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SPECIFICATION FOR ELECTRICAL RELAYS FOR POWER SYSTEM PROTECTION

PART 3 REQUIREMENTS FOR PARTICULAR GROUP OF RELAYS

Section 2 Dependent Specified Time Measuring Relays

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Indian Standard

SPECIFICATION FOR ELECTRICAL RELAYS FOR POWER SYSTEM PROTECTION

PART 3 REQUIREMENTS FOR PARTICULAR GROUP OF RELAYS

Section 2 Dependent Specified Time Measuring Relays

0. FOREWORD

0.1 This Indian Standard (Part 3/Sec 2) was adopted by the Indian Standards Institution on 20 January 1987, after the draft finalized by the Relays Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard is one of the series of standards being brought out to cover requirements of protection relays. General introduction to this series is given in IS : 3231 (Part 0)-1986*.

The standards published in the series so far are:

IS : 3231 Specification for electrical relays for power system protection:

(Part 0) - 1986	General introduction and list of parts (*first revision*)
(Part 1/Sec 1) - 1986	General requirements, Section 1 Contact performance (*first revision*)
(Part 1/Sec 2) - 1986	General requirements, Section 2 Insulation tests (*first revision*)
(Part 1/Sec 3) - 1986	General requirements, Section 3 High frequency disturbance test for static relays (*first revision*)
(Part 2/Sec 1) - 1987	Requirements for principal families, Section 1 All-or-nothing relays
(Part 2/Sec 2) - 1987	Requirements for principal families, Section 2 General requirements for measuring relays

*Specification for electrical relays for power system protection: Part 0 General introduction and list of parts (*first revision*).

(Part 3/Sec 1) - 1987	Requirements for particular group of relays, Section 1 Non-specified time or independent specified time measuring relays
(Part 3/Sec 2) - 1987	Requirements for particular group of relays, Section 2 Dependent specified time measuring relays
(Part 3/Sec 3) - 1987	Requirements for particular group of relays, Section 3 Biased percentage differential relays

0.3 According to classification on hierarchical basis [*see* IS : 3231 (Part 0)-1986*], this standard is a third level document.

0.4 This standard is to be read in conjunction with IS : 3231 (Part 2/ Sec 2)-1987† to which it makes the reference and supplements where the special requirements for dependent specified time measuring relays make this necessary.

0.5 In preparing this standard, assistance has been derived from the following:

IEC Publication 255-4 (1976) Electrical relays: Part 4 Single input energizing quantity measuring relays with dependent specified time. International Electrotechnical Commission.

BS 142 : Section 3.2 : 1983 Electrical protection relays: Part 3 Requirements for single input energizing quantity relays, Section 3.2 Specification for single input energizing quantity measuring relays with dependent specified time. British Standards Institution.

1. SCOPE

1.1 This standard (Part 3/Sec 2) covers requirements for single input energizing quantity measuring relays with dependent specified time, as a particular sub-family of measuring relays whose general requirements are specified in IS : 3231 (Part 2/Sec 2)-1987†.

*Specification for electrical relays for power system protection: Part 0 General introduction and list of parts (*first revision*).

†Specification for electrical relays for power system protection: Part 2 Requirements for principal families, Section 2 General requirements for measuring relays.

2. STANDARD VALUES

2.1 Standard Values of Dependent Specified Time — There are no standard values of dependent specified time. The relationship between operating times and characteristic quantity can be expressed by means of a characteristic curve. The shape of this curve shall be declared by the manufacturer.

2.1.1 *Dependent Time Relays with Increasing Function* — For dependent time relays whose time increases in accordance with the increase of characteristic quantity, the shape of the characteristic curve shall be specified by the manufacturer.

2.1.2 *Dependent Time Relays with Decreasing Function* — For dependent time relays whose operating times decrease with an increase of characteristic quantity. For relays with decreasing function, the most common characteristic curves follow a law of the following form:

$$t = \frac{k}{\left[\frac{G}{G_b}\right]^{\alpha} - 1}$$

where

t = theoretical operating time,

k = constant characterizing the relay,

G = value of the characteristic quantity,

G_b = basic value of the characteristic quantity, and

α = index characterizing the algebraic function.

