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Draft Indian Standard

ELECTRIC VEHICLE BATTERY SWAP SYSTEM – PART 4 LIGHT ELECTRIC VEHICLES – SECTION 1 GUIDELINES AND PACK DIMENSIONS

Last date for comments : **25 September 2022**

Electrotechnology in Mobility Sectional Committee, ETD 51

NATIONAL FOREWORD

(*Formal clauses will be added later***)**

The Indian Standards for an interoperable Battery as a Service (BaaS) System for Light Electric Vehicles consist of following series of standards:

Part 1 General Guidelines
Part 2 Safety Guidelines
Part 3 Central Management System
Part 4/Sec 1 Light Electric Vehicle- Guidelines and Pack Dimensions
Part 4/Sec 2 Light Electric Vehicle- Connection System
Part 4/Sec 3 Light Electric Vehicle- Communication protocol

In order to increase the pace of transformation of mobility, the Government of India is promoting Battery as a Service (BaaS) wherein the electric vehicles batteries can be replaced at the Battery Swap Station. BaaS is designed as an interoperable system for consumer convenience, faster adoption (scalability), and asset utilisation wherein within the light electric vehicle categories, any vehicle can use these battery packs inter-changeably. This standard covers Battery Swap System Guidelines and Pack Dimensions

The composition of the committee responsible for formulation of this standard is given at Annex E.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2: 1960 ‘Rules for rounding of numerical values (revised)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Draft Indian Standard

ELECTRIC VEHICLE BATTERY SWAP SYSTEM
PART 4 LIGHT ELECTRIC VEHICLES
SECTION 1 GUIDELINES AND PACK DIMENSIONS

1 SCOPE

1.1 This standard is applicable to Battery Swap System(BSS) connected to supply, with rated input supply voltage upto 415 V a.c, 50 Hz or up to 400 V d.c. and swappable battery system(SBS) with a nominal voltage of 48 V d.c. and a maximum working voltage of less than or equal to 60 V d.c.

1.2 The aspects covered in this standard include:

a) Requirements for Swappable battery system (*battery pack*), its dimensions, ratings and mass.
b) Requirements for Battery swap system.
c) Requirements for power transfer between the battery swap systems and swappable battery system;

1.3 The standard does not cover the detailed requirements for Battery swap systems located in hazardous areas where flammable gas or vapor and/or combustible materials, fuels or other combustible or explosive materials are present. Additional requirements as per CEA , PESO regulations may apply for such locations.

2 REFERENCES

The standards listed below contain provisions, which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below:

IS No	***Title***
1S 16504(Part 1):2019	Safety of Machinery — Electrical Equipment of Machines Part 1 General Requirements (First Revision)
IS 17017 (Part 1) : 2018	Electric Vehicle Conductive Charging System – Part 1 General Requirements
IS 17017 (Part 21/Section 2) : 2019	Electric Vehicle Conductive Charging System – Part 21 Electromagnetic Compatibility (EMC) Requirements – Section 2 Off-board Chargers
IS 17017 (Part 23) :2021	Electric Vehicle Conductive Charging System – Part 23 DC electric vehicle supply equipment
IS 17896(Part 1):2022/ IEC TS 62840-1:2016	Electric vehicle battery swap system - Part 1 General and Guidance
IS 17896(Part 1):2022/ IEC 62840-2:2016	Electric vehicle battery swap system - Part 2 Safety requirements

IS 17896 (Part 3)	Electric Vehicle Battery Swap System – Part 3 Central Management System for Interoperable Battery Packs (*under development*)
IS 17896 (Part 4/Sec 2)	Electric Vehicle Battery Swap System – Part 4 Light Electric Vehicle- Sec 2 Connection System (*under development*)
IS 17896 (Part 4/Sec 3)	Electric Vehicle Battery Swap System – Part 4 Light Electric Vehicle- Sec 3 Communication Protocol (*under development*)
IS/IEC 60529 : 2001	Degrees of protection provided by enclosures (IP Code)
IEC 60364-4-41:2005	Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock
IEC 60364-5-54:2011	Low-voltage electrical installations - Part 5-54: Selection and erection of electrical equipment - Earthing arrangements and protective conductors
IEC 61140:2016	Protection against electric shock - Common aspects for installation and equipment
ISO 11898-1:2015	Road vehicles — Controller area network (CAN) — Part 1: Data link layer and physical signalling
AIS-004(Part 3):2009	Automotive Vehicles –Requirements for Electromagnetic Compatibility
AIS-156:2020	Specific Requirements for L Category Electric Power Train Vehicles
CISPR 11:2015 +AMD1:2016 +AMD2:2019	Industrial, Scientific and Medical Equipment - Radio-frequency disturbance characteristics - Limits and Methods of Measurement

3 TERMINOLOGY

For the purpose of this standard, the following definitions in addition to those given in IS 17896 (Part 1) shall apply.

3.1 Battery as a Service (BaaS) Outlet

An installation that provides a removable battery swap service for electric vehicles

3.2 Battery Charging Station (BCS)

A unit in the BaaS Outlet through which the discharged batteries can be swapped with charged batteries. A BaaS Outlet can have more than one BCS or BSS.

3.3 Swappable Battery System Coupler/Connector
SBS Coupler/Connector

dedicated coupler for connecting a swappable battery system to an electric vehicle or to BSS.

