May, 2024 | Beijing

基于C2000™ Microcontroller Blockset 快速开发电机控制及数字电源产品

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MATLAB EXPO

Where is C2000 Real-time Control?

Energy Delivery

Solar Power

Charging Infrastructure

Wind Power

Digital Power

Telecom / Server
AC/DC Rectifiers

Uninterruptable
Power Supplies

DC/DC
Converters

C2000™
Real-time
Microcontrollers

Texas Instruments

Motor Control

Appliance

Drones

E-bike

Pumps

Industrial Drives

Robotics

Automation

Servo Drive

AC Drives

Sensors

Automotive

Power

Lighting

On-Board Charging

HV *DCDC*

Charging Stations

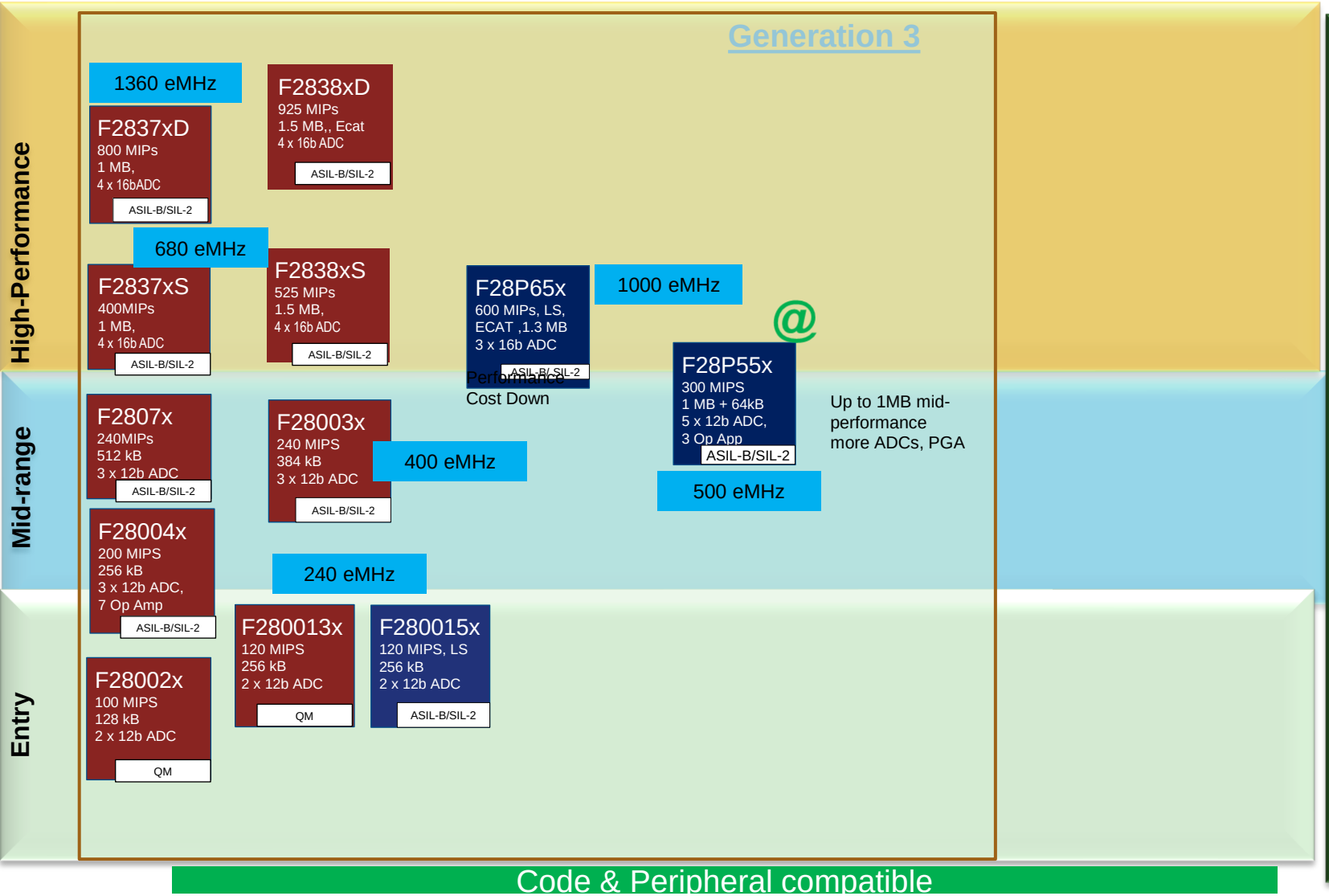
Motor

Traction Drive

Compressors

Pumps/ Power-Steering / Fans

C2000 Roadmap



C2000 Portfolio Offering

Broadest Portfolio of Real Time MCUs

- Software Compatible Portfolio
- Single core to Multi-core
- 32kB to 1.5MB Flash
- 6 to 36 PWM ch (150ps High-Res technology)
- Up to 40 ADC ch
- I2C, UART, SPI, CAN, CAN-FD, Ethernet, EtherCAT, USB
- Packages from 32 QFN (5x5mm), QFP, to 337 BGA
- Security, Safety Support, Industrial and Automotive

Flexible & Innovative Capabilities

- High Precision Analog Sensing & Feature Rich PWMs
- Floating-point DSP-Efficient CPU, Control Accelerators, & Parallel Multi-Core Processing
- TMU, FPU, & CLA for More Performance
- CLB for Peripheral Customization, FSI for high-speed communication, ERAD for Enhanced Diagnostics and Profiling
- Enabling GaN & SiC Technologies

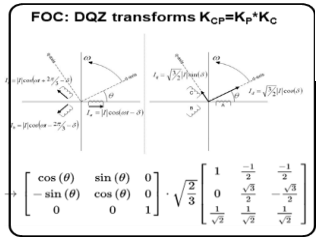
Real-time Control Systems Made Easy

- Over 25 Years of Expertise in Real-Time Control Systems
- Extensive Library of Public Reference Designs
- SysConfig, Free RTOS, Academy and Hardware Tools to Jump-Start your Design and Shorten the Time Between Evaluation and Production

eMHz: equivalent MHz for a Cortex-M7 based device to achieve same real-time signal chain performance as C28x based device

@ AI engine

C2000 strengths



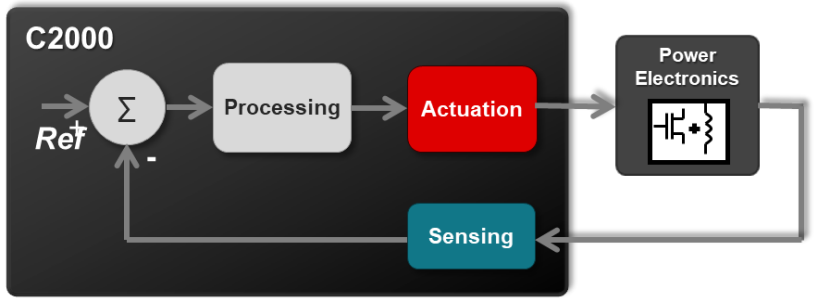
85% Improvement With TMU

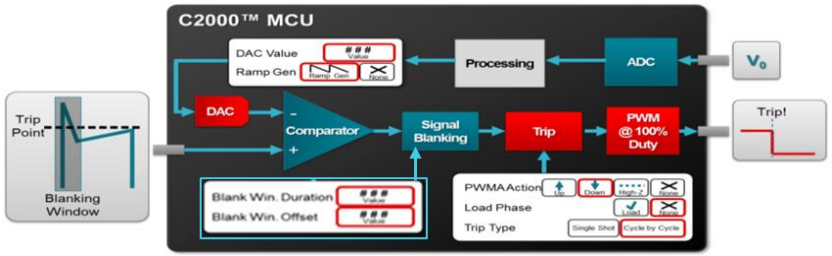
- **Quality MIPS Processing**
  - Floating point (32b/64b) DSP math
  - Control Law accelerator (Background loop)
  - Trigonometric Math Unit (TMU)
  - Viterbi Complex math & CRC Unit (VCU)
  - CPU+CLA pairs & multi-loops in parallel
  - Predictable shortest latency

- **Robust Connectivity**
  - Fast Serial interface, for reliable & high speed connection
  - 100Mbps EtherCAT including support for TwinCAT PLC
  - 100Mbps Ethernet IEEE 1588 PTP

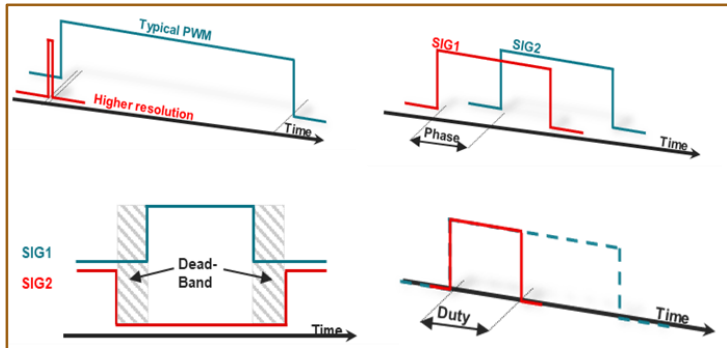
- **Safety :** ECC memory, Redundancy, ASIL-B, SIL-2 Safety
- **Security:** DCSM, Secure Boot, JTAG Lock, AES

- **Shortest Predictable latency system arch.**
  - Optimal latency architecture for peripherals & memories
  - Highly interconnected trip-trigger circuits





- **Fast & Precise Sensing**
  - 12b/16b ADC, post processing, early interrupt
  - Autonomous triggering & trip operation
  - Fast comparator (< 50ns), Windowed Comp
  - O/P filtering & blanking; Peak Current Mode Control
  - Simultaneous ADC-Comp
  - Fault protection with Comp Trip



- **Flexible & high resolution actuation**
  - High resolution duty, phase, dead-band, period control
  - Flexible Action Qual., Trip-zone config.
  - Shadow registers, one shot or global loading
  - PWM phase, timer Synchronization
  - Cycle by cycle trip, One shot trip
  - Advanced protection and control

- **Configurable Logic Block (CLB)**
  - Custom logic building including state-machines, sequencers, counters etc.
  - Extensive connections across device resources with flexibility to place logic as required

Digital Power: AC/DC, DC/AC, Bi-directional solutions

Type	Topology	TI Reference Design #	Power Rating	Input	Output	Efficiency	Supported C2000 Products
DC/AC	1Ph DC/AC	TIDM-HV-1PH-DCAC	600W	400VDC	110Vac/ 220Vac	98%	F28004x F2837x
AC/DC	2PH Interleaved PFC w/ Power Metering	TIDM-2PHILPFC	700W	110Vac/ 220Vac	400VDC	97%	F2803x
AC/DC	Valley Switching Boost PFC	TIDM-1022	750W	110Vac/ 220Vac	400VDC	92%	F28004x
AC/DC	CCM totem pole bridgeless PFC and half-bridge LLC	TIDA-010062	1kW	110Vac/ 220Vac	12VDC	99%	F28004x
AC/DC	Totem-Pole CrM PFC	TIDA-00961	1.6kW	85-265Vac	400VDC	99%	F28004x
AC/DC	Vienna Rectifier-based 3Ph PFC	TIDM-1000	2.4kW	110Vac/ 220Vac	600VDC/ 700VDC	98%	F2837x F28004x F2838x
Bi-directional AC/DC DC/AC	Bi-Directional 3Ph Interleaved Totem-Pole CCM PFC/Inverter	TIDM-02008	3.3kW	110Vac/ 220Vac	380VDC	98%	F28004x F28307x
				380VDC	120Vac/ 220Vac		
AC/DC	3Ph Interleaved Totem-Pole CCM PFC	TIDA-01604	6.6kW	110Vac/ 220Vac	400VDC	98%	F28004x
Bi-directional AC/DC DC/AC	3Ph PFC/Inverter Full-bridge	TIDA-01606/TIDA-010039	10kW	800VDC/ 1000VDC	400VAC	98%	F2837x
				400VAC	800VDC/ 1000VDC		

Digital Power DC/DC, Bi-directional solutions sorted by power rating

Type	Topology	TI Reference Design #	Power Rating	Input	Output	Efficiency	Supported C2000 Products
DC/DC	Peak Current Mode Control PSFB Converter	TIDM-02000	300W	200-400VDC	12VDC	92%	F28004x
DC/DC	2Ph Interleaved LLC	TIDM-1001	500W	370-410VDC	12VDC	95%	F2837x F28002x
DC/DC	2PH Interleaved Boost Converter with isolation	TIDM-SOLAR-DCDC	500W	200-300VDC	400VDC	94%	F2803x
DC/DC	Phase Shifted Full Bridge	TIDM-PSFB-DCDC	600W	380-400VDC	12VDC	95%	F2802x
DC/DC	Bi-directional Full-Bridge Boost Converter	TIDA-00951	2kW	48VDC	400VDC	94%	F2803x
DC/DC	CLLC Resonant Dual Active Bridge (DAB)	TIDM-02002	6.6kW	400-600VDC	280-450VDC	98%	F28004x
DC/DC	Dual Active Bridge (DAB)	TIDM-010054	10kW	700-800VDC	380-500VDC	98%	F28004x
DC/AC DC/DC	EV Traction Inverter + DC/DC	TIDM-02009	10kW	400VDC	12VDC		F2838x

Motor control solutions

Development Kits

BOOSTXL-3PHGANINV	F2837x, F28004x, F28002x
BOOSTXL-DRV8320RS	F28004x
BOOSTXL-POSMGR	F2838x, F2837x, F28004x, F28003X, F28002X
Servo Drive with CAN Interface	F28004x, F28003X, F28002x
TIDM-02006 - Multi-Axis Drive Over FSI	F2838x, F28004x, F28002x
TMDSHVMTRINSPIN	F28004x
TMDXIDDK379D	F2838x, F2837x, F28004X, F28002X
Universal Motor Control Lab	F28003x, F28002X, F280013X, F280015X

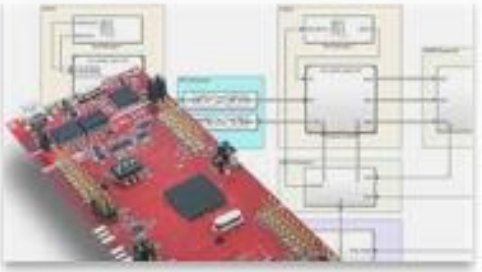
Solutions for TI C2000 MCUs(Previous)

Embedded Coder Support Package for TI C2000

Design, simulate and deploy Simulink models on TI C2000 processors, useful for quick prototyping all the way to production

Motor Control Blockset

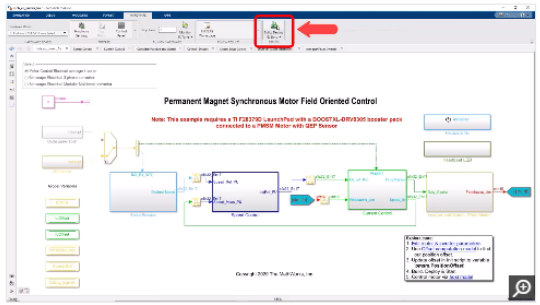
Simulate and generate code for control algorithms against motor and inverter models at all levels of fidelity



SoC Blockset Support Package for TI C2000

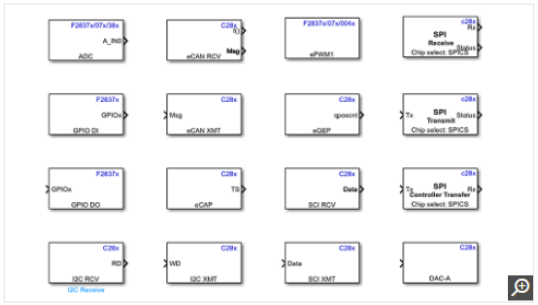
Multicore and peripheral modeling and targeting for TI C2000 multicore MCUs.

C2000 Microcontroller Blockset (New!)



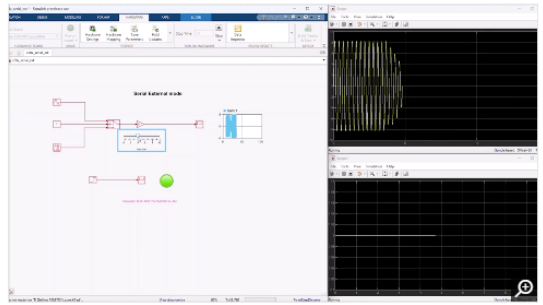
设计和部署 C2000 微控制器应用

对嵌入式应用软件进行建模，从您的模型生成实时可执行文件，并在 C2000 微控制器上运行它们。



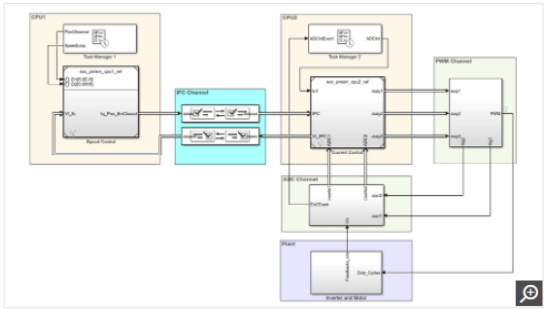
外围设备支持

对使用片上和板载外设（如 ADC、数字 I/O、ePWM、SPI、I2C、eCAP、eQEP 等）的应用进行建模。



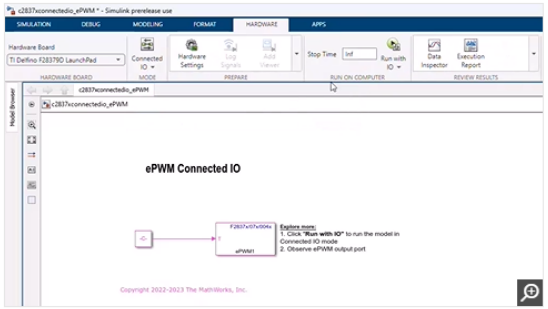
信号监控和参数调节

使用“监控和调节”功能执行实时信号监控和参数调节。



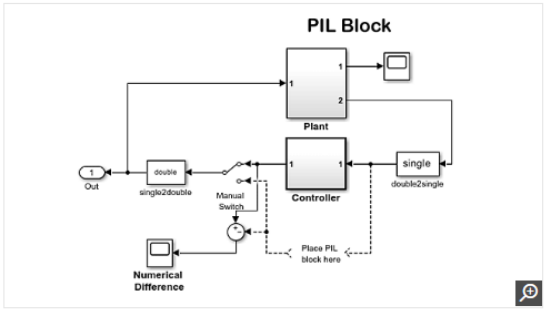
多核架构建模

使用 IPC 和控制率加速器 (CLA) 模块对用于多核执行的算法进行分区。



连接 I/O 仿真

将您的 Simulink 模型直接连接到支持的硬件以进行实时 I/O 数据交换。



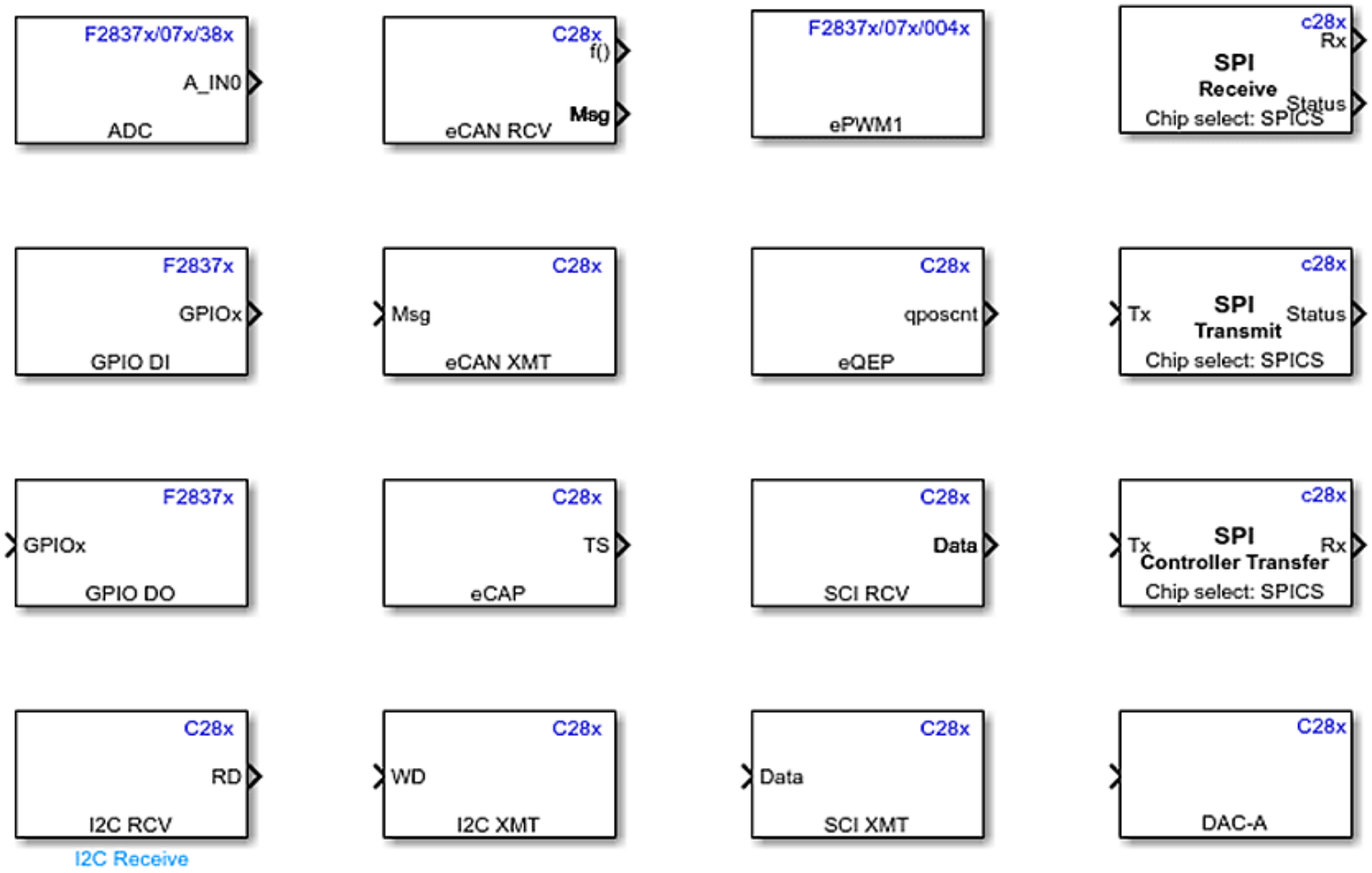
代码验证和确认

使用带有执行性能分析的处理器在环测试（需要 Embedded Coder）执行代码验证和确认。

Supported C2000™ Microcontroller Families

TI C2000 Generation 2 Microcontrollers	TI C2000 Generation 3 Microcontrollers	TI C2000 Concerto Microcontrollers
• F2806x • F2805x • F2803x • F2802x • F2833x • F281x • F280x • F2834x	• F2838xD • F2838xS • F2837xD • F2837xS • F28004x • F28002x • F2807x • F28003x • F280015x • F280013x • F28P65x	• F28M35x • F28M36x

Extensive Peripheral Support

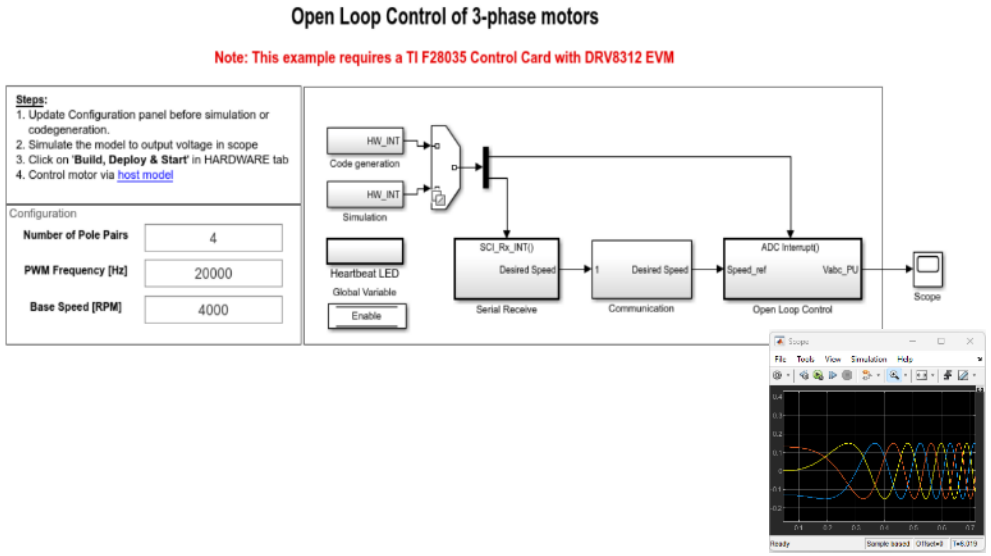


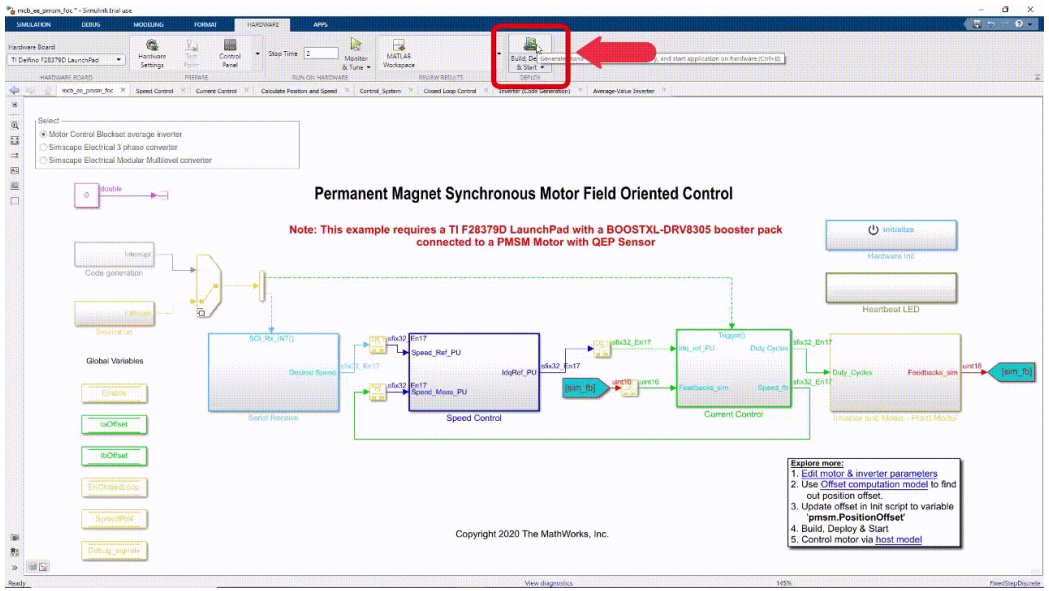
What is C2000 Microcontroller Blockset?

Design, simulate and implement applications for TI C2000 MCUs

video

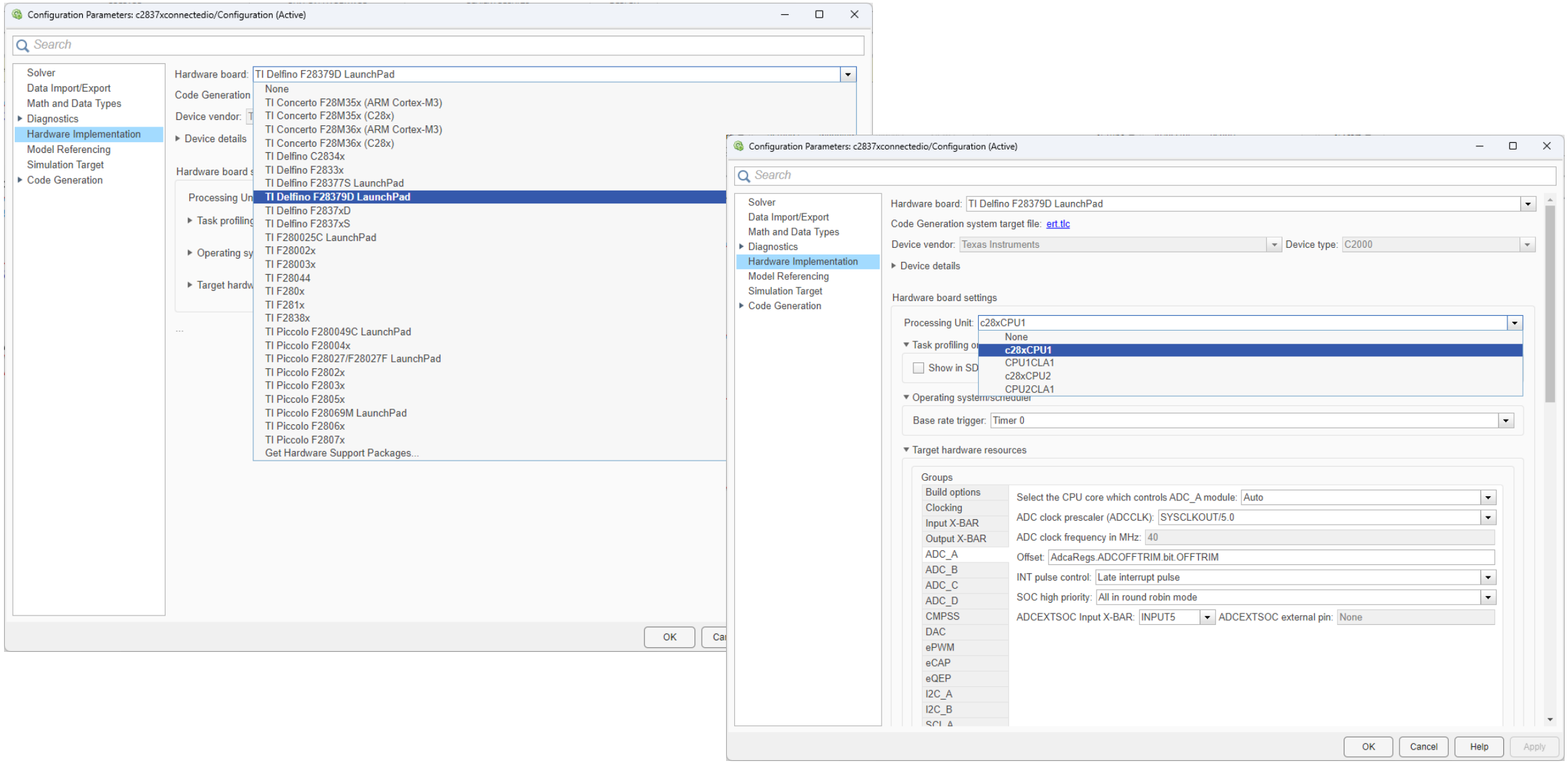
Design **Simulate** **Implement**



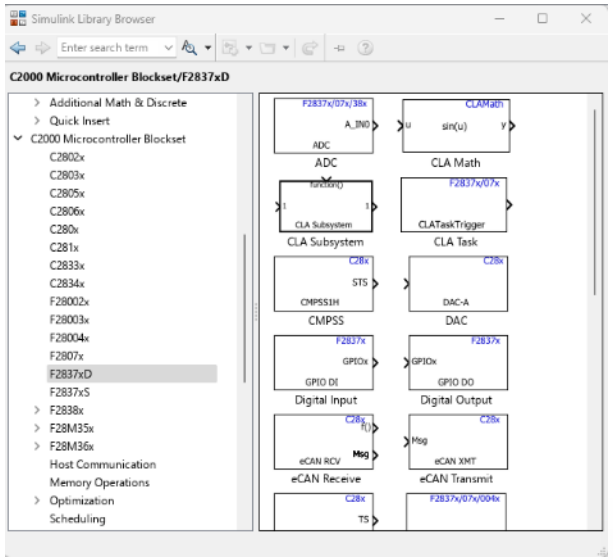


https://www.mathworks.com/products/ti-c2000-microcontroller.html

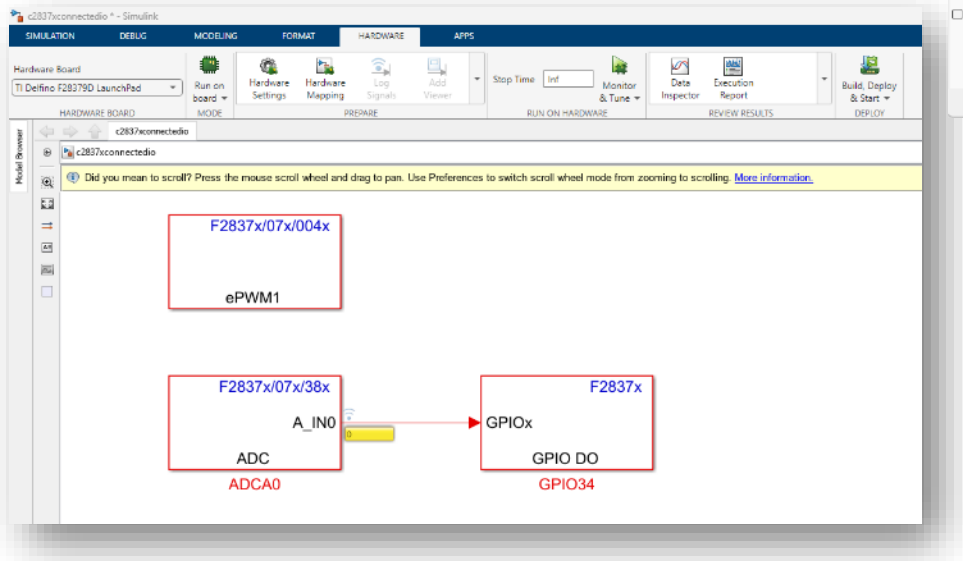
Configure C2000 Hardware

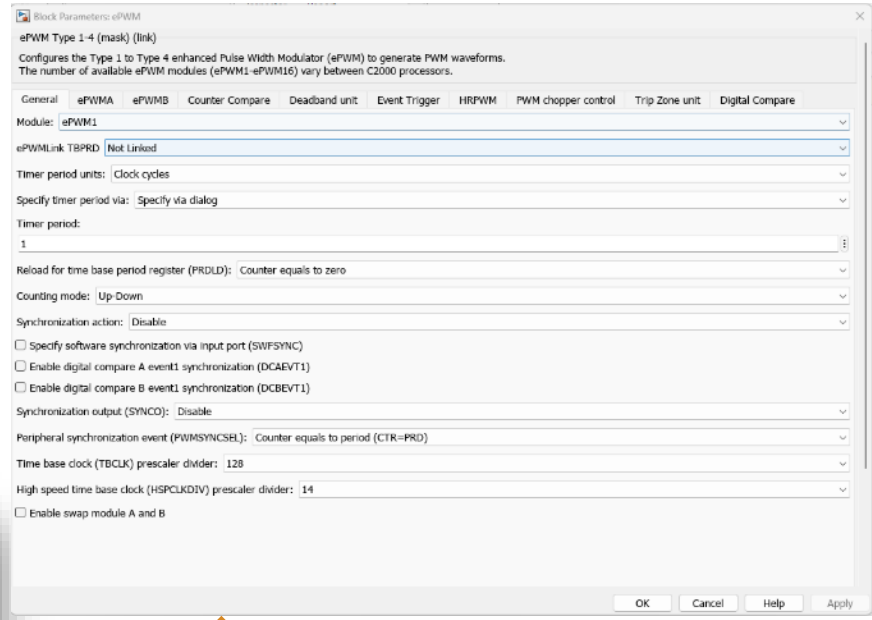


Peripheral Block Library



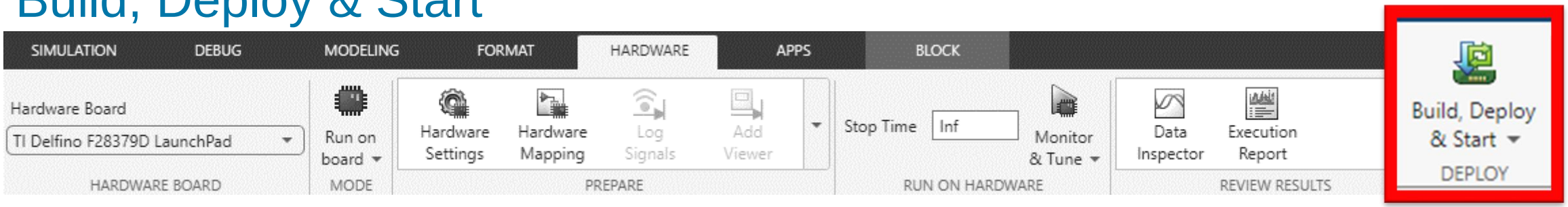
Drag and drop Peripheral Blocks





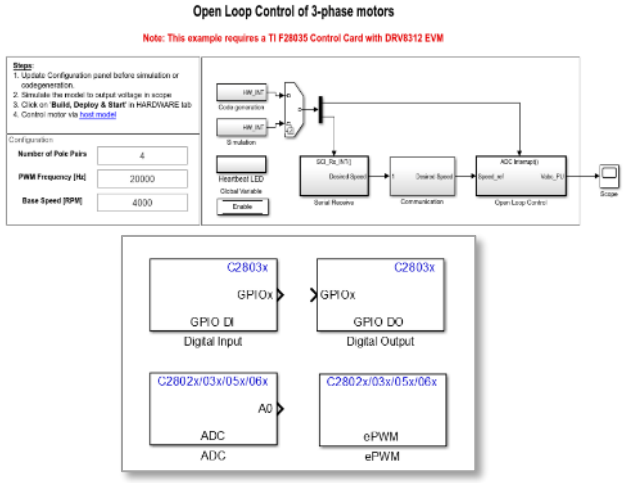
Configure Peripheral Blocks

Build, Deploy & Start



Simulink Model

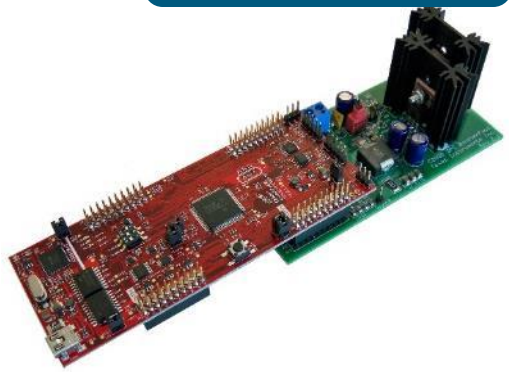
C2000 Blockset | **Motor Control Blockset**

