

AUTOMOTIVE INDUSTRY STANDARD

**Specific Requirements for A6 and A7
Category Electric Power Train
Agricultural Tractors**

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ON BEHALF OF
AUTOMOTIVE INDUSTRY STANDARDS COMMITTEE

UNDER
CENTRAL MOTOR VEHICLE RULES – TECHNICAL STANDING COMMITTEE

SET-UP BY
MINISTRY OF ROAD TRANSPORT & HIGHWAYS
(DEPARTMENT OF ROAD TRANSPORT & HIGHWAYS)
GOVERNMENT OF INDIA

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INTRODUCTION

The Government of India felt the need for a permanent agency to expedite the publication of standards and development of test facilities in parallel when the work of preparation of standards is going on, as the development of improved safety critical parts can be undertaken only after the publication of the standard and commissioning of test facilities. To this end, the erstwhile Ministry of Surface Transport (MoST) has constituted a permanent Automotive Industry Standards Committee (AISC) vide order no. RT-11028/11/97-MVL dated September 15, 1997. The standards prepared by AISC will be approved by the permanent CMVR Technical Standing Committee (CTSC). After approval, The Automotive Research Association of India, (ARAI), Pune, being the secretariat of the AIS Committee, has published this standard. For better dissemination of this information, ARAI may publish this standard on their website.

Electric and hybrid power train are being used in Agricultural tractors also. This standard prescribes the specific requirements for A6 and A7 Category Electric Power Train Agricultural Tractors.

While preparing this standard considerable assistance is derived from following International Standards:

Commission Delegated Regulation (EU) No 3/2014 Of October 24, 2013	Supplementing Regulation (EU) No 168/2013 of the European Parliament and of the Council with regard to vehicle functional safety requirements for the approval of two- or three-wheel vehicles and quadricycles
Regulation (EU) No 167/2013 of The European Parliament and of the Council of February 5, 2013	On the approval and market surveillance of agricultural and forestry vehicles
Commission Delegated Regulation (EU) 2015/208 Of December 8, 2014	Supplementing Regulation (EU) No 167/2013 of the European Parliament and of the Council with regard to vehicle functional safety requirements for the approval of agricultural and forestry vehicles

The AISC panel and the Automotive Industry Standards Committee (AISC) responsible for preparation of this standard are given in Annex 7 and Annex 8 respectively.

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Specific Requirements for A6 and A7 Category Electric Power Train Agricultural Tractors

1.0 SCOPE

- 1.1 This standard specifies the safety requirements for A6 (Hybrid Electric Agricultural Tractor) and A7 (Pure electric Agricultural Tractor) Category Electric Power Train Agricultural Tractors.

2.0 DEFINITIONS

For the purpose of this standard following definitions shall apply. For additional applicable terms, refer AIS-049 (Rev 1):2016, as amended from time to time, AIS 156:2020, as amended from time to time and IS 14272:2011, as amended from time to time.

- 2.1 **‘Active driving possible mode’** means the vehicle mode when application of the electric acceleration position sensor, activation of an equivalent control or release of the brake system will cause the electric powertrain to propel the vehicle.
- 2.2 **‘Barrier’** means the part providing protection against direct contact to the live parts from any direction of access.
- 2.3 **‘Conductive connection’** means the connection using connectors to an external power supply when the rechargeable electrical energy storage system (REESS) is charged.
- 2.4 **‘Coupling system for charging the REESS’** means the electrical circuit used for charging the REESS from an external electric power supply including the vehicle inlet.
- 2.5 **‘Chassis connected to the electric circuit’** means AC and DC electric circuits galvanically connected to the electrical chassis.
- 2.6 **‘Control’** means any part of the vehicle or component directly actuated by the driver which causes a change in the state or operation of the vehicle or one of the parts thereof.
- 2.7 **‘Direct contact’** means the contact of persons with live parts.
- 2.8 **‘Electrical chassis’** means a set made of conductive parts electrically linked together, whose potential is taken as reference.
- 2.9 **‘Electrical circuit’** means an assembly of connected live parts which is designed to be electrically energised in normal operation.
- 2.10 **‘Electric energy conversion system’** means a system that generates and provides electric energy for electric propulsion.

- 2.11 **‘Electric powertrain’** means the electrical circuit which includes the traction motor(s), and includes the REESS, the electric energy conversion system, the electronic converters, the associated wiring harness and connectors, and the coupling system for charging the REESS.
- 2.12 **‘Electronic converter’** means a device capable of controlling and/or converting electric power for electric propulsion.
- 2.13 **‘Enclosure’** means the part enclosing the internal units and providing protection against direct contact from any direction of access.
- 2.14 **‘Exposed conductive part’** means the conductive part which can be touched under the provisions of the protection degree IPXXB, and which becomes electrically energised under isolation failure conditions.
- 2.15 **‘External electric power supply’** means an alternating current (AC) or direct current (DC) electric power supply outside of the vehicle.
- 2.16 **‘High voltage’** means the classification of an electric component or circuit, if its working voltage is $> 60 \text{ V}$ and $\leq 1\,500 \text{ V DC}$ or $> 30 \text{ V}$ and $\leq 1\,000 \text{ V AC}$ root mean square (rms).
- 2.17 **‘High voltage bus’** means the electrical circuit, including the coupling system for charging the REESS that operates on high voltage.
- 2.18 **‘Indirect contact’** means the contact of persons with exposed conductive parts.
- 2.19 **‘Live parts’** means the conductive part(s) intended to be electrically energised in normal use.
- 2.20 **‘Operator’s work place’** means the space in the tractor for operator accommodation bounded by the barriers and enclosures provided for protecting the powertrain from direct contact with live parts.
- 2.21 **‘On-board isolation resistance monitoring system’** means the device which monitors the isolation resistance between the high voltage buses and the electrical chassis.
- 2.22 **‘Open type traction battery’** means a liquid type battery requiring refilling with water and generating hydrogen gas released to the atmosphere.
- 2.23 **‘Protection degree’** means the protection provided by a barrier or enclosure related to the contact with live parts by a test probe, such as a jointed test finger (IPXXB) or a test wire access probe (IPXXD).
- 2.24 **‘Service disconnect’** means the device for deactivation of the electrical circuit for the purpose of servicing or checking electrical components such as the REESS and fuel cell stack.

