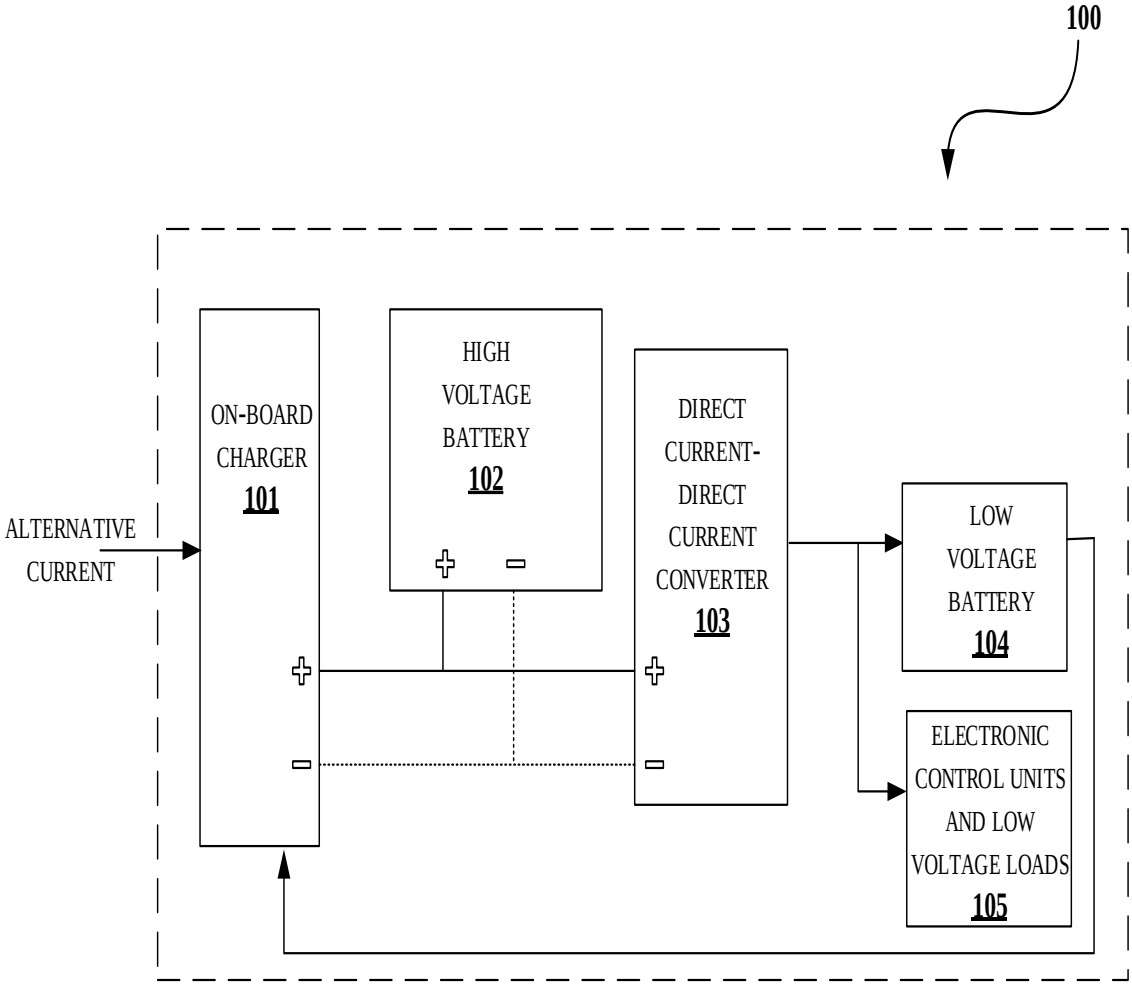


[Figure 1]

R Ramya Rao
Of K & S Partners
Agent for the Applicant
(IN/PA-1607)

