

IRS:TC 76-2000

**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS**

**INDIAN RAILWAY
STANDARD SPECIFICATION**

FOR

**TWO/THREE V.F. TRANSFORMERS (2T/3T) FOR
DERIVATION AND TERMINATION OF UNDERGROUND
TELECOM CABLE CIRCUIT.**

**(Tentative)
Serial No. TC 76-2000**

**ISSUED BY
RESEARCH DESIGNS AND STANDARDS ORGANIZATION
MANAK NAGAR, LUCKNOW – 226011**

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0. FORWARD:-

01 This specification is issued under the fixed serial no. IRS: TC 76, followed by the year of adoption as standard or in the case of revision, the year of last revision.

0.2 This specification requires reference to following Indian Railways Standard (IRS) and Indian Standards (IS) specification:

IRS:S 23 Electrical signalling & interlocking equipment.

IS:9000 Basic climatic and mechanical durability test for electronic components.

IRS: TC 30 Underground quad cable for special purpose in RE areas.

IRS: TC 14 Aluminium sheathed main telecom cable.

IS: 7328 High density polythene.

0.3 Wherever in this specification any of the above mentioned specification is referred to by number only without mentioning the year of issue, the latest issue to that specification is implied, otherwise the particular issue referred to is meant.

0.4 This specification is intended chiefly to cover the technical provisions and the provisions relating to supply of the materials and does not include all the necessary provisions of contract.

1. SCOPE:-

1.1 This specification covers the requirements of V.F. transformers 2T/3T used for terminating and derivation of the circuits in the underground telecom cables to specification IRS: TC 30 & IRS: TC 14.

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2. TERMINOLOGY:-

- 2.1 For the purpose of this specification, the terminology given in IRS:S 23 shall be applied.
- 2.2 The term referred to in this specification but not covered in IRS: S 23 is as under:
- 2.2.1 LOT- A lot is constituted by the transformers of the same of the same type manufactured in the same factory during the same period using the same process and materials.

3. GENERAL:-

- 3.1 The circuits carried in the 4/6 quad cable/ main telecom cables are derived at a number points on the route by means of V.F. transformers (2T/3T). The transformers used for the various circuits shall be of following types:-

Center tap should be made available so that phantom circuits can be derived from these transformers.

Type 1- V.F. transformers for loaded Main telecom quad cable and loaded quad cable, impedance ratio 1120:1120 ohms.

Type 2 - V.F. transformers for unloaded quad cable, impedance ratio 470 : 1120 ohms.

Type 3 - V.F. transformers for unloaded quad cable impedance ratio 1200 : 600 ohms.

Type 4 - V.F. transformers for unloaded quad cable impedance ratio 470: 470 ohms.

Type 5 - V.F. transformers for unloaded quad cable impedance ratio 470: 600 ohms.

- 3.2 These transformers are contained in cylindrical case as shown in APPENDIX- F & G.
- 3.2 General requirements of workmanship, limits and fits, test and inspection and rejection shall be in accordance with IRS: S 23 to the extent applicable.

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4. **DIMENSIONS & CONSTRUCTION:-**

- 4.1 The core and windings of the transformers shall be completely enclosed in a hermetically sealed metallic case while the terminations shall be taken out by insulated lead wires through suitable seals.
- 4.2 Each of primary and secondary winding shall be taken out with a common I identical centre by 3 wires, each of 300 mm length, 0.6 mm dia PVC insulated copper conductor from each transformer through six holes. An earth terminal in electrical contact with the transformer case shall be provided. The arrangement shall be as shown in APPENDIX – F & G.

The end of windings shall be terminated on the coloured polythene insulated lead wires. The conductor insulation shall conform to grade 41 KB of IS: 7328 and nominal radical thickness of the insulation shall be 0.25 mm. The colour scheme of lead wires shall be as indicated in APPENDIX – F & G.

- 4.3 Twin/Three transformer (2T/3T) size shall not exceed the dimensions shown in APPENDIX – F & G.
- 4.4 All exposed metallic surface/part shall be clear lacquer coated or otherwise suitably protected against corrosion.

