TESTING POWER TRANSFORMERS

SECTION ONE

Type test & Special test

Introduction

Type test

Unless otherwise specified, the following type tests, when required, shall be performed on one transformer for each constructional tipology :

- Lightning impulse test
- Temperature rise test

Special tests

Unless otherwise agreed, the following special tests shall be performed, when required, on one transformer for each constructional tipology :

- Measurement of sound level
- Short-circuit withstand test
- Zero-sequence impedante measurement
- Condensation test
- Condensation and humidity penetration test
- Low-temperature test
- Heating-shock test at -5°C
- Heating-shock test at -25°C

1 Type tests

1.1 Lightning impulse test

The voltage test shall be in accordance with List 1 or List 2 of Table no.5 of lEC Standards 60076- 4, depending on the insulation level of the transformer. The test impulse shall be a full standard lightning impulse :

1,2 ns ±30% 50 p.s ± 20%

The test voltage shall normally be of negative polarity. The circuit of the generator and the measuring connections must remain unchanged during calibration and during full voltage tests, The test sequence per line terminal shall be one calibration impulse at a voltage included between 50% and 75% of the full voltage, followed by three impulses at full voltage. During a test on a line terminal, the remaining line terminals are earthed (either solidly or through low impedance). During the calibration and during the tests, an oscilloscope shall clearly record the wave shape of the impulses (duration of the front, duration up to half-value). The test is successful if there are not significant differences in the records of current.

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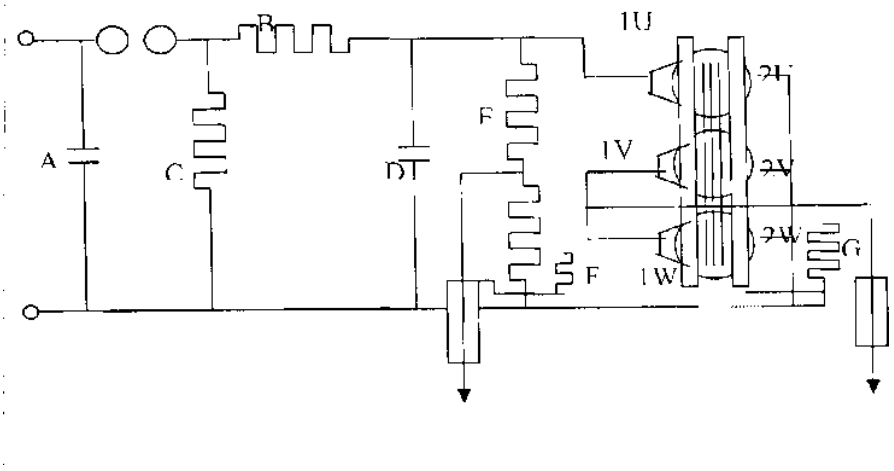

1.2. Temperature rise test

The test is for verifying whether the temperature rise limits of the windings , as agreed at the time of the enquiry, are respected. The test can be carried out by means of two different methods;

- Simulated loading method (in accordance with. IEC 60726 p.21.1.3)
- The method used is defined at the time of the enquiry.

The average temperature rise shall be determined by means of the variationof winding resistance. The core temperature rise shall be determined by use of a thermometer. All the carries at rated conditions shall be performed in accordance with IEC 60726.

Simulated loading method

Temperature rise test is made by utilising the rises obtained on two tests, one with no-load loss only, and one with load-loss only.
The no-load test, at the rated voltage and rated frequency, is continued until steady state conditions are obtained; individual winding temperature rises are then calculated by measurement of hot windings resistance, that shall be carried out as shortly as possible after disconnection. The short.circuit run with rated current flowing in one winding and the other winding short-circuited, is started immediately following the no-lpad run, and continued until steady state conditions are obtained; individual windings temperature rises are then calculated as above mentioned. The total winding temperature rise of each winding, with rated current in the winding and normal exitation of the core, shall be calculated in accordance with IEC Standards 60726.

