भारतीय मानक

Indian Standard

IS 9815 (Part 1) : 2024

सर्वो-मोटर प्रचालित स्वचालित लाइन वोल्टेज संशोधक

भाग 1 एक-फेज अनुप्रयोगों के लिए संशोधक — विशिष्टि

(तीसरा पुनरीक्षण)

Servo-motor Operated Automatic Line Voltage Correctors

Part 1 Correctors for Single-Phase Applications — Specification

(Third Revision)

ICS 29.200

भारतीय मानक ब्यूरो

BUREAU OF INDIAN STANDARDS

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December 2024 **Price Group 6**

Transformers Sectional Committee, ETD 16

FOREWORD

This Indian Standard (Part 1) (Third Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Transformer Sectional Committee had been approved by the Electrotechnical Division Council.

The servo-motor operated automatic line voltage correctors are commonly known as servo-stabilizers. These are used for electrical and electronic equipment where the type of load needs substantially constant voltage within close tolerances.

This standard servo-motor operated line voltage corrector was first published in 1981 and was revised in 1989 and 1994. This standard is being revised again to keep pace with the latest technological developments and international practices. In this revision, the following major changes have been made:

a) A reference clause has been added mentioning the latest version of all the referred standards; and

b) Editorial corrections have been done.

The composition of the Committee responsible for the formulation of this standard is given in Annex C.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*). The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

SERVO-MOTOR OPERATED AUTOMATIC LINE VOLTAGE CORRECTORS

PART 1 CORRECTORS FOR SINGLE-PHASE APPLICATIONS — SPECIFICATION

(Third Revision)

1 SCOPE

This standard (Part 1) covers the requirements for servo motor operated line voltage correctors for single- phase applications.

2 REFERENCES

The standards listed in Annex A 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 recent edition of these standards.

3 TERMINOLOGY

For the purpose of this standard, the following definitions in addition to those given in IS 1885 shall apply.

3.1 Hunting — Continuous rhythmic variation of output voltage above and below its rated value.

3.2 Servo-motor Operated Automatic Line Voltage Corrector — A unit with motor operated auto-transformer as its control element to give rated output voltage, the movement of the motor being automatically controlled by a voltage sensing arrangement.

4 SERVICE CONDITIONS

The provision **1.1** of IS 2026 (Part 1) shall be applicable.

5 RATING

5.1 The preferred kVA ratings for single-phase applications shall be as follows:

1, 2, 3, 5, 8, 10, 15, 16, 20, 25, 31.5, 40, 50, 60, 75, 100, 125, 150, 200, 250, 300 and 350

5.2 Rated Voltage

5.2.1 *Input Voltage Range*

Unless otherwise specified by the purchaser. Input voltage range shall be 160 V to 260 V.

5.2.2 *Output Voltage*

Unless otherwise specified by the purchaser, rated output voltage shall be 240 V.

5.3 Rated Frequency

The rated frequency for the purpose of this standard shall be 50 Hz.

5.4 Power Factor

Power factor at maximum load shall not be less than 0.95.

6 CONSTRUCTION

6.1 A voltmeter of accuracy class index 1.5 or better in accordance with IS 1248 (Part 2) shall be provided on the front panel with a suitable selector switch to indicate voltage at both input and output terminals.

6.2 Plugs and socket of suitable rating conforming to IS 1293 shall be provided for correctors rating up to 2 kVA. For correctors of higher rating suitable rated terminals at both input and output of the corrector shall be provided. In order to reduce collection of dust, louvers, whenever provided shall be in the sides and provided with suitable mesh.

6.3 A suitable indicator lamp to indicate that the unit is ‘ON’ shall be provided on the front panel.

6.4 The unit shall have arrangement to control output manually on the front panel.

6.5 The variable auto-transformer shall generally conform to IS 5142.

6.6 The cooling method shall be in accordance with IS 2026 (Part 2).

6.7 The unit shall have arrangement for setting of output voltage within ± 5 volts of rated output voltage, by means of suitable device on the panel which shall be capable of being locked in position.

