

A MODULAR BATTERY CONNECTOR AND BATTERY LOCKING SYSTEMS IN A VEHICLE AND METHODS THEREOF

CROSS REFERENCE TO RELATED APPLICATION

[001] This application is based on and derives the benefit of Indian Provisional Application 201941000708, filed on 7th January 2019, the contents of which are incorporated herein by reference.

TECHNICAL FIELD

[002] The embodiments herein generally relate to a battery module in a vehicle, more particularly to a modular battery connector and a method of providing the modular battery connector in the vehicle such as an electric vehicle. Further, embodiments herein relate to battery locking systems and methods for locking a battery pack in the vehicle to prevent theft of the battery pack.

BACKGROUND

[003] A battery pack is used as a power source in various applications such as automobiles, machineries, power systems and so on. For example, the battery pack is used to power an electric motor for propulsion of a vehicle such as an electric vehicle, a hybrid vehicle, a fuel cell vehicle and the like. A battery connector is used to facilitate charging or discharging of the battery pack. Usually, the battery connector includes a female connector electrically and/or electronically connected with the battery pack and a male connector electrically connected with the female connector. Due to swapping of battery pack, assembling the female connector to the male connector requires proper alignment of power pins and signal pins of the female connector with respect to corresponding power pins and signal pins of the male connector, which is cumbersome and tedious and a time consuming process. Usually, the female connector is assembled to the male connector in a single fixed orientation. Therefore, assembling the female connector to the male connector in a plurality of orientations would not be possible and is difficult and is one of the challenges posed to the original equipment manufacturers (OEM's).

[004] Further, the battery pack of the electric vehicle is mainly divided into two kinds, one being removable battery pack and the other being fixed battery pack according to different needs. Removable battery pack provides more convenient usage. The detachable

battery connector and its fixing means, commonly are of hook and knob type. However, the knob fixing mechanism may result in male and female end of the connector as shock poor contact, the contact resistance may increase resulting in melting of the terminal. In addition, the use of hook type or battery connector knob fixing mechanism, are prone to the risk as the connector may be unplugged by mistake, by the user of the vehicle. The unplugging may cause arcing phenomenon, causing increase in terminal connection resistance such that junction temperature increases, which causes erosion of the connector terminal. Thus, the battery connector has to be deployed in a secured manner inside the vehicle battery compartment. Moreover, the constant removal and placement of the battery pack for swap solutions demand improved safety for positioning of the battery pack inside the vehicle battery compartment.

[005] Each power pin is exposed to the other power pin of the male and/or female connector resulting in electrical interference of wiring harness, which is undesirable. Further, dust or other foreign particles may accumulate in between the power pins results in short circuit between the power terminals. The performance and life of the battery connector and/or the battery pack would be reduced when the power pins of the male connector are not mated properly with corresponding power pins of the female connector.

[006] Further, the interface of the female connector with a bottom cover of the battery pack, the clearances between male and female connectors, power pins and signal pin regions of the male and female connectors are subjected to entry of water leading to water flow into the battery pack which is undesirable and can lead to reduced performance of the battery pack and degradation of the internal components of the battery pack thereby reducing the life of the battery pack. For example, the watery entry into the battery pack may result in short circuit in printed circuit board of the battery pack, damage terminals and other electrical connections or components of the battery pack and can cause battery fire.

[007] Conventional electric vehicles have battery pack(s) mounted directly on chassis members, for ease of maintenance. Due to easy disassembly of the removable battery pack for charging purposes or battery swapping, there is often battery theft phenomenon, resulting in loss to the vehicle owners. Therefore, there is a requirement for locking the removable battery pack in the vehicle.

[008] Mostly, battery packs are secured in the chassis of the vehicle by using various bolts. However, fastening of the battery pack in the vehicle may not be a reliable locking

system and is tedious and a time consuming process. In some cases, the locking device consists of numerous components and parts which increase both the cost of manufacture and difficulty of assembly. In other cases, special tools and/or skill is required to assemble the battery pack. In still other cases, there is no reliable way to fixedly attach the securing device to the battery compartment of the vehicle so as to prevent access to and removal of the battery pack from the vehicle. In yet other cases, the securing device fitted loosely to the battery pack, may generate rattling and bumping sounds when the vehicle is driven over a rough or bumpy terrain.

[009] Other battery locking mechanisms are complex in design and incur high manufacturing costs.

[0010] Therefore, there exists a need for a modular battery connector and a method of providing the modular battery connector in a vehicle, which obviates the aforementioned drawbacks. Further, there exists a need for battery locking systems and methods for locking a battery pack in the vehicle, which obviates the aforementioned drawbacks.

SUMMARY

[0010A] According an aspect, there is provided a modular battery connector including: a first connector assembly comprising a housing, at least one first power pin, at least one second power pin, a plurality of signal pins, a plurality of temperature sensors, a plurality of first sealing members, a plurality of second sealing members, and a gasket; and a second connector assembly comprising a housing, at least one first power pin, a plurality of second power pins, a plurality of first signal pins, a plurality of second signal pins, a plurality of first sealing members and a plurality of second sealing members, wherein the first connector assembly and the second connector assembly are assembled such that each guide member receiving portion of the housing in the first connector assembly is adapted to receive corresponding each guide member of the second connector assembly, and

each locating portion of the housing is adapted to facilitate alignment of the first connector assembly with respect to the second connector assembly; wherein said at least one first power pin and corresponding said at least one of said plurality of second power pins of said second connector assembly is adapted to be engaged with corresponding said at least one first power pin and said at least one second power pin of said first connector assembly respectively; each of said first signal pin or each of said second signal pin of said second connector assembly is adapted to be engaged with corresponding each of said signal pin of said first connector assembly when said first connector assembly is assembled onto said second connector assembly in a first orientation or a second orientation; said housing of said first connector assembly includes at least one power pin isolating portion, at least one signal pin holding portion and a plurality of locating portions, wherein said locating portions are integrated with a main enclosing wall of said housing; and said housing of said second connector assembly includes at least one first power pin enclosing wall, at least one power pin isolating portion and a plurality of locating portions, wherein said locating portions are integrated with a main enclosing wall of said housing.

[0010B] There is provided a method of providing a modular battery connector, said method including: removably mounting a housing of a first connector assembly onto a bottom cover of a battery pack; floatably mounting by, a plurality of fastener bushes and a plurality of fasteners, a housing of a second connector assembly onto a bottom cover of a dock system provided in at least one of a vehicle and a charging station; and assembling the first connector assembly to the second connector assembly by aligning the first connector assembly with respect to the second connector assembly, wherein said assembling the first connector assembly to the second connector assembly by aligning the first connector assembly with the second connector assembly by, introducing each guide

member of the second connector assembly into corresponding guide member receiving portion provided in a housing of the first connector assembly, and introducing each locating portion of the housing of the second connector assembly into corresponding each locating portion provided in the housing of the first connector assembly, wherein at least one first power pin and at least one of a plurality of second power pins of the second connector assembly is adapted to be engaged with corresponding at least one first power pin and at least one second power pin of the first connector assembly respectively; and each first signal pin or each second signal pin of the second connector assembly is adapted to be engaged with corresponding each signal pin of the first connector assembly during assembly of the first connector assembly to the second connector assembly in a first orientation or a second orientation.

[0010C] There is provided a battery locking system in a vehicle, said system including: an actuator; and a locking member, wherein said locking member is adapted to engage a guide member of a connector assembly of a battery connector thereby locking a battery pack with the connector assembly.

[0010D] There is provided a battery locking system in a vehicle, said system including: a housing; at least one control valve adapted to be provided in communication with a controller unit of at least one of a battery pack and the vehicle, said control valve is adapted to be provided in fluid communication with said housing, a movable member adapted to be provided inside said housing, said movable member is movably connected to said housing; and a locking member adapted to be connected to said movable member, wherein said control valve is adapted to regulate fluid flow in said housing to move said movable member which in turn moves said locking member to engage said locking member with a guide member of a connector assembly of a battery connector thereby locking the battery pack with the connector assembly when said control valve receives information from the controller unit.

[0010E] There is provided a battery locking system in a vehicle, said system including: an electric motor including, a locking member adapted to be engaged with a guide member of a connector assembly of a battery connector thereby locking a battery pack with the connector assembly when said electric motor receives information from a controller unit of at least one of the battery pack and the vehicle.

[0010F] There is provided a battery locking system in a vehicle, said system including: an electric motor having a shaft; at least one driving member adapted to be rotatably connected to said shaft; and a locking member adapted to be movably connected to said driving member, wherein said driving member is adapted to move said

locking member to engage said locking member with a guide member of a connector assembly of a battery connector thereby locking a battery pack with the connector assembly when said electric motor receives information from a controller unit of at least one of the battery pack and the vehicle.

[0010G] There is provided a method for locking a battery pack in a vehicle, said method including: locking the battery pack to a guide member of a connector assembly of a battery connector in the vehicle.

[0011] Embodiments herein provide a modular battery connector.