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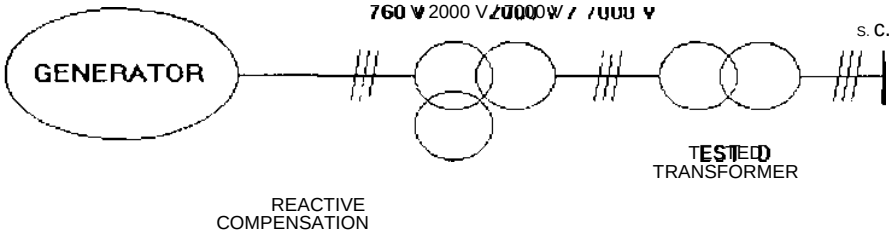

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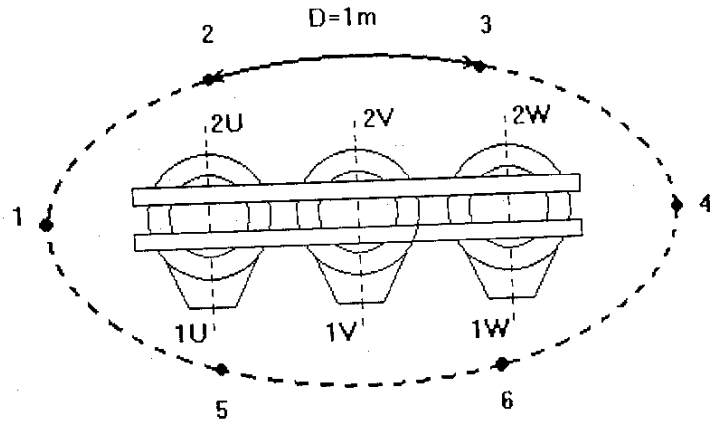

2.2 Short-circuit withstand test

The test shall be performed in accordance with IEC Standards 60076-5 in external laboratories.

2.3 Zero sequence impedance measurement

This test can be performed if either of the windings is either star connected or zig-zag connected, with accessible neutral conductor. When the neutral is not accessible, zero sequence impedance is infinite.
In case of two windings star-delta connected , zero-sequence impedance shall be measured on the star-connected winding and it will result approximately equal to short-circuit impedance, whose determination is described in par. 5.1.3. Zero-sequence impedance shall be measured by applying a single-phase voltage at rated frequency between the terminals of the winding under test, short-circuited, and the neutral.

2.4 Condensation test

The test shall be performed in accordance with attachment ZA of HD 538 Standards in external laboratories.

2.5 Condensation and humidity penetration test

The test shall be performed in accordance with attachment ZA of HD 538 Standards in external laboratories.

2.6 Low-temperature test

The test shall be performed in accordance with attachment ZB of HD 538 Standards.

Heating-shock test (-5 °C ; -25 °*C)*

The test shall be performed in accordance with attachment ZB of HD 538 Standards.

2.7 Fire-behaviour test

The test shall be performed in accordance with HD 464 S1/A3, in external laboratories.

SECTION TWO

Routine test

Introduction

The following routine tests must be carried out on all power transformers :

- separate-source voltage withstand test
- induced voltage test
- voltage ratio measurement and check of polarities and connections
- no-load current and no-load loss measurement
- winding resistance measurement
- short-circuit impedance and load loss measurement
- partial discharge measurement

in accordance with the International Basic Standards IEC 60726 for Dry-type power transformers

1 Dielectric tests - Separate-source voltage withstand test

The single-phase applied voltage wave shape shall be approximately sinusoidal. The test must be performed at rated frequency. At the end of the test, the test voltage shall be rapidly reduced up to 1/3 the full voltage before disconnection. The full test voltage shall be applied for 60 seconds between the winding under test and all the remaining windings, magnetic core, frame and enclosure connected to earth. The test shall be performed on all the windings.The test is successful if no failure occurs at full test voltage.

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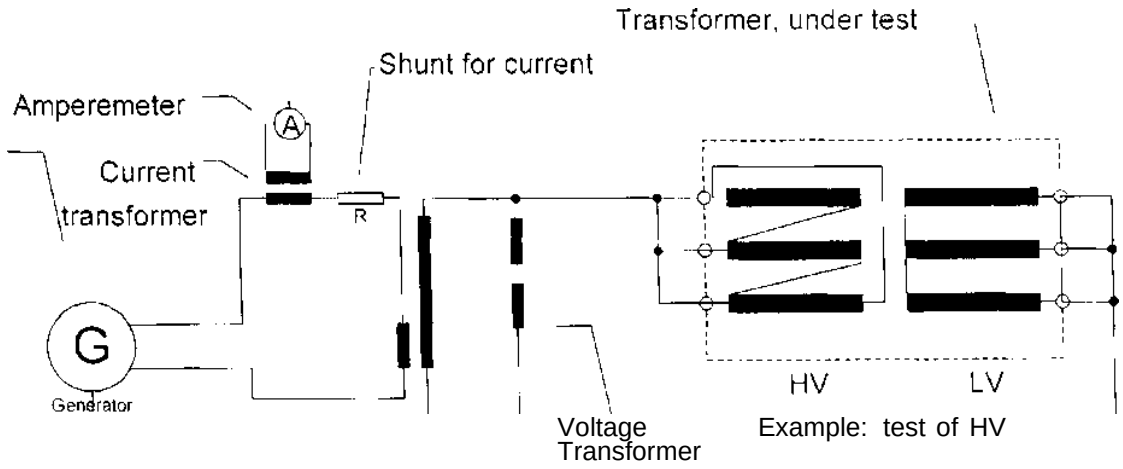

