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T60 Restricted Ground Fault Protection Calculation Examples

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This document outlines ground fault protection calculations for the GE Universal Relay (UR) T60 Transformer Protection System.

Introduction

The T60 is equipped with a number of Restricted Ground Fault (RGF) protection elements.

The RGF element uses a novel algorithm where the restraint current is a maximum of pre-calculated values based on positive, negative, and zero-sequence symmetrical components derived from measured winding phase currents. The actual ratio of the ground differential and restraint currents then is compared to the quantity formed by the pickup and a single slope RGF characteristic.

Examples of calculations follow.

Impedance-grounded transformer

Consider an impedance-grounded transformer with the following nameplate data:

- Transformer type — Delta/Wye 30°
- Rated MVA — 10 MVA
- Nominal phase-phase voltage — 33 kV (Winding 1) / 11 kV (Winding 2)
- Phase and Neutral CT ratios — 600:5
- Impedance — 10%
- Winding neutral grounded through resistance — $R_g = 6.3\ \Omega$

The rated load current of the Wye connected winding is calculated as

$$I_{rated} = \frac{\text{Rated MVA}}{\sqrt{3} \times \text{Winding 2 Nominal Voltage}} = \frac{10\text{ MVA}}{\sqrt{3} \times 11\text{ kV}} = 525\text{ A} \qquad \textbf{Eq. 1}$$

The maximum phase-to-ground primary fault current is calculated as

$$I_{gf(max)} = \frac{\text{Winding 2 Nominal Voltage}}{\sqrt{3} R_g} = \frac{11\text{ kV}}{\sqrt{3} \times 6.3\ \Omega} = 1000\text{ A} \qquad \textbf{Eq. 2}$$

For a winding fault point at 5% distance from the transformer neutral, the phase-to-ground primary fault current is calculated as

$$I_{fault} = 0.05 \times I_{gf(max)} = 50\ A \quad \textbf{Eq. 3}$$

Increases in phase current (I_{ph}) due to the fault are negligible, meaning that $3I_0 \approx 0$.

The ground differential pickup setting can be calculated as

$$I_{GD} = \left|3\vec{I_0} - \vec{I_g}\right| = \left|0 - \frac{I_{fault}}{\text{Phase CT Primary}}\right| = \frac{50\ A}{600} = 0.08\ \text{pu} \quad \textbf{Eq. 4}$$

Note that phase CT primary is used as a unit for calculating the RGF settings. Hence, magnitude scaling is applied to the measured ground current.

The restraint calculation algorithm provides very secure behavior of the element on external faults and CT saturation, and high sensitivity on internal faults. The setting of the slope is selected based on the following two criteria:

- Reliable detection of the internal fault currents corresponding to the point of the selected distance from the grounded neutral
- Security on external faults with or without CT saturation

Internal ground fault

Let us consider the case of an internal ground fault that occurs in the winding at 5% distance from the transformer neutral. According to the data from the example, the primary fault current of 50 A is

$$I_G = 0.08\ \text{pu} \quad \textbf{Eq. 5}$$

Based on 100% transformer load currents of 525 A on the Wye winding, the phase unit currents are

$$I_A = I_B = I_C = 0.875\ \text{pu} \quad \textbf{Eq. 6}$$

and the symmetrical components are

$$I\_1 = 0.875\ \text{pu}; \quad I\_2 = I\_0 = 0\ \text{pu} \quad \textbf{Eq. 7}$$

The ground differential current is calculated according to the following equation:

$$I_{GD} = \left|\vec{I_G} + \vec{I_N}\right| = 0.08\ \text{pu} + 0\ \text{pu} = 0.08\ \text{pu} \quad \textbf{Eq. 8}$$

The restraint current used by the relay algorithm is defined as the maximum from the IR1, IR2, IR0 quantities, based on the following symmetrical components calculations:

$$I_{GR} = \max(IR1, IR2, IR0) \quad \textbf{Eq. 9}$$

The value of IR1 is calculated using the positive-sequence current as follows:

$$\begin{array}{c}\text{If } |I\_1| > 2 \text{ pu of phase CT, and } |I\_1| > |I\_0|\text{, then } IR1 = 3 \times (|I\_1| - |I\_0|) \\ \text{else } IR1 = 0\end{array} \quad \textbf{Eq. 10}$$

However, if $|I\_1| < 1.5$ pu, then $IR1 = \frac{|I\_1|}{8}$.

The value of IR2 is calculated using the negative-sequence current.