5. **ELECTRICAL CHARACTERISTICS:-**

- 5.1 The transformers shall conform to the electrical characteristics given in Table-1.

6. **TESTS AND REQUIREMENTS:-**

- 6.1 The following shall constitute type tests:-
- a) Visual inspection (Clause 6.5)
 - b) Conformity to specification dimensions (Clause 4)
 - c) Test for electrical characteristics (Clause 5.1, table – I).
 - d) Climatic tests (Clause 6.4)
 - e) Bump test (Clause 6.7)
 - f) Test for sealing of transformers (Clause 6.6)

NOTE:-

For the purpose of type tests, return loss, inspection loss and winding balance tests of V.F. transformers shall be conducted at input levels from 0.1 to 10.0 milliwatts.

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- 6.1.1 The manufacturer shall submit six transformers of each type for type approval.
- 6.1.2 A type approval certificate shall be issued to the manufacturer if the samples pass all the prescribed tests. Type approval certificate shall normally be valid for three years from the date of issue. The type approval certificate once issued shall not be valid if a change in the design, construction, material used or manufacturing process is made subsequently, unless this change has the approval of the purchaser or his nominee.
- 6.2 The following shall constitute Routine tests:- To be carried out by the manufacturer before the product is offered for acceptance tests by RDSO official or purchaser/ consignee's representative.
- a) Visual inspection (Clause 6.5)
 - b) Conformity to specification dimensions (Clause 4)
 - c) Test for electrical characteristics (Clause 5.1)
 - d) Any other test considers to necessary by the manufacturer to ensure that the transformer conforms to the requirements of this specification.
- 6.3 The following shall constitute Acceptance test:- To be carried out on bulk produces lot by RDSO official or purchaser/ consignee's representative as the case be
- a) Visual inspection (Clause 6.5)
 - b) Conformity to specification dimensions (Clause 4)
 - c) Test for electrical characteristics (Clause 5.1)
 - d) Any other test considers to necessary by the purchaser or his nominee.

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6.4 CLIMATIC SEVERITY TEST:-

6.4.1 The climatic severity test shall be done in accordance with IS: 9000 as per sequence and severity indicated below:-

S.No.	Climatic cycle	Severity temp.°C	Duration	Test to be conducted	Required results
1.	Dry heat	70 ± 2	16 hrs	i) Applied high voltage ii) Insulation Resistance	i) Shall with stand ii) Shall be > 5000 Mega ohms
2.	First Damp Heat	55 ± 2 (RH 90 to 95%)	16 hrs.	Insulation Resistance	i) Shall be > 1000 Mega ohms ii) Shall be > 2500 Mega ohms (after 24 hrs. of recovery)
3.	Cold	- 10	2 hrs.	- do -	Shall be > 5000 Mega ohms
4.	Five Damp Heat	55 ± 2 (RH 90 to 95%)	16 hrs.	- do -	i) Shall be > 1000 Mega ohms ii) Shall be > 2500 Mega ohms. (after 24 hrs. of recovery)

NOTE: The transformers after being subjected to all the climatic tests in the order as given above shall be tested for electrical characteristics, the variation in values shall not be more than ±5% except insulation resistance, for which values have been specified above.

6.5 VISUAL INSPECTION:

6.5.1 Visual inspection shall be carried out as per clause 14.2 of IRS:S 23 to the extent applicable.

6.6 TEST FOR SEALING OF TRANSFORMERS:

There shall be no defect of sealing as indicated by the appearance of air bubbles when the transformer is immersed in water containing suitable detergent (1/2 oz. per gallon) the water being raising to a temperature of 8.5°C to 90°C and maintained at the temperature for 15 minutes. For production test, a suitable high temperature oil may be used instead of water.

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6.7 BUMP TEST:

- 6.7.1 The samples shall be mounted as per specification IS: 9000, taking care that the termination are not stressed and that equal number of samples are bumped in each of the three principal axes. Samples shall be subjected to bump test in accordance with IS: 9000. After the test, the samples shall be visually examined and shall not any sign of damage or deterioration.

