direction is capable of being received at the second antenna without passing through the electronics housing. The first signal passing in the first direction is not capable of being received at the first antenna without passing through the electronics housing. A second signal (e.g., the second signal **676**B in FIGS. **6**A-**7**B) passing in a second direction opposite the first direction is capable of being received at the first antenna without passing through the electronics housing. In some embodiments, positioning the first antenna includes positioning the second antenna between the electronics housing cover and a terminal block.

[0128] FIG. **8** is an illustrative example of a method, and other methods including fewer, additional, or alternative steps are possible consistent with this disclosure. Various modifications can be made to the process **800** in accordance with various embodiments disclosed herein. In some embodiments, process **800** is a manual process and at least one of its operations is performed by a user or operator. In some embodiments, process **800** is an automated process and at least one of its operations is performed using control circuitry.

[0129] In some embodiments, the BiDi charger **102** includes a particular packing configuration. In some implementations, a design and layout of components for the BiDi charger **102** enables compact packing of BiDi charger **102** components and increases maintainability and serviceability. In some implementations, the design and layout of components increases serviceability and safety of the BiDi charger **102** by allowing easy access to field serviceable components (e.g., the field serviceable components **242** in FIGS. **2** and **6**) and restricting access to non-field serviceable components (e.g., the electronic components **222** in FIGS. **2** and **3**B). The packing configuration is discussed in relation to FIGS. **9**-**12**.

[0130] FIG. **9** is a schematic illustration of components within the enclosure **260** of a BiDi charger (e.g., the BiDi charger **102** in FIGS. **1**, **2**, and **9**-**11**), in accordance with embodiments of the disclosure.

[0131] In some embodiments, the enclosure **260** forms an internal space **968** having an enclosure opening **969**. In some implementations, any one or combination of the electronics housing **220**, the service area housing **240**, or the external airflow generating assembly **270** are arranged within the internal space **968**.

[0132] In some embodiments, any one of combination of the electronics housing **220** or the service area housing **240** are coupled to the enclosure **260**. In some embodiments, a compartment opening (e.g., the opening **645**B in FIGS. **6**B and **7**B) of a compartment (e.g., the compartment **645**A in FIGS. **6**B and **7**B) of the service area housing **240** faces a front cover (e.g., the front cover **266** in FIGS. **2** and **10**) of the enclosure **260** (or, e.g., the opening **969**). In some examples, field serviceable components (e.g., the field serviceable components **242** in FIGS. **2** and **6**) are accessible through the opening of the compartment of the service area housing **240** when the front cover is removed. As shown in FIG. **9**, the front cover has been removed and the service area cover **256** would need to be removed (e.g., using standard tools or hardware) to service the field serviceable components.

[0133] In some embodiments, a cavity opening (e.g., the opening **337**B in FIGS. **3**B-**4**B) of a cavity (e.g., the cavity **337**A in FIGS. **3**B-**4**B) of the electronics housing **220** faces away from the front cover of the enclosure **260**. In some examples, electronic components (e.g., the electronic components **222** in FIGS. **2** and **3**B) are not accessible when the front cover is removed.

[0134] As shown in FIG. **9**, the electronics housing **220** would need to be removed from the internal space **968** (e.g., by removing the ribbons **262**A-**262**D) and decoupled from an electronics housing cover (e.g., the electronics housing cover **264** in FIGS. **2**, **3**A, **6**-**7**B, and **11**) to access the electronic components. In some embodiments, the electronics housing **220** is coupled to the electronics housing cover such that the cavity opening faces the electronics housing cover. In some embodiments, non-standard or specialty tools or hardware are needed to decouple the electronics housing **220** from the electronics housing cover. In some implementations, any one or combination of a security fastener, tamper-resistant or proof fastener, or lock, to name a few examples, may couple the electronics housing **220** from the electronics housing cover. In some embodiments, the enclosure **260** comprises the electronics housing cover and the ribbons **262**A-**262**D.

[0135] In some embodiments, the bottom **321**A of the electronics housing **220** faces the front cover of the enclosure **260**. The bottom **321**A may be referred to as a backside of the electronics housing **220**. For example, the backside may be more relevant when an orientation of the electronics housing **220** is such that the bottom **321**A does not face down or towards the ground, such as when the electronics housing **220** is arranged in the internal space **968**, or when the electronics housing **220** is oriented differently than surrounding components, such as when a bottom (e.g., the first bottom **643**A and/or second bottom **643**B in FIGS. **6**B and **7**B) of the service area housing **240** couples to the bottom **321**A.

