WC-draft
ETD 09 (26234)

Draft Indian Standard
On
Cables for Electric Vehicle Charging system

SECTION 1 GENERAL REQUIREMENTS

1 SCOPE

This Indian standard specifies construction, dimensions and test requirements for cables with extruded insulation and sheath having a voltage rating of up to and including 1 100V a.c or up to and including 1 500 V d.c for flexible applications under harsh conditions for the power supply between the electricity supply point of the charging station and the electric vehicle (EV).

The EV charging cable is intended to supply power and communication to an EV or plug-in hybrid vehicle (PHEV). Section 1 of this standard covers the general requirements and test methods specific to EV charging cables of rated voltages up to and including 1 100V. Section 2 covers the charging cables that are applicable for charging modes 1 to 3 for AC Charging. Section 3 covers charging cables for DC Charging according to mode 4 without use of a thermal management system. Section 4 covers charging cables for DC Charging according to mode 4 intended to be used with a thermal management system. Ordinary duty cables with rated voltage 300/500 V are only permitted for charging mode 1. Maximum conductor temperature for the cables in this part of standard is 90 ºC.

2 REFERENCE

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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 editions of the standards listed below.

IS No.	*Title*
IS 1885 (Part 32) : 1993)	Electrotechnical Vocabulary : Part 32 Electric Cable (*first revision*)

IS 4905 : 2015	Random Sampling and Randomization Procedures (*first revision*)
IS 8130 : 2013	Conductors for Insulated Electric Cable and Flexible Cords
IS 10810	Methods of test for cables
(Part 0) : 1984	General
(Part 1) : 1984	Annealing test for wires used in conductors
(Part 2) : 1984	Tensile test of Aluminum wires
(Part 3) : 1984	Wrapping test for Aluminum Wires
(Part 4) : 1984	Persulphate test for Copper
(Part 5) : 1984	Conductor Resistance Test
(Part 6) : 1984	Thickness of Thermoplastic and Elastomeric Insulation and Sheath
(Part 7) : 1984	Tensile Strength and Elongation at break of Thermoplastic and Elastomeric Insulation and Sheath
(Part 11) : 1984	Thermal Ageing in Air
(Part 13) : 1984	Ozone Resistant Test
(Part 15) : 1984	Hot Deformation Test
(Part 20) : 1984	Cold Bend Test
(Part 21) : 1984	Cold Impact Test
(Part 30) : 1984	Hot Set Test
(Part 43) : 1984	Insulation Resistance
(Part 44) : 1984	Spark Test
(Part 45) : 1984	High Voltage Test
(Part 53) : 1984	Flammability Test
(Part 58) : 1984	Oxygen Index Test
(Part 59) : 1984	Determination of the Amount of Halogen Acid Gas Evolved During Combustion of Polymeric Materials Takes form Cables
(Part 61) : 1984	Flame Retardant Test
(Part 63) : 1984	Smoke Density of Electric Cable Under Fire Conditions
(Part 64) : 1984	Measurement of Temperature
IS 17017 (Part 1) : 2018	Electric Vehicle Conductive Charging System Part 1 General Requirements

3 TERMINOLOGY

3.1 For the purpose of this standard definition given IS 1885 (Part 32) and IS 10810 (Part 0) shall apply in addition to the following:

3.1.1 *Routine Test* — Tests made by manufacturer on all the finished cable lengths to demonstrate integrity of the cable.

3.1.2 *Acceptance Test* — Test carried out on sample selected from the lot for the purpose of acceptance of the lot.

3.1.3 *Type Test* — Tests required to be made before supplying a type of cable covered in this standard on general commercial basis in order to demonstrate satisfactory performance characteristics to meet the intended applications. These tests are of such a nature that after they have been made, they need not to be repeated unless changes are made in the cable material or design or manufacturing process, which might change the performance characteristics.

3.1.4 *Halogen-Free Compound* — Compound not containing halogens which meets the requirements given in this document.

3.1.5 *Type of Compound* — Category in which a compound is placed according to its properties, as determined by specific tests.

NOTE — The type designation is not directly related to the composition of the compound.

3.1.6 *EVI* — Designation of insulation compound for cables in this document.

3.1.7 *EVM* — Designation of sheathing compound for cables in this document.

3.1.8 *Control Core (CC) And Pilot Core (CP)* **—** Designation for those cores in the cable that serve the basic control function to operate an EV supply system.

4 RATED VOLTAGE

The rated voltage of a cable is the reference voltage for which the cable is designed.

The rated voltage in an alternating current system is expressed by the combination of two values U_0/U expressed in volts, where:

a) U_0 is the r.m.s. value between any insulated conductor and "earth" (metal covering of the cable or the surrounding medium);

b) U is the r.m.s. value between any two phase conductors of a multicore cable or of a system of single core cables.

In an alternating current system, the rated voltage of a cable or cord shall be at least equal to the nominal voltage of the system for which it is intended. This condition applies to the values of both U_0 and U.

The maximum permanent operating voltage of the system (AC or DC) is stated in **Table 1**.

TABLE 1
EXAMPLES OF MAXIMUM PERMITTED VOLTAGES AGAINST RATED VOLTAGE OF CABLE
(*Clause* 4)

Sl.	**Rated Voltage of Cable**	**Maximum Permanent Permitted Operating Voltage of The System**			
		AC	**3 – Phase AC**	**DC**	
		Conductor-earth	**Conductor-earth**	**Conductor-earth**	**Conductor-conductor**
	U_0/U	U_0 max	U max		
(1)	(2)	(3)	(4)	(5)	(6)
1.	300/500 V	320 V	550 V	410 V	820 V
2.	450/750 V	480 V	825 V	620 V	1240 V
3.	0.6/1 KV	0.7 KV	1.2 KV	0.9 KV	1.8 KV

5 CONDUCTOR

5.1 Material

5.1.1 The conductor shall be composed of annealed bare or tinned copper with high conductivity.

5.1.2 *Construction* — The conductors shall comply with Class 5 requirements according to IS 8130.

A suitable separator over the conductor is permitted as manufacturer's discretion. Compliance shall be checked by inspection and measurement, to the requirement given in IS 8130.

5.1.3 *Electrical Resistance* — The DC resistance of each conductor at 20°C shall be in accordance with the requirements of IS 8130 confirming to class 5 of the conductor.

5.1.4 Nominal cross sectional area of conductor of cables covered in this standard are given in respective tables.

5.2 Size of the Cable

Sizes of the cable shall be:-

a) Power cores 300 / 500V : 1.5 mm² and 2.5 mm² - up to 3 cores

b) Power cores 450 / 750V : 1.5mm² to 35 mm² - up to 3 cores - up to 3,4 and 5 cores

c) Power cores 0.6/1kV: 10 to 95 mm² -up to 2 and 3 Core (DC Only)

d) Minimum cross sectional area of Pilot or control core shall be 0.5 mm²

6 INSULATION

The insulation shall be a compound of types and requirement as specified in **Table 2**. This insulation of power core shall be compound EV-1 or EV-2. The insulation resistance shall be in accordance with the specified values in the particular section.

6.1 The insulation shall be applied in such a way it fits closely over the conductor and so applied. It shall be possible to remove the insulation without damaging the conductor or conductor coating.

6.2 Thickness - The mean value of thickness of insulation shall be not less than the value specified value for each type and size of cables shown in relevant table of particular sections. The thickness at any point may be less than the specified value provided that the differences does not exceed 0.1 mm ± 10 percent of the nominal value specified.

6.3 For the pilot and control cores and any other cores other than power cores up to an including 0.75 mm² the minimum wall thickness shall not be less than 0.33 mm. For the pilot and control cores and any other cores other than power cores up to an including 1.0 mm² the minimum wall

thickness shall not be less than 0.41 mm. For bigger cross sections refer corresponding tables in the particular sections.

6.4 Mechanical Properties before and after Ageing - The insulation shall have adequate mechanical strength and elasticity within the temperature limits to which the cable may be exposed under normal use and shall meet the requirement given in the **Table 2**.

