

**Government of India
Ministry of Railways
(Railway Board)**

**INDIAN RAILWAY
STANDARD SPECIFICATION
FOR
Transformer - Rectifier Set**

Serial No. S 91-93

- 1. SCOPE**
 - 1.1 This specification covers the technical requirements of Transformer-Rectifier set for use in Railways signalling installations, where reliable AC supply is available.
 - 1.2 The performance of the Transformer-Rectifier set is guaranteed for a variation of $\pm 10\%$ around the rated nominal input voltage of 230/110V. In case the input voltage varies by more than 10%, use of a separate AC voltage stabilizer in conjunction with the transformer-rectifier set is recommended. Additional input tapplings of 200, 210 & 220V shall be provided to cater for cable voltage drop for remote locations. In case of 110V input unit, additional input tapplings shall be 90, 95 & 100 V.
 - 1.3 The nominal output voltage and current shall be specified by the purchaser. Recommended voltage ratings are 4, 6, 8, 12, 15, 24, 28, 35, 60, 65, 110, 120 & 130V and current ratings are 0.5, 1, 2, 3, 5, 10, 15, 20, 30 and 50 Amps.
- 2. GENERAL REQUIREMENTS**
 - 2.1 The Transformer-Rectifier set shall be air-cooled type having sufficient slots/holes provided for ventilation in such a way that dripping water does not enter inside easily.
 - 2.2 The outer casing of the transformer - rectifier set shall be fabricated of cold rolled closed annealed mild steel sheet of at least 2 mm thickness.
 - 2.3 The unit shall be of robust construction and withstand bumps and shocks as encountered in transportation by rail or road in unpacked condition.
 - 2.4 The slots/holes provided for ventilation shall be covered with wire mesh having 10 holes/cm square to prevent entry of rodents, lizards, etc.
 - 2.5 A circuit diagram on an anodized aluminum plate of minimum thickness of 1 mm shall be fixed conspicuously inside. All components shall be indelibly marked and their values/ratings indicated on the diagram.

- 2.6 The inside and outside surfaces of the transformer rectifier unit shall be painted to prevent corrosion. All metallic parts shall be chrome plated.
- 2.7 Cables and wire used shall conform to specification No. IRS:s 76-92 and shall be procured from RDSO approved suppliers. Cables and wires used shall be neatly held in position by bunching and strapping. The gauge of the wires used shall be such that the current density does not exceed 3 Amps/Sq.mm 50Hz.
- 2.8 All connections shall be made though crimped eyelets and shall be numbered with PVC cable marker rings.
- 2.9 Following components shall be provided on the front panel.
- i) A double pole ON/OFF switch conforming to IS: 4064 (Pt. I) for switching ON/OFF of the AC mains.
 - ii) Power 'ON LED' indication.
 - iii) HRC fuses of suitable rating conforming to IS: 9224 along with fuse carriers on the output side and input side.
 - iv) Once set of insulating output terminals for connection of load. The negative terminal shall be of black colour while positive terminal shall be of red colour. These shall be of sufficient size to facilitate connection of wires of size commensurate with rating.
 - v) Voltmeter and Ammeter of ranges 150% of the ratings, conforming to IS: 1248 shall be provided.
 - vi) A green terminal marked 'Earth' for earthing.
 - vii) Input taps shall be provided for 200V, 210, 220 and 230V (for unit of 230V nominal input) and 90,95 & 100 (for unit of 110V nominal input)
 - viii) Additional output taps shall be provided at 15V, 28V, 85V and 130V for 12, 24, 60 and 110V rating units respectively.
- 2.10 Provision shall be made to terminate the AC input leads on terminals provided on the equipment.
- 2.11 The transformer used shall be double wound and shall be vacuum impregnated. It shall be air-cooled type and shall conform to IS:6297 as far as applicable. Class 'B' insulating material shall be used.
- The temperature rise of the core and winding shall not be more than 55 deg. C over the ambient temperature under worst operating conditions. The gauge of the winding wire shall be such that the current density does not exceed 2.0 Am/Sq.mm. 50Hz.

