

# SYSTEM

< SYSTEM DESCRIPTION >

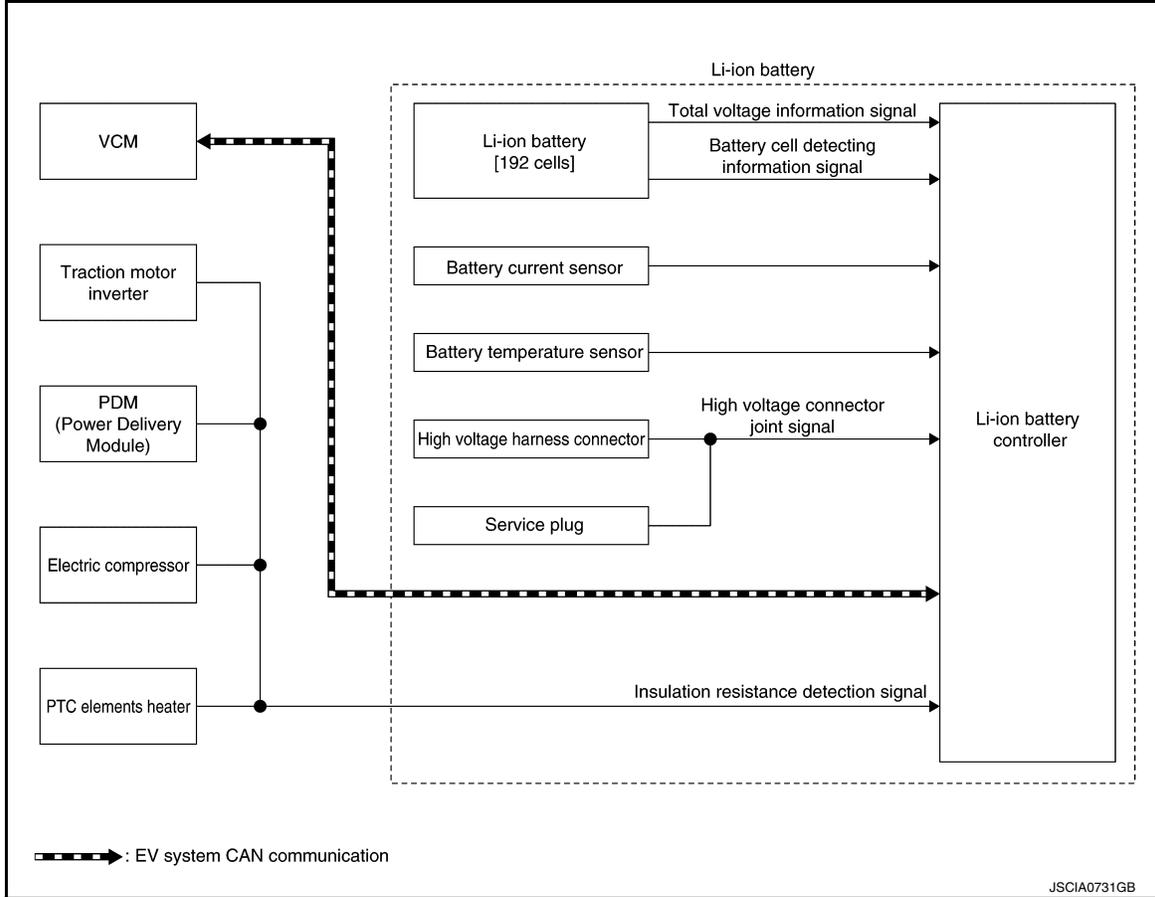
## SYSTEM

### LI-ION BATTERY CONTROL SYSTEM

#### LI-ION BATTERY CONTROL SYSTEM : System Description

INFOID:000000008745916

#### SYSTEM DIAGRAM



#### INPUT/OUTPUT SIGNAL ITEM

##### Input Signal Item

Transmit unit	Signal name	
VCM	EV system CAN	Target Li-ion battery remained energy signal

##### Output Signal Item

# SYSTEM

## < SYSTEM DESCRIPTION >

Received unit	Signal name	
VCM	EV system CAN	High voltage discharge permit signal
		Li-ion battery main relay cut request signal
		Li-ion battery connector interlock signal
		Li-ion battery voltage signal
		Li-ion battery current signal
		Li-ion battery chargeable power signal
		Li-ion battery dischargeable power signal
		Li-ion battery chargeable completion signal
		Li-ion battery available charge signal
		Li-ion battery capacity signal
		Li-ion battery gradual capacity loss signal
		Insulation resistance signal

### DESCRIPTION

The Li-ion battery controller (LBC) monitors the status of the inside of the Li-ion battery at all times and sends information, such as the charging status of Li-ion battery and possible power, to VCM (vehicle control module) via EV system CAN communication.

