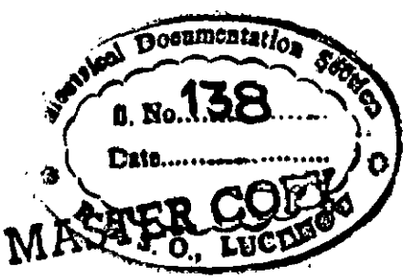
SPEC. No. E-16/13



QUALITY ASSURANCE TESTING OF DIODES OF SINGLE PHASE TRACTION POWER CONVERTORS

SPEC. No. E-16/13

FEBRUARY 1981

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ISSUED BY

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DRAFT- QUALITY ASSURANCE TESTING OF DIODES FOR SINGLE PHASE TRACTION POWER CONVERTORS.

INTRODUCTION

High reliability of the equipment is the pre-requisite for traction application. Traction application calls for devices of the rectifier to work under arduous service conditions of thermal cycles, dusty and salt laden atmosphere, high humidity, voltage transients and continuous vibrations and shocks. Therefore, devices are required to be of high reliability for traction application.

After the device has been properly selected to meet with the duty requirements, reliability of the device is the responsibility of the manufacturer. It is at the manufacturing stage the reliability is built into the device- beginning to end. It is, therefore, incumbent upon the manufacturer to ensure that the complete manufacturing process is designed and controlled as to maintain quality of the devices in volume production.

The purpose of this Quality Assurance Test Programme is to lay down detailed procedure for lot inspection and type approval for user's inspection as required vide clause 10 of IS-7788 as well as audit checks ensure periodical monitoring of the quality of the production and use of reliable devices for assembly of the traction rectifier sets.

1. Type Approval of the devices.

1.1 Any new device proposed or uprated by a manufacturer shall be subjected to the type tests as per APPENDIX - A. The devices shall not be used for assembly of the convertors till type approval is accorded for the device by RDSO/Railway. All facilities for carrying out the type and investigation tests shall be provided by the manufacturer. The tests shall be conducted in the presence of RDSO/Railways nominated representatives.

1.2 The sampling plan for type tests shall be as under. Samples shall be selected by RDSO/Railways' representative.

Lot quantity (Nos.)	Sample rate of the lot	
Upto 200	20%	Subject to minimum of
200 to 500	12%	40 devices
500 to 1000	10%	
Above 1000	7.5%	

1.3 In case of bulk orders, the lot offered for type testing and inspection shall be at least 50% of the total order.

....2/-

1.4 The programme of the type tests on the samples selected shall be as per APPENDIX-A.

2. Validity of the Type approval:

2.1 The type approval for a particular device shall be normally for a period of two years. Complete type tests as per Item I will be repeated before the validity of the approval is renewed. However, at the discretion of the RDSO/Lucknow, conducting of complete type test programme may be waived off or modified programmed may be repeated.

3. Manufacturer's Quality Assurance Programme:

3.1 It is at the manufacturing stage, from beginning to end, that the reliability is to be introduced into the devices. It starts with the choice of suppliers for the components and continues with incoming inspection, in line process controls, processing after construction, end of line screeening and testing and quality assurance testing. It is, therefore, incumbent upon the manufacturer to lay down quality control programme to monitor the manufacture and testing of the semiconductors. The manufacturer shall furnish the quality assurance programme proposed to be followed at the time of the placement of the order. Any changes made subsequently will be advised. Audit checks shall be carried out from time to time by the representative of RDSO/Railways to ascertain the implementation of the quality assurance programme.

4. Routine Tests

4.1 Routine tests including screening and burn-in tests shall be carried out on all devices as per APPENDIX-A by the manufacturer. The manufacturer will keep separate records for these routine tests carried out on the devices, which will be made available for inspection of the representatives of RDSO/Railways.

4.2 A certificate, as per the following proforma shall be furnished for each cubicle or for the lot of the spare diodes, supplied in respect of routine tests.

> Certified that all the diodes type No. as per the enclosed serial numbers used for the assembly of the cubicle S.No.__________, against contract/Order No.______________, dt.______________ have been subjected to the laid down routine tests and comply with the declared limits of the various finalised parameters of the device.

Quality Control Engineer

...3/-

5. Audit Check of the Routine Tests:

5.1 Ten percent of the devices from each cubicle offered for inspection, picked up at random by the representative of the Inspecting Authority, shall be subjected to routine tests, as indicated in APPENDIX-A in presence of the representative of the inspecting authority.