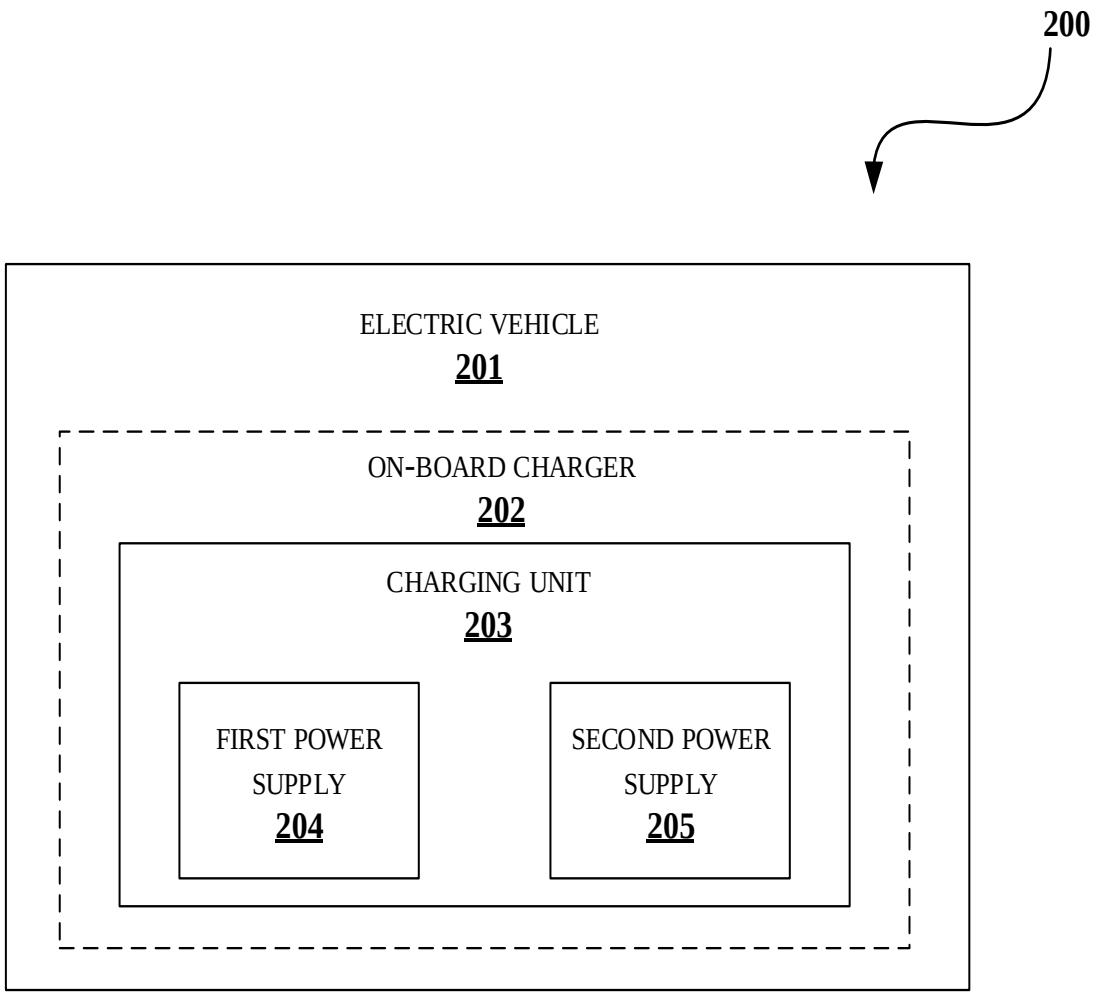


Figure 2a

R Ramya Rao
Of K & S Partners
Agent for the Applicant
(IN/PA-1607)