[0012] Embodiments herein provide the modular battery connector in at least a vehicle, which facilitates bi-directional orientation in which power pins and signal pins of a first connector assembly (female connector assembly) can be aligned and engaged with corresponding power pins and signal pins of a second connector assembly (male connector assembly) when the first connector assembly is being assembled onto the second connector assembly in a first orientation or a second orientation.

[0013] Embodiments herein provide a method of providing the modular battery connector in the vehicle.

[0014] Embodiments herein provide the modular battery connector in the vehicle, which is easy to align and assemble.

[0015] Embodiments herein provide the modular battery connector, which enables effective performance of the battery pack and ensures longer life of the battery pack.

[0016] Embodiments herein provide a bidirectional battery connector.

[0017] Embodiments herein provide the modular battery connector in the vehicle, which restricts entry of any of fluid (water), dust and any other foreign particles thereof thereby preventing short circuit in printed circuit board (PCB) of the battery pack, restricts damage to terminals and other electrical connections or components of the battery pack and also reduces the chances of battery fire.

[0018] Embodiments herein provide the modular battery connector, which restricts the possibility of electrical interference between at wire harness connections during assembly and operation or maintenance and also to restrict entry of dust or any foreign particles there between thereby preventing the chances of short circuit between power terminals.

[0019] Embodiments herein provide the modular battery connector in the vehicle, which includes a floating type second connector assembly which facilitates easy assembly of the first connector assembly with respect to the second connector assembly.

[0020] Embodiments herein provide the modular battery connector in the vehicle, which comprises temperature sensors for detecting temperature of power pins of the first connector assembly to determine mating position of power pins which can ensure effective performance and longer life of the modular battery connector and/or the battery pack.

[0021] Embodiments herein provide battery locking systems for the vehicle, which secures the battery pack to a guide member (guide pin) of the second connector assembly in the modular battery connector thereby preventing theft of the battery pack.

[0022] Embodiments herein provide methods for locking the battery pack in the vehicle.

[0023] Embodiments herein provide battery locking systems for the vehicle, which is reliable and incurs less cost.

[0024] Embodiments herein provide battery locking systems for the vehicle, which is automatic.

[0025] Embodiments herein provide an electro-hydraulic or pneumatic system for locking the battery pack in the vehicle.

[0026] Embodiments herein provide an electro-magnetic system for locking the battery pack in the vehicle.

[0027] Embodiments herein provide an electro-mechanical system for locking battery pack in the vehicle.

[0028] Embodiments herein provide a linear control system for locking the battery pack in the vehicle.

[0029] These and other embodiments herein will be better appreciated and understood when considered in conjunction with following description and accompanying drawings. It should be understood, however, that the following descriptions, while indicating embodiments and numerous specific details thereof, are given by way of illustration and not of limitation. Many changes and modifications may be made within the scope of the embodiments herein without departing from the spirit thereof, and the embodiments herein include all such modifications.

BRIEF DESCRIPTION OF DRAWINGS

[0030] The embodiments are illustrated in the accompanying drawings, throughout which like reference letters indicate corresponding parts in various figures. The embodiments herein will be better understood from the following description with reference to the drawings, in which:

[0031] Fig. 1a depicts a perspective view of a modular battery connector, according to first embodiments as disclosed herein;

[0032] Fig. 1b depicts a cross-sectional view of the modular battery connector, according to first embodiments as disclosed herein;

[0033] Fig. 2a depicts a perspective view of a first connector assembly (female connector assembly) of the battery connector, according to first embodiments as disclosed herein;

[0034] Fig. 2b depicts another perspective view of the first connector assembly, according to first embodiments as disclosed herein;

[0035] Fig. 3a depicts a cross-sectional view of the first connector assembly, where each first sealing element is engaged with corresponding each power pin to restrict fluid flow thereof, according to first embodiments as disclosed herein;

5 [0036] Fig. 3b depicts another cross-sectional view of the first connector assembly, where each second sealing element is engaged with corresponding each signal pin to restrict fluid flow thereof, according to first embodiments as disclosed herein;

[0037] Fig. 4a depicts a perspective view of a housing of the first connector assembly, according to first embodiments as disclosed herein;

10 [0038] Fig. 4b depicts a perspective view of a housing of a second connector assembly (male connector assembly), according to first embodiments as disclosed herein;

[0039] Fig. 5a depicts a perspective view of the second connector assembly, according to first embodiments as disclosed herein;

[0040] Fig. 5b depicts another perspective view of the second connector assembly, according to first embodiments as disclosed herein;

15 [0041] Fig. 6a depicts a cross-sectional view of the second connector assembly, where each first sealing element is engaged with corresponding each power pin to restrict fluid flow thereof, according to first embodiments as disclosed herein;

20 [0042] Fig. 6b depicts another cross-sectional view of the second connector assembly, where each second sealing element is engaged with corresponding each signal pin to restrict fluid flow thereof, according to first embodiments as disclosed herein;

[0043] Fig. 7a depicts an exploded view of the second connector assembly, according to first embodiments as disclosed herein;

25 [0044] Fig. 7b depicts a cross-sectional view of a portion of the modular battery connector, where the first connector assembly is secured onto a battery cover of a battery pack and the second connector assembly is floatably mounted onto a bottom cover of a dock system provided inside the vehicle, according to first embodiments as disclosed herein;

[0045] Fig. 8a depicts a perspective view of the housing of the first connector assembly being assembled onto the bottom cover of the battery pack, according to first embodiments as disclosed herein;

[0046] Fig. 8b depicts an exploded view of the modular battery connector, where the first connector assembly and the bottom cover of the battery pack is in assembled condition, according to first embodiments as disclosed herein;

5 [0047] Fig. 9 depicts a flowchart indicating a method of providing the modular battery connector in a vehicle, according to first embodiments as disclosed herein;

[0048] Fig. 10 depicts a cross sectional view of a battery locking system for locking the battery pack with a guide member (guide pin) of the second connector assembly of the modular battery connector in the vehicle, according to second embodiments as disclosed herein;

10 [0049] Fig. 11a depicts a cross-sectional view of an actuator (solenoid unit) with a locking member (plunger) being engaged with the guide member of the second connector assembly for locking the battery pack with the second connector assembly, according to second embodiments as disclosed herein;

15 [0050] Fig. 11b depicts a cross sectional view of the actuator with the locking member being disengaged from the guide member of the second connector assembly for unlocking the battery pack from the second connector assembly, according to second embodiments as disclosed herein;

20 [0051] Fig. 12a and fig. 12b depict a cross sectional view of the actuator, where a bush is mounted on the locking member and sealing elements is provided on the locking member and the bush to restrict fluid flow into the battery pack, according to second embodiments as disclosed herein;

[0052] Fig. 13 depicts a cross-sectional view of a battery locking system for locking the battery pack with the guide member of the second connector assembly of the modular battery connector in the vehicle, according to third embodiments as disclosed herein;

25 [0053] Fig. 14 depicts a cross-sectional view of a battery locking system for locking the battery pack with the guide member of the second connector assembly of the modular battery connector in the vehicle, according to fourth embodiments as disclosed herein;

30 [0054] Fig. 15 depicts a cross-sectional view of a battery locking system for locking the battery pack with the guide member of the second connector assembly of the modular battery connector in the vehicle, according to fifth embodiments as disclosed herein; and

[0055] Fig. 16 depicts a flowchart indicating a method for locking the battery pack in the vehicle, according to embodiments as disclosed herein.

DETAILED DESCRIPTION

[0056] The embodiments herein and the various features and advantageous details thereof are explained more fully with reference to the non-limiting embodiments that are illustrated in the accompanying drawings and detailed in the following description.

5 Descriptions of well-known components and processing techniques are omitted so as to not unnecessarily obscure the embodiments herein. The examples used herein are intended merely to facilitate an understanding of ways in which the embodiments herein may be practiced and to further enable those of skill in the art to practice the embodiments herein. Accordingly, the examples should not be construed as limiting the scope of the embodiments
10 herein.

[0057] The embodiments herein achieve a modular battery connector for a vehicle, which facilitates bi-directional orientation in which power pins and signal pins of a first connector assembly (female connector assembly) can be aligned and engaged with
15 corresponding power pins and signal pins of a second connector assembly (male connector assembly) when the first connector assembly is being assembled onto the second connector assembly in a first orientation or a second orientation. The embodiments herein achieve battery locking systems for vehicle, which secures the battery pack to a guide member (guide
pin) of the second connector assembly (male connector assembly) of the modular battery connector thereby preventing theft of the battery pack. Further, embodiments herein achieve
20 a method for locking the battery pack in the vehicle. Further, embodiments herein achieve a method of providing the modular battery connector in the vehicle. Referring now to the drawings Figs 1 through 16, where similar reference characters denote corresponding features consistently throughout the figures, there are shown embodiments.