5.2 In case any device, out of 10% sample lot devices, does not comply with the declared parameters, the following procedure shall be followed:

(a) In case more than one loco set is offered for inspection, then 20% of the devices will be taken as sample from each of the balance cubicles and subjected to routine tests. In case any device from this lot out of these samples also does not comply with the declared parameters, then the whole offered lot shall be taken as rejected.

The manufacturer shall rescreen the whole batch and re-assemble the cubicles with the devices complying with the spectification. These cubicles will again be subjected to the 10% check as detailed in 5.1 above.

(b) In case all the sample devices as per 5.2(a) above meet with the specification, then the particular cubicle will only be taken as rejected. Rescreening shall be done by the firm before offering it for reinspection.

5.3 In case of failure of the devices during 10% audit checks occures for more than two occasions in a year, the approval for the device may be taken as withdrawn.

6. Periodical sampling life tests

6.1 Routine tests to be carried out on 100% devices are mainly constitute electrical parameter screening for elimination of the ends of long tailed distribution. These tests, however, do not ensure total electrical and mechanical reliability of the device. It is, therefore, necessary to carry out periodical sampling life tests so as to verify that the complete manufacturing process ensures quality of the devices. Following sampling plan shall be followed for this purpose:

....4/-

(a) Two devices from each cubicle will be selected as sample by the representative of the inspecting authority.

(b) After every six months, the 10 devices out of the lot selected will be subject to the following tests in addition to all the routine tests in the presence of representative of RDSO/Railways.

i) Thermal cycling (Test No. 9)
ii) Load test (Test No.12)
iii) Blocking life (Test No.-15)

6.2 In case any device, out of these 10 samples, does not pass the above test, then further acceptance of any lot shall not be done, till the matter is investigated by the firm and necessary improvements in the manufacturing process implemented. The devices will be subjected to type test again before clearance for further supplies is accorded by RDSO/Railway.

APPENDIX - I

TEST PROGRAMME FOR SILICON DIODES

1. General

1.1 The type, routine and ingestigational tests on the silicon diodes shall be conducted as per latest IS:7788 with clarifications furnished hereunder. Some additional tests, not included in IS:7788, are also to be conducted as type or routine or special tests, as claried below:

1.2 Based on this general type and routine test programme, the manufacturer shall submit particular test programme, applicable for the offered device, indicating limit values of various parameters and test conditions such as voltage and current, base temperature, duration of test, reference temperature, etc. The details of the empirical relations proposed to be used for working out the final values of the parameters shall be indicated in the test programme.

1.3 The detailed proforma for recording readings, test results, observations, conclusions, etc. shall be submitted along with the particular test programme.

2. Summary of the Tests

Sl. No.	Nature of test	Reference clause of IS:7788-1975	
		Type test	Routine test
1.	Forward characteristic	10.1.2.1	
2.	Forward voltage drop		10.1.2.1 or 10.1.2.2
3.	Reverse characteristic	10.1.3	
4.	Reverse current		10.1.4
5.	Reverse voltage	10.1.5	10.1.5
6.	Reverse recovery charge	10.1.6	
7.	Thermal resistance	10.1.7.1	10.1.7.1
8.	Transient thermal impedance	10.1.7.2	
9.	Thermal cycling	10.1.8	
10.	Surge forward limit current	10.1.9.1	10.1.9.2
11.	Surge forward current	10.1.10	
12	Load	10.1.11	

13	Deterioration	10.1.12	
14.	Encapsulation	10.1.13	10.1.13
15	Blocking life	As per clause 4.1 below	As per clause below
16.	Environment tests		
16.1	Damp heat	-do- 4.2	
16.2	Corrosion	-do- 4.3	
17	Shock and vibration	-do- 4.4	
18	Robustness of the termination	-do- 4.5	
	INVESTIGATION TESTS		
19	Operating life	-do- 5.1	
20.	X-ray examination	-do- 5.2	

3. Additional details of the tests covered by IS:7788

Following additional details shall apply for the tests covered by IS:7788-1975

3.1 Test No. 2 Forward voltage drop (FVD)

The FVD grouping shall be classified based on 50 mV peak group corresponding to man rated device current rating. It will be verified that the characteristic is within the specified FVD group.

3.2 Tests No. 3&4 - Reverse Characteristics

In case of type test as per Clause 10.1.3, full reverse characteristic shall also be exhibited on the oscilloscope.

In case of routine test as per Clause 10.1.4, reverse characteristics shall be verified on the oscilloscope and shall be free from defects. The leakage current corresponding to PIV rating of the device shall be recorded.

