MATLAB EXPO

TI C2000™ 듀얼코어 마이크로 컨트롤러에 모터제어 알고리즘을 배포하기 위한 솔루션

정승혁 차장, 매스웍스코리아

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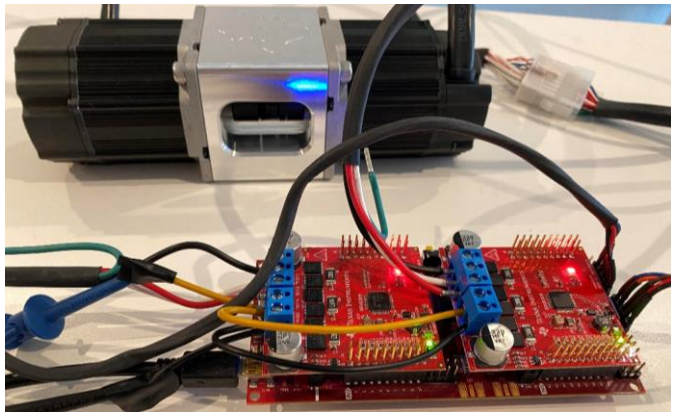
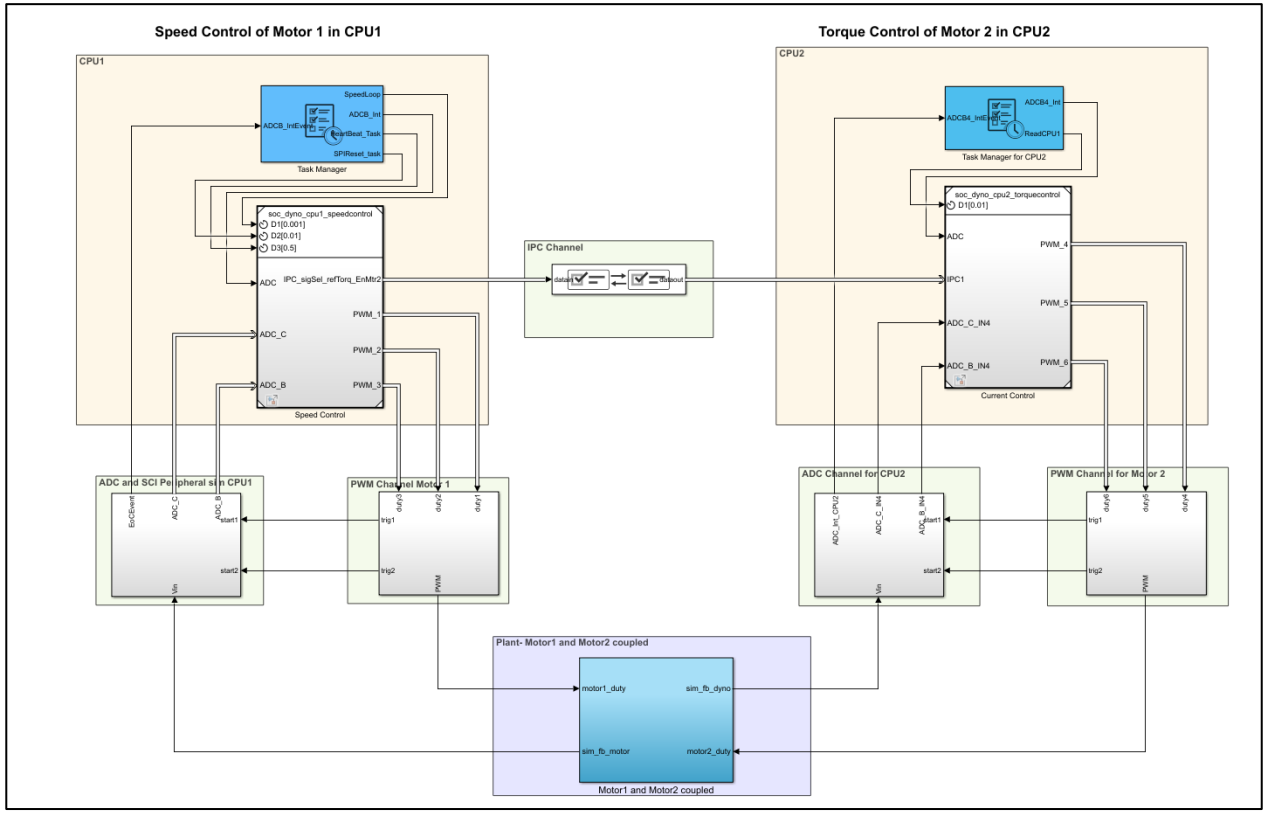
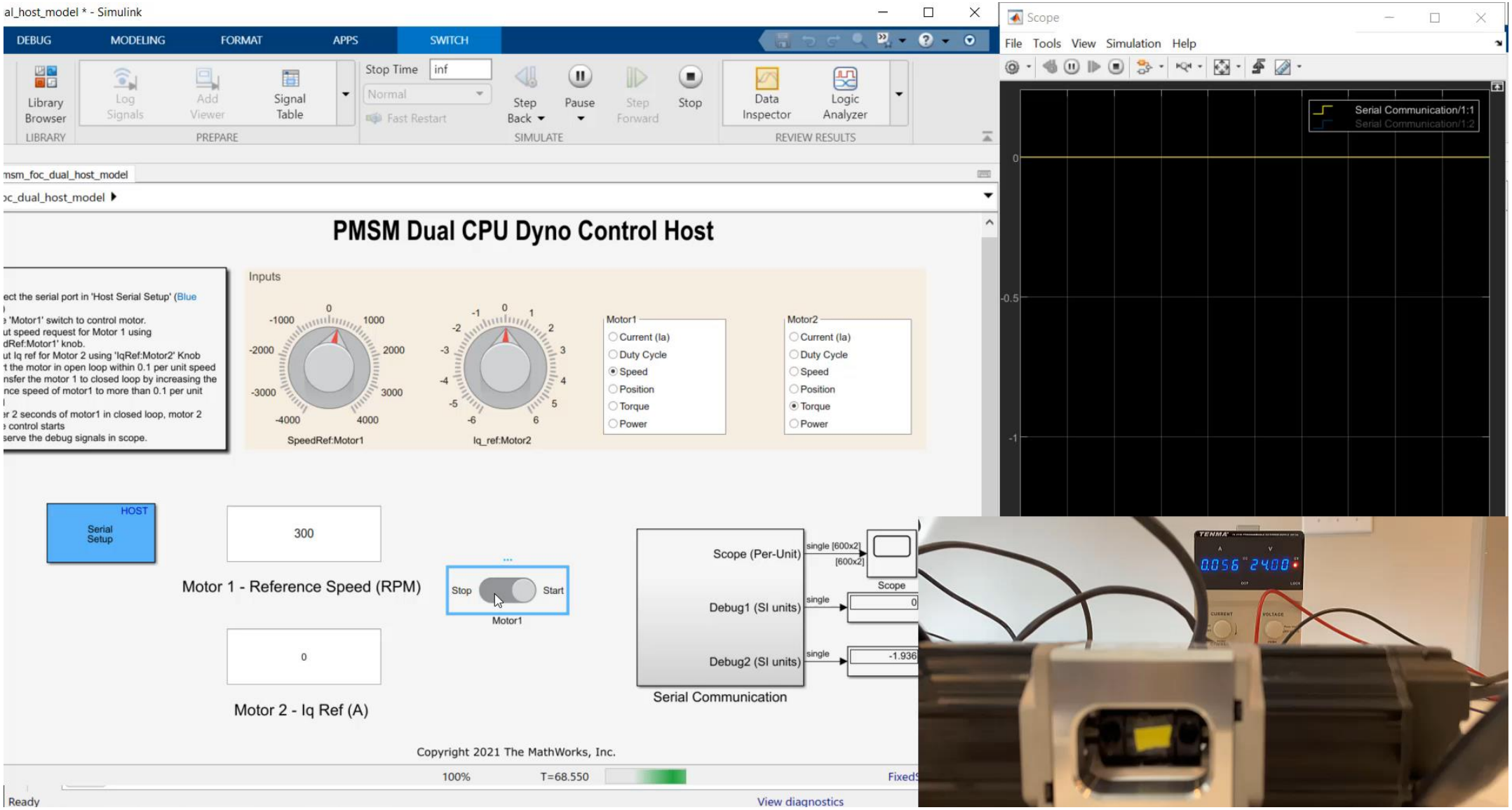
Key Takeaways

- Simulate sensorless Field-Oriented Control (FOC) on a dyno setup
- Complete Model-Based Design workflow for multicore microcontroller
- Hardware component and device driver behavior simulation
  - Enhanced on-device profiling



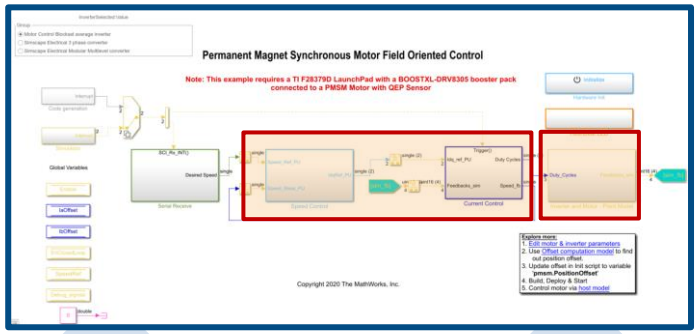


Dual CPUs PMSM Dyno Testing

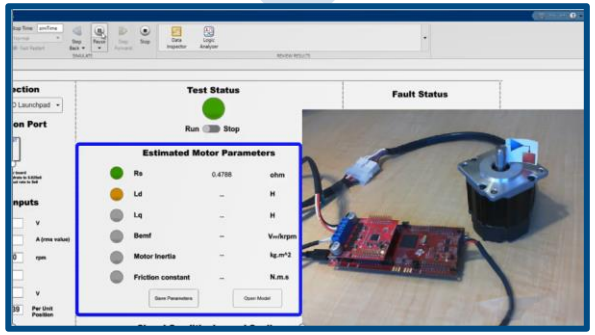


Workflow for Implementing Field-Oriented Control

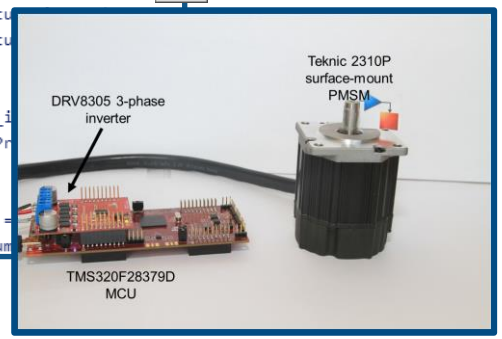
- Motor Control Blockset



Calibrate Sensors → Estimate Motor Parameters → Model Motor & Inverter → Design Control Algorithm → Deploy & Validate

