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ELECTRONIC CONTROLLER

Abstract

OBJECT To provide an electronic controller capable of achieving reprogramming even when a power supply switch is turned off.
SOLVING MEANS
An electronic control device **20** includes an in-device power supply **22**, a multi-function power supply **26**, and the controller **50**. The in-device power supply **22** is supplied with electrical power from a battery **10** and works to deliver electrical power or stop such delivery in response to turning on or off of a power supply switch **12**. The multi-function power supply **26** receives a supply of electrical power from the in-device power supply **22** in response to turning on of the power supply switch **12**. The controller **50** is supplied with electrical power from the multi-function power supply **26** and perform a reprogramming task. The multi-function power supply works to keep the in-device power supply delivering electrical power to the multi-function power supply in response to the power supply switch being turned on, thereby enabling the in-device power supply to continue to deliver electrical power to the controller through the multi-function power supply when the power supply switch is changed from an on-state to an off-state, and the controller is required to perform the reprogramming task.

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Background/Summary

CROSS REFERENCE TO RELATED DOCUMENT
[0001] The present application claims the benefit of priority of Japanese Patent Application No. 2024-18693 filed on Feb. 9, 2024, the disclosure of which is incorporated in its entirety herein by reference.
BACKGROUND
Technical Field
[0002] This disclosure relates generally to an electronic controller.
Background Art
[0003] International application No. WO 2014/045785 A1 teaches a control system for electrical vehicles which includes a power supply, a first microcomputer, and a second microcomputer. The first and second microcomputers share the power supply with each other, are equipped with control features different from each other, and have control programs rewritable independently from each other.
[0004] When it is required to perform a reprogramming task to revise the program in the above type of control system, a power supply switch which is used to deliver electrical power from a power supply or stop such power delivery may be turned off. When the power supply switch is turned off, it will cause no power to be delivered from the power supply both to the first microcomputer and to the second microcomputer, which makes it impossible to perform the reprogramming task.
SUMMARY
[0005] It is an object of this disclosure to provide an electronic controller which is capable of performing a reprogramming task even after a power supply switch is turned off.
[0006] According to one aspect of this disclosure, there is provided an electronic controller which comprises: (a) a first power supply which is supplied with electrical power from a power source and works to achieve or stop supply of electrical power in response to on- or off-operation of a power supply switch; (b) a multi-function power supply to which electrical power is delivered from the first power supply when the power supply switch is turned on; and (c) a controller to which electrical power is delivered from the multi-function power supply and which works to perform a reprogramming task. The multi-function power supply works to keep the first power supply delivering electrical power to the multi-function power supply in response to the power supply switch being turned on, thereby enabling the first power supply to continue to deliver electrical power to the controller through the multi-function power supply when the power supply switch is changed from an on-state to an off-state, and the controller is required to perform the reprogramming task.
[0007] The above structure works to continue to deliver electrical power to the controller even when the power supply switch is turned off, thereby enabling the reprograming task to be performed.
[0008] Reference marks or numbers in parentheses are attached to elements described in this

application. Such reference marks or numbers merely represent an example of a correspondence relation between the elements and parts in the following embodiments. This disclosure is, therefore, not limited to the embodiments by use of the reference marks or numbers.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The present disclosure will be understood more fully from the detailed description given hereinbelow and from the accompanying drawings of the preferred embodiments of the invention, which, however, should not be taken to limit the invention to the specific embodiments but are for the purpose of explanation and understanding only.

[0010] In the drawings:

[0011] FIG. **1** is a structural view which illustrates a system in which an electronic control device is used according to an embodiment; and

[0012] FIG. **2** is a flowchart of a task performed by a controller installed in an electronic control device according to an embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0013] The electronic control device **20** (which will also referred to herein as an electronic controller) according to the embodiment will be described below with reference to the drawings in which same reference numbers refer to the same parts or equivalents thereof, and explanation thereof in detail will be omitted.

[0014] The electronic control device **20** is used with, for example, a system which is installed in a vehicle and capable of performing reprograming for the electronic control device **20** even when the power supply switch **12** is turned off. Such a system will first be described below.

[0015] The system, as illustrated in FIG. **1**, includes the battery **10**, the power supply switch **12**, the external device **14**, and the electronic control device **20**.