TABLE 2
PROPERTIES OF ELECTRIC VEHICLE INSULATING COMPOUNDS
(*Clause* 6 *and* 6.4)

SI. No.	Tests	Unit	Test Requirement for Insulating compound		Test Method IS 10810 (Part No.)
			EVI - 1	EVI - 2	
(1)	(2)	(3)	(4)	(5)	(6)
1.	Tensile strength before ageing – median min	N/mm^2	15	8	7
2.	Elongation at break before ageing – median min	%	300	200	
3.	Ageing				
	a) Temperature	˚C	135 ± 2	135 ± 2	7
	b) Duration	days	7	7	
	c) Variation in Tensile strength	%	± 30	±30	
4.	Hot Set Test				
	a) Temperature	˚C	-	200 ± 3	31
	b) Duration	minutes	-	15	
	c) Load	N/cm^2	-	20	
	d) Elongation under load Max	%	-	100	
	e) Permanent Set Max	%	-	25	
5.	Hot Pressure Test				
	a) Temperature	˚C	120 ± 2	-	15
	b) Indentation Depth Max	%	50	-	
6.	Bending Test at Low Temperature for Core Dia ≤ 12.5 mm				
	a) Temperature	˚C	- 40 ± 2	- 40 ± 2	20
	b) Duration	hrs	16	16	
	c) Result	-	No Crack	No Crack	
7.	Cold Impact Test at Low Temperature for Core Dia ≥12.5mm				
	a) Temperature	˚C	- 40 ± 2	- 40 ± 2	21
	b) Duration	hrs	16	16	
	c) Result	-	No Crack	No Crack	
8.	Elongation Test at Low Temperature >12.5 mm				
	a) Temperature	˚C	- 40 ± 2	- 40 ± 2	

	b) Duration	hrs	16	16	Under preparation (refer IEC 60811-505)
	c) Elongation at Break Min	%	30	30	
9.	Hardness	Shore D	≥ 50		
				≥ 80	
10.	Assessment of Halogen				
	a) pH	pH	≥ 4.3	≥ 4.3	
	b) Conductivity	µS/mm	≤ 10 µS/mm	≤ 10 µS/mm	
	c) Halogen Content Max	%	0.5	0.5	
	d) Fluorine Content Max	%	0.1	0.1	

7 FILLERS

7.1 The fillers shall be of any one or combination of the following:

a) Compound based on polymeric material

b) Natural or synthetic textiles or

c) Paper dummy

In case of use of compound as fillers, it shall not have any harmful interaction between its constituents and the insulation and / or sheath. Compliance with the requirements shall be checked by compatibility test.

7.2 Compatibility Test

7.2.1 *Test Condition* — The sample shall be aged at 100 ± 2 °C for 168 hours in accordance with IS 10810 (Part 11). At the end of the testing, including 16 hours of cooling in desiccator kept away from direct sunlight Tensile strength and elongation tests are conducted on insulation and sheath and the result shall meet the requirements given in the **Table 3** below.

TABLE 3
(*Clause* 7.2.1)

Sl. NO.	PARAMETER	UNITS	EVI-1 / EVI-2 INSULATION	EVM-1 / EVI-2 /EVM-3 SHEATH
(1)	(2)	(3)	(4)	(5)
1.	Variation in tensile Strength - Variation Max.	%	± 30	± 30
2.	Variation in Elongation at break - Variation Max.	%	± 30	± 30

Note — Variation is the difference between before and after ageing median values, expressed as a percentage of before ageing.

7.2.2 *Application* — The fillers are applied in such a way spaces between cores are filled there by giving practically giving round shape. It is permissible to use polyester tape or films to keep assembly of cores and fillers together.

8 ASSEMBLY OF CORES

8.1 The cores are assembled by twisting together with suitable right lay in such a way that the outermost layer shall have right hand lay and successive layer beneath shall have opposite lay.

9 SCREEN (OPTIONAL)

a) The screen shall be applied over the taped assembled cores in form of braiding either with annealed plain copper or of annealed tinned copper as agreed between manufacturer and purchaser.

b) Strand diameter of braiding wire shall be as given below

1) Max. 0.16 mm for $d \leq 10$mm
2) Max. 0.21 mm for, $d \geq 10$ mm ≤ 20 mm
3) Max. 0.26 mm for, $d \geq 20$ mm ≤ 30 mm and
4) Max. 0.31 mm for, $d \geq 30$ mm

Where d is the fictitious diameter under the braid

c) Coverage shall be between 75 to 85 %

10 SHEATH

10.1 The sheath shall be a compound of types and requirement as specified in **Table 4**. This sheath of shall be suitable compound of EVM-1 or EVM-2 or EVM-3 grades.

10.2 The Sheath shall be extruded over the taped assembled core or over screen in such a way that it shall not adhere to cores.

10.3 Thickness - The mean value of thickness of insulation shall be not less than the value specified value for each type and size of cables shown in relevant table of particular sections. The thickness at any point may be less than the specified value provided that the differences does not exceed 0.1 mm ± 15% of the nominal value specified, unless otherwise specified. **5.6.4** Mechanical properties before and after ageing.

The Sheath shall have adequate mechanical strength and elasticity within the temperature limits to which the cable may be exposed under normal use and shall meet the requirement given in the **Table 4.**

TABLE 4
PROPERTIES OF ELECTRIC VEHICLE SHEATHING COMPOUNDS
(*Clause* 10.1 *and* 10.3)

Sl. No.	Tests	Unit	Test Requirement for Insulating compound			Test Method IS 10810 (Part No.)
			EVS-1	EVS-2	EVS-3	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	Tensile strength before ageing - median min	N/mm²	20	10	10	7
2.	Elongation at break before ageing - median min	%	300	150	300	
3.	Ageing					
4.	a) Temperature	°C	110 ± 2	130 ± 2	100 ± 2	7
	b) Duration	days	7	7	7	
	c) Variation in Tensile strength	%	± 30	± 30	± 30	
	d) Elongation at break after ageing Median, min	%	300	-	250	
	e) Variation in Elongation at break	%	± 30	± 30	± 30	
5.	Mineral oil immersion Ageing					
6.	a) Temperature	°C	100 ± 2	100 ± 2	100 ± 2	7
	b) Duration	days	7	7	7	
	c) Variation in Tensile strength	%	± 40	± 40	± 40	
	d) Elongation at break after ageing Median, min	%	300	-	-	
	e) Variation in Elongation at break	%	± 30	± 40	± 40	
7.	Hot set test					
	a) Temperature	°C	-	250 ± 3	250 ± 3	31
	b) Duration	minutes	-	15	15	
	c) Load	N/cm²	-	20	20	
	d) Elongation under load Max.	%	-	100	175	
	e) Permanent set max.	%	-	25	15	
8.	Hot Pressure Test					
	a) Temperature	°C	100 ± 2	-	-	15
	b) Indentation depth max.	%	50	-	-	
9.	Bending Test at low Temperature for core Dia ≤ 12.5 mm					
	a) Temperature	°C	- 40 ± 2	- 40 ± 2	- 35 ± 2	20
	b) Duration	Hrs.	16	16	16	
	c) Result	-	No crack	No crack	No Crack	
10.	Cold Impact Test at low Temperature for core Dia ≥12.5 mm					
	a) Temperature	°C	- 40 ± 2	- 40 ± 2	- 35 ± 2	Cl. 6.15

	b) Duration	Hrs.	16	16	16	
	c) Result	-	No crack	No crack	No Crack	
11.	Elongation Test at low Temperature >12.5 mm					
	a) Temperature	°C	- 40 ± 2	- 40 ± 2	-35 ± 2	Under preparation (refer IEC 60811-505)
	b) Duration	Hrs.	16	16	16	
	c) Elongation at break Min.	%	30	30	30	
12.	Heat Shock Test					
	a) Temperature	°C	150 ± 2	-	-	14
	b) Duration	Hrs.	1	-	-	
	c) Result	-	No crack	-	-	
13.	Water Resistance Test					
	a) Temperature	°C	80 ± 2	70 ± 2	70 ± 2	7
	b) Duration	days	7	7	7	
	c) Variation in Tensile strength	%	± 30	± 30	± 30	
	d) Elongation at break after ageing Median, min	%	300	-	-	
	e) Variation in Elongation at break	%	± 30	± 30	± 30	
14.	Resistance to acid and alkali solution of Outer sheath					
	Acid : 1 N Oxalic or Acetic acid					
	Alkaline solution : 1N Sodium Hydroxide					
	a) Temperature	°C	27 ± 2	70 ± 2	70 ± 2	7
	b) Duration	Hrs.	5	5	5	
	c) Variation in Tensile strength	%	± 40	± 40	± 30	
	d) Elongation at break after ageing Median, min	%	100	100	100	
15.	Tear Resistance	N/mm	40	10	10	
16.	Resistance to saponification mean value to be obtained, max	Mg of KOH/g	200	-	-	6.17
17.	UV Resistance of sheath					Refer Cl. 6.3
	a) Duration	Hrs.	720	720	720	
	b) No. of cycles	Nos.	360	360	360	
	c) Retention % of Tensile strenth, min	%	70	70	70	
	d) Retention % of Elongation at break , min	%	70	70	70	

11 OVERALL DIMENSION

11.1 The mean overall dimensions of the cable shall be within the limits specified in the Tables given in section 2 or 3 or 4.

