# 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

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| 2010/02 | Document reformat due to rebrand |
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# Contents

# 1 Introduction

The Ohmega family of Digital Distance Relays give full scheme protection with independent measurements for every zone and fault loop. Impedance starting elements are not required. Optional features provide a full range of protection functions supplements by control, metering, data storage and fibre optic data communication capabilities.

The relays can be applied to either overhead line or cable feeders and, depending on the availability and type of teleprotection channels available, can be configured to provide unit protection in a number of different models.

# 2 Current Transformer Requirements

The current transformers used with Ohmega relays should be class TPS to IEC 46-6 (ie BS3938 class x). The CT's should have a knee point voltage Vk as follows:-

Phase Fault

$$V_k \geq K.\frac{I_p}{N}\left(1 + \frac{X_p}{R_p}\right)(0.03 + R_{ct} + R_l)$$

Earth Fault

$$V_k \geq K.\frac{I_e}{N}\left(1 + \frac{X_e}{R_e}\right)(0.06 + R_{ct} + 2R_l)$$

Where:

$I_p$ = phase fault current calculated for $X_p/R_p$ ratio at the end of zone 1.

$I_e$ = earth fault current calculated for $X_e/R_e$ ratio at the end of zone 1.

N = C.T. ratio

$X_p/R_p$ = power system resistance to reactance ratio for the total plant including the feeder line parameters calculated for a phase fault at the end of zone 1.

$X_e/R_e$ = similar ratio to above but calculated for an earth fault at the end of zone 1.

$R_{ct}$ = C.T. internal resistance

$R_l$ = lead burden, C.T. to Ohmega terminals

K = factor chosen to ensure adequate operating speed and is <1. K is usually 0.5 for distribution systems, a higher value is chosen for primary transmission systems. Reyrolle Protection should be consulted.

Both $V_k$ values should be calculated and the higher value chosen for the C.T. to be used.

# 3 Determination Of Relay Settings

## 3.1 Information Required For The Setting Calculations

To match a distance protection relay to a feeder the following data must be known:-

- Positive sequence of the feeder Z1 ohm/km
- Zero sequence impedance of the feeder Zo ohms/km
- Length of protected feeder
- Maximum and minimum fault current infeed at relaying point
- Current transformer ratio
- Voltage transformer ratio
- Length of adjacent lines which are partially or wholly included within the Zone 2, 3 or 4
- The position, rating and reactance of any power transformers connected to the system within the zone 4 forward and reverse impedance reach.
- Fault current infeeds at tee-off points or remote substations
- Fault clearance time on circuits within the Zone 2 and Zone 3 and Zone 4 impedance reaches
- Maximum load current
- Phase angle of line impedance
- Maximum residual capacitance current at the relaying points for earth faults in adjacent circuits
- Minimum residual current available to operate the earth fault detector

## 3.2 Distance Protection Settings

The first settings in the menu are common for all zones. The relay will use a time-stepped scheme by default. All relay schemes are detailed in Section 3 of this manual.

### 3.2.1 Overall Settings

The first settings made in the distance protection menu apply to all zones of protection. The CT secondary, is set as set as 1A, 2A or 5A depending on the CT rating. The line angle is the angle of the positive sequence impedance of the feeder.

### 3.2.2 Residual Compensation Settings.

The Zone reach settings for each zone of protection are made in terms of the positive sequence impedance of the transmission line. To allow the earth fault comparators to correctly take account of the fault loop impedance, the ratio of voltage to current is multiplied by a factor of $K_N$+1, where $K_N$ is the Residual Compensation Factor, which may be determined from the following equation;

$$K_N = \frac{1}{3}\left(\frac{Z_0}{Z_1} - 1\right)$$

Settings made on the relay are:

EF Comp Z0/Z1 ratio. This is simply the ratio between the zero and positive sequence impedances.

EF Comp Z0 Angle. This is simply the angle of the zero sequence impedance.

The relay automatically calculates the residual compensation from these two settings.

## 3.3 Zone 1 setting

Normal practice is to make the Zone 1 setting equal to 80% of the positive sequence impedance of the protected feeder to allow for the inherent errors in estimating line impedance's and possible errors in voltage and current transformers.