3.4 Supply Equipment for Battery Swap Systems

Equipment intended for supply of energy for BSS consisting of power converter unit (PCU); control system (for example, EMS); battery dock; battery storage etc.

3.4 Digital Communication

The digitally encoded information exchanged between a SBS and BSS/electric power train vehicles of category L, E-Rickshaw/E-Cart and Quadricycles (in this standard, referred to as 'vehicle/EV'), as well as the method by which it is exchanged.

3.5 Rechargeable Electrical Energy Storage System (REESS) —

the rechargeable energy storage system that provides electric energy for electric propulsion.

A battery whose primary use is to supply power for starting the engine and/or lighting and/or other vehicle auxiliaries systems is not considered as a REESS.

NOTE — Primary use in this context means that more than 50% of the energy from the battery is used for starting the engine and/or lighting and/or other vehicle auxiliaries systems over an appropriate driving cycle, for example, IDC.)

The REESS may include subsystem(s) together with the necessary ancillary systems for physical support, thermal management, electronic control and enclosures.

NOTE – Battery pack and REESS are used interchangeably in the standard.

3.6 Power Converter Unit (PCU)

Power converter, local EMS and communication interface.

3.7 Controlled Current Charging (CCC)

power transfer method in which a battery swap system adjusts the charging current in accordance with the current value commanded by the swappable battery system

3.8 Capacity

total number of ampere-hours that can be drawn from a fully charged battery under specified conditions.

3.9 Capacity in Wh

total number of Watt-hours that can be drawn from a fully charged battery under specified conditions

3.10 Rated Capacity

total number of ampere-hours specified by supplier that can be drawn from a fully charged battery pack or system under specified set of test conditions such as discharge rate, temperature, discharge cut-off voltage, etc.

3.11 State of Charge (SOC)

available capacity in a battery pack or system expressed as a percentage of rated capacity.

3.12 Room Temperature (RT)

An ambient temperature of (25±2) °C

3.13 Maximum Working Voltage
highest value of a.c. voltage (rms) or of d.c. voltage which can occur in an electrical system under normal operating conditions according to the manufacturer's specifications.

3.14 Voltage Class A
classification of an electric component or circuit with a maximum working voltage of ≤ 30 V a.c. or ≤ 60 V d.c., respectively

Note – For more details, *see* ISO 6469-3.

3.15 Voltage Class B
classification of an electric component or circuit with a maximum voltage of (>30 and ≤1 000) V a.c. or (> 60 and ≤1 500) V d.c. respectively.

3.16 Ingress Protection code (IP Code)
coding system to indicate the degrees of protection provided by an enclosure against access to hazardous parts, ingress of solid foreign objects, ingress of water and to give additional information in connection with such protection.

3.17 Vehicle Identification Number (VIN)

A unique code, including a serial number used to identify individual motor vehicles as defined in ISO 3779 (content and structure) and ISO 4030 (location and attachment).

3.18 Battery Identification Number (BIN)

A unique code to identify the EV battery pack, indicating country, manufacturer, factory and line number in the factory, production date, serial number and battery type.

3.19 BaaS Outlet Number (BON)

A unique code to identify the Battery as a Service outlet for LEV indicating the BaaS outlet, country code, state code, district code and Identification number.

3.20 Battery Charging Station Number (BCSN)

A unique code to identify the Battery Swap Station indicating the charging station identifier, country code, state code, district code and identification number.

VIN	Vehicle Identification Number
BIN	Battery Identification Number
BON	BaaS Outlet Number
BCSN	Battery Charging Station Number

4 SYSTEM OVERVIEW

4.1 General

BSS shall include the following:

a) a storage system;
b) a charging system; and
c) a supervisory and control system.

Supporting system shall include the following:

a) a power supply system; and
b) a telecommunication system.

The swapping of battery packs shall be through manual means.

Suitable safety measures shall be ensured to place compatible chemistry battery packs in EV.

