TOP 10 QUESTION from the Tech Talk

TECHTALK

Fundamentals of Bus Differential Protection

In our Tech Talk, **Fundamentals of Bus Differential Protection**, we reviewed basic principles – from typical bus arrangements to protection techniques including methods to manage CT saturation conditions – and how this critical protection can minimize equipment damage, improving site safety. We also explored the evolution of common bus arrangements and components, protection techniques to ensure system stability, and advanced algorithms to handle CT saturation.

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LET'S GO!

GE VERNOVA

Fundamentals of Bus Differential Protection

QUESTION

ANSWER

What is the best type of relay to implement bus differential protection?

GE Vernova offers centralized and decentralized bus protection schemes in the B30/B90 UR and the P74x MiCOM families of relays. Here are a few of GE Vernova's bus protection relays:

- Low impedance bus protection: Multilin B90
- Low impedance busbar protection: Multilin B30
- MiCOM Agile P74x Series

What are the different bus protection schemes?

There are several schemes that are available including zone interlocking, overcurrent differential, high impedance, and low impedance. They are described in more detail below.

What is a zone Interlocking bus differential protection scheme?

This is a simple scheme that uses overcurrent relays placed on the incoming circuits and at all outgoing feeders. The feeder overcurrent relays are set to sense faults on the feeders and send a blocking signal to the incoming circuit overcurrent relay. The overcurrent relay on the incoming circuit is set to trip the busbar unless blocked by any of the feeder overcurrent relays. A short coordination timer is typically required. When using microprocessor based multi-functional relays, it is possible to integrate all the required overcurrent functions in one or a few relays. This not only reduces the wiring but also shortens the coordination time and speeds up the operation of the scheme. Modern relays provide for fast peer-to-peer communications using IEC 61850 GOOSE messaging to replace all wiring typically needed for the blocking signals. Although easy to apply and economical, the scheme is limited to simple busbar configurations.

What is an overcurrent bus differential protection scheme?

Typically, a differential current is created externally to an overcurrent relay by summation of all the CTs from each circuit. Preferably the CTs should be of the same ratio. If they are not the same, a matching CT (or several CTs) is/are needed. This in turn may increase the burden of the main CTs and most likely push the CT(s) into saturation much sooner. To deal with the CT saturation problem, typically definite time or inverse-time overcurrent characteristics are needed, slowing down the scheme. Although economical and applicable to distribution busbars, this solution does not match the performance of more advanced schemes and should not be applied to transmission-level busbars. The principle, however, is used as a protection function in an integrated microprocessor-based busbar relay. If this is the case, such unrestrained differential elements should be set above the maximum spurious differential current and may speed up operation on heavy internal faults as compared to a percent (restrained) bus differential element.

Fundamentals of Bus Differential Protection

QUESTION	ANSWER
What is a high impedance bus differential protection scheme?	In this scheme, CTs are paralleled together into a sensing relay or circuit, called a high impedance relay. Under normal conditions, currents going into and out of the bus will be equal and no current flows through the high impedance relay's coil. When an internal bus fault occurs, current is forced to flow through the high impedance relay's coil, creating a voltage drop and allowing the relay to operate. A stabilizing resistor (typically approximately 2,000 Ohms) is usually installed to avoid (external faults) or to increase differential (internal fault) current into the high impedance relay circuit. It is a simple technique which requires that all CTs used in the protection scheme have relatively high knee-point voltage, similar magnetizing characteristics, and the same ratio.
What is a low impedance bus differential protection scheme?	The low impedance bus relay differential vectorially sums the currents from all CT inputs to detect the difference or differential current resulting from an internal fault. This is done internally in the relay, so paralleling of CTs is not required. Unlike high impedance, this allows the use of CTs with different ratios and magnetizing characteristics. In the B30/B90 and P74x relays, each CT is monitored individually, allowing the CT to be used for multiple protection elements including backup overcurrent and breaker failure. This also allows easier troubleshooting of CT issues.
What is a check zone and why is it needed?	A check zone is an additional security measure to ensure there is an internal fault in the substation or bus arrangement, usually employed with dynamic buses. It is usually independent of isolation status and uses independent CTs (if available). It gives a permissive signal to the main bus differential zone to operate.
Can a bus protection relay be used when there are different CT ratios (either primary rating or secondary rating)?	For a high impedance bus protection scheme, the primary and secondary rating of all CTs should be the same. Low impedance bus protection schemes do not require all CTs to have the same primary or secondary rating. The low impedance relay accomplishes this by establishing a common per-unit base and performs the differential calculations in per-unit. Both the UR and MiCOM relays allow combinations of 5A or 1A secondary rated CTs and do not need to be specified ahead of time or selected in the order code.
For dynamic bus configuration, what happens if the disconnect state is unknown or erroneous? Should the bus differential be blocked?	It depends on the protection philosophy; our recommendation is not to block any critical protection function, especially if there is no backup. Another option is to default to protect the bus as a whole. However, a fault on one bus will also trip multiple buses.

Fundamentals of Bus Differential Protection

QUESTION

ANSWER

Can bus relays detect an open or grounded CT condition and alarm?

The GE Vernova UR and MiCOM family of bus differential relays include a CT Trouble element which is essentially a low set or sensitive bus differential zone. This element will pick up on CT issues since a low differential current will be established if a CT is opened or grounded. This function can be set to trigger an alarm.

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