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Influence of a tap changer position on the transformer's frequency response

Abstract. *The paper discusses the influence of tap changer position on the frequency response of a transformer winding.*

Keywords: transformer, frequency response, FRA, tap changer, OLTC

Introduction

Frequency Response Analysis (FRA) is currently a standard test used for diagnostics of transformer's active part mechanical condition. It is possible to perform repeatable measurements, if guidelines discussed in IEC standard are followed [1], but there are often problems with clear interpretation of obtained test results. When two curves measured in time intervals for the same test object and test setup are have the same shape, it means that no problems with mechanical condition are expected. However any visible differences between such curves may be a result of some kind of fault. An interpretation of visible changes depends on the experience of test personnel, aided with large database of many transformers test results. Sometimes various algorithms are used for analysis, but they hardly ever have unequivocal interpretation criteria, leaving the final judgement to the personnel [2].

One of problems is choosing the proper tap changer position during tests. By changing the tap number some part of the regulation winding is added (or in some cases added or subtracted) from the main winding. In this way additional inductance is added to the test object, but also a capacitance and resistance. This leads to changes in the shape of measured FRA curves. In the literature there are very few papers discussing the influence of tap changer position on FRA results, and all of them discuss only a case study of one unit [3-5]. In practical measurement's results interpretation tap changer position is often unknown or described as "1" which is the standard value in many test setup's software.

The standard gives clear guidelines for measurements of transformers with on-load tap changers (OLTC). There should be measured the main winding without a regulation winding and with full regulation winding connected in series. It should be remembered that some tap changers use a change-over selector, that allows the tapped winding to be connected in addition or subtraction to the main winding. This allows to reduce the number of taps or enlarge the regulating range. However, in the position with minimum number of effective turns the entire tap winding is connected to the circuit, that has its reflection in the shape of FRA curve (additional capacitances and resistances) [6]. In such case performing measurements on the first and the last tap is wrong, as main winding can be measured alone only in middle OLTC position.

This paper discusses the influence of tap number on the example of several units, having different power rating. These results are generalized to give criteria allowing to determine if the visible change is the result of different tap changer position or comes from the deformation.

Two examples of the tap changer position influencing FRA curves are given below. The first graph (Fig. 1a) shows results obtained from the distribution transformer 115/33 kV, 31.5 MVA, while Fig. 1b – autotransformer 400/110 kV, 450 MVA with change-over selector (two side phases).

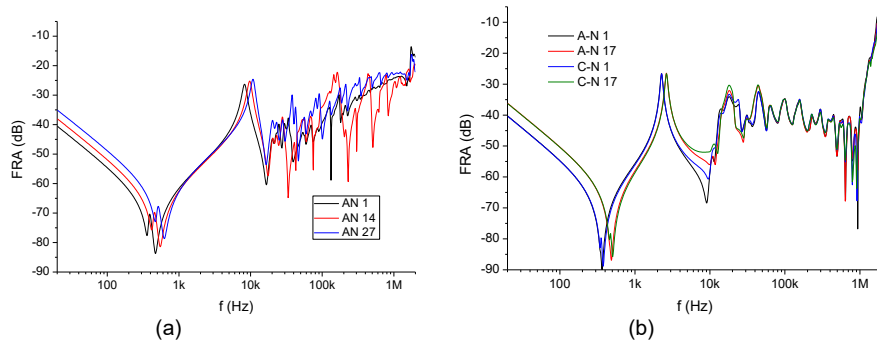


Fig.1. FRA results for various tap changer positions measured on transformers: a) 115/33 kV, 31.5 MVA, b) 400/110 kV, 450 MVA

In both cases tap changer position affects LF range (the first resonance), but also MF range. Further analysis of several units will lead to determination tap position's influence on the changes of frequency response.

References

1. IEC 60076-18: *Power transformers - Part 18: Measurement of frequency response*, IEC standard, 2012.
2. Nirgude P.M., Ashokraju D., Rajkumar A.D., Singh B.P., *Application of numerical evaluation techniques for interpreting frequency response measurements in power transformers*, IET Sci. Meas. Technol., 2, (5), pp. 275-285, 2008.
3. Siregar R., Muchtar A., *The Characteristics of FRA Results for Different Tap Position on Inter Bus Transformer (IBT) 166 MVA*, Proc. of the 9th Int. Conf. on Properties and Applications of Dielectric Materials, Harbin, China, 2009, pp. 265-267.
4. Bagheri M., Nezhivenko S., Phung B.T., Behjat V., *On-load Tap-changer Influence on Frequency Response Analysis of Transformer: A Case Study*, IEEE 11th Int. Symp. on Diagnostics for Electrical Machines, Power Electronics and Drives (SDEMPED), 2017, pp. 455-460.
5. Al-Ameri S., Yousof M.F., Ahmad H., Alsubari M., Talib M.A., *Examining faulty transformer tap changer using frequency response analysis*, Int. Symp. on Electrical Insulating Materials (ISEIM), 2017, pp. 259-262.
6. Krämer A., *On-Load Tap Changers for Power Transformers. Operation Principles, Applications and Selection*, Maschinenfabrik Reinhausen GmbH Publication, ISBN 3-00-005948-2, 2000.

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