NOTE — For relays with time multiplier settings, the expression is applicable at 100 percent time setting.

Three classes of curves following the above general formula are defined as follows:

a) Type A for $\alpha \leqslant 0{\cdot}5$,

b) Type B for $0{\cdot}5 < \alpha \leqslant 1{\cdot}5$, and

c) Type C for $\alpha > 1{\cdot}5$.

For each of these types, the following values are standardized but when they are not applicable, the manufacturer shall declare the characteristics of the curves appropriate in the design.

Relay Characteristic	*Type A*	*Type B*	*Type C*
k	0·14	13·5	80·0
α	0·02	1·0	2·0

NOTE — Type A above corresponds to normal inverse characteristic.

2.2 Standard Reference Values of Influencing Quantities and Factors and Standard Values of Their Nominal and Extreme Ranges

2.2.1 *Standard Reference Values of Influencing Quantities and Factors*

2.2.1.1 *Input energizing quantity* (*see* Table 1)

a) The reference magnitude of the input energizing quantity (reference for the determination of variation) for relays with decreasing function of Types A, B or C shall be 10 times the reference setting values unless otherwise specified by the manufacturer.

b) The manufacturer shall declare the reference magnitude of the input energizing quantity (reference for the determination of variations) for relays not having characteristics specified in item (a) and for relays with increasing function.

2.2.1.2 *Characteristic curve parameters* (*see* Table 1) — Reference parameters of characteristic time curves shall be in accordance with **2.1.**

TABLE 1 REFERENCE VALUES OF CHARACTERISTIC QUANTITY AND ASSIGNED ERRORS

(*Clauses* 2.2.1.1, 2.2.1.2 *and* 5.3.2.2)

Value of characteristic quantity as a multiple of basic value	2	5	10	20
Assigned error as a multiple of class index	2·5	1·5	1	1

2.2.2 *Standard Values of Limits of Normal Ranges of Influencing Quantities and Factors*

2.2.2.1 *Effective range of the input energizing quantity* (*see* Table 2)

a) For relays with decreasing function of Types A, B or C (*see* **2.1**), the limits of the effective range of input energizing quantity shall be between 2 and 20 times the basic values of the characteristic quantity, unless otherwise specified; and

b) The manufacturer shall declare the effective range of input energizing quantity for relays not having characteristics specified in (a) and for relays with increasing function.

TABLE 2 VALUES OF THE CHARACTERISTIC QUANTITY OF INPUT ENERGIZING QUANTITY FOR MECHANICAL DURABILITY TESTS

(*Clauses* 2.2.2.1 *and* 13.1)

Type of Relay	Characteristic Quantity	
	Initial Value	Final Value
(1)	(2)	(3)
Maximum measuring relay with decreasing function	0	To be declared by the manufacturer
Minimum measuring relay with increasing function	To be declared by the manufacturer	0

3. VALUES OF LIMITS OF OPERATIVE RANGE OF AUXILIARY ENERGIZING QUANTITIES

3.1 The values of limits of operative range of auxiliary energizing quantities shall be as specified in **4** of IS : 3231 (Part 2/Sec 2)-1987*.

4. THERMAL REQUIREMENTS

4.1 The thermal requirements shall be as specified in **5** of IS : 3231-(Part 2/Sec 2)-1987*.

5. ACCURACY

5.1 Requirements shall be in accordance with **6** of IS : 3231 (Part 2/ Sec 2)-1987* along with **5.2** and **5.3** of this standard.

5.2 Accuracy Relating to the Characteristic Quantity — In a dependent time relay, accuracy is associated only with the basic value and the threshold operating value of the characteristic quantity. The fundamental requirement is that the relay shall not operate at the basic value but shall operate at the threshold operating value. The manufacturer shall state the basic and threshold operating values. The conventional term 'setting value' has been applied either to the basic value or to the threshold operating value. For example, for a dependent time relay which operates at the setting, the setting value is the threshold value subject to allowable tolerances. Conversely, some relays are required not to operate at the 'setting', that is the 'setting value' is the basic value subject to allowable tolerances.