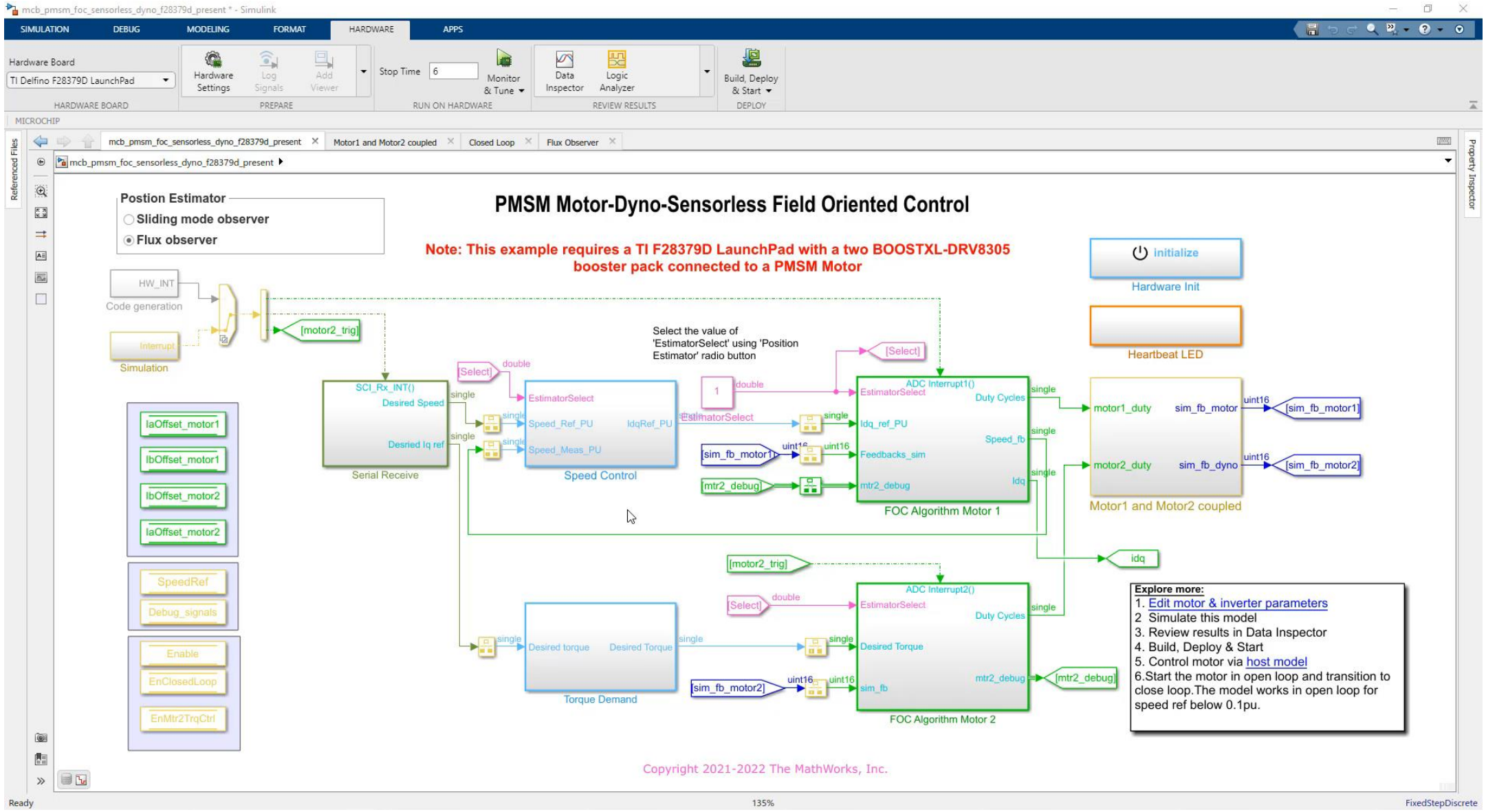



```
/* Product: '<S26>/Product1' */
mcb_pmsm_foc_hall_f28379d_B.Product1_j =
  mcb_pmsm_foc_hall_f28379d_B.Satu
  mcb_pmsm_foc_hall_f28379d_B.Satu

/* Sum: '<S26>/Sum2' */
mcb_pmsm_foc_hall_f28379d_B.Sum2_i
  + mcb_pmsm_foc_hall_f28379d_B.Pr

/* Sqrt: '<S26>/Sqrt' */
mcb_pmsm_foc_hall_f28379d_B.Sqrt =
  (mcb_pmsm_foc_hall_f28379d_B.Sum
```



[Webinar Series: Field-Oriented Control of PMSMs with Simulink]

Demo – PMSMs Dyno Model in FOC Sensorless Control



Challenges of Deployment on the Embedded Systems..

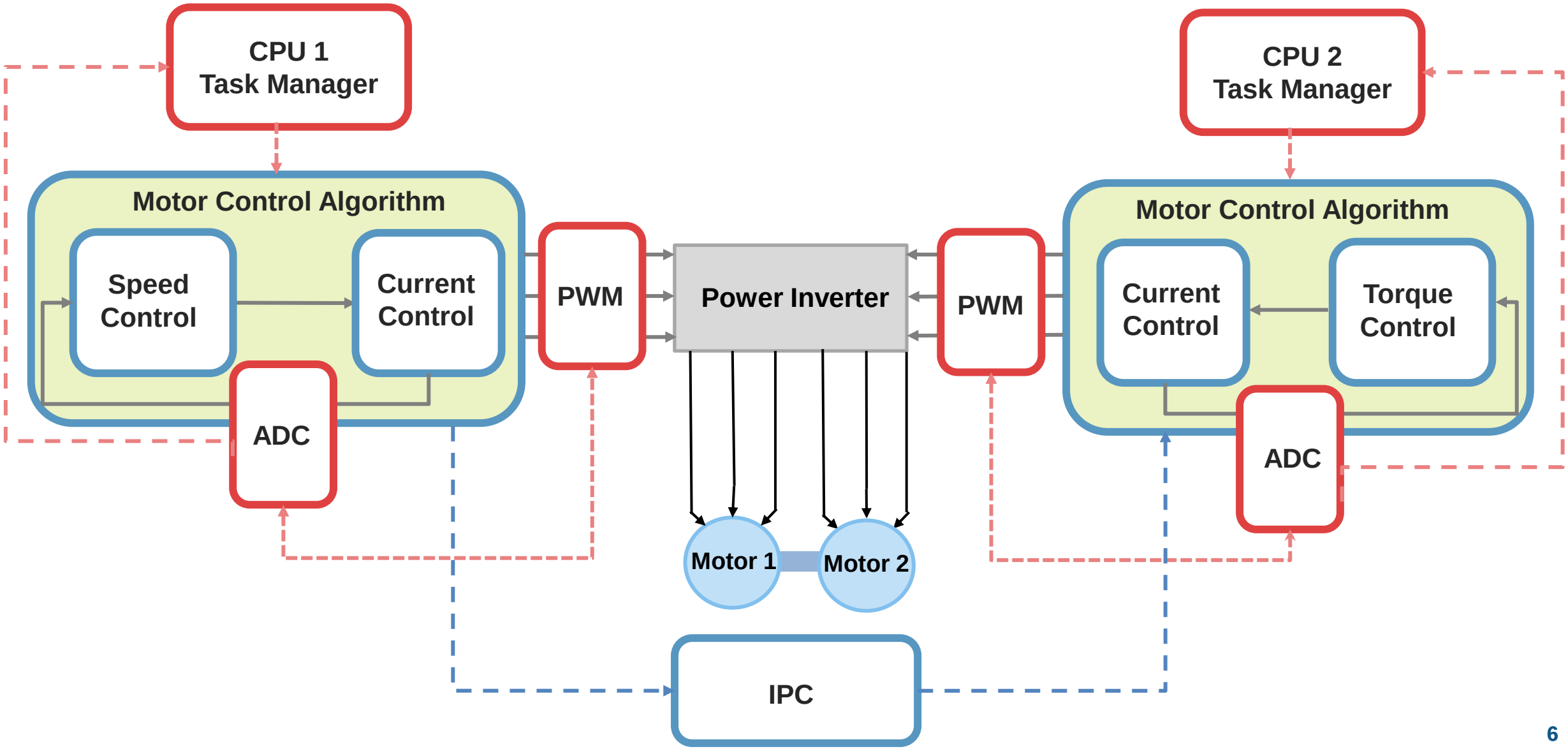
Model

- System requirement
  - TI C2000 dual-core processors
- Controller sample rate is 20kHz
  - Field-oriented control (FOC)
  - Sensorless control
  - Dyno setup (2 motors)
- No sensor delays in my model
- ADC-PWM synchronization

Multicore Processor

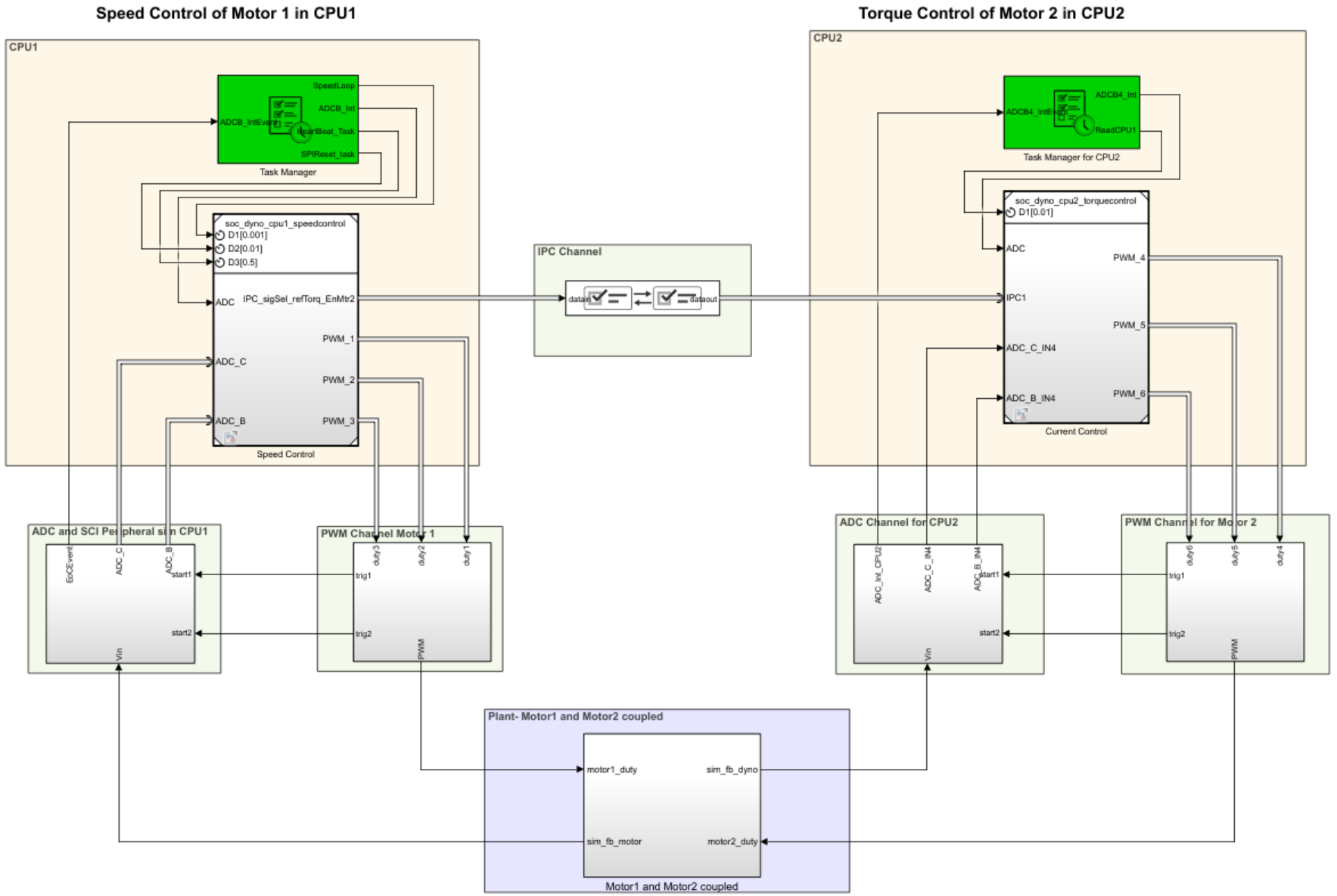
- How to implement and partition controls into two separated cores?
- How to communicate between CPU1 and CPU2?
- How to make sure task execution meets software requirement?

