

Indian Standard
SPECIFICATION FOR
ELECTRONIC SELF-BALANCING BRIDGE
INDICATORS AND RECORDERS

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Indian Standard

SPECIFICATION FOR ELECTRONIC SELF-BALANCING BRIDGE INDICATORS AND RECORDERS

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0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 27 February 1980, after the draft finalized by the Standardization of Industrial Process Measurement and Control Sectional Committee had been approved by the Executive Committee.

0.2 Self-balancing indicators and recorders are being increasingly used in process-control systems for monitoring and recording physical parameters that can be converted into dc voltage or resistance using sensing elements.

0.3 This standard has been formulated with a view to covering the requirements of electronic self-balancing bridge indicators and recorders and test methods for the same. Requirements and test for potentiometric indicators and recorders are covered in a separate specification.

0.4 This standard covers only those types of equipment intended for general purpose use, as those of intrinsically safe type may have to conform to special provisions, not forming part of this standard. It is intended to standardize the specific requirements of such intrinsically safe apparatus at a later stage.

0.5 The resistance thermometer elements to be used with indicators and recorders and their reference Indian Standards are given in Appendix A.

0.6 In the preparation of this standard considerable assistance has been derived from:

BS:4525:1970 Method of evaluating the performance of process controllers with analogue direct current signals. British Standards Institution.

GOST 7164-1971 Automatic potentiometers and balanced bridges SSI. General technical terms. Union of Soviet Socialist Republic.

0.7 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, shall be rounded off in accordance with IS:2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard describes the requirements of electronic self-balancing bridge indicators and recorders intended for measurement, recording and controlling temperatures and any other physical parameters that can be converted into resistance change.

1.2 This standard covers single, multipoint and multipen recorders.

1.3 This standard does not cover the following instruments:

- a) Instruments to be used in fire hazardous areas;
- b) Instruments to be used in marine applications, such as ship's boiler control; and
- c) Electronic self-balancing potentiometric indicators and recorders (*see 0.3*).

2. TYPES

2.1 Depending on the field of application, electronic self-balancing bridge indicators and recorders shall be of the following types:

- a) Indicators only,
- b) Indicators and recorders,
- c) Indicators and controllers, and
- d) Indicators, recorders and controllers.

3. DESIGN CHARACTERISTIC

3.1 According to design features, the four types of instruments described in **2.1** may be manufactured with the following specifications:

<i>Design Feature</i>	<i>Characteristics</i>
a) Accuracy class (according to measurement readings)	0.25, 0.5, 1.0
b) Chart drive mechanism	Electrical drive folding type, or re-rolling type
c) Shape of chart	Strip chart or circular type chart
d) Time of travel of instrument pointer over full length of scale	Travelling time: less than 1s 2.5 s, 5 s, 8 s
e) Number of pens	Single, Two or Three pens
f) Controls	ON-OFF, Time proportional with ON-OFF
g) Multipoint monitoring	2, 3, 4, 6, 12 and 24.

3.2 The design may also provide one or more of the following optional facilities:

- a) Event marker,
- b) Calibration checking facility, and
- c) Retransmission of signal.

4. MEASUREMENT RANGES

4.1 Preferred measurement ranges for measuring temperature shall be as given in Table 1.

TABLE 1 PREFERRED MEASUREMENT RANGES

Sl. No.	RATED RESISTANCE OF THERMOMETER AT 0°C (R_0 in ohms)	SYMBOL OF CALIBRATION	RANGE OF MEASUREMENT IN °C		
			From (4)	To (5)	
(1)	(2)	(3)	10 ohmsPt	0	300
				0	400
				0	500
				0	650
				300	650
2.	Platinum resistance thermometer, 46	46 ohmsPt	-120	30	
			0	100	
			0	150	
			0	200	
			0	300	
			0	400	
			0	500	
			200	500	
3.	Platinum resistance thermometer, 100	100 ohmsPt	-200	-70	
			-120	30	
			-90	50	
			0	50	
			0	100	
			0	150	
			0	200	
			0	300	
			0	400	
			0	500	
			200	500	
4.	Copper resistance thermometer, 53	53 ohmsCu	-50	50	
			-50	100	
			0	50	
			0	100	
			0	180	
5.	Copper resistance thermometer, 100	100 ohmsCu	-50	50	
			-50	100	
			-25	25	
			0	25	
			0	50	
			0	100	
6.	Nickel resistance thermometer, 100	100 ohmsNi	0	180	
			-50	50	
			-50	100	
			0	50	
			0	100	
			0	150	
0	180				

