Study Committee B1

Insulated Cables

Paper 10939_2022

Identification of Partial Discharges in Cable Terminations using Methods based on Acoustic, Electromagnetic and Electrical Measurements

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Motivation

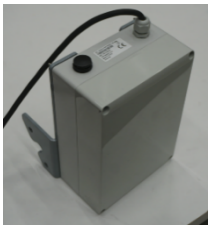
- Not many verified and cost-effective solutions on the market for online monitoring PD (partial discharge) in large fleets of cable terminations
- Goal to investigate whether it is possible to measure PD accurately and cost-effectively from outdoor cable terminations with different types of measuring devices
- Focus on verifying recognition capabilities of recently developed cost-effective and scalable RFI tool

Methods

- PD creates electromagnetic radiation and sound which can be measured
- Measurements in high voltage laboratories with an acoustic camera, RFI (radio-frequency interference) surveying tools and a mountable continuously measuring RFI based IoT device
- Introduction of artificial external and internal faults causing external and internal PD accordingly.
- Test samples: heat shrink medium voltage (MV, 24 kV) and oil-filled high voltage (HV, 123 kV) outdoor cable terminations

Acoustic camera

Continuous RFI (IoT)



Portable PD analyser

Handheld RFI

Results

- Total of 11 different faults were created and measured from which 4 are presented in this poster
- Fault type, applied voltage and measurement distance were varied
- Quantity of PD measured and confirmed by galvanic measuring systems

Discussion

- The results of the tools are not always directly proportional to the measured apparent charges of PD
- The actual substation environment is noisy both audibly and electromagnetically and required measuring distances might be longer than used in this study
- Results are promising but the detection capability of the tools should be tested in the substation environment. Testing the tools on actual cable termination faults would provide valuable information.

Conclusion

- Both RFI tools can detect internal PD from internal faults and external PD to some extent
- The acoustic camera detects and localizes external PD and produces clear PRPD patterns, but can't detect internal PD very well
- Combination of the tools could be used for cost-effective condition monitoring of cable terminations. Continuously measuring RFI tool for online monitoring and fault indication and other tools for pinpointing and classifying the fault

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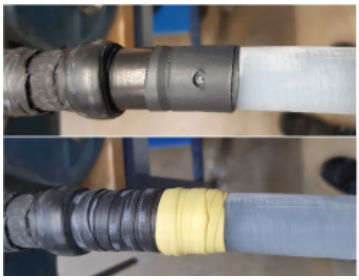
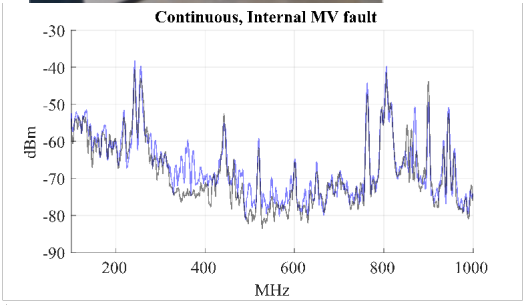
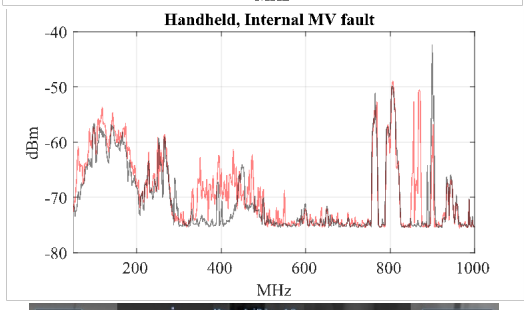
continued

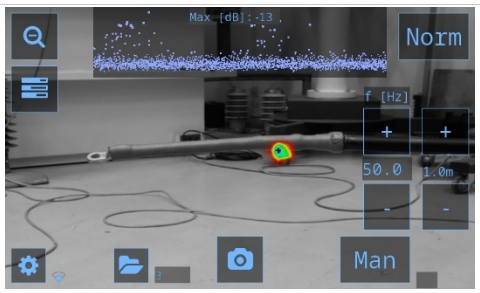
Internal MV fault

- Two holes in insulating tape, 24 kV with 118-270 pC.
- Below RFI from 3 m, acoustic from 1,2 m.



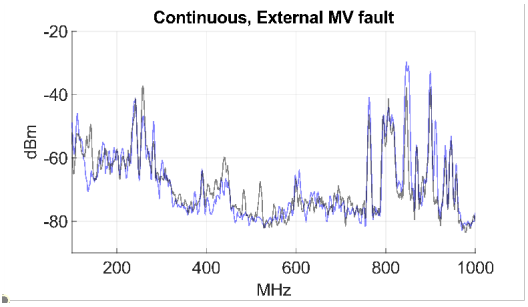


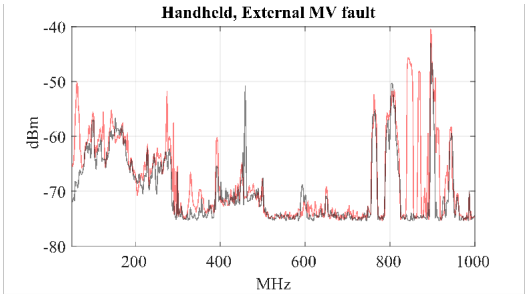


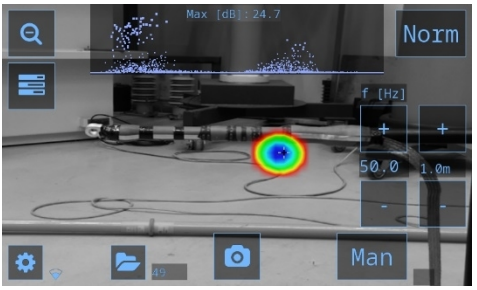


External MV fault

- Dry band fault, 9.2 – 11 kV with 2.5-6.5 nC.
- Below RFI measured from 5 m, acoustic from 1.2 m @ 11 kV with 5.5 nC.







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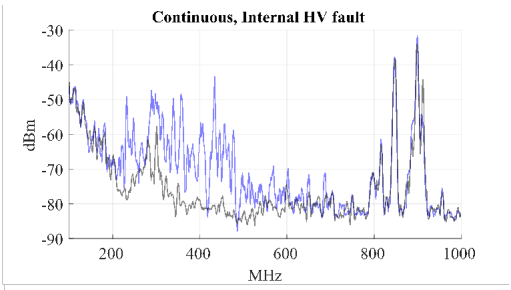
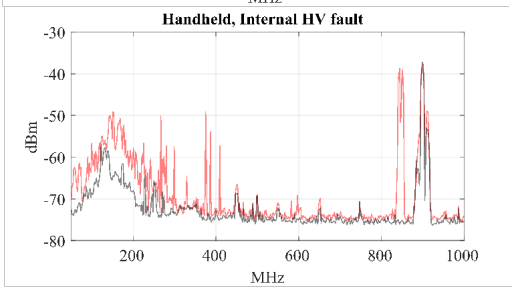
continued

Internal HV fault

- Cut in insulation, 44—110 kV with 100—8000 pC.
- Below RFI measured from 5 m @70 kV with 120 pC.





External HV fault

- Reduced creepage distance, 20 – 32 kV with 70-500 pC.
- Below RFI measured from 3 m, acoustic from 3.5 m @ 32 kV with 300-500 pC.