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Inventor(s)	TANABE; Yoshiharu et al.

POWER CONVERSION DEVICE

Abstract

A power conversion device includes: a first connector held by a support plate; a second connector held by the support plate to be adjacent to the first connector; and a bus bar connecting the first connector and the second connector to at least a capacitor unit and a DC/DC converter unit, in which the support plate includes a surrounding wall portion surrounding a partition wall portion from a side thereof, and the first connector and the second connector are provided to protrude from an outer wall surface of the surrounding wall portion and are formed such that cables are mountable thereon in a direction inclined relative to a wall surface of the partition wall portion.

Inventors: **TANABE; Yoshiharu (Hitachinaka-shi, JP), NAKANO; Kohei (Hitachinaka-shi, JP), UNEME; Takahiro (Tokyo, JP), WAKABAYASHI; Ryuta (Tokyo, JP)**

Applicant: **Hitachi Astemo, Ltd.** (Hitachinaka-shi,, JP); **HONDA MOTOR CO., LTD.** (Tokyo, JP)

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present invention claims priority under 35 U.S.C. § 119 to Japanese Application No. 2024-022219, filed on Feb. 16, 2024, the entire contents of which being incorporated herein by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to a power conversion device.

Description of Related Art

[0003] For example, Japanese Patent No. 6908004 (hereinafter, referred to as Patent Document 1) discloses a power conversion device that includes a plurality of high-voltage connectors.

[0004] The power conversion device disclosed in Patent Document 1 includes an input connector and an output connector as the high-voltage connectors. The input connector is configured to be connected with a connector of a power supply wiring connected to a DC power supply. The output connector is configured to be connected with a connector of a load wiring connected to an AC load such as a rotating electric machine.

[0005] In the power conversion device disclosed in Patent Document 1, the input connector and the output connector are provided to be aligned on a side surface of a case. An external connector (for example, the above-described connector of the power supply wiring or connector of the load wiring) is inserted into these input and output connectors in a horizontal direction. In this way, when a configuration is adopted in which the external connector is inserted into the connector of the power conversion device in the horizontal direction, the connector greatly protrudes to the side of the power conversion device. In addition, the external connector connected to the power conversion device also greatly protrudes to the side of the power conversion device. As a result, it is necessary to secure a large installation space for the power conversion device.

[0006] The present invention has been made in view of the above-described circumstances, and an object of the present invention is to be able to reduce the installation space for a power conversion device.

SUMMARY OF THE INVENTION

[0007] The present invention adopts the following configuration as means for obtaining the above object.

[0008] A power conversion device of an aspect of the present invention, includes a capacitor unit, a reactor unit, a DC/DC converter unit, and a power module forming a power conversion circuit; a support plate including a flat plate-shaped partition wall portion supporting the capacitor unit, the reactor unit, the DC/DC converter unit, and the power module; a first connector held by the support plate; a second connector held by the support plate to be adjacent to the first connector; and a bus bar connecting the first connector and the second connector to at least the capacitor unit and the DC/DC converter unit, in which the support plate includes a surrounding wall portion surrounding the partition wall portion from a side thereof, and the first connector and the second connector are provided to protrude from an outer wall surface of the surrounding wall portion and are formed such that cables are mountable thereon in a direction inclined relative to a wall surface of the partition wall portion.

[0009] In the power conversion device of the present invention, the first connector and the second connector adjacent to each other are provided to protrude from an outer wall surface of the surrounding wall portion of the support plate and are formed such that cables are mountable thereon in a direction inclined relative to a flat plate-shaped partition wall portion. Therefore, it is possible to further reduce the amount of protrusion of the first connector and the second connector from the outer wall surface than a case where the cables are mounted on the first connector and the second connector in a horizontal direction with respect to the flat plate-shaped partition wall portion. In addition, it is possible to further reduce the amount of protrusion of the cables in the horizontal direction than a case where the cables are mounted on the first connector and the second connector in the horizontal direction. Therefore, the power conversion device of the present embodiment can reduce the installation space when viewed in the normal direction of the partition wall portion.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0010] FIG. **1** is a schematic configuration diagram of a vehicle on which a power conversion device according to an embodiment of the present invention is mounted.
[0011] FIG. **2** is a circuit diagram showing an electrical schematic configuration of a buck-boost converter and an inverter included in the power conversion device according to the embodiment of the present invention.
[0012] FIG. **3** is an exploded perspective view showing a structural schematic configuration of the power conversion device according to the embodiment of the present invention.
[0013] FIG. **4** is a schematic cross-sectional view including a reactor unit of the power conversion device according to the embodiment of the present invention.
[0014] FIG. **5** is a schematic view in which an upper cover of a main body case of the power conversion device according to the embodiment of the present invention is omitted.
[0015] FIG. **6** is a perspective view of an internal bus bar included in the power conversion device according to the embodiment of the present invention.
[0016] FIG. **7** is a schematic view showing a stress relaxation portion provided in an intermediate portion of the internal bus bar.
DETAILED DESCRIPTION OF THE INVENTION
[0017] In the following, an embodiment of a power conversion device according to the present invention will be described with reference to the drawings.
[0018] FIG. **1** is a schematic configuration diagram of a vehicle **100** on which a power conversion device **1** of the present embodiment is mounted. The vehicle **100** is, for example, an electric vehicle or a hybrid vehicle. As shown in FIG. **1**, the vehicle **100** includes, for example, a high voltage battery HB, a low voltage battery LB, a motor M, and the power conversion device **1** of the present embodiment.
[0019] The high voltage battery HB is a secondary battery, such as a lithium ion battery, and outputs relatively high voltage DC power of, for example, about several hundred volts. The high voltage battery HB is a battery that outputs driving electric power to be supplied to the motor M and is a so-called driving battery. The low voltage battery LB is a secondary battery, such as a lead-acid battery, and outputs relatively low voltage DC power of, for example, about 12 V. The low voltage battery LB is a battery that outputs power for auxiliary devices to be supplied to auxiliary devices (not shown) and is a so-called auxiliary device battery.
[0020] The motor M generates rotational motive power by the driving electric power being supplied thereto from the high voltage battery HB through the power conversion device **1**. The rotational motive power generated by the motor M is transmitted to drive wheels of the vehicle **100** through a transmission mechanism (not shown). In the present embodiment, the motor M includes a first motor M**1** and a second motor M**2**. For example, the first motor M**1** generates motive power to be supplied to front wheels of the vehicle **100**. In addition, for example, the second motor M**2** generates motive power to be supplied to rear wheels of the vehicle **100**.
[0021] The power conversion device **1** of the present embodiment is a device that performs power