5. TECHNICAL REQUIREMENTS

5.0 The electronic self-balancing bridge indicators and recorders shall be manufactured in compliance with the requirements of this standard.

5.1 Power Supply — The power to the instrument shall be supplied from an ac mains of 240 V at 50 Hz.

5.2 Power Consumption — The power consumption shall be specified by manufacturer.

5.3 Supply Variations — Due to fluctuations in the supply voltage applied to the instrument power circuit within ± 10 percent of rated value, the additional reading error of the instrument shall not exceed 0.1 percent.

5.4 Supply Frequency Variation — With deviations in the instrument supply frequency within ± 3 percent of the rated value, the reading error of the instrument shall not exceed the limits of the permissible basic error.

5.5 Spurious Signal Rejection — The common mode rejection and the the series mode rejection shall be within the specification given by the manufacturer.

5.6 Accuracy Class — The basic error of the bridge indicator reading at all scale divisions shall not exceed the values given below:

<i>Accuracy Class</i>	<i>Basic Error of Readings</i>
0.25	± 0.25
0.5	± 0.5
1	± 1

NOTE — The basic error shall be expressed:

- for instrument with initial zero scale, in percentage of upper limit of effective range;
- for instruments with centre zero scale, in percentage of the sum of the absolute upper and lower limit values of effective range of measurement; and
- for instruments having a scale without zero, in percentage of the difference between upper and lower limit values of the effective range of measurement.

5.7 Hysteresis — Variation in reading determined as the difference in readings of the quantity being measured for decreasing and increasing values. The variation shall not exceed the absolute value of the allowable basic error of indication.

5.8 Threshold Sensitivity — The threshold sensitivity of instrument shall be better than:

- 0.1 percent for 0.25 and 0.5 class of accuracy.
- 0.2 percent for 1.0 class of accuracy.

5.9 Damping — The damping of the instrument shall be such as to ensure that the instrument pointer comes to rest within not more than 2 to 3 oscillations.

5.10 Electrical Insulation Strength — The electrical insulation of the instrument circuit shall withstand a practically sinusoidal voltage at 50 Hz applied for 1 minute at ambient temperature of $27 \pm 2^\circ\text{C}$ and a relative humidity less than 65 percent ± 5 percent.

<i>Points of Application of Voltage</i>	<i>Test Voltage</i> V (rms)
Power circuit to earth	1 500
Measuring circuit to earth	500
Power circuit to measuring circuit	1 500

5.11 Insulation Resistance — For indicators/recorders with floating inputs and outputs the insulation resistance between the electrical circuits of the instrument and earth and between likewise electrical circuits shall be not lower than $5 \text{ M}\Omega$ measured at $27 \pm 2^\circ\text{C}$ and RH 65 percent ± 5 percent.

5.11.1 For indicators/recorders with $50 \text{ k}\Omega$ to earth the power circuit test with respect to earth shall be carried out.

5.12 Overload — The instrument shall withstand without damages an overload caused by opening as well as shorting of input terminals, 20 percent greater than the maximum voltage of the quantity measured.

5.13 Short-Term Overload — The instruments shall withstand without damage 5 times for short-term connections an overload caused by opening as well as shorting of input terminals. The duration of these connections shall be 1 second after the moving element of the instrument strikes the stop pin of the instrument scale.

5.14 Differential Gap — The differential gap or the instruments with ON-OFF control actions shall be either of these mentioned below:

- a) 0.5 percent of span, and
- b) 1.0 percent of span.

