Improvement of the Insulation System of Unconventional Combined Instrument Transformer Using 3-D Electric-Field Analysis

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***Abstract*—This paper presents the new printed-circuit board (PCB) technology medium voltage combined instrument transformer. The capacitors of the voltage transformer and coils of the current-to-voltage transducers are designed and manufactured using PCB technology. The design of the insulation system of the combined transformer was carried out using electric field analysis. The electric field distributions, computed by applying the 3-D finite-element numerical method, are presented. The results for several different applications were compared with tests of real-life models.**

***Index Terms*—Instrument transformers, printed circuits, electric field, electrical insulation, finite element analysis.**

I. Introduction

THIS paper presents a new unconventional construction of a combined instrument transformer. The combined instrument transformer is composed of two parts: current and voltage transformers in a common housing [1]. The endings of the secondary windings of the current part of the combined instrument transformer at potential zero and the cable connecting of the capacitor voltage transformer at HV potential (during tests) are both in a insulator, [2]–[4]. The purpose of the combined transformers is to reduce the space occupied by the instrument transformers in the switchgear. But still **are being sought** unconventional solutions [5] that can replace the inductive instrument transformers and further reduce the dimensions.

In a voltage part the use of the original capacitors, which were made in a multilayer HDI PCB technology, is the novel feature of the combined transformer. Capacitors are multilayer PCBs heaving a special construction that can be installed together with the current part (Figs. 1 and 2(c)). Using this technology may reduce the dimensions of the MV distribution cell, but the small distances between the components cause insulation problems. The designs of the inductive measuring current transformer of class 0.5 and current ratio (25 ÷ 1200) A/5 A, which was built according to the Polish patent [7], and protective current transformer in the form of Rogowski coil of ratio 1 mV/1 A (traditional [8] or HDI PCB [9] technology) have also an innovative aspect.

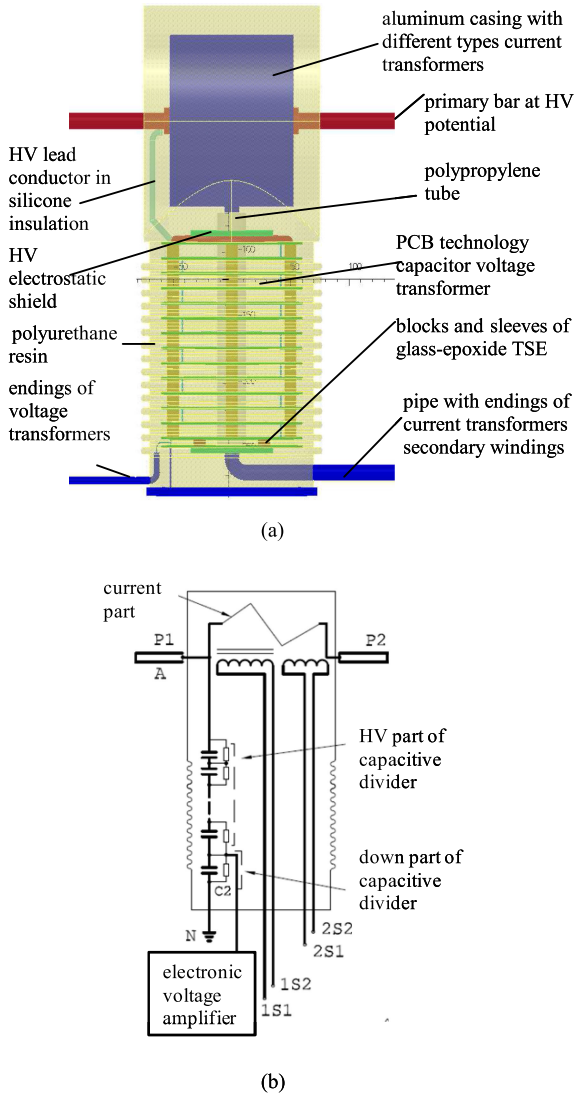

Fig. 1. (a) 3D model of the nonconventional hybrid combined transformer HPPN-15 (20 kV) and (b) its equivalent circuit, were P1, P2 primary terminals and 1S1, 1S2, 2S1, 2S2 secondary terminals of measurement and protective current transformers, A, N terminals of capacitor voltage transformers.

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