6.8 The variable auto-transformer shall have two micro switches at the ends to cut off power supply to servo-motor.

7 SAFETY REQUIREMENTS

7.1 Insulation

Provisions of **11.5** and **11.6** shall apply.

7.2 Provision for Earthing

Provisions of **27** of IS 302 (Part 1) shall apply.

7.3 Leakage Current Under Normal Operating Conditions

Provisions of **13.2** of IS 302 (Part 1) shall apply.

8 LIMITS OF TEMPERATURE-RISE

8.1 The temperature-rise of the transformer winding and core shall be in accordance with IS 2026 (Part 2).

8.2 During the temperature-rise test, the temperature-rise in the vicinity of the control circuit or of the enclosure, if totally enclosed type shall not exceed 10 °C above reference temperature of 45 °C.

9 PERFORMANCE REQUIREMENTS

9.1 The corrector shall keep the output voltage within ± 1 percent of the rated voltage irrespective of load and input voltage range.

9.2 The rate of correction of voltage shall not be less than 6 V/s between phase and neutral.

9.3 The corrector shall be free from hunting during automatic operation.

9.4 Losses

The manufacturer shall state the no-load and full load losses corresponding to minimum and maximum rated input voltages. The tolerances on these declared values shall be as provided in Table 1 of IS 2026 (Part 1).

9.5 The no-load current shall not be more than 5 percent of the rated output current.

9.6 Efficiency

In addition to the provision of **9.4**, the efficiency of the unit shall be not less than 95 percent.

10 MARKING

10.1 Terminals

The input, output and earth terminals shall be marked clearly.

10.2 Rating Plate

Each corrector shall be provided with a rating plate of weather-proof material fitted in a visible position. The entries on the rating plate shall be indelibly marked (for example, by etching, engraving or stamping). The information to be given on the rating plate shall be as under:

a) Type of line voltage corrector, namely, servo-motor operated;
b) Number of this standard, *see* IS 9815 (Part 1);
c) Manufacturer's name;
d) Manufacturer's serial number;
e) Number of phases: single;
f) Year of manufacture;
g) Rated kVA;
h) Rated frequency;
j) Rated input voltage range;
k) Rated output voltage;
m) Rated output current;
n) Type of cooling; and
p) Class of insulation.

In addition, the following information relevant to servo-motor shall also be given on the rating plate of the motor:

a) Rated torque;
b) Rated voltage;
c) Type of supply; and
d) Rated watts.

10.3 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

11 TESTS

11.1 General

The tests shall be conducted at room temperature with all those external fittings in place which are likely to affect the performance of the corrector.

11.2 Type Test

The following shall comprise type tests:

a) Physical examination (*see* **6** and **10**);

b) Insulation resistance (*see* 11.5);

c) High voltage test (*see* 11.6);

d) Provision for earthing (*see* 7.2);

e) Leakage current (*see* 7.3);

f) Output voltage (*see* 11.7);

g) No-load current (*see* 11.8);

h) Measurement of no-load losses (*see* 11.9);

j) Load loss test and efficiency (*see* 11.10);

k) Induced voltage test (*see* 11.11);

m) Test for continuous operation (*see* 11.12);

n) Temperature-rise test (*see* 11.13);

p) Test for rate of correction (*see* 11.14);

q) Locked rotor test for servo-motor (*see* 11.15); and

r) Damp heat test (*see* 11.16).

11.2.1 Type tests shall be carried out on number of samples of voltage correctors of same rating, design and type as given below:

Sl No.	*KVA Rating*	*Number of Samples*
(1)	(2)	(3)
i)	up to 10	2
ii)	Above 10	1

11.2.2 Sample(s) shall pass all the tests mentioned in 11.1 for proving conformity with the requirements of this standard. If any of the samples fails in any of the type tests, testing authority, at its discretion, may call for fresh samples not exceeding twice the original number and subject them to all the test or tests in which failure(s) occurred. No failure shall be permitted in the repeat test(s).

