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(54) Title of Invention: Drive device for hybrid vehicle and control method for same

(57) Abstract:

[Problem] In a drive device for a hybrid vehicle, to enable stable running of the vehicle even in time of abnormalities in the main battery, and also to reduce the required breakdown voltage of the DC-DC converter used in driving by an auxiliary device.

[Solving Means] The output of a main battery 50 is stepped up by a buck-boost converter 54 and supplied to an electric motor unit 52. A DC-DC converter 56 is connected between terminals on the main battery 50 side of the buck-boost converter 54, and through this, the required breakdown voltage is reduced. When the DC-DC converter 56 is not supplied with electricity from the main battery 50, a control unit 66 reduces the output voltage of the electric motor unit 52 to within the permissible input voltage range of the DC-DC converter 56. Furthermore, the control unit 66 connects the DC-DC converter 56 and the electric motor unit 52 directly, putting a switch 82 of the buck-boost converter 54 comprised of a chopper circuit in a regularly on state.

[Scope of Claims]

[Claim 1] A drive device for a hybrid vehicle, the drive device comprising a main battery, an engine, an electric motor that converts the output of the main battery into a drive force for the vehicle and also converts the drive force generated by the engine into electric power and charges the main battery, and a buck-boost converter that steps up the output of the main battery and supplies this to the electric motor unit and steps down the output of the electric motor unit and supplies this to the main battery;

wherein the drive device includes:

a DC-DC converter connected between the terminals of the buck-boost converter to which the main battery is connected, and generating electric power supplied to an auxiliary device on the basis of the output of the main battery;

a path switching means capable of configuring a direct electricity supply path that directly supplies output from the electric motor unit to the DC-DC converter; and

a control means that controls the path switching means so that when the supply of electricity from the main battery to the DC-DC converter is interrupted, the electric motor unit is controlled such that the output thereof becomes less than the breakdown voltage of the DC-DC converter, and the direct electricity supply path is constituted.

[Claim 2]

The drive device for a hybrid vehicle according to Claim 1, wherein:

the buck-boost converter is a chopper circuit having a first switch element and a second switch element connected in series between elements connected to the electric motor unit with at least one of the elements caused to act as a chopper in a step-up operation or step-down operation, and a reactor one end of which is connected to a connection point of the first switch element and the second switch element, with the reactor and the second switch element connected in series between terminals of the main battery;

the path switching means includes the first switch element and the second switch element; and

the control means persistently sets the first switch element to a conducting state and persistently sets the second switch element to an interrupted state, as control of the path switching means comprising the direct electricity supply path.

[Claim 3]

The drive device for a hybrid vehicle, wherein:

the buck-boost converter is a chopper circuit having a first switch element and a second switch element connected in series between elements connected to the electric motor unit with at least one of the elements caused to act as a chopper in a step-up operation or step-down operation, and a reactor one end of which is connected to a connection point of the first switch element and the second switch element, with the reactor and the second switch element

connected in series between terminals of the main battery;

the path switching means has a relay that short circuits between one terminal of the first switch connected to the electric motor unit and the terminal of the DC-DC converter connected on the reactor side; and

the control means sets the relay to a connection state as control of the path switching means comprising the direct electricity supply path.

[Claim 4]

A control method for a drive device of a hybrid vehicle, the drive device comprising a main battery, an engine, an electric motor that converts the output of the main battery into a drive force for the vehicle and also converts the drive force generated by the engine into electric power and charges the main battery, and a buck-boost converter that steps up the output of the main battery and supplies this to the electric motor unit and steps down the output of the electric motor unit and supplies this to the main battery and the buck-boost converter is the buck-boost converter is a chopper circuit having a first switch element and a second switch element connected in series between elements connected to the electric motor unit with at least one of the elements caused to act as a chopper in a step-up operation or step-down operation, and a reactor one end of which is connected to a connection point of the first switch element and the second switch element, with the reactor and the second switch element connected in series between terminals of the main battery;

wherein the control method includes:

a step for detecting stoppage of the supply of electricity from the main battery to the DC-DC converter;

a step for controlling the electric motor unit so that the output thereof is less than the breakdown voltage of the DC-DC converter, accompanying the stoppage of the supply of electricity; and

a step for persistently setting the first switch element to a conducting state and persistently setting the second switch element to an interrupted state.

[Detailed Description of the Invention]

[0001]

[Technical Field]

The present invention is related to a hybrid vehicle drive device, and more particularly to securing a supply of electricity to an auxiliary device when the main battery malfunctions.

