7SG163 Ohmega 300 Series

7SG163 Protection Relay

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:
Pre release

2010/02	Document reformat due to rebrand

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1 Introduction

High resistance earth faults present difficulties to impedance measuring elements since the resistive coverage required can often extend beyond the apparent impedance presented by maximum load conditions. In those cases a directional earth fault element can be used to supplement the basic distance protection.

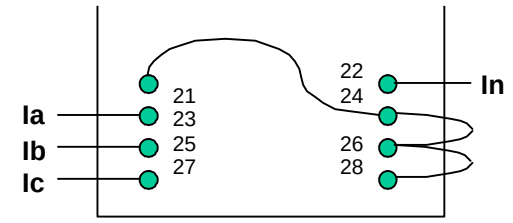


Figure 1. Connection of residual current.

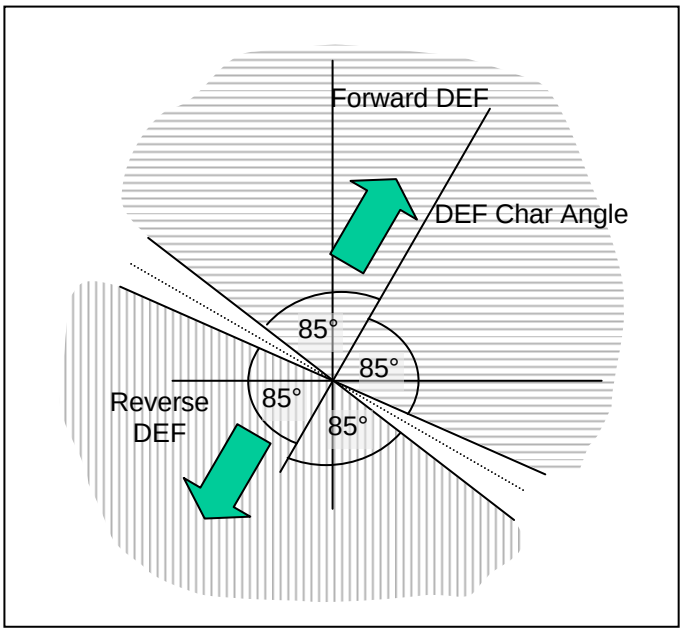
The relay applies two discrete directional elements, one in the forward direction, the other in the reverse direction.

The design of the directional earth fault elements is based on similar techniques as used for impedance measurement. The element is voltage polarised deriving this by summating the three phase to neutral voltages available in the relay. The zero sequence current providing the other input is derived from the fourth C.T. input which must be connected with the polarity as indicated in Figure 1.

2 DEF Direction and Characteristic Angle

The relay contains two directional elements - one forward and one reverse – which operate in parallel with each other. The forward DEF element will operate for fault current occurring in the forward direction – this element will be used for tripping. The reverse looking zone is usually a non-tripping element, used to generate a blocking signalling where a blocked overreach is applied.

The Characteristic Angle sets the maximum torque angle of the directional relay. Operation will occur for angles in the range +-85º of this setting. This should be set to the zero sequence impedance angle of the protected feeder.



The DEF element can be used either in conjunction with a signalling channel, operating as a simple high speed directional comparison scheme with the remote end DEF, with an IDMTL backup function if a residual current is detected. Both blocking and permissive schemes are supported.

The element can also be used as a time graded directional IDMTL relay with no signalling. This mode is referred to as DEF DIRECT TRIP.
More detail on these schemes is given in the next section.
Figure 2. DEF Operating Zones

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2.1 DEF Schemes

There are three possible DEF schemes for the relay.

2.1.1 DEF Direct Trip

In the *DEF Direct Trip* mode, the relay will trip on detecting an earth fault in the set direction. The DEF element is time graded, and may be set to standard IEC or ANSI Curves or as a DTL element.

2.1.2 DEF BOR

The relay incorporates a DEF blocking scheme (*DEF BOR)*. This is designed to be used in conjunction with a signalling channel. When the reverse-looking DEF element operates it sends a blocking signal, using the output contact assigned as *Signal Send 2,* to the remote end. In order to trip instantaneously on DEF the relay must detect a forward DEF and have NOT received a blocking signal to Status Input *Signal Receive 2* from the remote end. Obviously if one relay detects a fault in the forward direction, and it is does not operate the reverse-looking DEF element a the remote end the fault must be within the line section, and tripping should be carried out as quickly as possible.