[0136] In some embodiments, the external airflow generating assembly **270** is removable from the internal space **968** by removing the right-side ribbon **262**D. In some implementations, the front cover is not removed when removing the external airflow generating assembly **270**. In some embodiments, the external airflow generating assembly **270** is decoupled from any one or combination of the right-side ribbon **262**D, the electronics housing **220**, or the service area housing **240** when removed from the internal space **968**. In some implementations, the right-side ribbon **262**D is not removed when removing the external airflow generating assembly **270**.

[0137] In some embodiments, the enclosure **260** includes a first enclosure knockout **263**A or opening for input power. In some implementations, the first enclosure knockout **263**A provides access to an input terminal block (e.g., the input terminal block **254** in FIGS. **2**, **3**A, **6**B, and **7**A). In some embodiments, the first enclosure knockout **263**A is not used and a cutout (e.g., the cutout **365** in FIGS. **3**A and **7**A) in the electronics housing cover is used for input power. In some embodiments, the enclosure **260** includes a second enclosure knockout **263**B or opening for a charging cable (e.g., the charging cable **103** in FIG. **1**) to connect to the BiDi charger. In some implementations, the second enclosure knockout **263**B provides access for the charging cable to an electronic component (e.g., the electronic components **222** in FIGS. **2** and **3**B) and/or a field serviceable component (e.g., the field serviceable components **242** in FIGS. **2** and **6**). In some implementations, the bottom ribbon **262**B includes the first and/or the second enclosure knockout **263**A, **263**B.

[0138] FIG. **10** is a schematic illustration of an enclosure of a BiDi charger (e.g., the BiDi charger **102** in FIGS. **1**, **2**, and **9-11**), in accordance with embodiments of the disclosure.

[0139] In some embodiments, the enclosure **260** includes a user interface element **1082** and a light bar assembly **1080**. In some embodiments, the user interface element **1082** receives input (e.g., from a user) to control providing power to the vehicle. In some implementation, control circuitry receives the input (e.g., though I/O circuitry) and executes an application to control power based on the input. In some implementations, the user interface element **1082** includes any one or combination of a button, a switch, or a screen.

[0140] In some embodiments, the light bar assembly **1080** indicates a status of the BiDi charger **102**, which may include any one or combination of a fault status, a charging status, an idle status, or a discharge state status, to name a few examples. In some implementations, the light bar assembly **1080** includes any one or combination of an indicator light, a speaker, an actuator (e.g., for vibration-based or haptic feedback), or a display. In some embodiments, any of the user interface element **1082** or the light bar assembly **1080** are field serviceable.

[0141] The accent panel **274** couples to the front cover **266**, such as discussed in relation to FIGS. **2** and **10**. In some embodiments, the front cover **266** forms a front recess **1067** and the accent panel **274** is arranged in the front recess **1067**. The front cover **266** of the enclosure **260** provides access to an internal space (e.g., the internal space **968** in FIG. **9**) of the enclosure **260**. In some implementations, the front cover **266** is decoupled or removed from the enclosure **260** to provide access. In some implementations, the front cover **266** slides in relation to, or swings away from (e.g., using a hinge) the enclosure **260** to provide access.

[0142] In some embodiments, a signal (e.g., the second signal **676**B in FIGS. **6**A-**7**B) passes through any of the accent panel **274**, the front cover **266**, or a service area cover (e.g., the service area housing **240** in FIGS. **2**, **6**B, **7**B, and **9**) and is capable of being received at an antenna (e.g., the second antenna **646**B in FIGS. **6**A and **6**B) in the internal space of the enclosure **260**. In some embodiments, any of the accent panel **274**, the front cover **266**, or the service area cover comprises a non-metallic material. In some embodiments, any of the accent panel **274**, the front cover **266**, or the service area cover do not comprise a metallic material.

[0143] FIG. **11** is a schematic illustration of a mounting system **1183** for a BiDi charger (e.g., the BiDi charger **102** in FIGS. **1**, **2**, and **9-11**), in accordance with some embodiments of this disclosure.