- 2.25 **‘Solid insulator’** means the insulation coating of wiring harnesses insulating live parts against direct contact from any direction of access, covers insulating live parts of connectors, as well as varnish or paint applied for the purpose of insulation.
- 2.26 **‘Working voltage’** means the highest value of an electrical circuit voltage root-mean-square (rms) as specified by the vehicle manufacturer for each separate and galvanically isolated circuit, which may occur between any conductive parts in open circuit conditions or under normal operating condition.
- 2.27 **‘Agricultural tractor type’**, with regard to maximum continuous rated or net power and/or vehicle speed limitation by design, means vehicles which do not differ in such essential respects as the maximum continuous power output of the electric motor(s) and/or engine, the vehicle maximum design speed and the design characteristics of devices and methodology employed to effectively limit the vehicle’s achievable maximum speed and/or power output.
- 2.28 **‘Functional safety’** means the absence of unacceptable risk of physical injury or of damage to the health of persons or to property owing to hazards caused by mal-functional behaviour of mechanical, hydraulic, pneumatic, electrical or electronic systems, components or separate technical units.
- 2.29 **‘REESS’** means the rechargeable electric energy storage system (REESS) that provides energy for electric propulsion.
- 2.30 **"State of Charge (SOC)"** means the available electrical charge in a tested-device expressed as a percentage of its rated capacity.
- 2.31 **‘Type of Agricultural tractor with regard to electrical safety’** means vehicles which do not differ in such essential respects as the location of conducting parts and components of the entire electrical system installed in the vehicle, the installation of the electric powertrain and the galvanically connected high voltage bus as well as the nature and type of electric powertrain and the galvanically connected high voltage components.
- 2.32 **"Type of REESS"** means systems which do not differ significantly in such essential aspects as:
- (a) The manufacturer's trade name or mark;
 - (b) The chemistry, capacity and physical dimensions of its cells;
 - (c) The number of cells, the mode of connection of the cells and the physical support of the cells;
 - (d) The construction, materials and physical dimensions of the casing; and
 - (e) The necessary ancillary devices for physical support, thermal management and electronic control.

3.0 APPLICATION FOR APPROVAL OF AGRICULTURAL TRACTORS

- 3.1. Approval of an Agricultural Tractors type with regard to its electrical safety, including the High Voltage System:
 - 3.1.1. The application for approval of an Agricultural Tractors type with regard to specific requirements for the electric power train shall be submitted by the vehicle manufacturer or by his duly accredited representative.
 - 3.1.2. It shall be accompanied by the technical specifications in AIS 007 format and following particulars in Annex 5 format:
 - 3.1.2.1. Detailed description of the Agricultural Tractors type as regards the electric power train and the galvanically connected high voltage bus.
 - 3.1.2.2. For Agricultural Tractors with REESS, additional evidence showing that the REESS is in compliance with the requirements of paragraph 6 of this standard.
 - 3.1.3. An Agricultural Tractor's representative of the tractor type to be approved shall be submitted to the Test Agency responsible for conducting the approval tests and, if applicable, at the manufacturer's discretion with the agreement of the Test Agency, either additional vehicle(s), or those parts of the vehicle regarded by the Test Agency as essential for the test(s) referred to in the paragraph 6 of this standard.

4.0 APPLICATION FOR APPROVAL OF REESS

- 4.1. Approval of a Rechargeable Electrical Energy Storage System (REESS)
 - 4.1.1. The application for approval of a type of REESS or separate technical unit with regard to the safety requirements of the REESS shall be submitted by the REESS manufacturer or by their duly accredited representative.
 - 4.1.2. It shall be accompanied by the technical specifications in AIS 007 and Annex 6 format and comply with the following particulars:
 - 4.1.2.1. Detailed description of the type of REESS or separate technical unit as regards the safety of the REESS.
 - 4.1.3. A component(s) representative of the type of REESS to be approved plus, at the manufacturer's discretion, and with the agreement of the Test Agency, those parts of the Agricultural Tractor regarded by the Test Agency as essential for the test, shall be submitted to the Test Agency responsible for conducting the approval tests.

5.0 REQUIREMENTS REGARDING ELECTRICAL SAFETY

- 5.1 Requirements for the approval of a type of Agricultural Tractor with regard to electrical safety:
- 5.1.1 Agricultural Tractors which are propelled by means of one or more electric motors, including pure and hybrid electric agricultural tractors, shall fulfil the requirements of this clause.
- 5.2 General requirements concerning the protection against electrical shock and electrical safety applying to high voltage buses under conditions where they are not connected to external high voltage power supplies.
- 5.2.1 The protection against direct contact with live parts shall comply with the requirements set out below. The protections provided (e.g. solid insulator, barrier, enclosure) shall not be able of being opened, disassembled or removed without the use of tools.
- The protection against access to live parts shall be tested in accordance with the provisions laid down in Annex 3 of this standard — Protection against direct contacts of parts under voltage.
- 5.2.1.1 For protection of live parts in operator's work place, the protection degree IPXXD shall be met.
- 5.2.1.2 For protection of live parts in areas other than the operator's work place, the protection degree IPXXB shall be met.
- 5.2.1.3 For protection of live parts of vehicles where no operator's work place is present, the protection degree IPXXD shall be met by the entire vehicle.
- 5.2.1.4 Connectors (including vehicle inlet) are deemed to meet the requirements if:
- (a) They also comply with the protection degree IPXXB when separated without the use of tools;
 - (b) They are located underneath the vehicle floor and are provided with a locking mechanism (e.g. screw locking, bayonet locking);
 - (c) They are provided with a locking mechanism and other components shall first be removed with the use of tools in order to separate the connector; or
 - (d) The voltage of the live parts becomes \leq DC 60 V or \leq AC 30 V (rms) within one second after the connector is separated.
- 5.2.1.5 In case a service disconnect can be opened, disassembled or removed without the use of tools, the protection degree IPXXB shall be met under all these conditions.

5.2.1.6 Specific marking requirements

- 5.2.1.6.1 In the case of a REESS having high voltage capability, the symbol shown in Figure 1 shall be placed on or near the REESS. The symbol background shall be yellow, the bordering and the arrow shall be black.

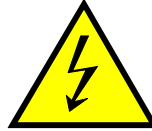


Figure 1
Marking of high voltage equipment

- 5.2.1.6.2 The symbol shall in addition be placed on all enclosures and barriers, which when removed expose live parts of high voltage circuits. This provision is optional for connectors for high voltage buses and does not apply to any of the following cases:
- (a) Where barriers or enclosures cannot be physically accessed, opened, or removed unless other vehicle components are removed with the use of tools; or
 - (b) Where barriers or enclosures are located underneath the vehicle floor.
- 5.2.1.6.3 Cables for high voltage buses, which are located fully within enclosures or outside any enclosures, shall be identified by having an outer covering with the colour orange.
- 5.2.2 The protection against indirect contact with live parts shall comply with the requirements set out below.
- 5.2.2.1 Concerning protection against electrical shock which could arise from indirect contact, the exposed conductive parts, such as the conductive barrier and enclosure, shall be securely galvanically connected to the electrical chassis for instance by connections with electrical wire, ground cable, welds or by connections using bolts so that no dangerous electric potential can exist.
- 5.2.2.2 The resistance between all exposed conductive parts and the electrical chassis shall be lower than 0.1Ω when there is current flow of at least 0.2 A . This requirement is deemed as satisfied if the galvanic connection has been established by welding.
- 5.2.2.3 In the case of vehicles intended to be connected to a grounded external electric power supply through a conductive connection, a device enabling the galvanic connection of the electrical chassis to the earth ground shall be provided.

