

IEEE PC 57.152 Field Test Guide

Proposed Draft of Chapter 6.1.7: Induced Voltage Test

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- 6.1.7.1 General
 - 6.1.7.2 Preliminary test procedures
 - 6.1.7.3 Special precautions before test
 - 6.1.7.4 Power factor pre-tests for excitation by M/G sets
 - 6.1.7.5 Pre-tests for excitation by static frequency converters
 - 6.1.7.6 Test procedure
 - 6.1.7.7 Test parameters and test acceptance criteria

6.1.7.1 General

Withstand AC voltage test with PD monitoring ($f = 80 \dots 240$ Hz, THD $\leq 5\%$, three-phase test, single phase acceptable) shall be applied as

- installation test when assembled on site,
- on-site test after repair,
- test for condition assessment,
- test for failure identification.

PD measurement according to IEEE Standard C57.113 (2010), measures to reduce the PD noise.

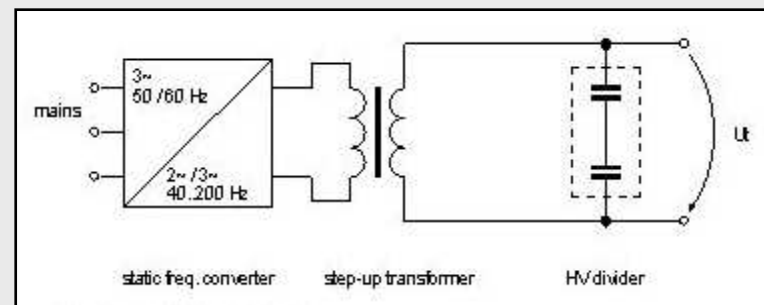
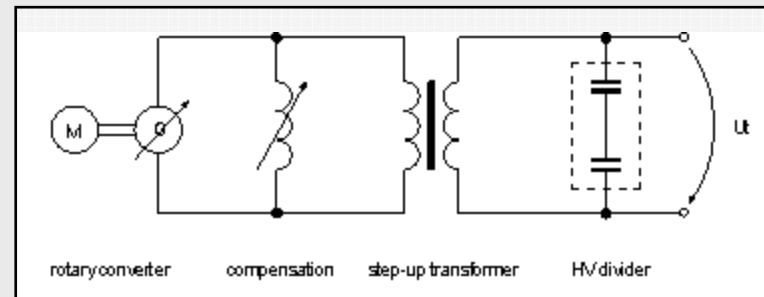
Voltage source:

a) **motor-generator (M/G) set**

for one or two fixed frequencies,
three and single phase operation.

b) **static frequency converter (SFC)**

for continuously variable frequency,
e.g. 80...240 Hz,
three and single phase operation.



6.1.7.2 Preliminary test procedures

Low-voltage tests, to show that the transformer under test is suitable for energizing:

- insulation resistance,
- power factor ,
- turns ratio ,
- oil dielectric strength,
- oil moisture content,
- dissolved gases in fluid

Recommended diagnostic characteristics:

Procedure	New transformer	Service-aged transformer
Power factor	< 0.5 %	< 2.0 %
Total dissolved gas ^a	< 0.5 %	< 0.8 %
Moisture content	< 10 ppm	< 15 ppm
Turns ratio	Within 0.5 % of nameplate	Within 0.5 % of nameplate

6.1.7.3 Special precautions before test

A **low PD noise level** is difficult to reach on site, but all precautions should be made to reach it. This means especially a very compact PD measuring circuit of PD-free, low-impedance HV and earth connections.

Furthermore, reduce the PD noise level by:

1. Avoid corona discharges at transformer under test by shielding points of high field concentration!
2. Apply corona rings also to sharp edges of nearby earthed or grounded objects!
3. Avoid not-grounded nearby objects!
4. Take care for good electrical contact of PD-free test voltage connections!
5. Clean the surfaces of the bushings!

Disconnect any transformer-mounted surge arrester before energizing!

Have in mind, that corona discharges may even influence the withstand voltage!

