Downed Conductor with HI-Z Fault Detection

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Project Background

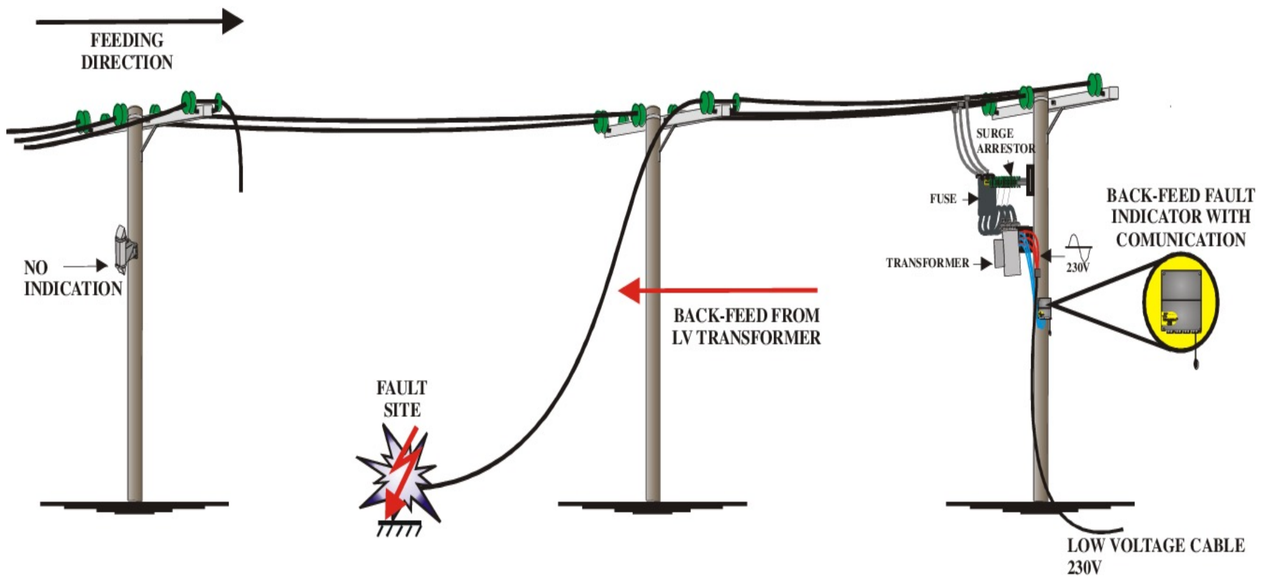
Southern California Edison owns more than 91,000 miles of distribution lines. Wildfires cause billions worth of damage every year and in some cases are created by downed conductors. Existing protection schemes are not 100% arcuate when detecting a high impedance fault.



Fire caused by a high impedance fault

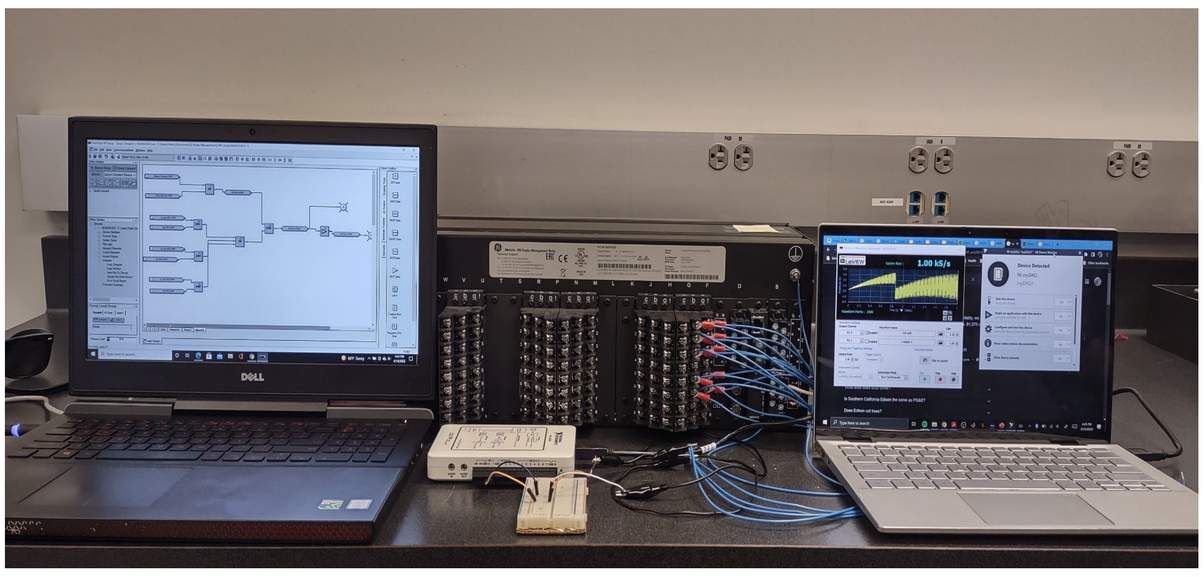
Project Objective

The objective is to create a detection technique that detects a High Impedance fault on distribution Circuits. The conductors on the distribution circuit are insulated and three phase, with one downed conductor.