11.2 Ovality

11.2.1 The difference between maximum and minimum measured values of the overall diameter of cables shall not exceed 15 percent of the maximum measured value at the same cross section.

12 GENERAL REQUIREMENTS FOR TESTS

12.1 Tests shall be carried out only after 16 hours after extrusion of Insulation or sheath and ambient temperature of 27 ± 2 °C.

13 TEST METHODS

13.1 Spark Test (Check on absence of faults in Insulation)

The types of wave forms used in this standard for this testing is either a.c voltage at 50 ± 10 Hz frequency.

TABLE 5
(*Clause* 13.1)

Sl. No.	Insulation thickness (mm)		Test Voltage kv (R.M.S)
	from	to	a.c
(1)	(2)	(3)	(4)
1.	0.26	0.60	6
2.	0.61	1.00	7
3.	1.01	1.50	10
4.	1.51	2.00	15
5.	2.01	2.50	20
6.	>2.5	-	25

13.2 Voltage test on cores (By water immersion)

13.2.1 The cores shall be carefully removed from the completed cable of min. 5 meters length, without damaging the insulation. The cores thus removed shall be immersed in water bath maintained at ambient temperature of 27 ± 2 °C, in such a way that the free ends are protruding approximately 200 mm from water level, for an hour and test voltage (HV) as per the table given below is applied to conductor and water being earthed for a period of 5 minutes and sample declared passed if its withstands the test.

TABLE 6
(*Clause* 13.2.1)

Sl. No.	Insulation thickness (mm)*	Rated Voltage	Test Voltage (V)		Test period in minutes	Result
			AC	DC		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	up to 0.6	300/500 V	1500		5	No breakdown
2.	>0.6 mm	300/500 V	2000	4000	5	No breakdown
		450/750 V	2500	5000	5	No breakdown
		1 100 V	3500	7000	5	No breakdown

Note — Nominal wall thickness given in relevant table to be considered not the measured value.

13.3 Voltage Test on Complete Cable (By Water Immersion)

13.3.1 The completed cable of min. 10 meters length, shall be immersed in water bath maintained at ambient temperature of 27 ± 2 °C, in such a way that the free ends are protruding approximately 200 mm from water level, for an hour and test voltage (HV) as per the table given below is applied to conductor of core 1 and all other conductors and screen if any with water being earthed for a period of 5 minutes. The test is repeated for all other cores as described above and sample declared passed if it's with stands the test.

TABLE 7
(*Clause* 13.3.1)

Sl. No	Rated Voltage	Test Voltage (V)		Test Period in minutes / per connection	Result
		AC	DC		
(1)	(2)	(3)	(4)	(5)	(6)
1.	300/500 V	2 000	4 000	5	No breakdown
2.	450/750 V	2 500	5 000	5	No breakdown
3.	1 100 V	3 500	7 000	5	No breakdown

Note — Ref. Test Method IS 10810 (Part 45).

13.4 The Cables shall have meet the insulation resistance test and the compliance to the same shall be as specified in Table 10, 11 and 12

13.5 High Voltage Test (DC Water Immersion)

13.5.1 The cores shall be carefully removed from the completed cable of min. 5 meters length, without damaging the insulation. The cores thus removed shall be immersed in Thermostatically controlled water bath , with aqueous solution of sodium chloride having concentration of 30 g/liter, maintained at (85 ± 2) °C, in such a way that the free ends are protruding approximately 200 mm from water level. The conductor is connected to negative pole and water is to the positive pole of DC HV supply by means of copper electrode. The core shall withstand dc test voltage of 600 V for 240 hours without breakdown. (Also Ref. **Table 4**)

13.6 Weathering / UV Resistance Test

13.6.1 *General* — This Test is done to assess the condition as manufactured and after exposed to the UV light and water there by determining the stability to UV radiation of the sheathing material.

13.6.2 *Equipment* **—** The testing Equipment shall have following facility, they are.

a) Xenon arc lamp ray source with borosilicate filters to get typical irradiance of 43 W/m^2 ± 15 percent with a spectrum between 300 nm and 400 nm.

b) Devise for automatic control of temperature, humidity and cycles

c) Deionised water generator to generate Deionized water with a conductivity ≤ 5 μs/cm; and the rate of flow should be sufficient to guarantee that all the test specimens can be washed;

d) A devise to control the irradiance.

13.6.3 *Test Procedure* — Test dumb bell sample of 10 specimens shall be produced in accordance with IS 10810 (Part 6). And numbered sequentially. All Five even test specimens shall be exposed to the treatment for 720 h in 360 cycles of 120 min defined as follows:

a) 102 min of dry radiation exposure at a temperature of (60 ± 3) ºC and relative humidity of (50 ± 10) percent, followed by;

b) 18 min of rain exposure, without radiation, at a temperature of (50 ± 3) ºC without relative humidity control;

On completion of 360 cycles of exposure, the test specimens shall be removed from the equipment and conditioned at ambient temperature for at least 16 h, in desiccator.

All five exposed even samples and another five UN exposed samples shall be tested for tensile strength and elongation in close succession. Respective Median Tensile strength and elongation of exposed and UN exposed samples.

13.6.4 *Requirement* — The sample declared passed if the aged sample retains Minimum 70 percent of Tensile strength and elongation at break, of that of the unexposed samples.

13.7 Flammability Test

The test is conducted in accordance with IS 10810 (Part 53). The period of burning after the removal of flame shall not exceed 60 seconds and the unaffected portion from the lower end of the top clam to the onset of Charring shall be at least 50 mm.

13.8 Oxygen Index Test

The test shall be conducted in accordance with IS 10810 (Part 58) at 27±2°C and the oxygen index shall not be less than 29 %

13.9 Temperature Index Test

The test shall be conducted in accordance with IS 10810 (Part 64) at minimum three temperature points and the minimum measured temperature index shall be 21 percent at a temperature of 250 °C.

13.10 Halogen Acid Evaluation Test

The test shall be conducted in accordance with IS 10810 (Part 59) and the level of halogen acid gas evolved shall not exceed 20 percent by weight.

13.11 Smoke Density Rating Test

The test shall be conducted in accordance with IS 13360 (Part 6/ Sec 9) and the smoke density rating shall be less than 20 percent.

13.12 Per Sulphate Test

The test shall be conducted for tinned copper conductor, in accordance with IS 10810 (Part 4) and shall meet the requirements specified in clause **6.1.1** of IS 8130

13.13 Compatibility Test

The Three test pieces of cable of 200 mm taken and marked sequentially shall be suspended vertically and substantially in the middle of the oven at least 20 mm away from any other piece and shall not occupy more than 2 percent of the volume of the oven. The sample taken, shall be preferably close to that of the sample taken for Tensile strength and Elongation at break without ageing.

The test pieces of cable shall be kept in the oven at the temperature and for the time specified in Table 13. On completion of ageing the test specimens shall be removed from the oven and placed in Desiccator avoiding direct sun light for a minimum period of 16 hours.

As soon as the specified heating period is completed, the test pieces of cable shall be removed from the oven and left at room temperature, avoiding direct sunlight, for at least 16 h.

From Each sample two specimen of either tubular or dumb-bell of each core, subjected to maximum of 4 cores, including the Yellow Green core and 2 dumb bell specimens of sheathing are prepared, resulting 6 specimens of each core and sheath.

Tensile strength and Elongation at break test conducted in accordance with IS 10810 (Part 7) and median value arrived at. The variation of respective median value obtained on unaged sample and the median value obtained on the compatibility test sample, expressed as percentage of the format.

This is to be done for all cores (max. 4) and outer sheath and declared passed if the variation percent is within the limit given in Table 13.

13.14 Flexing Test

For conductor cross section up to 4.0 Sq.mm This test is done in accordance with IS 10810 (Part 57).

However number of test cycles shall be 30000 cycles. During the test neither interruption, short circuit between the conductors nor short circuit between cores and screed nor short circuit between cables and pulleys shall occur. On completion of required number of cycles, examine the sheath

of the cable under normal or corrected vision for damages and visibility of any cable components such as screen, inner sheath, core etc., under the sheath and record.

Then cores are carefully removed and shall then withstand the voltage test on cores as prescribed in clause **6.2**.