[0002]

[Background of the Invention]

FIG. 3 is a summary circuit configuration diagram of a conventional drive device for a

hybrid vehicle. The drive device includes a main battery 2, an electric motor unit 4, a buck-boost converter 6, a DC-DC converter 8, a relay 10 and a fuse 12. The electric motor unit 4 includes, for example, two motor/generators (MG) 14 and 16 and inverters 18 and 20 corresponding to each MG. The output of the main battery 2 is stepped up by the buck-boost converter 6 and input into the electric motor unit 4, and the electric motor unit 4 converts that electric power into a drive force for the vehicle. On the other hand, the electric motor unit 4 can convert the engine torque and vehicle drive shaft torque into electric power and output such. The electric power generated in the electric motor unit 4 is for example stepped down by the buck-boost converter 6 and charged the main battery 2.

[0003]

The buck-boost converter 6 comprises a chopper circuit, and between the terminals of the buck-boost converter 6 connected to the electric motor unit 4, a parallel connection of a diode 22 and a transistor switch 24, and a parallel connection of a diode 26 and a transistor switch 28, are connected in series. One end of the parallel connection of the diode 26 and the transistor switch 28 is connected to a reactor 30, and this is one terminal of the buck-boost converter 6 on the main battery 2 side. The other terminal is pulled out from the other end of the parallel connection of the diode 26 and the transistor switch 28. This buck-boost converter 6, when stepping up, has the switch 24 set to an off state and the switch 28 switches periodically. On the other hand, when stepping down, the switch 28 is set to an off state and the switch 24 switches periodically.

[0004]

The DC-DC converter 8 converts the voltage of the input direct-current power, and charges an auxiliary battery 32 (for example, with 12V output voltage) that supplies electric power to a control circuit such as an ECU or the like. The DC-DC converter 8 is connected between the terminals of the buck-boost converter 6 on the electric motor unit 4 side. With this configuration, even if an abnormality occurs on the main battery 2 side, such as a battery abnormality, a fuse blowing, a relay abnormality or the like, the electric power generated by the electric motor unit 4 can be supplied to the DC-DC converter 8. In other words, even if an abnormality occurs on the main battery 2 side, it is possible to avoid the auxiliary battery 32 used in driving the control circuit such as an ECU or the like becoming empty, so it is possible to prevent the vehicle from becoming disabled.

[0005]

[Problem to be solved by the invention]

However, with the conventional configuration, the DC-DC converter needs to have a high breakdown voltage and as a result also has a high need regarding specifications for constituent parts. In addition, the circuit configuration becomes complex, creating the problem that reducing

costs and making the device more compact are difficult.

[0006]

In consideration of the foregoing, it is an object of the present invention to provide a drive device that can supply electricity to a DC-DC converter and in which operation of an auxiliary device is assured, even in the case of abnormalities in the main battery or the like, in addition to reducing the required breakdown voltage of the DC-DC converter.

[0007]

[Means for Resolving the Problem]

[Claim 1] The drive device for a hybrid vehicle according to the present invention is a drive device comprising a main battery, an engine, an electric motor that converts the output of the main battery into a drive force for the vehicle and also converts the drive force generated by the engine into electric power and charges the main battery, and a buck-boost converter that steps up the output of the main battery and supplies this to the electric motor unit and steps down the output of the electric motor unit and supplies this to the main battery; wherein the drive device includes: a DC-DC converter connected between the terminals of the buck-boost converter to which the main battery is connected, and generating electric power supplied to an auxiliary device on the basis of the output of the main battery; a path switching means capable of configuring a direct electricity supply path that directly supplies output from the electric motor unit to the DC-DC converter; and a control means that controls the path switching means so that when the supply of electricity from the main battery to the DC-DC converter is interrupted, the electric motor unit is controlled such that the output thereof becomes less than the breakdown voltage of the DC-DC converter, and the direct electricity supply path is constituted.