Voltmeter

2 Induced voltage test

The test voltage shall be twice the value corresponding to the rated voltage; it shall be applied between the terminals of the secondary windings, by maintaining the primary winding open. The duration of the test at full voltage shall be 60 s, and the frequency twice the rated value. The test shall start with a voltage lower than 1/3 the full test voltage, and it shall be quickly increased up to full value. At the end of the test, the voltage shall be rapidly reduced up to 1/3 the rated value before disconnection. The test is successful if no failure occurs at full test voltage.

CONNECTION SCHEME:

3 Voltage ratio measurement and check of polarities and connections

Voltage ratio measurement and check of polarities and connections shall be performed on all tap- changer positions; the correspondence between the numbers assigned to the tappings and the ratings shall also be checked. Voltage ratio measurement shall be performed phase by phase between the terminals of corresponding windings. Voltage ratio measurement is carried out by use of potentiometric method.

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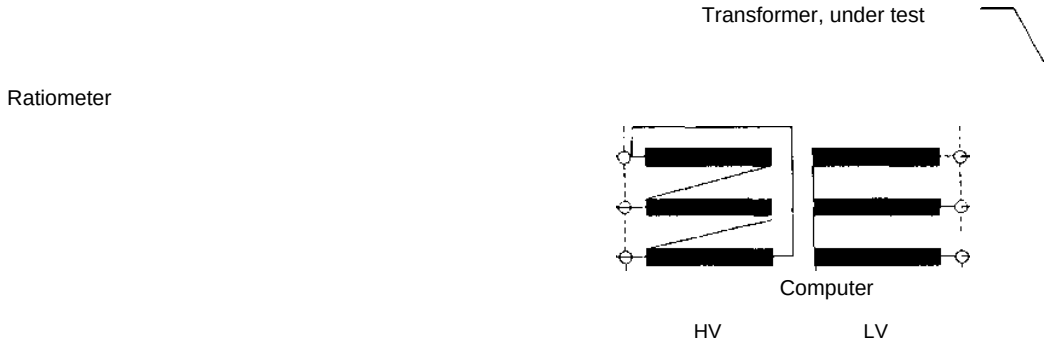

4 No-load current and no-load loss measurement

This test is performed by supplying LV windings at rated frequency and rated voltage. The wave shape shall be as nearly as possible of the sine-wave and the primary windings shall be open. The frequency of the test shall not differ from the rated value more than ± 1%. No-load current and loss shall be measured as well as the mean value and the effective value of the voltage. If these two readings are equal, no correction shall be applied on the measurement of no-load loss; otherwise, no-load loss shall be referred to sine-wave condition in accordance with IEC Standards 60076-1. No-load current shall result as the average value of three readings performed by effective value ammeters. Three wattmeters shall be used to measure the power, by using instrument transformers and transducers when necessary.