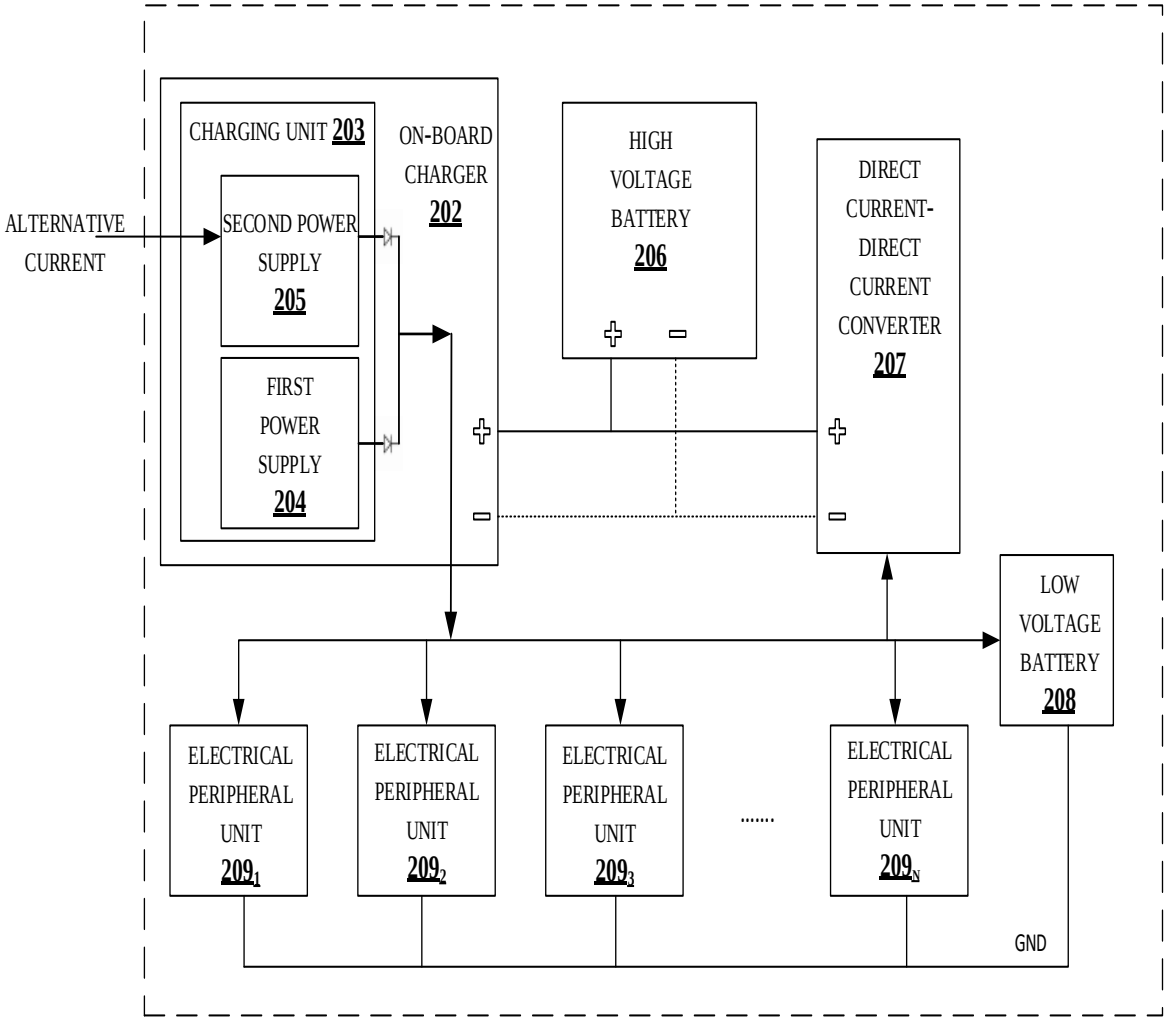


Figure 2b

R Ramya Rao
Of K & S Partners
Agent for the Applicant
(IN/PA-1607)

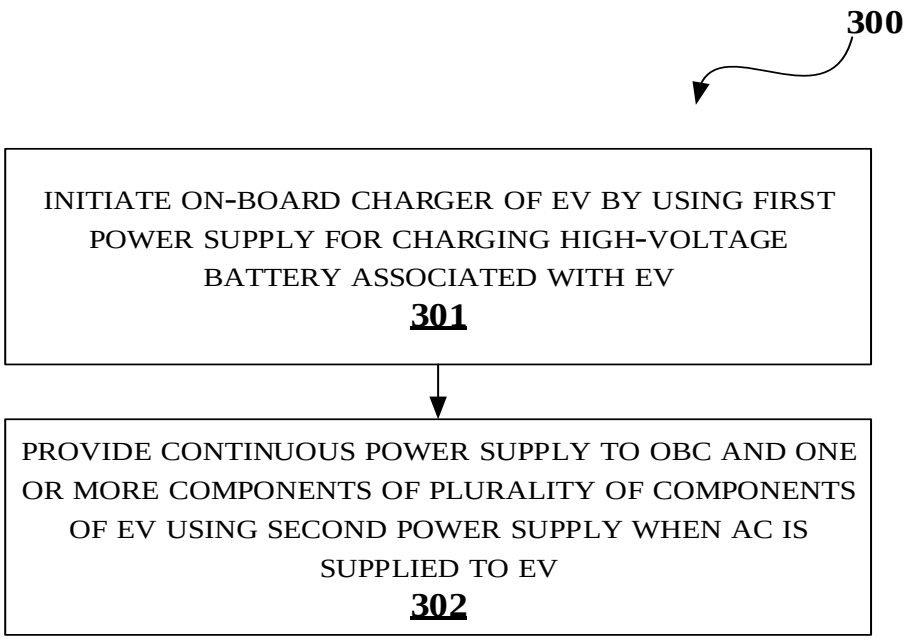


Figure 3

R Ramya Rao
Of K & S Partners
Agent for the Applicant
(IN/PA-1607)

