ALPS Series Compensation Calculations for Non-Standard PTs

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CALCULATIONS

For ALPS and LPS-D relays with series-compensation, the manual shows the protective levels of series capacitors as determined by the following formula:

$$PL_t = \frac{1}{95}\sum_1^n PL_n \qquad \text{(EQ 1)}$$

The value for PL_n is the gap flashing/MOV protective level in peak phase-to-neutral volts for each compensation capacitor. The value for PL_t equals the sum of the protection level of all capacitors in series to the fault, divided by the maximum peak line-to-neutral voltage PT_m, which is

$$\frac{115\ \text{V}}{\sqrt{3}} \times \sqrt{2}\ \text{V} = 95\ \text{pu V} \qquad \text{(EQ 2)}$$

for a standard 115 V PT.

The PL_t should thus be calculated as follows:

$$PL_t = \frac{1}{PT_m}\sum_1^n PL_n \qquad \text{(EQ 3)}$$

where

$$PT_m = \frac{PT_{\text{L-L sec. volts}}}{\sqrt{3}} \times \sqrt{2} \qquad \text{(EQ 4)}$$

The values for **Z1PLEVDET** and **Z1GLEVDET**, are, like PL_t, in pu as follows:

$$\textbf{Z1PLEVDET} = \sqrt{0.15 + 1.3\,PL_t^2} \quad \text{and} \quad \textbf{Z1GLEVDET} = \sqrt{0.15 + PL_t^2} \qquad \text{(EQ 5)}$$

EXAMPLE

Consider a system with the following series capacitor and CVT values:

- series capacitor impedance: 29.92 Ω
- series capacitor rating current: 2360 A
- protective level of MOV and gaps: 230 kV peak value
- CVT ratio: 500000 / 100 V

In this case, since there is only one capacitor, only one protective level PL_1 need be considered. We have:

$$PT_m = \frac{PT_{\text{L-L sec. volts}}}{\sqrt{3}} \times \sqrt{2} = \frac{100 \text{ V}}{\sqrt{3}} \times \sqrt{2} \approx 82 \text{ V} \qquad \text{(EQ 6)}$$

and

$$PL_1 = \frac{\text{MOV Protective Level}}{\text{PT Ratio}} = \frac{230 \text{ kV}}{500000 / 100} = 46 \text{ V} \qquad \text{(EQ 7)}$$

and, since there is only one protective level PL_1:

$$PL_t = \frac{1}{PT_m} \sum_1^n PL_n = \frac{1}{46 \text{ V}} \times 82 \text{ V} = 0.56 \text{ pu} \qquad \text{(EQ 8)}$$

Therefore, the phase and ground level detector settings are:

$$\textbf{Z1PLEVDET} = \sqrt{0.15 + 1.3 PL_t^2} = \sqrt{0.15 + 1.3 \times (0.56)^2} = 0.75 \qquad \text{(EQ 9)}$$

$$\textbf{Z1GLEVDET} = \sqrt{0.15 + PL_t^2} = \sqrt{0.15 + (0.56)^2} = 0.68 \qquad \text{(EQ 10)}$$