

SPECIFICATION No RDSO/2018/EL/SPEC/0140 Rev'0'

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS



SPECIFICATION FOR SINGLE PHASE TO THREE PHASE 2 X 130 KVA STATIC
CONVERTER (SIV) FOR CONVENTIONAL LOCOMOTIVES

Specification No: RDSO/2018/EL/SPEC/0140 Rev-'0'

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Approved by	Signature
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1.0 Introduction:

During 38th MSG meeting it was decided to develop 2x130 kVA Variable Voltage Variable Frequency (VVVF) Static Converter (SIV) with redundancy feature. This Static Converter shall be termed as SIV as defined in Clause 2.1 of this specification. This SIV shall be accommodated in the dimensional envelop of 1520 mm X 800 mm X 1700 mm. Control connections should be taken from side of the converter. In addition to this the size of the Choke shall not be more than 600 mm X 800 mm X 1700 mm. The choke may be provided separately. The cabinets shall be of stainless steel of grade SS-304.

SIV will get input supply voltage from auxiliary winding of main loco Transformer of 5400 KVA whose details are as under:-

1.1 The rating of 5400 KVA transformer is appended as under :

Winding	KVA rating	Current	Voltage
Primary	5400KVA,	252 A	22.5 kV
Secondary	5400 KVA	2 x 2700 A	1000 V
Auxiliary	270 KVA	325.30 A	830 V (2 x 415V)

Percentage impedance

- Main circuit 12%
- Auxiliary circuit 3 to 5%
- Magnetizing current at 22.5 KV = 2.5 A

1.2 The manufacturer shall submit detailed design of the equipment for approval to RDSO before commencing the manufacturing of prototype as mentioned in Clause 1.4 of this specification.

1.3 References to various specifications.

Standards	Title
IEC - 60077-1	Railway applications - Electric equipment for rolling stock - Part 1: General service conditions and general rules
IEC - 61287-1	Railway applications - Power converters installed on board rolling stock - Part 1: Characteristics and test methods
IEC - 60571	Railway applications - Electronic equipment used on rolling stock

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IEC – 61373	Railway applications - Rolling stock equipment - Shock and vibration tests
IEC-60529	Degrees of protection provided by enclosures (IP Code)
IEC – 60310	Railway applications - Traction transformers and inductors on board rolling stock
EN- 50153	Railway applications. Rolling stock. Protective provisions relating to electrical hazards
BS EN 50124-1: 2001 Part 1	Railway applications. Insulation coordination. Basic requirements. Clearances and creepage distances for all electrical and electronic equipment
IEC - 61000 series	Basic EMC publications include terminology, descriptions of electromagnetic phenomena and the EM environment, measurement and testing techniques, and guidelines on installation and mitigation.
IEC-60068-2-52	Salt mist, cyclic (sodium chloride solution)
EN- 50153	Railway applications – Rolling stock- Protective actions against electrical hazards.

1.3.1 The latest version of the aforesaid standards is to be considered for designing the equipment.

1.3.2 The requirements listed in this Specification are the minimum. The Manufacturer may adopt alternative internationally recognized codes, standards and specifications if it can demonstrate that such an alternative is superior with approval.

1.4 Reliability, Availability, Maintainability and Safety (RAMS)

1.4.1 GENERAL:- The Manufacturer shall design the 2 X 130 KVA converter to ensure high degree of reliability, availability and high degree of safety and shall conform to EN 50126/ IEC 62278. Reliability of electronic components shall conform to IEC 61709. The Manufacturer shall develop. A detailed RAMS assessment system along with targets in support of the design, manufacture and subsequent testing, commissioning, operation and maintenance of the 2 X 130 KVA converter so that it shall provide a high level of reliability. Each 130kVA SIV unit shall be identical and independent to function.

1.4.2 MAINTENANCE: The maintenance periodicity of unit should match with specified maintenance schedules periodicity of electric locomotives

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issued from time to time. The manufacturer shall supply the detailed maintenance manual and trouble-shooting directory to the Purchaser for easy maintenance and operation. One set of manual shall be supplied with each unit along with a soft copy. One hard and soft copy of the same is to be handed over to RDSO for Prototype approval. Fully illustrated maintenance manuals shall consist of followings along with other routine details.

