RNAM-based Probabilistic GIC Analysis

Supplementary material for the letter submission "*Reduced Nodal Admittance Matrix (RNAM) Method for Probabilistic GIC Analysis in Power Grids*". This MATLAB code compares the computational efficiency of the RNAM method with the classical algorithms, including the nodal admittance matrix method [1], the Lehtinen-Pirjola method [2] and the bus admittance matrix method [3].

NUMERICAL ROUTINES:

- **main_UQ_GIC_4methods.m**
  Routine aimed at providing a comparison of the four considered methods for the uncertainty quantification (UQ) of geomagnetically induced currents (GIC) in power grids.
- **t_GIC_4methods.m**
  Routine for the test and verification of the four GIC calculation methods. Emphasis is on the consistency check among the results available in the public literature [4].
- **"data" folder**
  - **GEF_YKC20150815_1sec.mat**

    Geoelectric field (GEF) time series calculated by using the Québec earth conductivity model [5] and the geomagnetic data at Yellowknife observatory from INTERMAGNET during the geomagnetic disturbance event on August 15, 2015.
  - **Grid_matrices_EPRI-21.mat**

    Matrices of power grid test case Benchmark EPRI-21 [4] for GIC calculation .
  - **Grid_matrices_IEEE_118-GMD.mat**

    Matrices of power grid test case IEEE 118-GMD [6] for GIC calculation.
  - **Grid_matrices_EPRI_21_BAM_ref.mat**

    BAM Design matrix of EPRI-21 calculated through the code shared in [3].

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2. D. H. Boteler and R. J. Pirjola, "Comparison of methods for modelling geomagnetically induced currents," *Ann. Geophys.*, vol. 32, no. 9, pp. 1177–1187, 2014.

3. S. Marsal et al., "A new standalone tool for DC-equivalent network generation and GIC calculation in power grids with multiple voltage levels," *Space Weather*, vol. 20, no. 3, p. e2021SW002984, 2022.

4. R. Horton, D. Boteler, T. J. Overbye, R. Pirjola, and R. C. Dugan, "A test case for the calculation of geomagnetically induced currents," *IEEE Trans. Power Del.*, vol. 27, no. 4, pp. 2368–2373, 2012.

5. D. H. Boteler, "The evolution of Québec earth models used to model geomagnetically induced currents," *IEEE Trans. Power Del.*, vol. 30, no. 5, pp. 2171–2178, 2015.

6. A. Haddadi, A. Rezaei-Zare, L. G´erin-Lajoie, R. Hassani, and J. Mahseredjian, "A modified IEEE 118-bus test case for geomagnetic disturbance studies–part I: Model data," *IEEE Trans. Electromagn. Compat.*, vol. 62, no. 3, pp. 955–965, 2020.