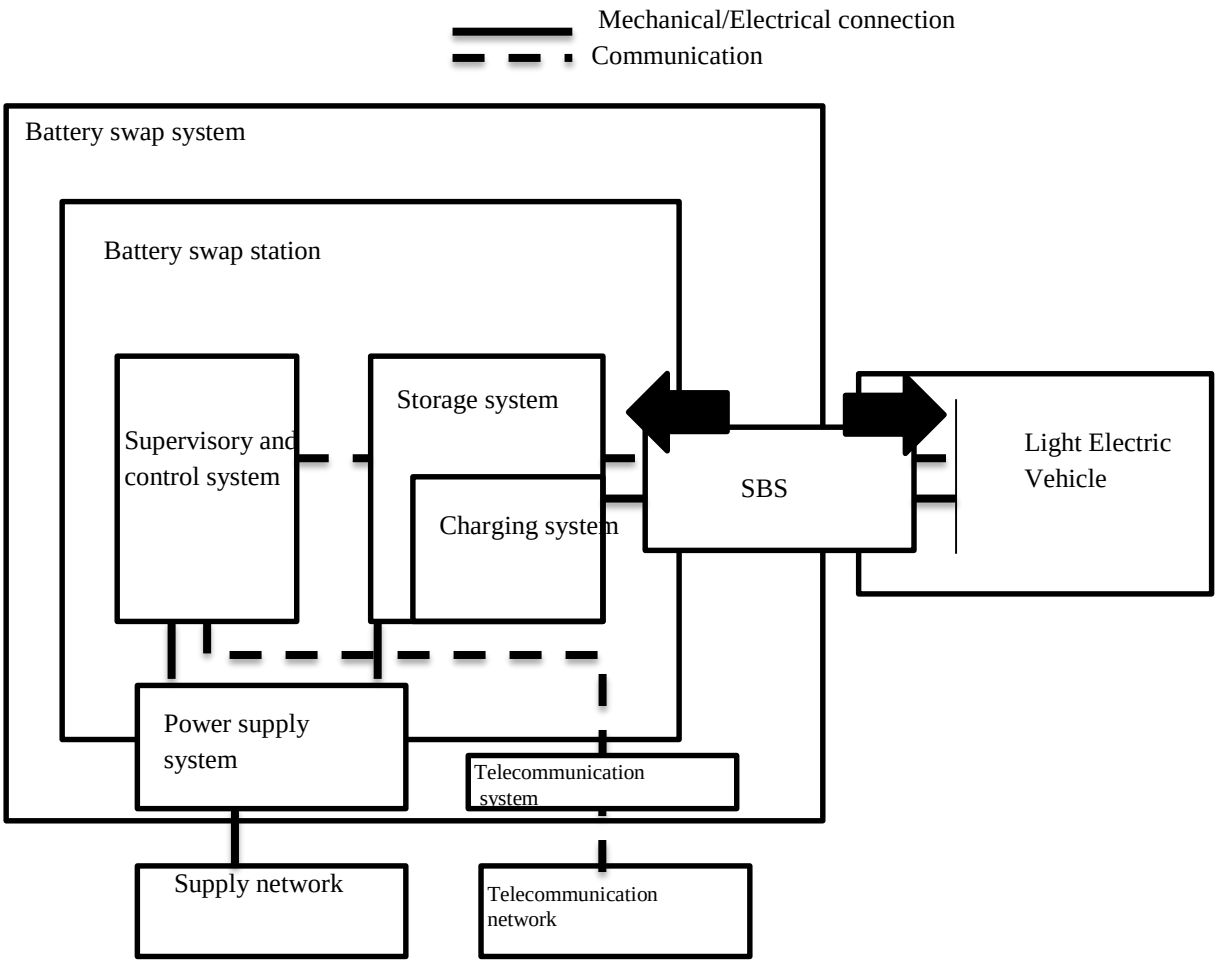


FIG. 1 – OUTLINE OF BATTERY SWAP SYSTEM

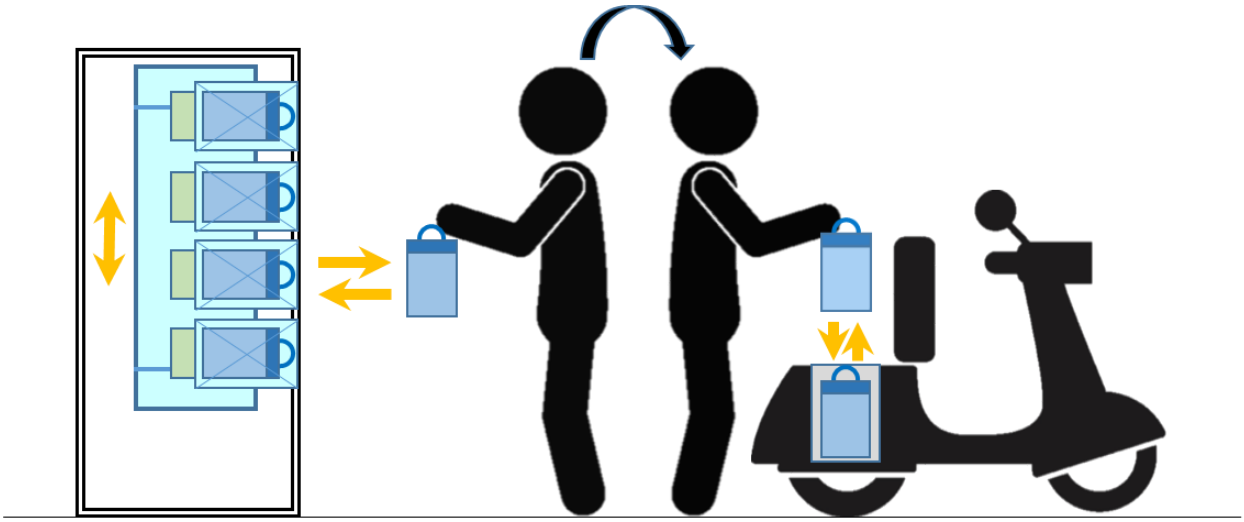


FIG. 2 – TYPICAL EXAMPLE OF MANUAL BATTERY SWAPPING

5 REQUIREMENTS OF BATTERY SWAP STATION

5.1 Rated voltage and rated current

The Battery Swap Station shall be designed for rated supply voltage of 415 V a.c.; 50 Hz or upto 400 V d.c. For ac input supply, supply cord and plug shall have suitable current rating to deliver maximum rated power.

The rated output voltage of Battery Swap Station for each swappable battery system (SBS) shall be 60 V d.c. The charge current to drawn shall be specified by the manufacturer.

5.2 Safety Requirements

5.2.1 *Protection against Electric Shock*

The battery swap station shall provide adequate protection against electric shock from direct contact and indirect contact. Relevant clauses of 1S 16504(Part 1)/IEC 60204-1 shall be applicable.