A short time delay, referred to as the DEF Permissive Trip Time is initiated, after the forward DEF element has picked up, to allow time for a blocking signal to be received from the remote end.

2.1.3 DEF POR

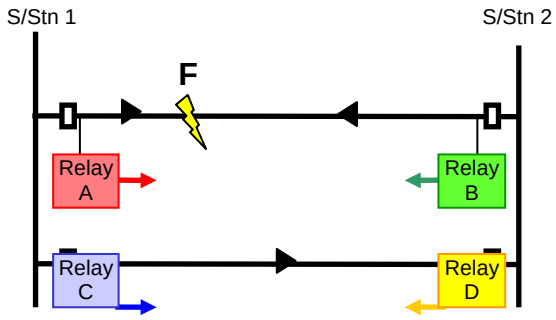
The permissive overreach scheme *(DEF POR*) is designed to be used in conjunction with a signalling channel. When the DEF element operates it sends a permissive signal, using the output contact assigned as *Signal Send 2,* to the remote end. In order to trip instantaneously on DEF the relay must detect a DEF and have received a signal to Status Input *Signal Receive 2* from the remote end. Obviously if the relays at both ends of the line detect a fault in the forward direction, the fault must be within the line section, and tripping should be carried out as quickly as possible.

In case the signalling channel fails, if the DEF element operates, and no signal is received from the remote end, the relay will carry out a time delayed DEF back-up trip.

Additional logic is included within the DEF Scheme to ensure correct operation of the relay.

2.1.3.1 Current Reversal Guard

A current reversal guard is included to prevent incorrect tripping on parallel feeders.
Consider a fault at Point F on the parallel line system shown below:



Both Relay A and Relay B will detect earth fault current in the forward direction. Both DEF elements will operate, permissive signals will be sent by both relays, and when these signals are received, Relays A and B will carry out a *DEF Aided Trip*, isolating the fault.

Observing the direction of current flow, Relay C will also detect earth fault current in the forward direction, and send a permissive signal to the remote end (Relay D). Relay D will detect earth fault current in the reverse direction, and will not operate when the permissive signal is received from Relay C.

Now consider a situation, where the circuit breaker controlled by Relay B operates slightly before the circuit breaker at A.

The direction of current seen by relays C and D will change, so Relay C will detect earth fault current in the reverse direction, and relay D will detect earth fault current in the forward direction.

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Under these circumstances, there is a “race condition” between the drop off of the *Signal Send 2* output from relay C and the operation of the forward DEF element at relay D.

If the DEF element at D operates before the Signal Send 2 from Relay C drops off, Relay D may mal-trip.

Thus, if the Circuit Breaker is closed, and the relay detects fault current in the reverse direction, the Current Reversal Guard logic is started. If the relay then detects a forward DEF it will enforce a time delay (the *DEF Current Reversal Reset*) on the DEF Aided Trip to allow the remote end Signal Send 2 element to drop off.

2.1.3.2 CB Echo

The DEF POR scheme relies upon relays at both ends of the line detecting the fault. With the circuit breaker at one end of the line open, the DEF element at one end cannot operate. Thus no permissive signal can be sent, so the fault would not be cleared until after the *DEF Back-up Trip Delay* for an in-zone fault.

Thus, if the local Circuit Breaker is open AND a permissive signal is received from the remote end, the relay will send (or “echo”) a permissive signal back to the remote end. The duration of this permissive signal is set as the *POR CB Echo Pulse Width*

2.1.3.3 Weak End Infeed

If one end of the line has little or no source of fault current, the relay may not see enough fault current to cause a trip. Thus, if the relay has not detected a fault in either the forward or reverse direction, and a permissive signal is received from the remote end, AND there is a residual voltage present (DEF WI RES OV LEVEL), AND the local CB is closed, the relay will carry out a “Weak Infeed” Trip, and send a permissive signal to the remote end allowing it to carry out a carrier aided trip, also.

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