[0016] The battery **10** functions as a power supply in this embodiment and is disposed outside the electronic control device **20** (which will be described later in detail). The battery **10** is electrically connected to the electronic control device **20** to deliver electrical power to the electronic control device **20**.

[0017] The power supply switch **12** is implemented by, for example, an ignition switch of the vehicle. The power supply switch **12** is arranged outside the electronic control device **20** and connected to the electronic control device **20**. When the power supply switch **12** is turned on, it outputs a signal whose level of voltage is high to the electronic control device **20**. Alternatively, when the power supply switch **12** is turned off, it outputs a signal whose level of voltage is low to the electronic control device **20**.

[0018] The external device **14** is equipped with a computer and a communication interface and located outside the electronic control device **20**. The external device **14** is connected to the electronic control device **20**. The external device **14** instructs the electronic control device **20** to perform a reprogramming task.

[0019] The electronic control device **20** includes the in-device power supply **22** (which will also be referred to as a first power supply), the power supply-side diode **24**, the multi-function power supply **26**, the first diode **31**, the second diode **32**, the OR circuit **34**, the transceiver **36**, the parallel wires **38**, and the transceiver-side diode **40**. The electronic control device **20** also includes the controller **50**, the power supply-side communication line **52**, the reset signal line **54**, the power line **56**, and the transceiver-side communication line **58**.

[0020] The in-device power supply **22** includes a DC-to-DC converter and a regulator. The in-device power supply **22** is connected to a cathode of the power supply-side diode **24**. The power supply-side diode **24** is connected at an anode thereof to the battery **10**. The electrical power is, therefore, supplied from the battery **10** to the in-device power supply **22** through the power supply-side diode **24**.

[0021] The multi-function power supply **26** (which will also be referred to as a second power supply) is made of a PMIC (Power Management Integrated Circuit). The multi-function power supply **26** is supplied with electrical power from the in-device power supply **22**.

[0022] The first diode **31** is connected at an anode thereof to the power supply switch **12**. The second diode **32** is connected at an anode thereof to the multi-function power supply **26**.

[0023] The OR circuit **34** is connected to a cathode of the first diode **31**, a cathode of the second diode **32**, and the in-device power supply **22**. The OR circuit **34** works to logically OR the signals from the power supply switch **12** and the multi-function power supply **26**. The OR circuit **34**, therefore, produces a signal that is high in voltage when an output from the power supply switch **12** or the multi-function power supply **26** is at a high level of voltage and outputs it (i.e., high-level signal) to the in-device power supply **22**. The OR circuit **34** outputs a low-level signal to the in-device power supply **22** when the low-level signals are inputted both from the power supply switch **12** and from the multi-function power supply **26**.

[0024] The transceiver **36** is equipped with an A/D converter. The transceiver **36** is connected to the parallel wires **38**. The parallel wires **38** are made of two discrete conductors extending parallel to each other and connected to the cathode of the transceiver-side diode **40**. The anode of the transceiver-side diode **40** is connected to the power supply switch **12**. The transceiver **36**, therefore, receives an on- or off-signal through the transceiver-side diode **40** and the parallel wires **38** in response to turning on or off of the power supply switch **12**. In other words, the transceiver **36** monitors an on- or off-state of the power supply switch **12**. The transceiver **36** outputs an on- or off-signal to the controller **50** in response to the on- or off-signal from the power supply switch **12**.

[0025] The controller **50** is mainly made of a microcomputer which includes a CPU, a ROM, a flash memory, a RAM, an I/O unit, and bus lines connecting them. The controller **50** is connected to first ends of the power supply-side communication line **52**, the reset signal line **54**, and the power line **56**. The power supply-side communication line **52**, the reset signal line **54**, and the power line **56** are connected at second ends thereof to the multi-function power supply **26**.

[0026] The controller **50** communicates with the multi-function power supply **26** through the power supply-side communication line **52** using, for example, an I2C (i.e., Inter-Integrated Circuit). The I2C is one of synchronous serial communication interfaces through which data is transmitted in synchronous with clocks.

[0027] The controller **50** receives a reset signal, as will be described later in detail, which is outputted from the multi-function power supply **26** through the reset signal line **54**. The controller **50** is also supplied with electrical power from the multi-function power supply **26** through the power line **56**.

