

Q4: The use of digital devices to enhance worker safety are shown in the reports 10105, 11133 and 10441. Can utilities show other examples where digitalization is being used to enhance worker safety?

Detection of Operation Timing for Gas Circuit Breaker by Acceleration Sensor that can eliminate work at high places

Preface

For maintenance and inspection of gas circuit breakers (GCB), it is common practice at site to test the opening and closing characteristics of the GCB operations and then compare the results with the previous characteristics. For operation test of the existing GCB at site, it is necessary to connect the measurement wiring to the bushing head at high place and to take various measures to prevent electric shock.

In this study, the acceleration sensor is installed onto the 145kV GCB tank. It is then possible to detect the operation timing of the stroke start, main contact closing, and stroke stop points during closing operation without using touch signal and stroke sensor. Figure 1 shows the overview of a GCB with measurement setup prototype.

In on-site work, workers' safety can be enhanced by eliminating work at high places, such as connecting touch signal lines to the bushing head, by using acceleration sensors to determine the operation timing of the GCB.

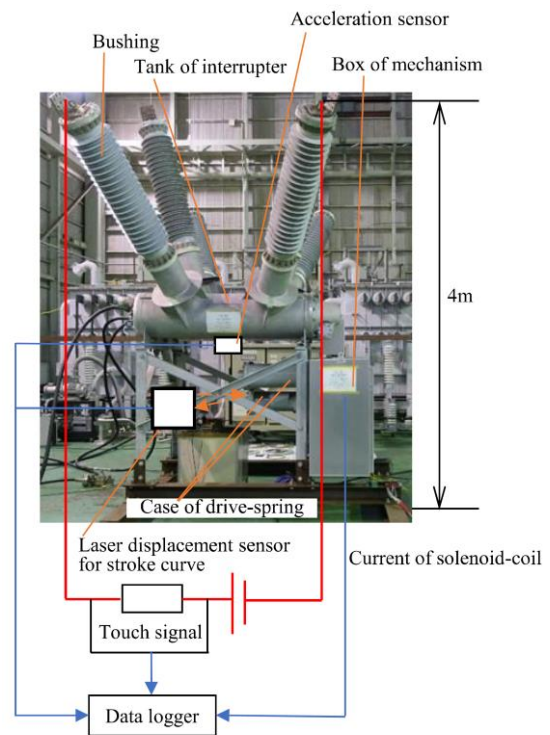


Fig. 1. Overview of GCB and measurement system.

Acceleration sensor measurement

Figure 2 shows the measurement results of the opening operation. It is difficult to identify the main contact opening point from the acceleration waveform since the acceleration change is small at the moment the main contact open. The reason is thought to be that the vibration is smaller than impact vibration such as main contact closing.

Figure 3 shows the measurement results of the closing operation. Three events of steep rise in acceleration are observed. The first rise matches the moment of stroke start, the

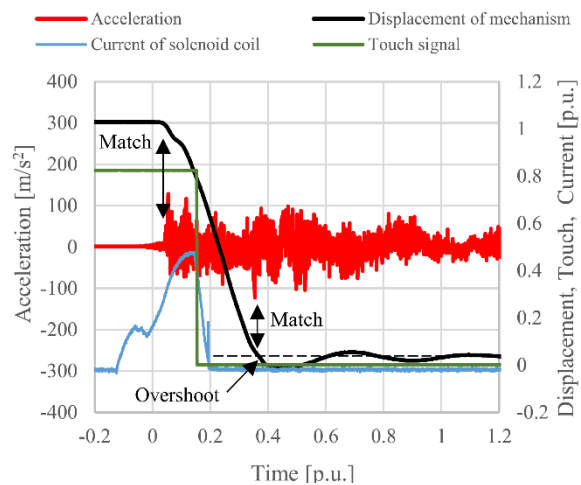


Fig.2. Measurement results of opening operation.

second rise matches the moment of main contact closing, and the third rise matches the moment of stroke stop.

Therefore, the detection of the main contact closing point almost matches the timing of the second steep rise in the acceleration.

In addition, Figure 4 shows the result of the measured closing time of seasonal temperature change. The change of the closing time obtained by touch signal, which is faster in summer and slower in winter, could be detected by the acceleration sensor as well. The maximum detection error of the closing time is 1.9 ms, and it is possible to easily determine the closing time of the existing GCB at site by using the acceleration sensor.

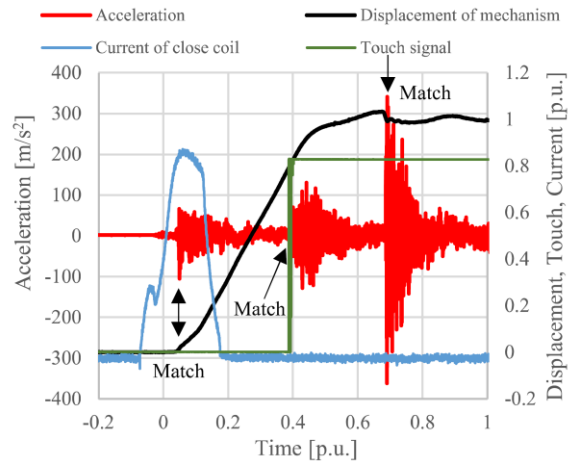


Fig.3. Measurement results of closing operation.

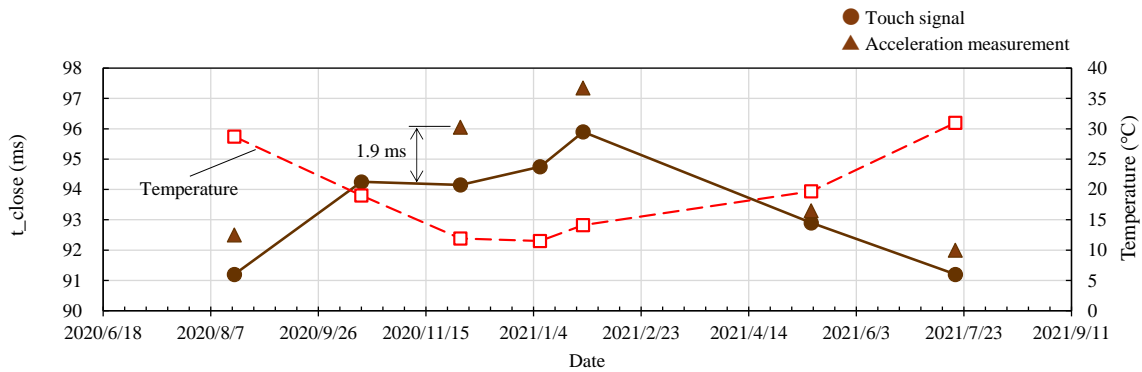


Fig.4. Closing time obtained from touch signal and acceleration of tank

Conclusion

According to this method, it is possible to determine the closing time by reading the time from the moment of the closing command to the second steep rise in the acceleration, without taking touch signal. In on-site work, workers' safety can be enhanced by eliminating work at high places, such as connecting touch signal lines to the bushing head, by using acceleration sensors to determine the closing time of the GCB.