13.15 Cyclic Bending Test

For conductor cross section above 4.0 sq.mm. This test is carried out in accordance with clause **5.9** of ISO 14572. The mechanical load excreted over the cable is given in table shown below Cable subjected to 10000 bending cycle. During the test neither interruption, short circuit between the conductors nor short circuit between cores and screed nor short circuit between cables and pulleys shall occur. On completion of required number of cycles, examine the sheath of the cable under normal or corrected vision for damages and visibility of any cable components such as screen, inner sheath, core etc., under the sheath and record then cores are carefully removed and shall then withstand the voltage test on cores as prescribed in clause **6.2**.

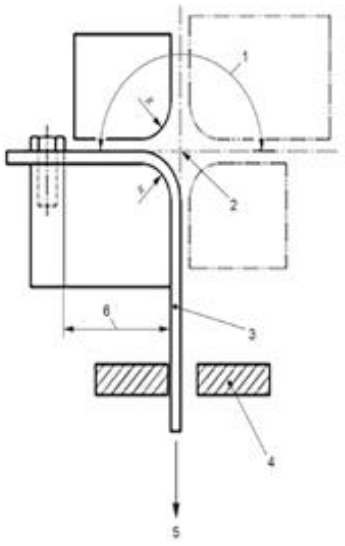

FIG 1 CYCLIC BENDING TESTER

Key:-

a) One Cycle (90˚C to each side)
b) Pivot
c) Cable
d) Fixed guide (optional)
e) Force F
f) Fixing point distance (recommended minimum of 100 mm)

TABLE 8
(*Clause* 13.15)

Sl. No.	**Cross sectional area of power cores**		**Excretion load In N**
	Above	**up to and including**	
		mm^2	

(1)	(2)	(3)	(4)
1.	-	2.5	20
2.	2.5	6	25
3.	6	16	50
4.	16	70	75
5.	70	-	100

13.16 Cold Impact Test

13.16.1 Usage of test the usage of this test shall be agreed between customer and supplier.

13.16.2 Test samples Prepare three test samples, each of 1.2 m length and remove 25 mm of insulation from each end.

13.16.3 Apparatus the apparatus is as shown below is positioned on a foam rubber pad of 40 mm thickness. The mass of the hammer is specified in below. Set the freezing chamber temperature to (−15 ± 2) °C.

13.16.4 Procedure Perform the "impact test" in the middle of the test sample.

Place the apparatus, positioned on the foam rubber pad, together with the test samples, in the freezing chamber for at least 16 h. If the apparatus is pre-cooled, a freezing time of 4 h is sufficient, providing that the test samples have reached the specified temperature. At the end of this period, place a test sample parallel to the steel base. The hammer is then allowed to fall from a height as given in the table below. Repeat the procedure for the remaining test samples. After the impact, allow the test samples to return to room temperature, and make a visual examination of either insulation or sheath or cable. Before examining the insulation of cables or cables without a sheath, the test pieces shall be allowed to attain approximately ambient temperature after the test.

The insulation shall then be examined after the test pieces have been twisted, while held straight, through an angle equal to 360° for each 100 mm length. If, however, it is not possible then the specimen shall be immersed in hand hot water (40 °C to 50 °C) then be cut open in the direction of the axis of the cables.

The inside and outside of the sheath and the insulation shall then be examined. The insulation of cables with sheath shall be examined on the outside only. The specimen declared passed if there is no crack, with normal or corrected vision without magnification.

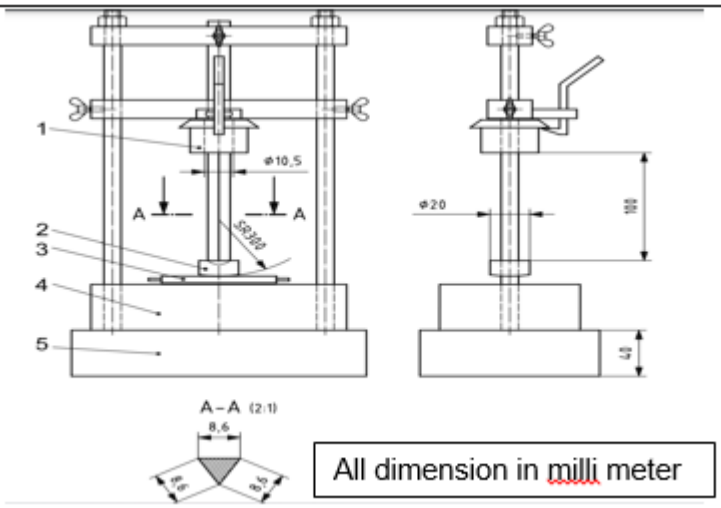

FIG 2 IMPACT TEST PARAMETER

Key:-

a) Hammer
b) Steel Intermediate Piece, 100 g
c) Test Sample
d) Steel Base, Mass 10 kg
e) Foam Rubber Pad

Sl. No.	Cable diameter (D) in mm	Mass of the hammer in g	Mass of steel intermediate piece in g	Height of fall in mm
(1)	(2)	(3)	(4)	(5)
1.	D ≤ 15	1 000	200	100
2.	D > 15 ≤ 25	1 500	200	150
3.	D > 25	2 000	200	200

13.17 Resistance to Saponification

13.17.1 Basic definition of specific terminology.

13.17.1.1 *Saponification value* — The quantity of potassium hydroxide, expressed in mg, required for the saponification of 1 g of the sample being examined.

13.17.1.2 *Saponification* — The formation of alkali salts, regardless of the form in which the corresponding acid occurs.

13.17.2 Test equipment's, materials, glass ware and chemicals

a) 250 ml flask with stopper, narrow necked with standard ground joint

b) Reflux condenser with standard ground joint

c) Burette

d) Weighing balance with 0.1mg accuracy

e) Thermostatically controlled oven with natural air flow

f) Thermostatically controlled water bath

g) Caustic potash solution c (KOH) 0. Mol/litter, ethanoic

h) Hydro chloric acid 0.5 Mol/litter

i) Phenolphthalein 1 percent in ethanol

j) Tetra hydra furan stabilised with 2.6 Di-tetr-buty l-4 methyl phenol

k) Boiling stones

l) Distilled water or deionised water

13.17.3 Sample of sufficient quantity taken which can take care of at least two tests. Weigh in 0.5g of finely granulated material in 250 ml flask with ground in stopper to the nearest 0.001g. Add 50 ml of tetrahydrofuran flask is sealed with the ground-in stopper and placed in the heating cabinet at 60°C until sample completely dissolved, then add 25 ml of caustic potash solution, using burette and add few boiling stones. The sample is saponified for 3 hours in the water bath under reflux and at boiling temperature. Immediately afterwards without cooling , add 50ml of distilled water and three drops of phenolphthalein solution, back titration is performed with Hydrochloric acid (consumption a). A black test shall be carried out in the same way (consumption b). The test shall be carried out on a least two samples Saponification Value = (b-a) x 28.05/ Weight in g the saponification value shall not exceed the maximum Value given in the Table 13.

13.18 Crush Resistance Test

13.18.1 *General* — This test specifies the method for determining resistance to crushing.

13.18.2 *Equipment Shall Consist of* —

a) An Electrical power driven compression machine to measure and indicate the compression force at rupture accurate to min.2 percent and a jaw separation speed of 10 ± 1 mm/minute

b) Two flat steel plates of 50 mm wide

c) A 20 mm Diameter solid drill rod with 50mm length is mounted to top still plate

d) A DC power supply of max. 30 Volts connected to drill rod or steel plate indicating the contact between the conductor and the drill rod or steel plates

13.18.3 *Preparation of Specimens* — The test specimen shall be taken from the finished cable or wire or wire or cable during manufacture. No special conditioning is required other than the condition specified in **5.8.1**. The specimen length shall be min. 25 meters and one end of specimen is stripped making the conductor bare, which is connected to one pole of DC power supply while the steel plates on both sides connected to other pole of power supply.

13.18.4 *Test Method* — Both still plates are mounted horizontally in the Compression equipment.

Ensure the specimen and the equipment in thermal equilibrium at room temperature, then place the specimen laid over the steel plate in lower side in such a way that the sum diameter solid steel drill rod bolted or otherwise to the top steel plate perpendicular to the central line of the lower static plate. The upper steel plate shall be lowered until the contact with the surface of the specimen under test at 125 mm from the free end and the compression shall continue at the rate of 10± 1 mm /minute, till the indicator indicating contact being made to the conductor.

Note — Down the compression force in newton's. Repeat the test on additional 9 points at least 250 mm apart.