conversion. For example, the power conversion device **1** converts DC power into AC power, converts AC power into DC power, or converts voltage. Specifically, the power conversion device **1** of the present embodiment steps up the driving electric power output from the high voltage battery HB, converts it into alternating current, and supplies the alternating current to the motor M. In addition, the power conversion device **1** of the present embodiment converts regenerative power output from the motor M into direct current, steps down it, and supplies it to the high voltage battery HB. Further, the power conversion device **1** of the present embodiment steps down the driving electric power output from the high voltage battery HB to generate power for auxiliary devices and supplies the power for auxiliary devices to the low voltage battery LB.
[0022] As shown in FIG. **1**, the power conversion device **1** of the present embodiment includes a buck-boost converter **2**, an inverter **3**, and a DC/DC converter **4**. The buck-boost converter **2**, the inverter **3**, and the DC/DC converter **4** constitute a power conversion circuit H that performs power conversion. The buck-boost converter **2** steps up or steps down the electric power. For example, the buck-boost converter **2** steps up the driving electric power supplied from the high voltage battery HB and outputs it to the inverter **3**. In addition, the buck-boost converter **2** steps down the regenerative power supplied from the inverter **3** and outputs it to the high voltage battery HB.
[0023] The inverter **3** converts the DC power into the AC power or converts the AC power into the DC power. For example, the inverter **3** converts DC driving electric power supplied from the buck-boost converter **2** into three-phase AC power and outputs the three-phase AC power to the motor M. In addition, the inverter **3** converts AC regenerative power supplied from the motor M into DC power and outputs the DC power to the high voltage battery HB. In the present embodiment, the inverter **3** includes a first inverter **3***a* and a second inverter **3***b*. The first inverter **3***a* is connected to the first motor M**1**. Further, the second inverter **3***b* is connected to the second motor M**2**.
[0024] The DC/DC converter **4** steps down the driving electric power output from the high voltage battery HB to convert it into power for auxiliary devices. The DC/DC converter **4** converts DC driving electric power into DC power for auxiliary devices.
[0025] FIG. **2** is a circuit diagram showing an electrical schematic configuration of the buck-boost converter **2** and the inverter **3**. As shown in FIG. **2**, the power conversion device **1** of the present embodiment includes the buck-boost converter **2** and the inverter **3** that are connected to each other.
[0026] The buck-boost converter **2** includes two power devices D, two capacitors C, and a reactor L. One capacitor C (hereinafter, referred to as a first capacitor C**1**) of the two capacitors C stores electric power before the step-up in a case where electric power is supplied from the high voltage battery HB to the motor M. In addition, the other capacitor C (hereinafter, referred to as a second capacitor C**2**) of the two capacitors C stores electric power after the step-up in a case where electric power is supplied from the high voltage battery HB to the motor M. Each of the first capacitor C**1** and the second capacitor C**2** is not limited to being formed of a single element. The first capacitor C**1** may be formed of a plurality of elements, or the second capacitor C**2** may be formed of a plurality of elements.
[0027] In addition, each inverter **3** includes three power devices D. Each power device D has a power transistor. These power transistors have semiconductor elements and are mounted on an insulated circuit board. In the present embodiment, one power device D includes two power transistors. However, a power device having a single power transistor may be provided. In this case, four power devices are provided in the buck-boost converter **2**, and six power devices are provided in the inverter **3**. For example, each power transistor includes a plurality of semiconductor elements formed of, for example, silicon carbide (SIC). The power transistor may include a semiconductor element formed of other materials such as silicon (Si) or gallium nitride (GaN).
[0028] FIG. **3** is an exploded perspective view showing a structural schematic configuration of the power conversion device **1** of the present embodiment. As shown in FIG. **3**, the power conversion device **1** of the present embodiment includes an intelligent power module **10**, a main body case **11**, a capacitor unit **12**, a reactor unit **13**, a DC/DC converter unit **14**, a motor output connector **15**, a