[0028] The controller **50** connects with a first end of the transceiver-side communication line **58**. The transceiver-side communication line **58** is connected at a second end thereof to the transceiver **36**. The controller **50** communicates with the transceiver **36** through the transceiver-side communication line **58** using, for example, a SPI (i.e., Serial Peripheral Interface) which is one of synchronous serial communication interfaces through which data is transmitted in synchronous with clocks. The SPI is higher in communication rate than the I2C.

[0029] When the power supply switch **12** is switched from an off-state to an on-state, it causes the level of voltage of an output from the power supply switch **12** to be changed from a low level to a high level. The power supply switch **12**, therefore, output the high-level signal to the OR circuit **34**. The OR circuit **34** then outputs a high-level signal to the in-device power supply **22**. The in-device power supply **22** supplies electrical power to the multi-function power supply **26**. The multi-function power supply **26** delivers electrical power to the controller **50** through the power line **56**.

[0030] The controller **50**, then, starts executing a program stored in the ROM installed therein to determine whether the transceiver **36** is malfunctioning using the signal outputted from the transceiver **36**. The controller **50** also controls the operation of the multi-function power supply **26** in order to enable the reprogramming task to be performed even after the power supply switch **12** is turned off. How to determine whether the transceiver **36** is malfunctioning and how to control the operation of the multi-function power supply **26** will be described later in detail.

[0031] The system using the electronic control device **20** is designed to have the above-described structure. How to determine whether the transceiver **36** is malfunctioning and how to control the operation of the multi-function power supply **26** by executing the program in the controller **50** will be described below with reference to FIG. **2**.

[0032] After entering the program in FIG. **2** in the controller **50**, the routine proceeds to step S**100** wherein it is determined whether the transceiver **36** is malfunctioning. In other words, the controller **50** determines whether the transceiver **36** is properly monitoring the on- or off-operation of the power supply switch **12**.

[0033] Specifically, the controller **50** obtains two signals (which will referred to below as a first signal and a second signal) which arise from an output of the power supply switch **12** and are received by the transceiver **36** through the parallel wires **38**. When the transceiver **36** is properly operating, it will cause the first and second signals to be the same, in other words, an absolute value of a difference in level between the first and second signals to be low. Accordingly, when such an absolute value is lower than a predetermined threshold value, the controller **50** determines that the transceiver **36** is properly operating. The predetermined threshold value is set by means of experiments or simulations performed to ensure the determination of malfunction of the transceiver **36**.

[0034] The controller **50** may alternatively communicate with the transceiver **36** and determine whether the transceiver **36** is malfunctioning using a CRC (i.e., Cyclic Redundancy Check) instead of the above way.

[0035] The voltage at the transceiver **36** when the transceiver **36** is properly operating may be defined as a reference voltage. The controller may determine whether the transceiver **36** is malfunctioning based on comparison between the voltage at the transceiver **36** and the reference voltage instead of the above way of the determination of malfunction. Specifically, the controller **50** obtains the voltage appearing within the transceiver **36** from the transceiver **36**. When an absolute value of a difference between the obtained voltage in the transceiver **36** and the reference voltage is lower than a reference threshold value, the controller **50** determines that the transceiver **36** is properly operating. Alternatively, when the above absolute value is higher than or equal to the reference threshold value, the controller **50** determines that the transceiver **36** is malfunctioning. The reference threshold value may be set by means of experiments or simulations performed to ensure the determination of malfunction of the transceiver **36**.

[0036] If a YES answer is obtained in step S**100**, meaning that the transceiver **36** is malfunctioning, in other words, the transceiver **36** is not properly monitoring the on- or off-state of the power supply switch **12**, then the routine proceeds to step S**120**. Alternatively, if a NO answer is obtained, meaning that the transceiver **36** is properly operating, in other words, the transceiver **36** is properly monitoring the on- or off-state of the power supply switch **12**, then the routine proceeds to step S**102**.

[0037] After step S**100**, the routine proceeds to step S**102** wherein the controller **50** outputs a control signal to the multi-function power supply **26** to instruct the multi-function power supply **26** to output the high-level signal to the OR circuit **34** in order to enable the reprogramming task to be performed even after the power supply switch **12** is turned off. The multi-function power supply **26** is responsive to the input of the control signal to produce and transmit the high-level signal to the OR circuit **34**. This causes the OR circuit **34** to output the high-level signal to the in-device power supply **22** regardless of the voltage level of the on- or off-signal outputted from the power supply switch **12**. The in-device power supply **22** is responsive to the high-level signal to continue to deliver electrical power to the multi-function power supply **26** even when the power supply switch

12 is turned off. The multi-function power supply **26** also delivers electrical power to the controller **50** through the power line **56** even when the power supply switch **12** is turned off. This enables the controller **50** to continue to operate properly to perform the reprograming task.