The device shall enable connection to the earth ground before external voltage is supplied to the vehicle and shall retain this connection until after the exterior voltage is removed from the vehicle.

Compliance with these requirements may be demonstrated by using the connector specified by the agricultural tractor manufacturer or by other analysis.

5.2.2.3.1 A galvanic connection of the electrical chassis to the earth ground does not need to be provided in the following cases:

- (a) The agricultural tractor can only use a dedicated charger that is protected when any single isolation fault arises;
- (b) The agricultural tractor's whole metallic body is protected when any single isolation fault arises; or
- (c) The agricultural tractor cannot be charged without completely removing the traction battery pack from the vehicle.

5.2.3 Isolation resistance shall comply with the requirements set out below.

5.2.3.1 Concerning electric power trains consisting of separate DC or AC-buses:

If AC buses and DC buses are galvanically isolated from each other, isolation resistance between all high voltage busses and the electrical chassis shall have a minimum value of 100 Ω/V of the working voltage for DC buses, and a minimum value of 500 Ω/V of the working voltage for AC buses.

The measurements shall be conducted in accordance with the provisions laid down in Annex 1 of this standard — Isolation resistance measurement method.

5.2.3.2 Concerning electric power train consisting of combined DC- and AC-buses:

If AC high voltage buses and DC high voltage buses are galvanically connected isolation resistance between all high voltage busses and the electrical chassis shall have a minimum value of 500 Ω/V of the working voltage.

However, if all AC high voltage buses are protected by one of the two following measures, isolation resistance between the high voltage bus and the electrical chassis shall have a minimum value of 100 Ω/V of the working voltage:

- (a) Double or more layers of solid insulators, barriers or enclosures that meet the requirements of points 5.2.1 to 5.2.1.6.3 independently, for example wiring harness; or
- (b) Mechanically robust protections that have sufficient durability over vehicle service life such as motor housings, electronic converter cases or connectors;

The isolation resistance between the high voltage bus and the electrical chassis shall be demonstrated by measurement.

The measurement shall be conducted according to Annex 1 of this standard - Isolation resistance measurement method.

5.2.3.3 Concerning Fuel cell Agricultural Tractors:

If the minimum isolation resistance requirement cannot be maintained over time, then protection shall be achieved by any of the following:

- (a) Double or more layers of solid insulators, barriers or enclosures that meet the requirements of points 5.2.1 to 5.2.1.6.3 independently; or
- (b) on-board isolation resistance monitoring system together with a warning to the driver if the isolation resistance drops below the minimum required value. The isolation resistance between the high voltage bus of the coupling system for charging the REESS, which is not energised besides during charging the REESS, and the electrical chassis need not be monitored.

The correct functioning of the on-board isolation resistance monitoring system shall be tested as described in Annex 2 of this standard — Confirmation method for function of on-board isolation resistance monitoring system.

5.2.3.4 Isolation resistance requirements for the coupling system for charging the REESS.

The vehicle inlet or the recharge cable when permanently connected to the vehicle, intended to be conductively connected to the grounded external AC power supply and the electrical circuit that is galvanically connected to the vehicle inlet/recharge cable during charging of the REESS, shall have an isolation resistance between the high voltage bus and the electrical chassis of at least 1.0 M Ω when the charger coupler is disconnected. During the measurement, the traction battery may be disconnected.

5.3 Requirements concerning the REESS

5.3.1 Protection in case of excessive current.

The REESS shall not overheat in case of excessive current or, if the REESS is prone to overheating due to excessive current, it shall be equipped with one or more protective devices such as fuses, circuit breakers and/or main contactors.

When applicable, the agricultural tractor manufacturer shall supply relevant data and analysis proving that overheating from excessive current is prevented without the use of protective devices.

- 5.3.2 Prevention of accumulation of gas.
- Places for containing open type traction battery that may produce hydrogen gas shall be provided with a ventilation fan or a ventilation duct or any other suitable means to prevent the accumulation of hydrogen gas. Vehicles with open type framework that do not allow accumulation of hydrogen gas at such places are not required to have a ventilation fan or a ventilation duct.
- 5.3.3 Protection against electrolyte spills.
- Electrolyte from the REESS, shall not spill from the agricultural tractor in its normal operation and during all the tests as per this standard.
- In case electrolyte is spilled from the REESS or its components due to other reasons, it shall not reach the driver nor any person on or around the agricultural tractor during normal conditions of use, parked condition (i.e. also when the agricultural tractor is parked on a slope) or any other normal functional operation.
- 5.3.4 Accidental or unintentional detachment.
- The REESS and its components shall be installed in the agricultural tractor in such a way so as to preclude the possibility of inadvertent or unintentional detachment or ejection of the REESS.
- The REESS and its components shall not be ejected when the agricultural tractor in its normal operation and any of the test as per this standard.
- 5.4 In-use safety requirements
- 5.4.1 Propulsion system power-on and power-off procedure
- 5.4.1.1 At the start-up, including system power-on, in order to select the active driving possible mode, at least two deliberate and distinctive actions shall be performed by the driver.
- 5.4.1.2 At least a momentary indication shall be given to the rider when the agricultural tractor is switched in active driving possible mode, however, this provision does not apply under conditions where an internal combustion engine provides directly or indirectly the agricultural tractor's propulsion power.
- 5.4.1.3 When leaving the agricultural tractor, the rider shall be informed by a signal (e.g. optical or audible signal) if the agricultural tractor is still in the active driving possible mode.
- 5.4.1.4 If the on-board REESS can be externally charged by the driver, agricultural tractor movement by its own propulsion system shall be impossible as long as the connector of the external electric power supply is physically connected to the agricultural tractor inlet. Compliance with this requirement shall be demonstrated by using the connector specified by the agricultural tractor manufacturer.

In case of permanently connected charge cables, the requirement above is deemed to be met when use of the charge cable obviously prevents the use of the agricultural tractor (e.g. cable is always routed over operator controls, rider's saddle, driver's seat, handle bar or steering wheel, or the seat covering the cable storage space needs to remain in open position).

5.4.1.5 If an agricultural tractor is equipped with a drive direction control unit (i.e. reversing device) the state of this unit shall be identified to the rider.

5.4.1.6 It is permitted that only one action is required to deactivate the active driving possible mode or to complete the power-off procedure.

5.4.2 Driving with reduced power

5.4.2.1 Indication of reduced power

If the electric propulsion system is equipped with a means to automatically reduce the agricultural tractor propulsion power (e.g. powertrain malfunction operating mode), significant reductions shall be indicated to the rider.

5.4.2.2 Indication of low energy content of REESS

If the state of charge in the REESS has a significant impact on agricultural tractor driving performance (i.e. acceleration and drivability, to be evaluated by the Test Agency together with the tractor manufacturer), a low energy content shall be indicated to the rider by an obvious device (e.g. a visual or audible signal). The indication used for point 5.4.2.1 shall not be used for this purpose.