The Li-ion battery controller performs control as per the following.

- Monitors the battery state and transfers chargeable/dischargeable power to VCM to prevent an error, such as overvoltage, over discharge or excessive temperature rise in the battery.
- Detects an error (overvoltage, over discharge, overcurrent, or excessive temperature rise) immediately at the time of error occurrence and requests VCM to disconnect the system main relay to interrupt the discharge/charge line.
- Maintains the optimum battery state constantly with a cell capacity adjustment function to prevent a reduction in charging/discharging capacity caused by cell capacity variations.
- Detects the connector fit state with the function to detect the fit of the high voltage harness connector and transfers the detected state to VCM so that the vehicle does not start with an unsteady state.
- Detects the insulation resistance state with the function to detect the insulation resistance between high and low voltage and transfers the detected state to VCM so that the vehicle does not start with an unusual state.
- Estimates a battery charge state and low battery state, based on the data obtained with the battery state detection function, and reflects on the battery capacity meter.

### BATTERY PROTECTION

The Li-ion battery has a voltage range capable of charge/discharge. If charged/discharged exceeding the range, excessive low capacity or malfunction may be caused. To prevent this, the Li-ion battery controller detects voltage of each cell and requests the control of charging/discharging energy to VCM so that the cell voltage stays within the voltage range.

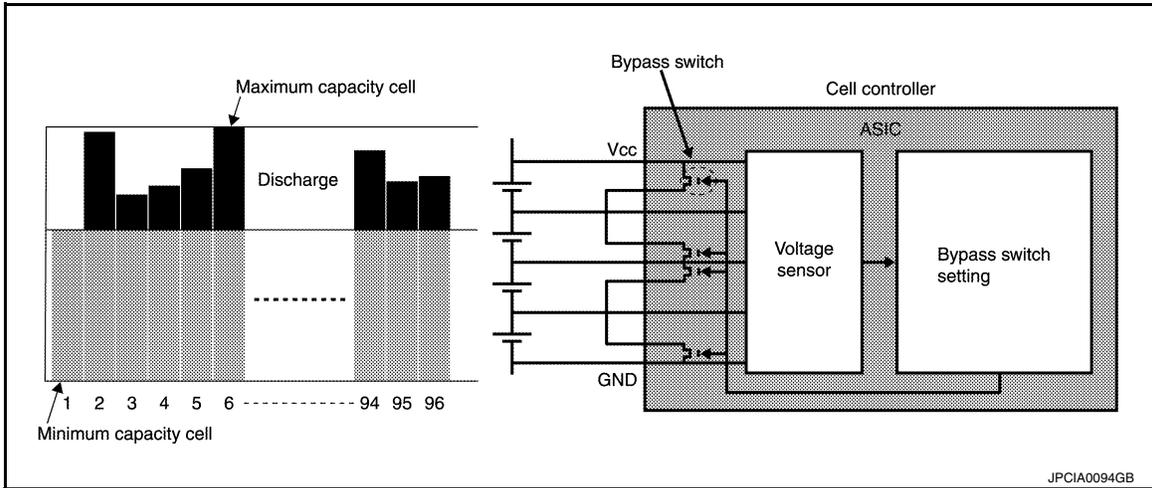
Control item	Control	Operating condition
Overvoltage/overcurrent protection	Charging energy control	Gradual control of charging energy as the cell voltage approaches the upper limit of the voltage capable of charging.
	System main relay cut	Cell voltage exceeds the voltage judged as overvoltage and maintains the voltage for more than the specified time.
Over discharge protection	Discharging energy control	Gradual control of discharging energy as the cell voltage approaches the lower limit of the voltage capable of discharging.
	System main relay cut	Cell voltage exceeds the voltage judged as over discharge and maintains the voltage for more than the specified time.
Excessive temperature rise protection	Charging/discharging energy control	Gradual control of charging/discharging energy as Li-ion battery temperature approaches the upper limit of the temperature capable of use.
	System main relay cut	Li-ion battery temperature exceeds the temperature judged as excessive temperature rise and maintains the temperature for more than the specified time.

