CUSTOMER STORY

Electric Motion Systems

Model-Based Design Approach with Embed for Regenerative Braking

ALTAIR Embed

"The E+ Electric Bike is the only one in the world with a powerful processor and advanced algorithms. We want to tell the world it has been possible because of [Embed]."

Rakesh Dhawan
President
Electric Motion Systems

Electric Motion Systems (EMS) wanted to create the world's most efficient electric bicycle. Dr. Ziaur Rahman, Director of Electrical Controls at EMS, had the design expertise to create a sophisticated space vector control with regenerative braking for a permanent magnet synchronous motor; however, he did not have low-level C and assembler experience, nor did he have bit-level product knowledge of the new TI F2801 digital signal controller that he wanted to use as his controller.

Initially, Rahman thought he would have to hire several embedded coders to help him with his design. Engineering colleages, however, recommended Embed (formerly called VisSim Embedded) based on their success with the product. Convinced, Rahman decided to give it a try and see how far it would take him.

High Level Debugging

The automatic C code generation from the Embed block diagram was accurate and efficient. What pleased Rahman even more, however, was how easily he could debug his algorithms using waveform analysis with Embed's digital scope capability. Rahman was able to trigger a waveform capture at the full sample rate of 20kHz using his own custom trigger conditions. This allowed him to play with parameters for filters and PID gains, and instantly see the results in Embed plots on the PC.

E+ ELECTRIC BIKE

INDUSTRY

Embedded Control Design

CHALLENGE

Create a sophisticated space vector control with regenerative braking for a permanent magnet synchronous motor (PMSM)

SOLUTION

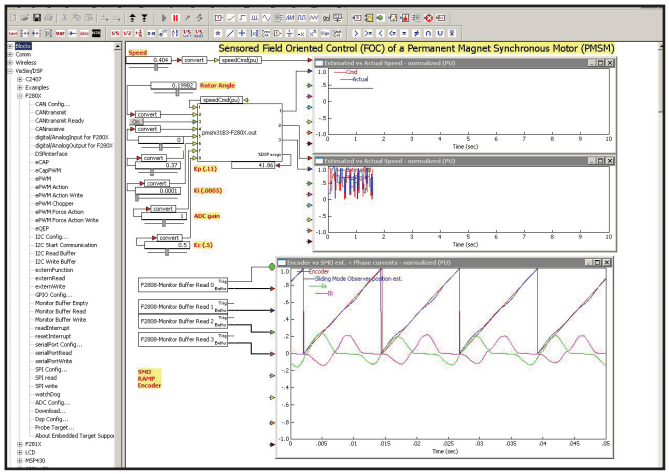
Use Embed to start with a conceptual algorithm design and proceed through MIL, SIL, PIL, and HIL, resulting in a working prototype

BENEFITS

- Automatic code generation reduces risk of introducing errors to the design
- Extensive peripheral support
- Significantly reduced RAM requirements allows more space for signal buffereing

Extensive Peripheral Support

Rahman needed to use the ePWM in a simple BLDC Hall sensored mode, then switch to a space vector mode once the bike hit a speed threshold, as well as put the ePWM into a locked phase mode for security. In addition, he needed to monitor bus voltage and inverter temperature, read and write EEPROM data via the F2801 I2C interface, and read and write RS485-based data packets to the main control panel. Both of the data I/O links were handled easily in Embed using the built-in I2C and serial I/O block support. To track protocol packet state, Rahman used the built-in state transition block.



Sensored Field Oriented Control of PMSM model.

Easy Task Scheduling

Rahman wanted his main control task to run at 20kHz with no jitter; his background tasks - which monitored the RS485 data packets and I2C - could run at 100Hz. This was easily accomplished in Embed: Rahman simply selected the Local Time Step option on the block containing the I/O subsystems and set them to 0.01s; then he activated the Codegen as Separate Thread option to schedule them to run periodically from the background idle loop.

Low RAM Usage

As the project neared completion, Rahman worried that he would not be able to fit everything in the 4K of RAM available on the F2801. Because the controller boards had already been designed and built, it was not cost effective to move to a more expensive higher RAM part. Fortunately, Embed has a significantly reduced RAM requirement, which, in the end, gave Rahman an extra 1K of RAM for signal buffering for debugging purposes.