



Code Generation for STM32 MCUs using MATLAB® and Simulink®

November 2014

- **ARM/ST/MathWorks initiative**
 - Optimized Cortex-M code for Embedded Coder based on ARM's CMSIS DSP SW library
 - Peripheral blockset for Simulink provided by ST based on STM32Cube abstraction layers; opening access for the use of whole STM32 portfolio
 - Compiler / IDE integration for MATLAB, based on Keil, IAR, and Atollic IDEs
- **Enables Model-Based Design Workflow for STM32 MCUs**
 - Create executable models, instead of paper documents
 - Generate code automatically, instead of by hand
 - Automate software integration, instead of manually
- **Reduces cost and time, improves quality**
 - ~33% cost & time reduction in ECU development
 - ~50% fewer specification errors

Why Matlab/Simulink on STM32 ?

- Simulation is always interesting when creating a mathematical algorithm
- Matlab/Simulink not only allows this simulation, but opens access to execution really being done on STM32 target, thus checking in real conditions the behavior of an algorithm
- Moreover, the algorithm can be connected to real internal STM32 peripherals, ending up with a complete processing 100% done in STM32, with no written lines of code and a complete model-driven approach, less prone to errors

Quick description of tools



Matlab

High level language for complex calculations

Simulink

Graphical development environment
Complete environment of simulation and implementation of embedded systems.

Embedded Coder

C code generation for embedded systems.
Embedded system interface



STM32Cube Embedded Software

Collection of embedded software components, highly portable from one STM32 to another

STM32CubeMX

Configuration software tool on the PC, able to generate initialization C code based on user choices

Toolchain

A toolchain from one of our partners is required to compile and link C code generated by Embedded Coder, STM32CubeMX and STM32Cube embedded software



Using scenarios and tools

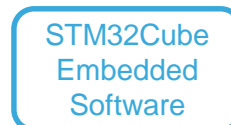
- Step 1: Pure simulation

- Everything done on the PC

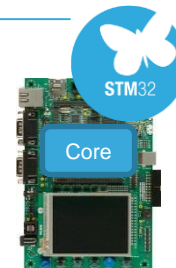


- Step 2: Processor-in-the-loop (PIL)

- Algorithm fully executed on STM32 MCU
- Data (Input or output) exchanged between MATLAB/Simulink and STM32 MCU via UART

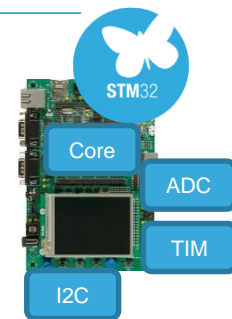
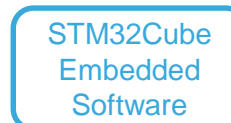


*: used only for UART



- Step 3: Everything on STM32

- Data (input or output) obtained from STM32 MCU through its peripherals (ADC, Timers, ...) and algorithm fully executed on STM32 MCU

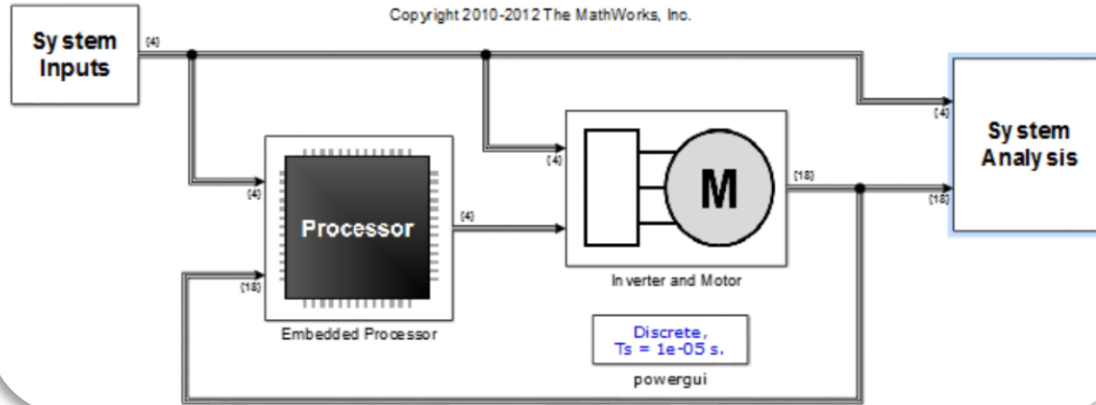




Step 1: Pure simulation

Field-Oriented Control of Permanent Magnet Synchronous Machine System Test Bench

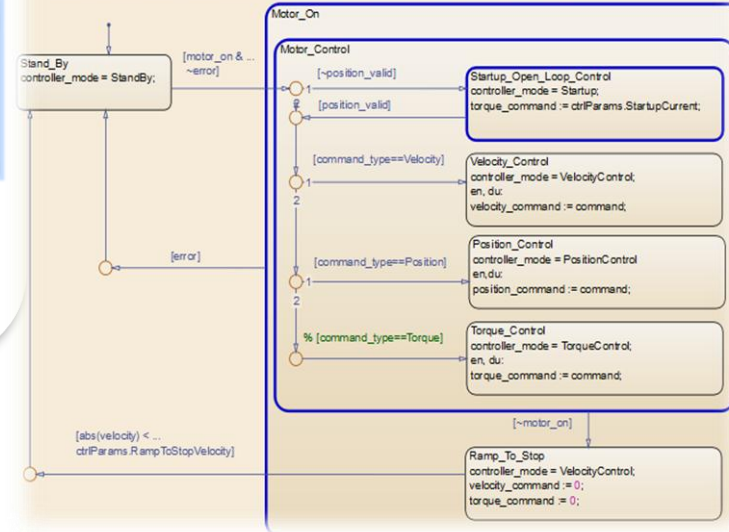
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Simulink

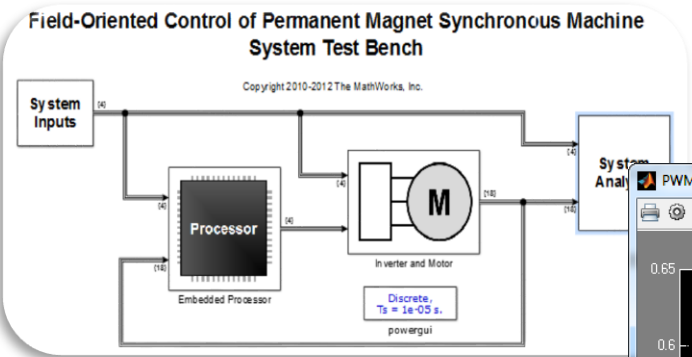
Controller Mode Scheduler

The motor control algorithm begins in a standby mode awaiting a command to turn the motor on. Once this command is issued the motor starts to identify a known motor position with valid position. The appropriate discrete loop control then begins. Upon a request to stop the motor, the motor will decelerate until zero speed is identified, after which the algorithm returns to the stand-by mode.



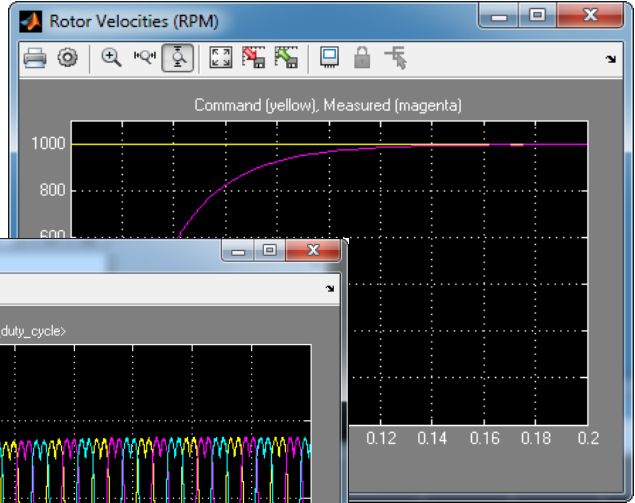
Stateflow

Simulate and Test on PC

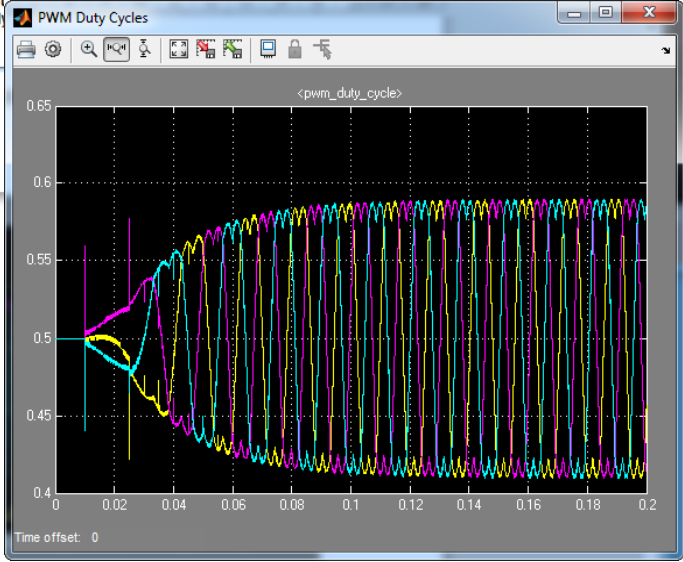


Simulink

PWM Duty Cycles



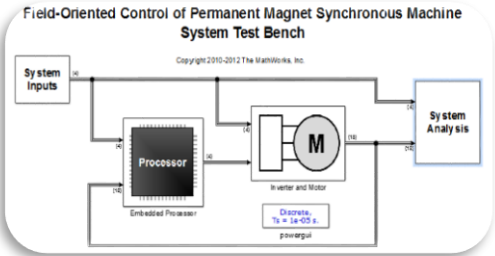
Command vs. Response





Step 2: Processor-in-the-loop

Processor-in-the-loop (PIL)



Host

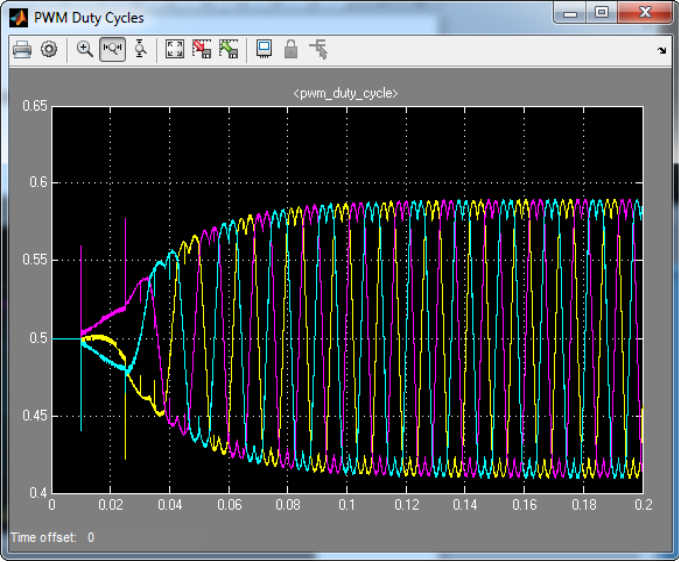
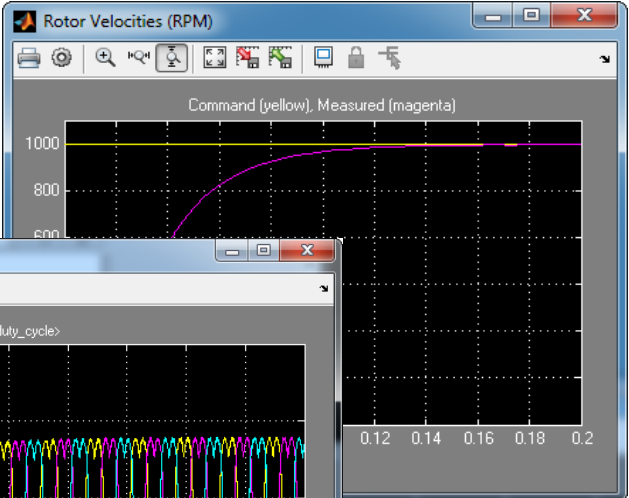