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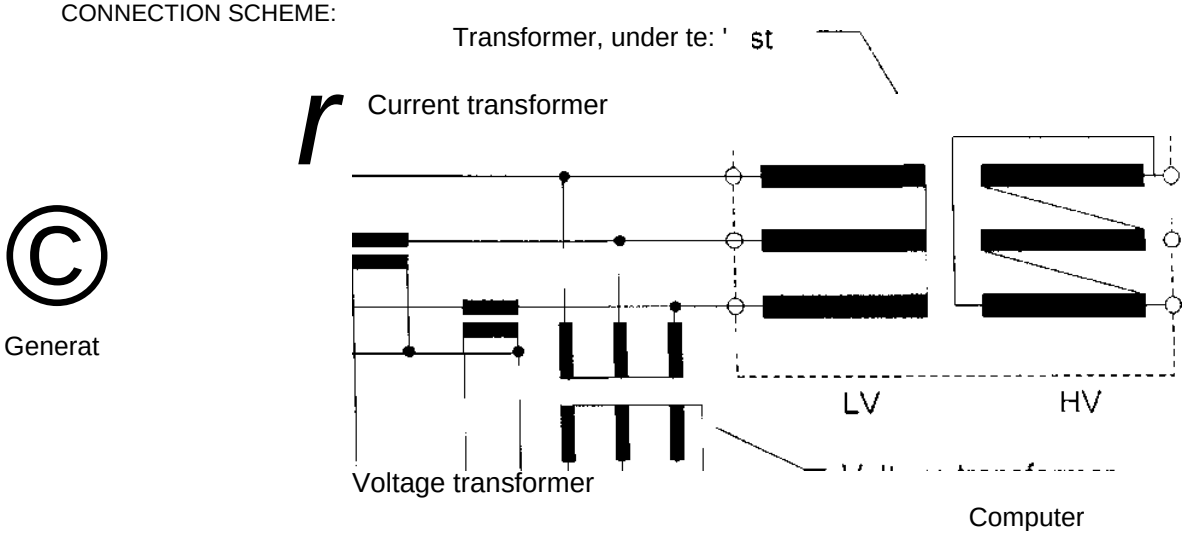

Generat

Watt and Current and voltage Transducers

5 Winding resistance measurement

Winding resistance measurement shall be performed when the windings are at ambient temperature without supply for a time long enough to achieve this condition. The measurements shall be carried out in direct current between terminals according to the sequence U-V; V-W; W- U.
Ambient temperature shall also be measured. It shall result as the average value of three measurements performed by apposite thermal sensors.

HV winding resistance measurement

HV winding resistance measurement shall be performed by measuring simultaneously voltage and current. The voltmeter and ammeter must be connected as follows :
voltmeter terminals must be connected beyond current cables;
the current shall not exceed 10% of winding rated current;
the measurement shall be carried out after voltage and current are stable.
Unless otherwise agreed, the HV winding shall be connected on principal tapping.

LV winding resistance measurement

LV winding resistance measurement shall be performed by measuring simultaneously voltage and current. The voltmeter and ammeter shall be connected as follows :
voltmeter terminals shall be connected beyond current cables;
the current shall not exceed 5% of winding rated current;
the measurement shall be carried out after voltage and current are stable.

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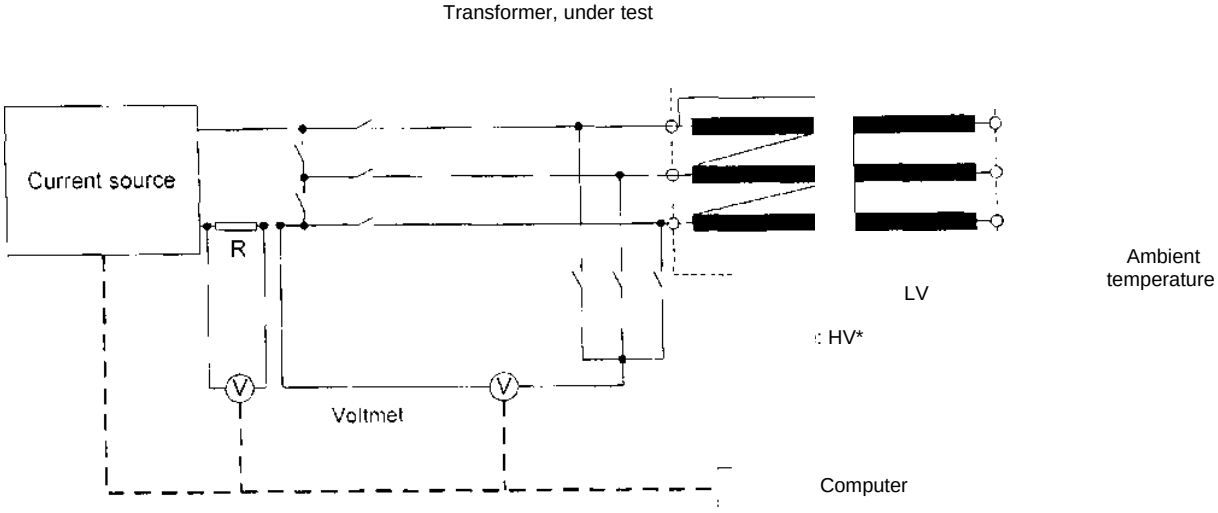