5.4.3 Driving backwards

It shall not be possible to activate the agricultural tractor reverse control function in an uncontrolled manner whilst the tractor is in forward motion, insofar as such activation could cause a sudden and strong deceleration or wheel lock. However, it may be possible for the vehicle reverse control function to be activated in such a way that it may slow down the vehicle gradually.

5.4.4 Determination of hydrogen emissions

5.4.4.1 This verification shall be carried out on agricultural tractor equipped with open type traction batteries and all requirements shall be met.

5.4.4.2 Agricultural tractor shall be equipped with on-board chargers. The tests shall be conducted following the method described in Annex 8 to AIS 038 (Rev. 2), The hydrogen sampling and analysis shall be the ones as prescribed, however, other analysis methods may be used provided that it can be demonstrated that these give equivalent results.

- 5.4.4.3 During a normal charge procedure under the conditions given in Annex 8 to AIS 038 (Rev. 2), hydrogen emissions shall be $< 125 \text{ g}$ measured over 5 hours, or below $(25 \times t^2)$ (g) during t^2 (h).
- 5.4.4.4 During a charge carried out by an on-board charger presenting a failure (conditions given in Annex 8 to AIS 038 (Rev 2), hydrogen emissions shall be below 42 g. Furthermore the on-board charger shall limit this possible failure to 30 minutes.
- 5.4.4.5 All the operations linked to the REESS charging shall be controlled automatically, included the stop for charging.
- 5.4.4.6 It shall not be possible to manually override the charging phases.
- 5.4.4.7 Normal operations of connection and disconnection to the mains or power cuts shall not affect the control system of the charging phases.
- 5.4.4.8 Charging failures that can lead to a malfunction of the on-board charger during subsequent charging procedures shall be permanently signalled to the driver or clearly indicated to the operator about to commence a charging procedure.
- 5.4.4.9 Detailed instructions concerning the charging procedure and a statement of conformity to the requirements as set out in points 5.4.4.1 to 5.4.4.8 shall be included in the agricultural tractor's instruction manual.
- 5.4.4.10 Test results obtained from other agricultural tractor types common to those within the same family, in accordance with the provisions laid down in Appendix 2 of Annex 8 to standard AIS 038 (Rev. 2), may be applied.

5.5 Protection against Water Effects

The test as per 5.5.1, 5.5.2 and 5.5.3 shall be performed. After each exposure (tractor still wet), the agricultural tractor shall then comply with the isolation resistance test with at least $100 \Omega/\text{V}$ of nominal voltage, but keeping the power equipment connected to the REESS (main switch closed), and before water test isolation resistance with at least $500 \Omega/\text{V}$ of nominal voltage.

These tests shall not apply to agricultural tractors having chassis connected electrical circuits where the maximum voltage between any live part and the electrical chassis or any exposed conductive part does not exceed 30V AC (rms) or 60 V DC.

5.5.1 Washing

This test is intended to simulate a normal washing of electric power train agricultural tractors, but not specific cleaning using high water pressure or underbody washing. The tractor manufacturer shall specify detailed conditions for such specific cleaning or washing in the owner's manual. The critical areas of the tractor regarding this test are border lines i.e. a seal of two parts as flaps, glass seals, outline of opening parts, outline of front grille, seals of lamps.

In the case of open tractors such as, without doors and windows, the manufacturer shall specify the procedure for normal washing also. In such cases, the washing test shall be conducted by taking into account the above recommendation.

The test uses a hose nozzle according to IPX5 as specified in IEC 60529 (Refer Annex-4 of this standard). Using fresh water with a flow rate of 12.5 l/min, all borderlines shall be exposed and followed in all directions with the water stream at a speed rate of 0.1 m/s, keeping a distance of 3 m between the nozzle aperture and the borderline.

5.5.2 Flooding

This test is intended to simulate the driving of an Electric Power Train tractors on flooded streets or in water puddles.

The tractor shall be driven in a wade pool, with water depth equivalent to from centre of front axle of tractor, over a distance of 500 m at a speed of 20 km/h or maximum speed whichever is lower.

If the wade pool used is less than 500 m in length, so that it has to be driven through several times, the total time including the periods outside the wade pool shall be less than 10 min.

5.5.3 Heavy Rainstorm

This test is intended to simulate a sudden heavy rainstorm e.g. a thunderstorm, when opening parts especially to access to the operator's work place, load and motor compartments are open except those requiring one or more tools.

In case of voltage class B equipment shielded from exposure to water, this test of the whole tractor may be replaced by equivalent tests on the components individually.

The critical areas of the tractor regarding this test are those accessible with opened opening parts. This test uses a spray nozzle according to IPX3 as specified in IEC 60529.

Using fresh water with a flow rate of 10 l/min, all surfaces with normally open opening parts shall be exposed for 5 min, possibly through a regular movement of the spray nozzle.

Note: Voltage class B equipment is an equipment with nominal voltage (U)

DC: $60 \text{ V} < U \leq 1500 \text{ V}$

AC: $30 \text{ V rms} < U \leq 1000 \text{ V rms} - 15 \text{ to } 150 \text{ Hz}$

6.0 REQUIREMENTS OF A RECHARGEABLE ELECTRICAL ENERGY STORAGE SYSTEM (REESS) WITH REGARD TO ITS SAFETY

REESS shall meet the requirements of Part II of AIS-156 standard.

7.0 TRACTION MOTOR POWER TEST

7.1 Motor Power Test: Test shall be carried out as per AIS-041(Rev 1):2015 using Bench Dynamometer Procedure.

7.2 Tractor Manufacture shall declare maximum PTO power as per IS 12036 standard, in technical specifications as per AIS 007 format and in Annex 5 format of this standard.

8.0 EMC TEST

8.1 The Rechargeable Energy Storage System (REESS) of tractor shall be charged according to the following normal overnight charge procedure.

- a) With the on-board charger, if fitted,
- b) With an external charger recommended by the manufacturer using the charging pattern prescribed for normal charging,
- c) In an ambient temperature comprised between $20 \text{ }^\circ\text{C}$ and $30 \text{ }^\circ\text{C}$.

The procedure excludes all type of special charges that could be automatically or manually initiated like, for instance, the equalization charges or the servicing charges. The tractor manufacturer shall declare that during the test, a special charge procedure has not occurred.

EMC (Radiated Emission and Radiated Immunity) tests given below, shall be done on tractor, in configuration other than “REESS charging mode coupled to the power grid” (means tractor not in charging condition)

8.2 Electric Agricultural Tractor

EMC (Radiated Emission and Radiated Immunity) tests shall be done as per AIS-004 (Part 3) for Electric Agricultural Tractor at constant speed corresponding to three quarters of the maximum speed of the tractor if there is no technical reason for the manufacturer to prefer another speed. The tractor’s motor shall be loaded with an appropriate torque. If need be, the transmission shafts may be disengaged (for example, in the case of tractors with more than two axles), provided they do not drive a component-emitting interference.

8.3 Hybrid Electric Agricultural Tractor

For radiated emission test as per AIS 004 (Part 3), of Hybrid Electric Agricultural tractor shall be tested as per procedure laid down in AIS-004 (Part 3) standard as applicable, over the specified frequency range with both the combustion engine and electric drive running, with constant speed corresponding to three quarters of the maximum speed of the tractor if there is no technical reason for the manufacturer to prefer another speed. The tractor's drive train shall be loaded with an appropriate torque. If need be, the transmission shafts may be disengaged (for example, in the case of tractors with more than two axles), provided they do not drive a component-emitting interference.

If the above condition is not possible, two separate tests shall be conducted as follows:

8.3.1 Electric Motor Drive Mode:

Test shall be conducted as per AIS-004 (Part 3) as applicable over specified frequency range from 30 MHz to 1000 MHz, provided that a continuous power source may be supplied to the Rechargeable Energy Storage System (REESS) to keep the vehicle running without starting the combustion engine, at maximum possible setting.

Manufacturer may facilitate this through service mode.

8.3.2 Engine Mode:

The test shall be conducted as per AIS-004 (Part 3), as applicable for engine type. Manufacturer may recommend energy storage level of REESS, such that combustion engine does not charge the REESS during the test.

8.3.3 Radiated Immunity test shall be done as per AIS 004 (Part 3) standard for Hybrid Electric Agricultural Tractor at constant speed corresponding to three quarters of the maximum speed of the tractor if there is no technical reason for the manufacturer to prefer another speed. The tractor's drive train shall be loaded with an appropriate torque. If need be, the transmission shafts may be disengaged (for example, in the case of tractors with more than two axles), provided they do not drive a component-emitting interference.

9.0 Criteria for Extension of Approval

9.1. Every modification of the agricultural tractor or REESS type with regard to this Standard shall be notified to the Test Agency which approved the agricultural tractor or REESS type. The Test Agency may then either:

9.1.1. Consider that the modifications made are unlikely to have an appreciable adverse effect and that in any case the agricultural tractor or the REESS still complies with the requirements, or

9.1.2. Require a further testing by Test Agency for necessary compliance of agricultural tractor or REESS to this standard.

10.0 TECHNICAL SPECIFICATIONS

- 10.1 Agricultural tractor manufacturer shall submit test vehicle specification in Annex 5 format for type approval.
- 10.2 Agricultural tractor manufacturer or REESS manufacturer shall submit technical specifications of REESS in Annex 6 format for type approval.

ANNEX 1

(See 5.2.3.2.)

**ISOLATION RESISTANCE MEASUREMENT METHOD FOR
VEHICLE BASED TESTS****1.0 General**

The isolation resistance for each high voltage bus of the vehicle shall be measured or shall be determined by calculation using measurement values from each part or component unit of a high voltage bus (hereinafter referred to as the "divided measurement").

2.0 Measurement method

The isolation resistance measurement shall be conducted by selecting an appropriate measurement method from among those listed in paragraphs 2.1. through 2.2. of this Annex, depending on the electrical charge of the live parts or the isolation resistance, etc.

The range of the electrical circuit to be measured shall be clarified in advance, using electrical circuit diagrams, etc.

Moreover, modification necessary for measuring the isolation resistance may be carried out, such as removal of the cover in order to reach the live parts, drawing of measurement lines, change in software, etc.

In cases where the measured values are not stable due to the operation of the on-board isolation resistance monitoring system, etc., necessary modification for conducting the measurement may be carried out, such as stopping of the operation of the device concerned or removing it. Furthermore, when the device is removed, it shall be proven, using drawings, etc., that it will not change the isolation resistance between the live parts and the electrical chassis.

Utmost care shall be exercised as to short circuit, electric shock, etc., for this confirmation might require direct operations of the high-voltage circuit.

2.1. Measurement method using voltage from off-vehicle sources**2.1.1. Measurement instrument**

An isolation resistance test instrument capable of applying a DC voltage higher than the working voltage of the high voltage bus shall be used.

2.1.2. Measurement method

An insulator resistance test instrument shall be connected between the live parts and the electrical chassis. Then, the isolation resistance shall be measured by applying a DC voltage at least half of the working voltage of the high voltage bus.

If the system has several voltage ranges (e.g. because of boost converter) in galvanically connected circuit and some of the components cannot withstand the working voltage of the entire circuit, the isolation resistance between those components and the electrical chassis can be measured separately by applying at least half of their own working voltage with those component disconnected.

2.2. Measurement method using the vehicle's own REESS as DC voltage source

2.2.1. Test vehicle conditions

The high voltage-bus shall be energized by the vehicle's own REESS and/or energy conversion system and the voltage level of the REESS and/or energy conversion system throughout the test shall be at least the nominal operating voltage as specified by the vehicle manufacturer.

2.2.2. Measurement instrument

The voltmeter used in this test shall measure DC values and shall have an internal resistance of at least 10 M Ω .

2.2.3. Measurement method

2.2.3.1. First step

The voltage is measured as shown in Figure 1 and the high voltage bus voltage (V_b) is recorded. V_b shall be equal to or greater than the nominal operating voltage of the REESS and/or energy conversion system as specified by the vehicle manufacturer.

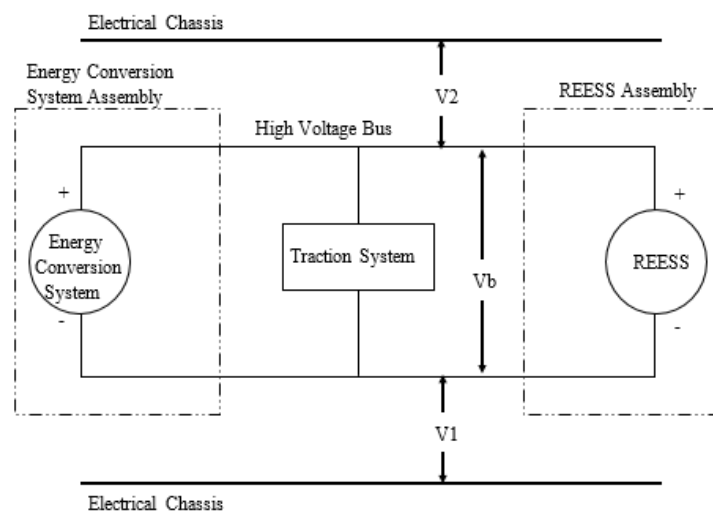


Figure 1
Measurement of V_b , V_1 , V_2

2.2.3.2. Second step

Measure and record the voltage (V1) between the negative side of the high voltage bus and the electrical chassis (see Figure 1).

2.2.3.3. Third step

Measure and record the voltage (V2) between the positive side of the high voltage bus and the electrical chassis (see Figure 1).

2.2.3.4. Fourth step

If V1 is greater than or equal to V2, insert a standard known resistance (Ro) between the negative side of the high voltage bus and the electrical chassis. With Ro installed, measure the voltage (V1') between the negative side of the high voltage bus and the electrical chassis (see Figure 2).

Calculate the electrical isolation (Ri) according to the following formula:

$$R_i = R_o \cdot (V_b / V_1' - V_b / V_1) \quad \text{or} \quad R_i = R_o \cdot V_b \cdot (1 / V_1' - 1 / V_1)$$

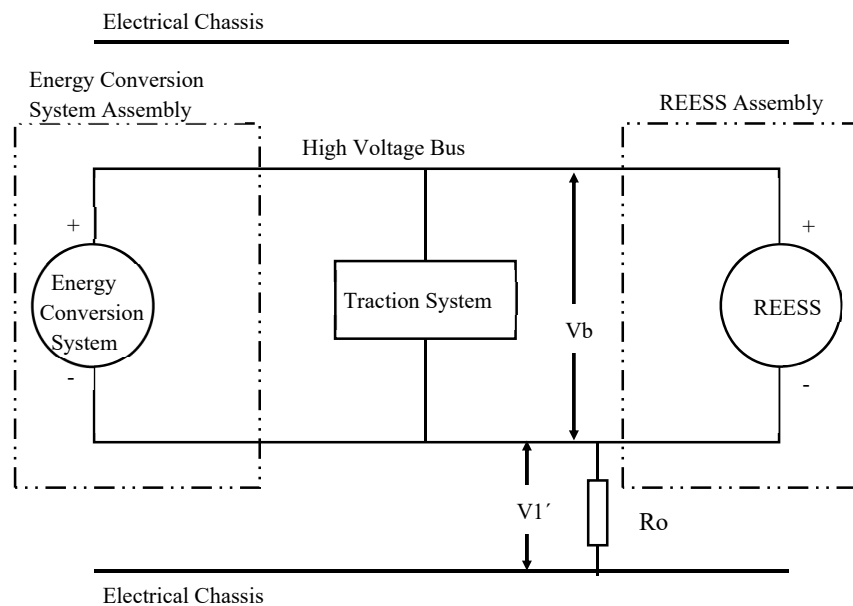


Figure 2
Measurement of V1

If V2 is greater than V1, insert a standard known resistance (Ro) between the positive side of the high voltage bus and the electrical chassis. With Ro installed, measure the voltage (V2') between the positive side of the high voltage bus and the electrical chassis (see Figure 3). Calculate the electrical isolation (Ri) according to the formula shown. Divide this electrical isolation value (in Ω) by the nominal operating voltage of the high voltage bus (in Volts).

Calculate the electrical isolation (R_i) according to the following formula:

$$R_i = R_o \cdot (V_b/V_2' - V_b/V_2) \quad \text{or} \quad R_i = R_o \cdot V_b \cdot (1/V_2' - 1/V_2)$$

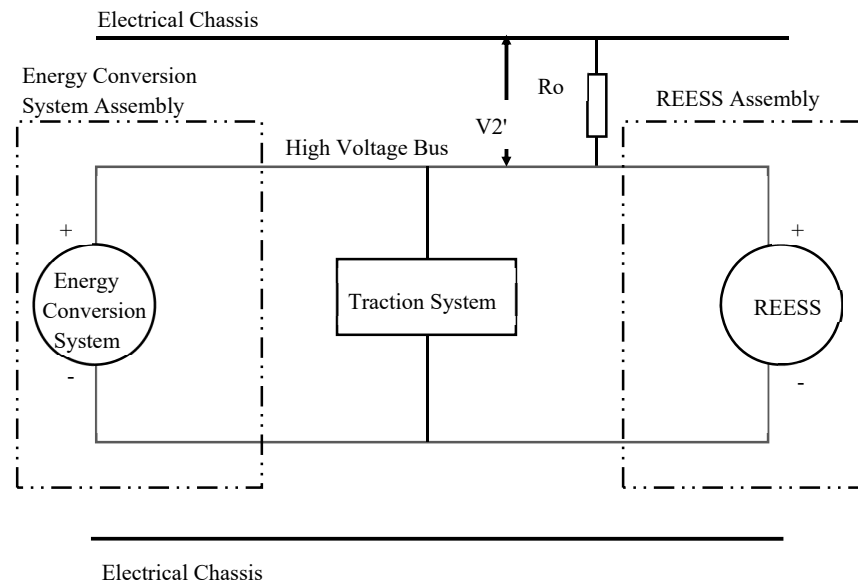


Figure 3
Measurement of V_2

2.2.3.5. Fifth step

The electrical isolation value R_i (in Ω) divided by the working voltage of the high voltage bus (in Volts) results in the isolation resistance (in Ω/V).

Note: The standard known resistance R_o (in Ω) should be the value of the minimum required isolation resistance (in Ω/V) multiplied by the working voltage of the vehicle plus/minus 20 per cent (in volts). R_o is not required to be precisely this value since the equations are valid for any R_o ; however, a R_o value in this range should provide good resolution for the voltage measurements.

ANNEX 2

(See 5.2.3.3. b)

**CONFIRMATION METHOD FOR FUNCTION OF ON-BOARD
ISOLATION RESISTANCE MONITORING SYSTEM**

- 1.0 The function of the on-board isolation resistance monitoring system shall be confirmed by the following method:

Insert a resistor that does not cause the isolation resistance between the terminal being monitored and the electrical chassis to drop below the minimum required isolation resistance value. The warning shall be activated.

ANNEX 3

(See 5.2.1)

**PROTECTION AGAINST DIRECT CONTACTS OF PARTS
UNDER VOLTAGE****1.0 Access probes**

Access probes to verify the protection of persons against access to live parts are given in Table 1.

2.0 Test conditions

The access probe is pushed against any openings of the enclosure with the force specified in Table 1. If it partly or fully penetrates, it is placed in every possible position, but in no case shall the stop face fully penetrate through the opening.

Internal barriers are considered part of the enclosure.

A low-voltage supply (of not less than 40 V and not more than 50 V) in series with a suitable lamp should be connected, if necessary, between the probe and live parts inside the barrier or enclosure.

The signal-circuit method should also be applied to the moving live parts of high voltage equipment.

Internal moving parts may be operated or otherwise repositioned slowly, where this is possible.

3.0 Acceptance conditions

The access probe shall not touch live parts.