The transformer under test shall be firmly fixed to the mounting plate of the table of the bump test machine.

The continuity of the windings shall be checked. Insulation resistance, dielectric strength, insertion loss and return loss of the transformer shall be measured before and after the bump test and there shall not be any variation in the values of these parameters.

6.8 TESTING CONDICTIONS:

- 6.8.1 All measurements and checks, unless specified otherwise shall be carried out at any combination of temperature, humidity and pressure with the following limits:-

- a) Temperature 15°C to 35°C
- b) Relative Humidity 45 to 75%
- c) Air pressure 860 to 1060 in bar (700 to 800 mm of mercury)

NOTE:- The temperature and humidity shall substantially be maintained constant during a series of measurements carried out as a part of one test on a lot.

6.9 Test methods of Electrical Characteristics of V.F. transformers (2T/3T).

- 6.9.1 Methods for testing the V.F. transformers 2T/3T shall be as follows:-

- a) Dielectric Strength Test:-

A 50 Hz sinusoidal alternating voltage shall be used for dielectric strength test. The voltage shall be raised at a rate not exceeding 500V (rms) per second and shall be maintained at the maximum value of 2000V (rms) for one minute. All windings not under test shall be connected to the case of the transformer.

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b) **Insulation Resistance Test:-**

The insulation resistance shall be measured by applying 500V D.C. for one minute ± 5 seconds between the case and each windings and also between windings.

NOTE:- Insulation resistance shall be conducted after the dielectric strength test.

- c) Impedance Ratio - As per APPENDIX A.
- d) Return loss - As per APPENDIX B.
- e) Insertion loss (also for attenuation distortion) - As per APPENDIX C.
- f) Bridging loss - As per APPENDIX D.
- g) Winding balance - As per APPENDIX E.

7. INSPECTION:-

- 7.1 The inspection and test shall be carried out to the satisfaction of the purchaser or his nominee.
- 7.2 Test certificate incorporating the results of the routine test must be furnished in quadruplicate prior to the inspection for the use of the purchaser/ his nominee.

8. SAMPLING:-

Unless otherwise agree to by the purchaser and the supplier, the sampling plan given below shall be adopted during acceptance tests/ inspection.

Lot consisting of 2T/3T	1 st sample size (N ₁)	2 nd sample size (N ₂)	Combined sample size (N ₁ + N ₂)	Acceptance number (C ₁)	Rejection number (C ₂)
1	2	3	4	5	6
Under 25	3	6	9	0	2
25 to 50	7	14	21	0	3
51 to 100	10	20	30	0	3
101 to 200	13	26	39	0	5
201 to 300	20	40	60	1	5
301 to 400	25	50	75	1	6

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The number of 2T/3T (N_1) as given in col. 2 shall first be selected and subjected to the acceptance test. If in the first sample the number of defective 2T/3T, that is those failing in one or more acceptance test, is less than/ equal to the corresponding number (C_1) given in col. 5 the lot shall be considered as conforming to the requirements of the acceptance tests. If the number of defective 2T/3T in the first sample is greater than or equal to the rejection number given in col. 6 the lot shall be acceptance test. If number of defective 2T/3T in the first sample lies between (C_1) and (C_2) a second sample of the size (N_2) as given in col. 3 shall be selected to acceptance test. If in the combined sample, the number of defective 2T/3T is less than (C_2) the lot shall be considered as conforming to the requirements of acceptance test.

The sample shall be selected at random from at least 10% of the package. For random selection of package all the packages in the lot shall be arranged in a serial order and every r th package shall be selected until the requisite number of packages is obtained:-

$$\text{'r' being the integral part of } \frac{\text{Total number of package in the lot.}}{\text{Total number of package to be selected.}}$$

9. PACKING:-

9.1 The transformer shall be suitably packed to facilitate handling and to prevent the likelihood of any or damage during transit and storage.

10. MANUFACTURER'S IDENTIFICATION:-

10.1 The following information shall be marked on the transformers:

- a) Manufacturer's name and identification mark.
- b) Year of manufacture.
- c) Serial number, Specification number
- d) Type of transformers.
- e) Indian Railway.
- f) Terminal connections as per Appendix F.