In this case, $IR2 = |I\_2|$ for the first two cycles, following complete de-energization of the winding (all three phase currents below 5% of nominal for at least five cycles). Otherwise, $IR2 = 3 \times |I\_2|$.

The value of IR0 is calculated using the zero-sequence current

$$IR0 = |I_G - I_N| = |I_G - (I_A + I_B + I_C)| \quad \textbf{Eq. 11}$$

Applying these formulas to our example gives us the following values:

$$IR1 = \frac{|I\_1|}{8} = \frac{0.875\text{ pu}}{8} = 0.109\text{ pu (since }|I\_1| < 1.5\text{ pu)} \quad \textbf{Eq. 12}$$

$$IR2 = 3 \times |I\_2| = 3 \times 0\text{ pu} = 0 \quad \textbf{Eq. 13}$$

$$IR0 = \left|\vec{I_G} - \vec{I_N}\right| = |0.08\text{ pu} - 0| = 0.08\text{ pu} \quad \textbf{Eq. 14}$$

Therefore, the ground differential current is

$$I_{GD} = \left|\vec{I_G} + \vec{I_N}\right| = |0.08\text{ pu} + 0| = 0.08\text{ pu} \quad \textbf{Eq. 15}$$

and the ground restraint current is

$$I_{GR} = \max(I_{R1}, I_{R2}, I_{R0}) = \max(0.109\text{ pu}, 0, 0.08\text{ pu}) = 0.109\text{ pu} \quad \textbf{Eq. 16}$$

The RGF element therefore calculates a ground differential/restraint ratio of

$$\frac{I_{GD}}{I_{GR}} \times 100\% = \frac{0.08\text{ pu}}{0.109\text{ pu}} \times 100\% = 73\% \quad \textbf{Eq. 17}$$

Thus, the slope should be set at some level below 73%.

Ideally, if no CT saturation is involved, the RGF protection detects no differential current during ground faults that are external to the zone. However, the RGF slope setting should also be selected to maintain the security on external faults with CT saturation.

External solid phase A to ground fault with no CT saturation

Consider an external solid phase a to ground fault with no CT saturation. Given the following currents and corresponding secondary values:

Primary currents	Secondary values
$I_A = 1000$ A	$I_A = 1000/600 = 1.67\text{ pu} \angle 0°$
$I_B = 0$ A	$I_B = 0$ pu
$I_C = 0$ A	$I_C = 0$ pu
$I_N = 1000$ A	$I_N = 1000/600 = 1.67\text{ pu} \angle 0°$
$I_G = 1000$ A	$I_G = 1000/600 = 1.67\text{ pu} \angle 180°$

The symmetrical components derived from the phase unit currents are

$$I\_1 = I\_2 = I\_0 = 0.557\text{ pu} \quad \textbf{Eq. 18}$$

The ground differential current is

$$I_{GD} = \left|\vec{I_G} + \vec{I_N}\right| = 1.67\text{ pu}\angle 0° + 1.67\text{ pu}\angle 180° = 0\text{ pu} \quad \textbf{Eq. 19}$$

The IR1, IR2, and IR0 currents are

$$IR1 = \frac{|I\_1|}{8} = \frac{0.557\text{ pu}}{8} = 0.07\text{ pu} \quad \textbf{Eq. 20}$$

$$IR2 = 3 \times |I\_2| = 3 \times 0.557\text{ pu} = 1.67\text{ pu} \quad \textbf{Eq. 21}$$

$$IR0 = \left|\vec{I_G} - \vec{I_N}\right| = |1.67\text{ pu}\angle 180° - 1.67\text{ pu}\angle 0°| = 3.34\text{ pu} \quad \textbf{Eq. 22}$$

The restraint current is the maximum of the three currents IR1, IR2, and IR0 as follows:

$$I_{GR} = \max(IR1, IR2, IR0) = 3.34\text{ pu} \quad \textbf{Eq. 23}$$

Therefore

$$\frac{I_{GD}}{I_{GR}} \times 100\% = \frac{0 \text{ pu}}{3.34 \text{ pu}} \times 100\% = 0\% \qquad \textbf{Eq. 24}$$

and the protection element is effectively in a non-operating stage.