- a) Description and arrangement.
- b) Technical data.
- c) Commissioning instructions
- d) Dismantling and assembly instructions.
- e) Particulars of recommended spares.
- f) Periodical inspection schedules.
- g) Periodical maintenance instructions along with trouble shooting instructions.
- h) Testing procedure for the equipment.
- i) Allowed limits for vital components.
- j) Detailed parts catalogue with description of items. The parts shall be detailed by sketches to facilitate ordering.
- k) Instructions for reclamation of over aged or worn out components.
- l) List of special tools with instruction for use.
- m) List of all the components with their average life.
- n) Preventive maintenance procedure and overhauling kits with list of equipment and man-hours required for various activities.
- o) Average life of SIV unit.
- p) The manufacturer shall supply suitable software for offline analysis of diagnostic data downloaded from the converter..

1.5 Documentation:

The Manufacturer shall submit the following information after completion of their design in printed form and neatly compiled in a booklet form :-

- a) Detailed Schematic Circuit diagrams of SIV
- b) Functional description with details of major equipment specification and data sheet.
- c) The description as per format in Annexure –B
- d) Protection concepts: Details of implementation i.e. through software and hardware shall be clearly spelt out as per IEC 60529 (Latest edition).
- e) The details of cooling fan, life of bearing, maintenance process/replacement procedure of cooling fan etc. will be submitted

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along with design document. Maintenance free sealed bearings shall be used for cooling fans .

- f) Mechanical interface diagram:. The converters are to be fitted in existing foot print.SIV should not infringe with the adjacent equipment of locomotive and have adequate clearance. Mechanical drawings of complete cubicles as well as Major sub-assemblies/Rack with details of dimensions, mounting arrangement, details of mounting accessories, drawings.
- g) Calculation of power devices:- Design calculations along with total loss calculation at rated power, heat sink design etc including the calculation of safety margin in voltage, current, thermal (for junction temperature) along with the limit value of power devices. Minimum airflow rate, which will give the desired cooling, shall also be mentioned. Air flow calculation shall also be submitted.
- h) Expected efficiency with respect to load.
- i) Detail operation of panel and function of each switch, indications and fault diagnostic feature.
- j) Test protocol with procedure of testing in detail .
- k) Specification of spares along with detail of address of sub vendors.
- l) Manufacturer will have to submit Bill of Material.

1.6 Infringement of patent rights:

Indian Railway shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, use of similar components used in design, development and manufacturing of converter and any other factor not mentioned herein which may cause such dispute. The entire responsibility to settle any such issues lies with the manufacturer.

1.7 Field Trial:

After successful type testing of prototype, the SIV unit(s) will be put to Field trial for minimum six months period in actual service condition in a locomotive. However, the number of units to be put for the field for trials may vary which is under discretion of RDSO. Prototype approval will be provided after such successful field trials.

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2.0 TECHNICAL SPECIFICATION

2.1 TERMINOLOGIES USED:

Terms/abbreviations used frequently in the document are explained here:

- a) MVSI: Motor for silicon rectifier cooling blower
- b) MVSL: Motor for smoothing reactor cooling blower
- c) MPH: Motor for transformer oil pump
- d) MCP: Motor for main compressors
- e) MVRH: Motor for main transformer cooling blower
- f) MVMT: Motor for traction motor cooling blower
- g) CHBA: Battery charger
- h) MVRF: Motor for Rheostatic brake blower
- i) SIV : 2 X 130 KVA Variable Voltage Variable Frequency static inverter .
- j) SIV -1 : One of the 130 KVA unit of SIV as defined in para 2.3.3 of this specification.
- k) SIV -2 : One of the 130 KVA unit of SIV supplying electrical power to battery charger along with other electrical load mentioned in para 2.3.3 of this specification.