5.15 Control Contact Ratings — The non-inductive contact rating of the microswitches shall be minimum 3A at 240 V, 50 Hz.

5.16 Calibration Check Up — Instrument may have a device permitting to check their proper working condition and calibration by automatically bringing the indicator at the initial scale mark or at a pre-set value when the control button is pressed.

5.17 Full Scale Travel Time — Full scale travel time of the instrument shall be less than 1, 2, 5 and 8 seconds.

5.18 Operating Environmental Condition — The instrument shall operate reliably at an ambient temperature ranging between 0 and 55°C and RH up to 95 percent.

5.19 Number of Measurement Ranges — The indicators shall be available for measuring either single range or multiranges.

5.20 Dials and Scales — The dials and scales of all instruments shall be marked in accordance with the relevant Indian Standard specifications.

5.21 Scale Length — The instruments shall be manufactured to have one of the following indicating scale lengths:

100, 130, 160, and 250 mm.

5.22 Recording Thickness — The records of single-pen, two-pen, or three-pen (continuous recording type) recording instrument shall be continuous smudge-free line trace having a thickness not greater than 0.6 mm.

5.23 Recording Error — The recording error shall be expressed in the same units as the basic error:

<i>Indicating Accuracy</i>	<i>Basic (Recording Error)</i>
0.25	0.5
0.5	1.0
1.0	1.5

5.24 Ink Colour — Ink used shall comply with IS: 8277-1976* and shall be of the following colour:

Pen No. 1	Blue
Pen No. 2	Red
Pen No. 3	Green

5.25 Charts — The recording charts used with electronic self-balancing bridge instruments shall meet the requirements of 'Indian Standard specification for charts for automatic recording measuring instruments (*under print*)'.

5.26 Chart Length — Chart rolls of 15 m or more with strip chart shall be provided which corresponds to minimum of 30 days requirements at the speed of 20 mm/h.

5.27 Chart Speeds — Recording instruments with a strip chart shall be provided with means of driving the chart at not less than three steps of speed if the instrument is not having automatic speed changing device and at least two steps if the instrument is equipped with an automatic speed change device.

The steps of speed shall be selected from the following:

- a) 15, 30, 60, 120, 240, 300, 360, 600, 720, 1 200, 1 800, 3 600, 7 200, 11 250, 18 000, 22 500 and 36 000 mm/h.

*Specification for water based recorder inks.

- b) 5, 10, 20, 40, 60, 120, 240, 300, 360, 600, 720, 1 200, 1 800, 3 600, 7 200, 11 250, 18 000, 22 500 and 36 000 mm/h.

At rated supply voltage with permissible deviations not exceeding ± 10 percent and a supply frequency of 50 Hz, the chart shall be driven at rated speed, accurate to ± 0.5 percent.

Instruments with circular chart recording shall be driven at a single speed equal to one revolution per 24 hours, or per week or per month.

5.28 Speed Error of Strip Chart — At the rated supply voltage with permissible deviations not exceeding ± 10 percent and at the frequency of 50 Hz, the strip chart speed shall be equal to the nominal value with an error of not more than ± 0.5 percent.

5.29 Pointers — The pointers for indication of indicating and recording instruments shall meet the requirements of IS: 1248-1968* and IS: 6236-1971† respectively.

5.30 Mounting Position — The mounting position of the instruments on the panels shall be specified as:

- a) suitable to be mounted on vertical panels, or
- b) suitable to be mounted on control desks, sloped up to a maximum angle of 75° from vertical.

5.31 Multipoint Instruments — Multipoint instruments shall be capable of monitoring multipoints as specified below:

- a) 2 points,
- b) 3 points,
- c) 4 points,
- d) 6 points,
- e) 12 points, and
- f) 24 points.

Input terminals of the recorder shall be coupled to the various monitoring points automatically at a fixed span of interval between points. This interval shall be greater than the response time of the instrument and shall be specified.