6.1.7.4 Power factor pre-test for excitation by M/G sets

Aim: Avoid generator runaways by sufficient inductive compensation for protection against dangerous over-voltages due to capacitive load.

Procedure: Apply a protection spark gap and operate at a voltage $V \leq 30\% V_{\text{test}}$ (rated test voltage) for accurate power factor measurement. The inductive compensation shall be adjusted to a value that will allow the test at 100% V_{test} without exceeding the generator limits.

Match the step-up transformer output to the test voltage level (optimum adaptation). Check all settings and remove the protection spark gap.

Check: Check the THD and the PD basic noise level.



6.1.7.5 Pre-tests for excitation by static frequency converters (SFC)

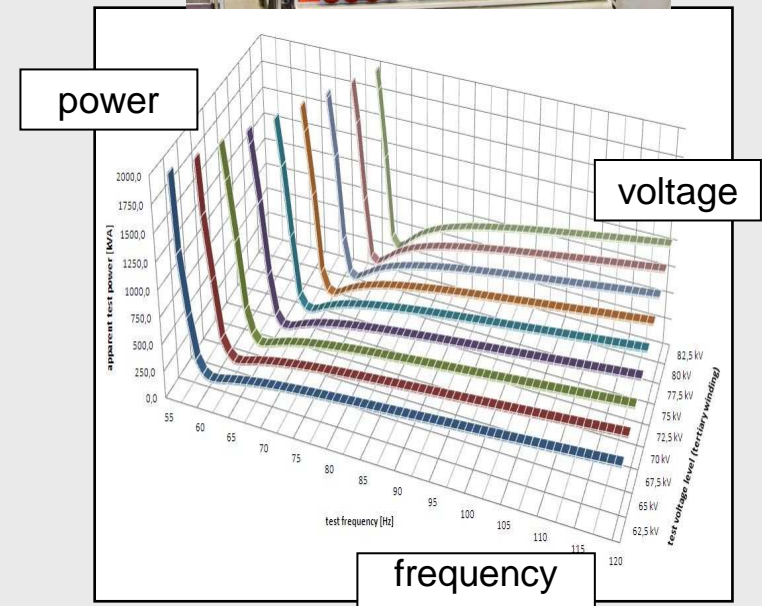
Situation: No danger of self-excitation of SCF !

Aim: Optimization of power supply.

Procedure: In case of huge test objects, the relation between SCF power and test power required by the transformer to be tested should be checked.

Furthermore the test power can be minimized by selection of the “self-compensation frequency”. Match the step-up transformer output to the test voltage level (optimum adaptation).

Check: Check the THD and the PD basic noise level.