Simulate Motor Control System with Peripherals and Task Execution

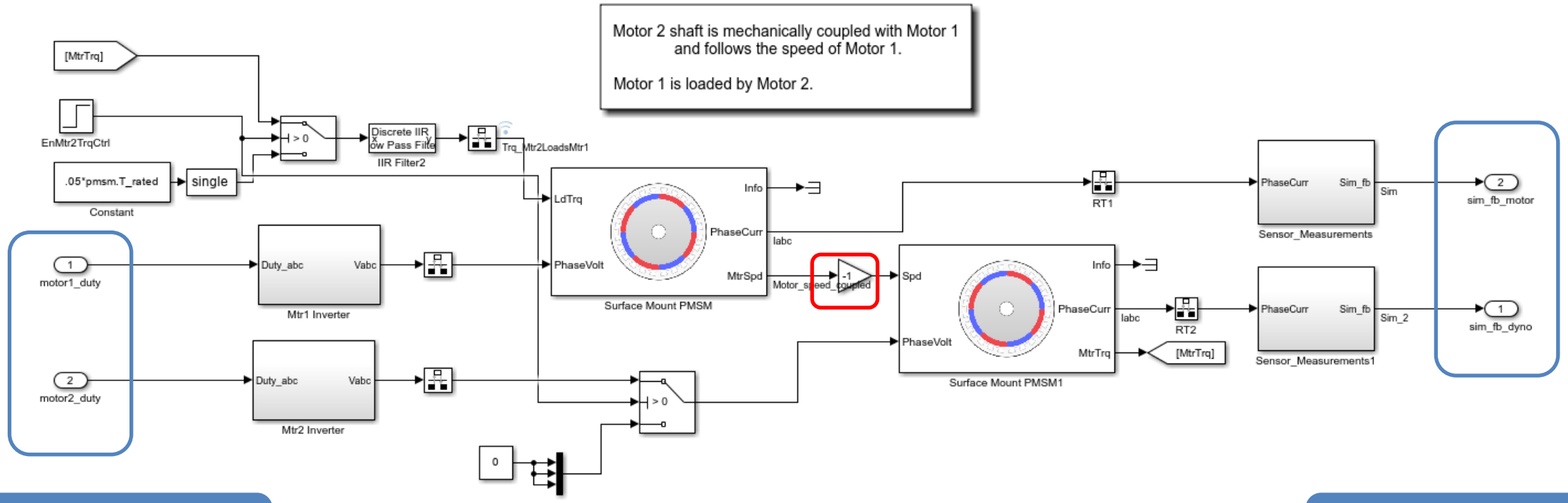


Model Multicore application Using SoC Blockset

Task Manager
IPC
PWM
ADC



Plant Subsystem



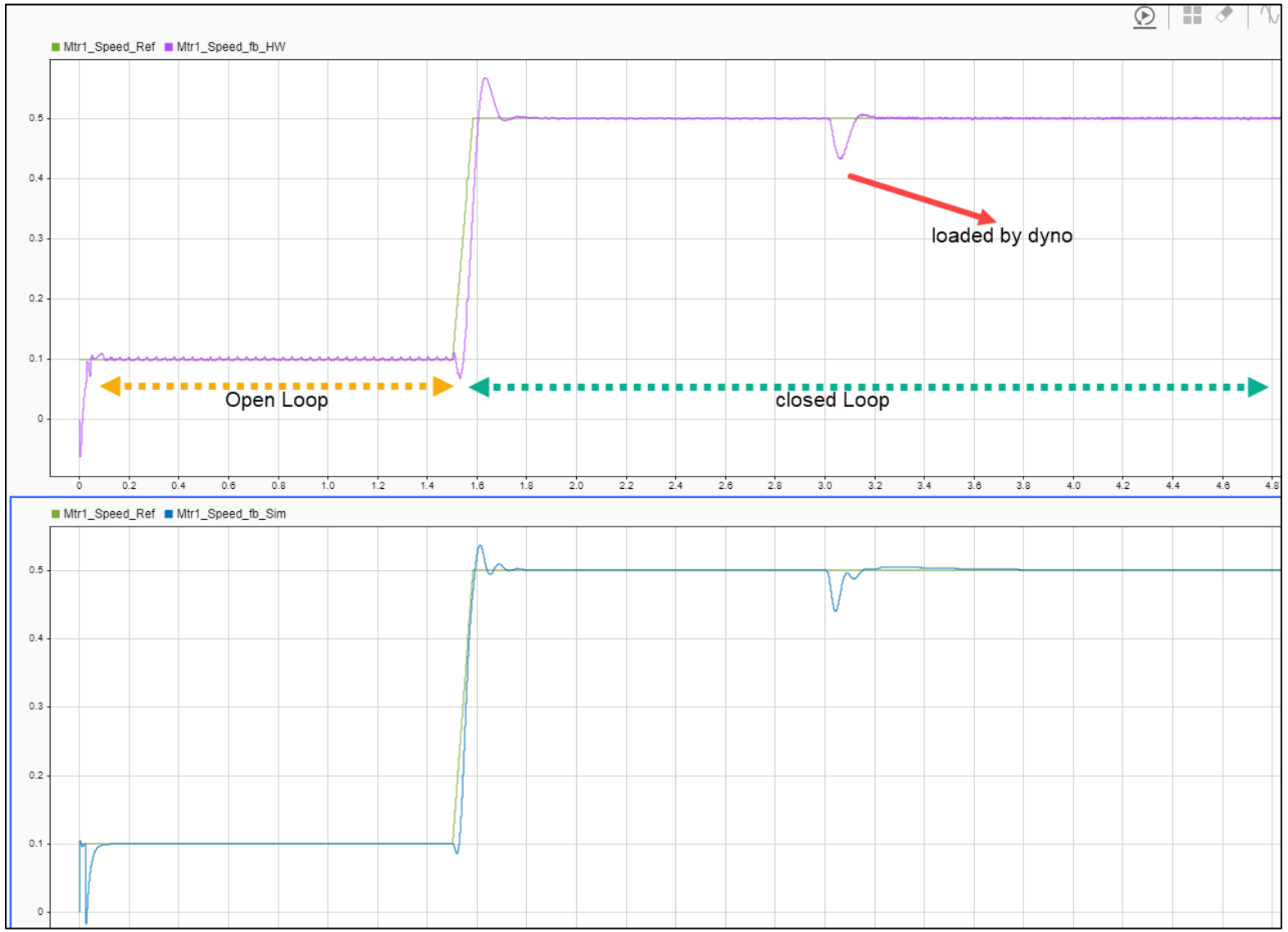
PWM Input

ADC Output

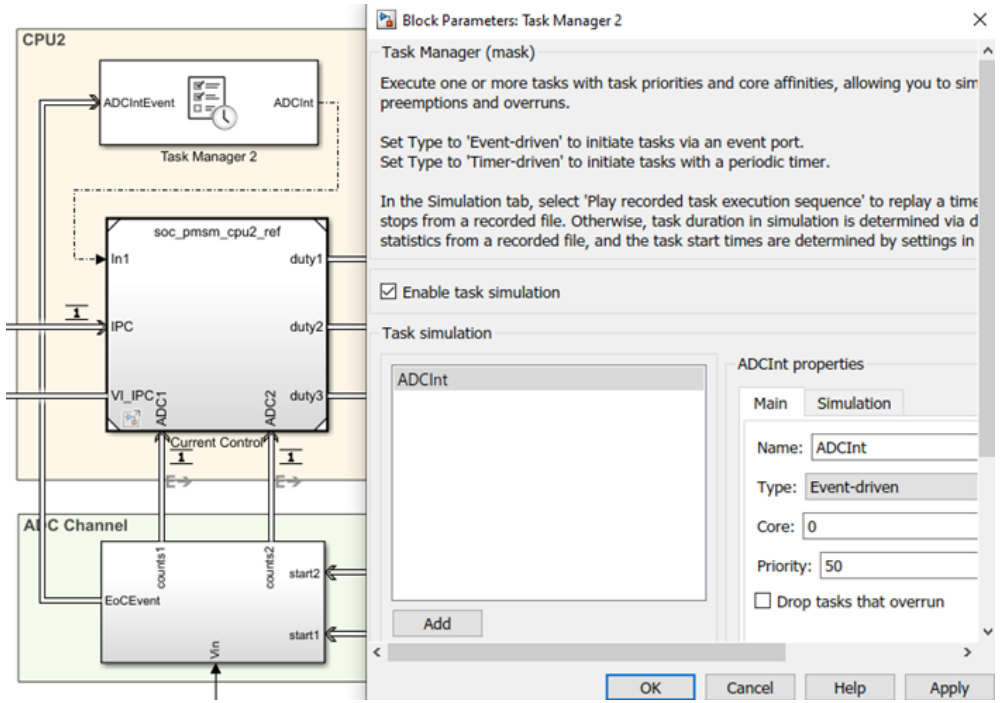
Hardware vs Simulation Analysis

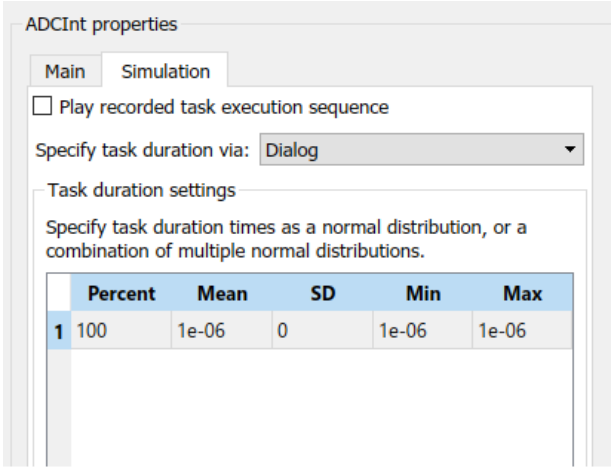
Captured HW signal using External mode