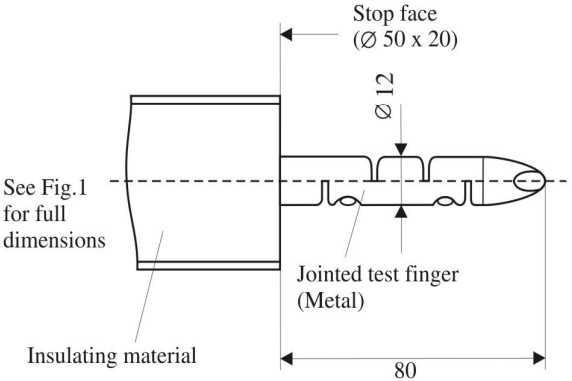
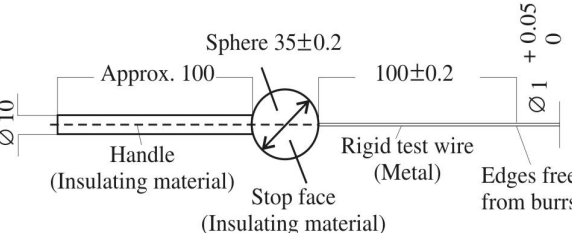
If this requirement is verified by a signal circuit between the probe and live parts, the lamp shall not light.

In the case of the test for IPXXB, the jointed test finger may penetrate to its 80 mm length, but the stop face (diameter 50 mm x 20 mm) shall not pass through the opening. Starting from the straight position, both joints of the test finger shall be successively bent through an angle of up to 90 degrees with respect to the axis of the adjoining section of the finger and shall be placed in every possible position.

In case of the tests for IPXXD, the access probe may penetrate to its full length, but the stop face shall not fully penetrate through the opening.

Table 1

ACCESS PROBES FOR THE TESTS FOR PROTECTION OF PERSONS AGAINST ACCESS TO HAZARDOUS PARTS

First numeral	Addit. letter	Access probe (Dimensions in mm)	Test force
2	B	<p style="text-align: center;">Jointed test finger</p>  <p style="text-align: center;">See Fig.1 for full dimensions</p> <p style="text-align: center;">Insulating material</p> <p style="text-align: center;">Jointed test finger (Metal)</p> <p style="text-align: center;">Stop face (Ø 50 x 20)</p> <p style="text-align: center;">Ø 12</p> <p style="text-align: center;">80</p>	10 N ± 10%
4, 5, 6	D	<p style="text-align: center;">Test wire 1.0 mm diameter, 100 mm long</p>  <p style="text-align: center;">Sphere 35 ± 0.2</p> <p style="text-align: center;">Approx. 100</p> <p style="text-align: center;">100 ± 0.2</p> <p style="text-align: center;">Ø 10</p> <p style="text-align: center;">Handle (Insulating material)</p> <p style="text-align: center;">Stop face (Insulating material)</p> <p style="text-align: center;">Rigid test wire (Metal)</p> <p style="text-align: center;">Edges free from burrs</p> <p style="text-align: center;">Ø 1 +0.05 / 0</p>	1N ± 10%

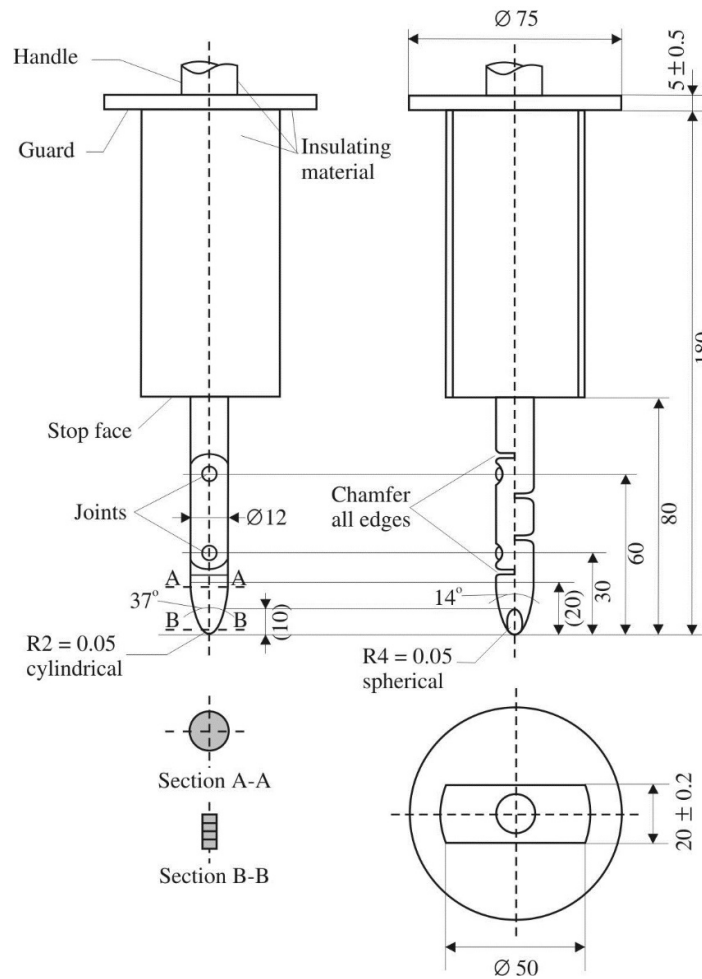


Figure 1
JOINTED TEST FINGER

Material: metal, except where otherwise specified

Linear dimensions in millimeters

Tolerances on dimensions without specific tolerance:

(a) On angles: 0/-10°;

(b) On linear dimensions: up to 25 mm: 0/-0.05 mm over 25 mm: ± 0.2 mm

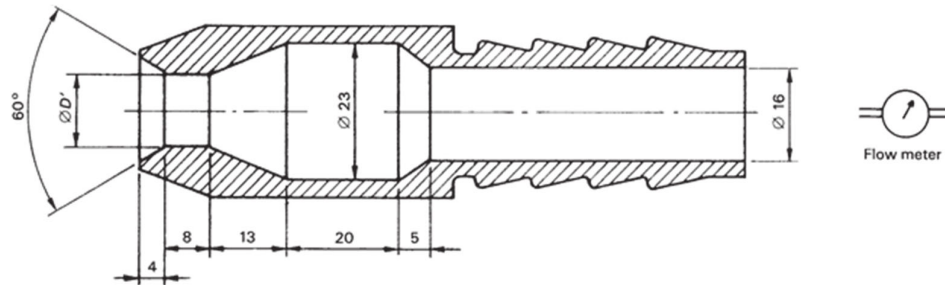
Both joints shall permit movement in the same plane and the same direction through an angle of 90° with a 0 to +10° tolerance.

ANNEX 4
(See 5.5.1.)

HOSE NOZZLE FOR THE TEST FOR PROTECTION AGAINST WASHING

This Annex specifies dimensionally the hose nozzle to be used for IPX5 test procedure as specified in IEC 60529 (All dimensions are in mm).

Test device to verify protection against water jets (hose nozzle)



ANNEX 5

(See 3.1.2.)