[0058] Fig. 1a depicts a perspective view of a modular battery connector (10),
25 according to first embodiments as disclosed herein. Fig. 1b depicts a cross-sectional view of the modular battery connector (10), according to first embodiments as disclosed herein. In the first embodiment, the modular battery connector (10) includes a first connector assembly (100), as shown in fig. 1a to fig. 3b, fig. 8a and fig. 8b) and a second connector assembly (200), as shown in fig. 1a, fig. 1b, fig. 5a to fig. 7a, and fig. 8b). The modular battery
30 connector (10) is adapted for charging and/or discharging of a battery pack (B), as shown in fig. 8b. For the purpose of this description and ease of understanding, the battery pack (B) is a removable main battery pack which can be removed from the vehicle for charging purposes and/or battery swapping. It is also within the scope of the invention to practice/ implement

the modular battery connector (10) for charging and/or discharging of a range extender battery pack or any other battery pack present in the vehicle. The modular battery connector (10) is adapted to facilitate bi-directional orientation in which power pins (103, 104), as shown in fig. 1b) and signal pins (106) of the first connector assembly (100) is engaged with
5 corresponding power pins (202, 204), as shown in fig. 1b) and corresponding signal pins (206, 208) of the second connector assembly (200) respectively when the first connector assembly (100) is assembled to the second connector assembly (200) in a first orientation or a second orientation. The second orientation is at least 180 degree with respect to the first orientation. For example, the rotation of the battery pack (B) by 180 degree results in change
10 of orientation. For the purpose of this description and ease of understanding, the modular battery connector (10) is explained herein below with reference to be provided in an electric vehicle having at least two wheels such as but not limited to electric motorcycles. However, it is also within the scope of the invention to practice/ implement the modular battery connector (10) in any of three wheeler electric vehicles, hybrid vehicles, fuel cell vehicles,
15 any other type of vehicles, machineries, power systems and other applications, without otherwise deterring the intended function of the modular battery connector (10) as can be deduced from the description and corresponding drawings.

[0059] Fig. 2a depicts a perspective view of a first connector assembly (100) of the modular battery connector (10), according to first embodiments as disclosed herein. Fig. 2b
20 depicts another perspective view of the first connector assembly (100), according to first embodiments as disclosed herein. The first connector assembly (100) is adapted to facilitate charging or discharging of a battery pack (B), as shown in fig. 8b) provided in the vehicle. The first connector assembly (100) is also called as a battery connector. The first connector assembly (100) is a part of the battery pack (B). The orientation of the first connector
25 assembly (100) is bidirectional. For the purpose of this description and ease of understanding, the first connector assembly (100) is considered to be a female connector assembly. In the first embodiment, the first connector assembly (100) includes a housing (102), at least one first power pin (103), at least one second power pin (104), a plurality of signal pins (106), a plurality of temperature sensors (108), a plurality of first sealing members (110), as shown in
30 fig. 3a), a plurality of second sealing members (112), as shown in fig. 3b), a gasket (114), as shown in fig. 2b) and a plurality of fasteners (116).

[0060] Fig. 4a depicts a perspective view of a housing (102) of the first connector assembly (100), according to first embodiments as disclosed herein. The housing (102) is

adapted to accommodate the power pins (103, 104), a portion of each signal pin (106) and guide members (210), as shown in fig. 5a) of the second connector assembly (200). The housing (102) of the first connector assembly (100) is secured onto corresponding portion of a bottom cover (C), as shown in fig. 7b to fig. 8b) of the battery pack (B) by using fasteners (116). In the first embodiment, the housing (102) includes a base (102B), a main enclosing wall (102D), as shown in fig. 2b), at least one first power pin receiving portion (102P), at least one second power pin receiving portion (102PS), a plurality of signal pin receiving portions (102S), at least one power pin isolating portion (102T), as shown in fig. 2a and fig. 4a), a plurality of signal pin holding portions (102H), a plurality of guide member receiving portions (102G), as shown in fig. 2b) and a plurality of locating portions (102L), as shown in fig. 2b).

[0061] The main enclosing wall (102D) extends from a bottom portion (102BP), as shown in fig. 2b) of the base (102B) of the housing (102). The main enclosing wall (102D) is adapted to enclose the at least one first power pin (103), the at least one second power pin (104) and the signal pins (106). For the purpose of this description and ease of understanding, the main enclosing wall (102D) substantially defines a rectangular shape configuration. It is also within the scope of the invention to provide the main enclosing wall (102D) is any other shape. The at least one first power pin receiving portion (102P) of the housing (102) is adapted to receive a portion of the at least one first power pin (103). For the purpose of this description and ease of understanding, the at least one first power pin receiving portion (102P) of the housing (102) is considered to be a through opening. The at least one second power pin receiving portion (102PS) of the housing (102) is adapted to receive a portion of the at least one second power pin (104). For the purpose of this description and ease of understanding, the at least one second power pin receiving portion (102PS) of the housing (102) is considered to be a through opening.

[0062] Each signal pin receiving portion (102S) of the housing (102) is adapted to receive a portion of corresponding each signal pin (106). For the purpose of this description and ease of understanding, each signal pin receiving portion (102S) of the housing (102) is considered to be a through opening. Each power pin receiving portion (102P) and each signal pin receiving portion (102S) is provided within the main enclosing wall (102D) of the housing (102).

[0063] The at least one power pin isolating portion (102T) is integrated on a top portion (102BT), as shown in fig. 2a) of the base (102B) of the housing (102) and is in

between the power pins (103, 104) which is being received by corresponding power pin receiving portions (102P, 102PS) of the housing (102). In the first embodiment, the power pin isolating portion (102T) is adapted to isolate the power pins (103, 104) from each other thereby restricting the possibility of electrical interference there between at wire harness
5 connections during assembly and operation or maintenance and also to restrict entry of dust or any foreign particles there between thereby preventing the chances of short circuit between power terminals. For the purpose of this description and ease of understanding, the power pin isolating portion (102T) is considered to be a protrusion provided on the base (102B) of the housing (102). It is also within the scope of the invention to secure a separate divider
10 component in between the power pins (103, 104) to isolate the power pins (103, 104). The power pin isolating portion (102T) of the housing (102) substantially defines a T shape configuration. It is also within the scope of the invention to provide the protrusion (102T) in any other shape without otherwise deterring the intended function of the protrusion (102T) as can be deduced from the description and corresponding drawings.

15 [0064] Each signal pin holding portions (102H) is adapted to hold corresponding each signal pin (106) at a desired position. Each signal pin holding portion (102H) intersects an end of corresponding each signal pin receiving portion (102S). For the purpose of this description and ease of understanding, each signal pin holding portion (102H) is considered to be at least one of a blind slit, a key hole and a groove which intersects the signal pin
20 receiving portion (102S).

[0065] Each guide member receiving portion (102G) of the housing (102) is adapted to receive corresponding each guide member (210) of the second connector assembly (200). For the purpose of this description and ease of understanding, each guide member receiving portion (102G) is considered to be a blind opening. Each guide member receiving portion
25 (102G) is parallel and opposite and spaced away with respect to the other guide member receiving portion (102G).

[0066] Each locating portion (102L) of the housing (102) is adapted to facilitate alignment of the first connector assembly (100) with respect to the second connector assembly (200). For the purpose of this description and ease of understanding, each locating
30 portion (102L) is considered to be an elongated groove provided on the main enclosing wall (102D) of the housing (102), as shown in fig. 2b).

[0067] The at least one first power pin (103) is adapted to be received by the at least one first power pin receiving portion (102P) of the housing (102). The at least one second power pin (104) is adapted to be received by the at least one second power pin receiving portion (102PS) of the housing (102). The at least one first power pin (103) and the at least one second power pin (104) is adapted to transmit power from the battery pack (B) to an electric motor (not shown) for propulsion of the vehicle. For the purpose of this description and ease of understanding, the at least one first power pin (103) is a positive power pin and the at least one second power pin (104) is a negative power pin.

[0068] Each signal pin (106) is provided in communication with a controller unit (not shown) of the battery pack (B). Each signal pin (106) is provided in communication with a controller unit (not shown) of the vehicle through corresponding signal pins (206, 208), as shown in fig. 5a and fig. 5b) of the second connector assembly (200). The signals pins (106) are adapted to provide information about parameters like but not limited to state of charge (SOC) of the battery pack (B), speed of the vehicle, current of battery pack (B), temperature of the battery pack (B) and other operating parameters of the battery pack (B) and/or the vehicle, from the controller unit (not shown) of the battery pack (B) to the controller unit (not shown) of the vehicle through corresponding signal pins (206, 208) of the second connector assembly (200). The signal pins (106) are also adapted to provide the information from the controller unit (not shown) of the vehicle to the controller unit (not shown) of the battery pack (B) through corresponding signal pins (206, 208) of the second connector assembly (200). A portion of each signal pin (106) is adapted to be received by corresponding each signal pin receiving portion (102S) of the housing (102). Each signal pin (106) is adapted to be retained by corresponding each signal pin holding portion (102H) of the housing (102) at a desired position in which a portion of each signal pin (106) is perpendicular to another portion of the signal pin (106) which is being received by the signal pin receiving portion (102S) of the housing (102). The number of signal pins (106) is 4. However, it is also within the scope of the invention to provide any number of signal pins without otherwise deterring the intended function of the signal pin (106) as can be deduced from the description and corresponding drawings.

[0069] Each temperature sensor (108) is adapted to detect the temperature of power pins (103, 104) of the first connector assembly (100) and accordingly each temperature sensor (108) provides the information about the measured temperature to the controller unit (not shown) of the battery pack (B) or the vehicle. Each temperature sensor (108) is engaged

with corresponding each power pin (103, 104) of the first connector assembly (100). The measured temperature of the power pins (103, 104) provides a proportional value for contact resistance of power pins which in turn determines mating position of power pins (103, 104) of the first connector assembly (100) with respect to corresponding power pins (202, 204) of the second connector assembly (200). The controller unit (not shown) of the battery pack (B) provides information to the controller unit (not shown) of the vehicle which in turn alerts/notifies the user of the vehicle that the battery pack (B) needs to be re-inserted properly when the power pins (103, 104) of the first connector assembly (100) are not mated properly with corresponding power pins (202, 204) of the second connector assembly (200). Therefore, the user reinserts the battery pack (B) properly such that power pins (103, 104) of the first connector assembly (100) are mated properly with corresponding power pins (202, 204) of the second connector assembly (200) thereby ensuring effective performance and longer life of the modular battery connector (10) and/or the battery pack (B). It is also within the scope of the invention to provide the temperature sensors to the second connector assembly (200) instead of the first connector assembly (100).

[0070] Fig. 3a depicts a cross-sectional view of the first connector assembly (100), where each first sealing element (110) is engaged with corresponding each power pin (103, 104) to restrict fluid flow thereof, according to first embodiments as disclosed herein. Each first sealing member (110) is engaged with corresponding each power pin (103, 104) to restrict entry of any of fluid (water), dust and other foreign particles thereof to prevent short circuit in printed circuit board (PCB) of the battery pack (B), restricts damage to terminals and other electrical connections or components of the battery pack (B) and also reduces the chances of battery fire. For the purpose of this description and ease of understanding, each first sealing member (110) is considered to be an O-ring. However, it is also within the scope of the invention to provide any other sealing means for restricting entry of fluid (water), dust and any other foreign particles at the power pin region of the first connector assembly (100) without otherwise deterring the intended function of each first sealing member (110) as can be deduced from the description and corresponding drawings.

[0071] Fig. 3b depicts another cross-sectional view of the first connector assembly (100), where each second sealing element (112) is engaged with corresponding each signal pin (106) to restrict fluid flow thereof, according to embodiments as disclosed herein. Each second sealing member (112) is engaged with corresponding each signal pin (106) to restrict entry of any of fluid (water), dust and other foreign particles thereof to prevent short circuit in

printed circuit board (PCB) of the battery pack (B), restricts damage to terminals and other electrical connections or components of the battery pack (B) and also reduces the chances of battery fire. For the purpose of this description and ease of understanding, each second sealing member (112) is considered to be an O-ring. However, it is also within the scope of the invention to provide any other sealing means for restricting entry of any of fluid (water), dust and any other foreign particles at the signal pin region of the first connector assembly (100) without otherwise deterring the intended function of the each second sealing member (112) as can be deduced from the description and corresponding drawings.

[0072] In an embodiment, the gasket (114) is adapted to be provided at the interface between the housing (102) and the bottom cover (C) of the battery pack (B) to restrict any of fluid (water), dust and other foreign particles into the battery pack (B).

[0073] Each fastener (116) is adapted to secure the housing (102) of the first connector assembly (100) to the bottom cover (C) of the battery pack (B). For the purpose of this description and ease of understanding, each fastener (116) is considered to be at least one of a screw and a bolt (Allen key bolt). It is also within the scope of the invention to provide any other type of fasteners for securing the first connector assembly (100) onto the bottom cover (C) of the battery pack (B) without otherwise deterring the intended function of the fasteners (216) as can be deduced from the description and corresponding drawings.

[0074] Fig. 5a depicts a perspective view of the second connector assembly (200), according to first embodiments as disclosed herein. Fig. 5b depicts another perspective view of the second connector assembly (200), according to first embodiments as disclosed herein. The second connector assembly (200) is adapted to facilitate charging or dis-charging of the battery pack (B). The second connector assembly (100) is also called as a charger connector. The second connector assembly (200) is a part of dock system in the vehicle and/or charging station. The orientation of the second connector assembly (200) is bidirectional. The second connector assembly (200) is removably mounted onto a bottom cover (D), as shown in fig. 7b) of the dock system inside the vehicle and/or charging station. For the purpose of this description and ease of understanding, the second connector assembly (200) is considered to be a male connector assembly. In the first embodiment, the second connector assembly (200) includes, a housing (201), at least one first power pin (202), a plurality of second power pins (204), a plurality of first signal pins (206), a plurality of second signal pins (208), a plurality of guide members (210), a plurality of first sealing members (212), as shown in fig. 6a), a

plurality of second sealing members (214), as shown in fig. 6b), a plurality of fastener bushes (216), as shown in fig. 5a, fig. 5b and fig. 7a) and a plurality of fasteners (218).

[0075] Fig. 4b depicts a perspective view of a housing (201) of the second connector assembly (200), according to first embodiments as disclosed herein. The housing (201) of the second connector assembly (200) is adapted to house the at least one first power pin (202), the second power pins (204), a portion of each first signal pin (206) and a portion of each second signal pin (208). In the first embodiment, the housing (201) includes a base (201B), a body (201D), as shown in fig. 5b), a main enclosing wall (201W), at least one first power pin receiving portion (201X), a plurality of second power pin receiving portions (201Y), a plurality of first signal pin receiving portions (201U), a plurality of second signal pin receiving portions (201V), as shown in fig. 6b), a first power pin enclosing wall (201E), a plurality of power pin isolating portions (201P), as shown in fig. 5b), a plurality of locating portions (201L) and a plurality of fastener bush receiving portions (201Z).

[0076] The body (201D) extends from a bottom portion (201BP), as shown in fig. 5b) of the base (201B) of the housing (201). The main enclosing wall (201W) extends from a top portion (201BT), as shown in fig. 4b) of the base (201B) of the housing (201). The main enclosing wall (201W) of the housing (201) is adapted to enclose the second power pins (204), the first signal pins (206) and the second signal pins (208) of the second connector assembly (200). For the purpose of this description and ease of understanding, the main enclosing wall (201W) is a rectangular shaped configuration. It is also within the scope of the invention to provide the main enclosing wall (201W) in any other shape without otherwise deterring the intended function of the main enclosing wall (201W) as can be deduced from the description and corresponding drawings.

[0077] The at least one first power pin receiving portion (201X) of the housing (201) is adapted to receive a portion of the at least one first power pin (202) of the second connector assembly (200). The at least one first power pin receiving portion (201X) is provided in the body (201D) of the housing (201). For the purpose of this description and ease of understanding the at least one first power pin receiving portion (201X) is considered to be a through opening.

[0078] Each second power pin receiving portion (201Y) of the housing (201) is adapted to receive a portion of corresponding each second power pin (204) of the second connector assembly (200). Each second power pin receiving portion (201Y) is provided in the

body (201D) of the housing (201). For the purpose of this description and ease of understanding each second power pin receiving portion (201Y) is considered to be a through opening.

[0079] Each first signal pin receiving portion (201U) of the housing (201) is adapted to receive a portion of corresponding each first signal pin (206) of the second connector assembly (200). Each first signal pin receiving portion (201U) is provided in the body (201D) of the housing (201). For the purpose of this description and ease of understanding, each first signal pin receiving portion (201U) is considered to be a through opening.

[0080] Each second signal pin receiving portion (201V) of the housing (201) is adapted to receive a portion of corresponding each second signal pin (208) of the second connector assembly (200). Each second signal pin receiving portion (201V) is provided in the body (201D) of the housing (201). For the purpose of this description and ease of understanding, each second signal pin receiving portion (201V) is considered to be a through opening.

[0081] The first power pin enclosing wall (201E) extends from the top portion (201BT) of base (201B) of the housing (201). The first power pin enclosing wall (201E) is provided inside the main enclosing wall (201W) of the housing (201). The first power pin enclosing wall (201E) of the housing (201) is adapted to enclose the at least one first power pin (202), as shown in fig. 5a) to isolate the at least one first power pin (202) from the second power pins (204), the first signal pins (206) and the second signal pins (208). The first power pin enclosing wall (201E) defines a space (201ES), as shown in fig. 4b) adapted to provide clearance to the at least one first power pin (202) for engagement of the at least one first power pin (202) with corresponding at least one first power pin (103) of the first connector assembly (100). For the purpose of this description and ease of understanding, the first power pin enclosing wall (201E) substantially defines a square shape configuration. It is also within the scope of the invention to provide the first power pin enclosing wall (201E) in any other shape without otherwise deterring the intended function of the first power enclosing wall (201E) as can be deduced from the description and corresponding drawings.

[0082] Each power pin isolating portion (201P) is integrated on the body (201D) of the housing (201) and is in between the at least one first power pin (202) and the second power pins (204) which are being received by the corresponding power pin receiving portions (201X, 201Y) of the housing (201). In the first embodiment, each power pin isolating portion

(201P) is adapted to isolate the at least one first power pin (202) and the second power pins (204) from each other thereby restricting the possibility of electrical interference there between at wire harness connections during assembly and operation or maintenance and also to restrict entry of dust or any foreign particles there between thereby preventing short circuit between power terminals. For the purpose of this description and ease of understanding, each power pin isolating portion (201P) is considered to be protrusion integrated on the body (201D) of the housing (201). It is also within the scope of the invention to secure a separate divider component in between the power pins (202, 204) to isolate the power pins (202, 204).

[0083] In an embodiment, each locating portion (201L) is integrated on the main enclosing wall (201W), as shown in fig. 4b) of the housing (201). Each locating portion (201L) of the housing (201) is adapted to facilitate alignment of the second connector assembly (200) with respect to the first connector assembly (100). Each locating portion (201L) of the housing (201) engages with corresponding each locating portion (102L) of the housing (102) of the first connector assembly (100) to facilitate alignment of the first connector assembly (100) with respect to the second connector assembly (200) in the first orientation and/or the second orientation. For the purpose of this description and ease of understanding, each locating portion (201L) is considered to be an elongated protrusion integrated on the main enclosing wall (201W) of the housing (201). It is also within the scope of the invention to provide grooves on the main enclosing wall (201W) of the housing (201) of the second connector assembly (200) and correspondingly protrusions can be provided on the main enclosing wall (102D) of the housing (102) of the first connector assembly (100) for alignment of the first connector assembly (100) with respect to the second connector assembly (200).

[0084] Each fastener bush receiving portion (201Z) is adapted to receive a portion of corresponding fastener bush (216) to facilitate mounting of the fastener bush (216) onto the housing (201). For the purpose of this description and ease of understanding, each fastener bush receiving portion (201Z) is considered to be a through opening.

[0085] A portion of the at last one first power pin (202) is adapted to be received by the first power pin receiving portion (201X) of the housing (201). A portion of each second power pin (204) is adapted to be received by corresponding each second power pin receiving portion (201Y) of the housing (201). The first power pin (202) is provided in the center of the male connector assembly (200). One second power pin (204) is provided to the right side of the first power pin (202), as shown in fig. 1a and fig. 5a and fig. 5b). Another second

power pin (205) is provided to the left side of the first power pin (202), as shown in fig. 5a and fig. 5b). In the first embodiment, the at least one first power pin (202) is provided in between the second power pins (204). The at least one first power pin (202) and each second power pin (204) are provided in line and parallel and spaced away from each other.

5 However, the arrangement of power pins can vary according to the type and configuration of the battery connector and the requirement of the application. The at least one first power pin (202) and at least one of the plurality of second power pins (104) is adapted to be engaged with corresponding at least one first power pin (103) and at least one second power pin (104) of the first connector assembly (100) to transmit power from the battery pack (B) to the

10 electric motor (not shown) for propulsion of the vehicle. For the purpose of this description and ease of understanding, the at least one first power pin (202) is a positive power pin and each second power pin (204) is a negative power pin.

[0086] Each signal pin (206, 208) is adapted to be provided in communication with the controller unit (not shown) of the vehicle. Each signal pin (206, 208) is provided in

15 communication with the controller unit (not shown) of the battery pack (B) through corresponding signal pins (106) of the first connector assembly (100). A portion of each first signal pin (206) is adapted to be received by corresponding each first signal pin receiving portion (201U) of the housing (201). A portion of each first signal pin (206) is perpendicular to another portion of the first signal pin (206) which is being received by the first signal pin

20 receiving portion (201U) of the housing (201). Each first signal pin (206) is parallel and spaced away from the corresponding another first signal pin (206).

[0087] A portion of each second signal pin (208) is adapted to be received by corresponding each second signal pin receiving portion (201V) of the housing (201). A portion of each second signal pin (208) is perpendicular to another portion of the second

25 signal pin (208) which is being received by the second signal pin receiving portion (201V) of the housing (201). Each second signal pin (208) is parallel and spaced away from corresponding another second signal pin (208). In the first embodiment, each second signal pin (208) is parallel and opposite and spaced away with respect to corresponding each first signal pin (206). It is also within the scope of the invention to provide the signal pins (206,

30 208) is any other orientation and configuration according to the requirement. The number of signal pins (206, 208) of the second connector assembly (200) is 8. It is also within the scope of the invention to provide the second connector assembly (200) with any number of signal

pins without otherwise deterring the intended function of the signal pins (206, 208) as can be deduced from the description and corresponding drawings.

[0088] Each guide member (210) of the second connector assembly (200) is adapted to be received by corresponding each guide member receiving portion (102G) of the housing (102) of the first connector assembly (100) to facilitate alignment of the first connector assembly (100) with the second connector assembly (200).

[0089] Fig. 6a depicts a cross-sectional view of the second connector assembly (200), where each first sealing element (212) is engaged with corresponding each power pin (202, 204) to restrict fluid flow thereof, according to embodiments as disclosed herein. Each first sealing member (212) is engaged with corresponding each power pin (202, 204) to restrict entry of any of fluid (water), dust and other foreign particles thereof to prevent short circuit in printed circuit board (PCB) of the battery pack (B), restricts damage to terminals and other electrical connections or components of the battery pack (B) and also reduces the chances of battery fire. For the purpose of this description and ease of understanding, each first sealing member (212) is considered to be an O-ring. However, it is also within the scope of the invention to provide any other sealing means for restricting entry of fluid (water), dust and any other foreign particles at the power pin region of the second connector assembly (200) without otherwise deterring the intended function of the each first sealing member (212) as can be deduced from the description and corresponding drawings.

[0090] Fig. 6b depicts another cross-sectional view of the second connector assembly (200), where each second sealing element (214) is engaged with corresponding each signal pin (206, 208) to restrict fluid flow thereof, according to first embodiments as disclosed herein. Each second sealing member (214) is engaged with corresponding each signal pin (206, 208) to restrict entry of any of fluid (water), dust and other foreign particles thereof to prevent short circuit in printed circuit board (PCB) of the battery pack (B), restricts damage to terminals and other electrical connections or components of the battery pack (B) and also reduces the chances of battery fire. For the purpose of this description and ease of understanding, each second sealing member (214) is considered to be an O-ring. However, it is also within the scope of the invention to provide any other sealing means for restricting entry of any of fluid (water), dust and any other foreign particles at the signal pin region of the second connector assembly (200) without otherwise deterring the intended function of the each second sealing member (214) as can be deduced from the description and corresponding drawings.

[0091] Each fastener bush (216), as shown in fig. 7a and fig. 7b) is adapted to receive corresponding fastener (218) therethrough to facilitate floatable mounting of the housing (201) of the second connector assembly (200) to the bottom cover (D) of the dock system inside the vehicle and/or charging station, where the second connector assembly (200) moves with respect to the fasteners (218) to facilitate assembly of the first connector assembly (100) with the second connector assembly (200). The floatable mounting of the second connector assembly (200) is adapted to restrict damage to the power pins (103, 104) of the first connector assembly (100) and the power pins (202, 204) of the second connector assembly (200) during assembly or removal of the first connector assembly (100) with respect to the second connector assembly (200) and also during operation of the vehicle. Each fastener bush (216) includes a body (216B) and a flange (216F) and a fastener receiving portion (216R), as shown in fig. 7a). The body (216B) of each fastener bush (216) is adapted to be received by corresponding each fastener bush receiving portion (201Z) of the housing (201). The flange (216F) of each fastener bush (216) is engaged with the top portion (201BT) of the base (201B) of the housing (201). The fastener receiving portion (216R) of each fastener bush (216) is adapted to receive corresponding each fastener (218) therethrough to facilitate floatable mounting of the second connector assembly (200) to the bottom cover (D) of the dock system and/or the charging station. For the purpose of this description and ease of understanding, the fastener receiving portion (216R) of each fastener bush (216) is considered to be a through opening. The fastener receiving portion (216R) of each fastener bush (216) and corresponding each fastener (218) defines a space (216RS), as shown in fig. 7b) there between to allow movement of the second connector assembly (200) with respect to the fasteners (218) during assembly of the first connector assembly (100) with the second connector assembly (200). The flange (216F) of each fastener bush (216) and head of corresponding each fastener (218) defines a space (216FS), as shown in fig. 7b) there between to allow movement of the second connector assembly (200) with respect to the fasteners (218) during assembly of the first connector assembly (100) with the second connector assembly (200).

[0092] Each fastener (218) is adapted to be received by each fastener receiving portion (216R) of corresponding each fastener bush (216) therethrough to facilitate floatable mounting of the second connector assembly (200) to the bottom cover (D) of the dock system inside the vehicle and/or the charging station. Each fastener (218) is not in contact with corresponding each fastener bush (216). Each fastener (218) includes a chamfer (218C, as

shown in fig. 7b) adapted to restrict movement of the fastener (218) when the fastener (218) is moved beyond a predetermined position.

[0093] It is also within the scope of the invention to provide components (203, 204, 206, 208) of the second connector assembly (200) to the first connector assembly (100) and correspondingly the components (103, 104, 106, 109) can be provided to the second connector assembly (200). In the first embodiment, for the current power pin configuration, the number of power pins (103, 104) of the first connector assembly is 2 and correspondingly, the number of power pins (202, 204) of the second connector assembly (200) is 3. It can also be vice-versa (i.e. 3 power pins in first connector assembly (100) and 2 power pins in second connector assembly (200)). The number of power pins can increase in Integer multiples. For example – 3/6/9/12... and so on, power pins on second connector assembly (200) or the first connector assembly (100) will have 2/4/6/8... power pins in first connector assembly (100) or the second connector assembly (200) respectively.

[0094] Fig. 9 depicts a flowchart indicating a method (20) of providing the modular battery connector (10) in the vehicle, according to first embodiments as disclosed herein. For the purpose of this description and ease of understanding, the method (20) is explained herein below with reference to providing the modular battery connector (10) in a vehicle having at least two wheels such as but not limited to electric motorcycles. However, it is also within the scope of this invention to practice/implement the entire steps of the method (20) in a same manner or in a different manner or with omission of at least one step to the method (20) or with any addition of at least one step to the method (20) of providing the battery connector (10) in any of three wheeler electric vehicles, hybrid vehicles, fuel cell vehicles, other type of vehicles, machineries, power systems and other applications, without otherwise deterring the intended function of the method (20) as can be deduced from the description and corresponding drawings. In the first embodiment, the method (20) includes, removably mounting a housing (102) of a first connector assembly (100) onto a bottom cover (C) of a battery pack (B) and at least one of electrically and electronically connecting the first connector assembly (100) to the battery pack (B), step (22); floatably mounting by, a plurality of fastener bushes (216) and a plurality of fasteners (218), a housing (201) of a second connector assembly (200) of the modular battery connector (10) onto a bottom cover (D) of a dock system provided in at least one of the vehicle and a charging station, step (24), and assembling the first connector assembly (102) onto the second connector assembly (104) by aligning the first connector assembly (100) with respect to the second connector assembly

(200) by introducing each guide member (210) of the second connector assembly (200) into corresponding guide member receiving portion (102G) provided in the housing (102) of the first connector assembly (100), and introducing each locating portion (201L) of the housing (201) of the second connector assembly (200) into corresponding each locating portion (102L) provided in the housing (102) of the first connector assembly (100), step (26), wherein at least first power pin (202) and at least one of the plurality of second power pins (204) of the second connector assembly (200) is adapted to be engaged with corresponding at least first power pin (103) and at least one second power pin (104) of the first connector assembly (100) respectively; and each first signal pin (206) or each second signal pin (208) of the second connector assembly (200) is adapted to be engaged with corresponding each signal pin (106) of the first connector assembly (100) respectively during assembly of the first connector assembly (100) with the second connector assembly (200) in a first orientation or a second orientation.

[0095] Further, the method (20) includes, locking the battery pack (B) with at least one guide member (210) of the second connector assembly (200), step (28), after the method step (26) of assembly of the first connector assembly (100) to the second connector assembly.

[0096] Therefore, a modular battery connector (10) and a method (20) of providing the modular battery connector (10) in a vehicle, which facilitates bi-directional orientation during assembly of a first connector assembly (100) to a second connector assembly (200) is provided.

[0097] Fig. 10 depicts a cross sectional view of a battery locking system (300) for locking the battery pack with the guide member (210) of the second connector assembly (200) of the modular battery connector (10) in the vehicle, according to second embodiments as disclosed herein. In the second embodiment, the battery locking system (300) comprises an actuator (302) and a locking member (304). For the purpose of this description and ease of understanding, the battery locking system (300) is explained herein below with reference to locking a removable battery pack in the vehicle having at least two wheels such as but not limited to electric motorcycles. However, it is also within the scope of the invention to practice/ implement the battery locking system (300) for locking the fixed battery pack or a range extender battery pack or any other type of battery pack present in a three wheeler electric vehicle, hybrid vehicles, fuel cell vehicles, any other type of vehicles, machineries, power systems and other applications, where locking of battery pack is required, without

otherwise deterring the intended function of the battery locking system (300) as can be deduced from the description and corresponding drawings.

[0098] The actuator (302) is mounted to the battery pack. For the purpose of this description and ease of understanding, the actuator (302) is considered to a unidirectional electromagnetic solenoid. It is also within the scope of the invention to provide a bidirectional electromagnetic solenoid or any other types of solenoids for moving the locking member (304) to lock and/or unlock the battery pack. In the second embodiment, the actuator (302) is adapted to move the locking member (304) away from the guide member (210), as shown in fig. 10 to fig. 12b) of the second connector assembly (200) to disengage the locking member (304) from the guide member (210) thereby unlocking the battery pack (not shown) from the second connector assembly (200) when the actuator (302) is energized by the controller unit (not shown) of the battery pack based on the information from the controller unit (not shown) of the vehicle to the controller unit (not shown) of the battery pack. For example, the actuator (302) is energized by the controller unit (not shown) of the battery pack in which the actuator (302) receives electric current from the battery pack (B) to move the locking member (304) for disengaging the locking member (304) from the guide member (210) of the second connector assembly (200) thereby unlocking the battery pack from the second connector assembly (200). For the purpose of this description and ease of understanding, the second connector assembly (200) is a male connector assembly, and the guide member (210) of the second connector assembly (200) is a guide pin. The guide member (210) is adapted to facilitate alignment of the second connector assembly (200) with respect to the first connector assembly (100), as shown in fig. 10). For the purpose of this ease of understanding, the first connector assembly (100) is considered to be a female connector assembly. The actuator (302) includes a housing (302H), as shown in fig. 12a) and coils (302C), as shown in fig. 12a). The housing (302) includes at least one locating portion (302L), as shown in fig. 12a) adapted to be integrated with the housing (302H). The locating portion (302L) of the housing (302H) is adapted to facilitate alignment of the actuator (302) with respect to a housing (201), as shown in fig. 12a) of the second connector assembly (200).

[0099] In the second embodiment, the locking member (304) is adapted to lock the battery pack with the guide member (210) of the second connector assembly (200). For the purpose of this description and ease of understanding, the locking member (304) is considered to be a plunger. A portion of the locking member (304) is received by a locking

member receiving portion (210G), as shown in fig. 10) of the guide member (210) to lock the battery pack (not shown) with male connector assembly (200). For the purpose of this description and ease of understanding, the locking member receiving portion (210R) is considered to be a groove provided on the guide member (210). The locking member (304) is movable between a locked position (as shown in fig. 11a) in which the locking member (304) is engaged with the guide member (210) of the second connector assembly (200) for locking the battery pack with the second connector assembly (200), and an unlocked position (as shown in fig. 11b) in which the locking member (304) is dis-engaged from the guide member (210) of the second connector assembly (200) for unlocking the battery pack from the second connector assembly (200). A portion of the locking member (304) is received inside the actuator (302). The battery locking system includes at least one resilient means (not shown) for loading the locking member (304) into the actuator (302). The locking member (304) is loaded against the guide member (210) through the resilient means (not shown) for locking the battery pack to the second connector assembly (200). The locking member (304) moves to the locked position on de-energization of the actuator (302) which occurs on switching-off of the electric current supply to the actuator (302) through controller unit (not shown). The locking member (304) moves to the unlocked position on energization of the actuator (302) which occurs on supply of electric current to the actuator (302) through the controller unit.

[00100] The resilient means (not shown) is adapted to provide force (spring force) to the locking member (304) to move the locking member (304) in a direction towards the guide member (210) to engage the locking member (304) with the guide member (210) of the second connector assembly (200) thereby locking the battery pack (not shown) to the second connector assembly (200) when the actuator (302) is in the de-energized condition. The resilient means (not shown) is adapted to retain the locking member (304) in engagement with the guide member (210) until the actuator (302) is in de-energized condition. For the purpose of this description and ease of understanding, the resilient means (not shown) is considered to be at least a spring. The resilient means (not shown) is provided inside the actuator (302) for loading the locking member (304) in the actuator (302) and to load the locking member (304) against the guide member (210). In another second embodiment, the resilient means (not shown) is provided external to the actuator (302) for providing a portion of the locking member (304) in the actuator (302) and to load the locking member (304) against the guide member (210).

[00101] The controller unit (not shown) of the battery pack receives user input and accordingly energizes the actuator (302) by switching on electric current to the actuator (302) to move the locking member (304) from the locked position to the unlocked position to facilitate removing of the battery pack from the vehicle. The controller unit is adapted to de-
5 energize the actuator (302) by switching off the electric current supply to the actuator (302) thereby enabling the resilient means (not shown) to move the locking member (304) to the locked position thereby locking the battery pack with the second connector assembly (200) based on the user input.

[00102] A bush (MB), as shown in fig. 12b) is mounted onto the locking member
10 (304) to support the locking member (304). The bush (MB) is adapted to be received by a bush receiving portion (not shown) of the housing (201) of the second connector assembly (200). A sealing member (S1), as shown in fig. 12b) is mounted onto the locking member (304) and is disposed between the bush (MB) and the locking member (304) to restrict fluid flow into the battery pack (not shown). Another sealing member (S2), as shown in fig. 12b)
15 is mounted onto the bush (MB) and is engaged with the housing (201) of the second connector assembly (200) and the housing (302H) to restrict fluid flow into the battery pack (not shown). For the purpose of this description and ease of understanding, each sealing member (S1 and S2) is considered to be an O-ring. However, it is also within the scope of the invention to provide any other sealing means for restricting fluid flow into the battery
20 pack without otherwise deterring the intended function of the battery pack as can be deduced from the description and corresponding drawings.

[00103] Fig. 13 depicts a cross-sectional view of a battery locking system (400) for locking a battery pack with the guide member (210) of the second connector assembly (200) in the vehicle, according to third embodiments as disclosed herein. In the third embodiment,
25 the battery locking system (400) includes a housing (402), at least one control valve (404), a movable member (406) and a locking member (408).

[00104] The housing (402) is mounted to the battery pack (not shown). For the purpose of this description and ease of understanding, the housing (402) is considered to be a single acting cylinder or a double acting cylinder. The housing (402) utilizes at least one of
30 pressurized fluid and compressed air as working medium for moving the locking member (408) between a locked position in which the locking member (408) is engaged with the guide member (210) of the second connector assembly (200) for locking the battery pack (not shown) to the second connector assembly (200), and an unlocked position in which the

locking member (408) is dis-engaged from the guide member (210) of the second connector assembly (200) for unlocking the battery pack (not shown) from the second connector assembly (200). The housing (402) is at least one of a hydraulic cylinder and a pneumatic cylinder.

5 [00105] The control valve (404) is provided in communication with the controller unit of the battery pack. The control valve (404) is provided in fluid communication with the housing (402). The control valve (404) is adapted to regulate fluid flow in the housing (402) to move the movable member (406) which in turn moves the locking member (408) to engage the locking member (408) with the guide member (210) of the second connector assembly
10 (200) thereby locking the battery pack with the second connector assembly (200) when the control valve (404) receives information from the controller unit of the battery pack.

 [00106] The movable member (406) is provided inside and movably engaged with the housing (402). The movable member (406) is moved to move the locking member (406) between the locked position and the unlocked position when the control valve (404) regulates
15 the fluid flow in the housing (402). For the purpose of this description and ease of understanding, the movable member (406) is considered to be a piston.

 [00107] The locking member (408) is adapted to engage the guide member (210) of the second connector assembly (200) for locking the battery pack with the second connector assembly (200) on movement of the movable member (406). For the purpose of this
20 description and ease of understanding, the locking member (408) is considered to be a connecting rod.

 [00108] The controller unit (not shown) is adapted to activate the control valve (404) which in turn regulates at least one the fluid flow from the control valve (404) to the housing (402) and the flow of fluid from the housing (402) to a tank (not shown) to move the locking
25 member (408) between the locked position and the unlocked position.

 [00109] Fig. 14 depicts a cross-sectional view of a battery locking system (500) for locking the battery pack with the guide member (210) of the second connector assembly (200) in the vehicle, according to fourth embodiments as disclosed herein. In the fourth embodiment, the system (500) includes an electric motor (502). The electric motor (502) is
30 provided in communication with a controller unit (not shown) of battery pack (not shown). The electric motor (502) includes a locking member (502S). The locking member (502S) is adapted to be moved to an extended position in which the locking member (502S) is engaged

with the guide member (210) of the second connector assembly (200) for locking the battery pack with the second connector assembly (200) when the electric motor (502) receives information the controller unit (not shown) of the battery pack based on the requirement of user. The locking member (502S) is adapted to be moved to an retracted position in which
5 the locking member (502S) is dis-engaged from the guide member (210) of the second connector assembly (200) for unlocking the battery pack from the second connector assembly (200) when the electric motor (502) receives information from the controller unit (not shown) of the battery pack based on the requirement of user. For the purpose of this description and ease of understanding, the locking member (502S) is considered to be an extendable and
10 retractable shaft.

[00110] Fig. 15 depicts a cross-sectional view of a battery locking system (600) for locking the battery pack with the guide member (210) of the second connector assembly (200) in the vehicle, according to fifth embodiments as disclosed herein. In the fifth embodiment, the battery locking system (600) includes an electric motor (602), at least one
15 driving member (603) and at least one locking member (604). The electric motor (602) is provided in communication with a controller unit (not shown) of battery pack (not shown). The electric motor (602) includes a shaft (602S). The driving member (603) is mounted onto the shaft (602S) of the electric motor (602). For the purpose of this description and ease of understanding, the driving member (603) is considered to be a pinion gear and the locking
20 member (604) is considered to be a gear rack.

[00111] The locking member (604) is movably connected to the shaft (602S) of the electric motor (602) through the driving member (603). It is also within the scope of the invention to provide any other types of gear system or gear trains or pulleys and belts, sprockets and chains, between the shaft (602S) of the electric motor (602) and the locking
25 member (604) for moving the locking member (604). The locking member (604) is adapted to be moved by the driving member (603) to a locked position in which the locking member (604) is engaged with the guide member (210) of the second connector assembly (200) for locking the battery pack with the second connector assembly (200) when the electric motor (602) receives information the controller unit (not shown) of the battery pack based on the
30 requirement of user. The locking member (604) is adapted to be moved by the driving member (603) to an unlocked position in which the locking member (604) is dis-engaged from the guide member (210) of the second connector assembly (200) for unlocking the battery pack from the second connector assembly (200) when the electric motor (602)

receives information from the controller unit (not shown) of the battery pack based on the requirement of user.

[00112] In another embodiments, any of linear control mechanism, a slidable mechanism, a telescopic adjustable mechanism, an extendable and retractable mechanism, an adjustable screw mechanism, a linear adjustable actuators and a telescopic cylinder mechanism, can be used for locking the battery pack with the guide member (210) of the second connector assembly (200).

[00113] Fig. 16 depicts a flowchart indicating a method (700) for locking the battery pack in the vehicle, according to embodiments as disclosed herein. For the purpose of this description and ease of understanding, the method (700) is explained herein below with reference to locking the battery pack in a vehicle having at least two wheels such as but not limited to electric motorcycles. However, it is also within the scope of this invention to practice/implement the entire steps of the method (700) in a same manner or in a different manner or with omission of at least one step to the method (700) or with any addition of at least one step to the method (700) for locking the battery pack in three wheeler electric vehicles, hybrid vehicles, fuel cell vehicles, other type of vehicles, machineries, power systems and other applications, without otherwise deterring the intended function of the method (700) as can be deduced from the description and corresponding drawings.

[00114] The method (700) includes, locking the battery pack to a guide member (210) of a connector assembly (200) of a battery connector (10). For the purpose of this description and ease of understanding, the guide member (210) is considered to be a guide pin and the connector assembly (200) is considered to be a male connector assembly. It is also within the scope of the invention to lock the battery pack with both guide members (210) of the second connector assembly (200).

[00115] The method step of locking the battery pack to the guide member (210) of the connector assembly (200) includes, moving the locking member (304) through a resilient means to engage the locking member (304) with the guide member (210) when an actuator (302) is de-energized through at least one of a controller unit of the battery pack and the vehicle based on user inputs.

[00116] Further, the method (700) includes, moving the locking member (304) through the actuator (302) to disengage the locking member (304) from the guide member (210) thereby unlocking the battery pack from the male connector assembly (200) when the

solenoid unit (302) is energized through the controller unit of at least one of the battery pack and the vehicle based on user input, where the actuator (302) is a unidirectional electromagnetic solenoid, the locking member (304) is a plunger, and the resilient means is a spring.

5 [00117] The method step of locking the battery pack to the guide member (210) of the connector assembly (200), by providing at least one of a bi-directional electromagnetic solenoid, a hydraulic or pneumatic cylinder battery locking system (400), an electric motor with extendable and retractable shaft battery locking system (500), an electric motor with rack and pinion gear battery locking system (600).

10 [00118] The method (700) includes, swiping radio frequency identification (RFID) card, by user of the vehicle at the charging station or battery swapping station.

 [00119] The method (700) includes reading data from the RFID card and setting up wireless communication with the controller unit of the vehicle and/or the battery pack and notifying the user of the same through a user interface.

15 [00120] The method (700) includes opening the dock door and pressing the button on battery pack to energize the actuator (302) thereby unlocking the battery pack from the second connector assembly (200).

 [00121] Therefore, systems (300, 400, 500, 600) and method (700) for locking the battery pack in an electric vehicle, which is reliable is provided.

20 [00122] The foregoing description of the specific embodiments will so fully reveal the general nature of the embodiments herein that others can, by applying current knowledge, readily modify and/or adapt for various applications such specific embodiments without departing from the generic concept, and, therefore, such adaptations and modifications should and are intended to be comprehended within the meaning and range of equivalents of the
25 disclosed embodiments. It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. Therefore, while the embodiments herein have been described in terms of embodiments, those skilled in the art will recognize that the embodiments herein can be practiced with modifications within the spirit and scope of the embodiments as described herein.

30

CLAIMS

1. A modular battery connector (10) comprising:

a first connector assembly (100) comprising a housing (102), at least one first power pin (103), at least one second power pin (104), a plurality of signal pins (106), a plurality of temperature sensors (108), a plurality of first sealing members (110), a plurality of second sealing members (112) and a gasket (114); and

a second connector assembly (200) comprising a housing (201), at least one first power pin (202), a plurality of second power pins (204), a plurality of first signal pins (206), and a plurality of second signal pins (208), a plurality of first sealing members (212), and a plurality of second sealing members (214),

wherein the first connector assembly (100) and the second connector assembly (200) are assembled such that

each guide member receiving portion (102G) of the housing (102) in the first connector assembly (100) is adapted to receive corresponding each guide member (210) of the second connector assembly (200), and

each locating portion (102L) of the housing (102) is adapted to facilitate alignment of the first connector assembly (100) with respect to the second connector assembly (200),

wherein

said at least one first power pin (202) and corresponding said at least one of said plurality of second power pins (204) of said second connector assembly (200) is adapted to be engaged with corresponding said at least one first power pin (103) and said at least one second power pin (104) of said first connector assembly (100) respectively;

each of said first signal pin (206) or each of said second signal pin (208) of said second connector assembly (200) is adapted to be engaged with corresponding each of said signal pin (106) of said first connector assembly (100) when said first connector assembly (100) is assembled onto said second connector assembly (200) in a first orientation or a second orientation;

said housing (102) of said first connector assembly (100) includes at least one power pin isolating portion (102T), at least one signal pin holding portion (102H) and a plurality of locating portions (102L), wherein said locating portions (102L) are integrated with a main enclosing wall (102D) of said housing (102); and

said housing (201) of said second connector assembly (200) includes at least one first power pin enclosing wall (201E), at least one power pin isolating portion (201P) and a plurality of locating portions (201L), wherein said locating portions (201L) are integrated with a main enclosing wall (201W) of said housing (201).

2. The modular battery connector (10) as claimed in claim 1, wherein each of said locating portion (201L) of said housing (201) engages with corresponding each of said portion (102L) of said housing (201) to facilitate alignment of said first connector assembly (100) with respect to said second connector assembly (200) when said first connector assembly (100) is assembled onto said second connector assembly (200) in said first orientation or said second orientation; said first connector assembly (100) is a female connector assembly; and said second connector assembly (200) is a male connector assembly.

3. The modular battery connector (10) as claimed in claim 1, wherein said at least first power pin (202) and each of said second power pin (204) of said second connector assembly (200) are provided in line and parallel and spaced away from each other; and each of said second signal pin (208) is parallel and opposite and spaced away with respect to corresponding each of said first signal pin (206) of said second connector assembly (200).

4. A method (20) of providing a modular battery connector (10), said method (20) comprising:

removably mounting a housing (102) of a first connector assembly (100) onto a bottom cover (C) of a battery pack (B);

floatably mounting by, a plurality of fastener bushes (216) and a plurality of fasteners (218), a housing (201) of a second connector assembly (200) onto a bottom cover (D) of a dock system provided in at least one of a vehicle and a charging station; and

assembling the first connector assembly (100) to the second connector assembly (200) by aligning the first connector assembly (100) with respect to the second connector assembly (200),

wherein said assembling the first connector assembly (100) to the second connector assembly (200) by aligning the first connector assembly (100) with the second connector assembly (200) by,

introducing each guide member (210) of the second connector assembly (200) into corresponding guide member receiving portion (102G) provided in a housing (102) of the first connector assembly (100), and

introducing each locating portion (201L) of the housing (201) of the second connector assembly (200) into corresponding each locating portion (102L) provided in the housing (102) of the first connector assembly (100),

wherein

at least one first power pin (202) and at least one of a plurality of second power pins (204) of the second connector assembly (200) is adapted to be engaged with corresponding at least one first power pin (103) and at least one second power pin (104) of the first connector assembly (100) respectively; and

each first signal pin (206) or each second signal pin (208) of the second connector assembly (200) is adapted to be engaged with corresponding each signal pin (106) of the first connector assembly (100) during assembly of the first connector assembly (100) to the second connector assembly (200) in a first orientation or a second orientation.

5. The method (20) as claimed in claim 4, wherein said method (20) comprises,

locking the battery pack (B) with at least one guide member (210) of the second connector assembly (200) after said assembly of the first connector assembly (100) to the second connector assembly (200),

wherein

the guide member (210) is a guide pin;

the first connector assembly (100) is a female connector assembly; and

the second connector assembly (200) is a male connector assembly.

6. The modular battery connector (10) as claimed in claim 1,

wherein each of said first sealing member (110) of said first connector assembly (100) is adapted to be engaged with corresponding each power pin (103, 104) of said first connector assembly (100) to restrict fluid flow thereof; each of said second sealing member (112) of said first connector assembly (100) is adapted to be engaged with corresponding each signal pin (106) of said first connector assembly (100) to restrict at least fluid flow thereof;

each of said first sealing member (212) of said second connector assembly (200) is adapted to be engaged with corresponding each power pin (202, 204) of said second connector assembly (200) to restrict fluid flow thereof; and

each of said second sealing member (214) of said second connector assembly (200) is adapted to be engaged with corresponding each signal pin (206, 208) of said second connector assembly (200) to restrict at least fluid flow thereof.

7. The modular battery connector (10) as claimed in claim 6, wherein said gasket (114) adapted to be provided at interface between a housing (102) of said first connector assembly (100) and a bottom cover (C) of a battery pack (B) to restrict at least fluid flow into the battery pack (B);

each of said sealing element (110, 112) of said first connector assembly (100) is at least an O-ring; and

each of said sealing element (212, 214) of said second connector assembly (200) is at least an O-ring.

8. The modular battery connector (10) as claimed in claim 1,

wherein each of said temperature sensor (108) is adapted to be engaged with corresponding each power pin (103, 104) of said first connector assembly (100) to detect a temperature of each power pin (104) and accordingly each of said temperature sensor (108) provides the information about the measured temperature to a controller unit of a battery pack (B).

9. The modular battery connector (10) as claimed in claim 9, wherein the measured temperature of power pins (103, 104) provides a proportional value for contact resistance of power pins which in turn determines mating position of power pins (103, 104) of the said first connector assembly (100) with respect to corresponding power pins (202, 204) of a second connector assembly (200).

10. The modular battery connector (10) as claimed in claim 1, wherein the second connector assembly (200) comprising:

a plurality of fasteners (218); and

a plurality of fastener bushes (216), where each of said fastener bush (216) is adapted to receive corresponding each of said fastener (218) therethrough to facilitate floatable mounting of a housing (201) of said second connector assembly (200) to a bottom cover (D) of a dock system provided in at least one of a vehicle and a charging station.

11. The modular battery connector (10) as claimed in claim 10, wherein each of said fastener bush (216) includes a body (216B), a flange (216F) and a fastener receiving portion (216R);

each of said fastener (218) is not in contact with corresponding each of said fastener bush (216);

the fastener receiving portion (216R) of each of said fastener bush (216) and corresponding each of said fastener (218) defines a space (216RS) there between to allow a movement of said second connector assembly (200) with respect to said fasteners (218) during assembly of said connector assembly (200) with said first connector assembly (100);

the flange (216F) of each of said fastener bush (216) and head of corresponding each of said fastener (218) defines a space (216FS) there between to allow a movement of said second connector assembly (200) with respect to said fasteners (218) during assembly of said connector assembly (200) with said first connector assembly (100); and

each of said fastener (218) defines a chamfer (218C) adapted to restrict movement of said fastener (218) when said fastener (218) is moved beyond a predetermined position.

12. The modular battery connector (10) as claimed in claim 1, wherein said at least one power pin isolating portion (102T) is adapted to be integrated with said housing (102), where said at least one power pin isolating portion (102T) is adapted to isolate at least one said first power pin (103) from at least one said second power pin (104) of said first connector assembly (100); and

said at least one signal pin holding portion (102H) is adapted to hold corresponding at least one signal pin (106) of said first connector assembly (100).

13. The modular battery connector (10) as claimed in claim 1, wherein

said at least one first power pin enclosing wall (201E) adapted to extend from a base (201B) of said housing (201), said at least one first power pin enclosing wall (201E) is adapted to isolate at least one power pin (202) from corresponding at least one another power pin (204) and corresponding at least one signal pin (206, 208) of said second connector assembly (200); and

said at least one power pin isolating portion (201P) adapted to be integrated with a body (201D) of said housing (201), said at least one power pin isolating portion (201P) is adapted to isolate said at least one power pin (202) from corresponding at least one another power pin (204).