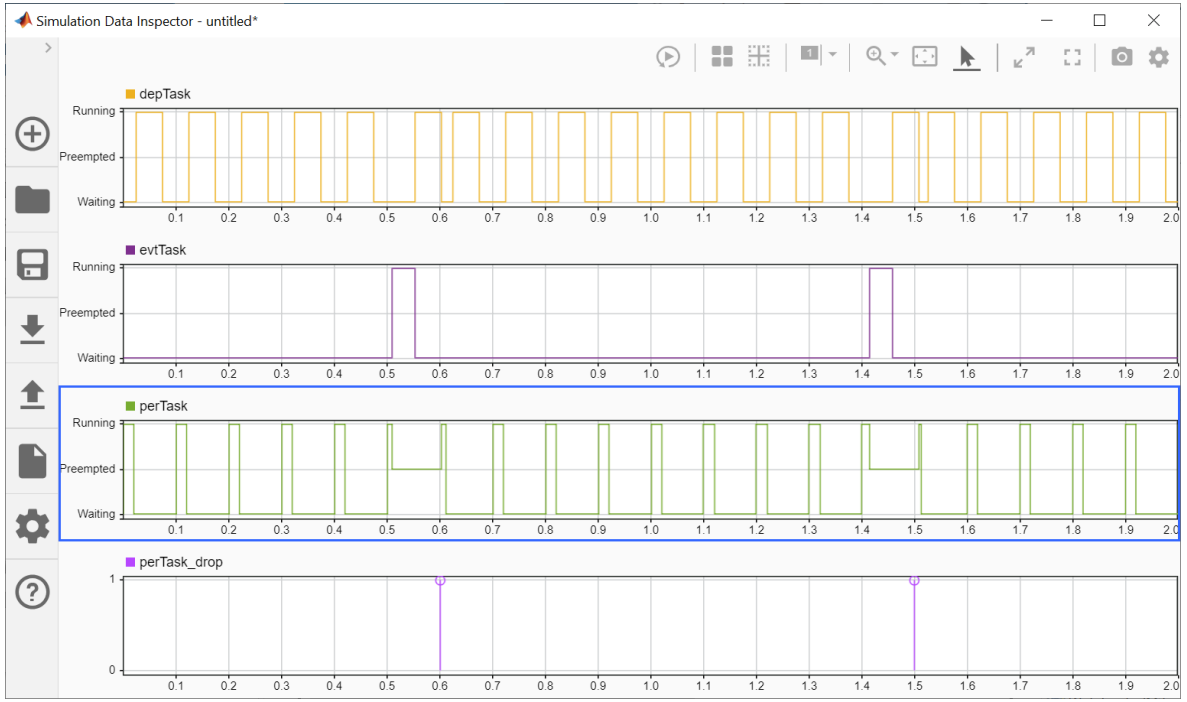
Simulation Result



Task Manager







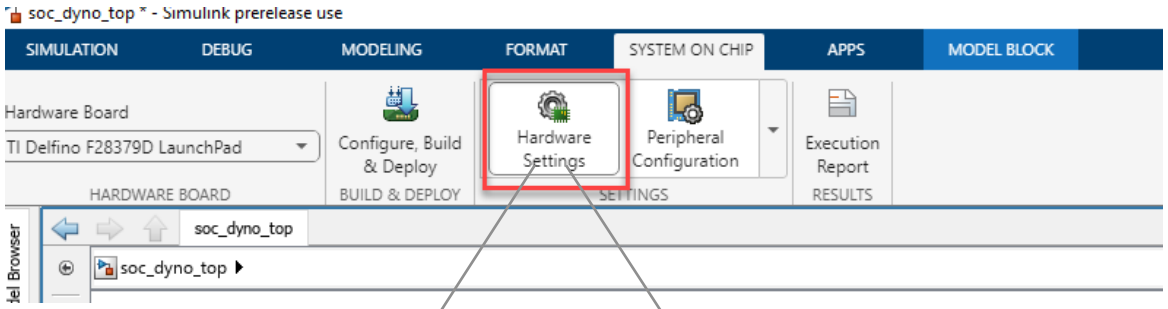
- Model/Simulate
  - Periodic/async tasks
  - Task priorities
  - Latencies
  - Duration as normal distribution

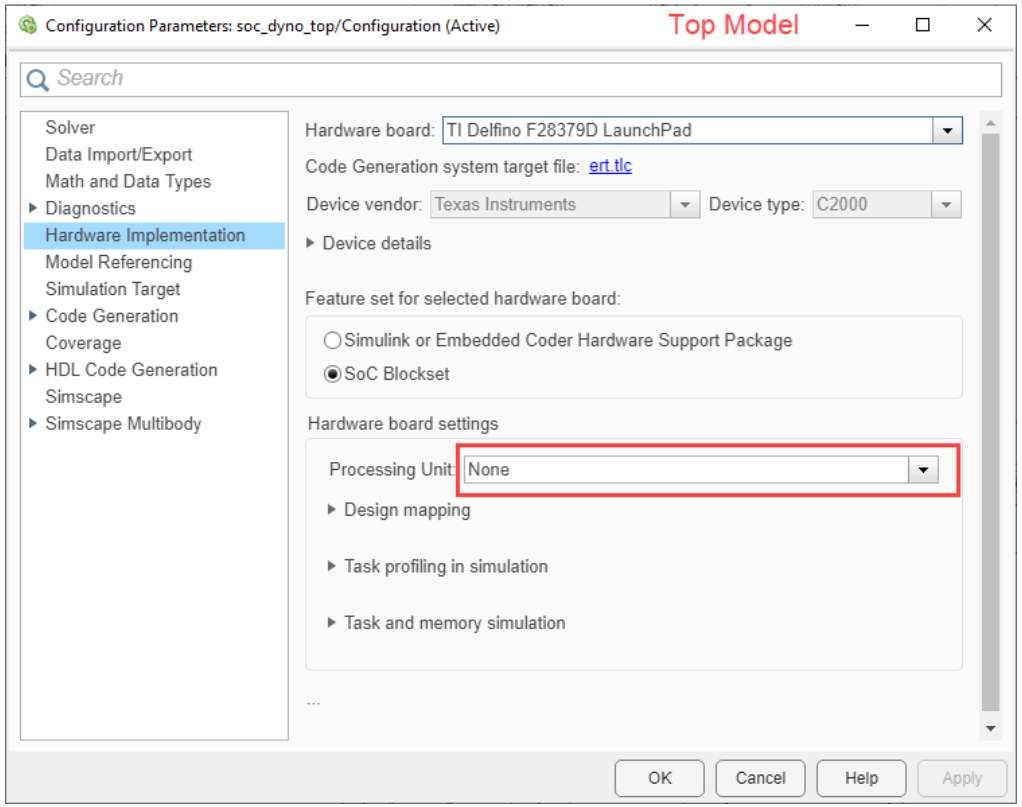
Task Manager
IPC
PWM
ADC

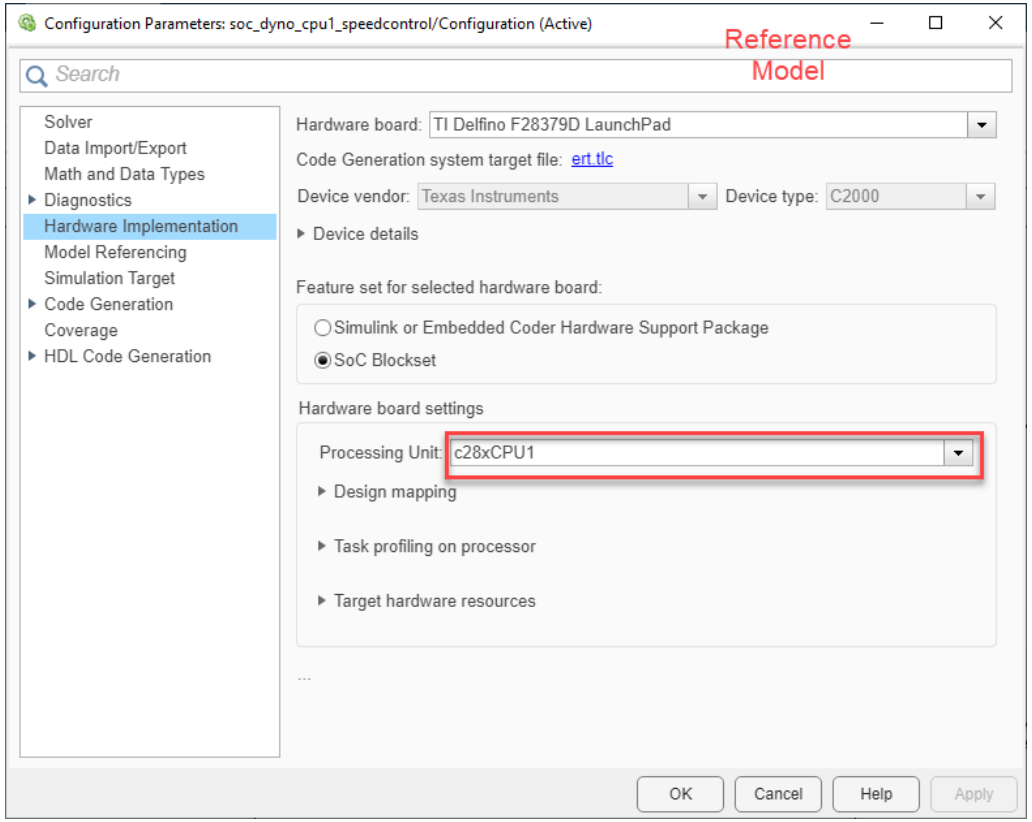
Model Configuration for Multicore Architecture

Top Model

- CPU #1 (c28xCPU1)
- CPU #2 (c28xCPU2)



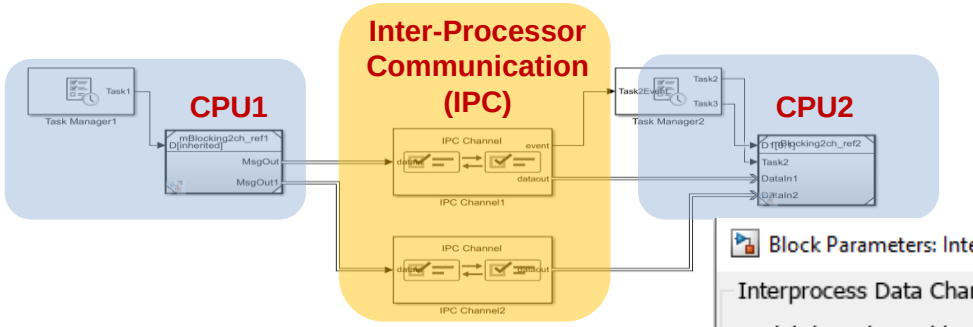


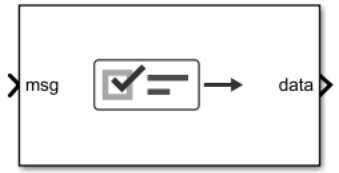


Inter-Processor Communication with **IPC Blocks**

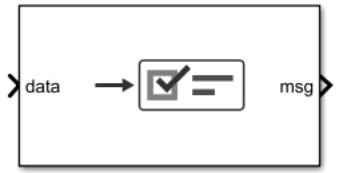
Task Manager
IPC
PWM
ADC

- Model the communication buffering and delay

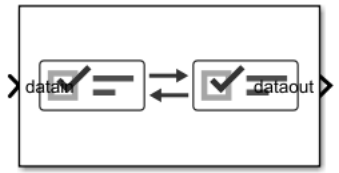




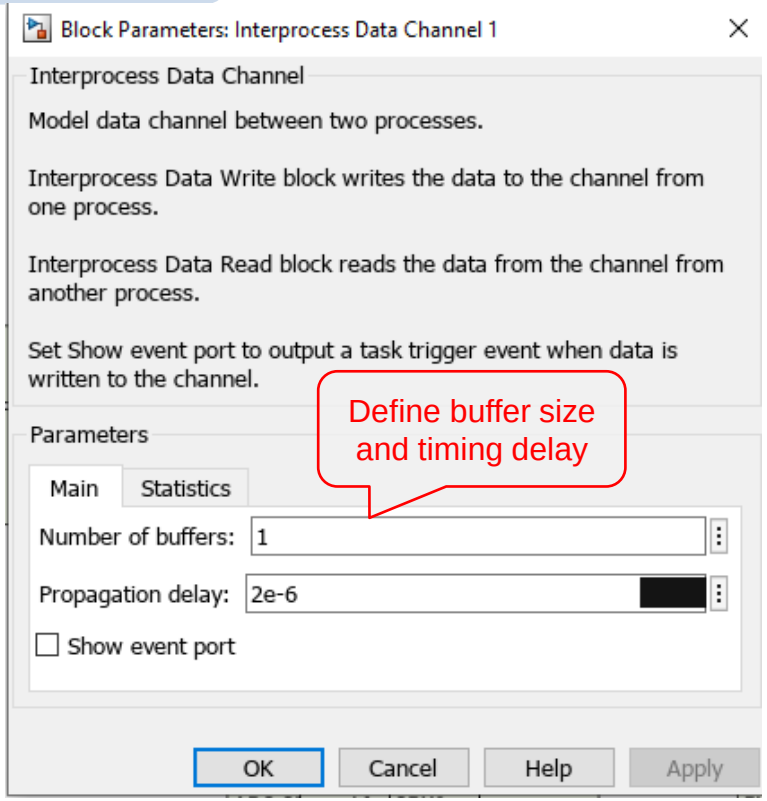
Interprocess Data Read

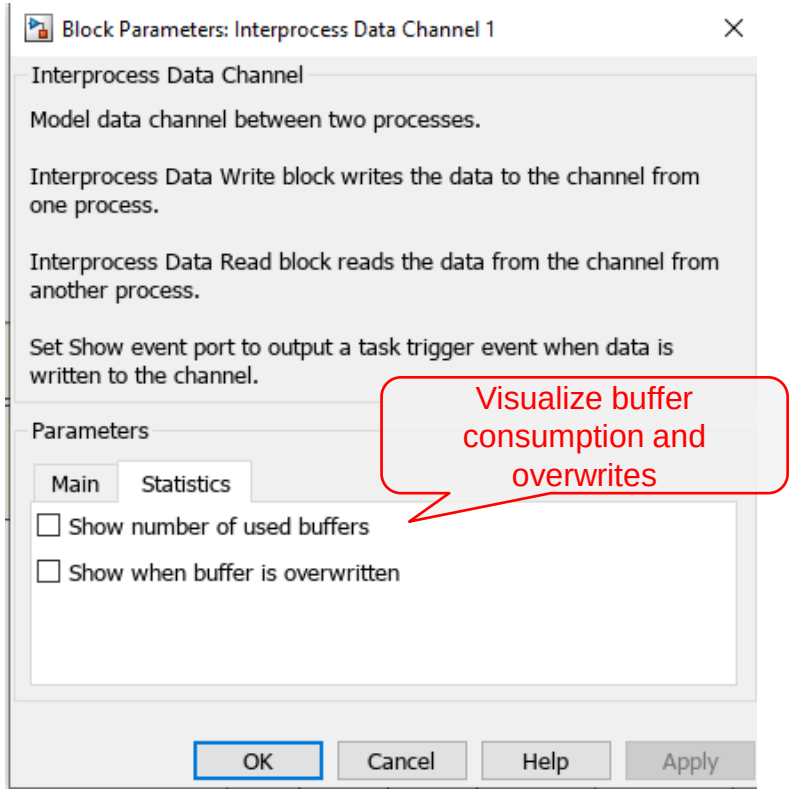


Interprocess Data Write



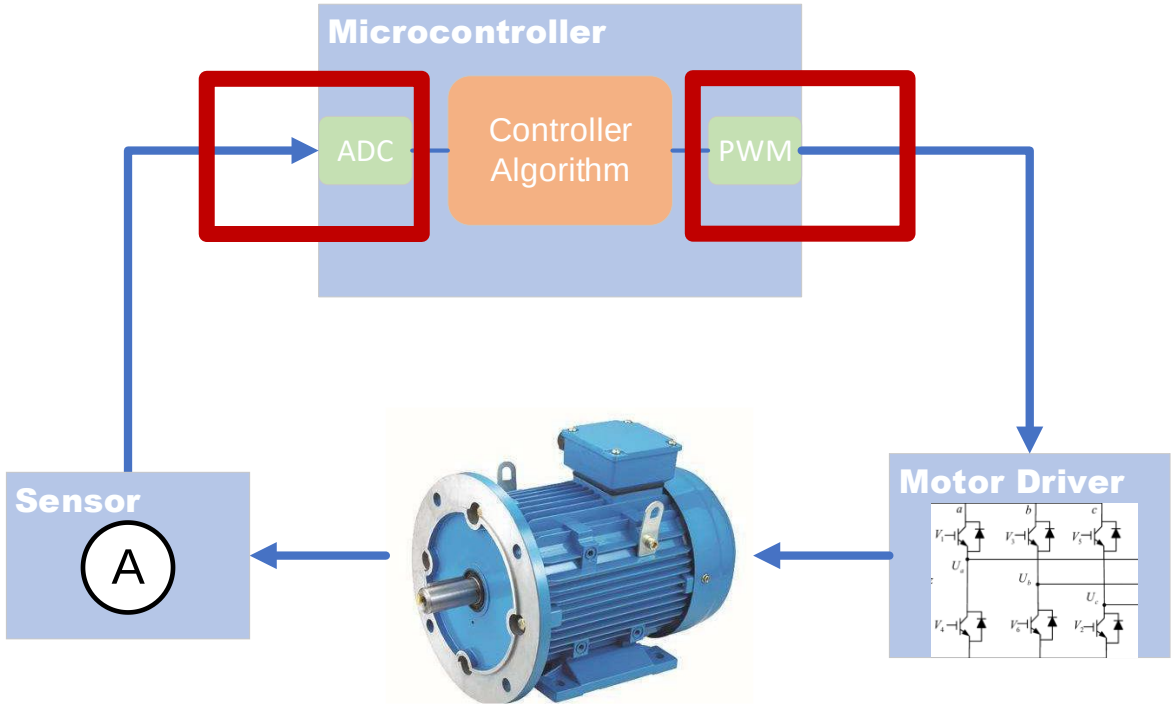
Interprocess Data Channel

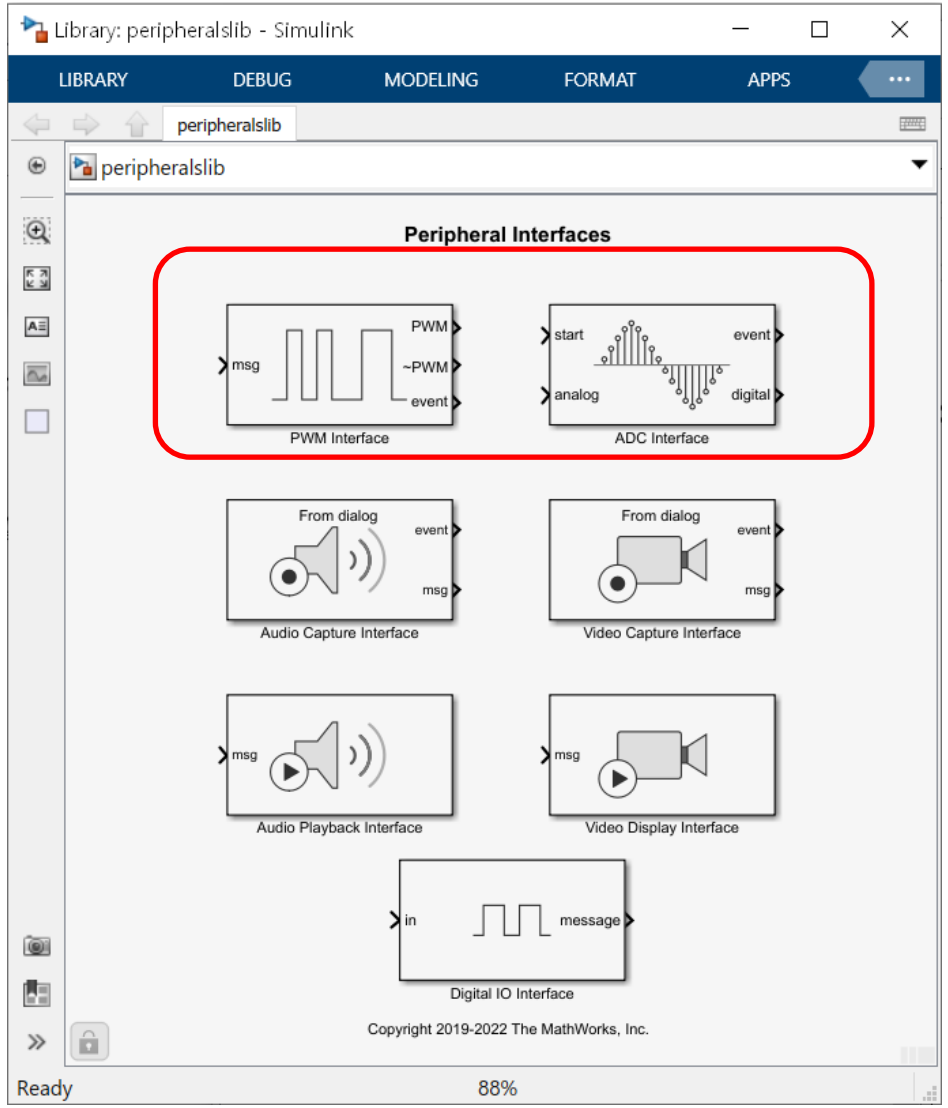




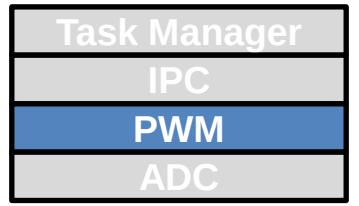
Motor control system modeling with **peripheral interface**

