

TOP **10**
QUESTION
from the Tech Talk



The ABCs of 87L: Line Current Differential Protection

In our Tech Talk, The ABCs of 87L: **Line Current Differential Protection**, learn about line differential principles - from equipment requirements to the balance between selectivity and security, to key challenges like the risk of communications impairments. We also talk about the impact of communications channel architecture on protection scheme and application considerations and methodologies for CT saturation detection, as well as differential settings.

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The ABCs of 87L: Line Current Differential Protection



QUESTION



ANSWER

Can you apply 87L to series-compensated lines (with and without IBR resources supplying fault current)?

Optimal performance of the 87L has been observed on series-compensated lines, as compared with other protections. It applies to inverter-based resources (IBR) as well, but sequence-component-based differential is not recommended. Ground differential can be applied if the step-up transformer on the IBR point-of-coupling is wye-grounded on the system side, providing reliable zero-sequence current.

What is the maximum channel delay for the Multilin L90 line current differential system to operate correctly?

The L90 can tolerate a channel delay of up to 28ms in one direction. Longer channel delays can affect the operating time to clear internal line faults. A typical delay is less than 3ms in one direction.

For slopes between 30% and 50%, where do these numbers come from?

In general, slopes are determined by CT accuracy. Slope 1 is for low to medium fault current levels where CTs operate in the linear part of the characteristics. Typically, CT error is below 10% in this part of the characteristics. The combined error from two terminals can be 20% in the worst-case scenario, which amounts to 30%. Slope 2 is for medium to high fault current levels where the error can be higher. If no saturation is expected, 50% is satisfactory; but when CT saturation is possible it has to be set higher.

Is the source impedance ratio (SIR) involved in the specification and settings of an 87L?

No, SIR is not directly involved in 87L specifications or settings. However, higher SIR means higher source impedance (weak source) behind 87L relays, which in turn means lower fault current contribution. Lower fault current during an internal fault means less sensitivity for resistive faults. If the opposite terminal is a strong source, this should not pose any challenges, but if both sources are weak, sensitivity may be impacted. Another potential problem for a very weak source is a disturbance detector, which may not be sensitive enough to detect a fault.

How is differential protection deactivated during a loss of the communication channel?

An 87L cannot operate without receiving data from the remote end or if the data received from the remote end is invalid. There are monitors inside the 87Ls that check if valid data is received and compare it with local data stored in the buffer. If no data is received or if it is received too late, 87L is inhibited. Not receiving data for some time will initiate a channel alarm.

Can the relays accommodate in-line transformers?

GE Vernova relays provide in-line transformer protection even without MV breaker CTs. Please refer to the [L90](#) or [L30](#) manuals. GE Vernova recommends only one transformer on any side as we do not believe two LV/MV transformers on either end is practical.



The ABCs of 87L: Line Current Differential Protection



QUESTION



ANSWER

What are the limitations for line current differential protection?

Limitations of the line current differential are mainly associated with the communications channel. For example, line length greater than 100 km limits direct fiber application. The quality of the channel can also be considered a limitation—87L requires high quality, high availability channels.

How can you determine points in restraining and operating zones of a differential slope?

The best approach is to follow manufacturer test recommendations or use manufacturer test tools. For example, for GE Vernova L90 and L30 relays, you can test 87L characteristics using the L90 Test Tool available [here](#). This tool exports test points into Excel with multiple points on the differential slope.

Why do you prefer a percentage bias differential relay over a simple differential relay?

A simple differential relay is an unrestrained differential relay. Unrestrained differential relays have no means to deal with CT errors, CT saturation, channel asymmetry, etc. The only means to deal with CT errors is time delay, which is not optimal as it delays the trip and is prone to maloperation. In other words, a percentage differential relay has much higher security, dependability, and faster operation time.

Can you have a line differential without a fiber connection (i.e. microwave)?

Yes, microwave multiplexers are widely used for 87L communications channels. Many customers have employed this method successfully for years.



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