13.18.5 Test requirement minimum average crush force shall be 4.0 kN for the cables with conductor with Cross section $\leq$ 4 sq.mm and for cable with conductor cross section > 4 sq.mm it should be 11.0 kN.

13.19 Tear Resistance Test

Sheath of the cable shall be subjected to this test in accordance with IS 10810-17 and shall meet the requirement as given table 3.

13.20 Resistance against Chemicals

13.20.1 *Test Condition* **—** A piece of complete cable shall be immersed in the chemical test medium, for 1 hour period at ambient temperature. The testing shall be done after 24 hours or within 48 hours, by bending around a mandrel for a close helix over 5 times the diameter of the cable, and when examined by normal or corrected vision without using magnifier shall show no cracks on outer surface. The chemicals used for these tests are

a) Hydraulic fluid

b) Gasoline unleaded

c) Polyglycol based brake fluid

d) Lubrication oil

e) Diesel

f) Ethylene glycol – water @ 1:1 ratio

g) Cleaning compound and

h) Urea solution of 32.5 %

13.21 Water Resistance Test on Sheath

13.21.1 The test bumbles are immersed in deionized or distilled water at a temperature and time prescribed in **Table 3**. At the end of this period the sample shall remove and suspended in air away from direct sunlight for a period of 16 to 24 hours, followed by Tensile testing in accordance with IS 10810 (Part 7) and shall meet the requirements given in **Table 3**.

13.22 Shrinkage Test

On sheathed cable done in accordance with IS 10810 (Part 12) and as per the conditions given in **Table 4** and maximum shrinkage shall be 3 percent.

13.23 Surface Resistance Test of Sheath

Carry out the test on three samples of completed cable, each about 250 mm in length.

13.23.1 *Test Procedure* — Clean the sheath of each of the samples with industrial methylated spirit, and apply to each sample two electrodes, consisting of wire helices of copper wire of between 0.2 mm to 0.6 mm diameter, at a distance of (100 ± 2) mm from each other and once again clean the surface of the sheath thoroughly between the electrodes.

Condition the samples with electrodes attached in a conditioning chamber at a temperature of (20 ± 2) °C and a relative humidity of (65 ± 5) percent for 24 h. immediately after removal from the conditioning chamber, apply a d.c. voltage of between 100 V and 500 V between the electrodes, for 1 minute then measure the resistance.

Multiply the measured resistance of each sample, in ohms, by *a*/100, where *a* is the circumference of the sheath of the sample, in millimetres. Record the median of the three values so obtained as the surface resistance of the sheath.

13.24 Inductance Between Power Cores

13.24.1 The total cable inductance between DC + and DC - shall not exceed 1µH/m

14 IDENTIFICATION

14.1 The manufacturer shall be identified throughout the length of the cable by manufacturers' name or trade-mark being printed, indented or embossed on the cable. In case none of these methods can be employed, or if the purchaser so desires, colour identification threads in accordance with the scheme to be approved by Bureau of Indian Standards shall be employed. The printing, indentation or embossing shall be done on the insulation in case of unsheathed cables and on the sheath in case of sheathed cables. The distance between any two consecutive printing, indentation and embossing shall not be more than 1 m or as agreed between manufacturer and customer.

14.2 Durability — In case of printed marking, it shall be durable and compliance with the requirements. The compliance with requirement shall be checked by trying to remove the marking of manufacturer's name or trade-mark and the colours of cores or numerals by rubbing lightly ten times with a piece of cotton wool or cloth soaked in water.

14.3 Legibility — All markings shall be clear and legible. The colours of the identification threads shall be easy to recognize or easily made recognizable, if necessary, by cleaning with petrol or other suitable solvent.

15 CORE IDENTIFICATION

15.1 General — Each power core shall be identified as specified in **14.2**. Each pilot, control, or any other additional core shall be identified as specified in **7.2** or **7.3**.

15.2 Identification by Colours —

15.2.1 *General Requirements* — Identification of the cores of a cable shall be achieved by the use of coloured insulation. Each power core of a cable shall have only one colour, except the core identified by a combination of the colours green and yellow. The colour of control (CC), pilot (CP) or any other additional core shall be clearly identified and different to the power cores. The colours green and yellow, when not in combination, shall not be used.

15.2.2 *Colour Scheme for Power Cores* — The preferred colour scheme (AC cables):

a) Three-core cable: green and yellow, blue, brown; or green and yellow, Red, black

b) Four-core cable: green and yellow, brown, black, grey; or green and yellow, Red, yellow, Blue

c) Five-core cable: green and yellow, blue, brown, black, grey or green and yellow, Red, yellow, Blue, black

The preferred colour scheme (DC cables):

a) Two-core cable: no preferred colour scheme

b) Three-core cable: green and yellow, no preference for other cores

The colours shall be clearly identifiable and durable.

15.2.3 *Colour combination green and yellow* — The distribution of the colours for the core coloured green and yellow shall comply with the following condition: for every 15 mm length of core, one of these colours shall cover at least 30 percent and not more than 70 percent of the surface of the core, the other colour covering the remainder.

15.3 Core Identification by Numbers

15.3.1 *General Requirements* — The colour of control (CC), pilot (CP) or any other core shall be clearly identified and different to the power cores. The insulation of the cores shall be of the same colour and numbered sequentially, starting at number 1. The numbers shall be printed in Arabic numerals on the outer surface of the cores. All the numbers shall be of the same colour, which shall contrast with the colour of the insulation. The numerals shall be legible.

15.3.2 *Preferred Arrangement of Marking* — The numbers shall be repeated, at regular intervals along the core, consecutive numbers being inverted in relation to each other. When the number is a single numeral, a dash shall be placed underneath it. If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. The spacing *d* between consecutive numbers shall not exceed 50 mm.

The arrangement of the marks is shown in Figure 3.

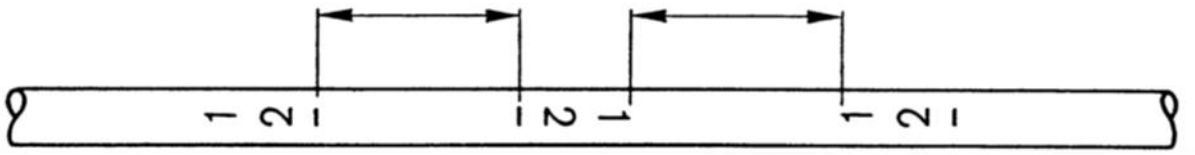

FIG 3 CORE MARKING BY NUMBERS

16 CABLE CODE

Refer clause **18.1**, **19.1**, **20.1**

17 SAMPLING

17.1 LOT

17.1.1 In any consignment the cables or the same size manufactured under essentially similar conditions of production shall be grouped together to constitute a lot.

17.2 SCALE OF SAMPLING

17.2.1 Samples shall be taken and tested from each lot for ascertaining the conformity of the lot to the requirement of the specification.

17.2.2 The number of drums (n) to be selected from the lot of drums (N) of consignment of cables shall be in accordance with col-2 and 1 of **Table 9** respectively. These samples shall be taken at random.

17.2.2.1 In order to ensure the randomness of selection, random number table, shall be used (*see* IS 4905- Methods for random sampling)

17.3 NUMBER OF TESTS AND CRITERION FOR CONFORMITY

17.3.1 Suitable length of test sample shall be taken from each of the drums selected. These test samples shall be subjected to each of the acceptance tests (*see* **16.2**). A test sample is called defective if it fails in any of the acceptance tests. If the number of defectives is less than or equal to the corresponding permissible number (a) given in Col 3 of **Table 9** the lot shall be declared as conforming to the requirements of acceptance tests otherwise not.

TABLE 9
NUMBER OF DRUMS TO BE SELECTED FOR SAMPLING AND PERMISSIBLE NUMBER OF DEFECTIVES
(*Clause* 17.2.2 *and* 17.3.1)

Sl. No.	NUMBER OF DRUMS IN THE LOT	NUMBER OF DRUMS TO BE TAKEN AS SAMPLE	PERMISSIBLE NUMBER OF DEFECTIVES
	(N)	(n)	(a)
(1)	(2)	(3)	(4)
1.	Up to 25	3	0
2.	26 to 50	5	0
3.	51 to 100	8	0
4.	101 to 300	13	1
5.	301 to above	20	1
6.	501 and above	32	2

SECTION 2 CABLES FOR AC CHARGING ACCORDING TO MODES 1, 2 AND 3

18 GENERAL PURPOSE CABLES

These cables are intended to be used for AC Charging according to modes 1, 2 and 3.