[0038] After step S**102**, the routine proceeds to step S**104** wherein it is determined whether the controller **50** is required to perform the reprogramming task when the power supply switch **12** is in the off-state.

[0039] Specifically, the controller **50** obtains from the transceiver **36** the voltage level of a signal outputted from the power supply switch **12**. When the signal outputted from the power supply switch **12** is at the low voltage level, the controller **50** concludes that the power supply switch **12** is in the off-state. Alternatively, when the signal outputted from the power supply switch **12** is at the high voltage level, the controller **50** concludes that the power supply switch **12** is in the on-state.

[0040] Further, when receiving a reprogramming instruction signal from the external device **14**, the controller **50** determines that the reprogramming task should be started. Alternatively, when receiving no reprograming instruction signal from the external device **14**, the controller **50** determines that the reprogramming task is required not to be performed.

[0041] If a NO answer is obtained in step S**104**, meaning that the power supply switch **12** is turned on or that the reprogramming task is required not to be performed, the routine returns back to step S**100**. Alternatively, if the power supply switch **12** is turned off, and the reprogramming task is required to be performed, then the routine proceeds to step S**106**.

[0042] In step S**106**, the controller **50** starts performing the reprogramming task in response to a signal outputted from the external device **14**.

[0043] When the controller **50** has started to be reprogrammed, the multi-function power supply **26** communicates with the controller **50** and determines whether the controller **50** is malfunctioning.

[0044] Specifically, the multi-function power supply **26** uses, for example, a watchdog timer to determine whether the controller **50** is failing in operation.

[0045] Instead of the above diagnostic manner, the multi-function power supply **26** may diagnose the controller **50** in the following way. The multi-function power supply **26** calculates a first parameter used to diagnose the failure in operation of the controller **50**. Similarly, the controller **50** calculates a second parameter used to diagnose the failure in operation of the controller **50**. The multi-function power supply **26** determines whether the first parameter calculated by the multi-function power supply **26** and the second parameter calculated by the controller **50** are matched with each other to diagnose whether the controller **50** is failing in operation. When the first parameter is identical with the second parameter, the multi-function power supply **26** determines that the controller **50** is operating properly. Alternatively, when the first parameter is different from the second parameter, the multi-function power supply **26** determines that the controller **50** is failing in operation.

[0046] Instead of the above diagnostic manner, the multi-function power supply **26** may alternatively determine whether the multi-function power supply **26** has properly received a signal from the controller **50** to diagnose the controller **50**. Specifically, when having received a signal from the controller **50**, the multi-function power supply **26** determines whether the controller **50** is properly operating. Alternatively, when receiving no signal from the controller **50**, the multi-function power supply **26** determines whether the controller **50** is failing in operation.

[0047] When the controller **50** is malfunctioning, it means that it is impossible for the controller **50** to properly perform the reprogramming task. The multi-function power supply **26**, therefore, changes the voltage level of a signal to be outputted to the OR circuit **34** to the low level. The multi-function power supply **26** then outputs such a low-level signal to the OR circuit **34**. In this case, the signal outputted from the power supply switch **12** is at the low voltage level, and the signal from the multi-function power supply **26** is at the low-voltage level. The OR circuit **34**, therefore, outputs the low-level signal to the in-device power supply **22**. The in-device power supply **22** then stops delivering electrical power to the multi-function power supply **26**.

Additionally, the multi-function power supply **26** stops delivering electrical power to the controller **50**. This minimizes waste or unnecessary consumption of electrical energy consumed in the electronic control device **20** when it is impossible to properly reprogram the controller **50**. Alternatively, when the controller **50** is properly operating, the multi-function power supply **26** keeps a signal outputted therefrom to the OR circuit **34** at the high voltage level.