The fundamental rule of protection against electric shock is provided by IEC 61140, which covers both electrical installations and electrical equipment.

This requirement needs to apply under:

a) normal conditions

b) single fault condition

For power supply equipment intended for fixed installation, the requirements specified in IEC 60364-7-722 shall be applicable.

For BCS, relevant clauses of IS 17017(Part 1):2018 and IS 17017 (Part 23):2018 shall be applicable.

5.2.2. *Ingress Protection*

5.2.2.1 *Ingress Protection for the enclosures*

Enclosures of the Battery Swap Station shall have an IP degree at least:

i) for indoor use – IP21C; and
ii) for outdoor use – IP44C.

Compliance is checked by test in accordance with IS/IEC 60529: 2001.

5.2.2.2 *IP degrees for connectors other than battery system connections*

Connectors of the Battery Swap Station other than battery system connections shall have an IP degree at least:

i) for indoor use – IP21B; and
ii) for outdoor use – IP44B.

Compliance is checked by test in accordance with IS/IEC 60529: 2001

5.2.3 *Fault Protection*

Fault protection shall consist of one or more recognized provision(s).

Battery Swap Station shall have following provisions:

a) automatic disconnection of supply as per 411 of IEC 60364-4-41:2005;
b) double or reinforced insulation as per 412 of IEC 60364-4-41:2005;
c) electrical separation for the supply of one item of current-using equipment as per 413 of IEC 60364-4-41:2005; and
d) extra-low-voltage (SELV and PELV) as per 414 of IEC 60364-4-41:2005.

5.2.4 *Protective Earth Conductor*

For Battery Swap System(BSS), a protective conductor shall be provided to establish an equipotential connection between the earthing terminal of the mains supply and the exposed conductive parts of the system.

This protective conductor shall be of sufficient rating in accordance with the requirements of IEC 60364-5-54.

5.3 Interface Requirements

5.3.1 *Interface connecting to Battery*

Typical interface requirement for basic communication on battery charging/discharging systems shall be as per Annex A.

The system shall carry out control pilot function through control pilot conductors and terminals specified in IS 17896(Part 4/Sec 2) (*under development*).

The storage system shall be fitted with a charging connector compatible with SBS coupler/connector as specified in IS 17896(Part 4/Sec 2) (*under development*).

5.3.2 *Interface connecting to CMS*

The interface requirements for connecting telecommunication system of Battery Swap Station to Central Management System(CMS) shall comply with the requirements specified in IS 17896(Part 4/Sec 3) (*under development*).

5.4 Communication Between Swappable Battery System (SBS) and Battery Swap Station/EV

5.4.1 *General*

The digital communication for charging/discharging control between SBS and Battery Swap Station shall comply with the requirements specified in IS 17896(Part 4/Sec 3) (*under development*).

5.4.2 *System Configuration*

The communication between SBS and Battery Swap Station /EV shall be established via basic communication and high-level communications.

Charging / discharging control process, such as start of charging / discharging and normal/emergency shutdown, shall be managed through the basic communication with signal exchange through control pilot lines.

In addition to the basic communication, the battery swap station shall be equipped with digital communication means in order to exchange the control parameters for charging / discharging between the Battery swap station and SBS through the control area network (CAN) over dedicated digital communication circuit according to ISO 11898-1.

5.4.3 *Digital Communication*
Digital communication shall be as specified in IS 17896(Part 4/Sec 3) (*under development*).

5.4.4 *Charging Discharging Control Process and State*
5.4.4.1 *General*

Charging / discharging control process of the Battery swap station shall consist of the following three stages:

a) process before the start of charging / discharging (initialization);
b) process during charging / discharging (energy transfer);
c) process of termination (shutdown).

SBS and Battery Swap Station / EV shall synchronize the control process with each other. The following signals and information shall be used for the synchronization:

a) signals through the control pilot circuit;

b) parameters through the digital communication circuit;
c) measurement values such as voltage and current level of the d.c. charging / discharging circuit.

SBS and Battery Swap Station / EV shall preserve specified time constraints and control timings for ensuring smooth charging control and operation.

Digital communication parameters, formats, and other communication requirements shall be as specified in IS 17896(Part 4/Sec 3) (*under development*).

5.4.4.2 *Initialization (process before the start of charging / discharging)*

In the initialization stage, SBS and Battery Swap Station/EV shall exchange the parameters for charging / discharging control. Circuit voltage shall be measured for checking whether SBS and Battery Swap Station are connected before the start of charging / discharging. The Battery swap station shall not proceed with the next stage of charging / discharging process unless its compatibility with SBS is verified. After compatibility verification, Battery Swap Station and SBS can confirm the power cut-off switch inside SBS.

5.4.4.3 *Energy transfer (process during charging/discharging)*

In this energy transfer stage, SBS shall continues to send a setting value of charging current or chargeable/dischargeable profile of the battery to the EV and/or BSS throughout the charging / discharging process. The parameters for the chargeable/dischargeable profile of the battery shall be as specified in IS 17896(Part 4/Sec 3) (*under development*).