6 *Short-circuit impedance and load loss measurement*

Short-circuit impedance and load loss measurement shall be performed at rated frequency, by applying on the transformer primary windings (connected on principal tapping) a three -phase sine-wave voltage system. The secondary windings shall be short-circuited. Applied voltage, current and load loss shall be measured.
The frequency of the test shall not differ from the rated frequency more than ± 1%. In case the rated power is higher than 1000 kVA, load loss shall be measured by using three wattmeters, in order to reduce measurement uncertainties. When necessary, instrument transformers and transducers shall be used. The measured values shall be referred to rated current and then calculated at reference temperature, This temperature is the annual average ambient temperature (20°C) increased by the permissible temperature rise in accordance with the temperature class of the windings. IEC 60726 specify the permissible temperature rises on table no. 4. Beside, IEC 60076-1 give a complete explanation of how to perform the carries at rated current and at reference temperature.

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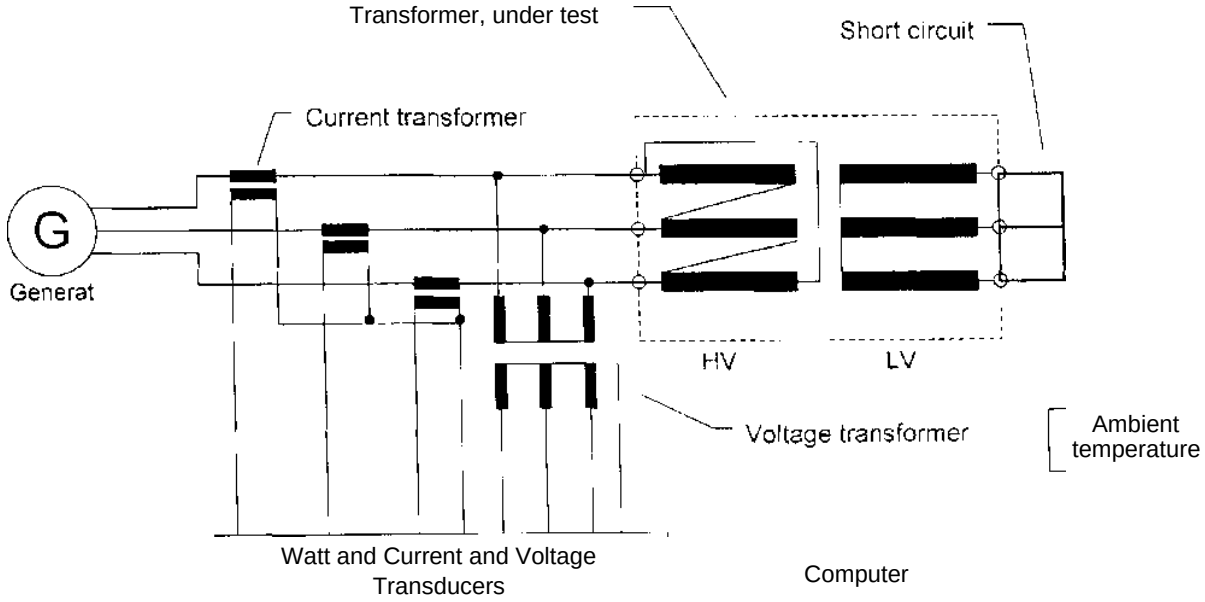

7 Partial discharge measurement

A basic measuring circuit for partial discharge test is shown in figure 2 , I EC Standards 60726. The low-voltage windings shall be supplied from an alternate 100 Hz voltage source. The voltage shape shall be as nearly as possible of the sine-wave. Unless otherwise specified, a pre-stress voltage of 1,5 Um shall be induced for 30 s, followed without interruption by a voltage of 1,1 Umfor three minutes, during which the partial discharge level shall be measured. The calibration of the measuring circuit is carried out by injecting simulated discharge pulses of 100pC at transforner terminals. Partial discharge measurement shall be carried out by use of an oscilloscope, in order to analise the developing of the ongoing phenomena. Test procedures must be in accordance with IEC Standards 60726. The test is successful if the partial discharge level is lower than 20 pC unless otherwise agreed between manufacturer and purchaser.

CONNECTION SCHEME: