

Induction Motor Drive using FLUX to SIMULINK Technology. (continued)

Martial BUSI, Sébastien CADEAU-BELLIARD - Cedrat S.A.

>> Note: These simulations were computed with PI regulators adjustment $P=2$ & $I=0.142857$.

a) Transient speed up to reference value

The flux density in the FE-model is obtained using the standard tools offered by FLUX.

Figures 5 to 7 show the computation results for a speed reference value equal to 100 radian per second which correspond approximately to 1000 rpm.

b) Transient speed up and response to a load torque of 20 N.m

Figures 8 to 10 show the computation results for a speed reference value equal to 150 radian per second

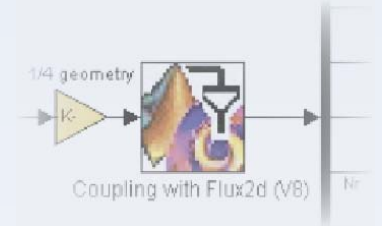
which correspond approximately to 1432 rpm and for a load torque applied at $t = 1,2s$.

Scalar control structure with equivalent model

c) Transient speed up and response to a load torque of 20Nm

We can represent the FE-model in FLUX by an equivalent first order model using a Matlab s-function. After calculation of the parameters of the diagram of Steinmetz shown in figure 15, a new Simulink computation was realised and the results are displayed in figures 12 to 14.

The same computation of speed up to 150 radian per second and response to a load torque of 20Nm is proceeded.



(continued on page 17)

Transient speed - Case a

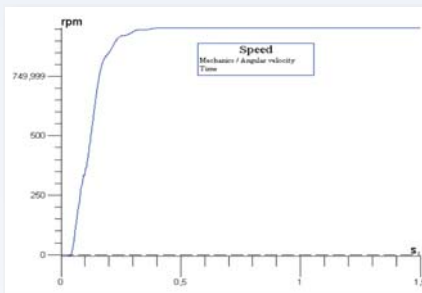


Figure 5: Mechanical speed.

Transient speed - Case b

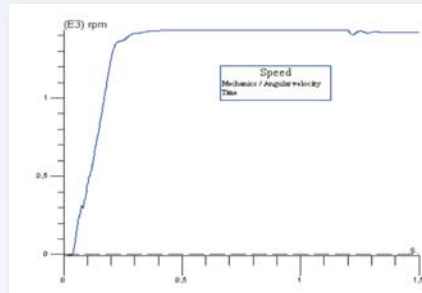


Figure 8: Mechanical speed.

Transient speed - Case c

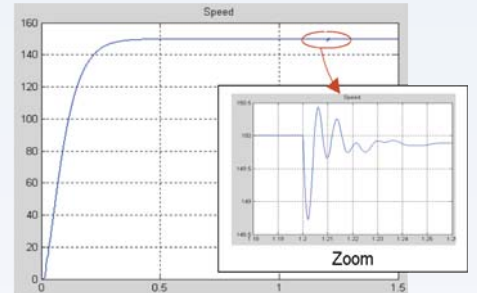


Figure 12: Mechanical speed.

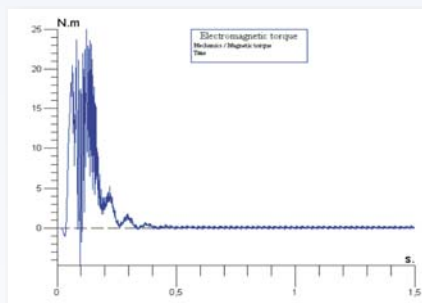


Figure 6: Electromagnetic torque.

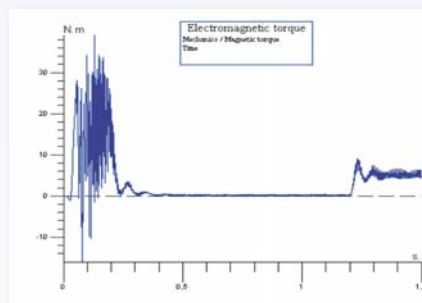


Figure 9: Electromagnetic torque.

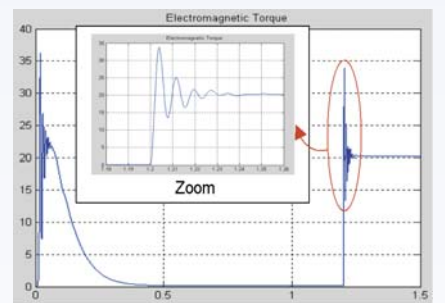


Figure 13: Electromagnetic torque.

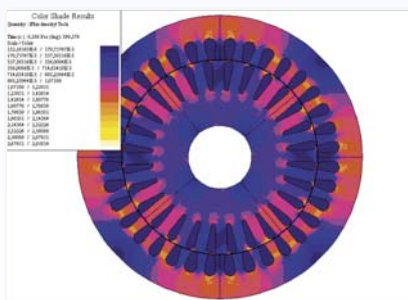


Figure 7: Flux density displayed with FLUX.