- Motor control peripheral interfaces

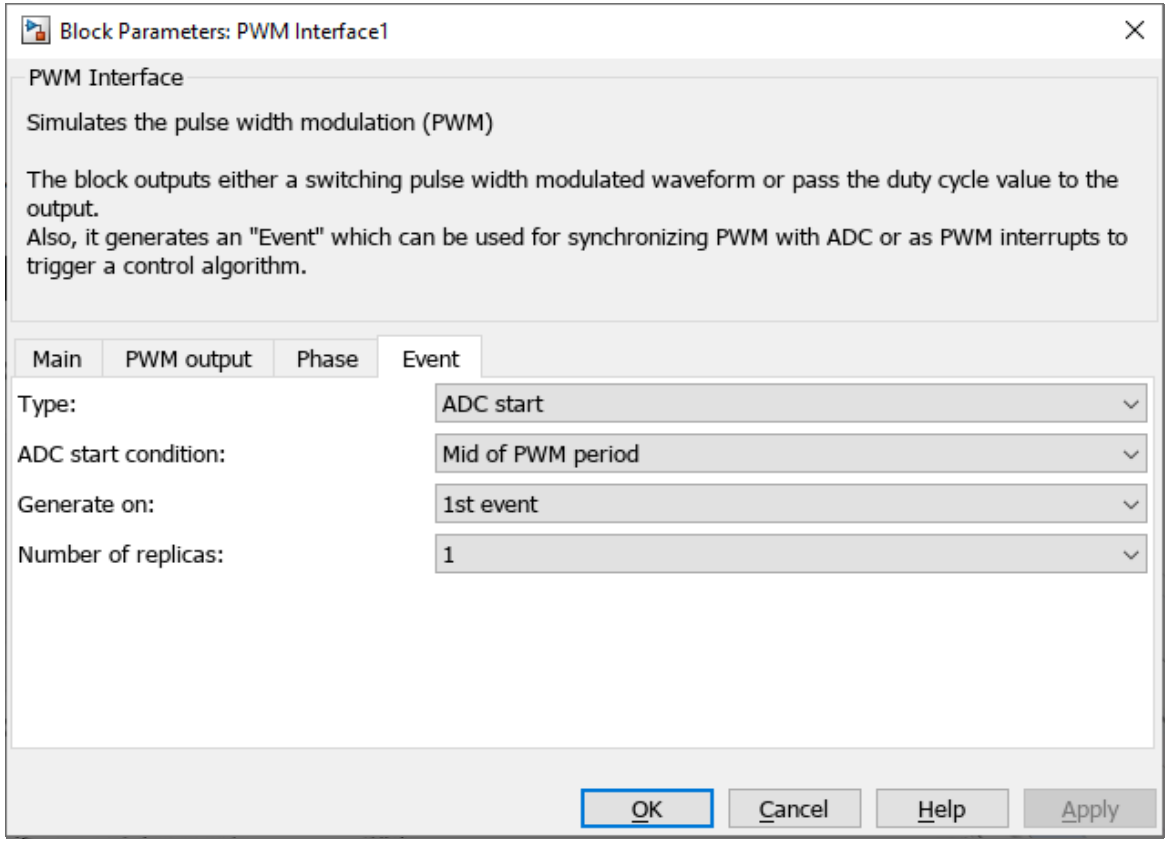


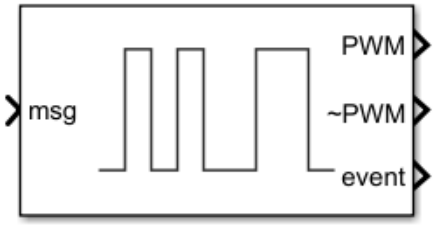


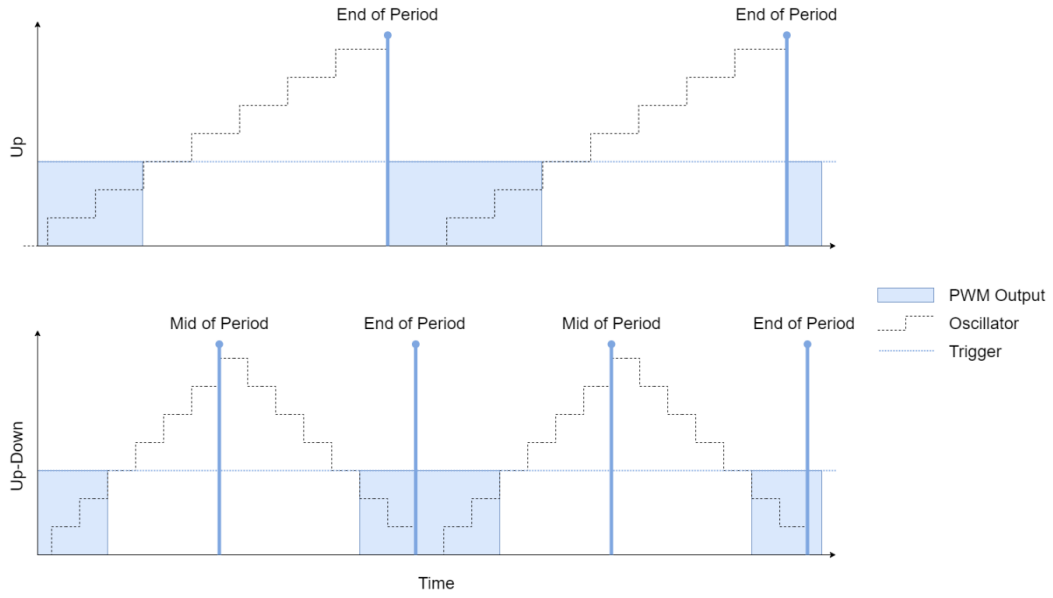
PWM Modeling



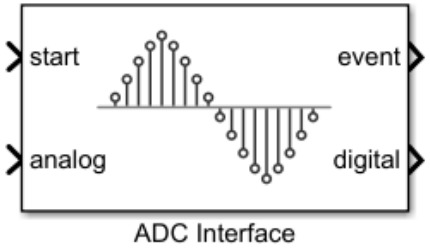
- PWM waveform simulation
- Event to synchronize with ADC or schedule a task



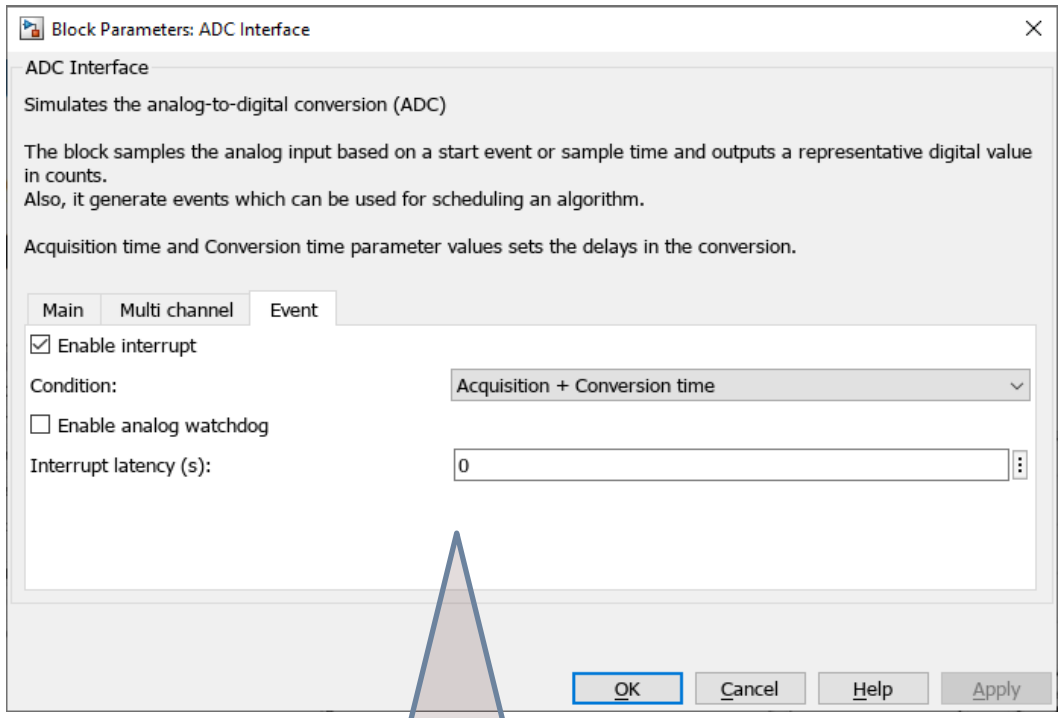


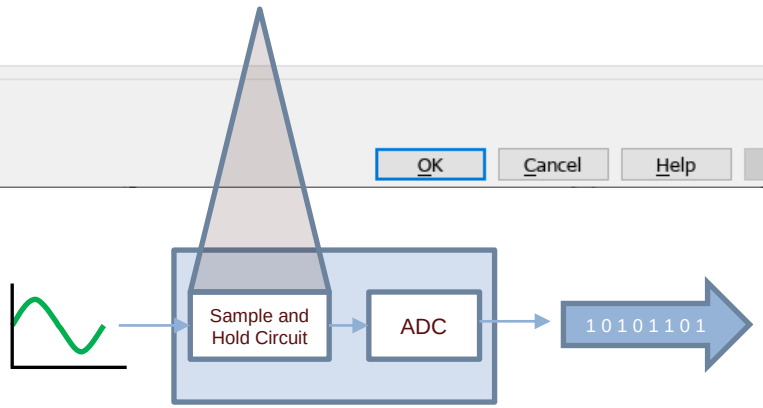


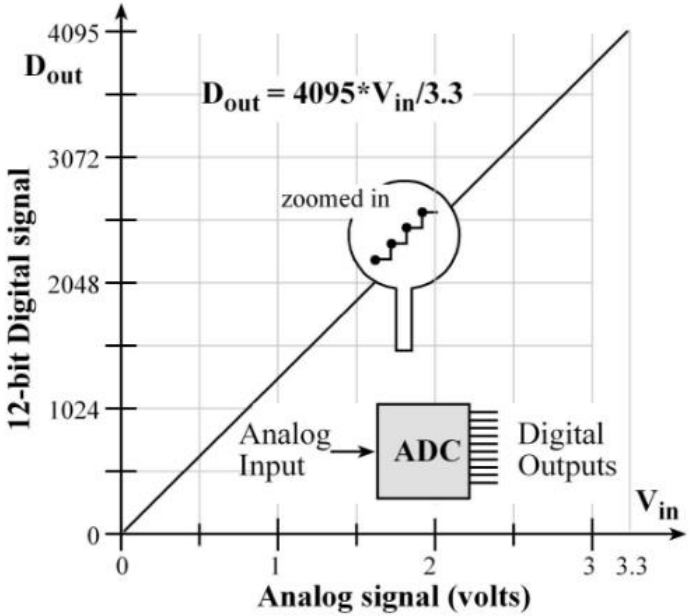
ADC Modeling

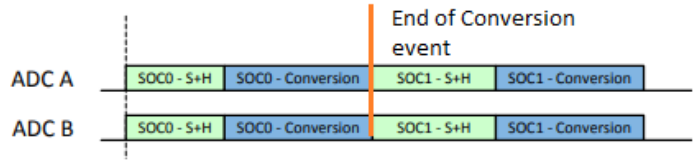


- Convert analog values to digital counts
- Model acquisition/conversion delays and trigger events

