Online PD monitoring of short cable systems installed in substations

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Acceptance tests on short cable systems installed in substations using conventional mobile generators are very complicated: a) different and special cable terminations must be used to remove the electrical connection with the power transformer, b) the low capacitance of the short cable system does not permit to get an appropriate resonance frequency. Special mobile high voltage generators to compensate reactive power are the most appropriate, but in practice, no acceptance tests are performed on these cables.

The consequences of an insulation failure of a cable termination installed in power substation can be very critical. The dielectric insulation health of cables that interconnect power transformers with GIS is important for the equipment integrity and for safety reasons because the high short circuit current existing in power substations.

Therefore, on line PD monitoring of these short cables is very convenient. However, some technical issues must be solved to get good insulation diagnosis: a) noise interference level on power substations are often very high, b) many different PD sources can appear coming from many different apparatus (switchgear, voltage and current transformers, power transforms, surge arresters, insulators), c) many different PD patterns must be distinguished associated to different dielectric media (air, paper-oil, solid insulation, etc.) and in dielectric interfaces (air-insulation, oil-insulation, interfaces between two insulations, etc.).

This paper describes a complete on-line PD monitoring system installed on short cable systems of substations that permit to perform synchronized PD measurements. PD sensors (HFCT, UHF) placed on the earth connections of the cable terminations are used. Additional HFCT PD sensors installed at the transformer earth connection is also convenient.

The methodology to remove the background noise from the measured signals and to discriminate each PD source detected is described in the paper. Using amplitude level, polarity sign, frequency spectrum content and the time delay of the arrival instant of each acquired pulse permits to determine the correct PD source emplacement.

The paper also describes some practical experiences in high voltage substations where specific signal processing tools were decisive to get a correct insulation diagnosis. Discrimination of the different sources, identification of the insulation affected and determination of the emplacement of each PD source are crucial for a good diagnosis, otherwise wrong insulation diagnosis can be performed.

Many intermittent PD sources appear in high voltage substations, some of them correlated to atmospheric conditions when outdoor substations are monitored. In other cases intermittent PD sources appear after switching operations due to overvoltages provoked and also due to load changes. In consequence, complementary variables supplied by thermal sensors, current and voltage sensors should to be also used to perform an appropriate insulation diagnosis. On line experiences show that the PD evolution of each PD source detected must be analyzed considering two measured parameters: PD amplitude and the PD rate (number PD pulses per period). A reliable noise rejection tool is fundamental to assure a stable PD sensitivity in different noise conditions that can appear in the power substation, in order to obtain coherent PD evolutions of each PD source.

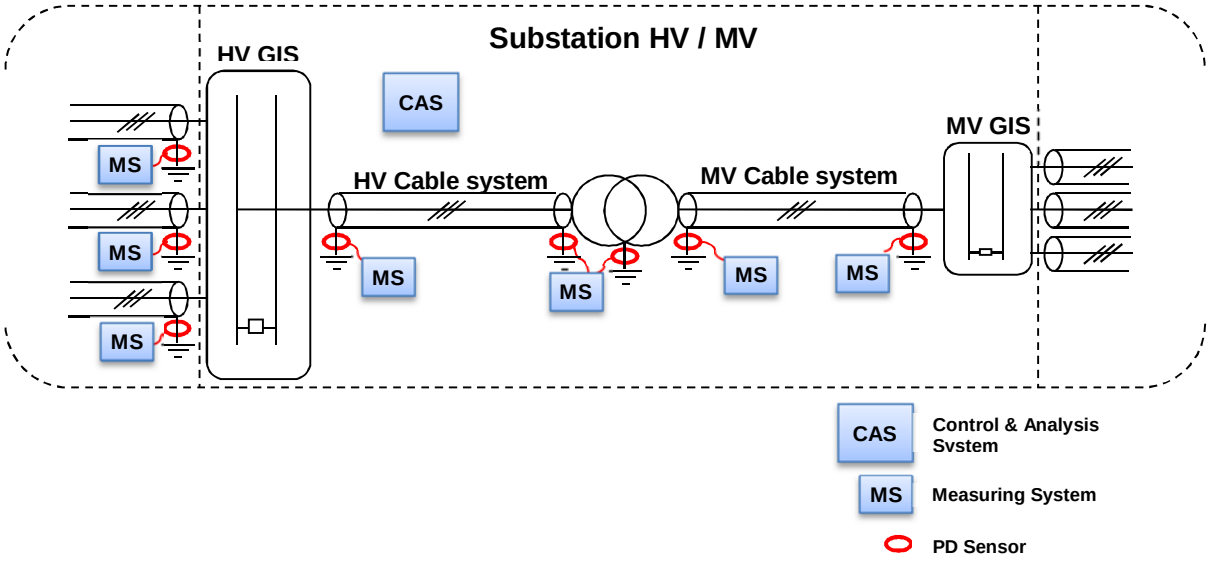

Fig. 1: Online PD monitoring system installed in power substation.