- 2.12 When tested in accordance with Cl. 8.2.1.6 or IS: 6297 (Pt. I) the transformer shall not show insulation resistance of lower than 1000 M. ohms when measured at an ambient temperature of 40 deg. C and RH of 60%. Also the insulation resistance value shall not fall below 500 M/ohms at the end of climatic tests. In case the temperature and humidity at the time of measurement are different, the IR value shall be computed using the graph in Annexure 'A'.
- 2.13 Semiconductor diodes in bridge configuration for full wave rectification shall be used. The peak inverse voltage of the diodes shall be more than double the expected voltage across them. Maximum temperature of semiconductor devices shall not rise by more than 35 deg.C above the ambient temperature. The current rating of the diodes used shall be more than twice the value of current through them.
- Diodes shall be mounted on heat sinks of adequate capacity and RC surge suppression network shall be used for protection of diodes. All electrical components shall be suitably derated to improve reliability.
- 2.14 Solid state industrial grade components of high reliability shall only be used. These shall conform to relevant IS specification.
- 2.15 All non-current carrying metal parts shall be bonded together and earthed. An earth terminal capable of accommodating a 4 mm dia. Wire, shall be provided.

3. **PERFORMANCE REQUIREMENTS**

- 3.1 The transformer rectifier unit shall be designed and manufactured for continuous operation at rated load in the ambient temperature range of 0 to 55 deg.C with RH reaching up to 95%.
- 3.2 The unit shall be rated for 230/110V AC single phase input voltage at a frequency of 50Hz \pm 2Hz.
- 3.3 The nominal output voltage and current shall be as specified by the purchaser.
- 3.4 The DC output of the unit shall be smoothened by use of a suitable filter such that the RMS ripple content of the output voltage when delivering the rated output current through a resistive load, measured by an oscilloscope shall not be more than 5%.
- 3.5 The overall watt efficiency shall not be less than 65% for rectifiers above 500VA capacity and shall be more than 55% for rectifiers of less than 500VA capacity.
- 3.6 The no load input current of the transformer-rectifier unit shall be less than 10% of the rated input current.

- 3.7 No load to full load voltage regulation of the transformer when measured with the highest voltage tapping on secondary side loaded to the rated current shall be 10% for < 100VA, 5% for 100VA & above.
- 3.8 The 'ON LOAD' output tap voltages shall be within 2.5% of the nominal voltages.
- 3.9 Each transformer-rectifier unit shall be provided with an anodised aluminium weather proof plate having following information.
- a) Name or trade mark of the manufacturer
 - b) IRS specification No.
 - c) Rate input voltage and frequency
 - d) Rated output voltage and current
 - e) 'Serial No. and year of the manufacture.
- 3.10 The output voltage regulation of transformer rectifier unit at no load to full load shall be <30% for 4 to 12V, <20% for 15-35V, <10% for 60 to 130V.

4. TESTS

4.1 Type tests

The following tests in undernoted sequence shall be carried out as type tests

- a) Visual inspection (Cl 4.4)
- b) Applied high voltage test (Cl. 4.5)
- c) Insulation resistance test (Cl. 4.6)
- d) Induced High voltage test (Cl. 4.7)
- e) Tests for continuous operation (Cl. 4.8)
- f) Performance test (Cl. 4.9)
- g) Temperature rise test (Cl. 4.10)
- h) Climatic tests (Cl. 4.11)

Type test shall be carried out on one sample. The sample shall successfully pass all the type tests for proving conformity with this specification. If the sample fails in any of the type tests, the purchaser or his nominee at his discretion may call for another sample of the same type and output rating and subject it to all tests or the tests in which failure (s) occurred. No failure shall be permitted in the repeat tests (s).

4.2 Acceptance test

- a) Visual inspection (Cl 4.4)
- b) Applied high voltage test (Cl. 4.5)
- c) Insulation resistance test (Cl. 4.6)
- d) Induced High voltage test (Cl. 4.7)
- e) Performance test (Cl. 4.9)

4.3 Routine Test

The following shall constitute routine tests and shall be conducted by the manufacturer on every transformer-rectifier unit and test results shall be submitted during the inspection.