18.1 Cable Types

a) ISEV001

b) ISEV002

c) ISEV003

d) ISEV004 and

e) ISEV005

18.2 Rated Voltage 1100V

18.3 Cable sizes and dimension shall be as per relevant Table 10, 11 and 12.

18.4 Insulation — Insulation for power Cable shall be of EVI and that of pilot or control cable shall be of EVI-1 or EVI-2.

18.5 Assembly — The core shall be twisted with suitable layer, with or without central filler however shall not adhere to cores. A separator shall be used if required.

18.6 Sheath — The sheath shall be of type

a) EVM-1 for ISEV001 cable

b) EVM-1 for ISEV002 cable

c) EVM-1 for ISEV003 cable

d) EVM-2 for ISEV004 cable and

e) EVM-3 for ISEV005 cable

18.7 Requirements — Thickness of insulation and sheath shall be as per table given in 10, 11 and 12 and shall meet the Tests for completed cables given in **Table 13**.

TABLE 10
TECHNICAL DATA FOR ISEV001 CABLE
(*Clause* 18.3 *and* 18.7)

Size	Thickness insulation	Sheath	Diameter	Insulation resistance at 90^0C
mm²	mm	mm	mm (max.)	MΩ.km
3 x 1.5	0.6	1	10.1	0.094
3 x 2.5	0.6	1	11,5	0.076

TABLE 11
TECHNICAL DATA FOR ISEV002 CABLE
(*Clause* 18.3 *and* 18.7)

Size	Thickness insulation	Sheath	Diameter	Insulation resistance at 90˚C
mm²	mm	mm	mm (max.)	MΩ.km
3 x 1.5	0.6	1.5	11.6	0.094
3 x 2.5	0.6	1.6	13.2	0.076

TABLE 12
TECHNICAL DATA FOR ISEV003, ISEV004 & ISEV005 CABLE
(*Clause* 18.3 *and* 18.7)

Size	Insulation thickness	Sheath Thickness			Maximum Diameter			Insulation resistance at 90˚C
		Three Core	Four Core	Five Core	Three Core	Four Core	Five Core	
mm²	mm	mm	mm	mm	mm	mm	mm	MΩ.km
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1.5	0.7	1.0	-	-	10.5	-	-	0.011
2.5	0.7	1.0	1.0	1.2	11.9	13.1	15	0.0086
4	0.7	1.1	1.1	1.3	13.8	15.2	17.3	0.0071
6	0.7	1.2	1.2	1.4	15.7	17.3	19.7	0.0061
10	0.7	1.4	1.4	1.5	19.0	20.9	23.4	0.0049
16	0.7	1.5	1.6	1.7	22.6	25.2	28.1	0.0041
25	0.9	1.7	1.9	2.0	28.0	31.5	35.2	0.004
35	0.9	1.9	2.1	2.3	32.9	37.0	41.5	0.0033

TABLE 13
TEST SCHEDULE
(*Clause* 18.7)

Sl. No.	Test	Test Type	Requirement Ref. to IS No. / Clause of this standard	Method of Test. Ref. to Part of IS 10810	ISEV001	ISEV002	ISEV003	ISEV004	ISEV005
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1.	Electrical Test								
	a) Conductor Resistance	R,A, T	IS 8130	5	X	X	X	X	X
	b) Voltage test on cores	A,T	13.2	45	X	X	X	X	X
	c) Spark Test	R	13.1	-	X	X	X	X	X
	d) Insulation resistance test at rated temperature	T	13.4 and relevant Tables	-	X	X	X	X	X
	e) DC Water immersion test	T	13.5	-	X	X	X	X	X
	f) Voltage Test on Complete cable	R,A, T	13.3	-	X	X	X	X	X
2.	Test On Conductor Material								
	1) Annealing test	R	IS 8130	1	X	X	X	X	X
	2) Conductor dimension	R	IS 8130	-	X	X	X	X	X
	3) Persulphate test	A, T	13.12		X	X	X	X	X
3.	Construction								
	a) General construction (Cable Design)	A,T	As per standard	-	X	X	X	X	X
	b) Thickness of insulation	A,T	Table 10,11&12	6	X	X	X	X	X
	c) Thickness of sheath	A,T	Table 10,11&12	6	X	X	X	X	X
	d) Braiding material	A,T	Cl.9		X	X	X	X	X
	e) Braiding coverage	A,T	Cl.9		X	X	X	X	X
	f) Diameter of cable	A,T	Table 10,11&12	6	X	X	X	X	X
	g) Ovality of cable	A,T	11.2		X	X	X	X	X
4.	Type Test On Insulation								
5.	a)Tensile strength of insulation- before ageing	A,T	Table 2	7	X	X	X	X	X
	b) Elongation at break of insulation before ageing	A,T	Table 2	7	X	X	X	X	X
	c)Ageing test on	T	Table 2	11	X	X	X	X	X

	insulation								
	d) Hot set test of insulation	A,T	Table 2	31	X	X	X	X	X
	e)Hot Pressure Test on insulation	A,T	Table 2	15	X	X	X	X	X
	f) Bending Test at low Temperature of insulation	T	-	20	X	X	X	X	X
	g) Cold Impact Test at low Temperature of insulation	T	Table 2, cl.13.16	-					
	h) Elongation Test at low Temperature of insulation	T	Table 2	-	X	X	X	X	X
	i) Hardness of insulation	T	Table 2		X	X	X	X	X
	j) Assessment of halogen								
	k) pH	A,T	Table 2	26	X	X	X	X	X
	l) Conductivity	A,T	Table 2	25	X	X	X	X	X
	m) Halogen Content max.	T	Table 2	59	X	X	X	X	X
	n) Fluorine content max.	T	Table 2	3025-60	X	X	X	X	X
6.	Test on Sheath								
	a) Tensile strength before ageing - median min	A,T	Table 3	7	X	X	X	X	X
	b) Elongation at break before ageing - median min	A,T	Table 3	7	X	X	X	X	X
	c) Ageing	T	Table 3	10	X	X	X	X	X
	d) Mineral oil immersion Ageing	T	Table 3	-	X	X	X	X	X
	e) Hot set test	A,T	Table 3	31					X
	f) Hot Pressure Test	A,T	Table 3	15	X		X		
	g) Bending Test at low Temperature for core Dia ≤12.5mm	T	-	20	X	X	X	X	X
7.	h) Cold Impact Test at low Temperature for core Dia ≥12.5mm	T	Table 3, cl.13.16	-					
	i) Elongation Test at low Temperature >12.5mm	T	Table 3	Under preparation (refer IEC 60811-505)	X	X	X	X	X
	j) Heat Shock Test	A,T	-	14	X		X		
	k) Water Resistance Test	T	13.21	-	X	X	X	X	X

	l) Resistance to acid and alkali solution of Outer sheath	T	Table 4	-	X	X	X	X	X
	m) Tear Resistance	T	13.19	17	X	X	X	X	X
	n) Resistance to saponification mean value to be obtained, Max	T	13.7	-	X		X		X
	o) UV Resistance of Sheath	T	13.6	-		X		X	X
8.	Test On Completed Cable								
	a) Compatibility test	T	13.13		X	X	X	X	X
	b) Cold impact Test	T	Table 3, cl.13.16	-	X	X	X	X	X
	c) Cold Bend Test	T	-	20	X	X	X	X	X
	d) Cold Elongation Test	T	Table 3	Under preparation (refer IEC 60811-505)	X	X	X	X	X
	e) Weathering / UV resistance test	T	13.6	-	X	X	X	X	X
	f) Shrinkage Test	T	13.22	12	X	X	X	X	X
	g) Flammability test	T	13.7	53	X	X	X	X	X
	h) Assessment of Halogen	T	13.10	59	X	X	X	X	X
	i) Flexing test	T	13.14		X	X	X	X	X
	j) Cyclic bending Test	T	13.15		X	X	X	X	X
	k) Resistance to Chemical	T	13.20		X	X	X	X	X
	l) Crush Resistance	T	13.18	-	X	X	X	X	X
	m) Surface resistance of sheath	A,T	13.23		X	X	X	X	X
	n) Ozone resistance test @ 25 ± 2 ^{0}C, 24 hrs. @ (250-300) x 10^{-4} concentration	T	10810 (part 13)	13	X	X	X	X	X

SECTION 3 CABLES FOR DC CHARGING ACCORDING TO MODE 4 WITHOUT USE OF A THERMAL MANAGEMENT SYSTEM

19 General Purpose Cables

Cables for DC charging according to mode 4 without use of thermal management system

19.1 Cable Types

a) ISEV-006

b) ISEV-007 and

c) ISEV-008

19.2 Rated Voltage 1.1 V AC and 1.5 kv dc

19.3 Power Cable Sizes and dimension shall be as per relevant **Table 14** and **15** Pilot and control cable shall be as per section 1 Optional one core of PE conductor is permissible and PE conductor is as given in **Table 14** and **15** Optional Auxiliary power cores of cross sections 2.5 to 6 sq.mm – up to two cores is permissible.