DC/DC converter output connector **16** (output connector), a DC power supply connector **17** (first connector), an air-conditioning equipment connector **18** (second connector), and an internal bus bar **19** (bus bar).
[0029] In the following description, for convenience of description, a side on which the DC/DC converter unit **14** and the like are positioned with respect to a partition wall portion **31***a* of a central plate **31**, which will be described later, of the main body case **11** is referred to as an upper side, and a side on which the intelligent power module **10** is positioned with respect to the partition wall portion **31***a* of the central plate **31**, which will be described later, of the main body case **11** is referred to as a lower side. However, the installation posture of the power conversion device **1** is not particularly limited. A direction orthogonal to the up-down direction is referred to as a "horizontal direction." A view of the power conversion device **1** as viewed in the up-down direction is referred to as a "plan view."
[0030] The intelligent power module **10** includes a power module **20**, a gate driver board **21**, an ECU board **22**, and the like. The power module **20** includes a plurality of power devices D having semiconductor elements, a power module case made of a resin that accommodates the power devices D, and the like.
[0031] The gate driver board **21** is a board provided with gate drivers that generate drive signals for the buck-boost converter **2** or the inverter **3**, which are formed of the power devices D. Such a gate driver board **21** is stacked on the power module **20**. The ECU board **22** is a board provided with an electronic control unit (ECU) that controls the gate driver board **21**. The ECU board **22** is stacked on the gate driver board **21**. The gate driver board **21** and the ECU board **22** may be integrated together.
[0032] The intelligent power module **10** includes the power devices D that form the buck-boost converter **2** or the inverter **3**. That is, the intelligent power module **10** forms at least a part of the buck-boost converter **2** or the inverter **3**.
[0033] The main body case **11** is a case that accommodates the intelligent power module **10**, the capacitor unit **12**, the reactor unit **13**, the DC/DC converter unit **14**, and the like. The main body case **11** includes an upper cover **30**, the central plate **31** (support plate), and a lower cover **32**. The upper cover **30**, the central plate **31**, and the lower cover **32** are formed to be separable in the up-down direction.
[0034] The upper cover **30** is a portion that covers, from above, the DC/DC converter unit **14** and the reactor unit **13** fixed to the central plate **31** from above. That is, the upper cover **30** is fastened to the central plate **31** through bolts (not shown) or the like.
[0035] The central plate **31** is a support plate positioned between the upper cover **30** and the lower cover **32**. The central plate **31** includes the flat plate-shaped partition wall portion **31***a* and a surrounding wall portion **31***b* provided to surround the partition wall portion **31***a* from the side of the partition wall portion **31***a*.
[0036] The partition wall portion **31***a* is disposed such that one surface (hereinafter, referred to as an upper surface **31***a***1**) thereof faces upward and the other surface (hereinafter, referred to as a lower surface **31***a***2**) thereof faces downward. The lower surface **31***a***2** is shown in FIG. **4**. Such a partition wall portion **31***a* supports, for example, the intelligent power module **10**, the capacitor unit **12**, the reactor unit **13**, and the DC/DC converter unit **14**. The partition wall portion **31***a* may directly support the intelligent power module **10**, the capacitor unit **12**, the reactor unit **13**, and the DC/DC converter unit **14** or may indirectly support the intelligent power module **10**, the capacitor unit **12**, the reactor unit **13**, and the DC/DC converter unit **14** through other portions.
[0037] In the present embodiment, the reactor unit **13** and the DC/DC converter unit **14** are disposed above the partition wall portion **31***a*. In addition, in the present embodiment, the intelligent power module **10** is disposed below the partition wall portion **31***a*. In addition, in the present embodiment, part of the capacitor unit **12** is provided to penetrate the partition wall portion **31***a* in the up-down direction. Therefore, the partition wall portion **31***a* is provided with an