Serial Cable

Target



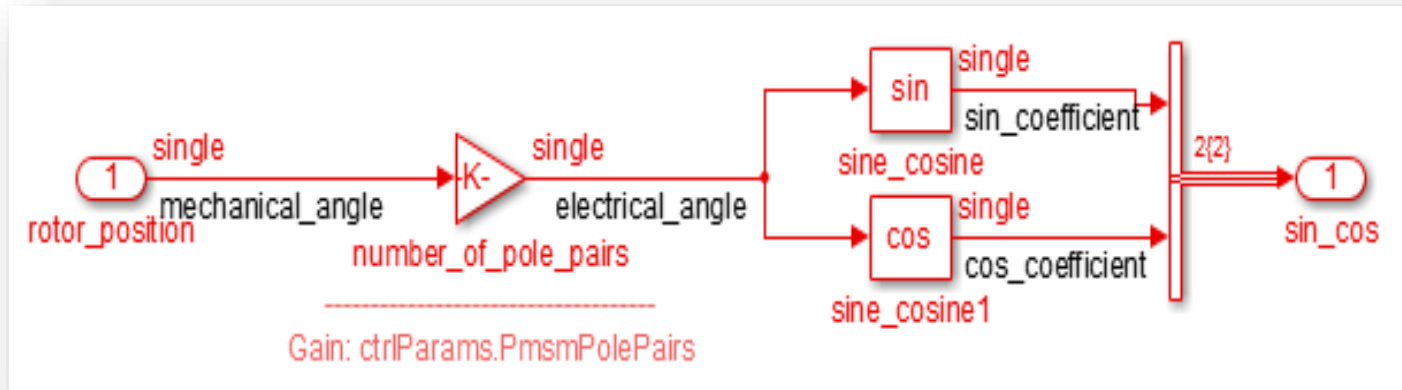
STM32



Compare to model results

Generate Cortex-M Optimized Code

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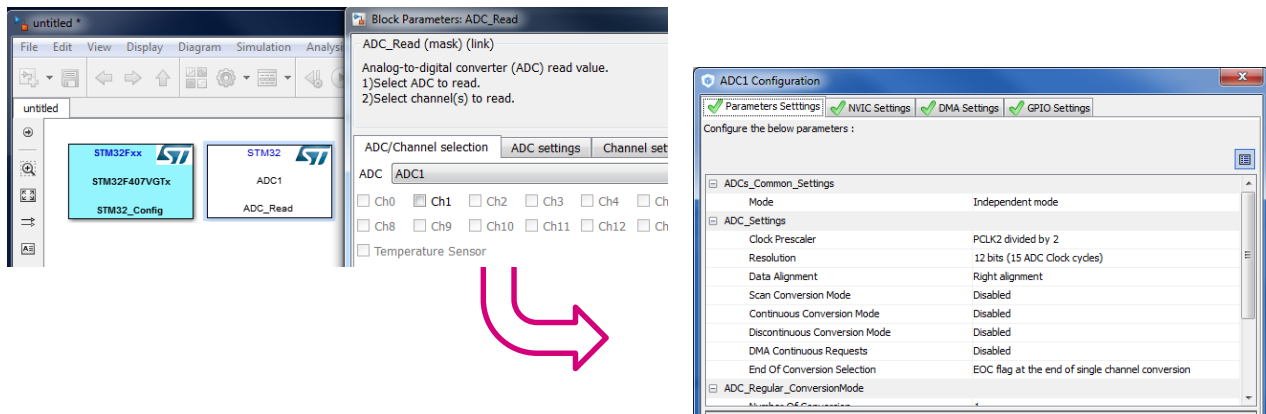
```
/* Trigonometry: '<S14>/sine_cosine1' */  
cos_coefficient = arm_cos_f32(sin_coefficient);
```

Embedded
Coder



Step 3: Everything on STM32

Handle data through real peripherals



- Configure your peripherals through a bridge with the STM32CubeMX tool
- Flash your device and run !
- More info at www.st.com/stm32-mat-target



- New Support Package for MATLAB, Simulink, and Embedded Coder
 - Generate optimized code
 - Automate build, integration and verification steps
- Now with ST and MathWorks you can:
 - Accelerate time to market
 - Reduce development costs
 - Improve product quality
- Join the Design Community !!!