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### HOW TO ADJUST CELL CAPACITY

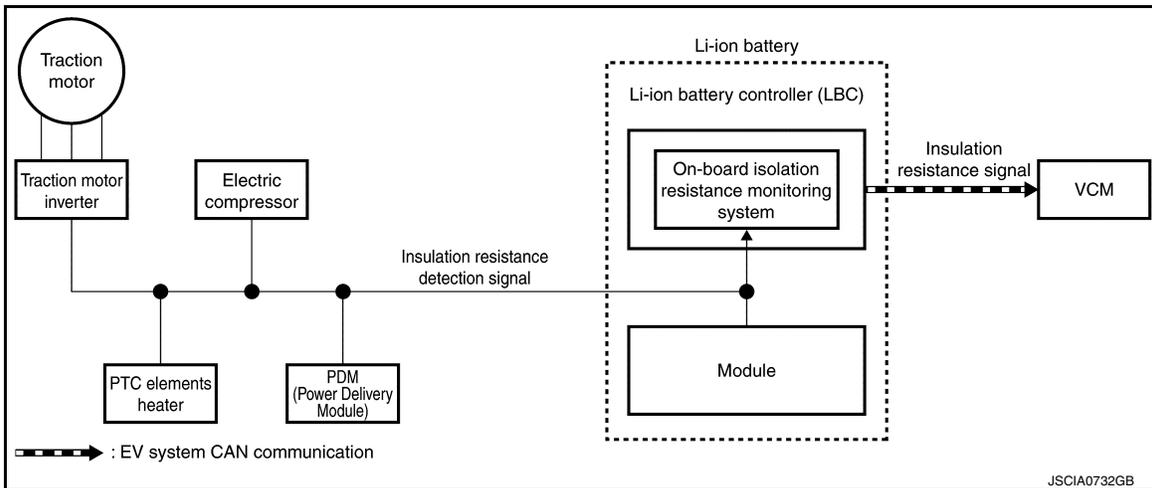
During cell capacity adjustment, the capacity of each cell is estimated based on the no-load voltage when the system starts, and the capacities are adjusted so that they are all at the target level. The voltage of each cell is detected inside the Li-ion battery controller. The bypass switches are then turned ON to discharge the cells that have excess capacity. In this way, capacity adjustment by the Li-ion battery controller allows the capacity of all cells to be fully utilized.



### INSULATION RESISTANCE LOSS DETECTION FUNCTION

The insulation resistance detection circuit mounted inside the Li-ion battery controller measures the insulation resistance of each high voltage part and sends the measurement results to VCM via EV system CAN communication.

VCM judges abnormal insulation resistance in each high voltage part, based on the received insulation resistance value.



