

Substation Automation and Protection Division

Pilot Protection Alternatives

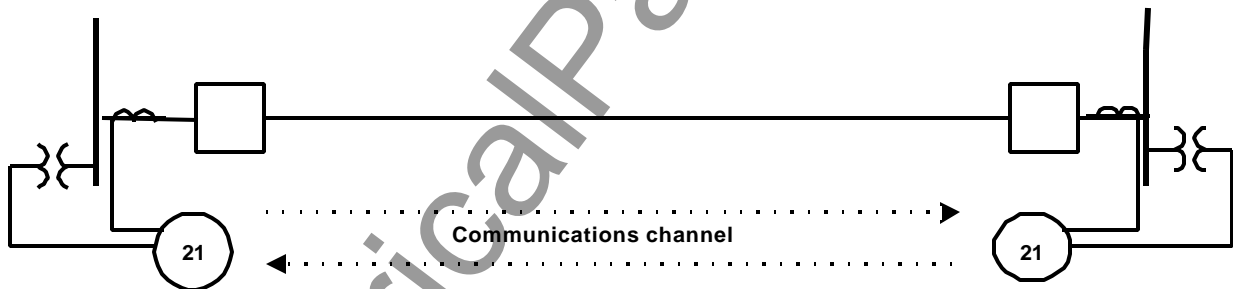
Introduction

This note discusses the application of directional comparison and phase comparison relay systems for use as transmission line protection.

Directional comparison

Directional comparison relay schemes use voltage and current at both line terminals to calculate the impedance to a forward or reverse fault. This information is exchanged between the two terminals in the form of a blocking signal, if the fault is behind the relay, or a permissive trip signal, if the fault is in front of the relay.

Directional comparison schemes come in many types : blocking, unblocking, permissive overreaching transfer trip, permissive under reaching transfer trip...the scheme is determined by what information is transferred to the remote terminal, and how the remote terminal handles the information. All of the schemes are based on an impedance measurement, which involves getting information from potential transformers and current transformers at both terminals. A completely redundant system as is often used on high voltage lines would require 2 sets of potential transformers and current transformers.



Directional comparison Scheme

In addition to the expense for 2 sets of potential transformers there are other limitations to the use of redundant directional comparison schemes. Two such limitations are: the response of the distance relay to power swings and the application on series compensated lines.

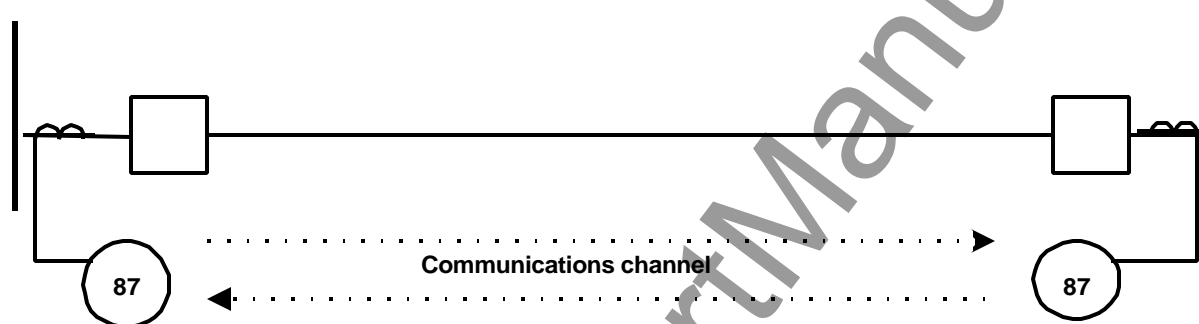
Transmission lines today are loaded to the maximum. Any perturbation on the system causes system swings that may or may not cause the entire system to go unstable. These swings wreak havoc with distance relays because the power swings look to the relays as a change in impedance that brings the impedance into the operate region for the relay. Techniques are available to block operation of distance relays during power swing conditions but these techniques by their nature, block the relay during a time when protection is most needed

Series capacitors either connected directly on the line or on adjacent lines pose problems to distance relays. Bypass schemes employed to protect the series capacitor during overcurrent conditions confuse the distance relay. Again, techniques are employed to ensure correct operation of distance schemes such as delaying

the relay operation until the system settles down. This slows down relay operation and ultimately, fault clearing.

Phase Comparison Scheme

A Phase comparison scheme is an attractive alternative to directional comparison schemes. Phase comparison as well as current differential schemes are current only schemes. That is, they require only current transformers for inputs. No potential transformers are used. Phase currents are measured at both terminals. A representation of this phase current is sent to the remote terminal for comparison with the local current. Current transformers are connected in such a way that the currents (remote and local) are in phase for an internal fault, and out of phase for an external fault.



Phase comparison Scheme

Since phase comparison schemes use current only, they are immune to certain problems discussed earlier with directional comparison systems. Since power swings are a through phenomena, power swings have not effect on current only schemes. The system does not have to be disabled during this disturbance. Likewise, series capacitors have no effect on the operation of current only schemes.

Conclusion

In addition to those points covered above, there are several reasons why "Current Only" schemes make a great complement to Directional comparison relay schemes. First, since it uses different operating principles, current differential relays don't have the same "holes" in protection as directional comparison schemes. Second, since current only schemes don't require potential transformers, an extra set of potential transformers is not needed to have a completely redundant system. The savings from not having to buy an extra set of potential transformers could be substantial. These reasons make phase comparison or current differential schemes the perfect complement to directional comparison schemes, both from an economical and technical standpoint.

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