

A Model-Based Design approach for embedded system development on STM32 microcontrollers



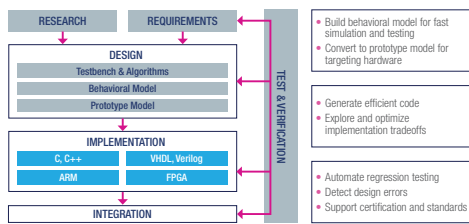
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OBJECTIVES

A new software tool that supports Model Based Design (MBD) is presented. It is suitable for running Simulink® application models for STM32 MCUs. The first Simulink® blockset library for STM32 peripherals allows us to implement Processor In the Loop (PIL) configuration and automatic code generation. The second Simulink® blockset includes extensive Math and Motor control functions based on the STM32 Motor control library.

MODEL-BASED DESIGN WORKFLOW

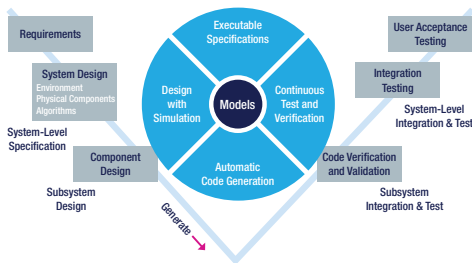
MBD modifies traditional methods adopted in model development processes and introduces a better way to implement the following workflow:



DEVELOPMENT PROCESS

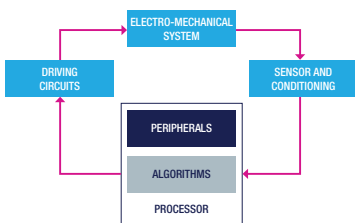
MBD employs the V-model development process illustrated below in its various phases. The V-model allows:

- Executable Specifications
- Design with Simulation
- Continuous Test and Verification
- Automatic Code Generation



SYSTEM MODEL PARTITIONING

The key for building a successful MBD platform is partitioning the system model and the embedded software code.



Block	Description	Simulation	Code generation
Electromechanical system	Averaged functional model	✓	✗
• Sensor and conditioning • Driving circuit	Fine-grained function model	✓	✗
Peripherals	Fine-grained function model	✓	✓
Algorithms	Core algorithm	✓	✓

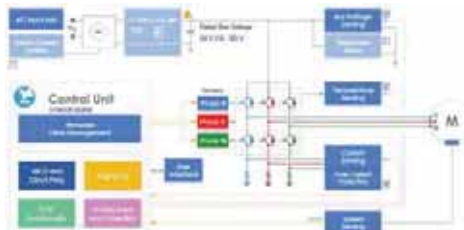
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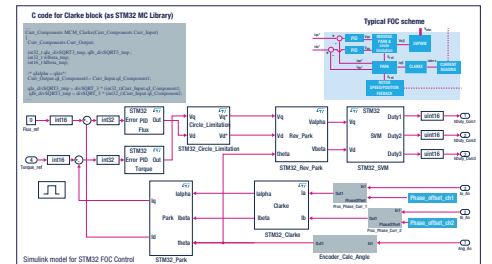
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MBD FITS STM32 ECOSYSTEM FOR FOC CONTROL OF PMSM MOTORS

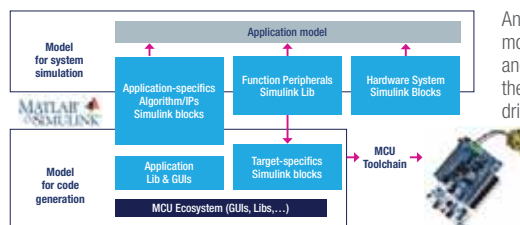


STM32 MC motor control firmware (X-CUBE-MCSDK) also includes the Permanent-magnet synchronous motor (PMSM) firmware library (FOC control) widely used in high-performance drives. The Simulink® library provided by ST is based on C legacy code firmware to optimize runtime execution and memory footprint.

The STM32 Motor Control Workbench PC software tool reduces the design time and effort needed for STM32 PMSM FOC firmware configuration. The project file is generated through the GUI and then used to configure the whole Motor Drive system model.



PARTITIONING PRINCIPLE FOR EMBEDDED SYSTEM MODELING



An MBD system can be conceptually divided into two main models: one is for simulation, based on algorithm/math blocks and functional emulation peripherals; the second is based on the same algorithm blocks plus the target-oriented peripheral driver blocks to generate auto-code.

MBD TOOLS FOR STM32 MCUS AND FOC MOTOR CONTROL

MathWorks **ST**

Matlab High level language for complex calculation

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

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

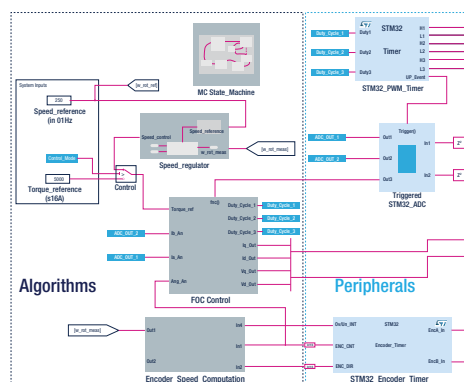
STM32-MAT/TARGET Simulink block-set to quickly deploy your application models in MATLAB and Simulink to STM32 MCUs.

STM32-MAT/MC(*) Simulink block-set with mathematical IP to support FOC Motor Control application for STM32 MCUs.

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

STM32-MAT/TARGET **STM32-MAT/MC**

ONE MODEL FOR SIMULATION AND AUTO-CODE GENERATION



One single model for both simulation and autocode generation is the novel approach in this work. Both Algorithms and Peripherals blocks generate an efficient C code based on STM32 MC FOC library and STM32 HAL libraries, respectively.

CONCLUSION