[0144] In some embodiments, the mounting system includes the mounting cleat **272**, a first retention feature **1188**, and a mounting bracket **1184**. The mounting cleat **272** is coupled to the electronics housing cover **264**, which may be used to couple the BiDi charger **102** to the mounting bracket **1184**.

[0145] The mounting cleat **272** includes first support feature **1186**A and a first alignment feature **1186**B. The mounting bracket **1184** includes a second support feature **1187**A, a second alignment feature **1187**B, and a second retention feature **1189**. In some embodiments, the mounting bracket **1184** is coupled or attached to an external structure and the mounting cleat **272** and the first retention feature **1188** engages the mounting bracket **1184** to mount the BiDi charger **102** to the external structure. In some implementations, the mounting bracket **1184** is attached to any or a wall, pillar, pole, or column. In some implementations, the mounting bracket is part of a stand or fixture. In some embodiments, any of the first support feature **1186**A, second support feature **1187**A, first retention feature **1188**, or second retention feature **1189** may be considered a mounting feature.

[0146] The first alignment feature **1186**B engages a second alignment feature **1187**B to align the BiDi charger **102** to the mounting bracket **1184**. The first support feature **1186**A engages the second support feature **1187**A to support and retain of the BiDi charger **102** on the mounting bracket **1184**. The first retention feature **1188** engages the second retention feature **1189** to retain the BiDi charger **102** on the mounting bracket **1184**.

[0147] In some embodiments, the first support feature **1186**A includes a flange of the mounting cleat **272**. The second support feature **1187**A includes a channel. The flange contacts the channel to support the BiDi charger **102**. In some embodiments, the first alignment feature **1186**B includes a first tab extending from the first support feature **1186**A. The second alignment feature **1187**B includes a slot in the second support feature **1187**A. The first tab is placed in the slot to align the BiDi charger **102**. In some embodiments, the first retention feature **1188** includes a shaft coupled to a head extending past the shaft exterior. In some implementations, the first retention feature **1188** includes a peg or a shoulder bolt. The second retention **1189** feature includes a groove in a second tab extending from the mounting bracket **1184**. The shaft is placed in the groove and the head extends over the second tab to retain the BiDi charger **102**.

[0148] In the embodiment depicted in FIG. **11**, there are two first retention features **1188** and two second retention features **1189**. In some embodiments, more or less may be used.

[0149] FIG. **12** is a flowchart of an illustrative process **1200** for servicing components (e.g., the field serviceable components **242** in FIGS. **2** and **6**) of a BiDi charger (e.g., the BiDi charger **102** in FIGS. **1**, **2**, and **9-11**), in accordance with embodiments of the disclosure.

[0150] The process **1200** begins at operation **1202** with removing a front cover (e.g., the front cover **266** in FIGS. **2** and **10**) of an enclosure (e.g., the enclosure **260** in FIGS. **2**, **9**, and **10**), such as described above with respect to FIGS. **2** and **10**. In some embodiments, the enclosure forms an internal space (e.g., the internal space **968** in FIG. **9**).

[0151] The process **1200** continues to operation **1204** with removing a housing cover (e.g., the service area cover **256** in FIGS. **2** and **9**) of a service area housing (e.g., the service area housing **240** in FIGS. **2**, **6**B, **7**B, and **9**), such as described above with respect to FIGS. **2** and **9**. In some embodiments, the service area housing is arranged within the internal space. The service area housing comprises field serviceable components (e.g., the field serviceable components **242** in FIGS. **2** and **6**) that are accessible when the housing cover is removed.

[0152] The process **1200** continues to operation **1206** with servicing at least one component of the field serviceable components, such as described above with respect to FIG. **2**. In some embodiments, the servicing includes removing and/or replacing the least one component. In some embodiments, the servicing includes servicing a first component of the field serviceable components that is (i) coupled to the service area housing and (ii) accessible only when the housing cover is removed. The servicing further includes servicing a second component of the field serviceable components that is coupled to the removable side of the enclosure.

[0153] FIG. **12** is an illustrative example of a method, and other methods including fewer, additional, or alternative steps are possible consistent with this disclosure. Various modifications can be made to the process **1200** in accordance with various embodiments disclosed herein. In some embodiments, process **1200** is a manual process and at least one of its operations is performed by a user or operator. In some embodiments, process **1200** is an automated process and at least one of its operations is performed using control circuitry.