insertion opening **31***c* through which the capacitor unit **12** is inserted.
[0038] The intelligent power module **10**, the capacitor unit **12**, the reactor unit **13**, and the DC/DC converter unit **14** are fastened by bolts or the like to bosses or the like provided in the partition wall portion **31***a*.
[0039] Flow paths (not shown) that guide a cooling liquid are provided inside the partition wall portion **31***a*. By flowing the cooling liquid through the flow paths, the partition wall portion **31***a* functions as a cooling jacket, and the intelligent power module **10**, the capacitor unit **12**, the reactor unit **13**, and the DC/DC converter unit **14** are cooled.
[0040] The surrounding wall portion **31***b* is provided to surround the intelligent power module **10**, the capacitor unit **12**, the reactor unit **13**, and the DC/DC converter unit **14** from the side of them. The surrounding wall portion **31***b* is connected to the edge portion of the partition wall portion **31***a* and is provided to protrude upward and downward from the partition wall portion **31***a*. The upper end of the surrounding wall portion **31***b* is in contact with the upper cover **30**. In addition, the lower end of the surrounding wall portion **31***b* is in contact with the lower cover **32**.
[0041] The lower cover **32** is a portion that covers, from below, the intelligent power module **10** fixed to the central plate **31** from below. In addition, the lower cover **32** also covers the capacitor unit **12** from below. Such a lower cover **32** is fastened to the central plate **31** through bolts (not shown) or the like.
[0042] In addition, the lower cover **32** is provided with an opening portion **32***a* for exposing the motor output connector **15**. A motor-side connector (not shown) is mounted on the motor output connector **15** through the opening portion **32***a*.
[0043] The capacitor unit **12** is connected to the intelligent power module **10** and is disposed on a side of the power module **20**. The capacitor unit **12** is a unit including the capacitors C provided in the buck-boost converter **2**. The capacitor unit **12** includes elements that form the capacitors C and a housing that covers the elements.
[0044] In the present embodiment, the capacitor unit **12** includes the first capacitor C**1** and the second capacitor C**2** provided in the buck-boost converter **2**. In the capacitor unit **12**, the elements forming the first capacitor C**1** are disposed inside the capacitor unit **12** to be positioned above the partition wall portion **31***a*. In addition, the elements forming the second capacitor C**2** are disposed inside the capacitor unit **12** to be positioned below the partition wall portion **31***a*.
[0045] The reactor unit **13** is fixed to the central plate **31**. The reactor unit **13** is connected to the intelligent power module **10** through a bus bar (not shown) and is disposed above the central plate **31** in the present embodiment. The reactor unit **13** is a unit including the reactor L provided in the buck-boost converter **2**.
[0046] FIG. **4** is a schematic cross-sectional view including the reactor unit **13** in the power conversion device **1** of the present embodiment. As shown in FIG. **4**, in the present embodiment, the reactor unit **13** includes a reactor case **13***b* (case) that covers a reactor element **13***a*. Further, the reactor case **13***b* includes a case main body **13***c* accommodating the reactor element **13***a*, and a flange portion **13***d* protruding laterally from the lower end of the case main body **13***c* and fastened to the central plate **31**. In this way, in the present embodiment, the reactor unit **13** is fastened to the central plate **31** by fastening the flange portion **13***d* to the partition wall portion **31***a* of the central plate **31**.
[0047] The DC/DC converter unit **14** is fixed to the central plate **31**. The DC/DC converter unit **14** is connected to the intelligent power module **10** through a bus bar (not shown) and is disposed above the central plate **31** in the present embodiment. The DC/DC converter unit **14** is a unit forming the DC/DC converter **4** shown in FIG. **1**.
[0048] The motor output connector **15** is a unit to which the motor-side connector is connected. In the present embodiment, the motor output connector **15** is disposed below the partition wall portion **31***a* of the central plate **31**. In addition, the motor output connector **15** is disposed further below the intelligent power module **10**. Such a motor output connector **15** is connected to the power module

20 through a motor connection bus bar.

[0049] The DC/DC converter output connector **16** is a connector for outputting electric power output from the DC/DC converter **4** to auxiliary devices and the like outside the power conversion device **1**. FIG. **5** is a schematic view in which the upper cover **30** of the main body case **11** is omitted. As shown in FIG. **5**, the surrounding wall portion **31***b* of the central plate **31** is formed in a rectangular shape in a plan view by connecting four side walls **31***d*. The four side walls **31***d* include long side walls **31***e* that form long sides of the rectangular shape and short side walls **31***f* that form short sides of the rectangular shape. The DC/DC converter output connector **16** is provided on one of the two long side walls **31***e* of the rectangular surrounding wall portion **31***b*. A connector connected to, for example, the low voltage battery LB is mounted on the DC/DC converter output connector **16**. As a result, the DC/DC converter unit **14** and the low voltage battery LB are electrically connected.

[0050] The DC power supply connector **17** is a connector configured to be connected to the high voltage battery HB. As shown in FIG. **5**, a cable CA connected to the high voltage battery HB is mounted on the DC power supply connector **17**. As a result, the power conversion device **1** and the high voltage battery HB are electrically connected. As shown in FIG. **5**, the DC power supply connector **17** is held by one (the short side wall **31***f* on the reactor unit **13**-side) of the short side walls **31***f* of the surrounding wall portion **31***b* of the central plate **31**.

[0051] The DC power supply connector **17** is provided to protrude from an outer wall surface (outer surface) of the short side wall **31***f*. As shown in FIG. **4**, the DC power supply connector **17** is formed such that the cable CA is mountable thereon in a direction inclined relative to a wall surface (the upper surface **31***a***1** or the lower surface **31***a***2**) of the partition wall portion **31***a*. The angle between the upper surface **31***a***1** or the lower surface **31***a***2** and the inclined direction is greater than −90° and less than 0°, or greater than 0° and less than 90°. In the present embodiment, the DC power supply connector **17** is formed such that the cable CA is mountable thereon from obliquely below.

[0052] As shown in FIG. **5**, in a plan view, the DC/DC converter unit **14** is positioned farther from the DC power supply connector **17** than the reactor unit **13**. That is, in the power conversion device **1** of the present embodiment, the DC/DC converter unit **14** that handles a lower voltage than the reactor unit **13** is disposed farther from the DC power supply connector **17** to which a high voltage is input than the reactor unit **13**.