### LI-ION BATTERY HEATER CONTROL SYSTEM

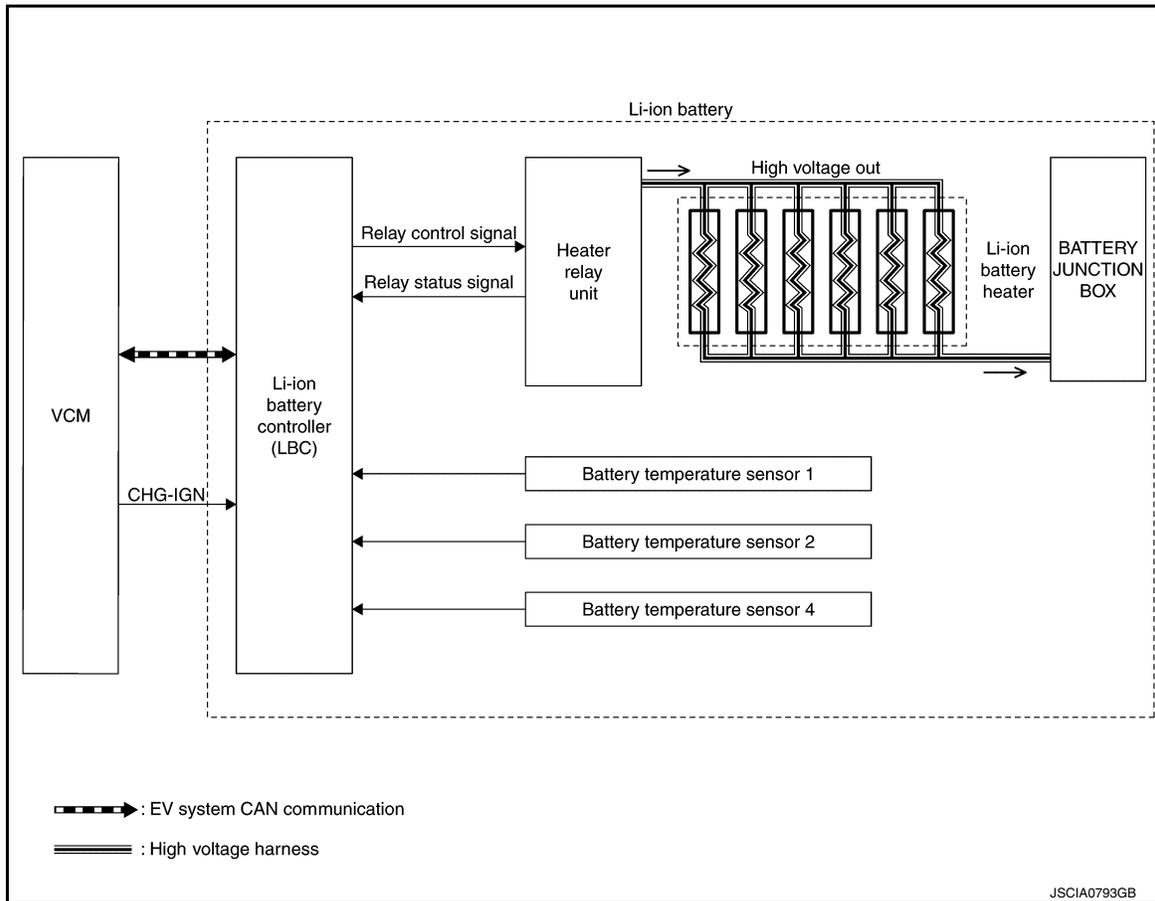
# SYSTEM

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## LI-ION BATTERY HEATER CONTROL SYSTEM : System Description

INFOID:000000008745917

### SYSTEM DIAGRAM



### INPUT/OUTPUT SIGNAL ITEM

#### Input Signal Item

Transmit unit	Signal name	
VCM	EV system CAN communication	Keep SOC request signal

#### Output Signal Item

Receive unit	Signal name	
VCM	EV system CAN communication	Next start time signal

### DESCRIPTION

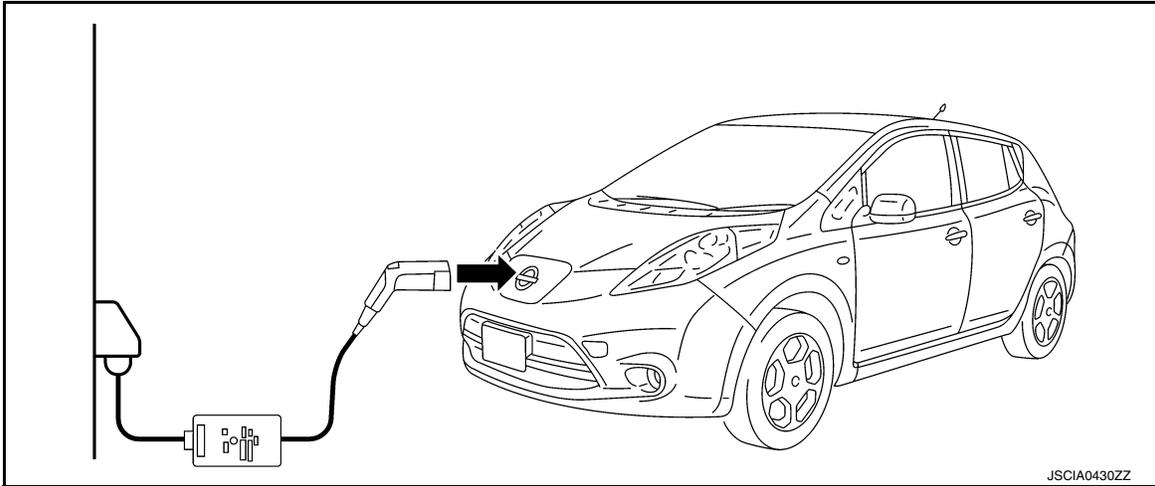
- When the temperature decreases [approximately  $-20^{\circ}\text{C}$  ( $-4^{\circ}\text{F}$ )] extremely in the battery pack, the Li-ion battery heater control system automatically activates the Li-ion battery heater to warm the inside of the battery pack for protecting Li-ion battery from freezing and preventing the decline in battery output. In addition, when the temperature in the battery pack is restored [approximately  $-10^{\circ}\text{C}$  ( $14^{\circ}\text{F}$ )], the Li-ion battery heater stops.
- The Li-ion battery controller (LBC) detects a temperature in the battery pack, according to a signal transmitted from the battery temperature sensor installed to the battery pack and judges the activation of the Li-ion battery heater.
- When the relay built in the heater relay unit turns ON, high voltage power is supplied to each Li-ion battery heater.
- LBC detects the ON/OFF status of the relay built in to heater relay unit.
- Even when the power switch is OFF, VCM periodically activates LBC to protect Li-ion battery from freezing.