- a) Visual inspection (Cl. 4.4)
- b) Insulation resistance test (Cl. 4.6)
- c) Induced High voltage test (Cl. 4.7)
- d) Performance test (Cl. 4.9)
- e) Tests for continuous operation (Cl. 4.8)

4.4 Visual Inspection

The Transformer-rectifier unit shall be examined for provision of all facilities stipulated in the Clause 2 of specification, correct wiring, proper mounting of components, workmanship and finish for which no tests have been specified.

4.5 Insulation Resistance test

This test shall be carried out

- a) Before the high voltage test
- b) After the high voltage test
- c) After the climatic test

The measurement shall be made at a potential of 500V, DC. The insulation resistance shall be measured between

- a) Input line terminals and the body of the transformer-rectifier unit.
- b) Output line terminals and the body of the transformer-rectifier unit.
- c) Input terminals and output terminals of the transformer-rectifier unit.

4.6 High Voltage Test

The transformer-rectifier unit shall withstand for one minute, a test voltage of 2000V, AC rms applied between power components and the body of the unit which shall be earthed.

4.7 Induced High Voltage test

The transformer of the unit without load shall be connected to a voltage equal to 2 times the nominal input voltage at double the rated frequency. The voltage shall be raised from $1/3^{\text{rd}}$ of the nominal value to full value. Full test voltage shall be maintained for one minute and shall then be rapidly reduced to $1/3^{\text{rd}}$ of the nominal voltage before being switched off. At the end of this test, the unit shall meet the requirements of IR test (Cl. 4.5) and no load input current (Cl. 3.6)

4.8 Continuous operation test

The unit shall be subjected to a continuous operation for 1000 hours in type test (Cl. 4.1 (e)) and for 240 hours in routine test (Cl. 4.3 (e)) at maximum rated input and 125% of the rated output current. After these tests, the unit shall not show any deterioration in its performance.

4.9 Performance test

The unit shall be tested to check the performance requirements specified under clause 3.2 to 3.8.

4.10 Temperature rise test

The cold resistance of transformer windings shall be measured after conditioning the unit. This temperature shall be taken as reference temperature T₁.

The transformer rectifier unit shall be connected to input voltage of 230V and rated maximum load shall be connected across the output terminals. The unit shall be kept ON till temperature equilibrium is reached i.e. the temperature variation between three successive readings taken at 30 minutes interval is less than 1 deg. C. Now hot resistance of transformer windings shall be measured within 1 minute of switching off the input supply. The ambient temperature T₂ shall be measured.

The temperature rise of the windings shall be computed by the following formula

$$T = \frac{R_1 - R_2}{R_1} (234.8 + T_1)$$

T is the temperature rise.

R₁ resistance of winding at the beginning of the test.

R₂ resistance at the end of the test.

4.11 Climatic test

4.11.1 Dry heat test

The unit shall be subjected to this test in accordance with IS:9000 (Part III/Section 5) - 1977 at 55 deg. C for a period of 16 hours. During the test, the unit shall be loaded with its rated capacity and at the end shall be checked for performance required as per clause 3.0.

4.11.2 Damp heat (Cyclic) test

For variant 1 for 7 cycles as per IS: 9000 (Pt. V) Section 2 shall be performed.

4.11.3 Cold Test

The test shall be done at 0 deg. C in un-energised condition for 2 hours duration as per IS:9000 (Pt. II).

4.11.4 Immediately after the damp heat test, the IR value of the unit and transformer shall be measured.

4.12 Sampling plan

The following sampling plan shall be adopted for acceptance tests

| Lot size | Sample size (except for temp. rise test & induced high voltage test) | Sample size (for temp. rise test & induced high voltage test) |
|-----------------|---|--|
| 2-8 | 2 | 1 |
| 9-15 | 3 | 1 |
| 16-25 | 5 | 2 |
| 26-50 | 8 | 2 |
| 51-100 | 13 | 3 |
| 101-150 | 20 | 3 |
| 151-200 | 32 | 3 |

4.13 Packing and Labeling

Transformer-Rectifier units complete shall be packed in suitable boxes/crates, strong enough, to prevent damage to the unit during transit and handling. Loose space inside the box/crate shall be filled up with suitable packing material.