Impact of inrush current protection on relay protection

Overview

The paper describes the influence of the inrush current on different types of protection functions as transformer differential, overcurrent, distance, busbar and line differential.

Key Takeaways

Yes, inrush current is an important consideration in relay protection, and relays are often selected or designed to handle these brief but high current surges.

Understanding Inrush Current

Inrush current is the initial surge of current that occurs when a device is first powered on, often much higher than the steady-state operating current. This is common in circuits with capacitors, transformers, or motors, where the current can be 10 to 30 times the normal operating value for a few milliseconds or microseconds. If not managed, inrush current can damage relay contacts, surrounding components, or wiring.

Relay Considerations for Inrush Current

Relays are rated not only for continuous current but also for their ability to withstand momentary high currents. This is often specified using TV ratings (Television load ratings) according to UL and CSA standards, which indicate the maximum inrush current a relay contact can handle. For example, TV4 relays can handle 65A inrush, while TV5 can handle 78A.

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Selecting a relay without considering inrush current can lead to contact welding, premature wear, or failure.

Protection Techniques

To protect relays from inrush current, several strategies are used: Precharge or inrush-limiting resistors: These resistors temporarily limit current into capacitive loads, allowing the relay to switch safely without being exposed to the full surge.

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C thermistors: These resistors have high resistance at startup, reducing inrush current, and then decrease resistance as they heat up, allowing normal operation. Zero-crossing solid-state switches: These devices switch AC loads at the voltage zero-crossing point, minimizing the peak inrush current through the relay. High-inrush rated relays: Relays specifically designed to handle high inrush currents are used in applications like LED drivers, transformers, and motors.

Practical Implications

Inrush current is particularly relevant in capacitive or inductive loads, such as inverters, power supplies, and motors. Proper relay selection and protection circuits ensure reliable operation, prevent component damage, and extend the lifetime of the relay and connected devices. Ignoring inrush current can lead to unstable operation, overheating, or even fire hazards in high-power circuits.

In summary, relay protection design explicitly considers inrush current, either through relay selection, ratings, or additional protective circuitry, making it a critical factor in safe and reliable electrical system design.

Article Content

Inrush currents and their effect on protective relays

The paper describes the influence of the inrush current on different types of protection functions as transformer differential, overcurrent, distance, busbar and line differential.

Inrush Current – Causes, Effects, Protection Circuits and Design

PDF file

Solutions for Current Protection

This current can be substantially higher than standard operating current. If not properly managed, it can reduce the effective operating life and impose damage to equipment. For example, inrush current

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How to choose high-capacity relays for inrush current prevention ...

This guide provides detailed information on high-capacity relays that are perfect for inrush current protection and discharge circuits, which is important for ensuring safety during use in energy storage

Practical Analysis of Various Types of Inrush Current and Implications ...

To prevent the malfunction of protective functions, the accurate identification of IC is a critical factor. The Inrush Current Detection (ICD) function is responsible for sending a blocking signal to the

Managing Inrush Current

This application note explores typical causes of inrush current, problems caused by inrush current, and solutions for inrush current featuring integrated load switches.

(PDF) Impact of transformer inrush currents on sensitive protection ...

This paper reviews impact of transformer inrush currents on four protection functions. For each category the problem is reviewed and quantified, and practical solutions are presented.

Research on the Impact of Inrush Current of Converter Transformers

Abstract: When closing converter transformers without load, inrush current arise due to the invalid suppression strategies, which pose a significant threat to power system. Studying the effect of inrush

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Manufacturers have developed features dealing with inrush currents to stabilize differen-tial relays and protection engineers have considered inrush currents in their coordination to avoid misoperation.

Inrush Current Effects on Relays

The paper describes the influence of the inrush current on different types of protection functions as transformer differential, overcurrent, distance, busbar and line differential.

Surge current causes, compoSurge current causes – Ebyte Official

Learn how inrush current damages electrical components. This guide provides a deep dive into power-on and load-switching surge mechanisms, offering standardized protection selection and

Electrical Protection Systems: IEC 60909 (2026) | Enginist

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Engineering trade-offs of flyback diodes: relay release delay, reverse recovery losses in PWM, layout parasitics, and clamp strategies (Zener, TVS, RC snubber). Selection checklist and FAQ.

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Rated Current: Requires comprehensive consideration of normal/overload currents, equipment starting inrush characteristics (e.g., motor starting current, transformer magnetizing inrush), and ensuring

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Specific protection operations could be triggered during transformer energization. High inrush current with large harmonic content can trigger over-current relays. Also, large inrush current in weak grid

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Inrush currents and their effect on protective relays

This paper explains in detail the phenomena of inrush in single-phase transformers during three conditions: transformer energization, external fault clearing and sympathetic inrush. It then focuses

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