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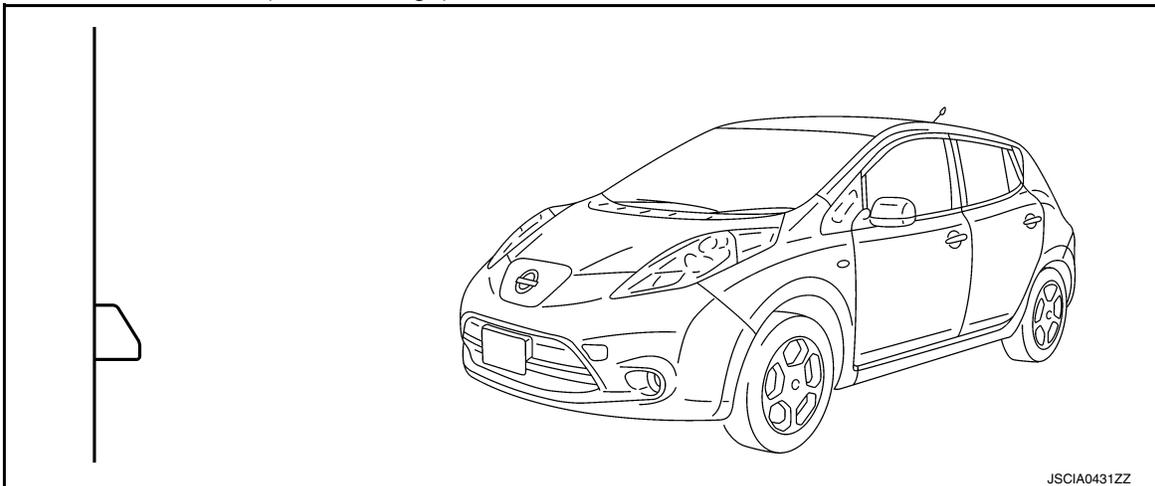
- When the temperature in Li-ion battery pack is low with no necessity of Li-ion battery heater operation, LBC estimates the time that Li-ion battery may freeze and transmits a next start time signal to VCM via EV system CAN communication to prepare for starting the Li-ion battery heater next time.
- When receiving a next start time signal via EV system CAN communication, VCM transmits a start request signal (CHG-IGN) to LBC after a lapse of the set time. When receiving a start request signal (CHG-IGN), LBC activates the Li-ion battery heater.

When EVSE is connected (normal charge)



- When the temperature in the battery pack is low outside the timer charge set time, VCM transmits a keep SOC request signal to LBC via EV system CAN communication. In this case Li-ion battery is not charged, and only Li-ion battery heater is activated.
- When timer charge starts at the set time, Li-ion battery is charged, and the Li-ion battery heater is activated.

When EVSE is not connected (normal charge)



- When the charge level of the Li-ion battery is low during the Li-ion battery heater operation, LBC stops the Li-ion battery heater operation even if the temperature in the battery pack is insufficient.