[0048] After step S**106**, the routine proceeds to step S**108** wherein the controller **50** determines whether the reprogramming performed in step S**106** is completed. If a NO answer is obtained, meaning that the reprogramming is not yet completed, then the routine returns back to step S**106** to continue to perform the reprogramming task. Alternatively, if a YES answer is obtained, meaning that the reprogramming is completed, then the routine proceeds to step S**110**.

[0049] When the reprogramming is completed, it leads to a risk that the multi-function power supply **26** may output a reset signal using a reset signal line to initialize the controller **50**, thus causing a signal transmitted from the controller **50** to the multi-function power supply **26** to be initialized. Such initialization will cause the signal outputted from the multi-function power supply **26** to the OR circuit **34** to be changed from the high level to the low level (i.e., an initial voltage level). In this case, the signal outputted from the power supply switch **12** is at the low level, and the signal outputted from the multi-function power supply **26** is at the low level. The OR circuit **34**, therefore, outputs the low-level signal to the in-device power supply **22**. The in-device power supply **22** then stops delivering electrical power to the multi-function power supply **26**. The multi-function power supply **26** also stops delivering electrical power to the controller **50**. This will cause the controller **50** to be unable to check the reprogramming even though the reprogramming is completed.

[0050] Consequently, after step S**108**, the routine proceeds to step S**110** wherein the controller **50** outputs a signal to the multi-function power supply **26** to instruct the multi-function power supply **26** to keep a signal transmitted to the OR circuit **34** at the high voltage level.

[0051] The routine proceeds to step S**112** wherein the controller **50** receives a reset signal from the multi-function power supply **26** through the reset signal line **54**, so that the controller **50** is initialized. The multi-function power supply **26** keeps a signal outputted to the OR circuit **34** at the high voltage level in response to the signal transmitted from the controller **50**, as described in step S**110**. This causes the in-device power supply **22** to continue to deliver electrical power to the multi-function power supply **26**. The multi-function power supply **26** also continues to supply electrical power to the controller **50**.

[0052] The routine then proceeds to step S**114** wherein the controller **50** checks the reprogramming performed in step S**106**.

[0053] The routine proceeds to step S**116** wherein it is determined whether the check of the reprogramming performed in in step S**114** is completed. If a NO answer is obtained, meaning that the check of the reprogramming is not yet completed, then the routine returns back to step S**114**. Alternatively, if a YES answer is obtained, meaning that the check of the reprogramming is completed, then the routine proceeds to step S**118**.

[0054] In step S**118**, as entered when the reprogramming and the check or verification thereof are completed, the controller **50** outputs a signal to the multi-function power supply **26** to instruct the multi-function power supply **26** to change the signal outputted to the OR circuit **34** to the low voltage level in order to complete the task in the controller **50**.

[0055] The multi-function power supply **26** then sets the signal transmitted therefrom to the OR circuit **34** to the voltage low level and outputs it to the OR circuit **34**. The signal outputted from the power supply switch **12** is at the low voltage level. Similarly, the signal outputted from the multi-function power supply **26** is also at the low voltage level. This causes the OR circuit **34** to output the low-level signal to the in-device power supply **22**, so that the in-device power supply **22** stops delivering electrical power to the multi-function power supply **26**. Additionally, the multi-function power supply **26** also stops delivering electrical power to the controller **50**, so that the controller **50** stops or completes the task.

[0056] If a YES answer is obtained in step S**100**, meaning that the transceiver **36** is malfunctioning, it is impossible for the transceiver **36** to properly monitor the on- or off-operation of the power supply switch **12**, thereby leading to a high possibility that the task performed by the controller **50** to achieve communication with the transceiver **36** may be improper, which results in a waste of electrical power supplied to the controller **50**.

[0057] Therefore, in step S**120**, the controller **50** outputs a signal to the multi-function power supply **26** to instruct the multi-function power supply **26** to change the level of a signal outputted to the OR circuit **34** to the low voltage level. The routine then terminates.

[0058] The multi-function power supply **26** then transmits the low-level signal to the OR circuit **34**. The signal outputted from the multi-function power supply **26** is at the low voltage level, but the power supply switch **12** is turned on, so that the signal outputted by the power supply switch **12** is at the high voltage level. This causes the OR circuit **34** to output the high-level signal to the in-device power supply **22**.