Settings other than 80% are possible, but to ensure that the relay does not overreach into the remote busbars, care is necessary when choosing such settings. It is particularly important to ensure that the impedance of the protected feeder is accurately known and the mutual effects due to adjacent feeders are considered for all known operating conditions. On a teed-feeder the Zone 1 impedance setting should be approximately 80% of the positive sequence impedance from the relaying point to the nearer of the remote ends.

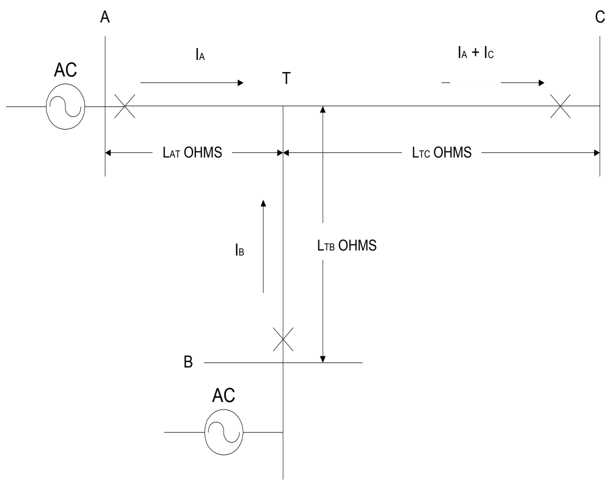
On lines with tee-off transformers connected to them, the Zone 1 setting can extend beyond the tee-off point, provided it does not reach beyond the windings of any transformer. If a transformer is earthed on the line side, it can supply zero sequence current which is equivalent to an infeed, and should be considered when choosing the Zone 1 setting.

On feeder transformers, Zone 1 should be set to cover at least 1.2 times the positive sequence impedance of the feeder. It should not, however, exceed 0.8 times the sum of the feeder impedance and the transformer impedance.
Having decided upon the impedance setting required, the relay setting is determined as follows:- Zone 1 Setting = $L_1 \times C/V$

where: $L_1$ = required Zone 1 reach in primary positive sequence ohms.
C = protection current transformer ratio
V = protection voltage transformer ratio

## 3.4 Zone 2 Setting

Zone 2 setting should be at least 1.2 times the positive sequence impedance of the protected feeder. For teed feeders the setting should be at least 1.2 times the impedance to the most remote end, the effect of infeeds at the tee points being allowed for as shown in choose the setting for maximum infeeds, but take care it does not encroach onto the second zone of distance protection of adjacent feeders for minimum fault infeed conditions.




On lines with tee-off transformers connected to them, the tee-off transformers can supply zero sequence current if they are earthed on the line side. This is equivalent to an infeed as indicated and must be taken into account when choosing the Zone 2 setting. Normally the Zone 2 reach will be set so that it does not extend beyond a power transformer, but should a particular application require an extended reach of this nature, then care should be taken to grade the protection accordingly.

The Zone 2 setting is obtained by adjusting the impedance setting.

$$Zone2\ Setting\ at\ A \geq 1.2\left[L_{AT} + L_{TC}\left(\frac{I_A + I_B}{I_A}\right)\right]$$

## 3.5 Zone 3 Setting

The Zone 3 setting will depend upon the system adjacent to the protected feeder and the amount of back-up protection required. To give back-up protection on the protected feeder, the Z3 should be at least equal to and not less than the Z2 setting.

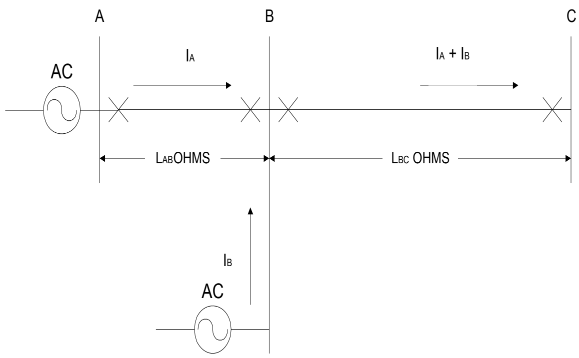
The Zone 2 and Zone 3 timers are normally set to give a grading margin between the zones.