5.32 Printing Cycle Time — The time taken between two consecutive printings shall be specified by the manufacturer.

5.33 Line Resistance Compensation — To reduce the effect of resistance change of the connecting wires upon the accuracy of the instrument, any of the methods described in 6.2.2 of IS: 2806-1964‡ shall be employed.

5.34 Current Flowing Through the Temperature Sensor — The current that flows through the temperature sensor (primary instrument)

*Specification for direct acting electrical indicating instrument (*first revision*).

†Specification for direct recording electrical measuring instruments.

‡Methods of temperature measurement by electrical resistance thermometers.

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shall be specified. This is an essential parameter since self heating of the sensor and in turn the error in the reading depends on the current flowing through the resistance thermometer.

6. ADDITIONAL REQUIREMENTS

6.1 Instrument case should protect the inside mechanism from dust and mechanical damages.

6.2 Distance between the pointer and the dial surface should not exceed 1.5 mm. The pointer tip should cover not less than $3/4$ length of the smallest scale division.

6.3 In multipoint recorders the recording of measured values of different transmitters shall be clearly distinguished by any of the following means of combinations:

- a) By using different numerals corresponding to each transmitter,
- b) Different coloured inks, and
- c) By using different notations.

6.4 Accessories Spare Parts — Each instrument shall be furnished with:

- a) accessories,
- b) spare parts,
- c) special tools,
- d) spare charts,
- e) mounting and operating instructions, and
- f) certificate of instrument.

7. PACKING AND MARKING

7.1 The bridge indicator/recorder shall be suitably packed to avoid damage during transit.

7.2 The instrument shall be clearly and indelibly marked with the following information prominently displayed on a name-plate:

- a) Manufacturer's name or trade-mark,
- b) Type of instrument in accordance with **2.1**,
- c) Type of sensor,
- d) Accuracy class,
- e) Measurement range,
- f) Rated supply voltage, and
- g) Rated frequency.

7.2.1 The instrument may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that

standard under the well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

8. TEST METHODS

8.1 General Conditions for Tests

8.1.1 When a full evaluation in accordance with this standard is not required, those tests which are required shall be performed and the results reported in accordance with the relevant clauses of the standard.

8.1.2 All tests should be carried out with the instrument cover in position.

8.1.3 The accuracy of the test methods shall be stated in the test report and shall be superior to the rated instrument accuracy by a factor of at least 5.

8.1.4 All tests shall be carried out with the instrument mounted as prescribed by the manufacturer or as is supposed to be mounted in the usual operation.

8.2 The tests shall be classified as type tests and routine tests as given below.

8.2.1 Type Tests

- a) Visual examination **(8.3)**,
- b) Test for ambient temperature **(8.4)**,
- c) Test for humidity **(8.5)**,
- d) Test for earthing **(8.6)**,
- e) Test for common mode interference **(8.7)**,
- f) Test for series mode interference **(8.8)**,
- g) Insulation resistance test **(8.9)**,
- h) Insulation strength test **(8.10)**,
- j) Checking of full-scale travel time **(8.12)**,
- k) Checking of damping **(8.13)**,
- m) Determination of hysteresis and threshold sensitivity **(8.16)**,
- n) Determination of effect of change of supply voltage **(8.18)**,
- p) Determination of effect of change of supply frequency **(8.19)**,
- q) Checking of the error of speed of strip chart **(8.20)**,
- r) Checking of printing cycle **(8.21)**,
- s) Test of quality of recording **(8.22)**, and
- t) Environmental tests (*under consideration*).

8.2.2 Routine Tests

- a) Visual examination **(8.3)**,

- b) Test for earthing (8.6),
- c) Insulation resistance test (8.9),
- d) Insulation strength test (8.10),
- e) Checking of full-scale travel time (8.12),
- f) Checking of damping (8.13),
- g) Determination of hysteresis and threshold sensitivity (8.16),
- h) Checking of printing cycle (8.21), and
- j) Test of quality of recording (8.22).

8.3 Visual Examination of Instrument — For visual examination, the completeness of instrument, external view and markings are checked (*see* 8.11).

