REL 350
AN-85L-01

Application Note

Substation Automation and Protection Division

Influence of The Equal and Unequal CT Ratios On The Setting of REL 350 Relays

Introduction

This application note will show how to calculate and pick the settings on the relay for the general application case, both CT at the two line end have the equal CT ratio, and CT's at two line ends have unequal ratios.

Application

Consider the line that is protected with REL350 relays at both ends like in Fig. 1

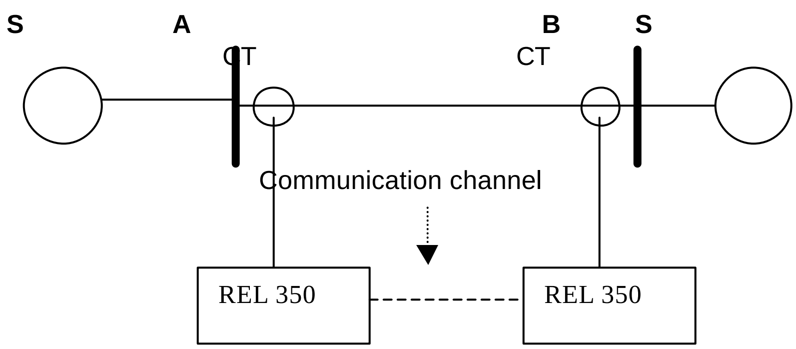

Figure 1 – Power system example for setting

The data that will be used in setting calculation is as follows:

L: Line of 30 miles length, positive and negative impedance is 24 Ohm and zero impedance is 82 Ohm.
The charging current of the line is 25 A primary.
S: system with nominal voltage 115kV

For the given load of 37 MVA, nominal load current is:

$$I_n = \frac{S_n}{\sqrt{3} * U_n} = \frac{37{,}000}{\sqrt{3} * 115} = 185.76A$$

Select current transformer with rated primary value of 200 A and rated secondary value of 5 A.

1) Current Transformers with equal CT ratio

For the phase subsystem (phase A, B, C) and ground subsystem, the local and remote keying levels must be the same at both line ends.

The recommended keyer levels are RPKY=LPKY=3.0A (See I.L.40-201.82, section 5.5.5).
Considering the maximum line load of the 37MVA, keyer level set value should be accordingly adjusted

$$RPKY = LPKY = 3 * \frac{185.76}{200} = 2.78A$$ **Set RPKY=LPKY=2.80A**

The line charging current is:

$$ICH = \frac{25A}{R_c} = \frac{25}{40} = 0.625A$$

In order to avoid misoperation of the protective system during external faults, local square wave thresholds (ISWP, ISWN) are slightly separated by the amount (PDIF) depending on the line charging current.
Take PDIF=1A (section 5.5.5.1.3). That value must be also accordingly adjusted as:

$$1 * \frac{185.76}{200} = 0.93A$$ **Set PDIF=0.9A**

The low set overcurrent, IPL, should be set at 1.5 ICH or 0.5 A, which ever is maximum.

$$IPL = 1.5 * 0.625 = 0.94A$$ **Set IPL=0.9A**

For the ground subsystem, for both terminals, the keyer levels are:

$$RGKY = LGKY = 2 * \frac{185.76}{200} = 1.86A$$ **Set RGKY=LGKY=1.9A**

GDIF setting again on the charging current of the line:

$$GDIF = 1 * \frac{185.76}{200} = 0.93$$ **Set GDIF=0.9A**

The low set overcurrent IGL should be set above the maximum expected unbalance in the system. Let's suppose that maximum expected unbalance in the system is 20A, converting to the secondary side 20/40=0.5A

IGL=0.5A

2) Current Transformers with different CT ratio

Let us suppose that CT at end A has the unchanged ratio 200/5 but CT at end B has ratio 400/5. In order not to have unselective trip, some modification in setting **must be done** at both line ends. Coefficient to adjust settings **at both line ends** is:

$$K = \frac{1}{\frac{higher\ CT\ ratio}{lower\ CT\ ratio}}$$

In our case the coefficient is:

$$K = \frac{1}{\frac{400}{200}} = 0.5$$

Recalculated setting values are:

$$RPKY = LPKY = 3 * \frac{185.76}{200} * K = 1.40A$$ **Set RPKY=LPKY=1.40A**

$$PDIF = 1 * \frac{185.76}{200} * K = 0.46A$$ **Set PDIF=0.5A**

$$RGKY = LGKY = 2 * \frac{185.76}{200} * K = 0.93A$$ **Set RGKY=LGKY=0.9A**

$$GDIF = 1 * \frac{185.76}{200} * K = 0.46A$$ **Set GDIF=0.5A**

If the CT ratio difference is less than 67% at both line ends (ex.1000/5 and 1500/5 where difference is 50%), it is not possible to see the operation of the relays during the full load current. "Misoperation" caused by different CT ratio could be manifested during the external faults. So it is strongly recommended to check current metering values at both line ends during the full load current. **They must be the same!**

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