

# Enhancements of Electric Machine Models: The EMachines Library

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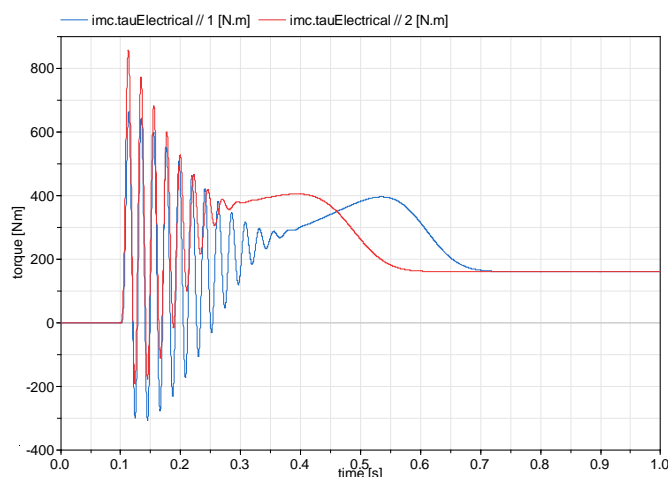
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The MSL already contains transient models of multi phase electric machines: `Modelica.Electrical.Machines` and `Modelica.Magnetic.FundamentalWave`. For the next release of the MSL, quasi static machine models are planned to be included. These models neglect electric transients for performance reasons (Kral, Haumer, 2014): `Modelica.Magnetic.QuasiStaticFundamentalWave`.

Both the transient and the quasi static models consider Joule, friction, core and stray load losses. However, more advanced effects like saturation and skin effect are not taken into account. The new EMachines Library deals with these advanced effects. First, the deep bar effect is implemented, followed by further effects. Furthermore, the new machine models are based on a parameter record to overcome the drawback of parameterization by multiple parameters.

The deep bar effect (Toliyat, Kliman, 2004) increases the effective resistance and decreases the effective stray inductance of the rotor bars. This effect strongly depends on the electrical rotor frequency. Therefore the stator current and torque of induction machines at stand still, i.e. slip = 1, is strongly affected. Furthermore, the additional losses caused by higher harmonics of non-sinusoidal currents due to inverter operation are increased. Modeling the deep bar effect allows the investigation of the starting behavior of induction machines fed by the grid in a more realistic way (Figure 1).



**Figure 1.** Transient torque w/o (blue) and with (red) skin effect

The EMachines library will be released as a supplemental library to the commercial EDrives library (Haumer, Kral, 2014).

## References

H. A. Toliyat, G. B. Kliman. Handbook of Electrical Motors. *CRC Press, 2004*.

Anton Haumer, Christian Kral. The New EDrives Library: A Modular Tool for Engineering of Electric Drives. *Modelica 2014*.

Christian Kral, Anton Haumer. New Multi Phase Quasi Static FundamentalWave Electric Machine Models for High Performance Simulations. *Modelica 2014(a)*.