External phase A to ground fault with saturation on the ground CT

Consider an external phase A to ground fault where the ground CT saturates as a result, producing only 5% of the total fault current on its secondary winding. As per the previous example, the phase fault currents (primary and secondary) are given as follows:

Primary currents	Secondary values
I_A = 1000 A	I_A = 1000/600 = 1.67 pu ∠0°
I_B = 0 A	I_B = 0 pu
I_C = 0 A	I_C = 0 pu
I_N = 1000 A	I_N = 1000/600 = 1.67 pu ∠0°
I_G = 50 A	I_G = 0.05 x 1000/600 = 0.0835 pu ∠180°

The symmetrical components derived from the secondary phase currents are

$$I\_1 = I\_2 = I\_0 = 0.557 \text{ pu} \qquad \textbf{Eq. 25}$$

The differential ground current is calculated as

$$I_{GD} = \left|\vec{I_G} + \vec{I_N}\right| = 1.67 \text{ pu}\angle 0° + 0.0835 \text{ pu}\angle 180° = 1.587 \text{ pu} \qquad \textbf{Eq. 26}$$

The IR1, IR2, and IR0 currents are

$$IR1 = \frac{|I\_1|}{8} = \frac{0.557 \text{ pu}}{8} = 0.07 \text{ pu} \qquad \textbf{Eq. 27}$$

$$IR2 = 3 \times |I\_2| = 3 \times 0.557 \text{ pu} = 1.67 \text{ pu} \qquad \textbf{Eq. 28}$$

$$IR0 = \left|\vec{I_G} - \vec{I_N}\right| = |0.0835 \text{ pu}\angle 180° - 1.67 \text{ pu}\angle 0°| = 1.753 \text{ pu} \qquad \textbf{Eq. 29}$$

The restraint current is the maximum of the three currents IR1, IR2, and IR0 as follows:

$$I_{GR} = \max(IR1, IR2, IR0) = 1.753 \text{ pu} \qquad \textbf{Eq. 30}$$

Therefore

$$\frac{I_{GD}}{I_{GR}} \times 100\% = \frac{1.587 \text{ pu}}{1.753 \text{ pu}} \times 100\% = 90.5\% \qquad \textbf{Eq. 31}$$

This is well above the restraint characteristic in the operating region if no special treatment to the restraint is provided.

For cases of CT saturation and switch-off conditions, the ground restraint I_{GR} is set to decay slowly. Since the CTs do not immediately saturate at the same instant the fault occurs, the restraint current is equal to the initial fault current value of 3.34 pu (as in the no-saturation case). The restraint drops to 50% of its original value after 15.5 cycles, so that if the worst case of saturation occurs after a cycle, the restraint current is approximately 3.23 pu, giving the following ratio:

$$\frac{I_{GD}}{I_{GR}} \times 100\% = \frac{1.587 \text{ pu}}{3.23 \text{ pu}} \times 100\% = 49\% \qquad \textbf{Eq. 32}$$

During CT saturation differential current will be increasing gradually and restraint decreasing gradually as CT enters into saturation. This calculations shows that due to memory effect of the restraint current in RGF element, the relay will use the higher restraint value and the application remains secure.

Solidly grounded transformer

Consider a solidly grounded transformer with the following nameplate data:

- Transformer type — Delta/Wye 30°
- Rated MVA — 10 MVA
- Nominal phase-phase voltage — 33 kV (Winding 1) / 11 kV (Winding 2)
- Phase and Neutral CT ratios — 600:5
- Impedance — 10%

The rated load current of the Wye connected winding is calculated as

$$I_{rated} = \frac{\text{Rated MVA}}{\sqrt{3} \times \text{Winding 2 Nominal Voltage}} = \frac{10\text{ MVA}}{\sqrt{3} \times 11\text{ kV}} = 525\text{ A} \quad \textbf{Eq. 33}$$

The maximum phase-to-ground primary fault current is calculated as

$$If(max) = \frac{\text{Rated MVA}}{\sqrt{3} \times \text{W2 Nominal Voltage} \times \%\text{ Impedance}} = \frac{10\text{ MVA}}{\sqrt{3} \times 11\text{ kV} \times 10\%} = 5248\text{ A} \quad \textbf{Eq. 34}$$

For a winding fault point at 5% distance from the transformer neutral, the phase-to-ground primary fault current is calculated as

$$I_{fault} = 0.05 \times I_{gf(max)} = 262\text{ A} \quad \textbf{Eq. 35}$$

Increases in phase current (Iph) due to the fault are negligible, meaning that $3I_0 \approx 0$. The ground differential pickup setting can be calculated as

$$I_{GD} = \left|3\overline{I_0} - \overline{I_g}\right| = \left|0 - \frac{I_{fault}}{\text{Phase CT Primary}}\right| = \frac{262\text{ A}}{600} = 0.437\text{ pu} \quad \textbf{Eq. 36}$$

Note that phase CT primary is used as a unit for calculating the RGF settings. Hence, magnitude scaling is applied to the measured ground current.