[0053] The air-conditioning equipment connector **18** is a connector configured to be connected to air-conditioning equipment (not shown). As shown in FIG. **5**, a cable CB connected to the air-conditioning equipment is mounted on the air-conditioning equipment connector **18**. As a result, the power conversion device **1** and the air-conditioning equipment are electrically connected. For example, as shown in FIG. **5**, the air-conditioning equipment connector **18** is connected to an air-conditioning equipment inverter **300** of the air-conditioning equipment.

[0054] As shown in FIG. **5**, the air-conditioning equipment connector **18** is held by one (the short side wall **31***f* on the reactor unit **13**-side) of the short side walls **31***f* of the surrounding wall portion **31***b* of the central plate **31**. That is, the air-conditioning equipment connector **18** is held by the same short side wall **31***f* as the DC power supply connector **17**. The air-conditioning equipment connector **18** is disposed at a position displaced in the horizontal direction from the DC power supply connector **17** and is held by the central plate **31** to be adjacent to the DC power supply connector **17**.

[0055] The air-conditioning equipment connector **18** is provided to protrude from the outer wall surface (outer surface) of the short side wall **31***f*. The air-conditioning equipment connector **18** is formed such that the cable CB is mountable thereon in a direction inclined relative to a wall surface (the upper surface **31***a***1** or the lower surface **31***a***2**) of the partition wall portion **31***a*. The angle between the upper surface **31***a***1** or the lower surface **31***a***2** and the inclined direction is greater than −90° and less than 0°, or greater than 0° and less than 90°. In the present embodiment, the air-conditioning equipment connector **18** is formed such that the cable CB is mountable thereon from obliquely below. In the present embodiment, the DC power supply connector **17** and the air-conditioning equipment connector **18** are formed such that the mounting angles of the cable CA and the cable CB are the same.

[0056] In addition, in the present embodiment, the air-conditioning equipment connector **18** is positioned farther from the side wall (the long side wall **31***e*) on which the DC/DC converter output connector **16** is provided than the DC power supply connector **17** in a plan view. Therefore, the cable CB to be connected to the air-conditioning equipment connector **18** is routed without intersecting the cable CA connected to the DC power supply connector **17** or a cable (not shown) connected to the DC/DC converter output connector **16**. Therefore, it becomes easy to route the cable CB to be connected to the air-conditioning equipment connector **18**.

[0057] As shown in FIG. **5**, the internal bus bar **19** is disposed inside the main body case **11** (above the upper surface **31***a***1** of the partition wall portion **31***a*) and is a strip-shaped conductor portion that connects the DC power supply connector **17** and the air-conditioning equipment connector **18** to the capacitor unit **12** and the DC/DC converter unit **14**. That is, the air-conditioning equipment connector **18**, the capacitor unit **12**, and the DC/DC converter unit **14** are connected to the high voltage battery HB through the DC power supply connector **17**.

[0058] FIG. **6** is a perspective view of the internal bus bar **19**. As shown in FIG. **6**, the power conversion device **1** of the present embodiment includes two internal bus bars **19**. As shown in FIG. **5**, each internal bus bar **19** is connected to the DC/DC converter unit **14** without crossing the DC/DC converter unit **14**. One internal bus bar **19** is connected to a positive terminal of the high voltage battery HB. In addition, the other internal bus bar **19** is connected to a negative terminal of the high voltage battery HB. An insulating cover may be mounted on these two internal bus bars **19** as needed.

[0059] Each internal bus bar **19** includes a first connection portion **19***a* connected to the DC power supply connector **17**, a second connection portion **19***b* connected to the air-conditioning equipment connector **18**, a third connection portion **19***c* connected to the capacitor unit **12**, and a fourth connection portion **19***d* connected to the DC/DC converter unit **14**.

[0060] As shown in FIG. **4**, the first connection portion **19***a* (refer to FIG. **6**) is disposed at the back portion of the DC power supply connector **17** and comes into contact with the terminal of the cable CA mounted on the DC power supply connector **17**. In addition, the second connection portion **19***b* (refer to FIG. **6**) is disposed in the back portion of the air-conditioning equipment connector **18** and comes into contact with the terminal of the cable CB mounted on the air-conditioning equipment connector **18**. As shown in FIG. **4**, an intermediate portion of the internal bus bar **19** is disposed above the flange portion **13***d* of the reactor unit **13**.

[0061] In addition, each internal bus bar **19** may include a stress relaxation portion **19***e* at an intermediate portion thereof as shown in FIG. **7**. The stress relaxation portion **19***e* is formed by curving the intermediate portion of the internal bus bar **19**. Such a stress relaxation portion **19***e* is an elastically deformable portion and can absorb, by elastically deforming, stress generated when the first connection portion **19***a* or the second connection portion **19***b* is connected to a counterpart member.

[0062] In addition, a portion of the internal bus bar **19** in the present embodiment between the first connection portion **19***a* connected to the DC power supply connector **17** and the second connection portion **19***b* connected to the air-conditioning equipment connector **18** is fixed to the central plate **31**. Specifically, the portion between the first connection portion **19***a* and the second connection portion **19***b* is fastened to a boss (not shown) or the like provided in the central plate **31**.