8.4 Test for Ambient Temperature — Sufficient time shall be allowed for stabilization at each of the following ambient temperature $0^{\circ}\text{C}+27^{\circ}\text{C}$ and $+55^{\circ}\text{C}$ or alternatively at the manufacturer's recommended maximum and minimum operating temperatures. At each of the temperatures mentioned above the response of the instrument is observed and it shall be within the specified limits (*see* 5.8) when checked at 10, 50 and 90 percent of the span.

8.5 Test for Humidity — The equipment shall be maintained for a period of at least 12 hours, in a chamber at atmospheric pressure at a temperature of $40\pm 2^{\circ}\text{C}$ and at a relative humidity of not less than 95 percent. The instrument shall be switched on for the final 4 hours of the above period and measurements shall be taken at intervals of 20 percent of span. With the equipment still in operation the temperature shall be allowed to fall below 27°C in not less than 1 hour. The chamber shall remain closed and saturation shall take place during this period.

8.5.1 After this test a visual inspection shall be conducted to check for effects of flashover, accumulations of condensate, deterioration of components, etc.

8.6 Test for Earthing — This test shall be applicable only to instruments with inputs and outputs which are isolated from earth. The test is carried out by measurement of the steady state change in indication caused by earthing each input terminal in turn. The change so measured shall not be more than the values specified in 5.6.

8.7 Test for Common Mode Interference — This test shall be applicable only to instruments with inputs and outputs which are isolated from earth. The test is carried out by measurement of the steady state changes caused by the application of an ac signal of 100 V rms at mains frequency between earth and each input terminal in turn. The phase of the interfering signal shall, in each case, be varied over 360° with respect to the phase of the mains input to the instrument power supply. There shall be no

perceptible vibration of the indicator pointer or broadening of recorder trace during the test.

8.8 Test for Series Mode Interference — The test is carried out by measurement of the steady state changes resulting from the injection of an ac signal as specified by the manufacturer at mains frequency in each of the input leads in turn. This shall be done via the secondary winding of a transformer connected in series with these leads; the transformer primary voltage shall be such that if the secondary had 100 ohms across it the secondary terminal voltage would be 1 V rms. The phase of the interfering signal shall, in each case, be varied over 360° with respect to the phase of the mains to the instrument power supply.

8.9 Insulation Resistance Test — Electrical resistance of insulation shall be checked with the help of Megger with a rated output of 500 ± 30 volts, for conformity with 5.11.

Before testing it is necessary:

- a) to short-circuit the terminals for power supply,
- b) to short-circuit the terminals for connecting the signalling device, and
- c) to short-circuit the terminals for connecting the transmitter.

For checking the insulation resistance of the power circuit with respect to the case of the instrument, it is necessary to connect the earth terminal of the case with the earth terminal of Megger and the other terminal of the power circuit with the second terminal of Megger.

For checking the insulation resistance of the measuring circuit and of the circuit of additional devices with respect to case of the instrument, it is necessary to connect the earth terminal of the case with the earth terminal of the Megger and the other terminal of the circuit under check with second terminal of Megger.

For checking the insulation resistance of the power circuit with respect to the measuring circuit and circuits of additional devices, it is necessary to connect the instrument terminal for power supply from 240 V with one of the terminal of Megger and the short-circuited terminals of the circuit under check with the other terminal of Megger.

8.10 Checking of Electrical Insulation Strength — Before checking the electrical strength of insulation, it is necessary to make the same preparation as for checking the resistance of insulation.

Checking of electrical strength of insulation shall be carried out on a special device having power of not less than 0.25 kVA on the high voltage side.

The testing voltage shall be applied to those circuits between which the test of insulation strength is to be performed. The leads from the device shall be connected in the same way as for determining the electrical resistance of insulation.

The recorder shall conform to the requirements specified in 5.10.

NOTE — After the tests for insulation resistance and strength of insulation, instrument connections are restored to the original position.

8.11 Checking of the Pointer Movement — Checking of pointer movement shall be carried out by visual examination. To do this, the voltage across the input signal terminals is changed when the pointer shall move along the full scale. The movement of the pointer shall be smooth and continuous.