2.2 GENERAL DESCRIPTION :

SIV shall be IGBT based on out-put side. There shall be two types of output. (i) 415V, 3- phase & (ii) 110 V DC . Three phase AC output of the converter shall be connected to the loads as described later in this specification. The SIV shall have at least one inbuilt independent switch mode power supply (SMPS) type Battery Charger with galvanic isolation integrated in the same cabinet to provide 110 V DC to batteries and other small DC loads of the locomotive described in this specification.

Normally both the convertors will be in running condition. In case of failure of one converter, the faulty converter should get isolated and the other converter should take over and supply to the loads connected to faulty converter in addition to its own load. However, firm shall make provision in software for operation at 50Hz as well as 44Hz to limit the load in case of changeover due to isolation of faulty converter. The manufacturer shall design the scheme such that automatic changeover takes place within 20 seconds. The changeover and isolation of faulty converter shall be done with the help of contactors with interlocking feature. The Cooling arrangement for the power devices and choke should be the part of equipment supplied by OEM. Individual blower fan shall be provided for both the SIV unit.

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2.3 Converter Ratings:

2.3.1 INPUT:

2.3.1.1 Input Voltage:

Input voltage available for 2 X 130 kVA SIV shall be 830 V at 22.5 KV supply of OHE voltage. Input voltage to SIV may vary according to OHE voltage as shown below:

Power Supply System

Nominal voltage : 22.5 KV 50 HZ single phase AC
corresponding voltage auxiliary voltage is
830 V

Normal variation of : 19 KV to 27.5 KV
supply voltage

Occasionally maximum : 31 KV
voltage

Occasionally minimum : 16.5 KV
Voltage

Variation of supply : 50 Hz \pm 8 %
frequency

2.3.1.2 Power factor:

Input power factor (pf) shall be maintained at 0.8 or more (at full load) for OHE voltages from 20 kV to 28.5 kV. Above 28.5 kV, pf shall not be less than 0.55.

2.3.1.3 Control supply:

The control supply will be 110 V DC nominal but SIV performance should not be affected if battery voltage varies from 78 V to 136 V DC. CFL fittings, DC-DC converter etc. are also connected through battery, SIV unit performance shall not be effected due to flickering / harmonics on this account.

2.3.1.4 Input power arrangement:

- i. R-C circuit is placed across the auxiliary winding of transformer 5400 KVA. A combination of four capacitors of $0.47\mu\text{f}/2\text{ KV}$ (Two in parallel) are placed across auxiliary winding of Transformer with center point earth. Alternatively in some of the transformers two nos. of $1\mu\text{f}/2\text{ KV}$ in series may be placed across auxiliary winding with center point earth.

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- ii. Panto bouncing duration up to 45 ms (loss of contact with OHE) shall not affect SIV performance.

2.3.2 OUTPUT:

3 phase AC voltage (L-L): 415 V \pm 5%

- a) Output Frequency: 50 Hz \pm 3%,
- b) KVA output: 2 X 130 kVA or more.
- c) Short time current Rating : 360 A for 5 seconds.
- d) Total Harmonic Distortion (THD) in output Voltage : Less than 10%.
- e) DC output of battery charger: The output of fully charged Battery shall be 110V \pm 5%, 20A with current ripple less than 5%. The battery charger characteristics shall be suitable for charging 75 Ah batteries for Electric Loco as well as power supply electrical loads operating at 110 V. The charging cycle shall be such that after charging of battery, the charger shall go to trickle mode. The battery charger shall have over current protection to limit battery charging current between 8A -10 Amps. There should be a provision of isolation of Battery using HBA switch.
- f) Efficiency at rated output: Minimum 92% at rated load (130 kVA) at 0.8 \pm 0.02 pf (lag) at 830 volts.
- g) Rated capacity of 2 X 130 kVA converter is expected for entire voltage range of 20 kV to 30 kV. However, degraded performance in terms of lower output voltage or frequency is acceptable below 20 kV and manufacturer will specify the extent of degradation in performance. It will not be possible to regulate the duty cycle of the loads for any part of the voltage range.
- h) The converter shall be suitable for generating 3- phase out put at variable voltage and variable frequency.
- i) The manufacturer will keep the provision for isolation of battery Charger so that 2 X 130 kVA converter does not trip in case battery charger section is faulty.