TABLE – I (CLAUSE 5.1)

		TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5
S.No.	Characteristics	Terminating & tapping transformer for V.F. circuits.	Terminating & tapping transformer for Polythene insulated V.F. quad	Terminating & tapping transformer for inter wire	Terminating & tapping transformer for Polythene insulated V.F. quad	Terminating & tapping transformer for inter wire
1.	Impedance Ratio	1120:1120 ± 2%	470 : 1120 ± 2%	1120 : 600 ± 2%	470 : 470 ± 2%	470 : 600 ± 2%
2.	Insulation resistance with 500V winding – case	10,000 Mega ohms	10,000 Mega ohms	10,000 Mega ohms	10,000 Mega ohms	10,000 Mega ohms
3.	Dielectric strength winding – case	2KV (rms) for 1 mm.	2KV (rms) for 1 mm.	2KV (rms) for 1 mm.	2KV (rms) for 1 mm.	2KV (rms) for 1 mm.
4.	Return loss	More than 20dB	More than 20dB	More than 20dB	More than 20dB	More than 20dB
5.	Insertion loss	Not more than 0.6 dB	Not more than 0.6 dB	Not more than 0.6 dB	Not more than 0.6 dB	Not more than 0.6 dB
6.	Bridging loss with secondary open	Not more than 0.015 dB	Not more than 0.015 dB	Not more than 0.015 dB	Not more than 0.015 dB	Not more than 0.015 dB
7.	Attenuation distortion	Within ± 0.1 dB	Within ± 0.1 dB	Within ± 0.1 dB	Within ± 0.1 dB	Within ± 0.1 dB
8.	Winding balance	More than 60 dB	More than 60 dB	More than 60 dB	More than 60 dB	More than 60 dB
9.	Open circuit drain	-	-	600 ohms side open 1120 ohms side 20V<=2mA 50V<=7mA	-	600 ohms side open 470 ohms side 20V<=2mA 50V<=7mA

NOTE:-

All parameters shall be measured on V.F. range (i.e. 300 – 3400 Hz) for type at signal strength of 0 dB at transformers terminal.

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APPENDIX – A
(Clause 6.9.1c)

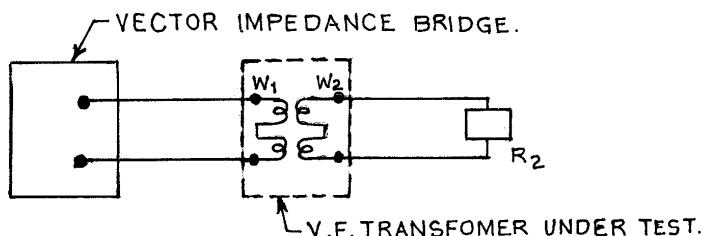
IMPEDANCE RATIO MEASUREMENT OF V.F. TRANSFORMERS (2T / 3T)

A – 1 METHOD A

A – 1.1 EQUIPMENT REQUIRED :

- a) Vector impedance bridge.
- b) Resistors.

A - 1.2 CIRCUIT :-



W_1 = Primary winding , W_2 = Secondary winding

Impedance Ratio R_1/R_2

R_1 = Resistance equal to the nominal impedance of the secondary side.

R_2 = Resistance equal to the nominal impedance of the secondary side.

Primary impedance = Reading Z_1 indicated by the meter.

Similarly, for secondary impedance measurement connect the meter on the secondary side and terminate primary by R_1 .

Secondary impedance = Reading ratio = Z_1/Z_2

Where Z_1 = Primary impedance measured when the secondary is terminated with resistance R_2 .

Z_2 = Secondary impedance measured when the primary is terminated with resistance R_1 .

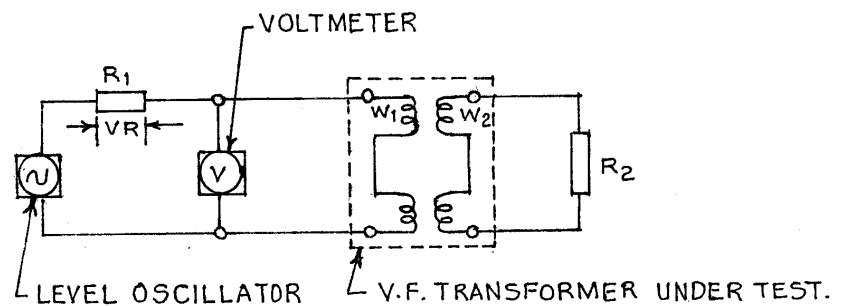
NOTE :- The above measurements shall be made with an output power at level of 0 dBm across the transformer under test. Method A should normally be used for the measurement. In case it is difficult to adjust the 0 dBm level across the transformer by using Method A, Method B given below may be employed for the measurement.

A - 2 METHOD B

A - 2.1 EQUIPMENT REQUIRED:

- a) Level oscillator
- b) Resistances.
- c) Voltmeter.

A - 2.2 CIRCUIT:



W_1 = Primary winding , W_2 = Secondary winding

Adjust voltage V corresponding to 0 dBm level with reference to R_1 . Measurement V_R and thereby current.

$$I = V_R / R_1$$

Primary impedance = V/I ohms.

Similarly, the impedance of the secondary side shall be measured after changing W_1 for W_2 and terminating by R_1 for R_2 .

Secondary impedance = V/I ohms.

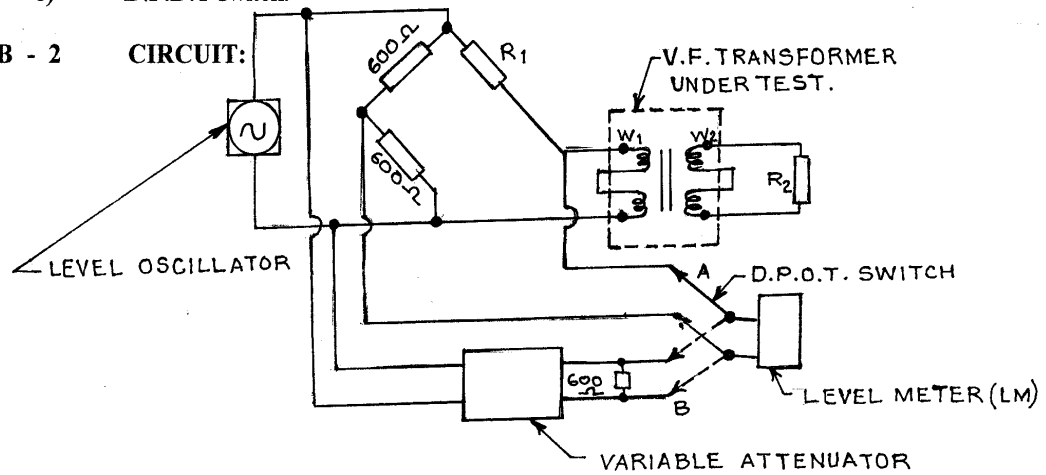
APPENDIX - B
(Clause 6.9.1d)

RETURN LOSS MEASUREMENT OF V.F. TRANSFORMER (2T / 3T)

B - 1 EQUIPMENT REQUIRED:

- a) Low impedance level oscillator 100 Hz to 5 KHz.
- b) Variable attenuator 0 to 100 dB.
- c) Level meter (high input impedance).
- d) Resistors.
- e) D.P.D.T switch.

B - 2 CIRCUIT:



- W_1 = Primary winding , W_2 = Secondary winding.
 R_1 = Resistance equal to nominal impedance on primary side.
 R_2 = Resistance equal to the nominal impedance on secondary side.

With switch in position A, note the reading indicated by Level Meter (LM). Next, with the switch in position B, vary the attenuator to obtain the same reading of LM.

B - 3 RESULT:

Return loss = Reading of the attenuator - 6 (dB)

NOTE: The above measurement shall be made with signal strength at 0 dBm level across the transformer under test.

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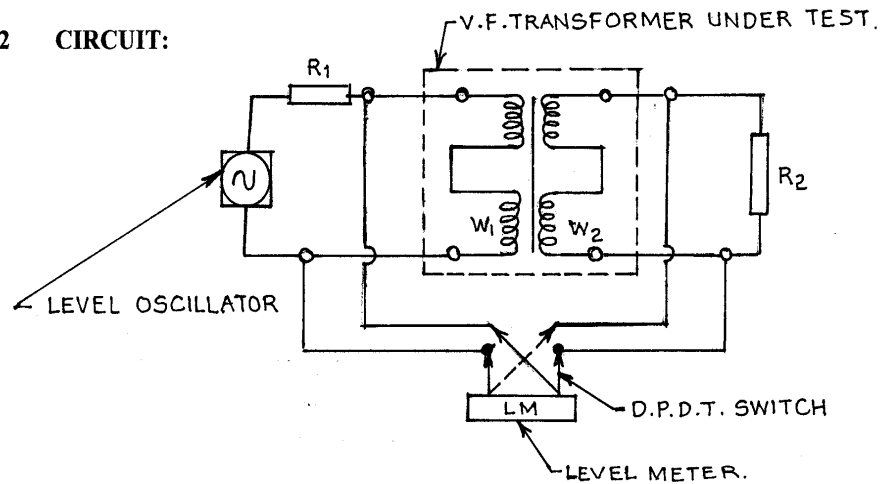
APPENDIX - C
(Clause 6.9.1e)

INSERTION LOSS MEASUREMENT OF V.F. TRANSFORMERS (2T / 3T)

C-1 EQUIPMENT REQUIRED:

- a) Low impedance level oscillator 100 Hz to 5 KHz.
- b) Level meter (high input impedance)
- c) Resistors.
- d) D.P.D.T switch.

C-2 CIRCUIT:



- W₁ = Primary winding , W₂ = Secondary winding
V_p = Voltage measured on the primary side.
V_s = Voltage measured on the secondary side.
R₁ = Resistance equal to the nominal impedance on primary side.
R₂ = Resistance equal to the nominal impedance on secondary side.

C-3 RESULT:

The value of insertion loss of the transformer under test is to be calculated from the formula :-

$$\text{Insertion loss} = 20 \log V_p / V_s - 10 \log R_1 / R_2 \text{ dB.}$$

NOTE : The above measurement shall be made with signal strength at 0 dBm level across the transformer under test.

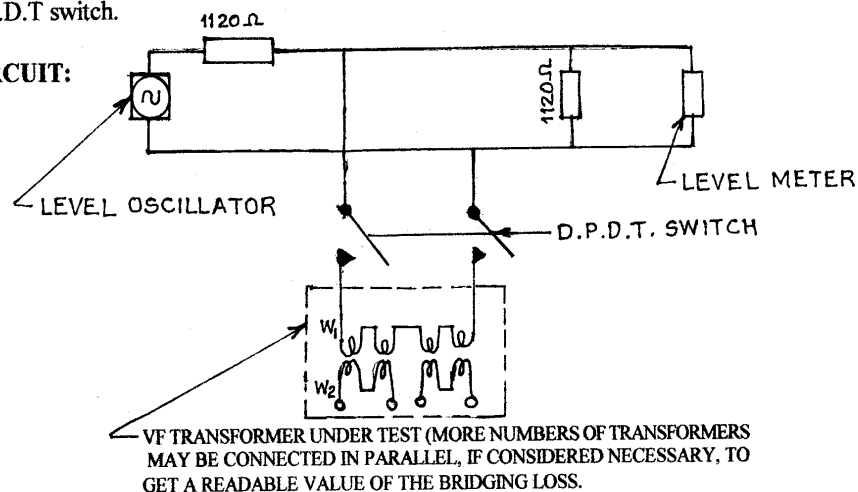
APPENDIX - D
(Clause 6.9.1f)

BRIDGING LOSS MEASUREMENT OF V.F. TRANSFORMERS (2T / 3T)

D - 1 EQUIPMENT REQUIRED:

- a) Low impedance level oscillator 100 Hz to 5 KHz.
- b) Level meter (high input impedance)
- c) Resistors.
- d) D.P.D.T switch.