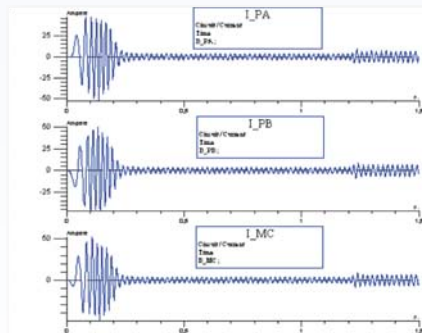


Figure 10: Phase currents.

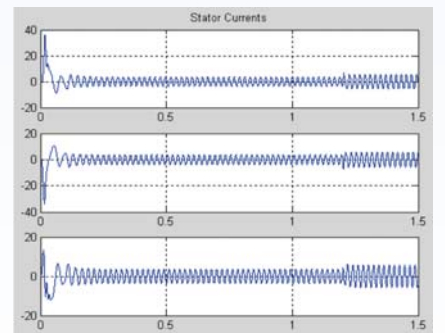


Figure 14: Phase currents.

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Conclusion

In first time, we notice that the range of curves in Simulink and FLUX are not very the same and that because of the regulators tuning. Because FLUX take saturation and no-linear phenomena into account we have made different regulators adjustment which allows a good enslavement.

The coupling with FLUX enables to see that a proper servo-control of the torque is more difficult for transient speed while a simple SIMULINK model does not account properly for this difficulty. Indeed, the only simulation with Simulink underestimates the response time to reach steady state after applying the load torque.

Then, the advantage of the co-simulation shows the interest to take into account for dynamic and non-linear phenomena.

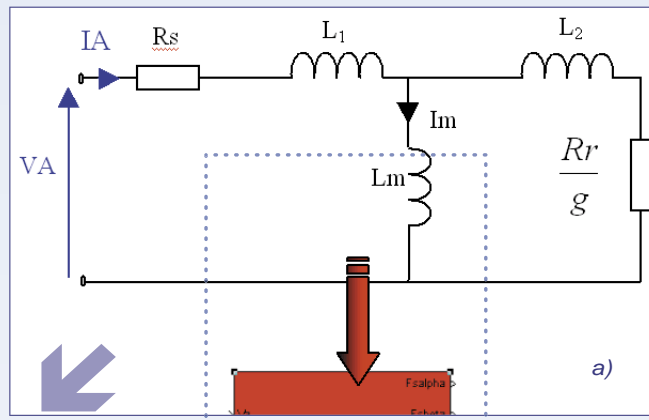
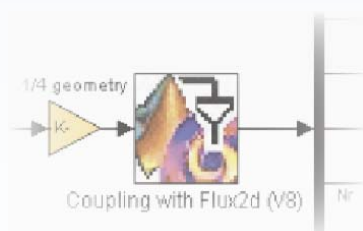
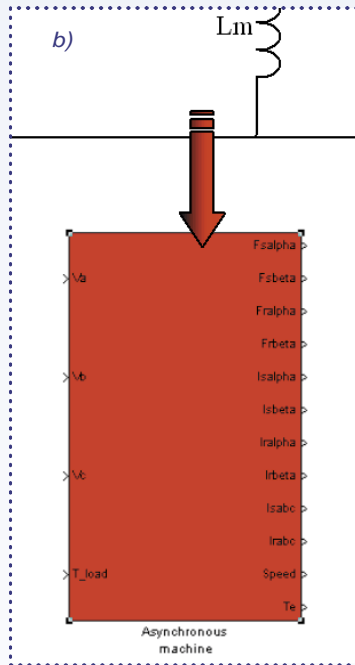


Figure 15 a-b: Asynchronous machine first order model.



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The calibration of the magnet is performed through the measure of the magnetic moment according to the IEC60404-14 standards. The measures of the magnetic moment is performed by mean of the new fluxmeter DIGITAL FLUX and with the Helmholtz coil. The magnetic moment is a very useful parameter to compare the specific properties of the hard magnetic materials, the «permanent magnets».

APPLICATION

MAGNETS

Main features

- ❑ The system is suitable to magnetize and calibrate the ferrite magnetic material having a diameter of 8 mm and a length between 5 and 15 mm.
- ❑ The system is completely automated and works non-stop autonomously for 4 – 6 hours.
- ❑ The magnets are packed in 500 mm long tubes, which are loaded inside the magnetizer and automatically separated, calibrated and reinserted in the tubes. Then the tubes are placed inside expanded polystyrene blister packs.
- ❑ The main features are the precision of calibration of ±1,5% and the production speed, the working cycle varies between 10 and 15 seconds for each piece of magnet.
- ❑ The measurement for the magnets is performed through a Helmholtz coil and it is an absolute value.
- ❑ This equipment is particularly suitable to calibrate the magnets used inside the air pressure switches.

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