The threshold operating value for current relay shall be not more than 1·3 times the basic value. The corresponding recommended threshold operating value for voltage and frequency relays are 1·15 and 1·06 times the basic value. For other types of relays, the value shall be a subject of agreement between the manufacturer and the user.

5.3 Accuracy Relating to Time

5.3.1 *Effective Range of the Characteristic Quantity*

a) For relays with decreasing function of the Types A, B or C (*see* **2.1.2**), unless otherwise specified, between 2 and 20 times, the basic value of the characteristic quantity; and

b) For relays with increasing function and all other relays with decreasing function as indicated by the manufacturer.

5.3.2 *Assigned Error* — The assigned error is indentified by a class index (declared by the manufacturer), which may be multiplied by

*Specification for electrical relays for power system protection: Part 2 Requirements for principal families, Section 2 General requirements for measuring relays.

factors corresponding to different values of the characteristic quantity within its effective range. The assigned error can be declared as:

a) The theoretical curve of time/characteristic quantity bounded by curves representing maximum and minimum limits of the assigned error obtained under reference condition (*see* Fig. 1), and

b) An assigned error claimed at the maximum limit of the effective range multiplied by stated factors (*see* Note) corresponding to different values of the characteristic quantity.

NOTE — The assigned error is expressed as a percentage of the theoretical time corresponding to each value of the characteristic quantity.

5.3.2.1 The preferred values of class indices are:

1·5, 2·5, 5, 7·5, 10, 20 and 30.

The manufacturer may quote other values.

5.3.2.2 For relays with decreasing function of the Types A, B and C, the value of the limiting error shall be related to the class index in accordance with Table 1, unless otherwise declared by the manufacturer.

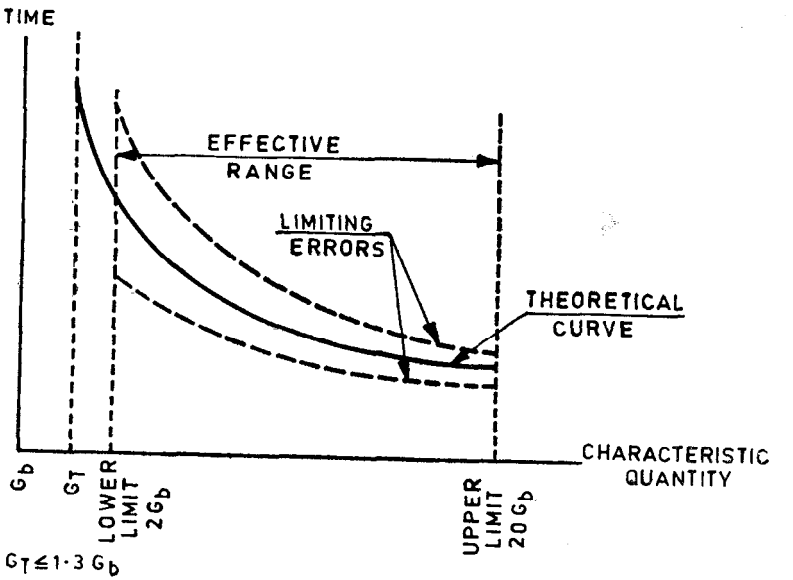

FIG. 1 GRAPHICAL PRESENTATION OF ASSIGNED ERRORS SHOWING MAXIMUM AND MINIMUM LIMITS (LIMITING ERRORS)

5.3.2.3 The assigned error is declared at the upper limit of the effective range.

5.3.2.4 For all other dependent time relays, the manufacturer shall declare the theoretical curve and assigned error over the effective range.

6. RATED BURDEN AND RATED IMPEDANCE

6.1 The requirements for rated burden and rated impedance shall be as specified in **8** of IS : 3231 (Part 2/Sec 2)-1987*.