8.12 Checking of Full-Scale Travel Time — The time of full-scale travel of the pointer shall be determined in the following order.

8.12.1 To the terminals meant for connecting the transmitter, a bridge shall be connected and a voltage corresponding to the initial scale value of the instrument is read.

8.12.2 The voltage shall be changed to the value corresponding to the final scale mark and simultaneously the stop-watch started.

8.12.3 Change of voltage shall be made as quickly as possible. The stop-watch shall be stopped instantaneously as the pointer reaches the end of scale.

8.12.4 The travel time from end of scale to the beginning shall be determined in the same manner.

8.12.5 The full-scale travel time of the pointer is calculated on the mean of the two measurements, and shall conform to the requirements specified in 3.1 (d).

8.13 Checking of Damping — Damping shall be checked in the following order, for conformity with 5.9.

8.13.1 The voltage corresponding to the initial scale value shall be set on the bridge. Damping shall be observed by quickly changing this value to 10 percent of full-scale value.

8.13.2 In a similar manner, damping shall be checked for 50 percent and 90 percent of the full-scale value.

8.13.3 Damping shall also be checked for small changes of voltages on the bridge, equal to, for example, 1 to 2 percent of the measurement range of the instrument.

NOTE — Before checking damping, instrument shall be 'on' for not less than 30 minutes.

8.14 Determination of Basic Error — The basic error shall be determined under the following conditions (see 5.23).

- a) Ambient temperature $27 \pm 2^\circ\text{C}$,
- b) Supply voltage to instrument power circuit $240 \text{ V} \pm 6$,
- c) Supply frequency $50 \pm 1.5 \text{ Hz}$,

- d) In the vicinity of testing there shall be no external magnetic field (except that of the earth), and
- e) The checking bridge shall be of accuracy better than at least five times the instrument accuracy.

After connecting the checking bridge, the instrument shall be switched 'on' to be heated for not less than the time specified by the manufacturer.

By smoothly changing the voltage fed to the checking bridge, the pointer shall be brought over the scale mark to be tested.

The basic error shall be determined on all the scale marks for increasing and decreasing values of the quantity to be measured.

The basic error is calculated according to the following formula:

$$\epsilon = \frac{E-u}{E_1-E_f} \times 100 \text{ percent (1)}$$

where

- ϵ = basic error in percent,
- E = thermo-emf according to relevant Indian Standard or corresponding to the given scale mark in mV;
- u = bridge reading in mV of the readings, upscale or downscale (the reading causing maximum error is chosen); and
- E_1, E_f = thermo-emf or voltage corresponding to the initial and final scale mark respectively in mV.

NOTE — Determination of basic error of indication of multipoint instruments is carried out in all positions of the switch and for all of the scale values.

8.15 Determination of basic error of recording (*see* 5.23) on strip chart shall be carried out exactly in the same way as the determination of basic error of indication. For this the reading is taken by stopping the pen (for multipoint recorder—the printing drum) on the given mark of the strip chart.

8.15.1 While determining the error of recording at a relative humidity of more than 60 percent, it is necessary to take into account its effect on the geometrical dimensions of the strip chart.

8.16 Determination of Hysteresis and Threshold Sensitivity — Hysteresis is determined alongwith the determination of basic error of instrument.

It is calculated according to the following formula:

$$\gamma = \frac{U_1-U_2}{E_f-E_1} \times 100 \text{ percent}$$

where

- γ = hysteresis in percent,
- U_1 = reading of the checking bridge, while the quantity being measured is decreased,

U_2 = reading of the checking bridge while the quantity being measured is increased, and

E_1, E_t = as in **8.14**.

8.16.1 Testing of threshold sensitivity (*see* **5.8**) shall be performed after the determination of hysteresis. With the help of checking of bridges a change of voltage of which movement of the carriage is noticeable shall be introduced. Then the voltage shall be changed in the same direction to a value equal to that specified in **5.8**.

