

Long Term Development Statement (LTDS)

Appendix 8: Equivalent Infeed Impedance Calculations

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This document outlines the Equivalent Infeed Impedance Calculations for the data exchanges of the proposed LTDS Common Information Model (CIM) revision.

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1 Introduction

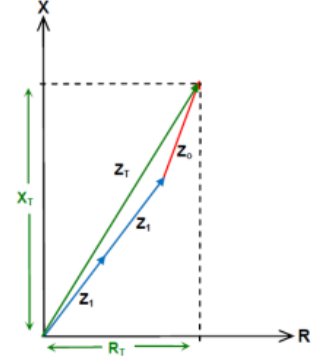
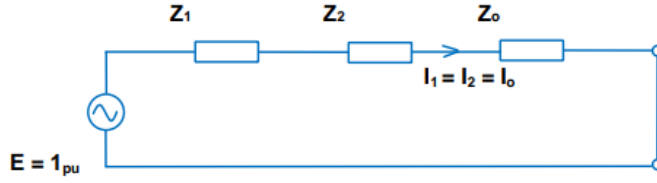
In the current version of LTDS the positive and zero sequence impedance parameters ($R1$, $X1$, $R0$ and $X0$) are explicitly specified. In the proposed revision of the LTDS these values can be calculated using the single and three phase fault current magnitudes and angles. The equations are presented below.

Note that the equations can produce negative zero sequence parameters. This is acceptable as the zero sequence parameters are not used in isolation, they are always combined with at least the positive sequence impedance in sequence networks analysis.

The following parameters are used by the equations:

- $I_{3\phi}$ – three phase fault current magnitude, in kA (exchanged using `gb:ShortCircuitResult.symmetricalBreakingCurrent` for `gb:ShortCircuitResult.faultKind` with value `gb:ShortCircuitFaultKind.threePhase`)
- $\theta_{3\phi}$ – three phase fault current angle, in degrees (exchanged using `gb:ShortCircuitResult.symmetricalBreakingCurrentAngle` for `gb:ShortCircuitResult.faultKind` with value `gb:ShortCircuitFaultKind.threePhase`)
- $I_{1\phi}$ – single phase fault current magnitude, in kA (exchanged using `gb:ShortCircuitResult.symmetricalBreakingCurrent` for `gb:ShortCircuitResult.faultKind` with value `gb:ShortCircuitFaultKind.singlePhase`)
- $\theta_{1\phi}$ – single phase fault current angle, in degrees (exchanged using `gb:ShortCircuitResult.symmetricalBreakingCurrentAngle` for `gb:ShortCircuitResult.faultKind` with value `gb:ShortCircuitFaultKind.singlePhase`)

2 Three phase fault



The following equations apply for three phase fault:

$$Z_1 = \frac{E}{I_1} \text{ where } I_1 = I_{3\phi(pu)} = \frac{I_{3\phi}}{I_B}; \quad I_B = \frac{MVA_B}{\sqrt{3} \cdot V_L}; \quad MVA_B \text{ is base MVA; } V_L \text{ is the line to line voltage}$$

$$I_1 = \frac{I_{3\phi}}{\frac{MVA_B}{\sqrt{3} \cdot V_L}} = \frac{\sqrt{3} \cdot V_L \cdot I_{3\phi}}{MVA_B}; \quad Z_1 = \frac{1}{\frac{\sqrt{3} \cdot V_L \cdot I_{3\phi}}{MVA_B}}$$

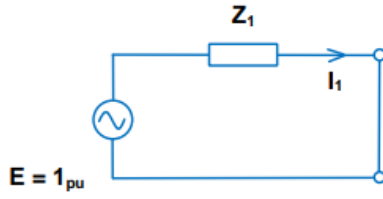
$$Z_{1(pu)} = \frac{MVA_B}{\sqrt{3} \cdot V_L \cdot I_{3\phi}};$$

$$Z_1 = R_1 + jX_1 = \frac{E \angle 0^\circ}{I_1 \angle \theta_{3\phi}} = Z_1 \angle (-\theta_{3\phi});$$

$$R_{1(pu)} = \frac{MVA_B}{\sqrt{3} \cdot V_L \cdot I_{3\phi}} \cos(\theta_{3\phi});$$

$$X_{1(pu)} = \frac{MVA_B}{\sqrt{3} \cdot V_L \cdot I_{3\phi}} \sin(-\theta_{3\phi});$$

3 Single phase fault



The following equations apply for single phase fault:

$$I_1 = \frac{E}{Z_1 + Z_2 + Z_3}; \quad I_1 = I_2 = I_0 = \frac{1}{3} I_{1\phi(pu)};$$

Assume $Z_1 = Z_2$, i. e. positive and negative sequence impedance are equal

$$I_{1\phi(pu)} = \frac{3E}{2Z_1 + Z_0} = \frac{3E}{Z_T}; \quad Z_T = \frac{3E}{I_{1\phi(pu)}}; \quad I_{1\phi(pu)} = \frac{I_{1\phi}}{I_B} = \frac{\sqrt{3} \cdot V_L \cdot I_{1\phi}}{MVA_B}; \quad I_B = \frac{MVA_B}{\sqrt{3} \cdot V_L}$$

$$Z_T = \frac{3MVA_B}{\sqrt{3} \cdot V_L \cdot I_{1\phi}};$$

$$R_T = \frac{3MVA_B}{\sqrt{3} \cdot V_L \cdot I_{1\phi}} \cos(\phi_{1\phi});$$

$$X_T = \frac{3MVA_B}{\sqrt{3} \cdot V_L \cdot I_{1\phi}} \sin(-\phi_{1\phi});$$

$$R_0 = R_T - 2R_1;$$

$$X_0 = X_T - 2X_1;$$

$$R_{0(pu)} = \frac{3MVA_B}{\sqrt{3} \cdot V_L \cdot I_{1\phi}} \cos\phi_{1\phi} - \frac{2MVA_B}{\sqrt{3} \cdot V_L \cdot I_{3\phi}} \cos\phi_{3\phi} = \frac{MVA_B}{\sqrt{3} \cdot V_L} \left[\frac{3\cos\phi_{1\phi}}{I_{1\phi}} - \frac{2\cos\phi_{3\phi}}{I_{3\phi}} \right];$$

Similarly,

$$X_{0(pu)} = \frac{MVA_B}{\sqrt{3} \cdot V_L} \left[\frac{3\sin(-\phi_{1\phi})}{I_{1\phi}} - \frac{2\sin(-\phi_{3\phi})}{I_{3\phi}} \right]$$