

Long Term Development Statement (LTDS)

Appendix 8: Equivalent Infeed Impedance Calculations

Publication date: 14 July 2023

Team: Digitalisation and Decentralisation;
Energy Systems Management and
Security

Email: flexibility@ofgem.gov.uk

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

It is part of the supporting artefacts that accompany the package of technical documentation setting out the outputs delivered by the LTDS reforms working group. We are publishing these documents to ensure all interested parties have full visibility of the outcomes of this programme of work, which is intended to form the basis of a future consultation on a proposed implementation of the CIM for the LTDS data. As such, the guidance offered in this package of documentation is not mandatory at this stage and will be subject to consultation before any changes to this data requirement are mandated.

© Crown copyright 2023

The text of this document may be reproduced (excluding logos) under and in accordance with the terms of the [Open Government Licence](#).

Without prejudice to the generality of the terms of the Open Government Licence the material that is reproduced must be acknowledged as Crown copyright and the document title of this document must be specified in that acknowledgement.

Any enquiries related to the text of this publication should be sent to Ofgem at:
10 South Colonnade, Canary Wharf, London, E14 4PU.

This publication is available at www.ofgem.gov.uk. Any enquiries regarding the use and re-use of this information resource should be sent to: psi@nationalarchives.gsi.gov.uk

Contents

1 Introduction 4

2 Three phase fault..... 4

3 Single phase fault 5

1 Introduction

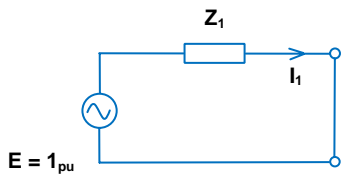
In the current version of LTDS the positive and zero sequence impedance parameters ($R1$, $X1$, $R0$ and $X0$) are explicitly specified. In the proposed revision of the LTDS these values can be calculated using the single and three phase fault current magnitudes and angles. The equations are presented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

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

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

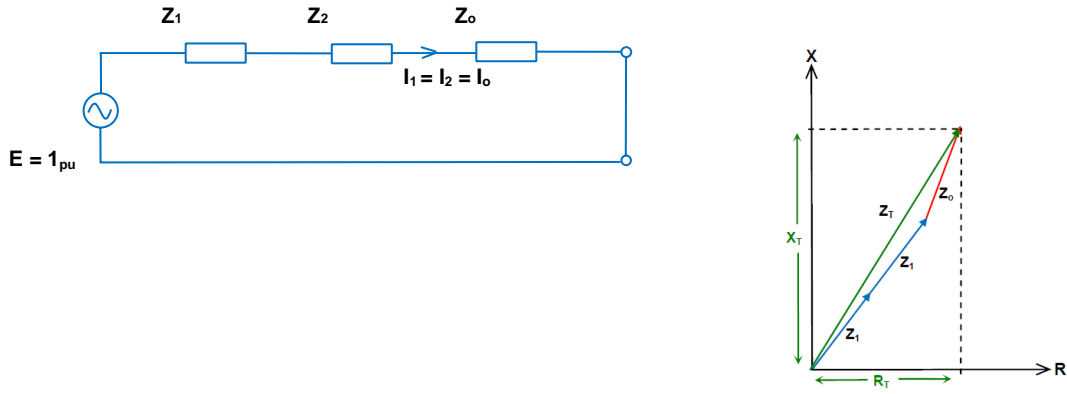
$$Z_{1(pu)} = \frac{MVA_B}{\sqrt{3} \cdot V_L \cdot I_{3\phi}}$$

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

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

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

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,

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