2.3.3 Load distribution on SIV

Distribution of load in SIV shall be as follows:

SIV -1		KW
Traction motor blower -1 (MVMT-1)		26.0
Traction motor blower-2 (MVMT-2)		26.0
Motor for main transformer /DBR (MVRH/MVRF)		22.0
Total maximum connected load on SIV -1		74.0
SIV -2		KW

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Motor for silicon rectifier (MVSI -1)	3.0
Motor for silicon rectifier (MVSI -2)	3.0
Motor for silicon rectifier (MVSL -1)	3.0
Motor for silicon rectifier (MVSL -2)	3.0
Compressor motor 3 X 10.5 kW Or Compressor motor 2 X 15 kW Or Compressor motor 2 X 18 kW	36 (max)
Oil pump for transformer (MPH)	3.5
Cab Heater/AC 1& 2 (single phase)	4
Cab fan 4 no (single phase)	1.5 (approx)
Total maximum connected load (AC) on SIV -2	57
In addition to above Battery charger shall also be connected for charging 75 AH loco battery	
Other DC loads	
Control circuit	6 A inductive
CFL lighting, Head light, flasher light.	400 Watt (approx)

2.3.4 Working of motor/ auxiliaries connected to SIV :

Three phase motors as listed below are fed by SIV. Based on their requirement for loco operation, brief details of their start and normal working is given in table -1 below:

Table -1

(a)	MVSL1&2, MVSI 1& 2, MPH	Connected as soon as locomotive circuit breaker switched ON.
(b)	MVRH & MVMT 1& 2	These blower motors are connected with time delay one by one.
(c)	MVRF	During Rheostatic braking operation, first MVRH will be OFF and MVRF will be switched ON (DOL start). Once the electrical braking operation is over, MVRF will be cut OFF and MVRH will be switched ON (DOL start) in addition to all other loads defined in (a), (b) & (d).
(d)	MCPs	Compressors are to be switched ON/OFF Direct On Line (DOL) depending on air requirement. MCPs start Direct on line after some delay of loads (a) & (b) OR (a), (b) & (c).

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Note:- SIV shall be capable of achieving the rated output with auxiliary motors in group (a), (b) & (d) in table -1 above connected to it within 15 seconds.

2.4 Protection:

2.4.1 The devices used in the converter shall be protected against high rate of rise of voltage & current, line transient surge, switching surges etc. The converter shall be protected against:-

- a) IP-54 for electronics.
- b) Earth fault in ac input circuit.
- c) Earth fault in 3-phase load.
- d) Aux. Converter phase fault.
- e) Line to line short circuit due to dead short at motor terminals.
- f) Thermal over loading.
- g) Fuse failure in converter.
- h) High / Low voltage in dc link.
- i) Failures of power supply to control electronics.
- j) Input over voltage / Under voltage.
- k) Input over current.

The details of such protection shall be submitted by the manufacturer for review during design stage.

2.4.2 The static converter should be suitably protected against the climatic and environmental conditions as mentioned in chapter -3.

2.4.3 The equipment shall be protected against internal transient, spikes & surges as per limit laid down as per IEC 60571-1.

2.5 Fault Diagnostics & Trouble Shooting:

- i) The provision shall be made to download the fault data on a laptop computer through a standard USB port. Storage of at least 50 faults for each SIV unit along with background data shall be provided. Details of fault which leads to tripping of converter shall be stored. SIV status shall be available on display panel to be provided on SIV as follows:

Description	LED indication	Remarks
SIV -1 OK	Green	The indication is ON when there is no fault in the SIV-1.
SIV -1Fault	Red	The indication is ON when fault occurs in SIV -1.
SIV -2 OK	Green	The indication is ON when there is no

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		fault in the SIV-2
SIV -2Fault	Red	The indication is ON when fault occurs in SIV -2
Input earth fault	Red	The indication is ON when there is earth fault at input side.
Output earth fault	Red	The indication is ON when there is earth fault at output side.

Push Button: Yellow colour, spring return, Common Reset Push Button to reset the fault in SIV-1 or SIV-2.

There shall be provision of Auto reset in order to reset spurious/transient faults.

ii) Input /output earth fault

Both the converter shall have provision to work with output earth fault. Converter should be suitably protected for earth fault at the input side.

2.6 Marking:

The major equipment / subassemblies shall bear marking and serial number. The equipment shall contain serial number and make of manufacturer.

- a) All equipment / cubicles shall contain nameplates of anodized aluminum with engraved / punched letters.
- b) The SIV rating plate shall be marked with the following information.
 - i. Type /Make.
 - ii. Contract number
 - iii. Month and year of manufacture/ batch no. / Serial no.
 - iv. Rating –Input/output voltage, frequency and wave shape
 - v. Connection diagram with terminal marking.

2.7 Cable:

The use of wires / cables shall be as per RDSO specification for cable No-ELRS/SPEC/ELC/0019 Rev'4' of Feb 2018. All the cable terminations shall be made through crimped sockets/ lugs. Each cable/ wire shall be numbered at both ends for easy identification. Cable grommets/ glands of suitable size with proper fitment as required for input and output cables are to be provided at cable entry/exit.

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3.0 CLIMATIC & ENVIRONMENTAL CONDITION

The climatic and environmental conditions prevailing in India are the following:

3.1	Atmospheric temperature	Stabled Locomotive under sun	75 ° C
		On board working loco under sun	60 ° C
		Minimum temperature	(-) 5°C (Also snow fall in certain area during winter season)
		Average temperature.	47 ° C
3.2	Humidity	100% saturation during rainy season	
3.3	Altitude	Upto 2500 m above mean sea level	
3.4	Rain fall	Very heavy in certain areas. The loco equipment shall be designed suitably.	
3.5	Atmospheric conditions	Extremely dusty and desert terrain in certain areas. The dust concentration in air may reach a high value of 1.6 mg/m ³ . In many iron ore and coal mine areas, the dust concentration is very high affecting the filter and air ventilation system.	
3.6	Coastal area	Equipment shall be designed to work in coastal area in humidity and salt laden and corrosive atmosphere.	
		Maximum pH value	8.5
		Sulphate	7 mg per litre
		Max. concentration of chlorine	6 mg/ litre.
		Maximum conductivity	130 μ siemens /cm
3.7	Vibration	The equipment shall be designed to withstand the vibrations and shock encountered in service satisfactorily as specified in IEC-61373 latest Publication for Shock & Vibration on Rolling-stock vehicle. The vibration test shall be done as mounted in the actual operating condition.	
3.8	Electromagnetic pollution	High degree of electromagnetic pollution is anticipated in locomotive machine room, where the equipment will be mounted. Necessary precaution shall be taken in this regard. The equipment shall be design to cater to the EMC/EMI requirements as per IEC-61000-4-6.	

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4.0 TESTS

4.1 The converter shall be tested in accordance with relevant/latest specifications/standards as indicated below:-

During testing IEC no 61287-1-2014-07 edition 3.0

SN	TEST	CLAUSE	TYPE	ROUTINE
1.	Visual inspection	IEC 61287-1 clause 4.5.3.1	✓	✓
2.	Verification of dimension & tolerances	IEC 61287-1 clause 4.5.3.2	✓	✓
3.	Weighing	IEC 61287-1 clause 4.5.3.3	✓	
4.	Marking inspection	IEC 61287-1 4.5.3.4	✓	✓
5.	Cooling system performance tests	IEC 61287-1 clause 4.5.3.5	✓	
6.	Test of the degree of protection	IEC 61287-1 clause 4.5.3.6	✓	
7.	Di Electric test	IEC 61287-1 clause 4.5.3.7	✓	✓
8.	Insulation resistance test	IEC 61287-1 clause 4.5.3.8	✓	✓
9.	Tests of Mechanical & Electrical protection and measuring equipment	IEC 61287-1 clause 4.5.3.9	✓	✓
10.	Light Load test	IEC 61287-1 clause 4.5.3.10	✓	✓
11.	Commutation test	IEC 61287-1 clause 4.5.3.11	✓	
12.	Acoustic Noise Measurement	IEC 61287-1 clause 4.5.3.12	✓	
13.	Temperature Rise test	IEC 61287-1 clause 4.5.3.13	✓	
14.	Power Loss Determination.	IEC 61287-1 clause 4.5.3.14	✓	
15.	Supply Overvoltage & Transient energy test	IEC 61287-1 clause 4.5.3.15	✓	
16.	Sudden variations of Load	IEC 61287-1 clause 4.5.3.16	✓	
17.	Safety requirements inspection	IEC 61287 clause 4.5.3.17	✓	
18.	Tests for withstanding Vibration and shock	IEC 61373 Clause 4.5.3.18	✓	
19.	Short time supply interruption test	IEC 61287-1 clause 4.5.3.21	✓	
20.	Current Sharing	IEC 61287-1 clause 4.5.3.22	✓	
21.	Load break test	IEC 61287-1 clause 5.1.3.5	✓	

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22.	Short circuit	IEC 61287-1 clause 5.2.2.8	✓	
23.	Rated Current load	IEC 61287-1 clause 7.4.5	✓	
24.	Voltage & frequency ranges verification	IEC 61287-1 clause 7.5.5	✓	
25.	Overload capability test	IEC 61287-1 clause 7.5.6	✓	
26.	Performance test	IEC 60571 clause 12.2.3	✓	✓
27.	Dry heat test	IEC 60571 clause 12.2.5	✓	
28.	Damp heat test, cyclic	IEC 60571 clause 12.2.6	✓	
29.	Surges, Electrostatic Discharge & Transient burst susceptibility tests	IEC 60571.1 clause 12.2.8 & as per IEC 61000-4-2	✓	
30.	Radio frequency test	IEC 60571.1 clause 12.2.9 & IEC 61000-4-6	✓	
31.	Salt mist test	IEC 60571.1 clause 12.2.11	✓	
32.	Burn in	As per Annexure no B	✓	

- 4.2** The prototype SIV unit shall be inspected & tested by the RDSO at the factory premises or at mutually decided venue where all the facilities shall be made available for carrying out the prototype test at the cost of manufacturer. The SIV unit(s) shall be kept for field trials for a period of minimum 06 months. RDSO will associate and witness the tests in the locomotive also. Any defect noticed/design improvement felt necessary as a result of the tests / field trials shall be carried out by the manufacturer on priority. The number of SIV units for field trial may vary as decided by RDSO. Prototype approval shall be given after successful field trials.
- 4.3** The type test shall be performed on one unit of a given design as per specification. In addition, the manufacturer shall repeat the type tests after 05 years without any additional cost. The five years will be counted from the date of successful clearance of type test of the prototype unit.
- 4.4** Necessary arrangement shall be made by the manufacturer to carry out all the tests as per specification.
- 4.5** Type test shall also be repeated in following cases:-
- Major Modification of equipment, which is likely to affect its function.
 - Resumption of production after an interruption of more than two years.

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- 4.6** Routine tests shall be carried out on each SIV unit by inspecting agencies of Railways.
- 4.7** RDSO/ authorized representative of IR may carry out quality audit on manufacturing process and quality control of the manufacturer at any time to ensure quality & reliability of product.
- 4.8** The Manufacturer shall submit a type test and routine test protocol to RDSO for approval before commencement of prototype tests.
- 4.9** Visual inspection – In addition to IEC 61287-1 clause no 4.5.3.1, list of materials, make, rating of equipment, sub-assemblies shall be checked from the Bill of Material (BOM) submitted with design document. Bill of material shall be approved along with design document. Any change in make or rating of important equipment and sub-assemblies shall be made only with prior approval of RDSO. All the important dimensions shall be mentioned with tolerances.
- 4.10** Power loss determination test –In addition to IEC 61287-1 clause no 4.5.3.14, this test shall be done at voltage corresponding to 22.5 kV in OHE. The efficiency will be measured at full and 80 % of load at 0.8 pf ± 0.02 pf. However, performance at other different input voltage such as 16.5 KV, 17.5 kV, 19 kV, 25 kV, 27 kV, 30 kV and 31 KV shall also be recorded.
- 4.11** BURN in test - The electronic cards used in SIV unit shall be subjected to the temperature cycle as shown in Annexure - B. The cards shall be kept energized during the test. This test shall be done for at least 5 cycles in which one cycle duration is 15 hours.
- 4.12** Cooling test – In addition to IEC 61287-1 clause no 4.5.3.5, the purpose of this test is to verify the cooling of various component / assemblies. The airflow rate shall be measured to confirm compliance as indicated in design document or claimed by the manufacturer.
- 4.13** Insulation resistance and Dielectric test - In addition to IEC 61287-1 clause no 4.5.3.8 & clause no 4.5.3.7, the insulation resistance with 1000 V/500 V megger shall not be less than 10 M Ω for all the circuits. The dielectric test shall be carried out after shorting semiconductor device, pulse transformer and electronic cards earthed if necessary before applying Dielectric voltage.
- 4.14** Leakage current test : –
The followings are the voltage and corresponding leakage current limits:

Location	Voltage	Duration (sec)	Leakage current
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	(rms)		should be less than (mA)
Input Circuit	3.3 KV	60	50
110 V control side	1.5 kV	60	10
24 V electronics side	500 V	60	10
Battery Charger- (415V side)	2 kV	60	10

- 4.15** Temperature rise test – In addition to IEC 61287-1 clause no 4.5.3.13, the SIV unit converter shall be loaded to full load for at least 6 hours with input OHE voltage of 20 kV and The temperature rise shall be recorded by temperature detectors (not by temperature sticker) mounted at the specified reference points on the body of semiconductor devices, capacitors, and other components as mutually agreed between Railways and manufacture. The temperature rise recorded at ambient temperature shall be extrapolated for an ambient temperature of 55 °C. If inspection authority feels the temperatures of other places are also to be recorded, the provision of the same may be made.
- 4.16** 25% safety margin in the rating both voltage and current under worst condition shall be ensured.
- 4.17** Thermal margin of 10° C for junction temperature under worst operating condition for power devices shall be ensured.
- 4.18** Cooling arrangement of electronics shall be made in such a way that temperature of electronics is maintained 20° C lower than the maximum temperature allowed for the electronic card.
- 4.19** DC link discharge – The DC link voltage shall come down below 50 V within 5 minutes.
- 4.20** Short time rating - Short time rating of SIV unit for 360A for 5 seconds shall be verified by actual test.
- 4.21** Short circuit test: - It shall be conducted at the output of SIV unit for demonstration of protection.

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Annexure—A

DATA TO BE FURNISHED BY THE MANUFACTURER

1.0 Rating at 50 Hz and reduced frequency of 44 HZ

Continuous rating KVA PFV.....Hz.

Short time rating KVA PFV.....Hz.

2.0 Cubicle for SIV 1 &2 combined

2.1. Cubicle size (including all projections)

Height ----- mm

Width ----- mm

Depth ----- mm

2.2 Weight ----- Kgs

3.0 Switching Devices Used

3.1 Type

3.2 Make

3.3 Voltage and - Current -----

3.4 Characteristic curve -----

3.5 Total power devices used per cubicle -----

3.6 Maximum permissible junction temp ----- Degree C

4.0 Cubicle for Choke

Height ----- mm

Width ----- mm

Depth ----- mm

4.1 Rating of choke ----- KVA

4.2 Insulation for choke ----- Class

5.0 Details Of Protection – IP protection provided for different modules.

6.0 Cooling Arrangement Details:-

1. No. of cooling fan with Data Sheet

2. Operating voltages

3. Current

4. Watts

5. Efficiency

6. Type of Bearing

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7.0 Efficiency

- 7.1 No load losses ----- Watt
- 7.2 Full load efficiency at rated input voltage ----- %
- 7.3 Efficiency at 80 % load at rated input Voltage ----- %
- 7.4 Efficiency at full load and reduced frequency (44 Hz) ----- %

8.0 Output wave-shape and Voltage THD at full load at 50 Hz and reduced frequency 44 HZ.

9.0 Battery Charger

9.1 Rating at 50 Hz and reduced frequency

- Output Voltage ----- V
- Output Current ----- A
- Ripple factor ----- %

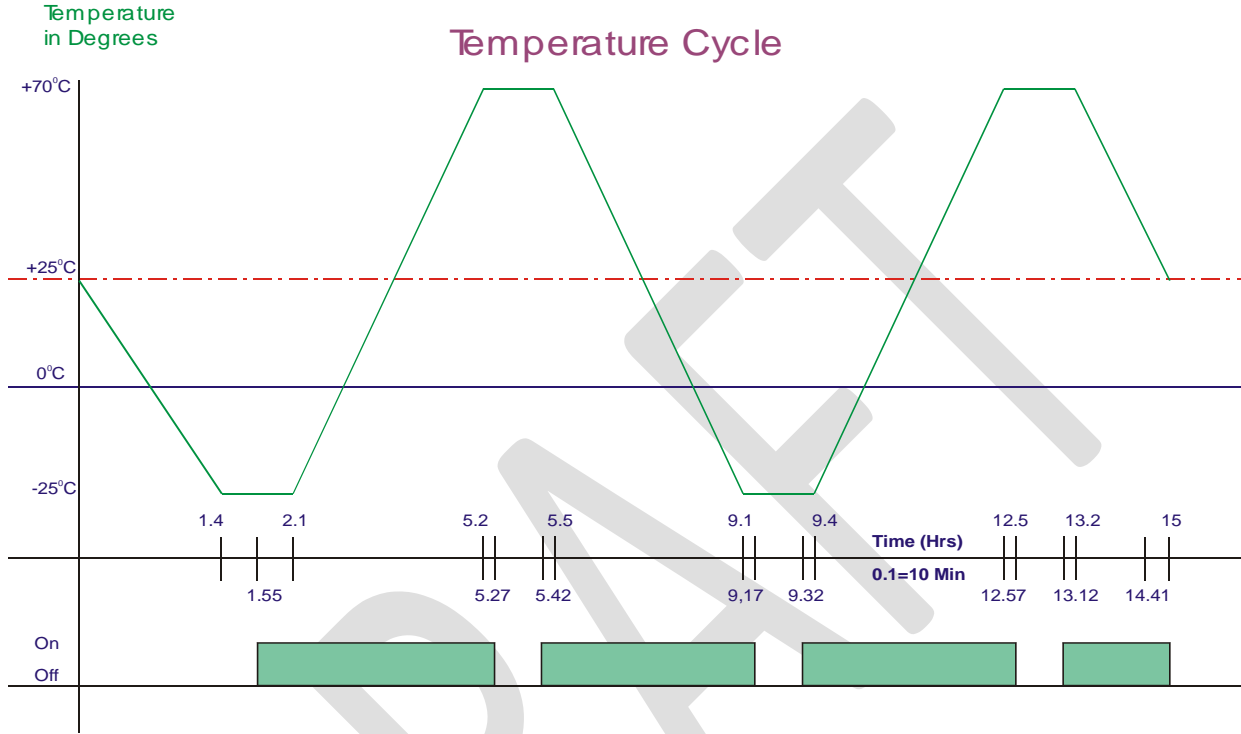
10.0 Technical Data Of Cable Used For Internal Wiring:-

- 10.1 Type
- 10.2 Specification with standard.
- 10.3 Colour
- 10.4 Size

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Annexure—B

BURN-IN TEST



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