[0059] Afterwards, when turned off, the power supply switch **12** outputs the low-level signal. The signal outputted from the multi-function power supply **26** is, therefore, changed to the low voltage level. Accordingly, when the power supply switch **12** is turned off, the OR circuit **34** outputs the low-level signal to the in-device power supply **22**, so that the in-device power supply **22** stops delivering electrical power to the multi-function power supply **26**. Additionally, the multi-function power supply **26** also stops delivering electrical power to the controller **50**. In other words, when the power supply switch **12** is changed from the on-state to the off-state when the transceiver **36** is malfunctioning, the multi-function power supply **26** stops the delivery of electrical power thereto from the in-device power supply **22**. This minimizes the unnecessary consumption of electrical power consumed in the electronic control device **20** when it is impossible to properly perform the task in the transceiver **36** or the controller **50**.

[0060] The controller **50** works to perform the task in the above-described way. The operation of the electronic control device **20** to enable the reprogramming task to be performed even when the power supply switch **12** is turned off will be described below in detail.

[0061] The electronic control device **20**, as described already, includes the in-device power supply **22**, the multi-function power supply **26**, and the controller **50**. The in-device power supply **22** is supplied with electrical power from the battery **10** and works to achieve or stop supply of electrical power in response to the on- or off-operation of the power supply switch **12**. When the power supply switch **12** is turned on, the multi-function power supply **26** receives a supply of electrical power from the in-device power supply **22**. The controller **50** is supplied with electrical power from the multi-function power supply **26** and perform the reprogramming task. The multi-function power supply **26** is responsive to the signal, as generated by the controller **50** in step S**102** when the power supply switch **12** is turned on, to keep the in-device power supply **22** delivering electrical power to the multi-function power supply **26**. This enables the in-device power supply **22** to continue to deliver electrical power to the controller **50** through the multi-function power supply **26** and the power line **56**, as discussed in steps S**104** to S**106**, when and after the power supply switch **12** is switched from the on-state to the off-state, and the controller **50** starts to be reprogrammed

[0062] The electrical power, therefore, continues to be delivered to the controller **50** after the power supply switch **12** is turned off, thereby enabling the controller **50** to be reprogrammed.

[0063] The above-described structure of the electronic control device **20** in this embodiment offers the following beneficial advantages.

1) The multi-function power supply **26** is responsive to the signal, as produced by the controller **50** in step S**110**, to continue the supply of electrical power from the in-device power supply **22** to the controller **50** when the reprogramming task is being completed. In other words, the multi-function power supply **26** works to continue to deliver the electrical power to the controller **50** at least until the controller **50** completes the reprogramming task.

[0064] The above operation causes the supply of electrical power to the controller **50** to continue even when the controller **50** receives the reset signal which performs the initialization of the controller **50**. This enables the verification of the reprogramming to be achieved properly after the controller **50** is reprogrammed even when the controller **50** receives the reset signal.

2) When it is required to reprogram the controller **50**, the multi-function power supply **26** communicates with the controller **50** to determine whether the controller **50** is malfunctioning. When the controller **50** is determined to be malfunctioning, the multi-function power supply **26** stops the in-device power supply **22** from delivering the electrical power to the controller **22**.

[0065] The above operation minimizes waste of electrical power consumed in the electronic control device **20** when the controller **50** fails in performing the reprogramming task and also alleviates a risk that the battery **10** which serves to deliver electrical power to the in-device power supply **22** may run out.

3) The controller **50**, as described in step S**100**, analyzes the signal outputted from the transceiver **36** to diagnose the operation of the transceiver **36**. When the transceiver **36** is determined to be malfunctioning, the multi-function power supply **26** is responsive to the signal, as produced by the controller **50** in step S**120**, to stop the supply of electrical power from the in-device power supply **22** when the power supply switch **12** is changed from the on-state to the off-state.

[0066] The above operation minimizes waste of electrical power consumed in the electronic control device **20** when the transceiver **36** or the controller **50** fails in operation thereof and also alleviates a risk that the battery **10** which serves to deliver electrical power to the in-device power supply **22** may be exhausted.

Other Embodiments

[0067] This disclosure is not limited to the above embodiments, but may be realized by various embodiments without departing from the purpose of the disclosure. This disclosure includes all possible combinations of the features of the above embodiments or features similar to the parts of the above embodiments. The structures in this disclosure may include only one or some of the features discussed in the above embodiments unless otherwise inconsistent with the aspects of this disclosure.