19.4 Insulation — Insulation for power Cable shall be of EVI and that of pilot or control cable shall be of EVI-1 or EVI-2. Wall thickness of auxiliary power cable cores shall be min. 0.8 mm.

19.5 Screen — The screen over a core or an assembly of cores (pairs / Quad) shall be of copper or tinned copper braid with 80 ± 5 percent coverage.

19.6 Core Identification — Refer Section 1

19.7 Assembly — The core shall be twisted with suitable layer. Centre – core is not permitted. A separator shall be used if required and braid applied over it.

19.6 Sheath — The sheath shall be of type

a) EVM-1 for ISEV-006

b) EVM-2 for ISEV-007 and

c) EVM-3 for ISEV-008

19.7 Marking

19.7.1 Marking shall be in line with relevant clauses of section 1, further to rated voltage, number and nominal cross section of Power cores and PE conductor, if any.

19.8 Requirements: Refer Table 16.

TABLE 14
TECHNICAL DATA ISEV – 006
(*Cause* 19.3)

Size of power cable*	**Size of PE conductor**	**Thickness**		**Diameter**	**Insulation resistance at 90^0C**
		insulation	**Sheath**		
mm²	**mm²**	**mm**	**mm**	**mm (max.)**	**MΩ. km**
(1)	(2)	(3)	(4)	(5)	(6)
2 x 4	4	0.8	1.1	13.3	0.0079
2 x 6	6	0.8	1.2	14.8	0.0068
2 x 10	10	0.8	1.3	17.4	0.0055
2 x 16	16	0.8	1.5	20.7	0.0044
2 x 25	16	1	1.7	25.9	0.0043
2 x 35	16	1	1.9	29.7	0.0037
2 x 50	25	1.1	2.2	34.8	0.0034
2 x 70	35	1.2	2.5	40.7	0.0031
2 x 95	50	1.2	2.7	45.1	0.0028

2 x 120	70	1.3	2.9	50.5	0.0027
2 x 150	95	1.5	3.2	56.4	0.0028

Note — Power cable could be split in two smaller cores.

TABLE 15
TECHNICAL DATA FOR ISEV – 007 and 8
(*Cause* 19.3)

Size of power cable*	**Size of PE conductor**	**Thickness**		**Diameter**	**Insulation resistance at 90 °C**
		insulation	**Sheath**		
mm²	**mm²**	**mm**	**mm**	**mm (max.)**	**MΩ.km**
(1)	(2)	(3)	(4)	(5)	(6)
2 x 4	4	0.8	1.9	15.2	0.0079
2 x 6	6	0.8	2.0	16.7	0.0068
2 x 10	10	0.8	2.2	19	0.0055
2 x 16	16	0.8	2.4	22.3	0.0044
2 x 25	16	1.0	2.8	28	0.0043
2 x 35	16	1.0	3.2	32.3	0.0037
2 x 50	25	1.1	3.6	37.7	0.0034
2 x 70	35	1.2	4	43.8	0.0031
2 x 95	50	1.2	4.4	48.7	0.0028
2 x 120	70	1.3	4.8	54.5	0.0027
2 x 150	95	1.5	5.3	60.9	0.0028

Note — Power cable could be split in two smaller cores.

TABLE 16
TEST SCHEDULE
(*Cause* 19.8)

Sl. No.	**Test**	**Test Type**	**Requirements Ref. to IS No. / Clause of this standard**	**Method of Test. Ref. to Part of IS 10810**	**ISEV-006**	**ISEV-007**	**ISEV-008**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.	Electrical Test						
	a)Conductor Resistance	R,A,T	IS 8130	5	X	X	X
	b) Voltage test on cores	A,T	13.2	45	X	X	X
	c) Spark Test	R	13.1	-	X	X	X
	d) Insulation resistance test at rated temperature	T	13.4 and relevant Tables	-	X	X	X
	e) DC Water immersion test	T	13.5	-	X	X	X
	f) Voltage Test on Complete cable	R,A,T	13.3	-	X	X	X
2.	Test On Conductor Material						
	a) Annealing test	R	IS 8130	1	X	X	X
	b) Conductor dimension	R	IS 8130	-	X	X	X
	c) Persulphate test	A, T	13.12		X	X	X
3.	Construction						
	a) General construction (Cable Design)	A,T	As per standard	-	X	X	X

	b) Thickness of insulation	A,T	Table 10,11 &12	6	X	X	X
	c) Thickness of sheath	A,T	Table 10,11 &12	6		X	
	d) Braiding material	A,T	Cl.9			X	
	e) Braiding coverage	A,T	Cl.9		X	X	X
	f) Diameter of cable	A,T	Table 10,11 &12	6	X	X	X
	g) Ovality of cable	A,T	11.2		X	X	X
4.	Type Test On Insulation						
	a) Tensile strength of insulation- before ageing	A,T	Table 2	7	X	X	X
	b) Elongation at break of insulation before ageing	A,T	Table 2	7	X	X	X
	c) Ageing test on insulation	T	Table 2	11	X	X	X
	d) Hot set test of insulation	A,T	Table 2	31	X	X	X
	e) Hot Pressure Test on insulation	A,T	Table 2	15	X	X	X
	f) Bending Test at low Temperature of insulation	T	-	20	X	X	X
	g) Cold Impact Test at low Temperature of insulation	T	Table 2, cl.13.16	-			
	h) Elongation Test at low Temperature of insulation	T	Table 2	-	X	X	X
	i) Hardness of insulation	T	Table 2		X	X	X
	j) Assessment of halogen						
	k) pH	A,T	Table 2	26	X	X	X
	l) Conductivity	A,T	Table 2	25	X	X	X
	m)Halogen Content Max.	T	Table 2	59	X	X	X
	n) Fluorine content Max.	T	Table 2	3025-60	X	X	X
5.	Test On Sheath						
	a) Tensile strength before ageing - median min	A,T	Table 3	7	X	X	X
	b) Elongation at break before ageing - median min	A,T	Table 3	7	X	X	X
	c) Ageing	T	Table 3	10	X	X	X
	d) Mineral oil immersion Ageing	T	Table 3	-	X	X	X
	e) Hot set test	A,T	Table 3	31			
	f) Hot Pressure Test	A,T	Table 3	15	X		X
	g) Bending Test at low Temperature for core Dia $\leq$12.5mm	T	-	20	X	X	X
	h) Cold Impact Test at low Temperature for core Dia $\geq$12.5mm	T	Table 3, cl.13.16	-			
	i) Elongation Test at low Temperature >12.5mm	T	Table 3	Under preparation (refer IEC 60811-505)	X	X	X
	j) Heat Shock Test	A,T	-	14	X		X
	k) Water Resistance Test	T	13.21	-	X	X	X
	l) Resistance to acid and alkali solution of Outer sheath	T	Table 4	-	X	X	X
	m) Tear Resistance	T	13.19	17	X	X	X
	n) Resistance to saponification mean	T	13.7	-	X		X

	value to be obtained, Max						
	o) UV Resistance of Sheath	T	13.6	-		X	
6.	Test On Completed Cable						
	a) Compatibility test	T	13.13		X	X	X
	b) Inductance between Power cores	A,T	Cl.13.24		X	X	X
	c) Cold impact Test at -35 °C	T	Table 3, cl.13.16	-	X	X	X
	d) Weathering / UV resistance test	T	13.6	-	X	X	X
	e) Shrinkage Test	T	13.22	12	X	X	X
	f) Flammability test	T	13.7	53	X	X	X
	g) Assessment of Halogen	T	13.10	59	X	X	X
	h) Resistance to Chemical	T	13.20		X	X	X
	i) Crush Resistance test		13.18		X	X	X
	j) Burst Pressure Test (in accordance with ISO 1402)	T	-		X	X	X
	k) Bending test followed after immersion in water, by voltage test of 3.5 kv / 5 minutes	T	Table 2	-	X	X	X

SECTION 4 CABLES FOR DC CHARGING ACCORDING TO MODE 4 INTENDED TO BE USED WITH A THERMAL MANAGEMENT SYSTEM

20 GENERAL PURPOSE CABLES

Cables for DC charging according to Mode 4 intended to be used with a thermal management system

20.1 Cable Types

a) ISEV-009

b) ISEV-010 and

c) ISEV-011

20.2 Rated Voltage 1.1 V a.c. and 1.5 kV d.c

20.3 Power Cable Sizes and dimension shall be as per relevant **Table** 17 and **18** Pilot and control cable shall be as per section 1 Optional one core of PE conductor is permissible and PE conductor is as given in **Table** 17 and 1 Optional Auxiliary power cores of cross sections 2.5 to 6 Sq.mm – up to two cores is permissible Optional Temperature Sensor core is also covered.