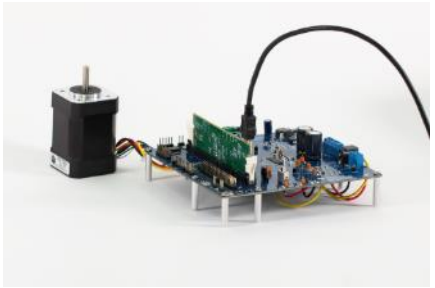


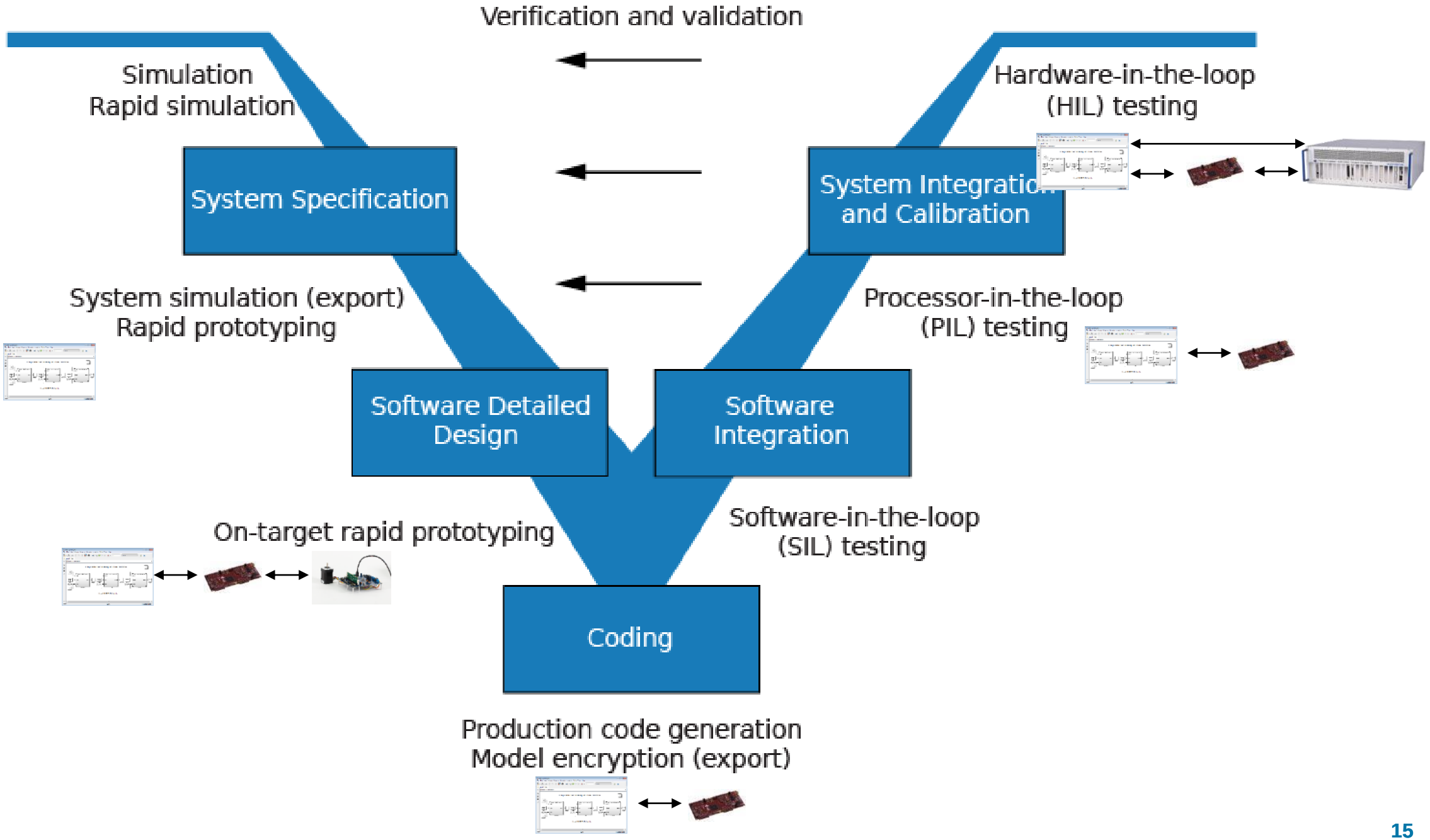
Embedded Coder

CCS Project

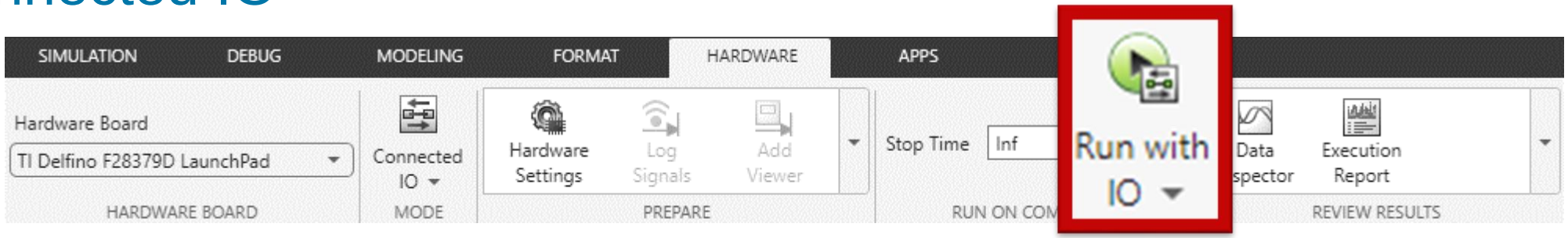
Run on C2000

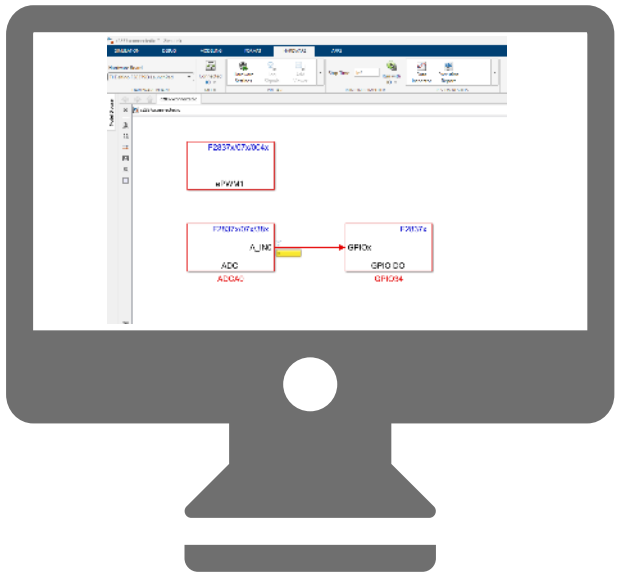




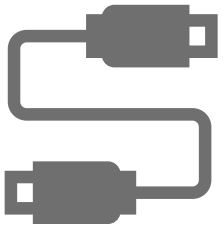

Verification and validation
Simulation
Rapid simulation
Hardware-in-the-loop
(HIL) testing
System Specification
System Integration
and Calibration
System simulation (export)
Rapid prototyping
Processor-in-the-loop
(PIL) testing
Software Detailed
Design
Software
Integration
On-target rapid prototyping
Software-in-the-loop
(SIL) testing
Coding
Production code generation
Model encryption (export)