[0068] The controller or how to construct it referred to in this disclosure may be realized by a special purpose computer which is equipped with a processor and a memory and programmed to execute one or a plurality of tasks created by computer-executed programs or alternatively established by a special purpose computer equipped with a processor including one or a plurality of hardware logical circuits. The controllers or operations thereof referred to in this disclosure may alternatively be realized by a combination of an assembly of a processor with a memory which is programmed to perform one or a plurality of tasks and a processor made of one or a plurality of hardware logical circuits. Computer-executed programs may be stored as computer executed instructions in a non-transitory computer readable medium.

[0069] A power source which delivers electrical energy to the in-device power supply **22** is the battery **10** in the above embodiment, but however, may alternatively be implemented by another source, such as a grid-scale battery.

[0070] The power supply switch **12** is provided by an ignition switch installed in the vehicle in the above embodiment, but however, may alternatively be implemented by another switch for use in delivering electrical power within the electronic control device **20**.

[0071] The above embodiments realize the following unique structures.

First Structure

[0072] An electronic controller comprises: (a) a first power supply (**22**) which is supplied with electrical power from a power source (**10**) and works to achieve or stop supply of electrical power in response to on- or off-operation of a power supply switch (**12**); (b) a multi-function power supply (**26**) to which electrical power is delivered from the first power supply when the power supply switch is turned on; and (c) a controller (**50**) to which electrical power is delivered from the multi-function power supply and which works to perform a reprogramming task. The multi-function power supply works to keep the first power supply delivering electrical power to the multi-function power supply in response to the power supply switch being turned on, thereby enabling the first power supply to continue to deliver electrical power to the controller through the multi-function power supply when the power supply switch is changed from an on-state to an off-state, and the controller is required to perform the reprogramming task.

Second Structure

[0073] The electronic controller as set forth in the first structure, wherein when the reprogramming task is completed in the controller, the multi-function power supply keeps the first power supply delivering electrical power thereto.

Third Structure

[0074] The electronic controller as set forth in the first structure, wherein when the controller is required to perform the reprogramming task, the multi-function power supply communicates with the controller to determine whether the controller is malfunctioning. When it is determined that the controller is malfunctioning, the multi-function power supply stops the first power supply from delivering electrical power to the multi-function power supply.

Fourth Structure

[0075] The electronic controller as set forth in any one of the first to third structures, further comprises a transceiver (**36**) which receives an on-signal or an off-signal from the power supply switch and outputs a signal indicative thereof to the controller. The controller analyzes the signal from the transceiver to determine whether the transceiver is malfunctioning. When the transceiver is determined to be malfunctioning, and the power supply switch is changed from the on-state to the off-state, the multi-function power supply stops the first power supply from delivering electrical power to the multi-function power supply.

Claims

1. An electronic controller comprising: a first power supply which is supplied with electrical power from a power source and works to achieve or stop supply of electrical power in response to on- or off-operation of a power supply switch; a multi-function power supply to which electrical power is delivered from the first power supply when the power supply switch is turned on; and a controller to which electrical power is delivered from the multi-function power supply and which works to perform a reprogramming task, wherein the multi-function power supply works to keep the first power supply delivering electrical power to the multi-function power supply in response to the power supply switch being turned on, thereby enabling the first power supply to continue to deliver electrical power to the controller through the multi-function power supply when the power supply switch is changed from an on-state to an off-state, and the controller is required to perform the reprogramming task.

2. The electronic controller as set forth in claim 1, wherein when the reprogramming task is completed in the controller, the multi-function power supply keeps the first power supply delivering electrical power thereto.

3. The electronic controller as set forth in claim 1, wherein when the controller is required to perform the reprogramming task, the multi-function power supply communicates with the controller to determine whether the controller is malfunctioning, and when it is determined that the controller is malfunctioning, the multi-function power supply stops the first power supply from delivering electrical power to the multi-function power supply.

4. The electronic controller as set forth in claim 1, further comprising a transceiver which receives an on-signal or an off-signal from the power supply switch and outputs a signal indicative thereof to the controller, wherein the controller analyzes the signal from the transceiver to determine whether the transceiver is malfunctioning, when the transceiver is determined to be malfunctioning, and the power supply switch is changed from the on-state to the off-state, the multi-function power supply stops the first power supply from delivering electrical power to the multi-function power supply.