The restraint calculation algorithm provides very secure behavior of the element on external faults and CT saturation, and high sensitivity on internal faults. The setting of the slope is selected based on the following two criteria:

- Reliable detection of the internal fault currents corresponding to the point of the selected distance from the grounded neutral
- Security on external faults with or without CT saturation

Internal ground fault

Let us consider the case of an internal ground fault that occurs on in the winding at 5% distance from the transformer neutral. According to the data from the example, the primary fault current of 262 A is

$$I_G = 0.437\text{ pu} \quad \textbf{Eq. 37}$$

Based on 100% transformer load currents of 525 A on the Wye winding, the phase unit currents are

$$I_A = I_B = I_C = 0.875\text{ pu} \quad \textbf{Eq. 38}$$

and the symmetrical components are

$$I\_1 = 0.875\text{ pu; } I\_2 = I\_0 = 0\text{ pu} \quad \textbf{Eq. 39}$$

The ground differential current is calculated according to the following equation:

$$I_{GD} = \left|\vec{I_G} + \vec{I_N}\right| = 0.437\text{ pu} + 0\text{ pu} = 0.437\text{ pu} \quad \textbf{Eq. 40}$$

The restraint current used by the relay algorithm is defined as the maximum from the IR1, IR2, IR0 quantities, based on the following symmetrical components calculations:

$$I_{GR} = \max(IR1, IR2, IR0) \quad \textbf{Eq. 41}$$

The value of IR1 is calculated using the positive-sequence current as follows:

$$\text{If } |I\_1| > 1.5 \text{ pu of phase CT, and } |I\_1| > |I\_0|, \text{ then } IR1 = 3 \times (|I\_1| - |I\_0|) \text{ else } IR1 = 0 \quad \textbf{Eq. 42}$$

However, if

$$|I\_1| < 1.5 \text{ pu, then } IR1 = \frac{|I\_1|}{8} \quad \textbf{Eq. 43}$$

The value of IR2 is calculated using the negative-sequence current.

In this case, IR2 = |I_2| for the first two cycles, following complete de-energization of the winding (all three phase currents below 5% of nominal for at least five cycles). Otherwise, IR2 = 3 x |I_2|.

The value of IR0 is calculated using the zero-sequence current

$$IR0 = |I_G - I_N| = |I_G - (I_A + I_B + I_C)| \quad \textbf{Eq. 44}$$

Applying these formulas to our example gives us the following values:

$$IR1 = \frac{|I\_1|}{8} = \frac{0.875 \text{ pu}}{8} = 0.109 \text{ pu (since } |I\_1| < 1.5 \text{ pu)} \quad \textbf{Eq. 45}$$

$$IR2 = 3 \times |1\_2| = 3 \times 0 \text{ pu} = 0 \quad \textbf{Eq. 46}$$

$$IR0 = \left|\vec{I_G} - \vec{I_N}\right| = |0.437 \text{ pu} - 0| = 0.437 \text{ pu} \quad \textbf{Eq. 47}$$

Therefore, the ground differential current is

$$I_{GD} = \left|\vec{I_G} + \vec{I_N}\right| = |0.437 \text{ pu} + 0| = 0.437 \text{ pu} \quad \textbf{Eq. 48}$$

and the ground restraint current is

$$I_{GR} = \max(I_{R1}, I_{R2}, I_{R0}) = \max 0.109 \text{ pu}, 0, 0.437 \text{ pu} = 0.437 \text{ pu} \quad \textbf{Eq. 49}$$

The RGF element therefore calculates a ground differential/restraint ratio of

$$\frac{I_{GD}}{I_{GR}} \times 100\% = \frac{0.437 \text{ pu}}{0.437 \text{ pu}} \times 100\% = 100\% \quad \textbf{Eq. 50}$$

Thus, the slope should be set at some level below 100%, say 70%.

Ideally, if no CT saturation is involved, the RGF protection detects no differential current during ground faults that are external to the zone. However, the RGF slope setting also should be selected to maintain the security on external faults with CT saturation.

External solid phase A to ground fault with no CT saturation

Consider an external solid phase a to ground fault with no CT saturation. Given the following currents and corresponding secondary values.