D - 2 CIRCUIT:



W_1 = Primary winding , W_2 = Secondary winding

- a) Disconnect the switch SW and note the reading of the level meter in dB.
- b) Connect the DPDT switch SW and note the reading of the level meter in dB.

D - 3 RESULT:

The difference in reading in (D - 2 a) and (D - 2 b) gives the value of the bridging loss. If there are 'n' transformers connected in parallel then this difference of reading should be divided by n to get the bridging loss of one transformer.

NOTE: The above measurement shall be made with signal strength at 0 dBm level across the transformer under test.

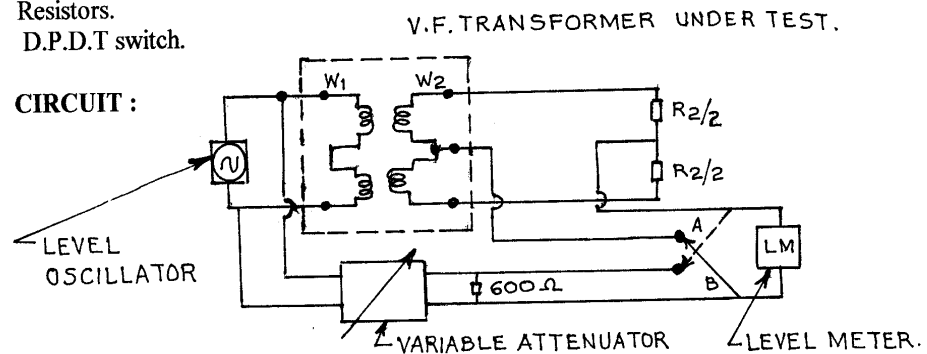
APPENDIX - E
(Clause 6.9.1g)

MEASUREMENT OF WINDING BALANCE OF V.F. TRANSFORMERS (2T / 3T)

E - 1 EQUIPMENT REQUIRED :

- Low impedance level oscillator 100 Hz to 5 KHz.
- Variable attenuator 0 to 100 dB.
- Level meter (high input impedance)
- Resistors.
- D.P.D.T switch.

E - 2 CIRCUIT :



- W_1 = Primary winding , W_2 = Secondary winding
 R_1 = Resistance equal to the nominal impedance on primary.
 R_2 = Resistance equal to the nominal impedance on secondary.

With the switch in position A, note the reading indicated by level meter

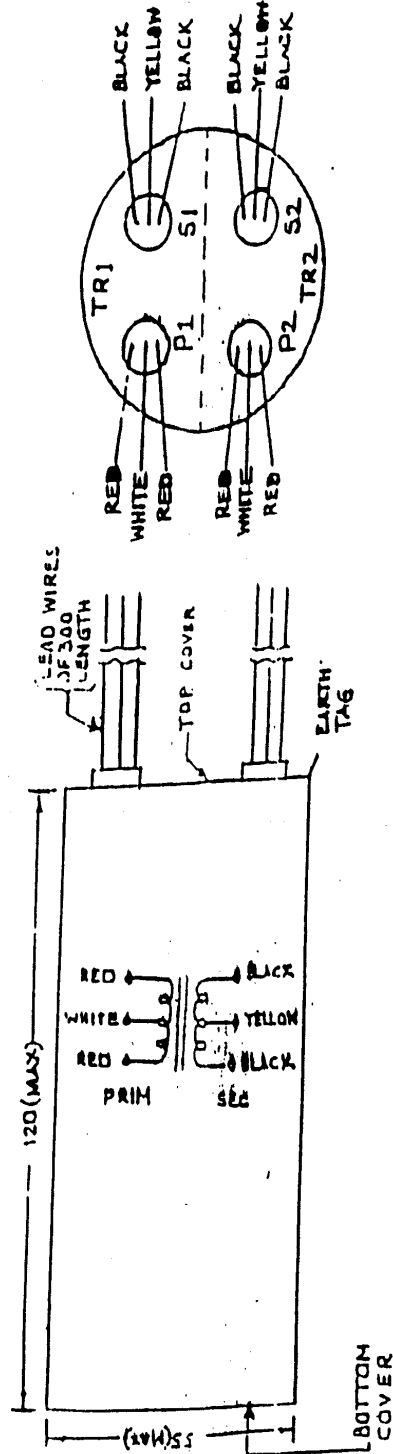
Next, with the switch in position B, vary the attenuator pad to obtain the same reading of Level Meter (LM). If the value of attenuator pad reading is b_0 , then –