FORM 2

THE PATENTS ACT 1970
[39 OF 1970]
&
THE PATENTS RULES, 2003

COMPLETE SPECIFICATION

[See section 10; Rule 13]

TITLE: "A CHARGING UNIT AND METHOD FOR CHARGING AN ELECTRIC VEHCILE"

Name and Address of the Applicant:

TATA PASSENGER ELECTRIC MOBILITY LIMITED of Nanavati Mahalaya, Floor 3 & 4, Plot 18, Mudhana Shetty Marg, Near BSE, Fort, Mumbai, Mumbai City, Maharashtra 400 001

Nationality: India

The following specification particularly describes the invention and the manner in which it is to be performed.

TECHNICAL FIELD

The present subject matter is related in general to an Electric Vehicle (EV), more particularly, but not exclusively the present subject matter relates to a charging unit and method for charging an EV.

BACKGROUND

The advancement of technology has fuelled a demand for Electric Vehicle (EV). The EV is an environmental friendly option as the EV produce no tailpipe emissions such as carbon monoxide, hydrocarbons and so on. The electric vehicles are powered by an electric motor. The electric motor is powered by rechargeable batteries that can be charged by an On-Board Charger (OBC).

Generally, a low voltage supply plays a major role in the electric vehicles. All Electronic Control Units (ECU) in the electric vehicle require low voltage supply for functioning. The OBC is provided with low voltage supply and operated using different kinds of wake-up signals from Vehicle Controller Unit (VCU) of the EV. At present, the OBC initiates charging when the low voltage supply is provided along with one or more required parameters by a Battery Management System (BMS) of the EV. If the low voltage supply is not available, the OBC may not work. During charging process of the EV, when the low voltage supply gets discharged below a certain specified value, the charging process of the EV may be terminated independent of whether rechargeable battery is charged up to desired value or not. Thus, low voltage discharge affects time required to charge the rechargeable battery.

Figure 1 shows an existing architecture for charging the rechargeable battery of the EV. Figure 1 comprises an OBC 101, a High Voltage (HV) battery 102, a Direct Current (DC) – Direct Current (DC) converter 103, a Low Voltage (LV) battery 104, Electronic Control Units (ECU) and low voltage loads 105. In Figure 1, the OBC 101 utilises AC power supply from a charging gun to charge the HV battery 102. During the charging process, the DC-DC converter 103 simultaneously utilises power from the HV battery 102 to charge the LV battery 104, the ECUs and low voltage loads 105. The simultaneous charging and discharging of the HV battery 102 affect overall charging process resulting in more charging time.

The information disclosed in this background of the disclosure section is only for enhancement of understanding of the general background of the invention and should not be taken as an acknowledgement or any form of suggestion that this information forms the prior art already known to a person skilled in the art.

SUMMARY

In an embodiment, the present disclosure relates to a charging unit for charging an Electric Vehicle (EV). The charging unit comprises a first power supply and a second power supply. The first power supply is configured to initiate an On-Board Charger (OBC) of the EV for charging a high-voltage battery associated with the EV. The second power supply is configured to provide a continuous power supply to the OBC and one or more components of a plurality of components of the EV during the charging of the high-voltage battery, when an Alternating Current (AC) is supplied to the EV.

In an embodiment, the present disclosure relates to a method for charging an Electric Vehicle (EV). The method comprises initiating an On-Board Charger (OBC) of the EV for charging a high-voltage battery associated with the EV using a first power supply. Upon initiating, the method comprises providing a continuous power supply to the OBC and one or more components of a plurality of components of the EV using a second power supply, when an Alternating Current (AC) is supplied to the EV for charging the EV.

The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments, and features described above, further aspects, embodiments, and features will become apparent by reference to the drawings and the following detailed description.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this disclosure, illustrate exemplary embodiments and, together with the description, serve to explain the disclosed principles. In the figures, the left-most digit(s) of a reference number identifies the figure in which the reference number first appears. The same numbers are used throughout the figures to reference

like features and components. Some embodiments of system and/or methods in accordance with embodiments of the present subject matter are now described, by way of example only, and regarding the accompanying figures, in which:

[Figure 1] shows an existing architecture for charging an EV.