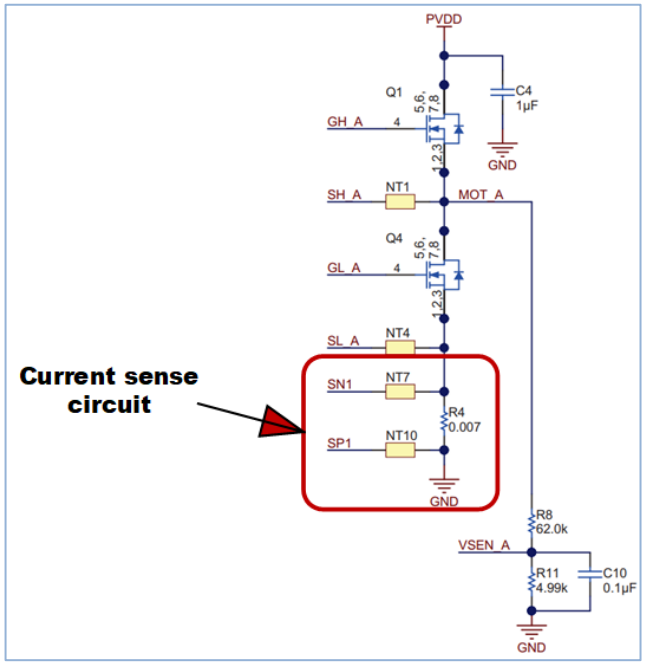


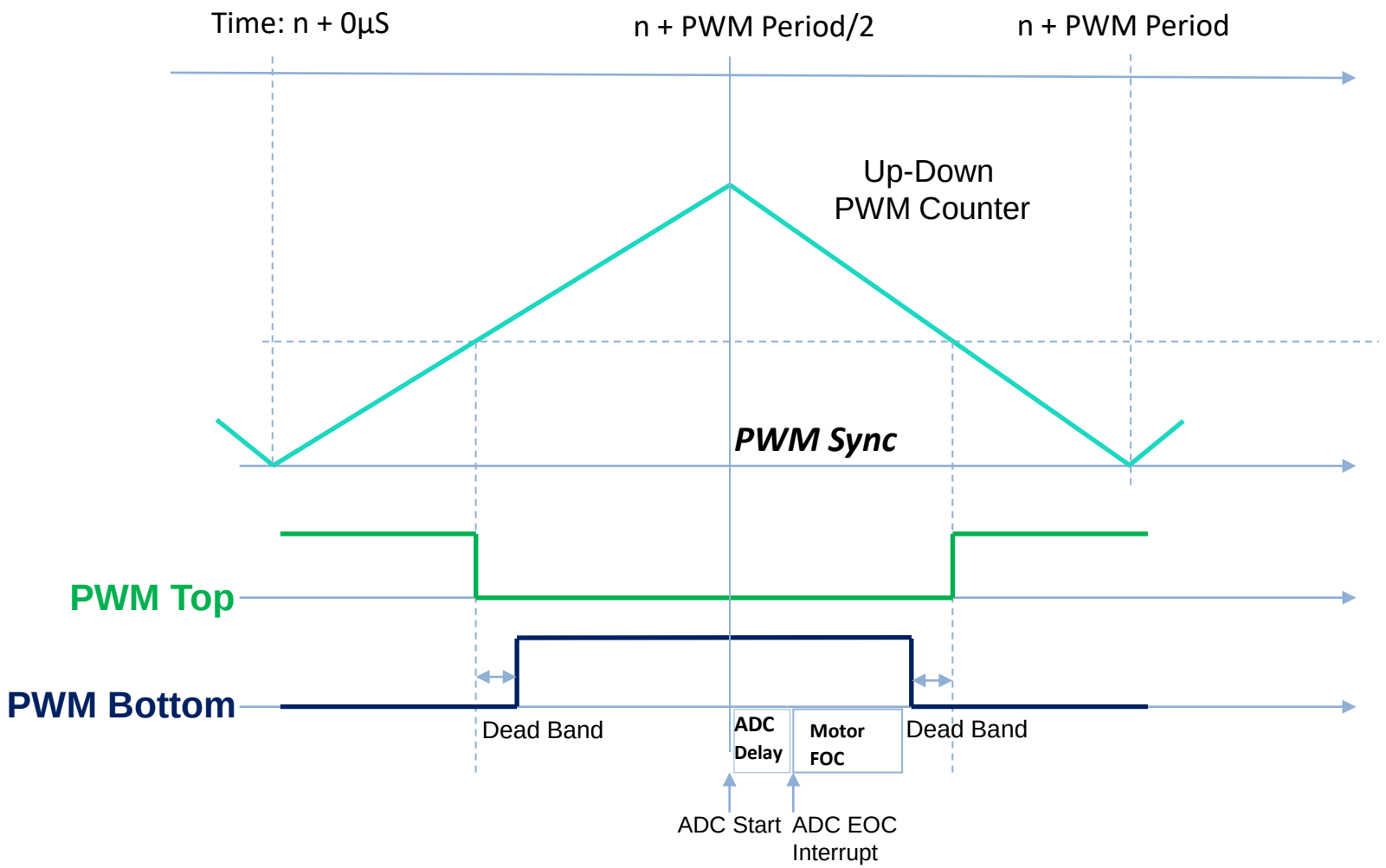






ADC – PWM Synchronization

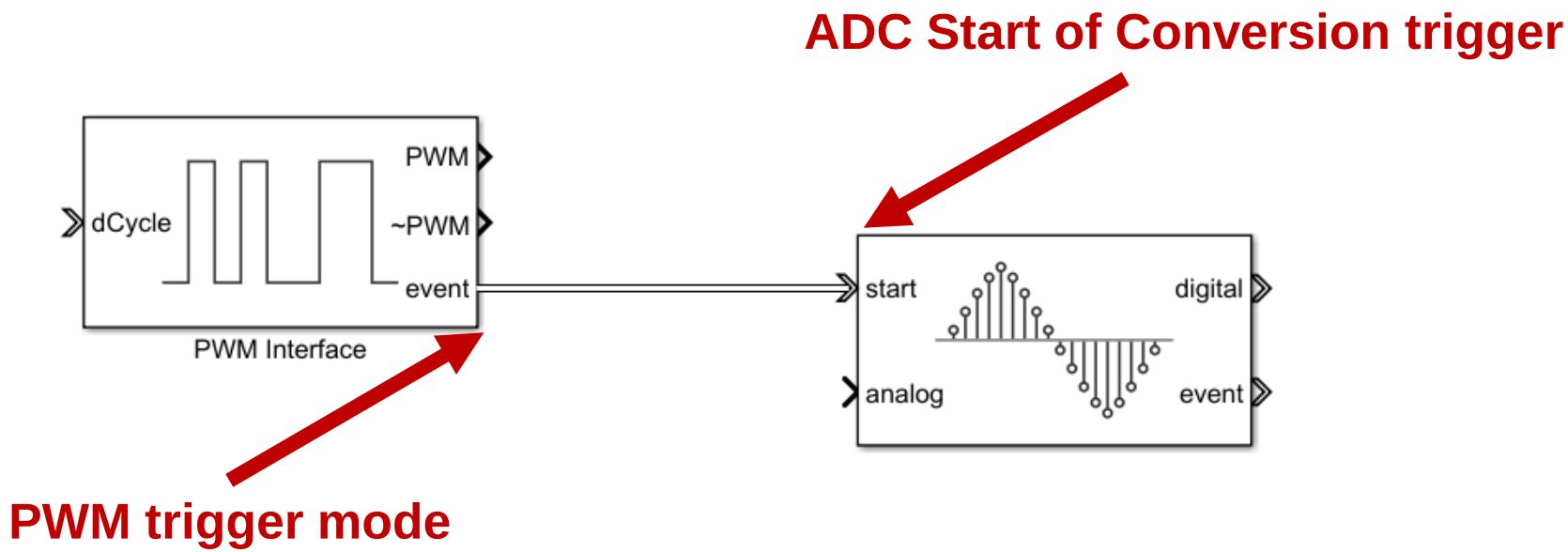




[Video: Adding MCU Peripheral Modeling in Motor Control Using SoC Blockset]

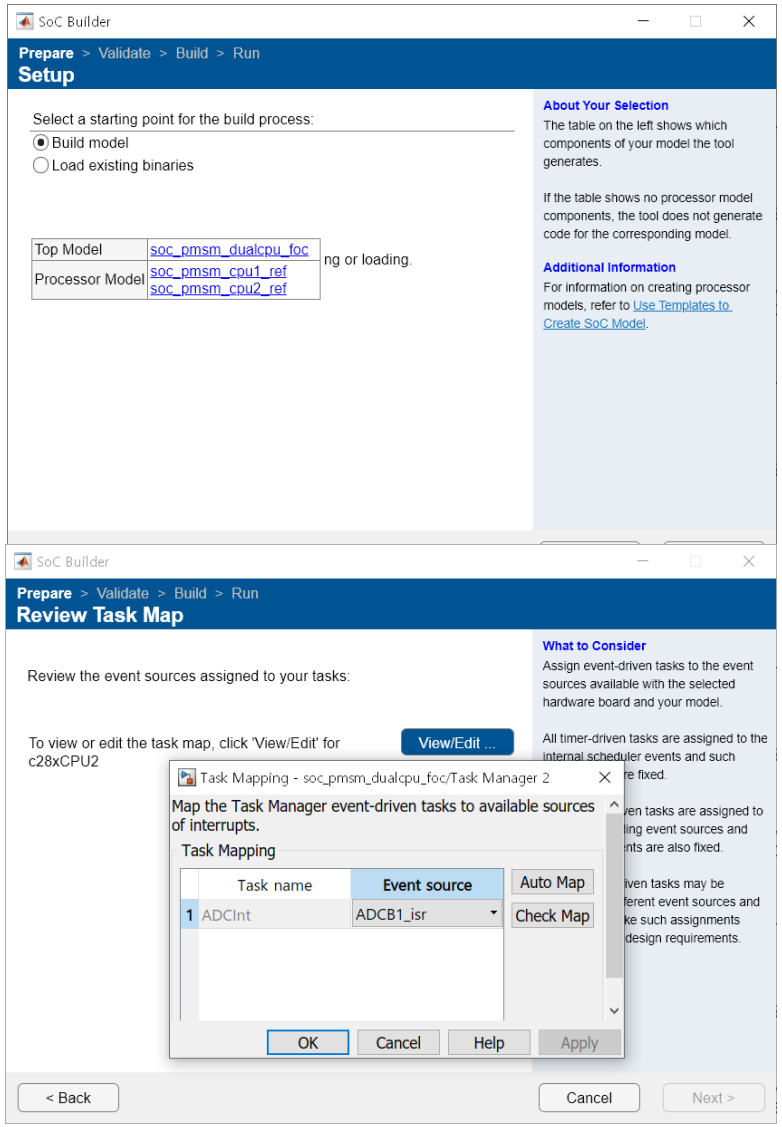
Enable ADC/PWM synchronization simulation

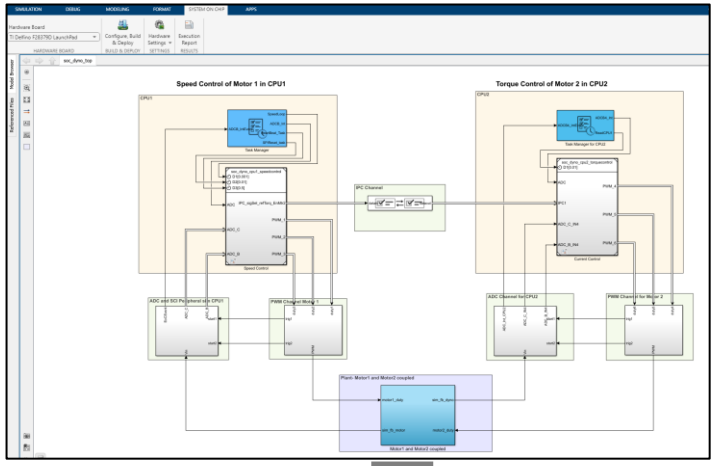
- To provide stable ADC input, the synchronization between ADC and PWM is required for close-loop motor control