System Level Requirements

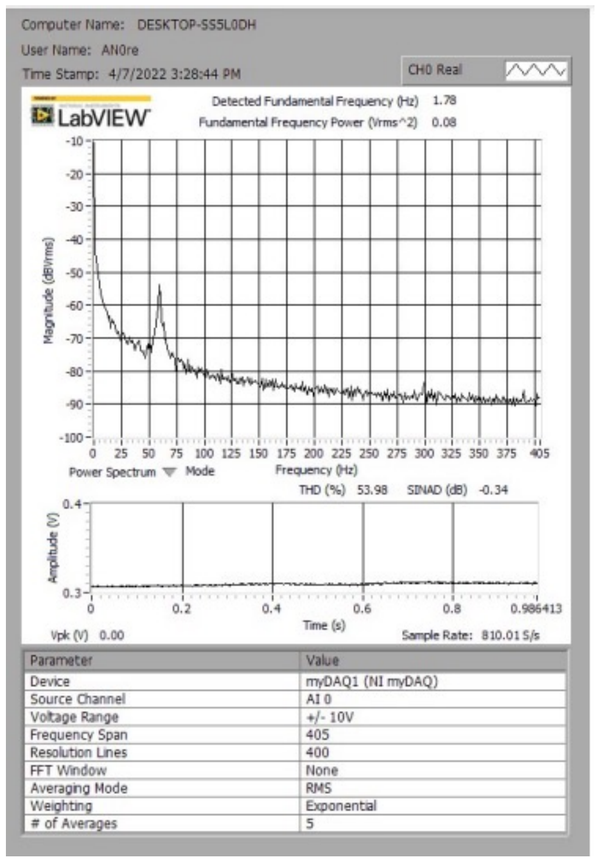
- Detecting a down conductor that has a high impedance fault causing the line currents to be very low compared to normal operating values
- The detection technique should isolate only the component under fault leaving as much of the electric network in operation
- Using a Digital Relay (GE F60)



Testing algorithm using function generators

System Overview/Approach

In designing a detection algorithm for Hi-Z faults, first we determined some of the characteristics of these types of faults which include low fault currents, and harmonic distortion. Using this information, we used built-in protection features of the F-60 relay as well as harmonic monitoring to detect and alert the presence of Hi-Z faults.



Parameter	Value
Device	myDAQ1 (NI myDAQ)
Source Channel	AI 0
Voltage Range	+/- 10V
Frequency Span	405
Resolution Lines	400
FFT Window	None
Averaging Mode	RMS
Weighting	Exponential
# of Averages	5

The graph to the left shows the disturbance a high impedance fault makes in the harmonics of the system, therefore using harmonics was an ideal approach.

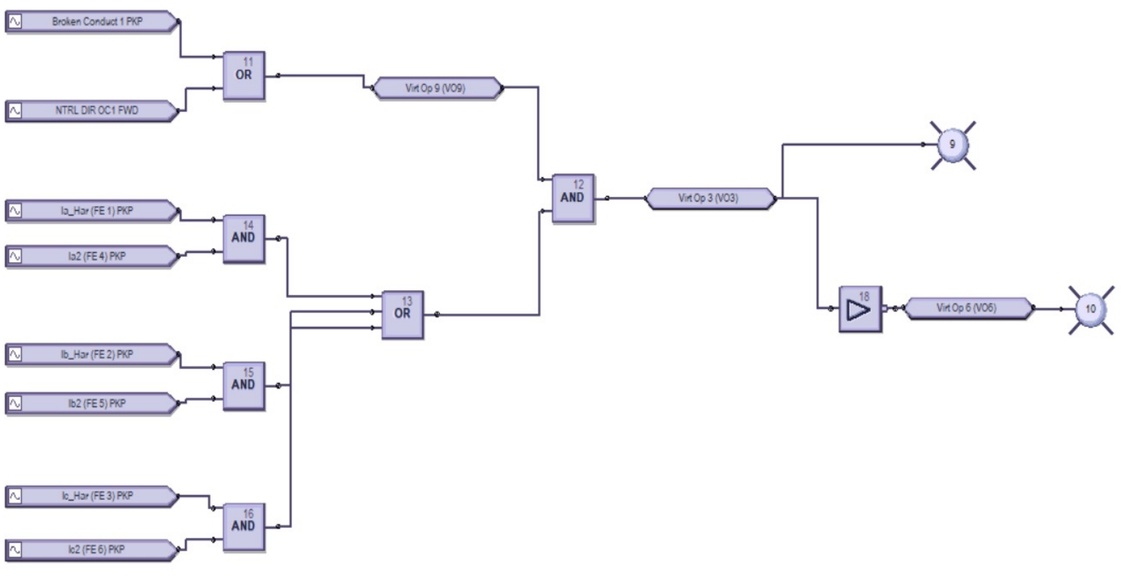
Results/Conclusions

The team successfully detected the Hi-Z fault simulated waveform utilizing the GE F60. The downed conductor was detected using the Hi-Z detection algorithm along with the GE F60 broken conductor operand. The next steps are to increase selectivity to reduce false positives. Reducing false positives will keep the circuit breaker from tripping consistently causing utility customers to lose power.



Circuit Breaker

The detection algorithm logic is shown below. It shows the combination of logic gates and Flex Elements from the GE-F60 that detect high impedance faults.



Detection Algorithm