[0154] The foregoing is merely illustrative of the principles of this disclosure and various modifications may be made by those skilled in the art without departing from the scope of this disclosure. The above-described embodiments are presented for purposes of illustration and not of limitation. The present disclosure also can take many forms other than those explicitly described herein. Accordingly, it is emphasized that this disclosure is not limited to the explicitly disclosed methods, systems, and apparatuses, but is intended to include variations to and modifications thereof, which are within the spirit of the following claims.

What is claimed is:

1. An apparatus, comprising:
- an electronics housing having a bottom and a side, wherein the bottom and the side at least partially form a cavity having an opening;
- an electronics housing cover coupled to the electronics housing, wherein:
  - the electronics housing cover at least partially covers the opening of the cavity; and
  - a portion of the electronics housing cover extends beyond the side of the electronics housing;
- a first antenna disposed adjacent to the bottom and external to the cavity of the electronics housing; and
- a second antenna disposed adjacent to the side and external to the cavity of the electronics housing, wherein:
  - a first signal passing in a first direction is capable of being received at the second antenna without passing through the electronics housing;
  - the first signal passing in the first direction is not capable of being received at the first antenna without passing through the electronics housing; and
  - a second signal passing in a second direction opposite the first direction is capable of being received at the first antenna without passing through the electronics housing.

2. The apparatus of claim **1**, wherein:
- the electronics housing cover forms a cutout; and
- the first signal passing in the first direction and through the cutout is capable of being received at the second antenna.

3. The apparatus of claim **1**, further comprising a terminal block coupled to the side of the electronics housing, wherein the second antenna is disposed between the electronics housing cover and the terminal block.

4. The apparatus of claim **1**, further comprising communications circuitry, wherein:
- the communications circuitry is electronically coupled to the first antenna and the second antenna and configured to receive the first signal and the second signal;
- the communications circuitry is configured to receive the first signal and the second signal from the first antenna and the second antenna; and
- the communication circuitry is external to the cavity of the electronics housing.

5. The apparatus of claim **4**, wherein the communications circuitry is disposed between the bottom of the electronics housing and the first antenna.

6. The apparatus of claim **4**, wherein:
- the communications circuitry is configured to control an electronic switch based on the received first signal and received second signal.

7. The apparatus of claim **1**, wherein each of the bottom of the electronics housing, the side of the electronics housing, and the electronics housing cover comprise a metallic material.

8. The apparatus of claim 1, further comprising an enclosure forming an internal space, wherein:
the enclosure comprises:
the electronics housing cover;
a front cover; and
a plurality of sides coupled to the electronics housing cover and the front cover;
the electronics housing, the first antenna, and the second antenna are arranged in the internal space of the housing; and
the second signal passing in the second direction and through the front cover is capable of being received at the first antenna.

9. The apparatus of claim 1, further comprising a service area housing having a first bottom, a second bottom, and a side, wherein the first bottom, the second bottom, and the side at least partially form a compartment having an opening, wherein:
the compartment of the service area housing comprises a first depth corresponding to the first bottom and a second depth corresponding to the second bottom, the second depth is deeper than the first depth;
the first bottom of the service area housing is coupled to the bottom of the electronics housing;
the second bottom of the service area housing is arranged adjacent to the electronics housing cover;
the first antenna is arranged in the compartment and disposed adjacent to the opening of the service area housing; and
the second antenna is arranged in the compartment and disposed adjacent to the second bottom of the service area housing.

10. An apparatus, comprising:
an electronics housing having a bottom and a plurality of sidewalls, wherein the plurality of sidewalls form an external antenna recess;
an electronics housing cover coupled to a recess sidewall of the plurality of sidewalls of the electronics housing, wherein a portion of the electronics housing cover extends over the external antenna recess;
a first antenna disposed adjacent to and external to the bottom of the electronics housing; and
a second antenna disposed in the external antenna recess, wherein:
a first signal passing in a first direction is capable of being received at the second antenna without passing through the electronics housing;
the first signal passing in the first direction is not capable of being received at the first antenna without passing through the electronics housing; and
a second signal passing in a second direction opposite the first direction is capable of being received at the first antenna without passing through the electronics housing.

