Application Note

Differential Tap Settings

Introduction

Current differential relaying is the measure of the current flowing into a protected zone and the current flowing out of the protected zone. The power through a zone theoretically matches exactly (sum to zero). If it does not, there is a fault (or something else) within the protected zone creating a mismatch. This mismatch in current is called the Differential Current or the Operate Current.

When the zone of protection includes a transformer, there is a healthy source of magnitude mismatch that must be accounted for since the transformer scales the voltage and current and so changes both in magnitude. This variation leads to an imbalance in the currents, and, when unaccounted for, it can cause a differential relay to misinterpret this as a fault. Tap settings are used to scale the currents for this known condition.

BE1-FLEX Solution

To handle variances in CT ratios and current magnitude variances when a power transformer is in the protected zone, the measured currents must be tap-adjusted to eliminate magnitude mismatch prior to being used by the Phase Differential Protection (87) element.

The tap adjust factors can be manually calculated per the equation in Figure 1, or the user can enter the MVA and kV base parameters as seen in Table 1. After entering the appropriate parameters, the BE1-FLEX will calculate the tap-adjust factors using CT Ratio (CTR) and Compensation Factor (COMP) parameters from the Power System CT Setup settings. For a transformer application, the mismatch will be at a minimum if the actual transformer voltage ratings are used. If the transformer has a load tap changer, the voltage rating at the middle of the adjustment range should be used.

$$TAPn = \frac{MVA \times 1000 \times COMPn}{\sqrt{3} \times kVn \times CTRn}$$

Figure 1 - Manual Tap Calculation

Table 1 - Base Parameters for TAP Calculation

Parameter	Description	Explanation
Tapn	Restraint Winding	Tap per Circuit/Virtual Circuit used in the zone.
MVA	MVA base	Full load MVA or top rating of the protected equipment.
kVn	kV base for Circuit/Virtual Circuit n	L-L Voltage in kV for each Circuit/Virtual Circuit.
CTRn	CT ratio for Circuit/Virtual Circuit n	Actual ratio not effective ratio.
COMPn	Phase compensation adjustment factor for Circuit/Virtual Circuit n	√3 if CTs are connected in Delta (CT connection = DAB or DAC). 1 in all other cases. See the *Power System Configuration* chapter in the BE1-FLEX instruction manual.

The BE1-FLEX can accommodate a large, but not infinite, mismatch in sensed currents. The sensed currents can be tap adjusted up to a spread ratio of 50:1. If the ratio between the largest and smallest taps are greater than 50, it will be necessary to adjust the CT ratios to bring the tap factors closer together. When the auto tap calculation feature is used, the BE1-FLEX will give an error message if the spread ratio is greater than 50.

If one of the calculated taps is outside the acceptable range (0.4 to 20 A), the auto-tap calculation feature will select the nearest acceptable tap and calculate the other tap (two at a time) so that the correct spread ratio is maintained. If the user is manually calculating the taps, the same adjustment should be made.

BESTCOMS*Plus*® is used to provide auto tap calculation by filling in MVA and kVA on the Differential Zone Setup screen as shown in red circles. See Figure 2. It pulls the CT ratio and connections shown by the blue circles from the "Power Systems" settings. Pressing "Calculate Taps" will then fill in the "Tap Setting" from each circuit.

For More Information

For detailed information on the BE1-FLEX, please visit the Basler Electric website at www.basler.com to download product bulletins, instruction manuals, and BESTCOMS*Plus*® software. You can contact Basler's technical support or application specialists at +1 618.654.2341 or by email to info@basler.com.

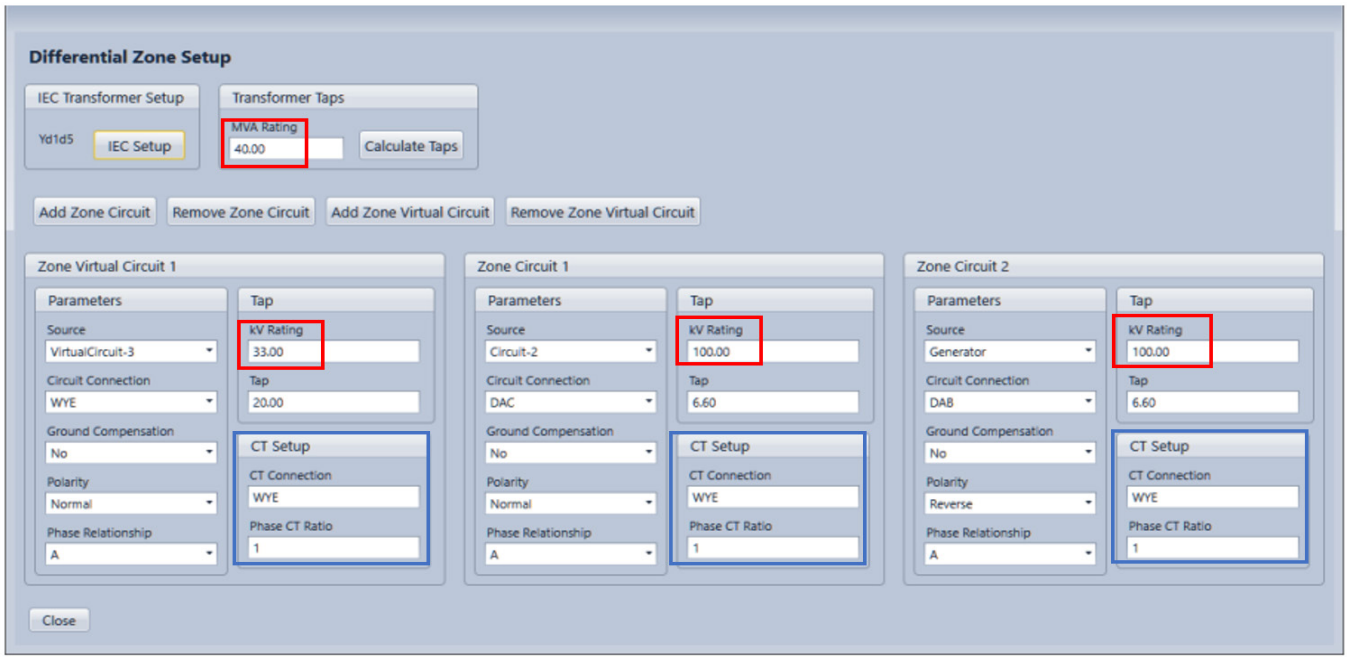

Figure 2 - BESTCOMS*Plus*® Differential Zone Setup Screen

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