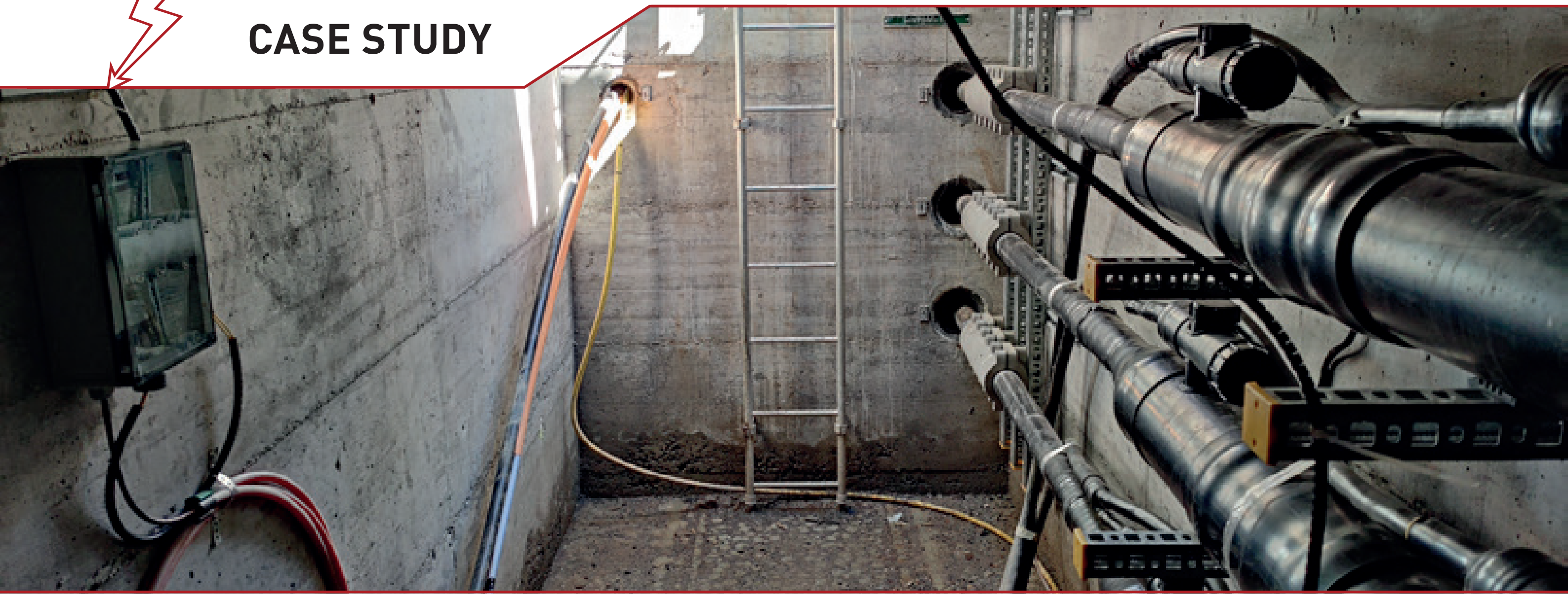
CASE STUDY



Fiber-based Current Monitoring

Switzerland

Project Overview

With the usage of insulated HVAC power cables, a comprehensive monitoring solution is becoming increasingly important – one that computes cable ratings based on thermal profiling (RTTR), detects and locates cable hot spot temperatures (Distributed Temperature Sensing - DTS) as well as cable faults and Third Party Intrusion (TPI) events (Distributed Acoustic Sensing - DAS). Additionally, permanent electrical condition monitoring of cable accessories and terminations is gaining traction for early detection of issues within the entire cable system (e.g. cable insulation failures, bonding issues, CLB flooding).

AP Sensing, together with Brugg Cables, performed a study to measure sheath currents with the aim of electrical condition monitoring of the operator's asset. AP Sensing's sheath current monitoring solution (Fiber-based Current Monitoring - FbCM) was implemented to minimize the risk of unexpected downtimes. These downtimes can be caused by link box faults such as a defective sheath voltage limiter (SVL) or cable sheath damages resulting from unexpected ground contact as a consequence of TPI events such as digging. Reliable detection of these defects enables the identification and analysis of issues in an early stage and thus reduces maintenance efforts and costs.

Solution

AP Sensing's monitoring solution was deployed successfully on the longest HV cable installed in Switzerland. The 110 kV AC cable measures 32 km in length. 35 cable joints separate this cable into five major sections. Our FbCM solution is installed on all three sheath current cables at two cross-link boxes of

Background

- HVAC power cable monitoring in order to compute cable ratings, and detect + locate cable hotspots, faults and TPI events.
- Continuous monitoring of sheath currents at cable terminations and link boxes enables early warning of electrical faults

Solution & Benefits

- Fiber-based Current Monitoring (FbCM) solution using DAS for a 110 kV underground cable
- Valuable insight into the cable's operation, revealing small imbalances and resulting in a small dependency of the load. Additionally, measurement of transient events such as resultant inrushes from switches

Leading the Way with Passion.

two major sections. This FbCM solution uses our already-installed DAS interrogator to determine the sheath currents.