One of the following two algorithms shall be activated/enabled.

i) Chargeable/dischargeable profile of the battery (mainly for the EV):

a.) SBS shall charge/discharge within the range of the chargeable/dischargeable parameters as specified in IS 17896(Part 4/Sec 3) (*under development)* with SBS as master and the EV as slave.
b.) During the whole charging/discharging controlling process, the EV shall receive the chargeable/dischargeable parameters required for SBS.
c.) The EV shall specify a control target as the command value and shall control charging/discharging procedures.
d.) The chargeable/dischargeable parameters from SBS shall be submitted to the EV at certain intervals in accordance with the system requirements.
e.) The EV shall control the charging/discharging parameters responding to the changes of the command values from SBS.

Note- Considering using battery-specific settings value instead of Chargeable/dischargeable parameters of the battery

ii) Required charging current value (mainly for BSS):
a.) SBS shall charge using CCC (Controlled Current Charging) with SBS as master and BSS as slave.

b.) BSS shall receive the charging current value requested by SBS (command value), throughout the charging control process.
c.) BSS shall set the command value as control target and regulate the d.c. charging current.
d.) The command value from SBS shall be notified to BSS at regular intervals according to the system requirements.
e.) BSS shall regulate the d.c. charging current responding to the change of command value of SBS.

5.4.4.4 *Shutdown (process of termination)*

a) Charging / discharging process (mainly for the EV):

Normal shutdown process of the EV occurs either when SBS capacity reaches the specific limit or when a user stops the charging/discharging process by normal shutdown operation. (Vehicle ON/OFF switch)

The emergency shutdown process shall occur under a fault condition. After completion of charging session, the shutdown phase shall allow safe handling of SBS and the EV by user.

On notifying end of charging by SBS, the EV shall reduce the charge /discharge current to zero.

b) Charging process (mainly for BSS)
Normal shutdown shall occur when SBS capacity reaches a certain limit, or when the charging process is stopped by BSS.

Emergency shutdown shall occur under a fault condition.

After completion of charging session, the shutdown phase shall allow safe handling of SBS and BSS by user.

On notifying end of charging by SBS, BSS shall reduce the charge current to zero.

5.5 Communication to CMS

The telecommunication system or telecommunication port of BSS to telecommunication network, if any, shall comply with the requirements specified in IS 17896(Part 3) (*under development*).

5.6 Electromagnetic Compatibility Requirements

Battery Swap Station in charging mode shall be subjected to (applicable) tests as per Table 2:

Table 2–Electromagnetic compatibility requirements
(*Clause* 5.6)

SI. No.	Test	Test Specifications	Performance Criteria	Test Method

1	Electrostatic Discharge (ESD)	±4 kV – Contact Discharge (CD) ±8 kV – Air Discharge (AD)	B	IS 17017 (Part 21/Sec 2)
2	Radiated RF Fields			
2.1	Range 1	10 V/m, 80-1000 MHz, 80% AM (1 kHz)	A	IS 17017 (Part 21/Sec 2)
2.2	Range 2	3 V/m, 1.4-2 GHz, 80% AM (1 kHz)	A	
2.3	Range 3	3 V/m, 2-2.7 GHz, 80% AM (1 kHz)	A	
3	Voltage Dips and Interrupts	40% residual voltage for 10/12 cycles at 50 Hz 70% residual voltage for 25/30 cycles at 50 Hz 0% residual voltage for 1 cycle at 50 Hz 0% residual voltage for 250/300 cycles at 50 Hz	B B B C	IS 17017 (Part 21/Sec 2)
4.	Radio frequency emissions	IS 17017 (Part 21/Sec 2)/ CISPR 11: 2015	Class A limits	IS 17017 (Part 21/Sec 2)

6 REQUIREMENTS OF SWAPPABLE BATTERY SYSTEM

6.1 Dimension, Mass and Rating

Swappable battery system (SBS) shall nominal voltage of 48 V d.c. and maximum working voltage less than or equal to 60V d.c.

Permissible dimensions, mass and capacity of SBS shall be as per Table 3. Figuratively, the dimensions and the placement of SBS coupler/connector is give in Annex C.

Table 3 – Permissible dimensions, mass and capacity of one SBS

(Clause 6.1)

Vehicle Type	Dimensions mm	Minimum Rated Capacity kWh	Maximum Mass kg
All L category	180^{+0}_{-10} (L) X 160^{+0}_{-10} (W) X 310^{+0}_{-20} (H)	1.2	12

NOTE : SPECIFIC COMMENTS FOR INCREASING THE MAXIMUM BATTERY PACK MASS TO 15 KG ARE INVITED BY BIS DG.

6.2 Safety Requirement

SBS shall comply with the requirements of AIS-156. For SBS coupler/connector other than AIS-156, requirements of insertion–extraction test as per Annex B shall be complied with.

6.3 IP Degrees

SBS shall have atleast IP67, according to IS/IEC 60529: 2001.

6.4 Interface

6.4.1 *Interface connecting to EV*

Typical interface requirement for basic communication on battery charging/discharging systems shall be as per Annex A.

The system shall carry out control pilot function through control pilot conductors and terminals specified in IS 17896(Part 4/Sec 2) (*under development*).

The storage system shall be fitted with a charging connector compatible with SBS coupler/connector as specified in IS 17896(Part 4/Sec 2) (*under development*).

6.4.2 *Interface connecting to CMS*

The interface requirements for connecting telecommunication system of BSS to Central Management System(CMS) shall comply with the requirements specified in IS 17896(Part 3) (*under development*).