Primary currents	Secondary values
I_A = 5248 A	I_A = 5248/600 = 8.74 pu $\angle 0°$
I_B = 0 A	I_B = 0 pu
I_C = 0 A	I_C = 0 pu
I_N = 5248 A	I_N = 5248/600 = 8.74 pu $\angle 0°$
I_G = 5248 A	I_G = 5248/600 = 8.74 pu $\angle 180°$

The symmetrical components derived from the phase unit currents are

$$I\_1 = I\_2 = I\_0 = 2.913 \text{ pu} \quad \textbf{Eq. 51}$$

The ground differential current is

$$I_{GD} = \left|\vec{I_G} + \vec{I_N}\right| = 8.74 \text{ pu } \angle 0° + 8.74 \text{ pu } \angle 180° = 0 \text{ pu} \quad \textbf{Eq. 52}$$

The IR1, IR2, and IR0 currents are

$$IR1 = 0 \qquad \textbf{Eq. 53}$$

$$IR2 = 3 \times |I\_2| = 3 \times 2.913 \text{ pu} = 8.74 \text{ pu} \qquad \textbf{Eq. 54}$$

$$IR0 = \left|\vec{I_G} - \vec{I_N}\right| = |8.74 \text{ pu } \angle 180° - 8.74 \text{ pu } \angle 0°| = 17.48 \text{ pu} \qquad \textbf{Eq. 55}$$

The restraint current is the maximum of the three currents IR1, IR2, and IR0 as follows:

$$I_{GR} = \max(IR1, IR2, IR0) = 17.48 \text{ pu} \qquad \textbf{Eq. 56}$$

Therefore

$$\frac{I_{GD}}{I_{GR}} \times 100\% = \frac{0 \text{ pu}}{17.48 \text{ pu}} \times 100\% = 0\% \qquad \textbf{Eq. 57}$$

and the protection element is effectively in a non-operating stage.

External phase A to ground fault with saturation on the ground CT

Consider an external phase A to ground fault where the ground CT saturates as a result, producing only 5% of the total fault current on its secondary winding. As per the previous example, the phase fault currents (primary and secondary) are given as follows.

Primary currents	Secondary values
$I_A = 5248$ A	$I_A = 5248/600 = 8.74 \text{ pu } \angle 0°$
$I_B = 0$ A	$I_B = 0$ pu
$I_C = 0$ A	$I_C = 0$ pu
$I_N = 5248$ A	$I_N = 5248/600 = 8.74 \text{ pu } \angle 0°$
$I_G = 262$ A	$I_G = 0.05 \times 5248/600 = 0.437 \text{ pu } \angle 180°$

The symmetrical components derived from the secondary phase currents are

$$I\_1 = I\_2 = I\_0 = 2.913 \text{ pu} \qquad \textbf{Eq. 58}$$

The differential ground current is calculated as

$$I_{GD} = \left|\vec{I_G} + \vec{I_N}\right| = 0.437 \text{ pu } \angle 180° + 8.74 \text{ pu } \angle 0° = 8.303 \text{ pu} \qquad \textbf{Eq. 59}$$

The IR1, IR2, and IR0 currents are

$$IR1 = 0 \qquad \textbf{Eq. 60}$$

$$IR2 = 3 \times |I\_2| = 3 \quad 2.913 \text{ pu} = 8.74 \text{ pu} \qquad \textbf{Eq. 61}$$

$$IR0 = \left|\vec{I_G} - \vec{I_N}\right| = |0.437 \text{ pu } \angle 180° - 8.74 \text{ pu } \angle 0°| = 9.177 \text{ pu} \qquad \textbf{Eq. 62}$$

The restraint current is the maximum of the three currents IR1, IR2, and IR0 as follows:

$$I_{GR} = \max(IR1, IR2, IR0) = 9.177 \text{ pu} \qquad \textbf{Eq. 63}$$

Therefore

$$\frac{I_{GD}}{I_{GR}} \times 100\% = \frac{8.303 \text{ pu}}{9.177 \text{ pu}} \times 100\% = 90.5\% \qquad \textbf{Eq. 64}$$

This is well above the restraint characteristic in the operating region if no special treatment to the restraint is provided.

