



### B.6.2. Mesures d'un champ électrique sur des composants MT et HT avec un détecteur électro-optique

MAILAND M., ZAENGL W., ETH Zürich, Zürich, Suisse  
AUMEIER W., Raychem, Munich, Allemagne

#### Résumé

Les mesures électro-optiques offrent une nouvelle manière de diminuer certains problèmes inhérents aux techniques classiques de mesures de champs, tels que les distorsions de champ causées par des détecteurs de grande dimension et souvent sous potentiel électrique.

Un détecteur électro-optique basé sur l'effet Pockels a été utilisé pour réaliser des mesures sans création de potentiel électrique par le biais de fibres optiques sur moyenne (MV) et haute tension (HV). Ce petit détecteur non-métallique provoque des distorsions de champ très réduites par rapport aux classiques détecteurs sphériques et métalliques. La sensibilité répond très bien aux conditions requises par les composants MV et HV et garantit une non saturation du signal.

Dans cette étude, les fonctions vectorielles du champ électrique sont démontrées tant sur des extrémités de câbles MV et HV, que sur des jonctions et autres composants. Les systèmes géométriques de contrôle de tension comme les cônes, sont comparés avec des systèmes de contrôle de tension, semi-conducteur, non-linéaire. Les matériaux polymériques à réponse non-linéaire sur les voltages fournis ont été confirmés. Les résultats de mesures ont été comparés avec les estimations théoriques.

Une mesure automatique et la mise à jour des données acquises ont été développées.

#### Introduction

Electric field measurement is used for optimisation of power transmission components, for controlling electrical discharge processes and EMI phenomena as well. Commercial techniques like antenna- or sphere condenser devices are affecting the measured field by the probe itself through metallic interfaces or non-potential free operation. Introducing a passive potential-free Pockels sensor has the advantage of direct spot to spot electric field measurement with nearly no field distortion and a linear characteristic from DC to the GHz region.

In this article we describe the principle of measuring electric field patterns along predefined grid on calibration devices and the application of the sensor on medium (MV) cable components esp. nonlinear stress control layers.

Experimental results have been tested against theoretical predictions and simulations.

#### Experimental

##### Sensor head

The technique used is based on the known Pockels effect and described elsewhere [1], [2]. This principle was used for a potential free Pockels sensor shown in Fig. 1. The  $\text{Bi}_4\text{Ge}_3\text{O}_{12}$  crystal and a quarter wave plate is placed between crossed polarisers. The incident and output light are focussed by Graded Index (GRIN) lenses into optical fibers serving as an optical connection of sensor head to the electronics. The light source is

### B.6.2. Electric field measurements on MV and HV components with an electrooptic sensor

MAILAND M., ZAENGL W., ETH Zürich, Zürich, Switzerland  
AUMEIER W., Raychem, Munich, Germany

#### Abstract

Electrooptical measurements offer a new way for minimising certain problems associated with conventional field measurement techniques which are in general non-potential free operation and field distortion caused by the large size of the sensors. An electrooptical sensor based on the Pockels effect has been used to achieve inherent potential free operation by means of optical fibres up to the medium (MV) and high voltage region (HV) by means of optical fibres. This small, non-metallic sensor design causes lower field distortion compared to commonly used metal-sphere sensors. The sensitivity matches very well to the conditions of MV and HV components to be investigated and guarantees no saturation effects of the sensor signal.

In this investigation, electric field vector mappings are demonstrated on different MV and HV cable terminations, joints and other components as well. Geometric stress control systems like cones and equipotential foils were compared with non-linear semi-conductive stress control materials. Polymeric materials exhibiting a non-linear dependence on the supplied voltage has been confirmed. Measurement results were compared with the theoretical estimations.

An automatised measurement and data acquisition setup has been developed.

a low noise LED which is placed together with the photodetector, a low noise amplifier and batteries in a double screened case. The optical output signal, an intensity modulated light, represents the electric field strength on the output of the amplifier by a voltage in the range of  $\pm 2\text{V}$  and can be processed with voltmeters, digitizers and spectrum analysers as well.

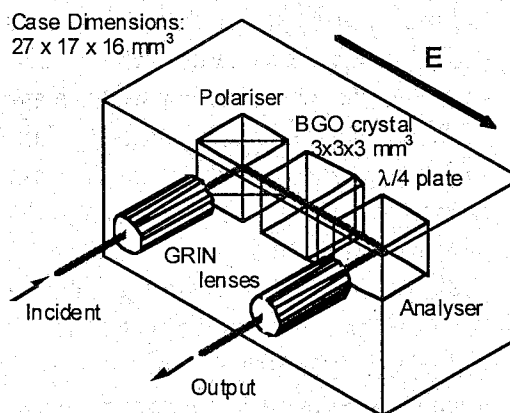


Fig. 1: Principle of the Pockels sensor

Inside the crystal the linear polarised light vector is split into two components in the direction of two crystal axes. With applied electric field, the phase shift between the two wave fronts causes elliptical polarised emerging light. The quarter wave plate acts like