[0063] The power conversion device **1** of the present embodiment may include a bus bar through which electric power flows, in addition to the internal bus bar **19**. For example, the power conversion device **1** may include a bus bar that connects the capacitor unit **12** and the reactor unit **13**. Further, the internal bus bar **19** may include a portion that connects the capacitor unit **12** and the reactor unit **13**.

[0064] In the power conversion device **1** of the present embodiment, the DC power supply connector **17** is connected to the high voltage battery HB through the cable CA, and DC power is supplied thereto from the high voltage battery HB. The power conversion device **1** steps up the DC power with the buck-boost converter **2**, converts the stepped up DC power into alternating current with the inverter **3**, and supplies the alternating current to the motor M. In addition, the power conversion device **1** converts regenerative power supplied from each motor M into DC power with the inverter **3**, steps down the DC power with the buck-boost converter **2**, and supplies the stepped down DC power to the high voltage battery HB.

[0065] Further, the power conversion device **1** of the present embodiment supplies DC power supplied from the high voltage battery HB to the air-conditioning equipment through the internal bus bar **19** and the air-conditioning equipment connector **18**. In addition, the power conversion device **1** of the present embodiment steps down DC power supplied from the high voltage battery HB with the DC/DC converter **4** and supplies the stepped down DC power to the low voltage battery LB.

[0066] The power conversion device **1** of the present embodiment described above includes the capacitor unit **12**, the reactor unit **13**, the DC/DC converter unit **14**, and the power module **20**. The capacitor unit **12**, the reactor unit **13**, the DC/DC converter unit **14**, and the power module **20** form the power conversion circuit H. In addition, the power conversion device **1** of the present embodiment includes the central plate **31**, the DC power supply connector **17**, the air-conditioning equipment connector **18**, and the internal bus bar **19**. The central plate **31** includes the flat plate-shaped partition wall portion **31***a* that supports the capacitor unit **12**, the reactor unit **13**, the DC/DC converter unit **14**, and the power module **20**. The DC power supply connector **17** is held by the central plate **31**. The air-conditioning equipment connector **18** is held by the central plate **31** to be adjacent to the DC power supply connector **17**. The internal bus bar **19** connects the DC power supply connector **17** and the air-conditioning equipment connector **18** to at least the capacitor unit **12** and the DC/DC converter unit **14**. In addition, the central plate **31** includes the surrounding wall portion **31***b* that surrounds the partition wall portion **31***a* from the side of the partition wall portion **31***a*. The DC power supply connector **17** and the air-conditioning equipment connector **18** are provided to protrude from the outer wall surface of the surrounding wall portion **31***b* and are formed such that the cables are mountable thereon in a direction inclined relative to the wall surface of the partition wall portion **31***a*.

[0067] In the power conversion device **1** of the present embodiment, the DC power supply connector **17** and the air-conditioning equipment connector **18** adjacent to each other are provided to protrude from the outer wall surface of the surrounding wall portion **31***b* of the central plate **31** and are formed such that the cables are mountable thereon in a direction inclined relative to the flat plate-shaped partition wall portion **31***a*. Therefore, it is possible to further reduce the amount of protrusion of the DC power supply connector **17** and the air-conditioning equipment connector **18** from the outer wall surface than a case where the cables are mounted on the DC power supply connector **17** and the air-conditioning equipment connector **18** in the horizontal direction with respect to the flat plate-shaped partition wall portion **31***a*. In addition, it is possible to further reduce the amount of protrusion of the cables in the horizontal direction than a case where the cables are mounted on the DC power supply connector **17** and the air-conditioning equipment connector **18** in the horizontal direction. Therefore, the power conversion device of the present embodiment can reduce the installation space therefor when viewed in the normal direction (the up-down direction) of the partition wall portion **31***a*.

[0068] In addition, in the power conversion device **1** of the present embodiment, the reactor unit **13**, the DC/DC converter unit **14**, and the internal bus bar **19** are disposed above the upper surface that is one of wall surfaces of the partition wall portion **31***a*. Further, the internal bus bar **19** is connected to the DC/DC converter unit **14** without crossing the DC/DC converter unit **14** in a plan