Figure 2a shows a block diagram of an Electric Vehicle (EV), in accordance with some embodiments of the present disclosure;

Figure 2b shows a detailed architecture of the EV for charging of the EV, in accordance with some embodiments of the present disclosure; and

Figure 3 illustrate a flowchart showing an exemplary method for charging the EV, in accordance with some embodiments of present disclosure.

It should be appreciated by those skilled in the art that any block diagrams herein represent conceptual views of illustrative systems embodying the principles of the present subject matter. Similarly, it will be appreciated that any flow charts, flow diagrams, state transition diagrams, pseudo code, and the like represent various processes which may be substantially represented in computer readable medium and executed by a computer or processor, whether such computer or processor is explicitly shown.

DETAILED DESCRIPTION

In the present document, the word "exemplary" is used herein to mean "serving as an example, instance, or illustration." Any embodiment or implementation of the present subject matter described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other embodiments.

While the disclosure is susceptible to various modifications and alternative forms, specific embodiment thereof has been shown by way of example in the drawings and will be described in detail below. It should be understood, however that it is not intended to limit the disclosure to the forms disclosed, but on the contrary, the disclosure is to cover all modifications, equivalents, and alternative falling within the spirit and the scope of the disclosure.

The terms “comprises”, “comprising”, or any other variations thereof, are intended to cover a non-exclusive inclusion, such that a setup, device, or method that comprises a list of components or steps does not include only those components or steps but may include other components or steps not expressly listed or inherent to such setup or device or method. In other words, one or more elements in a system or apparatus proceeded by “comprises… a” does not, without more constraints, preclude the existence of other elements or additional elements in the system or method.

The terms “includes”, “including”, or any other variations thereof, are intended to cover a non-exclusive inclusion, such that a setup, device, or method that includes a list of components or steps does not include only those components or steps but may include other components or steps not expressly listed or inherent to such setup or device or method. In other words, one or more elements in a system or apparatus proceeded by “includes… a” does not, without more constraints, preclude the existence of other elements or additional elements in the system or method.

In the following detailed description of the embodiments of the disclosure, reference is made to the accompanying drawings that form a part hereof, and in which are shown by way of illustration specific embodiments in which the disclosure may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the disclosure, and it is to be understood that other embodiments may be utilized and that changes may be made without departing from the scope of the present disclosure. The following description is, therefore, not to be taken in a limiting sense.

The present disclosure relates to a charging unit and a method for charging an Electric Vehicle (EV). At present, the On-Board Charger (OBC) in the EV utilises Alternating Current (AC) supply from a charging gun to charge a high-voltage battery of the EV. During the charging process, Direct Current (DC)-Direct Current (DC) converter of the EV utilises power from the high-voltage battery to charge Electrical Peripheral Units (EPU) and a Low Voltage (LV) battery of the EV. The simultaneous charging and discharging of the high-voltage battery affects the charging process. Thus, resulting in more time during the charging of the high-voltage battery of the EV. To overcome this, the present disclosure charges the EV using a charging unit. The charging unit

comprises a first power supply and a second power supply. The first power supply initiates the OBC of the EV for charging the high-voltage battery of the EV. The second power supply provides a continuous power supply to the OBC and one or more components from a plurality of components of the EV during the charging of the high-voltage battery when AC is supplied to the EV. As the second power supply directly powers the one or more components when the AC is supplied, load on the DC-DC converter is reduced for charging the one or more components. This reduces discharge of power from the high-voltage battery by the DC-DC converter. Thus, the present disclosure reduces the charging time of the EV.

Figure 2a shows a block diagram of an Electric Vehicle (EV) 201. The EV 201 may include an On-Board Charger (OBC) 202, and a charging unit 203. The charging unit 203 comprises a first power supply 204 and a second power supply 205. The EV 201 is powered by an electric motor. The electric motor is powered by rechargeable batteries that can be charged by the OBC 202. The OBC 202 is mounted inside the EV 201 for charging the rechargeable batteries. The OBC 202 is a device that converts an Alternating Current (AC) supply to Direct Current (DC) for charging the EV 201. The OBC 202 may receive the AC supply from a charging station. In an embodiment, the charging unit 203 is configured in the OBC 202 of the EV 201.In the illustrated embodiment, the OBC 202 is utilised to charge the EV 201.