- Balance between two winding halves of secondary side = $b_0 + 20 \log_{10} R_2 / R_1 + 3$ (dB)
- Similarly the balance of two halves of the primary side will be measured after changing W_1 for W_2 and terminating R_1 by R_2 . Balance between winding halves of the primary side = $b_0 + 10 \log_{10} R_2 / R_1 + 3$ (dB).

NOTE :

The above measurement shall be made with signal strength to 0 dBm level across the transformer under test.

APPENDIX-F
 IRS: TC 76-2000
 (CLAUSE A.2)



1. LENGTH OF LEAD WIRES SHALL BE 300 mm
2. CONTAINER WITH BOTTOM AND TOP COVERS, SHALL BE MADE OF 1.5mm THICK BRASS SHEET.
2. ZT ASSEMBLY SHALL BE HERMETICALLY SEALED.
1. ALL DIMENSIONS IN MILLIMETERS.

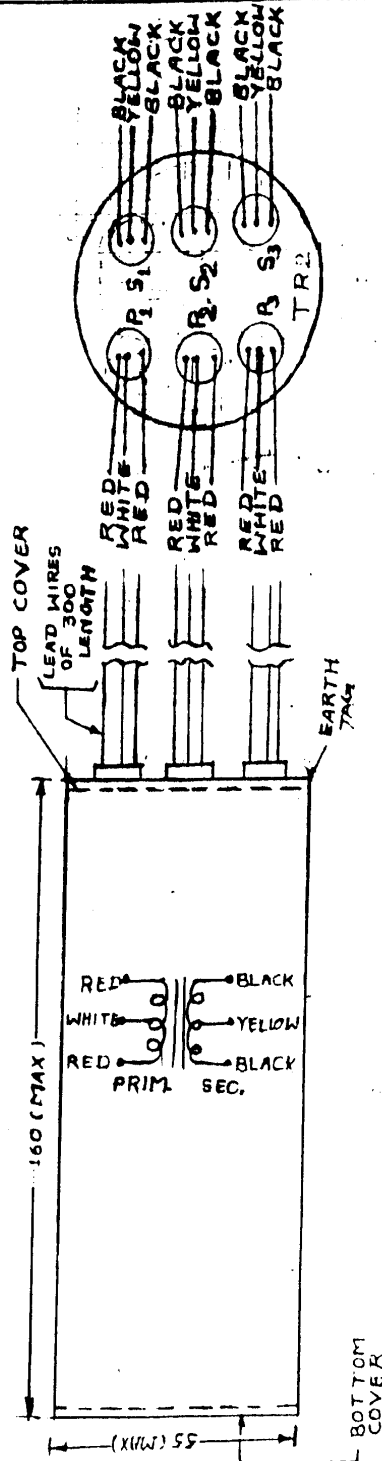
NOTES:-

R D S O

'2T'VF.TAPPING
 TRANSFORMER

TCDO/RE/2T

APPENDIX-G
 IRS: TC 76-2000
 (CLAUSE 4.2)



- 4 LENGTH OF LEAD WIRES SHALL BE 300MM.
- 3. CONTAINER WITH BOTTOM AND TOP COVERS SHALL BE MADE OF 1mm THICK BRASS SHEET SEALED.
- 2 3T ASSEMBLY SHALL BE HERMETICALLY SEALED.
- 1. ALL DIMENSIONS IN MILLIMETERS.

NOTES:-

R. D. S. O.
'3T' VF TAPPING TRANSFORMER
TCDO/RE/3T