...3/-

3.3 Test No. 9 - Thermal Cycling

The test shall be conducted as per Clause 10.1.8 of IS:7788-1975. The test shall be conducted for 20,000 cycles and no parameters shall change. The test shall be further continued till any of the parameters exceed the limit value/abnormal variation is noticed or the device fails.

All the parameters that may be affected by the test i.e. forward voltage drop, reverse leakage current, thermal resistance, etc. shall be measured and recorded at the beginning of the test and thereafter every 5000 cycles till no change in parameters is noticed. The moment any change is noticed, the parameters shall be checked after every 1000 cycles till the change in any parameter is found beyond limit or device fails. The test will be considered satisfactory in case there is no change in the values recorded for the device under test in the beginning.

3.4 Test No. 10 - Surge forward current

The test will be carried out with 50% reverse voltage applied between current pulses.

3.5 Test No. 12 - Load Test

The forward characteristic, reverse characteristic thermal resistance, etc. shall be measured at the beginning and at the end of the test. The test will be considered satisfactory in case there is no change in the value of the parameters recorded for the device under test at the beginning.

3.6 Test No. 14 - Encapulation Test

The test shall be carried out with Helium gas detector method for the type test.

4. Additional tests not covered by IS:7788

4.1 Blocking life

Type Test - This test shall be carried out by applying rated peak reverse voltage (either full or half wave rectified) on the devices in an ambient temperature equal to the maximum rated junction temperature for a period of 30 days. Leakage current shall be measured at the beginning of the test and then checked after every 7 days. The test will be considered satisfactory in case no change of leakage current takes place.

....4/-

Routine Test - This test shall be carried out on every device in the same way as type test, but for a period of 24 hours.

4.2 Environmental tests

4.2.1 Test No. 16.1 - Damp heat

This test will be carried out as per IS:9000 (Pt.IV) 1979 with the following details:

Conditioning	Temperature of 55 ±2°C and relative humidity of 93% $^{+2}_{-3}$ The device shall be placed with the base facing upwards.
Severities	21 days.
Final measurements	
Visual inspection-	Condition of the plating of the base, flexible lead, etc.
Electrical	Insulation resistance before and after the test.

4.3 Corrosion

This test shall be carried out as per Clause 26 of IEC 571. The duration of the test shall be 48 hours. The device shall be subjected to visual examination for corrosion of the plating, etc. at the end of the test.

4.4 Vibration test

This test shall be carried out generally as per Clause 28 of IEC 571 (Rules for electronic equipment used on rail vehicles), with the following severities:

4.5 Robustness of the termination

The details of the test will be mutually finalised. The manufacturer shall declare the tensile strength of terminal and the proof load will be at least 2 times the declared terminal strength.

5. Investigation Tests

5.1 Operating life test

This test will be carried out on the devices under the following operating conditions:

....5/-

i) Loaded to the maximum rated forward current.
ii) Maximum repetitive peak voltage applied.
iii) At rated case temperature.

The test will be carried out for a period of 30 days. All the parameters, viz. forward voltage drop, reverse leakage current and thermal resistace shall be recorded at the beginning of the test and then checked after every 7 days. The test will be considered satisfactory in case there is no change in any of the parameters for device under test.

5.2 X-ray examination

The purpose of this test is to detect faulty construction or the presence of foreign particles after encapsulation. This test will be carriedout after shock/ vibrations test. The method of conducting test shall be mutually decided. The devices under test shall be serialised and then X-ray followed.

Annexure-I

Type Test Plan

The samples selected for type testing as per Clause 1.2 shall be subjected to the various tests as per the following plan:

GROUP A

(On all devices of the sample lot of 40)

Visual and mechanical inspection
verification of dimensions
electrical performance
(Test Nos 1,2,3,4,5,6,7,10)

Encapsulation Test No.14

Group B (10 devices)	Group C (25 devices)			Group D (5 devices)		Group E (5 devices)
T Transient thermal impedance (18) Surge forward Current (11)	C1 10 devices deterioration	C3 5 devices Investigation test - Operating life (19)	C2 10 devices Blocking test.	D1 Damp heat (16.1)	D2 Corrosion (16.2)	Vibration & Shock(17) Investigation Test X-ray Examination (20)
B1 (5devices) Load test(12)	B2 (5 devices) Thermal cycling(9) Terminal strength (18)					

NOTE: The above figures show the minimum number of devices to be subjected to various tests. The actual number of devices shall be determined by the sample lot in the same proportion.

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