Figure 2b shows a detailed architecture of the EV for charging of the EV, in accordance with some embodiments of the present disclosure.

The detailed architecture illustrates the OBC 202, the charging unit 203 comprising the first power supply 204 and the second power supply 205, a high-voltage battery 206, a Direct Current (DC)-Direct Current (DC) converter 207, a Low Voltage (LV) battery 208 and Electrical Peripheral Units (EPU) 209. In an embodiment, the EV 201 comprises the DC-DC converter 207 which is used to convert power from the high-voltage battery 206 to low voltage power to charge the LV battery 208 and the EPU 209. In an embodiment, the EV 201 comprises the OBC 202 which is implemented with the charging unit 203. The charging unit 203 initiates the OBC 202 of the EV 201 for charging the high-voltage battery 206 by using the first power supply 204. The high-voltage battery 206 is a rechargeable battery used to power the EV 201. The first power supply 204 initiates the OBC 202 by providing a low voltage supply to the OBC 202. Upon initiating the

OBC 202, the charging unit 203 provides a continuous power supply to the OBC 202 and the one or more components of a plurality of components of the EV 201 using the second power supply 205. The plurality of components of the EV 201 comprises the EPU 209 of the EV 201. The EPU 209 may include, but is not limited to, Telematics Control Unit (TCU), Vehicle Controller Unit (VCU), Battery Management System (BMS), cluster, radiator fan, Body Control Module (BCM), cooling pump, and the like. In an embodiment, the charging of the high-voltage battery 206 is performed when an AC supply is provided to the OBC 202 through a charging gun. The continuous power supply is divided between the OBC 202 and the one or more components of the plurality of components based on predefined parameters. The predefined parameters may include, but is not limited to, input current, power factor, voltage, efficiency factor and the like. In an embodiment, the charging unit 203 selects at least one component of the plurality of components other than the one or more components for providing a power supply from the DC-DC converter 207 when the AC supply is supplied. The at least one component of the plurality of components is selected based on priority level of the plurality of components. In an embodiment, the at least one component which receives power supply from the DC-DC converter 207 may be associated with a first level of priority. While the one or more components which receive continuous power supply from the second power supply 205 are associated with a second level of priority. The at least one component associated with the first level of priority may include, but is not limited to, a cooling battery system and so on. The components associated with the second level of priority may include, but is not limited to, Air Conditioning (AC) and so on.

In an example, consider the EV 201 is supplied with the AC supply through a charging gun. Initially, for the OBC 202 to charge the high-voltage battery 206, the OBC 202 is initiated by the first power supply 204. The charging unit 203 of the EV 201 utilises the first power supply 204 and initiates the OBC 202 to charge the high-voltage battery 206. Further, the charging unit 203 utilises the second power supply 205 to convert the AC supply to DC supply for providing continuous power supply to the OBC 202 and the one or more components of the plurality of components of the EV 201. In an embodiment, the BMS of the EV 201 may calculate an amount of power required for the high-voltage battery 206 based on a state of charge of the high-voltage battery 206, state of health of the high-voltage battery 206, and so on. The BMS provides the calculated amount of power to the OBC 202 via communication lines. The OBC 202 charges the

high-voltage battery 206 based on the calculated amount of power. In an embodiment, during the charging of the high-voltage battery 206, the DC-DC converter 207 of the EV 201 may provide power supply to at least one component of the plurality of components other than the one or more components. The DC-DC converter 207 of the EV 201 provides the power supply to the at least one component based on the priority level of the plurality of components. In an embodiment, the DC-DC converter 207 provides the power supply to the at least one component associated with the first level of priority when they are switched ON.

Figure 3 illustrate a flowchart showing an exemplary method for charging the EV, in accordance with some embodiments of present disclosure.

As illustrated in **Figure 3,** the method 300 may include one or more blocks for executing processes in the charging unit 203. The method 300 may be described in the general context of computer executable instructions. Generally, computer executable instructions can include routines, programs, objects, components, data structures, procedures, modules, and functions, which perform particular functions or implement particular abstract data types.

The order in which the method 300 are described may not intended to be construed as a limitation, and any number of the described method blocks can be combined in any order to implement the method. Additionally, individual blocks may be deleted from the methods without departing from the scope of the subject matter described herein. Furthermore, the method can be implemented in any suitable hardware, software, firmware, or combination thereof.