Connected IO

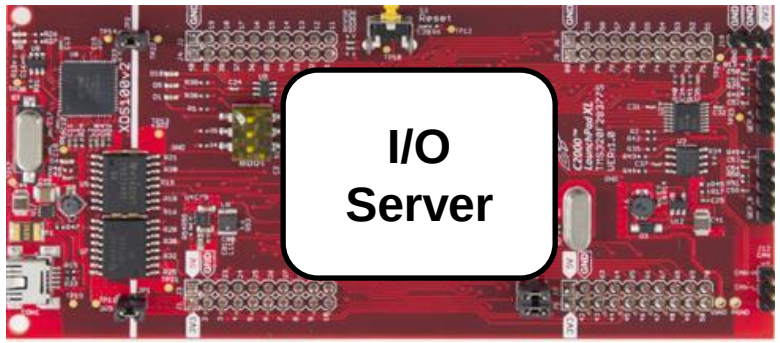




Simulink Model Running on Host in Near Real-Time

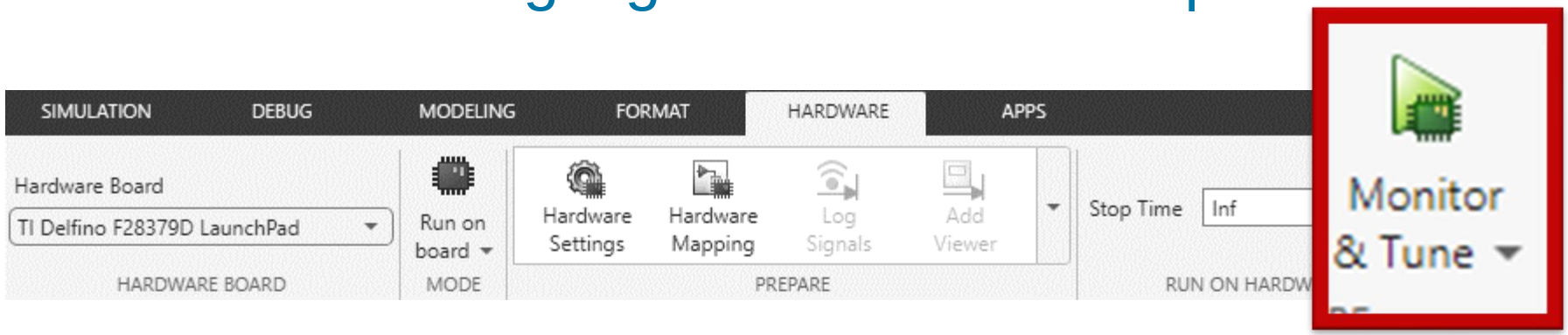


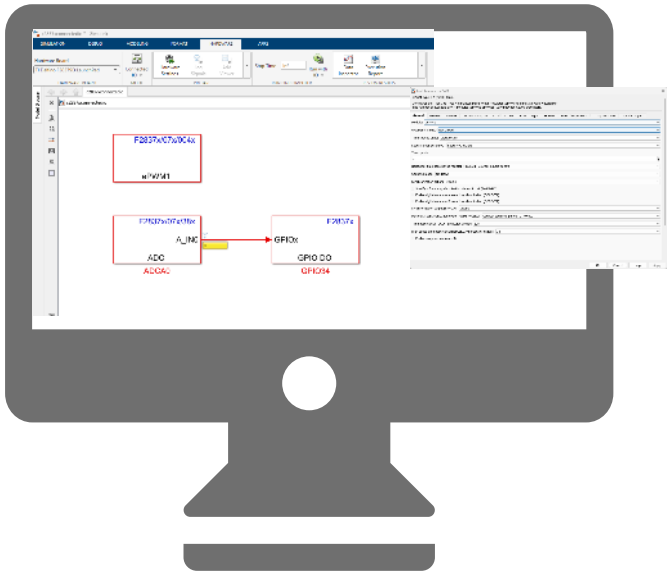
Data Exchange over COM Port



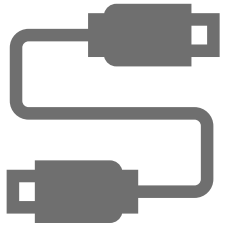
Connected I/O Server Running on Hardware Exchanges Peripheral Inputs and Outputs with Host

Monitor and tune – Log signal data and tune parameters

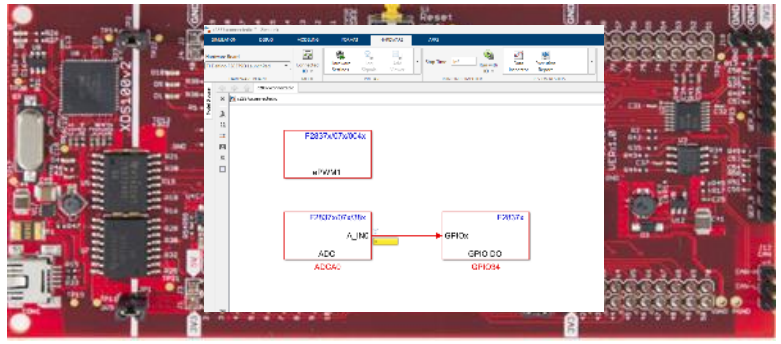




Simulink Model on Host Allows Interaction with Code Running on Hardware

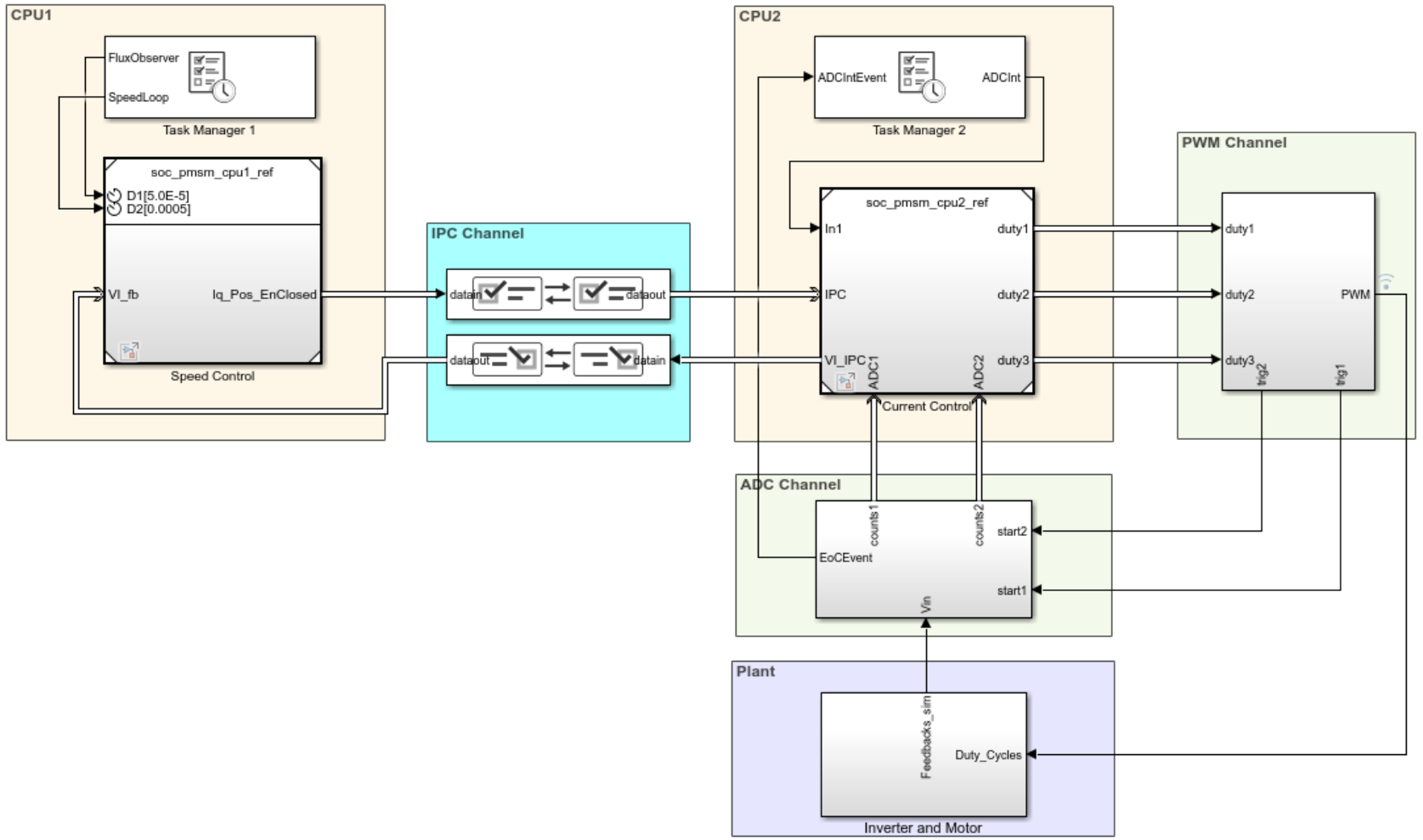


Data Exchange over XCP over Serial, TCP I/P and CAN



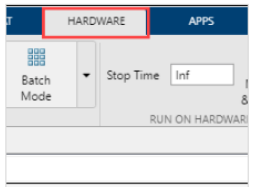
Generated C Code From Model Running on Hardware in Real-Time

Single Model for Multi-Core



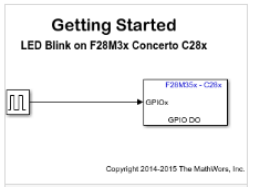
81 Reference Model Examples to get started with

Getting Started



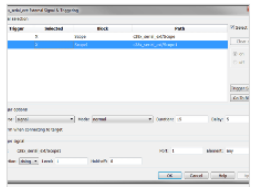
Getting Started with Texas Instruments C2000 Microcontroller Blockset

Use C2000™ Microcontroller Blockset to run a Simulink® model on Texas Instruments C2000 hardware.