SoC Builder App

Build, load, and execute SoC model on SoC, FPGA, and MCU boards

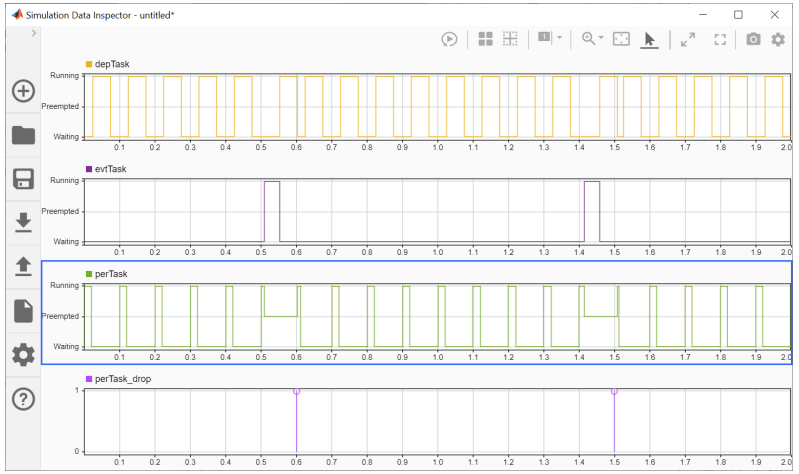


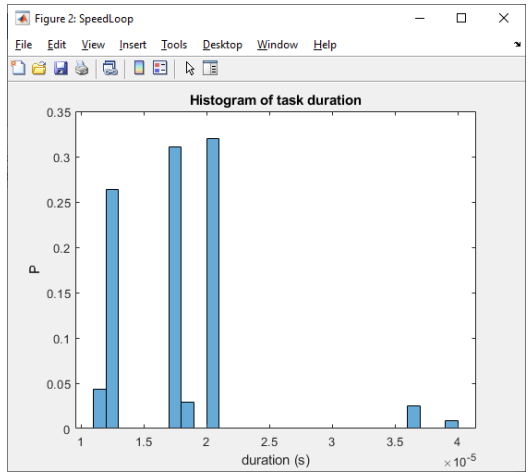


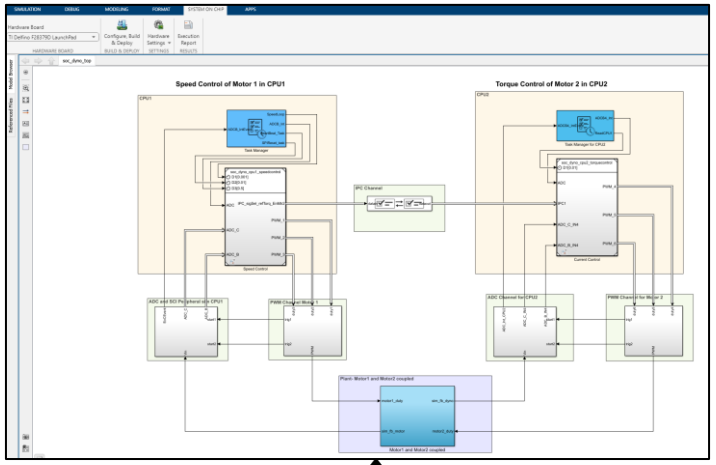
SoC Builder

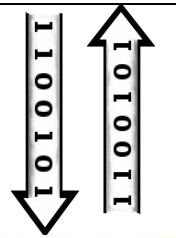
SoC Blockset Key Functionalities – On-Device Profiling

- Real-time performance profiling on hardware, including
  - Task execution
  - CPU utilization
  - Communication buffering and delay
  - Real-time SDI view
  - Analysis report



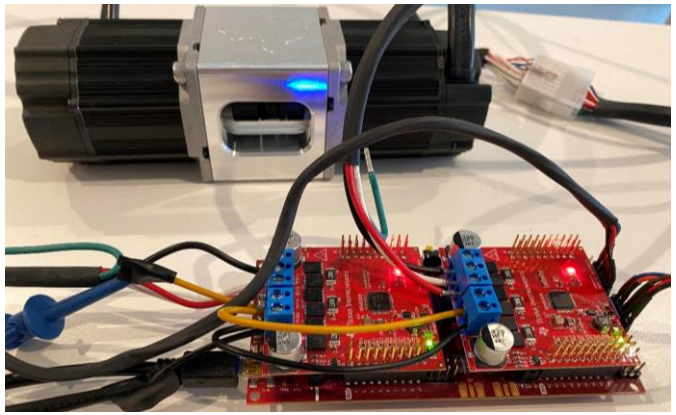


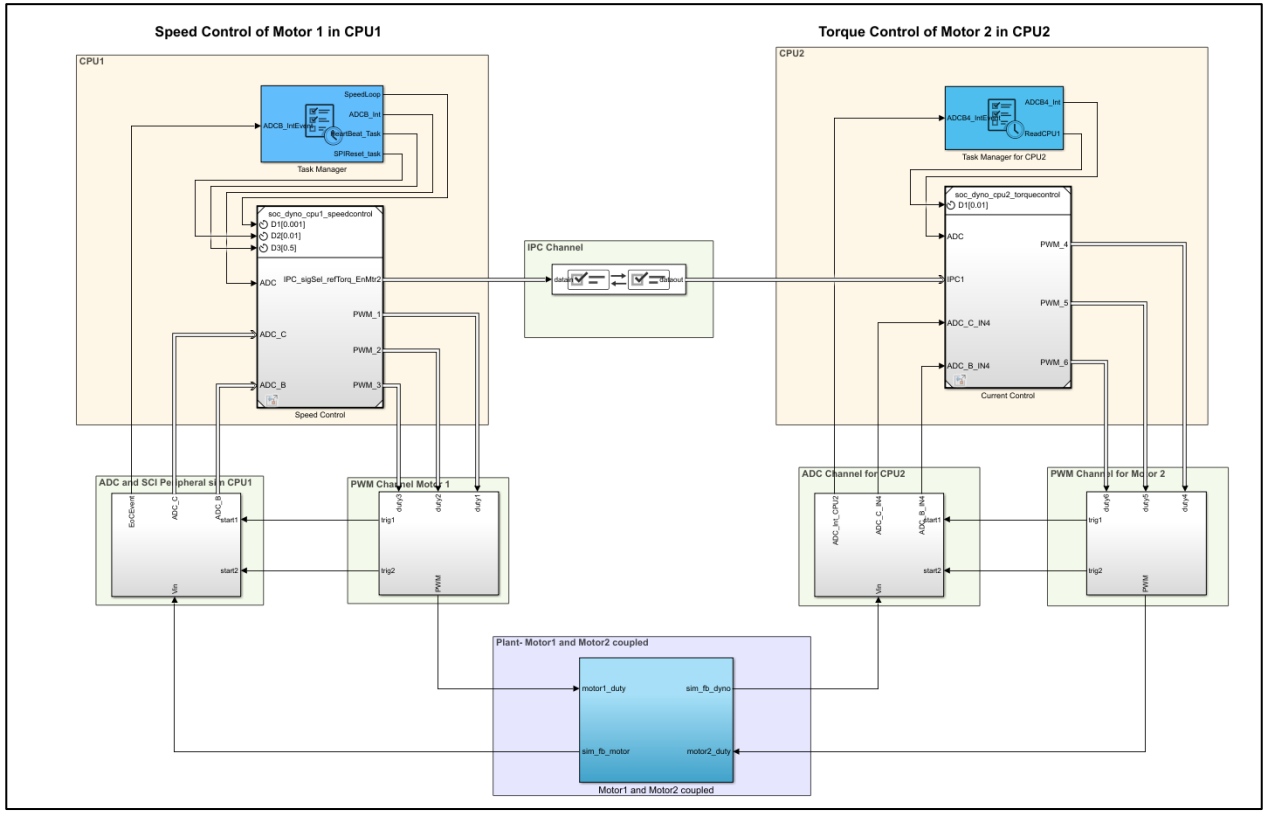




Wrap Up

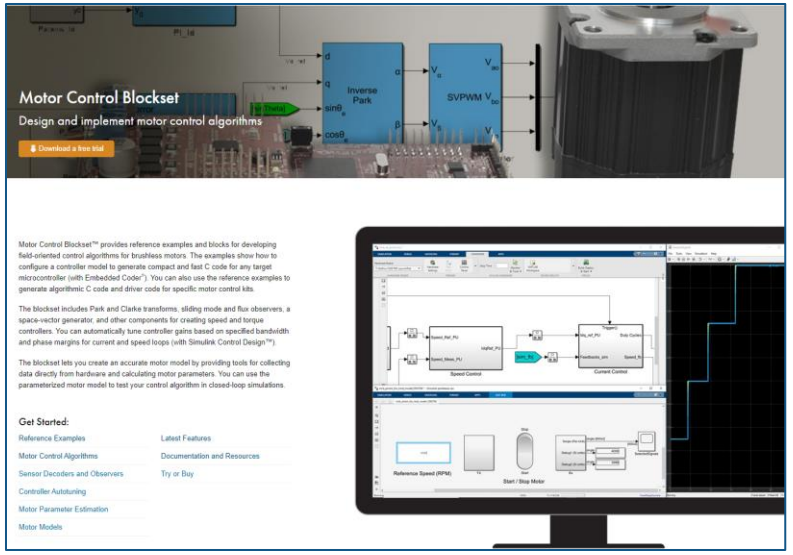
- Simulate sensorless field-oriented control (FOC) on a dyno setup
- Complete Model-Based Design workflow for multicore microcontroller
- Hardware component and device driver behavior simulation
  - Enhanced on-device profiling



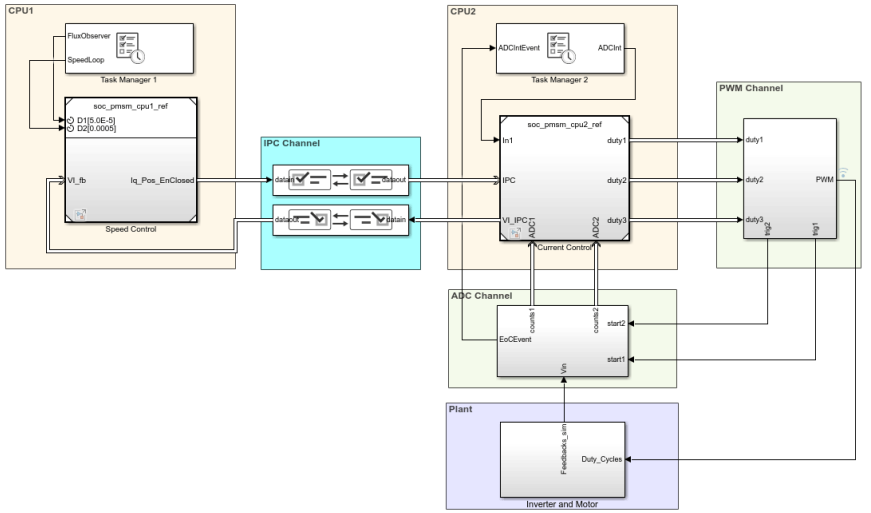


Learn More

- Recording webinars
  - Field Oriented Control Made Easy
  - Motor Control with TI Multicore MCUs Using Simulink
  - Implementing Motor and Power Electronics Control on an FPGA-Based SoC
- Shipping Demos
  - Partition Motor Control for Multiprocessor MCUs
  - Control PMSM Loaded with Dual Motor (Dyno)
  - Integrate MCU Scheduling and Peripherals in Motor Control Application



Field-Oriented Control on Dual CPU Processor



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