At block 301, initiating, the OBC (202) of the EV 201 for charging the high-voltage battery 206 associated with the EV 201 by using the first power supply 204.

At block 302, providing, a continuous power supply to the OBC (202) and one or more components of the plurality of components of the EV 201 using the second power supply 205 when the AC is supplied to the EV 201 for charging the EV 201. The plurality of components of the EV 201 comprises electrical peripheral units of the EV 201 and the LV battery 208. Particularly, the power supply is divided between the OBC (202) and the one or more components of the plurality of components based on the predefined parameters. The predefined parameters may include, but is not limited to, voltage, input current, power factor, and efficiency factor. Further, the charging unit

203 is configured for selecting at least one component of the plurality of components other than the one or more components for providing a power supply from the DC-DC converter 207 associated with the EV 201. In an embodiment, the at least one component which receive power supply from the DC-DC converter 207 may be associated with the first level of priority. While the one or more components which receive continuous power supply from the second power supply 205 are associated with the second level of priority. In an embodiment, the priority level of the plurality of components are configured by a user.

An embodiment of the present disclosure provides the second power supply to charge the OBC and the electrical peripheral units of the EV. The second power supply directly powers the electrical peripheral units when an Alternating Current (AC) is supplied. As such, load on the DC-DC converter is reduced for charging the electrical peripheral units. This reduces discharge of power from a high voltage battery of the EV by the DC-DC converter. Thus, reducing the charging time of the high voltage battery of the EV.

An embodiment of the present disclosure reduces usage of the LV battery and the DC-DC converter during the charging of the EV.

The described operations may be implemented as a method, system or article of manufacture using standard programming and/or engineering techniques to produce software, firmware, hardware, or any combination thereof. The described operations may be implemented as code maintained in a "non-transitory computer readable medium", where a processor may read and execute the code from the computer readable medium. The processor is at least one of a microprocessor and a processor capable of processing and executing the queries. A non-transitory computer readable medium may include media such as magnetic storage medium (e.g., hard disk drives, floppy disks, tape, etc.), optical storage (CD-ROMs, DVDs, optical disks, etc.), volatile and non-volatile memory devices (e.g., EEPROMs, ROMs, PROMs, RAMs, DRAMs, SRAMs, Flash Memory, firmware, programmable logic, etc.), etc. Further, non-transitory computer-readable media may include all computer-readable media except for a transitory. The code implementing the described operations may further be implemented in hardware logic (e.g., an integrated circuit chip, Programmable Gate Array (PGA), Application Specific Integrated Circuit (ASIC), etc.).

An "article of manufacture" includes non-transitory computer readable medium, and /or hardware logic, in which code may be implemented. A device in which the code implementing the described embodiments of operations is encoded may include a computer readable medium or hardware logic. Of course, those skilled in the art will recognize that many modifications may be made to this configuration without departing from the scope of the invention, and that the article of manufacture may include suitable information bearing medium known in the art.

The terms "an embodiment", "embodiment", "embodiments", "the embodiment", "the embodiments", "one or more embodiments", "some embodiments", and "one embodiment" mean "one or more (but not all) embodiments of the invention(s)" unless expressly specified otherwise.

The terms "including", "comprising", "having" and variations thereof mean "including but not limited to", unless expressly specified otherwise.

The enumerated listing of items does not imply that any or all of the items are mutually exclusive, unless expressly specified otherwise.

The terms "a", "an" and "the" mean "one or more", unless expressly specified otherwise.

A description of an embodiment with several components in communication with each other does not imply that all such components are required. On the contrary a variety of optional components are described to illustrate the wide variety of possible embodiments of the invention.

When a single device or article is described herein, it will be readily apparent that more than one device/article (whether or not they cooperate) may be used in place of a single device/article. Similarly, where more than one device or article is described herein (whether or not they cooperate), it will be readily apparent that a single device/article may be used in place of the more than one device or article, or a different number of devices/articles may be used instead of the shown number of devices or programs. The functionality and/or the features of a device may be alternatively embodied by one or more other devices which are not explicitly described as having such functionality/features. Thus, other embodiments of the invention need not include the device itself.

The illustrated operations of **Figure 3** show certain events occurring in a certain order. In alternative embodiments, certain operations may be performed in a different order, modified, or removed. Moreover, steps may be added to the above-described logic and still conform to the described embodiments. Further, operations described herein may occur sequentially or certain operations may be processed in parallel. Yet further, operations may be performed by a single processing unit or by distributed processing units.