6.5 Communication between Swappable Battery System (SBS) and EV

The digital communication for charging/discharging control between SBS and EV shall comply with the requirements specified in IS 17896(Part 4/Sec 3) (*under development*).

6.6 Electromagnetic Compatibility Requirements

SBS shall comply with requirements specified in AIS-004(Part 3).

7 MARKING AND INSTRUCTIONS

7.1 Installation Manual of Battery Swap System/ Station

The installation manual along with wiring instructions of battery swap system/ station shall be supplied with each unit. The manual shall indicate installation requirements, the characteristics of protection devices used, explicitly, describing their type and rating. The information may be provided in a detailed electric diagram. The installation manual shall indicate ratings or any other information that denote special (severe or unusual) environmental conditions of use.

7.2 User Manual of Battery Swap System/ Station

Information for user related to operation of battery swap system/ station shall be provided by the manufacturer in a user's manual.

7.3 Marking of Battery Swap System/ Station

The manufacturer shall provide battery swap system/ station with one or more labels, marked in a durable manner and located at place(s) such that they are visible and legible when installed.

a) Manufacturer's name, or trade mark;
b) Type designation or identification number or any other means of identification, making it possible to obtain relevant information from the manufacturer;
c) Date of manufacture;
d) Type of current;
e) Number of phase;
f) Rated voltage (input and output if different)
g) Rated current (input and output if different);
h) Degree of protection;
i) Operating temperature;
j) Country of manufacture;
k) Additional marking such as "Indoor Use Only", or the equivalent, if intended for indoor use only; and
l) Identifiers for compatible SBS and couplers/connectors.

7.4 Marking of Swappable Battery System (SBS)

7.4.1 *Marking Information*

The manufacturer shall provide SBS with label marked in a durable manner and located at place(s) such that they are visible and legible when installed.

a) Manufacturer's name, or trade mark;
b) Type designation as specified in **7.4.2**;
c) Date of manufacture (encoded in dd/mm/yyyy format);
d) rated capacity; and
e) nominal voltage.

Disposal information and recommended charging instructions may be marked or supplied with SBS. It may carry additional digital marking, as agreed between user and supplier.

7.4.2 *Type Designation*

SBS shall be designated in the following order:

N1 A1 A2 A3 N2 / N3 / N4 – N5

where

N1 – number of series connected cells;
A1 – negative electrode with marking
I for carbon;
L for lithium metal or lithium alloy;
T for titanium; and
X for others;
A2 – positive electrode with marking
C for cobalt;
F for iron;
Fp for iron phosphate;
M for manganese;
Mp for manganese phosphate;
N for nickel;
T for titanium;
V for vanadium; and
X for others;
A3 – shape of the cell with marking
R for cylindrical;
P for prismatic;
N2 – maximum diameter (if R) or maximum thickness (if P) rounded up to the next whole number (in mm);

N3 – maximum width (if P) in millimetres rounded up to the next whole number (in mm) (may be eliminated in case of cylindrical cell);

N4 – maximum overall height rounded up to the next whole number (in mm); and

N5 – number of parallel connected cells if more than two.(may not be indicated if value is 1).

ANNEX A
(*normative*)

INTERFACE REQUIREMENTS OF BATTERY SWAP SYSTEM (BSS)

A-1 GENERAL

The annexure provides the specific requirements for the Battery Swap System(BSS), in addition to the general requirements. Battery Swap System shall utilise dedicated CAN communication network for digital communication between Battery Swap Station / EV and SBS for controlling the charging / discharging of swappable battery system(SBS). The SBS coupler/connector configuration shall be as per IS 17896(Part 4/Sec 2)(*under development*). For digital communication, specific details of the communication actions and parameters shall be as per IS 17896(Part 4/Sec 3)(*under development*).

A-2 INTERFACE CIRCUIT DIAGRAM

The interface circuit between Battery Swap Station/EV and SBS for charging / discharging control shall be as per Figure A-1. CAN communication shall be provided for digital communication with SBS charger / EV. Parameters for the interface circuit are specified in table A.1. The terminal layout shall be as per Figure A-2.

