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Impact of inrush current protection on relay protection



Overview

One of the main causes for incorrect operation of the transformer relay protection are inrush currents.

Key Takeaways

Yes, inrush current is a critical consideration in relay protection, particularly for transformers and inductive loads, to prevent nuisance tripping while ensuring fault detection.Understanding Inrush Current

Inrush current is the initial surge of current that occurs when an electrical device, such as a transformer, motor, or capacitor, is first energized. This current can be several times higher than the device's normal operating current and typically lasts only a few cycles or milliseconds . For transformers, inrush currents can reach 8 to 15 times the rated current, often resembling a phase-to-phase fault in magnitude . In AC motors and power converters, inrush occurs due to the charging of input capacitances or magnetizing currents .

Relevance to Relay Protection

Relays, especially overcurrent and differential relays, must distinguish between harmless inrush currents and actual fault conditions. If a relay trips during inrush, it can cause unnecessary outages. To address this:

• Instantaneous overcurrent elements (50) are set above the worst-case inrush peak, often with a safety margin of 1.5x to 1.6x .

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• Differential protection (87) compares primary and secondary currents; during inrush, the differential signal is large but contains a high second harmonic component, which can be used to restrain tripping .

• Harmonic blocking or inrush restraint allows relays to remain stable during energization while still detecting internal faults with low harmonic content .
Practical Measures
• Precharge circuits or inrush current limiting resistors are used in DC and AC circuits to reduce the initial surge, protecting relays and other components .

• Relay settings are coordinated with system time constants (L/R decay) to ensure the trip time exceeds the inrush duration, preventing false trips .

• In high-voltage or sensitive applications, relays may incorporate time-overcurrent elements (51) and second harmonic restraint to balance protection and stability .
Summary

Inrush current is explicitly considered in relay protection design. Protective relays are configured to ignore transient inrush currents while remaining sensitive to genuine faults. Techniques such as harmonic restraint, precharge circuits, and careful setting of instantaneous and time-overcurrent elements ensure reliable operation without nuisance tripping . This is particularly important for transformers, motors, and circuits with large capacitive or inductive loads.

Article Content

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Exciting and inrush currents in transformers that often make protection relays go crazy (photo credit: Andrew George

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Explore the design challenges of inrush current, how to use NTC thermistors to limit the inrush current, and choosing the right

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Third, impact of the combination of inrush currents and saturated CTs on sensitive ground overcurrent protection is addressed.

Inrush Current – A Guide to the Essentials | RECOM

If the power supply has a fast-reacting over-current limit, the high peak inrush current could cause it to go into

A Review: Transformer Protection for Magnetizing Inrush Current

The protection is not issue to elaborate. The key issue is the false tripping of the relay due to mal-operation. It misidentifies the

How do I reduce the Inrush Current?□CTC POWER

If the inrush current is not suppressed, the input power might have no output due to protection circuit, and it maybe

Inrush-current limiter circuits (ICL) with Triacs and Thyristors

Indeed, if nothing is implemented to limit the inrush current, the startup current can easily be 10 to 20 times higher than the steady

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Improving Inrush Current Protection Many applications today, including industrial machinery, power tools and other high current

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PDF | On Mar 23, 2018, Bogdan Kasztenny published Impact of Transformer Inrush Currents on Sensitive Protection Functions How

Inrush Detection Through Current Wave Shape Analysis – Advanced ...

A distorted waveform produced by IBRs during a fault event may have significant impact on the inrush stabilizing algorithm in

How to limit PFC re-rush current

The inrush current is limited by RT to a low value, and the PFC output bulk capacitor (CBULK) charges gradually. Once the output

Inrush Current: Causes, Limiters and Protection Circuits

Power Electronics News Explores The Causes and Effects Of Inrush Current. Plus, Learn How To Reduce It With

Research on the Impact of Inrush Current of Converter Transformers

When closing converter transformers without load, inrush current arise due to the invalid suppression strategies, which pose a

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Introduction TRANSFORMER energization is a switching operation which causes inrush transient currents with

Transformer Magnetizing Inrush Current: Causes, Effects & Prevention

Transformer inrush current is a highamplitude transient during energization, caused by core saturation and residual

Inrush Current Impact on Transformer Protection

This paper discusses the effect of inrush current on transformer protection. Inrush current occurs when a transformer is energized

Fundamentals of Transformer Inrush Final1

Abstract — This paper will present an overview on the phenomenon of transformer inrush and its impact on differential relays. In

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