Finally, the language used in the specification has been principally selected for readability and instructional purposes, and it may not have been selected to delineate or circumscribe the inventive subject matter. It is therefore intended that the scope of the invention be limited not by this detailed description, but rather by any claims that issue on an application based here on. Accordingly, the disclosure of the embodiments of the invention is intended to be illustrative, but not limiting, of the scope of the invention, which is set forth in the following claims.

While various aspects and embodiments have been disclosed herein, other aspects and embodiments will be apparent to those skilled in the art. The various aspects and embodiments disclosed herein are for purposes of illustration and are not intended to be limiting, with the true scope and spirit being indicated by the following claims.

Referral numerals:

Reference Number	Description
100	Existing architecture
101	OBC
102	HV battery
103	DC-DC converter
104	LV battery
105	ECU and LV loads
201	Electric Vehicle
202	OBC
203	Charging unit
204	First power supply
205	Second power supply
206	HV Battery
207	DC-DC converter
208	LV battery
209	Electrical Peripheral Unit

We claim:

1. A charging unit (203) for charging an Electric Vehicle (EV) (201), comprising:

a first power supply (204) configured to initiate an On-Board Charger (OBC) (202) of the EV (201) for charging a high-voltage battery (206) associated with the EV (201); and

a second power supply (205) configured to provide a continuous power supply to the OBC (202) and one or more components of a plurality of components of the EV (201) during the charging of the high-voltage battery (206), when an Alternating Current (AC) is supplied to the EV (201).

2. The charging unit (203) as claimed in claim 1, wherein the continuous power supply is divided between the OBC (202) and the one or more components of the plurality of components based on predefined parameters.

3. The charging unit (203) as claimed in claim 2, wherein the predefined parameters comprise voltage, input current, power factor, and efficiency factor.

4. The charging unit (203) as claimed in claim 1, wherein the plurality of components of the EV (201) comprises electrical peripheral units (209) of the EV (201) and a low voltage battery (208).

5. The charging unit (203) as claimed in claim 1, wherein at least one component of the plurality of components other than the one or more components is selected for providing a power supply from a Direct Current (DC)-Direct Current (DC) converter (207) associated with the EV (201), when the AC supplied to the EV (201).

6. A method for charging an Electric Vehicle (EV) (201), the method comprising:

initiating, by a charging unit (203), an On-Board Charger (OBC) (202) of the EV (201) for charging a high-voltage battery (206) associated with the EV (201) by using a first power supply (204); and

providing, by the charging unit (203), a continuous power supply to the OBC (202) and one or more components of a plurality of components of the EV (201) using a second

power supply (205), when an Alternating Current (AC) is supplied to the EV (201) for charging the EV (201).

7. The method as claimed in claim 6, wherein the continuous power supply is divided between the OBC (202) and the one or more components of the plurality of components based on predefined parameters.

8. The method as claimed in claim 7, wherein the predefined parameters comprise voltage, input current, power factor, and efficiency factor.

9. The method as claimed in claim 6, wherein the plurality of components of the EV (201) comprises electrical peripheral units (209) of the EV (201) and a low voltage battery (208).

10. The method as claimed in claim 6, further comprising selecting at least one component of the plurality of components other than the one or more components for providing a power supply from a Direct Current (DC)-Direct Current (DC) converter (207) associated with the EV (201), when the AC supplied to the EV (201).

Dated 25th day of July, 2022



R Ramya Rao
OF K & S PARTNERS
AGENT FOR THE APPLICANT(S)
IN/PA-1607

A CHARGING UNIT AND METHOD FOR CHARGING AN ELECTRIC VEHCILE

ABSTRACT

Embodiments of present disclosure relates to charging unit and method for charging the EV. The charging unit comprises first power supply and second power supply. The first power supply initiates OBC of EV for charging a high-voltage battery associated with EV. Upon initiating, the second power supply provides a power supply to OBC and one or more components of a plurality of components of EV during charging of the high-voltage battery, when AC is supplied to EV. The second power supply directly powers the one or more components when the AC is supplied. Thus, load on DC-DC converter of EV is reduced for charging the one or more components. This reduces discharge of the power from the high-voltage battery of EV by the DC-DC converter. Thus, the charging unit reduces the time required for charging the high-voltage battery of the EV.

Figure 2b