11.3 Acceptance Tests

The following shall constitute acceptance tests:

a) Physical examination (*see* 6 and 10);

b) Insulation resistance (*see* 11.5);

c) High voltage test (*see* 11.6);

d) Leakage current (*see* 7.3);

e) Provision for earthing (*see* 7.2);

f) Output voltage (*see* 11.7);

g) No-load current (*see* 11.8);

h) Measurement of no-load losses (*see* 11.9);

j) Measurement of load losses and efficiency (*see* 11.10); and

k) Induced voltage test (*see* 11.11).

A recommended sampling plan for acceptance tests is given in Annex B.

11.4 Routine Tests

The following shall constitute routine tests and shall be carried out on all correctors:

a) Insulation resistance (*see* 11.5);

b) High voltage test (*see* 11.6);

c) Output voltage (*see* 11.7);

d) No-load current (*see* 11.8);

e) Measurement of no-load losses (*see* 11.9); and

f) Measurement of load losses (*see* 11.10).

11.5 Insulation Resistance Test

The insulation resistance between the terminals and body of the corrector shall be measured and recorded. It shall not be less than 5 megaohm when measured at 500 V d.c. at room temperature not exceeding 45 °C.

11.6 High Voltage Test

A test voltage as given in 11.6.1 shall be applied at rated frequency for one minute between the winding and the body of the corrector which shall be earthed. There shall be no disruptive discharge or collapse of test voltage.

11.6.1 *Test Voltage*

a) *For routine test* — 1.5 kV (rms). The voltage shall be applied, on the whole unit.

b) *For type and acceptance test* — 2.5 kV (rms). The voltage shall be applied to power components only. In addition, the whole unit shall be tested at 1.5 kV (rms).

11.6.2 When carried out as a type test, this test shall be carried out immediately after temperature-rise test.

11.7 Output Voltage Test

For this test a voltmeter of accuracy class index better than 0.5 shall be connected across the output terminals. The output voltage for different input voltage shall be recorded for different input voltages both at full-load and at no-load covering specified input range, not less than five voltage reading at approximately equal intervals shall be taken at corrector input and output points excluding the mains lead. The voltage shall not differ by more than 1 percent of the rated output voltage.

For rating up to 5 kVA, the test will be conducted by actually loading the corrector. For rating above

5 kVA rating, if it is not feasible to load the corrector actually, the test may be conducted at no-load only; after reducing the minimum input voltage to the extent of the short-circuit impedance voltage of the corrector at 0.95 p.f. The short-circuit impedance voltage of the corrector to be determined at the lowest input voltage condition.

11.8 No-Load Current Test

The no-load current shall be measured at rated frequency with the rated lowest and highest input voltage applied to the input terminals, the output terminals being kept open-circuited.

11.9 No-Load Loss Test

Method for carrying out no-load loss test shall be same method for carrying out no-load current. This test may be combined with the test of **11.8**.

11.10 Load Loss Test and Efficiency

This test shal1 be carried out generally in accordance with **10.4** of IS 2026.

11.11 Induced Voltage Test

To test inter turn insulation of the winding, an a.c. voltage equal to twice the output voltage unit of the corrector shall be applied to the output terminals of the windings. The test voltage shall be of frequency of twice or more than twice of the rated frequency. The test voltage shall be applied for a duration of:

$$\frac{120 \times \text{Rated frequency}}{\text{Test frequency}} \text{ (seconds)}$$

But not less than 15 s. After this the corrector shall pass the no-load current test as specified in **9.5** and **11.8**.

11.12 Test Continuous Operation

11.12.1 The corrector shall be subjected to a continuous run for 24 h at no-load while the input voltage is varied from minimum to maximum of the input voltage range and back to minimum in not more than one minute. After this test, the corrector shall pass the output voltage test in accordance with **11.7**.

11.12.2 The corrector shall be subjected to a continuous run for 8 h at full load after reducing the input voltage set to give rated current under short-circuit condition and the motor set to the maximum position of the corrector. In that position the motor of the corrector will be moved from minimum position to maximum position and back in not more than 1 min. After the test the corrector shall pass the output voltage test in accordance with **11.7**.