[0008]

With the present invention, the voltage of the main battery is stepped up by a buck-boost converter and supplied to an electric motor unit. On the other hand, the power generated by the electric motor unit is stepped down by the buck-boost converter and charges the main battery. The DC-DC converter is provided between terminals of the buck-boost converter on the main battery side and not between terminals on the electric motor side. Through this, the breakdown voltage required by the DC-DC converter is reduced. The DC-DC converter is supplied with electricity from the main battery, and supplies a power supply for an auxiliary device that acts at a still lower voltage in general. When the supply of electricity from the main battery to the DC-DC converter is stopped due to a malfunction in the main battery or the like, the electric power generated by the electric motor unit is supplied to the DC-DC converter, so the inability to control the vehicle and the inability to run caused by a lack of residual charge amount in the auxiliary battery can be avoided. When electricity is supplied to the DC-DC converter from the electric motor unit, the output voltage of the electric motor unit is controlled to be less than the

breakdown voltage of the DC-DC converter, so stepping down with the buck-boost converter is not necessary, and the output of the electric motor unit is supplied without change to the DC-DC converter via a direct electricity supply path. This kind of configuration that does not use stepping up or stepping down by the buck-boost converter makes it possible to avoid the difficulties of controlling the buck-boost converter so as to satisfy specifications such as the current capacity and breakdown voltage of the DC-DC converter, so that stable control is easily realized.

[0009]

A preferred embodiment of the present invention is a drive device for a hybrid vehicle wherein: the buck-boost converter is a chopper circuit having a first switch element and a second switch element connected in series between elements connected to the electric motor unit with at least one of the elements caused to act as a chopper in a step-up operation or step-down operation, and a reactor one end of which is connected to a connection point of the first switch element and the second switch element, with the reactor and the second switch element connected in series between terminals of the main battery; the path switching means includes the first switch element and the second switch element; and the control means persistently sets the first switch element to a conducting state and persistently sets the second switch element to an interrupted state, as control of the path switching means comprising the direct electricity supply path.

[0010]

In this embodiment, different control is accomplished for the step-up action and the step-down action in the first switch element and the second switch element of the buck-boost converter, and through this, a direct supply of electricity from the electric motor unit to the DC-DC converter is accomplished. That is to say, in the step-up action and the step-down action, one of the switch elements is periodically switched on and off but when a direct supply of electricity from the electric motor unit is accomplished, the first switch element is kept in an on state and the second switch element is kept in an off state. Through this, a configuration is possible in which the DC-DC converter is directly connected to the output terminal of the electric motor unit.

[0011]

In addition, another preferred embodiment of the present invention is a drive device for a hybrid vehicle, wherein: the buck-boost converter is a chopper circuit having a first switch element and a second switch element connected in series between elements connected to the electric motor unit with at least one of the elements caused to act as a chopper in a step-up operation or step-down operation, and a reactor one end of which is connected to a connection point of the first switch element and the second switch element, with the reactor and the second switch element connected in series between terminals of the main battery; the path switching

means has a relay that short circuits between one terminal of the first switch connected to the electric motor unit and the terminal of the DC-DC converter connected on the reactor side; and the control means sets the relay to a connection state as control of the path switching means comprising the direct electricity supply path.

[0012]

With this embodiment, a relay is provided as a separate switch element in parallel with the first switch element. Through this, even when the first switch element malfunctions, it is possible to supply electricity to the DC-DC converter.

[0013]

The control method for a drive device of a hybrid vehicle according to the present invention is a control method for a drive device of a hybrid vehicle, the drive device comprising a main battery, an engine, an electric motor that converts the output of the main battery into a drive force for the vehicle and also converts the drive force generated by the engine into electric power and charges the main battery, and a buck-boost converter that steps up the output of the main battery and supplies this to the electric motor unit and steps down the output of the electric motor unit and supplies this to the main battery and the buck-boost converter is the buck-boost converter is a chopper circuit having a first switch element and a second switch element connected in series between elements connected to the electric motor unit with at least one of the elements caused to act as a chopper in a step-up operation or step-down operation, and a reactor one end of which is connected to a connection point of the first switch element and the second switch element, with the reactor and the second switch element connected in series between terminals of the main battery; wherein the control method includes: a step for detecting stoppage of the supply of electricity from the main battery to the DC-DC converter; a step for controlling the electric motor unit so that the output thereof is less than the breakdown voltage of the DC-DC converter, accompanying the stoppage of the supply of electricity; and a step for persistently setting the first switch element to a conducting state and persistently setting the second switch element to an interrupted state.

[0014]

[Best Mode for Implementing the Invention]

Next, embodiments of the present invention will be described with reference to the drawings.