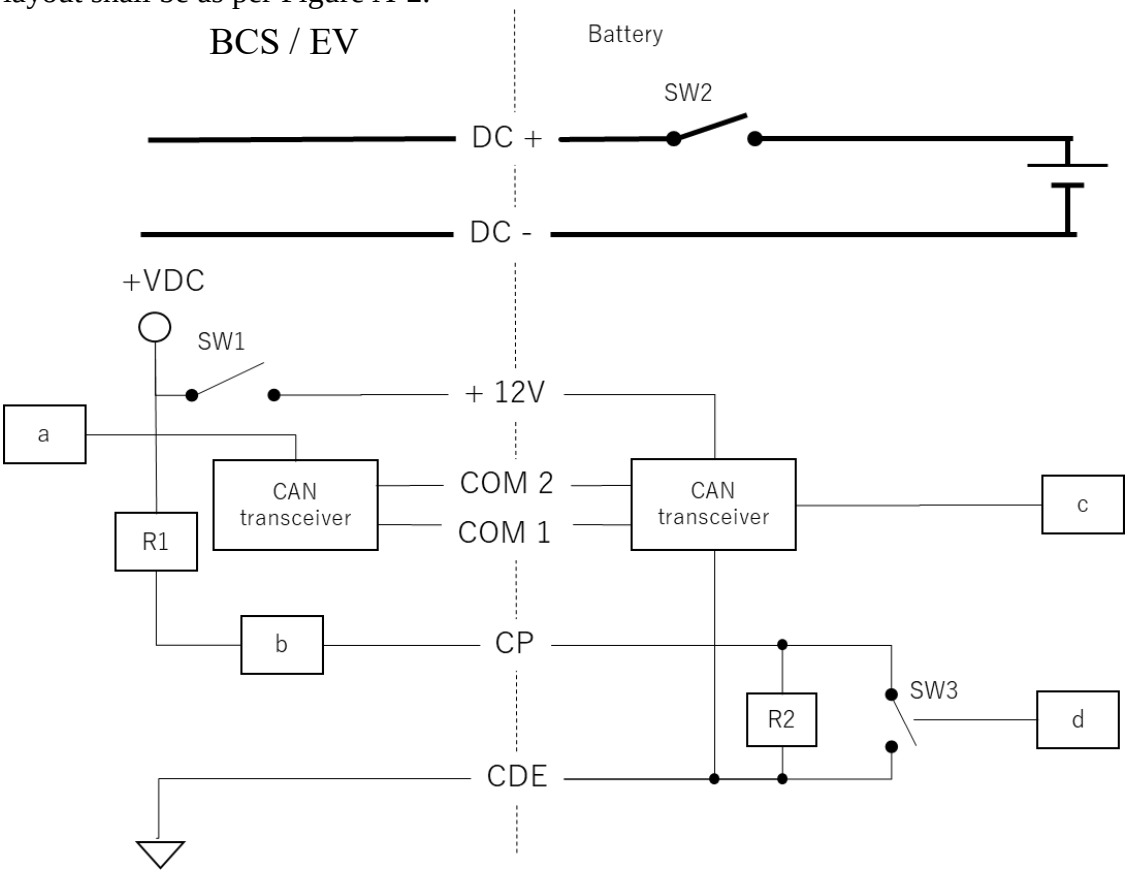
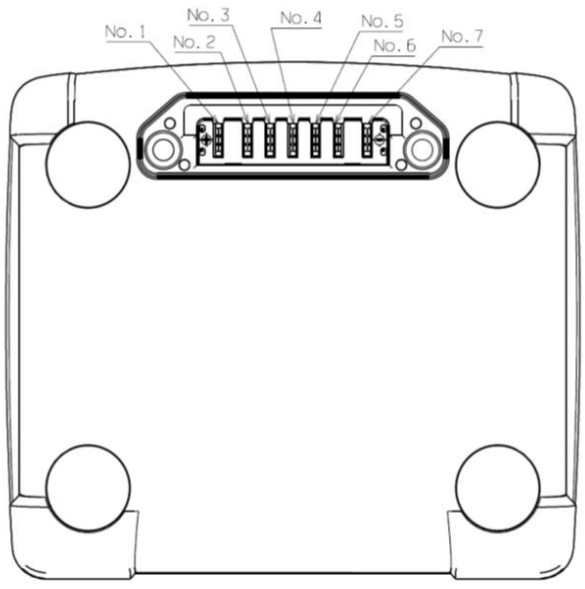


FIG A.1 – INTERFACE CIRCUIT FOR BATTERY SWAP SYSTEM(BSS)

Key		
Battery Swap Station	a	CAN communication
	b	CP voltage sensing
	R1	Resistor
	SW1	+12V Switch
Swappable Battery System (SBS)	SW2	Power Switch
	c	CAN communication
	d	SW3 drive circuit
	R2	Resistor
	SW3	CP Switch
SBS Coupler/Connector	DC +	DC power supply (positive terminal)
	DC -	DC power supply (negative terminal)
	+12V	Battery start/stop signal from BSS
	CP	Battery connection detection Charge start/stop signal
	COM 2 COM 1	CAN communication cables
	CDE	Common Ground between BSS and SBS



	Function
1	DC+
2	+12V
3	CP
4	CDE
5	COM 1
6	COM 2
7	DC-

FIG. A.2 –TERMINAL LAYOUT OF SBS COUPLER/CONNECTOR

Table A.1− Parameters for interface circuit
(Clause A–2*)*

SI. No.	Terminal/Wire	Parameters	Typical value	Unit
1	+12V	＋VDC	12	V
2	CP	R1	1500	Ω
3	CP	R2	1000	Ω

A-2.1 Control Pilot Circuit

The charging states of BSS shall be in accordance with the voltage of control pilot as specified in Table A.2.

Table A.2 – Charge state of BSS and voltage of control pilot circuit
(Clause A–2.1*)*

Charge state	Voltage of control pilot (V)	Status of SW3	Condition of Battery
State A	12	-	Disconnected
State B	5	Off	Connected No energy transfer
State C	0-5 (*pulsed*)	100Hz On-Off	Connected Energy transfer possible
State E	0	On	Connected Abnormal

A-2.2 DC Current Control

A-2.2.1 *Charging Current Control*

Recommended specifications for the output response performance of Battery Swap Station Table A-3

Table A.3− Requirements for the Output Response Performance of Battery Swap Station

(*Clause* A-2.2.1)

Item	**Condition**	**Specification**		
		Minimum	**Maximum**	**Unit**
Output accuracy	Charging current request: 0A to 10A	I – 0.3	I + 0.3	A
	Charging current request: greater than 10A	0.95 X I	1.05 X I	
Control delay to Battery request		—	3	sec

A-2.2.2 *Vehicle Current Control*

Discharging and regeneration of battery system in the EV shall be within the battery specifications.