view.
[0069] In a case where the internal bus bar **19** crosses the DC/DC converter unit **14**, it is necessary to install a shield plate or the like between the internal bus bar **19** and the DC/DC converter unit **14** in order to reduce noise caused by a current flowing through the internal bus bar **19**. On the other hand, in the power conversion device **1** of the present embodiment, since the internal bus bar **19** does not cross the DC/DC converter unit **14**, it is not necessary to install the shield plate, and it is possible to reduce the weight and the cost.
[0070] In addition, in the power conversion device **1** of the present embodiment, the reactor unit **13** includes the reactor case **13***b* that covers the reactor element **13***a*. In addition, the reactor case **13***b* includes the flange portion **13***d* protruding laterally from the lower end of the case main body **13***c* and fastened to the central plate **31**. In addition, the DC power supply connector **17** and the air-conditioning equipment connector **18** are formed such that the cables are mountable thereon from obliquely below. Further, the intermediate portion of the internal bus bar **19** is positioned above the flange portion **13***d*.
[0071] In the power conversion device **1** of the present embodiment, the DC power supply connector **17** and the air-conditioning equipment connector **18** are formed such that the cables are mountable thereon from obliquely below. Therefore, the back end portions of the DC power supply connector **17** and the air-conditioning equipment connector **18** are positioned above the inlet openings of the DC power supply connector **17** and the air-conditioning equipment connector **18**. Thus, in the power conversion device **1** of the present embodiment, the internal bus bar **19** can be disposed higher than a case where the cables are mounted on the DC power supply connector **17** and the air-conditioning equipment connector **18** in the horizontal direction, and part of the internal bus bar **19** can be positioned above the flange portion **13***d* of the reactor unit **13**. In this way, by positioning the intermediate portion of the internal bus bar **19** above the flange portion **13***d*, it is possible to reduce the size of the power conversion device **1** in a plan view.
[0072] In addition, in the power conversion device **1** of the present embodiment, the internal bus bar **19** includes the first connection portion **19***a* connected to the DC power supply connector **17** and the second connection portion **19***b* connected to the air-conditioning equipment connector **18**. In addition, a portion of the internal bus bar **19** between the first connection portion **19***a* and the second connection portion **19***b* is fixed to the central plate **31**.
[0073] For example, by fixing a portion close to the first connection portion **19***a* to the central plate **31**, it is possible to prevent the first connection portion **19***a* and the terminal of the cable CA mounted on the DC power supply connector **17** from being separated from each other due to vibration or the like of the vehicle **100**. In addition, similarly, by fixing a portion close to the second connection portion **19***b* to the central plate **31**, it is possible to prevent the second connection portion **19***b* and the terminal of the cable CB mounted on the air-conditioning equipment connector **18** from being separated from each other due to vibration or the like of the vehicle **100**. In the present embodiment, since the portion between the first connection portion **19***a* and the second connection portion **19***b* is fixed to the central plate **31**, it is possible to prevent both the first connection portion **19***a* and the second connection portion **19***b* from being separated from the terminals of the cables with one fixing point.
[0074] In addition, in the power conversion device **1** of the present embodiment, the internal bus bar **19** includes the stress relaxation portion **19***e* formed by curving the intermediate portion thereof. According to the power conversion device **1** of the present embodiment, the internal bus bar **19** can absorb, by elastically deforming, stress generated by the first connection portion **19***a* or the second connection portion **19***b* being brought into contact with the terminal of the cable from obliquely below.
[0075] In addition, in the power conversion device **1** of the present embodiment, the DC/DC converter unit **14** is positioned farther from the DC power supply connector **17** than the reactor unit **13** in a plan view. According to the power conversion device **1** of the present embodiment, the

DC/DC converter unit **14** that handles a lower voltage than the reactor unit **13** is disposed farther from the DC power supply connector **17** to which a high voltage is input than the reactor unit **13**. Accordingly, it is possible to shorten the internal bus bar **19**.

[0076] In addition, in the power conversion device **1** of the present embodiment, the surrounding wall portion **31***b* is formed in a rectangular shape in a plan view. In addition, the DC power supply connector **17** and the air-conditioning equipment connector **18** are provided on the side wall **31***d* of the surrounding wall portion **31***b* corresponding to one side of the rectangular shape. In addition, the DC/DC converter output connector **16** of the DC/DC converter unit **14** is provided on the long side wall **31***e* connected to the short side wall **31***f* provided with the DC power supply connector **17** and the air-conditioning equipment connector **18**. In addition, the air-conditioning equipment connector **18** is an air-conditioning equipment connector configured to be connected to the air-conditioning equipment inverter **300** and is positioned farther from the long side wall **31***e* provided with the DC/DC converter output connector **16** than the DC power supply connector **17** in a plan view.

[0077] According to the power conversion device **1** of the present embodiment, the cable CB to be connected to the air-conditioning equipment connector **18** can be routed so as not to intersect with the cable CA connected to the DC power supply connector **17** or a cable (not shown) connected to the DC/DC converter output connector **16** in a plan view. Therefore, it becomes easy to route the cable CB to be connected to the air-conditioning equipment connector **18**.

[0078] Although the appropriate embodiments of the present invention have been described above with reference to the accompanying drawings, the present invention is not limited to the above embodiments. The shapes, combinations and the like of the constituent members shown in the above-described embodiment are merely examples and can be variously changed based on design requirements and the like within the scope of the present invention.

[0079] For example, in the above-described embodiment, the configuration in which the cables can be mounted on the DC power supply connector **17** and the air-conditioning equipment connector **18** from obliquely below has been described. However, the present invention is not limited to this, and a configuration can also be adopted in which the cables can be mounted on the DC power supply connector **17** and the air-conditioning equipment connector **18** from obliquely above.

[0080] In addition, in the above-described embodiment, the configuration in which the first connector is the DC power supply connector **17** and the second connector is the air-conditioning equipment connector **18** has been described. However, the present invention is not limited to this. The first connector and the second connector adjacent to each other may be other types of connectors.