As a result the carriage shall move immediately in the same direction. Threshold sensitivity shall be checked at 10, 50 and 90 percent of span both for decreasing and increasing values of the quantity being measured.

8.17 Checking the Working Order of Control Button — Checking of the working order of control button shall be done by pressing it. As a result, the instrument pointer shall place itself at the initial scale mark or at the pre-set value with an error not exceeding ± 0.5 percent of the range of measurement.

8.18 Determination of Effect of Change of Supply Voltage — The effect of change of supply voltage shall be determined on a device providing means of regulating the supply voltage by ± 10 percent.

According to method stated in **8.14** and **8.16**, the basic error and threshold sensitivity are determined at supply voltage of the specified value ± 10 percent.

Effect of change of supply voltage shall be checked at three scale markings, for example, at 10, 50 and 90 percent of the range of measurement.

8.19 Determination of Effect of Change of Supply Frequency — The effect of change of supply frequency on instrument reading shall be determined on a device providing means of regulating the frequency of 50 Hz by ± 3 percent.

According to the method stated in **8.14** and **8.16**, the basic error and threshold sensitivity shall be determined at supply frequencies of 48.5 and 51.5 Hz.

The effect of changes of supply frequency shall be determined at three scale markings for example at 10, 50 and 90 percent of the range of measurement.

8.20 Checking the Error of Speed of Strip Chart — For checking the speed error of strip chart, the gear train corresponding to the speed under check is arranged in the reducer of the instrument.

On the right wall of bracket, a scratch mark shall be made.

Instrument shall be switched on and a line is marked close to and in the same horizontal plane of the strip chart. The stop-watch shall be started at the moment this line passes the scratch mark.

Then within a little time when the diagram chart moves not less than 300-400 mm, a fresh line is again made on the strip chart. The moment this line passes the scratch mark, the stop-watch shall be stopped.

The checking of error in the speed of strip chart shall be carried out at the specified speed.

Speed error of the strip chart is calculated by the following formula:

$$\left(\frac{72\,000 \times n}{Vt} - 1 \right) \times 100 \text{ percent}$$

where

- n = No. of division between the lines marked on the strip chart (length of each division assuming to be 20 mm),
- t = time read on the stop-watch in seconds, and
- V = nominal value of speed under test in mm/h.

8.21 Checking the Printing Cycle — For checking the printing cycle, gears corresponding to the cycle value in accordance with the type of instrument under measurement shall be set in turns.

For every setting of cycle value, time of the cycle shall be checked with the help of stop-watch.

8.22 Test of Quality of Recording — The test of quality of recording is carried out during continuous use of the instrument for 3 hours. For checking the recording of instruments, terminals meant for connecting thermometers are connected to a resistance such that:

- a) for single point instruments, the line of recording is placed at the central portion of strip chart; and
- b) for multipoint instruments, the line of recording is placed over the whole width of strip chart.

NOTE — The line of recording of the first number should be placed at a distance, for example, 5 to 10 percent of the scale length from the initial scale mark and the last number at a distance, for example, 90 to 95 percent of the scale length from the initial scale mark.

The following are controlled in the process of operation:

- a) Quality of the line of recording, its thickness (*see 5.22*) for single point instruments.
- b) Quality of impressions (*see 6.3*) correspondence of colour/number on the printing drum, selector switch and block meant for switching thermometer (*see 5.31*) for multi-point instruments.

Correspondence of numbers is checked by the fact that throughout the test, the line of recording corresponding to minimum resistance should be printed with No. 1 and line of recording corresponding to maximum resistance should be printed with the number of the last transducer.

APPENDIX A

(Clause 0.5)

RESISTANCE THERMOMETERS (TEMPERATURE SENSORS)

A-1. The different resistance thermometer elements shall be as given below:

<i>Resistance Thermometer Elements</i>	<i>Ref Indian Standard</i>
Platinum	IS: 2848-1965*
Nickel	IS: 5883-1970†
Copper	—

*Specification for platinum resistance thermometer elements.

†Specification for nickel resistance thermometer elements.