11. The apparatus of claim 10, wherein:
the electronics housing cover forms a cutout; and
the first signal passing in the first direction and through the cutout is capable of being received at the second antenna.

12. The apparatus of claim 10, further comprising a terminal block coupled to the recess sidewall of the electronics housing, wherein:
the second antenna is disposed between the electronics housing cover and the terminal block;
the bottom and the plurality of sidewalls form a cavity of the electronics housing for housing a plurality of electronic components; and
the terminal block is configured to provide power to the plurality of electronic components.

13. The apparatus of claim 10, further comprising communications circuitry, wherein:
the communications circuitry is electronically coupled to the first antenna and the second antenna;
the communications circuitry is configured to receive the first signal and the second signal from the first antenna and the second antenna; and
the communication circuitry is positioned adjacent to and external to the bottom of the electronics housing.

14. The apparatus of claim 13, wherein the communications circuitry is disposed between the bottom of the electronics housing and the first antenna.

15. The apparatus of claim 10, wherein each of the bottom of the electronics housing, the recess sidewall of the electronics housing, and the electronics housing cover comprise a metallic material.

16. A method, comprising:
positioning a first antenna adjacent to and external to a bottom of an electronics housing, the electronics housing comprising:
the bottom and a plurality of sidewalls, wherein:
the plurality of sidewalls form an external antenna recess;
an electronics housing cover is coupled to a recess sidewall of the plurality of sidewalls of the electronics housing; and
a portion of the electronics housing cover extends over the external antenna recess; and
positioning a second antenna in the external antenna recess, wherein:
a first signal passing in a first direction is capable of being received at the second antenna without passing through the electronics housing;
the first signal passing in the first direction is not capable of being received at the first antenna without passing through the electronics housing; and
a second signal passing in a second direction opposite the first direction is capable of being received at the first antenna without passing through the electronics housing.

17. The method of claim 16, wherein:
positioning the second antenna in the external antenna recess comprises positioning the second antenna between the electronics housing cover and a terminal block;
the terminal block is coupled to the recess sidewall of the electronics housing;
the bottom and the plurality of sidewalls form a cavity of the electronics housing for housing a plurality of electronic components; and
the terminal block is configured to provide power to the plurality of electronic components.

18. The method of claim 16, further comprising electronically coupling the first antenna and the second antenna to communications circuitry, wherein:
the communications circuitry is configured to receive the first signal and the second signal from the first antenna and the second antenna; and

the communication circuitry is positioned adjacent to and external to the bottom of the electronics housing.

19. The method of claim **16**, wherein:

the electronics housing cover forms a cutout and is part of an enclosure forming an internal space, the enclosure comprising:

the electronics housing cover;

a front cover; and

a plurality of sides coupled to the electronics housing cover and the front cover, wherein the electronics housing is arranged inside the internal space of the enclosure; and

the method further comprises decoupling the front cover from the plurality of sides, wherein:

positioning the first antenna adjacent to and external to the bottom of the electronics housing comprises positioning the first antenna in the internal space of the enclosure;

positioning the second antenna in the external antenna recess comprises positioning the second antenna in the internal space of the enclosure;

the first signal passing in the first direction and through the cutout is capable of being received at the second antenna; and

while the front cover is coupled to the plurality of sides, the second signal passing in the second direction and through the front cover is capable of being received at the first antenna.

20. The method of claim **16**, wherein:

the electronics housing cover forms a cutout;

a service area housing having a bottom and a side is coupled to the electronics housing, wherein:

the bottom and the side of the service area housing at least partially form a compartment having an opening;

a first portion of the bottom of the service area housing is arranged adjacent to the bottom of the electronics housing; and

a second portion of the bottom of the service area housing is arranged adjacent to the cutout of the electronics housing cover;

positioning the first antenna adjacent to and external to the bottom of the electronics housing comprises positioning the first antenna in the compartment and adjacent to the opening of the service area housing;

positioning the second antenna in the external antenna recess comprises positioning the second antenna in the compartment and adjacent to the second portion of the bottom of the service area housing; and

the first signal passing in the first direction and through the cutout and the second portion of the bottom of the service area housing is capable of being received at the second antenna.

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