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DC and AC characterization of a Low-Field Nb₃Sn prototype conductor for a DEMO TF Coil

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The DEMO ENEA Low Field W&R (Wind and React) conductor, developed in the frame of the conceptual design studies for the Toroidal Field (TF) coils of DEMO, has been designed to be constituted of a small number of superconducting Nb₃Sn strands and a high number of stabilization copper wires. It has been extensively characterized at the SULTAN facility in February 2021. The conductor has been operated up to its target current, 70.8 kA, and characterized up to a background magnetic field of 10.78 T. The test program included AC loss measurements with sinusoidal pulsing and measurements of current sharing temperature (T_{cs}) and critical current (I_c) before and after cyclic loading. At the end, the AC loss measurements were repeated with the sinusoidal pulsing and also with unipolar trapezoidal ramps. Critical temperature (T_c) measurements were also performed on the virgin conductor at the beginning of the test campaign and at the end of the test campaign. In the present work, the main DC and AC characterization's results and analysis are reported. Concerning DC tests, premature quench phenomena prevented from operating the conductor at the target current –field conditions, probably owing to the sample layout in the transition region to the joint box. Nevertheless, T_{cs} stability was observed, with no performance degradation due to cycling. A comparative analysis of sinusoidal and trapezoidal measurements is presented, aimed at evaluating the characteristic cable coupling time constant as function of the field variation rate, and at comparing the results to other previous low and high field conductors, as well designed and characterized for the DEMO TF coils.

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