Our FbCM solution consists of conventional current transformers connected to an electrical signal transducer which translates the measured currents into a fiber optic strain signal that is subsequently interrogated by AP Sensing's DAS system. The installation can also be carried out on a cable that is in operation, as it is not necessary to disconnect any cable components.

FbCM uses galvanically-insulated current transformers and is immune to electromagnetic interference. Another advantage of the solution is the purely passive measurement method with analog translation of the measured variables. This reduces susceptibility to errors and increases robustness and longevity. AP Sensing's integrated software processes the sheath current data and enables real-time evaluation of the measured data.

Results

Since its installation in August 2022, AP Sensing's FbCM system has been continuously monitoring sheath currents of the 110 kV cable at two cross-link boxes.

In this installation we also monitor harmonics up to the 20th order, which enables the detection and analysis of harmonic distortions. The harmonic distortions measured in this project originate from a pumped storage plant where inductor motors are powered by the cable. A power factor correction accounts for the difference in the overall offset between the different FbCM sensor locations. The sheath currents measured by the FbCM sensors are within the expected range, indicating that the cable is in good condition. Cable operation was interupted for scheduled maintenance on November 8, which results in a load drop and thus their associated sheath currents. Only a weak dependency on the line current has been observed that indicates an electrically well-balanced design of the sections. Spectrograms for all three sensors connected to the measured link box are shown in Figure 3. Here we can see a broad band spectral response to a sudden inrush current resulting from switching the power factor correction.

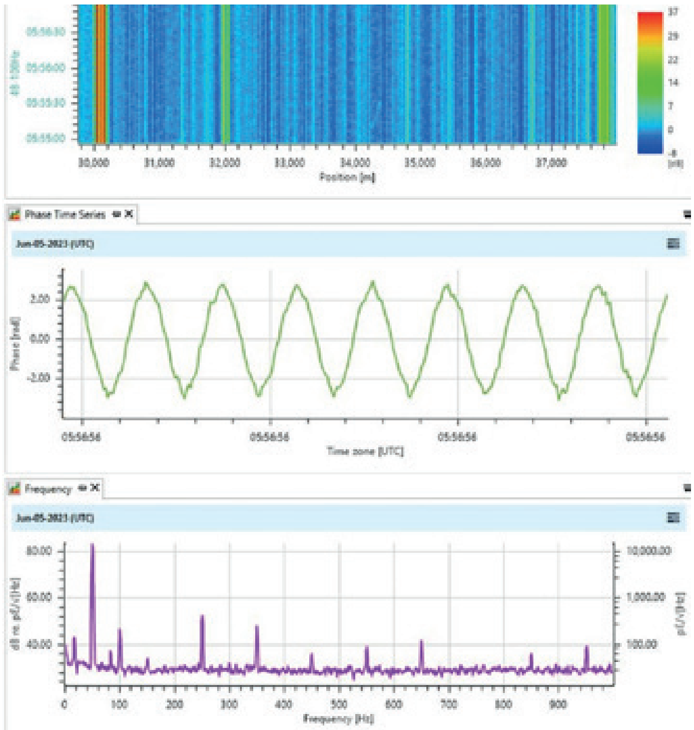


Figure 1: Screenshot of the DAS Configurator Client. (Top) Frequency Band Energy (FBE) waterfall plot with current sensors installed in multiple positions. (Middle) Time series of the current equivalent phase of one sensor. (Bottom) Corresponding frequency spectrum.

Conclusion

The implementation of AP Sensing's FbCM technology proved to be an efficient solution, enabling permanent and accurate measurement of sheath currents. This purely passive, fiber optic-based and robust technology allows for long-term recording of sheath currents and therefore detection of material degradation, unwanted ground contact, defective SVL's and monitoring of transient events and harmonic distortions introduced by, for example, generators. In a unique integration with AP Sensing's DAS system, this combined solution acoustically detects and localizes TPI events and assesses if the sheath/ insulation of the cable has been damaged.

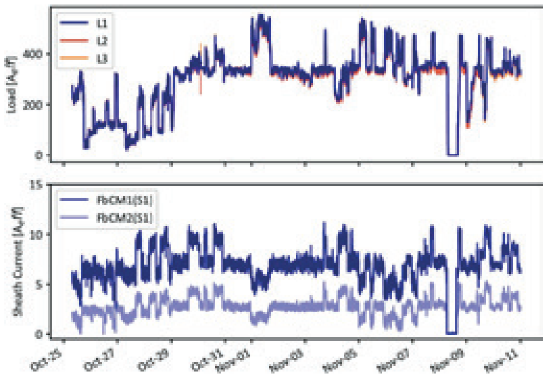


Figure 2: Historic load values (top) and the associated measured sheath currents (bottom) on phase L1 on the different major sections. On November 8, scheduled maintenance led to inoperation for a few hours.

For more information:
www.apsensing.com
info@apsensing.com