11.13 Temperature-Rise Test

11.13.1 *Measurement of Temperature of Cooling Air*

The cooling air temperature shall be measured by means of several (at least 3) thermometers placed at different points around the corrector, at a level approximately half-way up the cooling surface, at a distance of 1 m to 3 m from the cooling surface. The thermometers shall be protected from draught and abnormal heat radiation.

The value to be adopted for the temperature of the cooling air for the test is the average of the readings taken on these thermometers at equal intervals of time during the last quarter of the test period.

The temperature of the cooling air shall be as constant as possible during the test period, especially during the last quarter.

11.13.2 The test of **11.13.1** shall be repeated with Variac in the maximum position and winding temperature of the winding carrying full load current shall be measured.

11.13.3 *Determination of Winding Temperature*

The winding temperature shall be measured using the resistance method. The temperature of winding (θ_2) at the end of test period shall be calculated and its measured resistance (R_2) at that temperature and its measured resistance (R_1) at some other temperature (θ_1) using the following formula:

$$\theta_2 \frac{R_2\ (235\ +\theta_1\ )}{R_1} - 235 \text{ (for copper)}$$

$$\theta_2 \frac{R_2\ (235\ +\theta_1\ )}{R_1} - 225 \text{ (for alumimium)}$$

where

$\theta 1$ and $\theta 2$ are measured in °C.

11.13.4 *Duration of Temperature-Rise Test*

Evidence shall be obtained that the highest temperature-rise shall be in accordance with the requirements of **8.1** even if the tests were continued until thermal equilibrium is reached. Temperature readings shall be taken where possible during operation, as well as when the corrector is shut down. The test shall not be regarded as completed until the temperature rise increment is less than 1 °C in 1 h.

The loading shall be done in accordance with **5.2** of 1S 2026 (Part 2), the corrector being set at the highest loss position, as obtained during test for loan

losses (*see* **11.10**). For this purpose, the loading may be done by short circuiting the output terminals suitably.

11.14 Test for Rate of Correction

The sensing and control arrangement shall be disconnected and the corrector voltage shall be set for manual operation. The output voltage shall be decreased to the minimum. The servo-motor shall be energized and the time required to raise it to the maximum shall be measured and recorded. The rate of correction shall be calculated from rated range of input voltage divided by the time so measured. The test shall be repeated as above for lowering it to the minimum.

11.15 Locked Rotor Test for Servo-motor

11.15.1 *Purpose of the Test*

As there is a possibility of the servo-motor remaining energized at the end of the run of the brush arms of the continuously variable voltage auto-transformer or even at any other position (due to some mechanical defect), it is necessary to ensure that the servo-motor is capable of withstanding the application of full rated voltage under locked rotor condition for a reasonably long time without damage due to excessive temperature-rise.

11.15.2 *Measurement of Forward, Reverse and Stalling Current*

These currents shall be measured with full rated. voltage applied to the motor. The three values of current shall not differ by more than 5 percent of the mean value. In case of dc motor, the provision relating to stalling current is not applicable.

11.15.3 In any of the current measured under the test at **11.15.2**, is found to be more than 150 mA, the motor shall be kept under locked rotor condition for a period of 1 hour. The temperature-rise of any of the winding at the end of the test shall not be more than 60 °C for Class A and 75 °C for Class E insulation when measured by resistance method.

11.16 Damp Heat Test

The corrector shall be subjected to the damp heat (cycling) test in accordance with IS/IEC 60068-2-30. The test shall be carried out at a temperature of 40 °C ± 1 °C and the degree of severity shall be 2 cycles.

After the damp heat treatment, all acceptance tests shall be repeated on the equipment. However, as repeated tests, the dielectric tests shall be carried out at 75 percent of the initial test values. The recovery period shall be minimum 12 h and the corrector shall be operated at no load for a further period of 2 h before carrying out repeat tests. Voltmeter, if provided with automatic line voltage corrector shall be removed during this test.