For cases of CT saturation and switch-off conditions, the ground restraint IGR is set to decay slowly. Since the CTs do not immediately saturate at the same instant the fault occurs, the restraint current is equal to the initial fault current value of 17.48 pu (as in the no-saturation case). The restraint drops to 50% of its original value after 15.5 cycles, so that if the worst case of saturation occurs after a cycle, the restraint current is approximately 16.91 pu, giving the following ratio:

$$\frac{I_{GD}}{I_{GR}} \times 100\% = \frac{8.303\text{ pu}}{16.91\text{ pu}} \times 100\% = 49\% \qquad \textbf{Eq. 65}$$

During CT saturation differential current will be increasing gradually and restraint decreasing gradually as CT enters into saturation. This calculations shows that due to memory effect of the restraint current in RGF element, the relay uses the higher restraint value and the application remains secure.

External phase A to ground fault at transformer full load with saturation on the ground CT

Consider an external phase A to ground fault at transformer full load where the ground CT saturates as a result, producing only 5% of the total fault current on its secondary winding. As per the previous example, the phase fault currents (primary and secondary) are given as follows.

Primary currents	Secondary values
I_A = 5248 A	I_A = 5248/600 = 8.74 pu ∠0°
I_B = 525 A	I_B = 525/600 = 0.875 pu ∠-120°
I_C = 525 A	I_C = 525/600 = 0.875 pu ∠-240°
I_N = 4719 A	I_N = 4719/600 = 7.865 pu ∠0°
I_G = 262 A	I_G = 0.05 x 5248/600 = 0.437 pu ∠180°

The symmetrical components derived from the secondary phase currents are

$$I\_1 = 3.496\text{ pu} \qquad \textbf{Eq. 66}$$

$$I\_2 = I\_0 = 2.621\text{ pu} \qquad \textbf{Eq. 67}$$

The differential ground current is calculated as

$$I_{GD} = \left|\vec{I_G} + \vec{I_N}\right| = 0.437\text{ pu }\angle 180° + 7.865\text{ pu }\angle 0° = 7.428\text{ pu} \qquad \textbf{Eq. 68}$$

The IR1, IR2, and IR0 currents are

$$IR1 = 3 \times |I\_1 - I\_0| = 2.625\text{ pu} \qquad \textbf{Eq. 69}$$

$$IR2 = 3 \quad |I\_2| = 3 \times 2.622\text{ pu} = 7.865\text{ pu} \qquad \textbf{Eq. 70}$$

$$IR0 = \left|\vec{I_G} - \vec{I_N}\right| = 0.437\text{ pu }\angle 180° - 7.865\text{ pu }\angle 0° = 8.302\text{ pu} \qquad \textbf{Eq. 71}$$

The restraint current is the maximum of the three currents IR1, IR2, and IR0 as follows:

$$I_{GR} = \max(IR1, IR2, IR0) = 8.302\text{ pu} \qquad \textbf{Eq. 72}$$

Therefore

$$\frac{I_{GD}}{I_{GR}} \times 100\% = \frac{7.428\text{ pu}}{8.302\text{ pu}} \times 100\% = 89.5\% \qquad \textbf{Eq. 73}$$

This is well above the restraint characteristic in the operating region if no special treatment to the restraint is provided.

For cases of CT saturation and switch-off conditions, the ground restraint IGR is set to decay slowly. Since the CTs do not immediately saturate at the same instant the fault occurs, the restraint current is equal to the initial fault current value of 15.73 pu (as in the no-saturation case). The restraint drops to 50% of its original value after 15.5 cycles, so that if the worst case of saturation occurs after a cycle, the restraint current is approximately 15.22 pu, giving the following ratio:

$$\frac{I_{GD}}{I_{GR}} \times 100\% = \frac{7.428\text{ pu}}{15.22} \times 100\% = 48.8\% \qquad \textbf{Eq. 74}$$

Summary

These examples help to identify the boundaries from the security/sensitivity range for setting the RGF slope. In our case, the slope has to be above 50% (assuming very severe saturation leading to only 5% current from the saturated ground CT), and below 70% (assuming detection of faults on the winding at 5% distance from the neutral point).

For further assistance

For product support, contact the information and call center as follows:

GE Grid Solutions
650 Markland Street
Markham, Ontario
Canada L6C 0M1
Worldwide telephone: +1 905 927 7070
Europe/Middle East/Africa telephone: +34 94 485 88 54
North America toll-free: 1 800 547 8629
Fax: +1 905 927 5098
Worldwide e-mail: multilin.tech@ge.com
Europe e-mail: multilin.tech.euro@ge.com
Website: http://www.gegridsolutions.com/multilin/