7SG164 Ohmega 400 Series

Distance Protection Relays

Document Release History

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

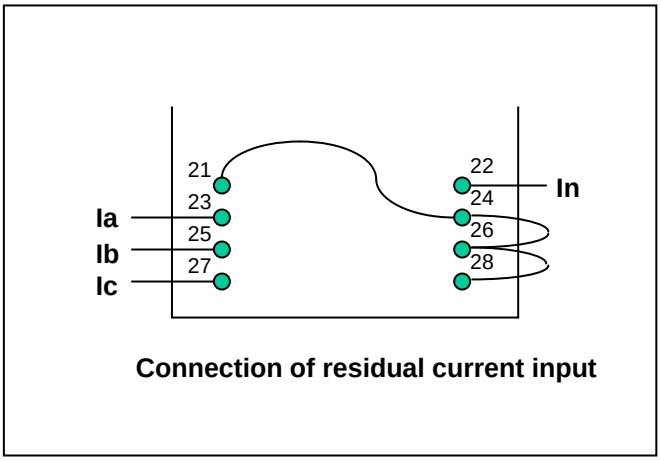
2010/02	Document reformat due to rebrand

Contents

1 Directional Earth Fault Protection

1.1 Applications

Very 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.



Connection of residual current input

The design of the directional earth fault element 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 as indicated.

1.2 DEF Operation.

1.2.1 DEF Direction and Characteristic Angle.

The directionality of the relay can be set to either forward or reverse. With the relay set to forward operation will occur for fault current occurring within the forward operating zone. With the relay set to reverse operation will occur for fault current occurring within the reverse operating zone.

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

1.2.2 DEF Current Setting.

This is the level of residual current at which the DEF element picks up.

1.2.3 DEF Time Delay.

This setting provides a time delay on pick-up which is applied to an Aided DEF trip (in DEF POR mode), or Direct DEF trip (in DEF direct mode).

1.2.4 DEF & Single Pole Tripping (Some models only)

When a single pole trip occurs, the unbalance in the system can cause operation of the DEF element. Thus, during a single pole trip, the relay will inhibit operation of its DEF elements. This feature is enabled by default, but can be disabled using the *DEF Pole Open Block* setting.

1.2.5 The DEF Protection Outputs

The *DEF Protection* output operates for any DEF Operation (aided or back-up), and the *DEF Aided Trip* output will only operate for an aided DEF trip.

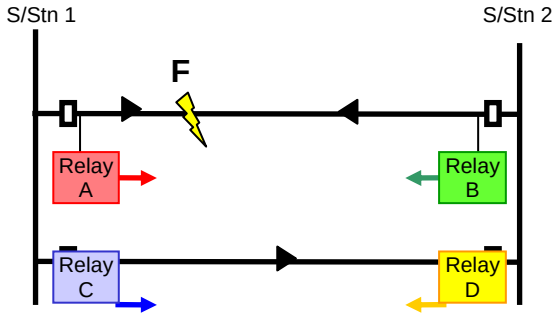
DEF Schemes
There are two active schemes for the relay.

1.2.6 DEF Direct Trip
In the *DEF Direct Trip* mode, the relay will trip on detecting an earth fault in the set direction. It is very difficult to grade a DTL overcurrent element on current, so this mode is intended for used mainly to simplify commissioning. This allows easy testing of pickup time delays, etc.

1.2.7 DEF POR
The other DEF scheme is *DEF POR* (permissive overreach). This 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. Also the relay will carry out a DEF back-up trip after a time delay known as the *DEF Back-up Trip Time*.

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

1.2.7.1 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.
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.

1.2.7.2 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*

1.2.7.3 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.

2 Relay Settings

Directional Earth Fault	Disable, **Enable**
DEF Scheme	Def Direct Trip / Def Por
DEF Char Angle	-15..95 **(80 º)**
DEF Weak Infeed Trip	**Disable**, Enable
DEF Pole Open Block	Disable, **Enable**
DEF1 Direction	**Forward**, Reverse
DEF1 Current Setting	0.05..4 **(1x In)**
DEF1 Time Delay	0..20000 **(1000ms)**
DEF2 Direction	Forward, **Reverse**
DEF2 Current Setting	0.05..4 **(1xIn)**
DEF2 Time Delay	0..20000 **(1000ms)**
DEF CR Guard Res OV Level	0..20 **(5V)**
SR2 Dropoff	0..60000 **(1ms)**
DEF Current Rev Reset	0..60000 (**200ms)**
CB Echo Pulse Width	0..60000 (**250ms)**
DEF Backup Trip Delay	0..60000 (**1ms)**
SS2 Dropoff	0..60000 (**1ms)**

Status Inputs:	**DEF CB CLOSED, BLOCK DEF**
Relay Outputs:	**DEF AIDED TRIP, DEF PROTECTION**