Control and Characteristic Map Generation of Permanent Magnet Synchronous Machines and Induction Machines with Squirrel Cage

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Due to different requirements for simulation during the design process of an electric drive system, investigations were carried out to supply models of different stages with consistent sets of parameters. Therefore physical models of the Modelica Standard Library (MSL) were equipped with state-of-the-art control strategies to operate in realistic conditions. These include field-oriented algorithms for permanent magnet and induction machines including field-weakening, current and voltage limitations as well as maximum torque per ampere blocks.

In the full paper it is presented how the losses computed by the physical model are transfered to the characteristic maps. Those losses are stored in tables to speed up simulation in cases where dynamics are of minor interest. These table-based models can then be used for energetic, thermal and life-time analysis with a consistent set of parameters generated from their physical counterparts. The physical models from which the map-based models were created can be applied when dynamics or other detailed effects in the machine or the controller are of interest.

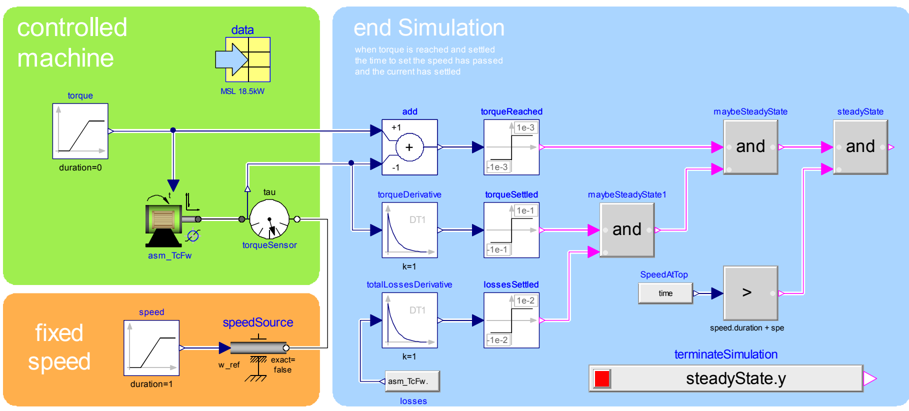

Figure 1: Model for loss calculation of a torque controlled induction machine

The transformation from physical models is done by a *Modelica* function that calls the model shown in Figure 1 within a loop to compute the loss table. This comes with the advantage, that a more precise machine model can simply replace the current model from the MSL with the advancements in modeling being directly represented in the characteristic map. Moreover the influences of the control algorithm like maximum torque per ampere are reflected in the characteristic map.

In the presented case the characteristic loss map was created depending on the angular velocity and the torque supplied by the machine. The results in the full paper show that errors smaller than 1% can be realized when doing energetic investigations. The speed-up in simulation times are found to be between a factor of 7 and ≥ 200. This factor is likely to rise if more complex models are applied.