**ESSENTIAL CHARACTERISTICS OF A6 AND A7 CATEGORY
AGRICULTURAL TRACTORS****1.0 General**

- 1.1. Mark (trade name of manufacturer):
- 1.2. Type:
- 1.3. Agricultural Tractor Category:
- 1.4. Model Name
- 1.5. Manufacturer's name and address:
- 1.6. If applicable, name and address of manufacturer's representative:
- 1.7. Drawing and/or photograph of the Agricultural Tractor:
- 1.8. Type Approval Report number of the REESS:
- 1.9. Propulsion system (e.g. hybrid, electric):

2.0 Electric motor (traction motor)

- 2.1. Type (winding, excitation):
- 2.2. Maximum net power and / or maximum 30 minutes power (kW) as per AIS 041: (Rev. 1), as amended and revised from time to time
- 2.3. Max PTO Power (kW) (Declared Value)
- 2.4. Rated PTO Power (kW) (Declared Value)

3.0 REESS

- 3.1. Trade name and mark of the REESS:
- 3.2. Indication of all types of cells:
 - 3.2.1. The cell chemistry:
 - 3.2.2. Physical dimensions:
 - 3.2.3. Capacity of the cell (Ah):
- 3.3. Description or drawing(s) or picture(s) of the REESS explaining:

- 3.3.1. Structure:
- 3.3.2. Configuration (number of cells, mode of connection, etc.):
- 3.3.3. Dimensions:
- 3.3.4. Casing (construction, materials and physical dimensions):
- 3.4. Electrical specification:
 - 3.4.1. Nominal voltage (V):
 - 3.4.2. Working voltage (V):
 - 3.4.3. Rated capacity (Ah):
 - 3.4.4. Maximum current (A):
- 3.5. Gas combination rate (in per cent):
- 3.6. Description or drawing(s) or picture(s) of the installation of the REESS in the Agricultural Tractor:
 - 3.6.1. Physical support:
- 3.7. Type of thermal management
- 3.8. Electronic control:
- 4.0 Fuel Cell (if any)**
 - 4.1. Trade name and mark of the fuel cell:
 - 4.2. Types of fuel cell:
 - 4.3. Nominal voltage (V):
 - 4.4. Number of cells:
 - 4.5. Type of cooling system (if any):
 - 4.6. Max Power (kW):
- 5.0 Fuse and/or circuit breaker**
 - 5.1. Type:
 - 5.2. Diagram showing the functional range:
- 6.0 Power wiring harness**
 - 6.1. Type:

7.0 Protection against Electric Shock

7.1. Description of the protection concept:

8.0 Additional data

8.1. Brief description of the power circuit components installation or drawings/
pictures showing the location of the power circuit components installation:

8.2. Schematic diagram of all electrical functions included in power circuit:

8.3. Working voltage (V):

8.4. System descriptions for low performance driving mode(s)

8.4.1. Systems' SOC level(s) for which power reduction is activated, descriptions, rationales

8.4.2. Descriptions for systems' reduced power mode(s) and similar mode(s), rationales

ANNEX 6
(SEE 4.1.2.)

ESSENTIAL CHARACTERISTICS OF REESS

1.0 REESS

- 1.1. Trade name and mark of the REESS:
- 1.2. Indication of all types of cells:
 - 1.2.1. The cell chemistry:
 - 1.2.2. Physical dimensions:
 - 1.2.3. Capacity of the cell (Ah):
- 1.3. Description or drawing(s) or picture(s) of the REESS explaining
 - 1.3.1. Structure:
 - 1.3.2. Configuration (number of cells, mode of connection, etc.):
 - 1.3.3. Dimensions:
 - 1.3.4. Casing (construction, materials and physical dimensions):
 - 1.3.5. Mass of REESS (kg):
- 1.4. Electrical specification
 - 1.4.1. Nominal voltage (V):
 - 1.4.2. Working voltage (V):
 - 1.4.3. Rated capacity (Ah):
 - 1.4.4. Maximum current (A):
- 1.5. Gas combination rate (in percentage):
- 1.6. Description or drawing(s) or picture(s) of the installation of the REESS in the vehicle:
 - 1.6.1. Physical support:
- 1.7. Type of thermal management:
- 1.8. Electronic control: (Battery Management System)
 - 1.8.1. Make:
 - 1.8.2. Model

1.8.3 Type (Active /Passive etc.) :

1.9. Category of Agricultural Tractors on which the REESS can be installed:

ANNEX 7
(See Introduction)

**COMPOSITION OF AISC PANEL ON
SPECIFIC REQUIRMENTS FOR A6 and A7 CATEGORY ELECTRIC
POWER TRAIN AGRICULTURAL TRACTORS***

Convener	
Mr. A.A. Deshpande	The Automotive Research Association of India (ARAI)
Members	Representing
Mr. M. M. Desai	ARAI
Mr. K B Patil	ARAI
Mr. J. J. R. Narware	CFMTTI, Budni
Mr. C. V. Chimote	CFMTTI, Budni
Ms. Vijayanta Ahuja	ICAT
Mr. V M Dhanasekar	GARC
Mr. V J Baiju	GARC
Mr. R.Srinivasan	GARC
Mr. R.P.Vasudevan	TMA
Mr Nitin Janga	Escorts Agri Machinery
Mr. Mansingh Jagdale	John Deere Equip. Pvt. Ltd
Mr. Philip Koshy	John Deere Equip. Pvt. Ltd
Mr. Shubham Khawshi	John Deere Equip. Pvt. Ltd
Mr. Pradeep Shinde	Mahindra & Mahindra Ltd
Mr. P S Rajaram	Mahindra & Mahindra Ltd
Mr. Murugeshan	Mahindra & Mahindra Ltd
Mr. Venkatesan	Tractors And Farm Equipment Ltd
Mr. Ravindran V	Tractors And Farm Equipment Ltd

* At the time of approval of this Automotive Industry Standard (AIS)

ANNEX 8
(See Introduction)

COMMITTEE COMPOSITION *
Automotive Industry Standards Committee

Chairperson	
Dr. Reji Mathai	Director The Automotive Research Association of India, Pune
Members	Representing
Representative from	Ministry of Road Transport and Highways (Dept. of Road Transport and Highways), New Delhi
Representative from	Ministry of Heavy Industries and Public Enterprises (Department of Heavy Industry), New Delhi
Shri S. M. Ahuja	Office of the Development Commissioner, MSME, Ministry of Micro, Small and Medium Enterprises, New Delhi
Shri Shrikant R. Marathe	Former Chairman, AISC
Shri R.R. Singh	Bureau of Indian Standards, New Delhi
Director	Central Institute of Road Transport, Pune
Director	Global Automotive Research Centre, Chennai
Director	International Centre for Automotive Technology, Manesar
Director	Indian Institute of Petroleum, Dehra Dun
Director	Vehicles Research and Development Establishment, Ahmednagar
Director	Indian Rubber Manufacturers Research Association
Representatives from	Society of Indian Automobile Manufacturers
Shri R. P. Vasudevan	Tractor Manufacturers Association, New Delhi
Shri Uday Harite	Automotive Components Manufacturers Association of India, New Delhi
Shri K. V. Krishnamurthy	Indian Construction Equipment Manufactures' Association (ICEMA), New Delhi
Member Secretary	
Shri Vikram Tandon	The Automotive Research Association of India, Pune

* At the time of approval of this Automotive Industry Standard (AIS)