On lines with tee-off transformers, the transformers can supply zero sequence current if they are earthed on the line side. This is equivalent to an infeed as indicated in and should be considered when choosing the Zone 3 setting. Care should be taken to grade the Zone 3 setting with the rest of the system.

As with Zone 2, the Zone 3 reach will normally be set so that it does not extend beyond a power transformer, however if a particular application requires an extension of reach beyond a transformer then the protection should be graded accordingly.

The Zone3 setting is obtained by adjustment of the impedance range.
The characteristic of the zone 3 allows for a reverse reach setting which is adjustable and this is programmed as a secondary impedance.

$$Zone\ 3\ Setting\ at\ A \geq 1.2\left[L_{AB} + L_{BC}\left(\frac{I_A + I_B}{I_A}\right)\right]$$




## 3.6 Zone 4 Setting

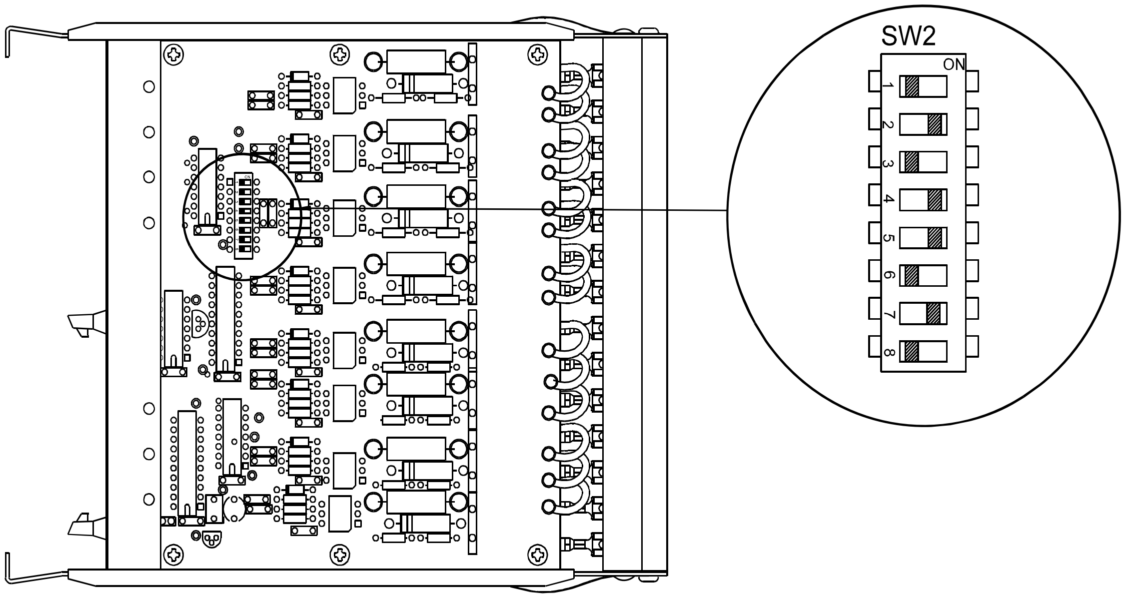
The Zone 4 setting has an independent impedance range the line angle is the mirror image of the forward angle and is not selectable. The Zone 4 impedance element can be used to directly trip the relay or it can be used with the scheme logic to provide reverse looking schemes.

**APPENDIX A Status Inputs**

As stated in the “Performance Specification”, status inputs used for protection signalling are high speed devices with operating times of under 5ms.  As supplied, all status inputs are of this type.

Should the user require any status input to meet the requirements of ESI 48-4-1, i.e. to have high stability in the presence of spurious signals, the relevant status input module should be withdrawn from the relay case and the DIL switch for the desired inputs changed. “Slow” status inputs operate only once a capacitor has discharged and have an inherent pickup delay of 20ms.




Note: Switch SW2 controls 8 status inputs. As supplied, all switches are in the left hand position and all status inputs are high speed devices.
For high stability use, the relevant switch should be moved to the right hand position as shown for switches 2, 4, 5 & 7.