7. MECHANICAL REQUIREMENTS

7.1 The mechanical requirements shall be as specified in **9** of IS : 3231 (Part 2/Sec 2)-1987*.

8. CONSTRUCTIONAL REQUIREMENTS

8.1 The constructional requirements shall be as specified in **10** of IS : 3231 (Part 2/Sec 2)-1987*.

9. CONTACT PERFORMANCE

9.1 The contact performance shall be in accordance with IS : 3231 (Part 1/Sec 1)-1986†.

10. INSULATION REQUIREMENTS

10.1 Insulation requirements shall be in accordance with IS : 3231 (Part 1/Sec 2)-1986‡.

11. MARKINGS AND DATA

11.1 Markings and data shall be as specified in **11** of IS : 3231 (Part 2/ Sec 2)-1987*.

12. THERMAL TESTS

12.1 Thermal tests shall be made in accordance with **13** of IS : 3231 (Part 2/Sec 2)-1987*.

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*Specification for electrical relays for power system protection: Part 2 Requirements for principal families, Section 2 General requirements for measuring relays.

†Specification for electrical relays for power system protection: Part 1 General requirements, Section 1 Contact performance.

‡Specification for electrical relays for power system protection: Part 1 General requirements, Section 2 Insulation tests.

13. TEST CONDITIONS

13.1 The values of the characteristic quantity or input energizing quantity for mechanical durability tests shall be as specified in Table 2. The transition from initial to final value shall be sudden.

14. ACCURACY TESTS

14.1 Determination of Errors Relating to Specifications — Tests for determination of errors relating to specified time shall be performed in accordance with the following conditions:

a) All tests shall be applied under reference conditions;

b) The relay shall be in a new condition;

c) The manufacturer shall, if relevant, declare the previous energizing conditions of relay, that is, he shall state if thermal equilibrium, due to self-heating has to be reached before the beginning of the test. In the absence of any such declaration, the relay shall be assumed to be at reference ambient temperature at the beginning of the test;

d) When the relay includes one or more auxiliary energizing quantities, the manufacturer shall declare:

i) if the initial values are rated values or zero;

ii) if the final values are zero or rated values; and

e) The manufacturer shall declare how the relay is to be energized for these tests, if conditions differ from those in Table 3. The switching from initial value to final value shall be sudden.

TABLE 3 TEST CONDITIONS RELATING TO THE CHARACTERISTIC QUANTITY FOR DETERMINING ERRORS RELATING TO SPECIFIED TIME

Type of Relay	Characteristic Quantity	
	Initial Value	Final Value
(1)	(2)	(3)
Decreasing function	0	Extreme values of effective range and at least one intermediate value
Increasing function	Rated value	

14.2 Variations Relating to Time — The variations due to a single influencing quantity departing from its reference conditions but within the nominal range of use shall be determined:

a) with all other influencing quantities at their reference conditions, and

b) at the reference value of the characteristic quantity stated in accordance with **2.2.1.1** (a) and (b).

14.3 Determination of Errors and Variations Associated with Characteristic Quantity — Tests for determination of errors associated with characteristic quantity shall be performed in accordance with the following conditions:

a) As items (a), (b), (c) and (d) of **14.1**;

b) The setting adjustment (if any) to the operating time of relay shall be at its reference value;

c) For maximum measuring relays (usually increasing function), the characteristic quantity shall be increased gradually from a value below the basic value to the operating value [*see* **14.3** (d)]; and

d) For minimum measuring relays (usually increasing function), the characteristic quantity shall be decreased gradually from a value above the basic value to the operating value.

NOTE — At the operating value, the operating time may approach infinity. In such cases and as a practical convention, an approximation of the operating value may be taken as that value which has an operating time not greater than ten times the time at the nearest limit of the effective range unless otherwise stated by the manufacturer.

15. TEST CONDITIONS FOR MEASUREMENT OF OVERSHOOT

15.1 During tests for the determination of overshoot, the initial and final values of the characteristic quantity shall be as specified in Table 4.

TABLE 4 INITIAL AND FINAL VALUES OF CHARACTERISTIC QUANTITY

TYPE OF RELAY	CHARACTERISTIC QUANTITY	
	Initial Value	Final Value
(1)	(2)	(3)
Maximum measuring relays	Upper limits of effective range	0
Minimum measuring relays	Lower limit of effective range	Rated value

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N = 1 kg,m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s(s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2