

Case Studies of Relay Protection CT Faults and Analysis



Overview

One of the practical concerns for the protection engineer is the actual ability of a CT to replicate the primary current.

Key Takeaways

CT faults, particularly saturation and grounding issues, can cause protective relays to misoperate, and careful analysis of event data is essential to identify and mitigate these issues. Overview of CT Faults in Relay Protection

Current transformers (CTs) are critical for connecting the power system to protective relays, stepping down high primary currents to manageable secondary levels. While modern ANSI C-class CTs typically maintain 1-2% accuracy, certain conditions such as high fault currents, high X/R ratios, or excessive burden can lead to CT saturation, causing relays to misoperate. CT saturation distorts the secondary current waveform, which can trigger false trips or prevent correct operation of differential, overcurrent, or bus protection relays.

Case Study Examples

- **Line Differential Relay Misoperation** At a dual-breaker line terminal, a line differential relay experienced undesirable operation due to CT saturation. The root cause was linked to the CT's inability to accurately replicate high asymmetrical fault currents. Mitigation involved selecting higher accuracy class CTs, increasing the turns ratio, and reducing connected burden to prevent saturation.

- **Generator Differential Relay** Generator differential relays can misoperate when CTs saturate during high fault currents. In one case, oscillography data showed that the relay tripped incorrectly because the CT secondary current was distorted. Corrective measures included verifying CT sizing against maximum symmetrical and asymmetrical fault currents and ensuring proper relay settings .
 - **Low-Impedance Bus Differential Relay** CT saturation also affected low-impedance bus differential relays. The event logs indicated that the relay responded to distorted secondary currents, leading to false trips. Solutions involved using CTs with higher saturation voltage and minimizing the burden to maintain accurate current replication .
 - **Transformer Restricted Earth Fault (REF) Misoperation** A transformer REF relay misoperated during an external ground fault. Initial suspicion of wrong CT polarity was ruled out; detailed analysis revealed incorrect shorting and grounding of the neutral CT, causing a ground potential difference that induced current in the relay circuit . Corrective action required proper CT grounding and verification of neutral connections.
 - **Shunt Reactor Negative Sequence Overcurrent Misoperation** CT saturation caused a 13.8 kV shunt reactor to misoperate on negative sequence overcurrent. Despite normal-looking current waveforms, analysis confirmed CT saturation as the root cause. This highlighted the need for advanced analytical tools to detect subtle CT saturation effects .
 - **Inverter-Based Resource (IBR) Fault Current Variations** With increasing integration of IBRs, fault current contributions vary widely, complicating relay coordination. Events showed that CTs and relays could misoperate due to unexpected inverter fault currents, emphasizing the importance of standardized modeling and testing for IBRs .
- Analysis and Mitigation Strategies**
- **CT Selection:** Use the highest accuracy class CTs with sufficient saturation voltage (V_X) and appropriate turns ratio to handle expected fault currents .
 - **Burden Management:** Minimize connected burden to reduce the likelihood of CT saturation.
 - **Event Analysis Tools:** Oscillography and relay event logs are essential for identifying CT saturation and grounding issues. Novel analytical methods can detect subtle saturation effects that may not be obvious from waveform inspection .
 - **Grounding Practices:** Ensure proper CT grounding and shorting, especially for transformer neutral CTs, to prevent induced currents from ground potential differences .
 - **Coordination with IBRs:** Account for variable fault contributions from inverter-based resources in protection studies to avoid misoperations .
- Key Takeaways**

CT faults, particularly saturation and improper grounding, are a common cause of relay misoperation. Each protection scenario may require a tailored approach, including careful CT selection, burden management, and advanced event analysis. Understanding these case studies helps protection engineers design more reliable systems and implement corrective actions effectively.

Article Content

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Remote backup protection consists of relays that are set to respond to faults in the next zone of protection. This type of protection is

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Abstract. This paper analyses the unusual mal-operation of the differential protection for transformer current differential protection

A real-life case study of relay coordination (step by step tutorial ...

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Study of Relay Protection Fault Analysis and Treatment

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This paper introduces the concept of relay protection of hidden faults, its characteristics, and then analyzes the

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To determine stability voltage for through fault V_s'' Voltage across the relay at IFS (VS) CT Resistance (RCT)

Event Analysis: Innovative Tools and Strategies for Protection

Event analysis can be very challenging and encounter many obstacles, making it essential for protection engineers to develop a

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Over the decades, busbar protection products based on different relay technologies ranging from static relays to

Impact of CT saturation on overcurrent relays

The aim of this study is to investigate the impact of CT saturation on overcurrent relays using both a physical relay test

Fault Analysis in Power System: Know Types & Importance of Fault Analysis

A thorough fault analysis using engineering software provides invaluable input for power system protection, ratings of equipment, and

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The investigation results presented in this paper show that the new algorithm provided sensitive protection for the

Relay Performance Verification using Fault Event Records

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