[0015]

[First Embodiment]

FIG. 1 is a summary circuit configuration diagram of a drive device for a hybrid vehicle

according to a first embodiment of the present invention. The drive device comprises a main battery 50, an electric motor unit 52, a buck-boost converter 54, a DC-DC converter 56, a relay 58, a fuse 60, an auxiliary battery 62, an engine 64 and a control unit 66. The electric motor unit 52 comprises two MG 70 and 72 and inverters 74 and 76 corresponding to the MG, for example. The MG 70, for example, has the function of electrically accomplishing torque transfer from the output shaft of the engine 64 to the vehicle drive shaft, and the function of converting all or a portion of the engine torque into electrical energy. On the other hand, the MG 72 provides torque to the vehicle drive shaft and also, during braking or the like, receives torque from the vehicle drive shaft and regenerates electrical energy. In this manner, in the electric motor unit 52, it is possible to generate electricity, and the generated electric power is for example stepped up in the buck-boost converter 54 and charges the main battery 50.

[0016]

The buck-boost converter 54 comprises a chopper circuit, and between the terminals of the buck-boost converter 54 connected to the electric motor unit 52, a parallel connection unit of a diode 80 and a transistor switch 82, and a parallel connection unit of a diode 84 and a transistor switch 86, are connected in series. At the connection point between the two parallel connection units, a reactor 88 is connected and this becomes one terminal of the buck-boost converter 54 on the main battery 50 side. The other terminal is pulled out from the side of the parallel connection unit of the diode 84 and the transistor switch 86 to which the reactor 88 is not connected. This buck-boost converter 54, when stepping up, has the switch 82 in an off state and periodically switches the switch 86, and on the other hand, when stepping down has the switch 86 in an off state and periodically switches the switch 82. For example, the voltage between the terminals of the main battery 50 is around 200 ~ 300 V, the normal operating voltage of the electric motor unit 52 is around 500 V, and the buck-boost converter 54 accomplishes voltage conversion between these.

[0017]

The DC-DC converter 56 is connected between the terminals of the buck-boost converter 54 on the main battery side 50, and converts the voltage of direct-current power input from the main battery 50 and charges the auxiliary battery 62 (output voltage 12 V, for example). In this manner, by positioning the DC-DC converter 56 on the main battery 50 side of the buck-boost converter 54, the breakdown voltage required by the DC-DC converter 56 can respond to the output voltage of the main battery 50 and can comprise a lower breakdown voltage than when positioned on the electric motor unit 52 side. In addition, through this it is possible to lower the specifications of the constituent components of the DC-DC converter 56, and in addition, to simplify circuit composition and thereby enable costs to be reduced and greater compactness to be achieved.

[0018]

The auxiliary battery 62 is used as a power supply of a control circuit such as the control unit 66 or the like. The control unit 66 is a control circuit for accomplishing control of operation of the various parts of the main drive device, and targets of control include the switches 82 and 86, the inverters 74 and 76 and the engine 64.

[0019]

The fuse 60 is to prevent excess electric current from flowing to the main battery 50, and is connected in series with the main battery 50. The relay 58 controls connection/disconnection of the main battery 50, the DC/DC converter 56 and the buck-boost converter 54 and the like to a load.

[0020]

Next, operation of the main drive device when an abnormality occurs in the main battery 50 or the like will be explained. For example, when an abnormality occurs in the main battery 50 itself, when the fuse 60 blows, when an abnormality occurs in the relay 58 or the like, the supply of electric power from the main battery 50 to the load cannot be accomplished. In such cases, it is possible to cause the vehicle to run by using the engine 64, and it is possible to accomplish power generation in the electric motor unit 52.

[0021]

The control unit 66, upon detecting by means of an undepicted detection means that the supply of electric power from the main battery 50 to the load has become impossible, reduces the output of the engine 64 and also controls the inverters 74 and 76 to make the direct-current output from the electric motor unit 52 within the range of permissible input voltages of the DC-DC converter 56. In addition, the control unit 66 periodically sets the switch 86 to an off state and periodically sets the switch 82 to an on state. Through this, the buck-boost converter 54 is switched to a configuration in which the input power provided between the terminals on the electric motor unit 52 side is simply output to between the terminals on the main battery 50 side without change, and the output electric power of the electric motor unit 52 is supplied to the DC-DC converter 56.

[0022]

Through the operation of this main drive device, even in cases in which the DC-DC converter 56 cannot be supplied with electricity from the main battery 50 due to malfunction of the main battery 50 or the like, it is possible to maintain the residual charge amount of the DC-DC converter 56, and it is possible to avoid the vehicle becoming unable to run.

[0023]

As described above, when an abnormality in the main battery 50 or the like is detected,

the control unit 66 can immediately start supplying electricity directly to the DC-DC converter 56 from the electric motor unit 52, but may also monitor the residual charge amount of the auxiliary battery 62 and start the direct supply of electricity when this residual charge amount drops below a prescribed level. In this case, until the stored power of the auxiliary battery 62 is consumed and drops to the prescribed level, the engine 64 and the electric motor unit 52 can operate normally and the running performance of the vehicle can be ensured.

[0024]

[Second Embodiment]

FIG. 2 is a circuit summary circuit configuration diagram of the main components of a hybrid vehicle drive device according to a second embodiment of the present invention. The parts not shown in the figure are the same as FIG. 1 of the above-described embodiment and are incorporated into the below explanation. In addition, in the below explanation, the same reference symbols are used for the same constituent elements as in the above-described embodiment. In FIG. 2, parts of the DC-DC converter 56 and the buck-boost converter 54 in the drive device are shown.

[0025]

This embodiment is configured such that the power supply of the DC-DC converter 56 can be taken from each of the main battery 50 and the electric motor unit 52. Specifically, a path 100 is provided that connects one terminal of the electric motor unit 52 (equivalent to the end on the side of the diode 80 and the switch 82 to which the reactor 88 of the parallel connection unit is not connected) to one terminal of the DC-DC converter 56. A relay 102 and a diode 104 are connected in series in this path. In addition, the terminal of the DC-DC converter 56 to which this path is connected is also connected via a diode 106 to a line linking the relay 58 and the reactor 88. The diodes 104 and 106 are connected in an orientation that can supply electricity to the DC-DC converter 56 from the electric motor unit 52 and the main battery 50, respectively, and for example, the respective anodes of the diodes 104 and 106 are connected to the terminal of the DC-DC converter 56 together. Through these diodes, even when the relay 102 is in a conduction state, it is possible to prevent a short circuit between the main battery 50 and the electric motor unit 52 via the path 100.

[0026]

The DC-DC converter 56 can receive a supply of electricity from the main battery 50 and can also receive a supply of electricity from the electric motor unit 52 through the relay 102 being set to a conduction state. As described in the first embodiment, when supplying electricity from the electric motor unit 52 to the DC-DC converter 56, control can be accomplished to reduce the output of the electric motor unit 52 to match the specifications of the DC-DC converter 56.

[0027]

With this configuration, even when the switch 82 of the buck-boost converter 54 malfunctions and cannot be turned on, it is possible to supply electricity from the electric motor unit 52 to the DC-DC converter 56.

[0028]

[Efficacy of the Invention]

With the drive device for a hybrid vehicle according to the present invention, and the control method thereof, the DC-DC converter receives a supply of electricity exclusively from the main battery having relatively low voltage, and when an abnormality occurs so that the supply of electricity from the main battery cannot be received, the configuration is such that a supply of electricity is received from the electric motor unit. Through this, it is possible to reduce the breakdown voltage of the DC-DC converter and at the same time it is possible to ensure output from the DC-DC converter even in the case of abnormalities in the main battery or the like. Hence, operation of the various control devices that operate on the basis of the output of the DC-DC converter can be ensured, making it possible for running of the vehicle to continue.

[Brief Description of the Drawings]

[FIG. 1] is a summary circuit configuration diagram of a drive device for a hybrid vehicle according to a first embodiment of the present invention.

[FIG. 2] is a circuit summary circuit configuration diagram of the main components of a hybrid vehicle drive device according to a second embodiment of the present invention.

[FIG. 3] is a summary circuit configuration diagram of a conventional drive device for a hybrid vehicle.

[Description of Reference Symbols]

50 Main battery

52 Electric motor unit

54 Buck-boost converter

56 DC-DC converter

58 Relay

60 Fuse

62 Auxiliary battery

64 Engine

66 Control unit

70, 72 Motor/generator (MG)

74, 76 Inverter

82, 86 Transistor switch

102 Relay

[Drawings]
[FIG. 1]

56 DC-DC converter

62 Auxiliary battery

64 Engine

66 Control unit

74 Inverter

76 Inverter

[FIG. 2]

To main battery

56 DC-DC converter

To electric motor unit

[FIG. 3]

8 DC-DC converter

18 Inverter

20 Inverter

32 Auxiliary battery