This work proposes to develop a novel real-time (RT) magnetic equivalent-circuit machine model, for providing accurate electromagnetic (EM) device characteristics in a time frame acceptable for RT applications. Utilizing this model with the Hardware-in-the-Loop (HIL) concept enables a wide variety of useful applications. HIL concept requires accurate, RT models to emulate the characteristics of the modeled system, thus the proposed method provides a larger range of observable dynamics for large-scale simulations, controller tests, or hardware emulations. The proposed model is implemented for a switched reluctance machine (SRM) on a field-programmable gate array (FPGA). Finite-element analysis (FEA), lumped parameter modeling, and an experimental test bed serve to benchmark the modeling accuracy and RT applicability under static, dynamic, and controlled test conditions.