Relay Protection Characteristic Circle

Article Overview

The relay protection characteristic circle is the graphical representation of a distance relay's operating region on the impedance (R-X) plane, typically forming a circle that defines the zone of protection.

Definition and Purpose

In distance protection, relays measure the apparent impedance to a fault using the ratio of voltage to current at the relay location. The characteristic circle represents the boundary within which the relay will operate to trip the circuit breaker. If the calculated impedance falls inside the circle, the relay interprets it as a fault within its designated zone and initiates tripping, ensuring selective and fast protection of transmission lines ( ).

Formation of the Circle

For a phase mho relay, the circle is formed on the R-X diagram (resistance vs. reactance). The diameter and position of the circle are influenced by:

o Source impedance behind the relay
o Line impedance to the fault
o Polarizing voltage used for directional sensitivity The mho relay uses the faulted phase voltage as a polarizing quantity, and the operating signal is derived from the voltage-to-current ratio. The 90? phase relationship between the operating voltage and polarizing voltage ensures that the relay operates only for faults in the forward direction ( ).

Dynamic Characteristics

Modern relays exhibit dynamic behavior due to memory action in the polarizing circuit. Initially, the characteristic may appear as a large circle that shrinks to the steady-state mho circle as the memory decays. This allows the relay to handle high-resistance or close-in faults more effectively than indicated by the steady-state circle ( ).

Variations and Adjustments

o Offset mho characteristic: The circle's center can be shifted to improve directional sensitivity and avoid overreaching ( ).
o Lens or tomato-shaped characteristics: Used in digital relays to accommodate wide load swings or resistive faults, modifying the circular shape to suit specific system conditions ( ).
o Reactance supervision: Sometimes combined with the circle to block operation for highly resistive or external faults ( ).

Practical Significance

The characteristic circle allows fast, selective, and reliable tripping without requiring communication with other relays. Its shape and size can be adjusted to:

o Cover a specific percentage of the line length (Zone 1 typically 80-85%)
o Avoid tripping for faults beyond the protected line
o Maintain security against load variations and fault resistance By visualizing the relay's operating region on the R-X plane, engineers can set, test, and coordinate distance relays effectively, ensuring optimal protection of transmission lines ( ).

Types of protection relays are mainly based on their characteristic, logic, on actuating parameter and operation

Numerical techniques are the newest way to implement distance and directional relay elements. These relays use torque-like

The characteristic of mho relays on the admittance diagram is, therefore, a straight line and is shown in the figure below. Mho relay is

This comparison summarize characteristics of all protection relay types described in

ABSTRACT This paper describes the dynamic characteristic of phase mho relays which use the faulted phase voltage as the

A traditional line distance protective relay reach tries to test the entire MHO characteristic as shown in the following image. This test

This study proposes a protection relay using a microcontroller to detect and classify faults in transmission

Various combinations of voltages and currents are possible in the power system in an event of fault. Distance relays use these

The mho Circle The mho circle is the most used relay characteristic for step distance protection. For this reason, we will put more

microprocessor-based relay shapes a distance operating characteristic by making calculations. With respect to the "standard"

The impedance from the relay to the reach point determines the diameter of the mho circle. Vectors dZ and Z will always be at right

Any protective relay operating on impedance would therefore ignore such changes, and trip only if the line"s characteristics were to

Knowledge of true protective relay characteristics has not been communicated fully and properly from protective relay

Abstract: Protective relays and devices have been developed over 100 years ago to provide "last line" of defense for the electrical

Figure 2 - Distance relay characteristics As an illustration in conjunction with the figure, suppose a fault arose, the

The types of protective relays that exist are overcurrent, electromechanical, directional, distance, pilot, and differential

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