[0081] The above-described embodiments can also be described as, for example, the following appendices.

APPENDIX 1

[0082] A power conversion device includes: a capacitor unit, a reactor unit, a DC/DC converter unit, and a power module forming a power conversion circuit; a support plate including a flat plate-shaped partition wall portion supporting the capacitor unit, the reactor unit, the DC/DC converter unit, and the power module; a first connector held by the support plate; a second connector held by the support plate to be adjacent to the first connector; and a bus bar connecting the first connector and the second connector to at least the capacitor unit and the DC/DC converter unit, in which the support plate includes a surrounding wall portion surrounding the partition wall portion from a side thereof, and the first connector and the second connector are provided to protrude from an outer wall surface of the surrounding wall portion and are formed such that cables are mountable thereon in a direction inclined relative to a wall surface of the partition wall portion.

APPENDIX 2

[0083] The power conversion device according to Appendix 1 is in which the reactor unit, the DC/DC converter unit, and the bus bar are disposed above an upper surface that is one of wall surfaces of the partition wall portion, and the bus bar is connected to the DC/DC converter unit without crossing the DC/DC converter unit in a plan view.

APPENDIX 3

[0084] The power conversion device according to Appendix 1 or 2 is in which the reactor unit includes a case covering a reactor element, the case includes a flange portion protruding laterally from a lower end of a case main body and fastened to the support plate, the first connector and the second connector are formed such that the cables are mountable thereon from obliquely below, and an intermediate portion of the bus bar is positioned above the flange portion.

APPENDIX 4

[0085] The power conversion device according to any one of Appendixes 1 to 3 is in which the bus bar includes a first connection portion connected to the first connector and a second connection portion connected to the second connector, and a portion of the bus bar between the first connection portion and the second connection portion is fixed to the support plate.

APPENDIX 5

[0086] The power conversion device according to any one of Appendixes 1 to 4 is in which the bus bar includes a stress relaxation portion formed by curving an intermediate portion thereof.

APPENDIX 6

[0087] The power conversion device according to any one of Appendixes 1 to 5 is in which the first connector is a DC power supply connector configured to be connected to a battery, and the DC/DC converter unit is positioned farther from the DC power supply connector than the reactor unit in a plan view.

APPENDIX 7

[0088] The power conversion device according to Appendix 6 is in which the surrounding wall portion is formed in a rectangular shape in the plan view, the first connector and the second connector are provided on a side wall of the surrounding wall portion corresponding to one side of the rectangular shape, an output connector of the DC/DC converter unit is provided on another side wall of the surrounding wall portion connected to the side wall on which the first connector and the second connector are provided, and the second connector is an air-conditioning equipment connector configured to be connected to an air-conditioning equipment inverter and is positioned farther from the side wall on which the output connector is provided than the first connector in the plan view.

Claims

1. A power conversion device comprising: a capacitor unit, a reactor unit, a DC/DC converter unit, and a power module forming a power conversion circuit; a support plate including a flat plate-shaped partition wall portion supporting the capacitor unit, the reactor unit, the DC/DC converter unit, and the power module; a first connector held by the support plate; a second connector held by the support plate to be adjacent to the first connector; and a bus bar connecting the first connector and the second connector to at least the capacitor unit and the DC/DC converter unit, in which the support plate includes a surrounding wall portion surrounding the partition wall portion from a side thereof, and the first connector and the second connector are provided to protrude from an outer wall surface of the surrounding wall portion and are formed such that cables are mountable thereon in a direction inclined relative to a wall surface of the partition wall portion.

2. The power conversion device according to claim 1, in which the reactor unit, the DC/DC converter unit, and the bus bar are disposed above an upper surface that is one of wall surfaces of the partition wall portion, and the bus bar is connected to the DC/DC converter unit without crossing the DC/DC converter unit in a plan view.

3. The power conversion device according to claim 1, in which the reactor unit includes a case covering a reactor element, the case includes a flange portion protruding laterally from a lower end of a case main body and fastened to the support plate, the first connector and the second connector are formed such that the cables are mountable thereon from obliquely below, and an intermediate portion of the bus bar is positioned above the flange portion.

4. The power conversion device according to claim 1, in which the bus bar includes a first connection portion connected to the first connector and a second connection portion connected to the second connector, and a portion of the bus bar between the first connection portion and the second connection portion is fixed to the support plate.

5. The power conversion device according to claim 1, in which the bus bar includes a stress relaxation portion formed by curving an intermediate portion thereof.

6. The power conversion device according to claim 1, in which the first connector is a DC power supply connector configured to be connected to a battery, and the DC/DC converter unit is positioned farther from the DC power supply connector than the reactor unit in a plan view.

7. The power conversion device according to claim 6, in which the surrounding wall portion is formed in a rectangular shape in the plan view, the first connector and the second connector are provided on a side wall of the surrounding wall portion corresponding to one side of the rectangular shape, an output connector of the DC/DC converter unit is provided on another side wall of the surrounding wall portion connected to the side wall on which the first connector and the second connector are provided, and the second connector is an air-conditioning equipment connector configured to be connected to an air-conditioning equipment inverter and is positioned farther from the side wall on which the output connector is provided than the first connector in the plan view.