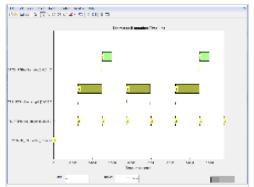
Getting Started with C2000 Microcontroller Blockset for F28M3x Concerto...

In this example, you will learn how to configure a simple Simulink® model to generate code for ARM and C28x cores of Concerto F28M3x



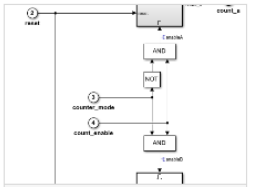
Parameter Tuning and Signal Logging with Serial Communication

Perform parameter tuning and data logging with a Simulink® model running in Texas Instruments™ C2000 targets.



Real-Time Code Execution Profiling

Use C2000™ Microcontroller Blockset for real-time execution profiling of generated code.

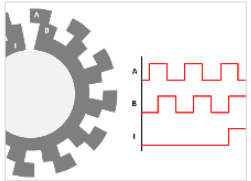


Code Verification and Validation with PIL

Use Texas Instruments™ C2000™ Processor for code verification and validation using PIL in C2000™ Microcontroller Blockset.

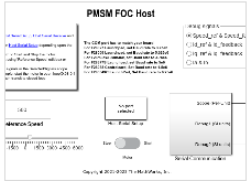
Link to list of all C2000 MCU Blockset Examples

Motor Control



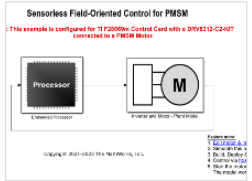
Field-Oriented Control of PMSM with Quadrature Encoder Using C2000...

Implements the field-oriented control (FOC) technique to control the speed of a three-phase permanent magnet synchronous



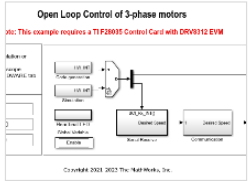
Field-Oriented Control of PMSM with Hall Sensor Using C2000 Processors

Implements the field-oriented control (FOC) technique to control the speed of a three-phase permanent magnet synchronous



Sensorless Field-Oriented Control of PMSM Using C2000 Processors

Implements the field-oriented control (FOC) technique to control the speed of a three-phase permanent magnet synchronous



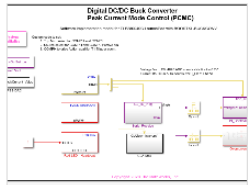
Open-Loop Control of 3-Phase AC Motors Using C2000 Processors

Uses open-loop control (also known as scalar control or Volts/Hz control) to run a motor. This technique varies the stator voltage

Control PMSM Loaded with Dual Motor (Dyno) Using C2000 Processors

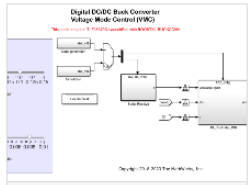
Uses field-oriented control (FOC) to control two three-phase permanent magnet synchronous motors (PMSM) coupled in a dyno setup.

Power Conversion



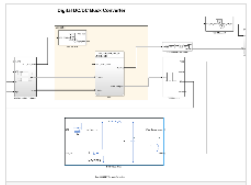
Digital DC/DC Buck Converter Using Peak Current Mode Control

Use the Comparator Subsystem (CMPSS) to regulate buck converter output voltage (BOOSTXL-BUCKCONV) using Peak Current



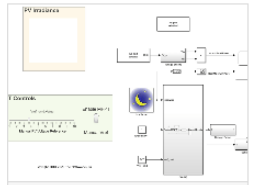
Closed Loop Control of a DC-DC Buck Converter

Model a closed loop control of a DC-DC buck converter in the C2000™ Microcontroller Blockset. The model runs on a F28379D Launchpad



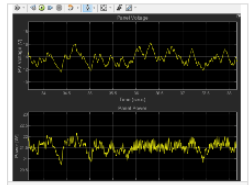
DC-DC Buck Converter Using MCU

Develop a DC-DC buck converter power regulator application.Typical challenges with power conversion simulation and deployment include:



Photovoltaic Inverter with MPPT Using Solar Explorer Kit

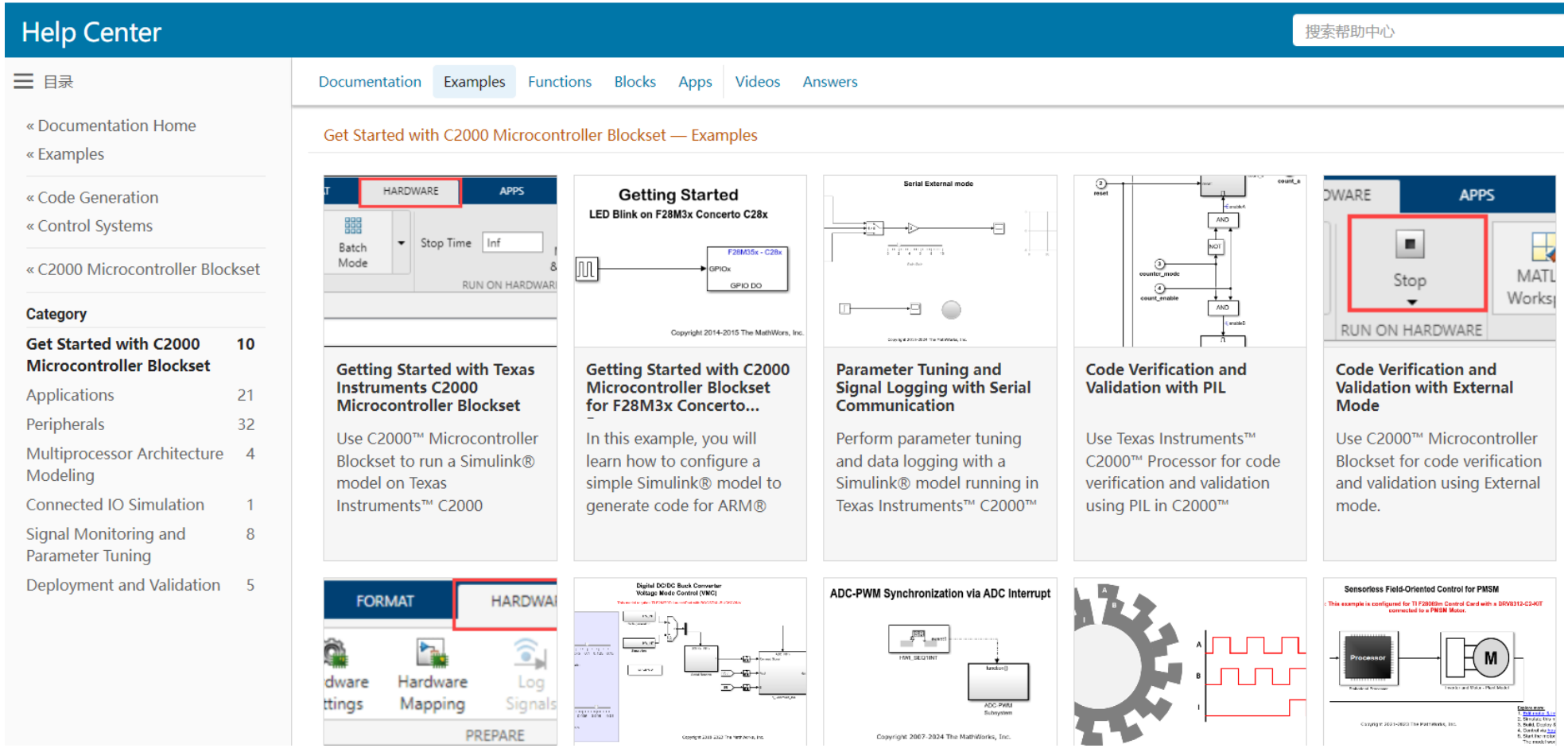
Implement a photovoltaic (PV) inverter system using the C2000™ Microcontroller Blockset. The example uses the Texas Instruments