ANNEX A

(*Clause* 2)

LIST OF REFERRED STANDRDS

IS No.	*Title*
IS 302 (Part 1) : 2008	Safety of household and similar electrical appliances: Part 1 General requirements (*sixth revision*)
IS 1248 (Part 2) : 2021	Direct acting indicating analogue electrical measuring instruments and their accessories: Part 2 Special requirements for ammeters and voltmeters (*fourth revision*)
IS 1293 : 2019	Plugs and socket-outlets for household and similar purposes of rated voltage up to and including 250 V and rated current up to and including 16 A — Specification (*fourth revision*)
IS 1885 (Part 38) : 1993/IEC Pub 50 (421) (1990)	Electrotechnical vocabulary: Part 38 Power transformers and reactors (*second revision*)
IS 2026	Power transformers:
(Part 1) : 2011	General (*second revision*)
(Part 2) : 2010	Temperature — Rise (*first revision*)
IS 4905 : 2015/ ISO 24153 : 2009	Random sampling and randomization procedures (*first revision*)
IS 5142 : 1969	Specification for continuously variable voltage auto transformers
IS/IEC 60068-2-30 : 2005	Environmental testing: Part 2 Tests, Section 30 Test Db: Damp heat Cyclic (12 h + 12 h Cycle)

ANNEX B

(*Clause* 11.3)

SAMPLING PROCEDURE FOR ACCEPTANCE TESTS

B-l LOT

In any consignment, all the regulators of the same type and rating manufactured from the same material under similar condition of production shall be grouped together to constitute a lot.

B-2 SELECTION OF SAMPLE

B-2.1 The number of regulators to be selected from the lot shall depend upon the size of the lot and shall be in accordance with co1 (2) and col (3) of Table 1.

B-2.2 These regulators shall be selected from the lot at random. For the purpose of random selection, reference may be made to IS 4905.

B-3 CRITERIA FOR CONFORMITY

The regulators selected in accordance with co1 (2) and (3) of Table 1 shall be subjected to the acceptance tests specified in **11.2**. A regulator failing to satisfy any one or more of the requirements of acceptance tests shall be termed as defective. The lot shall be considered as conforming to the requirements of acceptance test if the number of defective in the first sample is less than or equal to the acceptance number (α_1) given in co1 (5) of Table 1.

If the number of defectives is greater than or equal to the first rejection number (r_l) given in co1 (6) of Table 1, the lot shall be considered as nonconforming to the requirements of acceptance tests. If the number of defectives is between acceptance number and first rejection number, the second sample (n_2) of the same size shall be selected from the lot at random and subjected to the acceptance tests. The lot shall be considered as conforming to the requirements of acceptance tests if the number of defectives in the two samples combined is less than the second rejection number (r_2) given in col (7) of Table 1, otherwise not.

Table 1 Sample Size and Criteria for Conformity

(*Clauses* B-2.1 *and* B-3)

Sl No.	Lot Size Second	First Sample Size	Second Sample Size	Acceptance Number	First Rejection Number	Second Rejection Number
	(N)	(n_1)	(n_2)	(α_1)	(r_1)	(r_2)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Up to 15	2	–	0	1	1
ii)	16 to 25	3	–	0	1	1
iii)	26 to 50	5	5	0	2	2
iv)	51 to 100	8	8	0	2	2
v)	101 to 300	13	13	0	2	2
vi)	301 and above	20	20	0	3	4

NOTE — For lots of size up to 25, the decision about acceptance or rejection of the lot shall be taken on the basis of first sample only.

ANNEX C

(*Foreword*)

COMMITTEE COMPOSITION

Transformers Sectional Committee, ETD 16

Organization	*Representative*(*s*)
Central Power Research Institute, Bengaluru	SHRI S. SUDHAKAR REDDY **(*Chairperson*)**
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Bureau of Energy Efficiency, New Delhi	MISS P. SAMAL SHRI KAMRAN SHAIKH (*Alternate* I) SHRI MUKHE K. SAI SATVIK (*Alternate* II)
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Ministry of Heavy Industries and Public Enterprises, New Delhi	SHRI VIJAY MITTAL SHRI VIKAS DOGRA (*Alternate*)

Organization	*Representative*(*s*)
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Member Secretary
SHRI ABINASH BORDOLOI
SCIENTIST 'C'/DEPUTY DIRECTOR
ELECTROTECHNICAL, BIS

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-www.bis.gov.in or www.standardsbis.in.

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