6.1.7.6 Test procedure

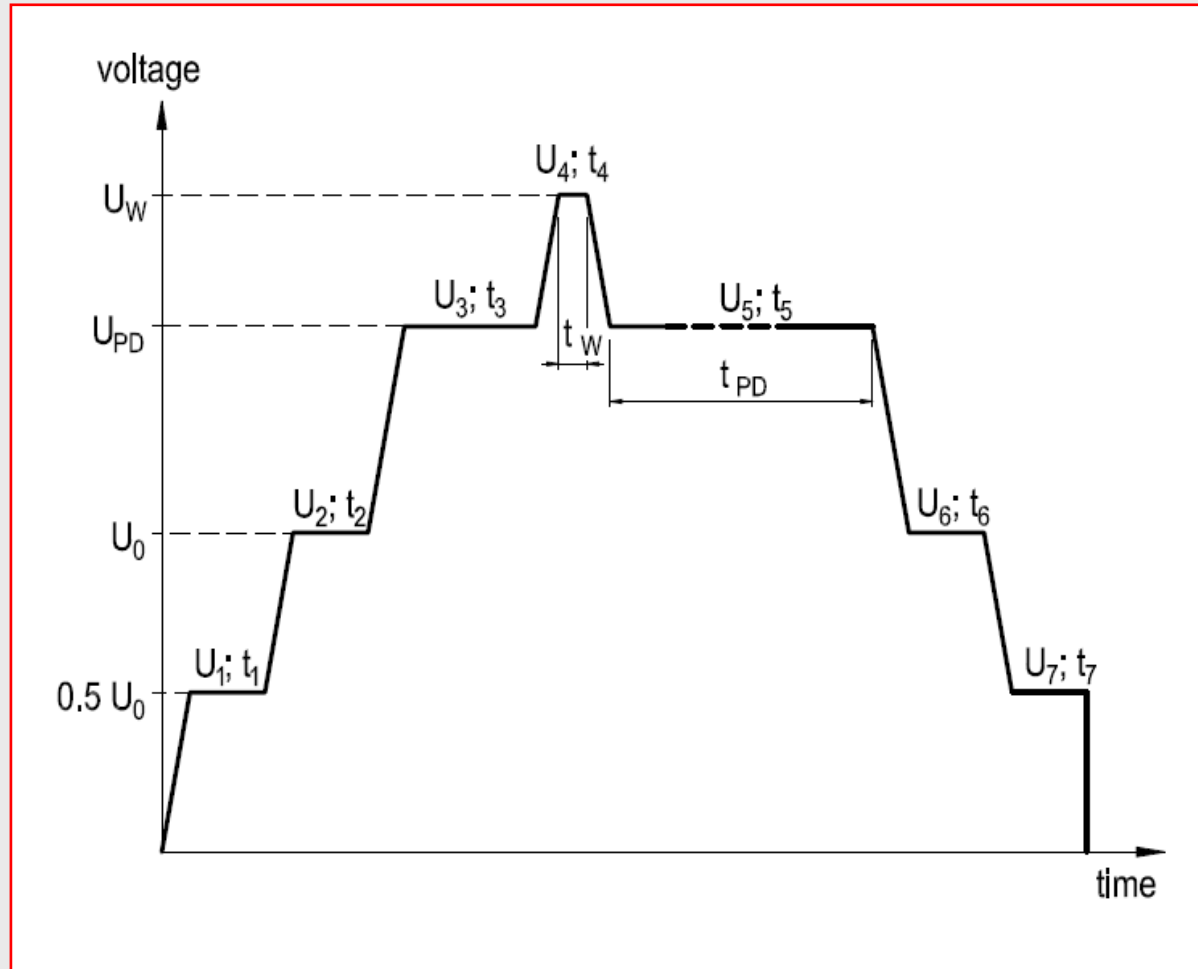
withstand voltage level

PD test voltage level

line-to-ground voltage level

start voltage level

All voltage levels are PD monitored, PD test at U_5 .



Time durations: $t_1 = t_2 \geq 3\text{min}$, $t_3 \geq 5\text{min}$, $t_4 = t_w \cdot 120 (f_{\text{test}})$ s, $t_5 = t_{\text{PD}} \geq 20\text{min} (?)$, $t_6 = t_7 \leq 3\text{min}$

6.1.7.7 Test parameters and test acceptance criteria

Test parameters:

The withstand test voltage level $U_4 = U_W$ as well as the PD measuring voltage level $U_5 = U_{PD}$, its duration $t_5 = t_{PD}$ and the PD acceptance level q_{PD} are usually subject to negotiation:

$$\begin{aligned}U_W &= 1.2U_0 \dots U_T \\U_{PD} &= 0.8 \dots 0.9 U_W \\t_{PD} &= 20 \dots 60 \text{ min} \\q_{PD} &= 500 \dots 1000 \text{ pC}\end{aligned}$$

Acceptance criteria:

- 1) No breakdown of the test voltage occurs during the whole cycle.
- 2) None of the PD levels recorded at the test voltage U_{PD} exceeds the agreed PD limit.
- 3) The PD level measured during the PD test does not exhibit any steady raising trend or sudden sustained increase by more than 100 pC.
- 4) The PD levels at identical voltage levels before and after the withstand test (Fig. 1): U_2 and U_6 : U_3 and U_5) shall not increase by more than 100 pC.

Next steps

We ask for your comments, proposals, changes or extensions!



We are sure that field testing of power transformers will play an important role for the power systems of the future.

Thank you for your attention!