ANNEX B
(*Clause* 6.2)
(*normative*)

TEST PROCEDURE FOR INSERTION-EXTRACTION OF SBS COUPLER/CONNECTOR

B-1 GENERAL

For SBS coupler/connector other than AIS-156, this insertion–extraction test is carried out to determine their mechanical strength and durability.

B-1 TEST METHOD

B-1.1 Test Procedure

The test shall be performed on the swappable battery system (SBS, *device under test*) and Electric Vehicle. SBS shall be subjected to insertion and extraction in EV for 10,000 cycles of operation at speed recommended by the manufacturer.

The device under test shall be subjected to contamination by dipping into a solution of 5 percent by volume of salt and 5 percent by volume of sand (ISO 12103-A4 – Coarse Grade Test Dust, or the equivalent) suspended in distilled water contained in vessel filled with the solution to a depth of 25 ±5 mm. DUT shall be subjected to exposure to contaminants for a maximum of five seconds after each 1000 cycles of operation and allowed to dry completely by wiping externally before resuming the cycling test.

No adjusting, cleaning, lubricating or conditioning of the DUT contacts shall be carried out during the test duration.

The test may be carried out on the SBS coupler/connector, subject to demonstration that there is no structural change from SBS for performing the test.

B-1.2 Test Requirements

The device under test shall be visually inspected for compliance if:

a) there is no abrasion that affects normal use;
b) there is no detachment of parts;
c) there is no wear or tear that can cause degradation of insulation; and
d) there is no loosening of connections.

ANNEXURE C
(*Clause* 6.1)
(*normative*)
DIMENSIONS OF BATTERY PACK

C-1 DIMENSIONS OF BATTERY PACK

Figure C-1 shows dimensions of a battery pack/system for EV.

Dimensions in millimetres

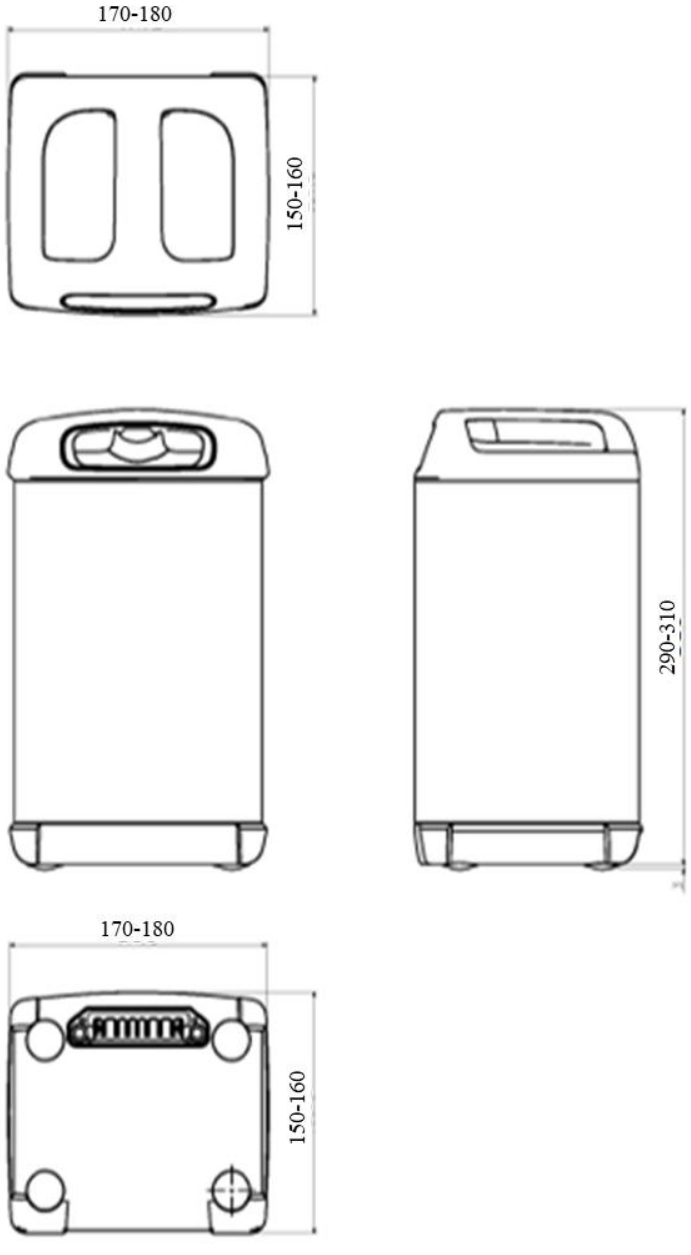


FIG. C-1 — BATTERY PACK DIMENSIONS

ANNEX D

LIST OF ABBREVIATIONS

a.c.	Alternating Current
BCU	Battery Control Unit
BSS	Battery Swap System
C	Capacity, expressed in ampere-hours (A·h)
CAN	Control Area Network
CMS	Central Management System
d.c.	Direct Current
I	Current
REESS	Rechargeable Electrical Energy Storage System
RT	Room temperature
SOC	State of Charge
W	Watt
SBS	Swappable Battery System

ANNEX E

COMMITTEE COMPOSITION

(will be added later)