20.4 Insulation - Insulation for power Cable shall be of EVI-2 and that of pilot, auxiliary power cores and temperature sensor cores shall be a compound type EVI-1 or EVI-2. Wall thickness of auxiliary power cable cores shall be min. 0.8 mm.

20.5 Screen - The screen over a core or an assembly of cores (pairs / Quad) shall be of copper or tinned copper braid with 80 ± 5 percent coverage.

20.6 Tubes

20.6.1 Fluid filled tubes shall be made of material resistant to the media used as coolant and its compatibility of tube material shall be tested with the cables materials in accordance with IS 10810

(Part 7) The tube material shall withstand an ageing of 120 Dec. for 168 hour and the variation in TS and elongation properties shall not be more than ± 30 percent of unaged sample.

20.7 Core Identification — refer relevant clause in General section.

20.8 Assembly — The core shall be twisted with suitable layer. Centre – core is not permitted. A separator shall be used if required and braid applied over it.

20.9 Sheath — The sheath shall be of type.

a) EVM-1 for ISEV-009

b) EVM-2 for ISEV-010 and

c) EVM-3 for ISEV-011

20.10 Marking

20.10.1 Marking shall be in line with relevant clauses of section 1, further to rated voltage, number and nominal cross section of Power cores and PE conductor, if any. Additionally, the following marking is mandatory.

"USE FOR DEDICATED ACTIVELY COOLED SYSTEMS"

20.21 Requirements: Refer Table 19

TABLE 17
TECHNICAL DATA ISEV – 009
(*Clause* 20.3)

Size of power cable*	Size of PE conductor	Thickness		Diameter	Insulation resistance at 90 °C
		Insulation	Sheath		
mm²	mm²	mm	mm	mm (max.)	MΩ. km
(1)	(2)	(3)	(4)	(5)	(6)
2 x 16	25	0.8	1.5	20.7	0.0044
2 x 25	25	1	1.7	25.9	0.0043
2 x 35	25	1	1.9	29.7	0.0037
2 x 50	25	1.1	2.2	34.8	0.0034
2 x 70	25*	1.2	2.5	40.7	0.0031
2 x 95	25*	1.2	2.7	45.1	0.0028
2 x 120	25*	1.3	2.9	50.5	0.0027
2 x 150	258	1.5	3.2	56.4	0.0028

Note — Power cable could be split in two smaller cores.

TABLE 18
TECHNICAL DATA FOR – ISEV – 010 & 11
(*Clause* 20.3)

Size of power cable*	Size of PE conductor	Thickness		Diameter	Insulation resistance at 90^0C
		insulation	Sheath		
mm²	mm²	mm	mm	mm (max.)	MΩ.km
(1)	(2)	(3)	(4)	(5)	(6)

2 x 16	16	0.8	2.4	22.3	0.0044
2 x 25	16	1.0	2.8	28	0.0043
2 x 35	16	1.0	3.2	32.3	0.0037
2 x 50	25	1.1	3.6	37.7	0.0034
2 x 70	35	1.2	4	43.8	0.0031
2 x 95	50	1.2	4.4	48.7	0.0028
2 x 120	70	1.3	4.8	54.5	0.0027
2 x 150	95	1.5	5.3	60.9	0.0028

Note — Power cable could be split in two smaller cores.

TABLE 19
TEST SCHEDULE
(*Clause* 20.21)

Sl. No.	**Test**	**Test Type**	**Requirements Ref. to IS No. / Clause of this standard**	**Method of Test. Ref. to Part of IS 10810**	**ISEV-009**	**ISEV-010**	**ISEV-011**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.	Electrical Test						
	a) Conductor Resistance	R,A,T	IS 8130	5	X	X	X
	b) Voltage test on cores	A,T	13.2	45	X	X	X
	c) Spark Test	R	13.1	-	X	X	X
	d) Insulation resistance test at rated temperature	T	13.4 and relevant Tables	-	X	X	X
	e) DC Water immersion test	T	13.5	-	X	X	X
	f) Voltage Test on Complete cable	R,A,T	13.3	-	X	X	X
2.	Test On Conductor Material						
	a) Annealing test	R	IS 8130	1	X	X	X
	b) Conductor dimension	R	IS 8130	-	X	X	X
	c) Persulphate test	A, T	13.12		X	X	X
3.	Construction						
	a) General construction (Cable Design)	A,T	As per standard	-	X	X	X
	b) Thickness of insulation	A,T	Table 10,11&12	6	X	X	X
	c) Thickness of sheath	A,T	Table 10,11&12	6		X	
	d) Braiding material	A,T	Cl.9			X	
	e) Braiding coverage	A,T	Cl.9		X	X	X
	f) Diameter of cable	A,T	Table 10,11&12	6	X	X	X
	g) Ovality of cable	A,T	11.2		X	X	X
4.	Type Test On Insulation						
	a) Tensile strength of insulation-before ageing	A,T	Table 2	7	X	X	X
	b) Elongation at break of insulation before ageing	A,T	Table 2	7	X	X	X
	c) Ageing test on insulation	T	Table 2	11	X	X	X
	d) Hot set test of insulation	A,T	Table 2	31	X	X	X
	e) Hot Pressure Test on insulation	A,T	Table 2	15	X	X	X

	f) Bending Test at low Temperature of insulation	T	-	20	X	X	X
	g) Cold Impact Test at low Temperature of insulation	T	Table 2, cl.13.16	-			
	h) Elongation Test at low Temperature of insulation	T	Table 2	-	X	X	X
	i) Hardness of insulation	T	Table 2		X	X	X
	j) Assessment of halogen						
	k) pH	A,T	Table 2	26	X	X	X
	l) Conductivity	A,T	Table 2	25	X	X	X
	m) Halogen Content Max.	T	Table 2	59	X	X	X
	n) Fluorine content Max.	T	Table 2	IS 3025-60	X	X	X
5.	Test On Sheath						
	a) Tensile strength before ageing - median min	A,T	Table 3	7	X	X	X
	b) Elongation at break before ageing - median min	A,T	Table 3	7	X	X	X
	c) Ageing	T	Table 3	10	X	X	X
	d) Mineral oil immersion Ageing	T	Table 3	-	X	X	X
	e) Hot set test	A,T	Table 3	31			
	f) Hot Pressure Test	A,T	Table 3	15	X		X
	g) Bending Test at low Temperature for core Dia $\leq$12.5 mm	T	-	20	X	X	X
	h) Cold Impact Test at low Temperature for core Dia $\geq$12.5 mm	T	Table 3, cl.13.16	-			
	i) Elongation Test at low Temperature >12.5 mm	T	Table 3	Under preparation (refer IEC 60811-505)	X	X	X
	j) Heat Shock Test	A,T	-	14	X		X
	k) Water Resistance Test	T	13.21	-	X	X	X
	l) Resistance to acid and alkali solution of Outer sheath	T	Table 4	-	X	X	X
	m)Tear Resistance	T	13.19	17	X	X	X
	n) Resistance to saponification mean value to be obtained, Max	T	13.7	-	X		X
	o) UV Resistance of Sheath	T	13.6	-		X	
6.	Test On Completed Cable						
	a) Compatibility test	T	13.13		X	X	X
	b) Inductance between Power cores	A,T	Cl.13.24		X	X	X
	c) Cold impact Test at -35 °C	T	Table 3, cl.13.16	-	X	X	X
	d) Weathering / UV resistance test	T	13.6	-	X	X	X
	e) Shrinkage Test	T	13.22	12	X	X	X
	f) Flammability test	T	13.7	53	X	X	X
	g) Crush Resistance test	T	13.18		X	X	X
	h) Assessment of Halogen	T	13.10	59	X	X	X
	i) Resistance to Chemical	T	13.20		X	X	X
	j) Bending test followed after immersion in water, by voltage test of 3.5 kv / 5 minutes	T	Table 2	Ref. Note	X	X	X

Note — On completion of test as per 6.9 of the table above, inspect the sheath for any damage followed by air leakage test with 300 kPa and maximum allowed leakage is 25 ml/min.