MPPT Using Flyback Converter in TI Solar Micro Inverter Development Kit

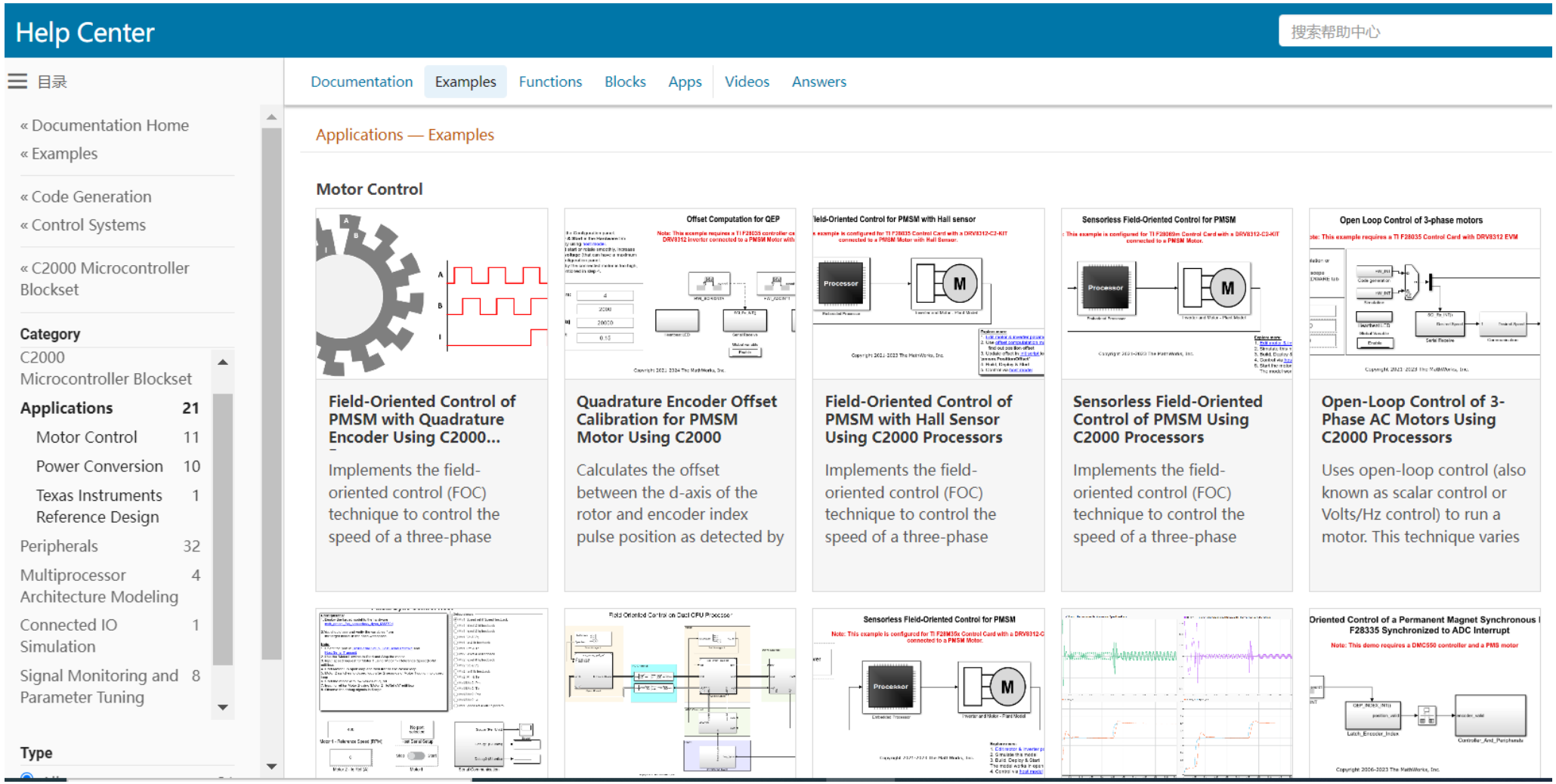
Implement a Maximum Power Point Tracking (MPPT) Algorithm along with control of DC-DC flyback converter using the C2000™

C2000 Microcontroller Blockset Examples



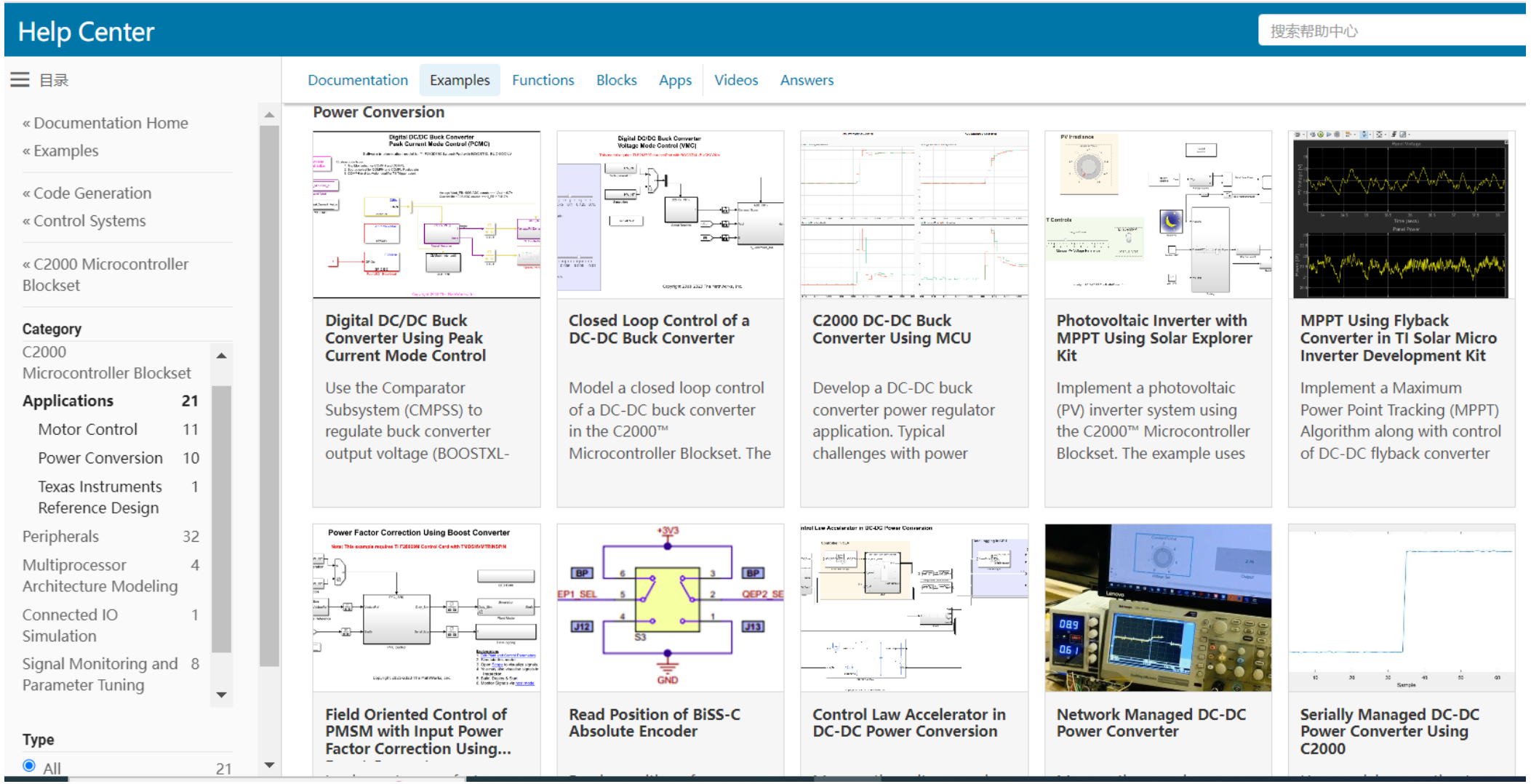
[Example link]

Motor Control Example



[Example link]

Power Conversion Example



[Example link]

MathWorks C2000 Resources

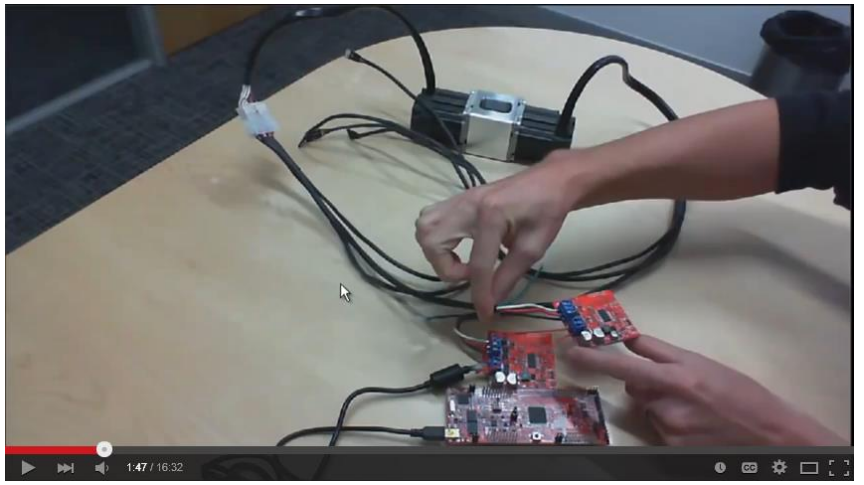
Visit: https://www.mathworks.com/products/ti-c2000-microcontroller.html

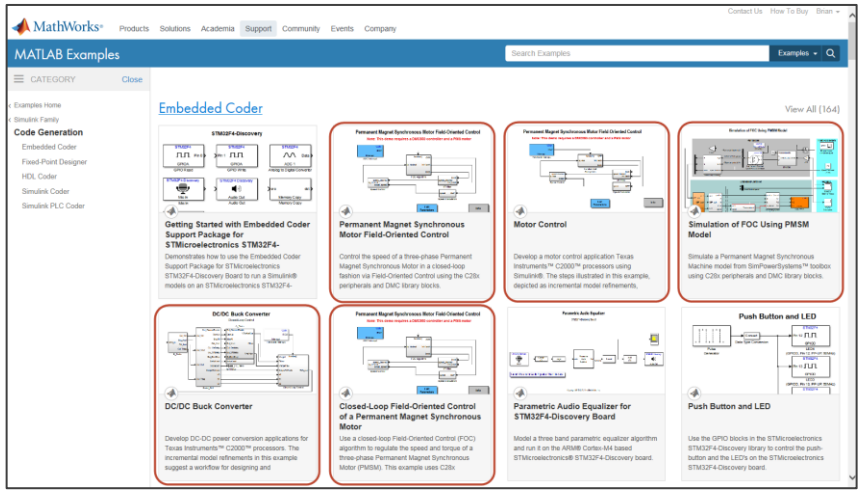
- TI resources on MathWorks.com
- - www.mathworks.com/ti
- - ti@mathworks.com

- C2000 resources on TI.com
- - www.ti.com/C2000

And More Resources

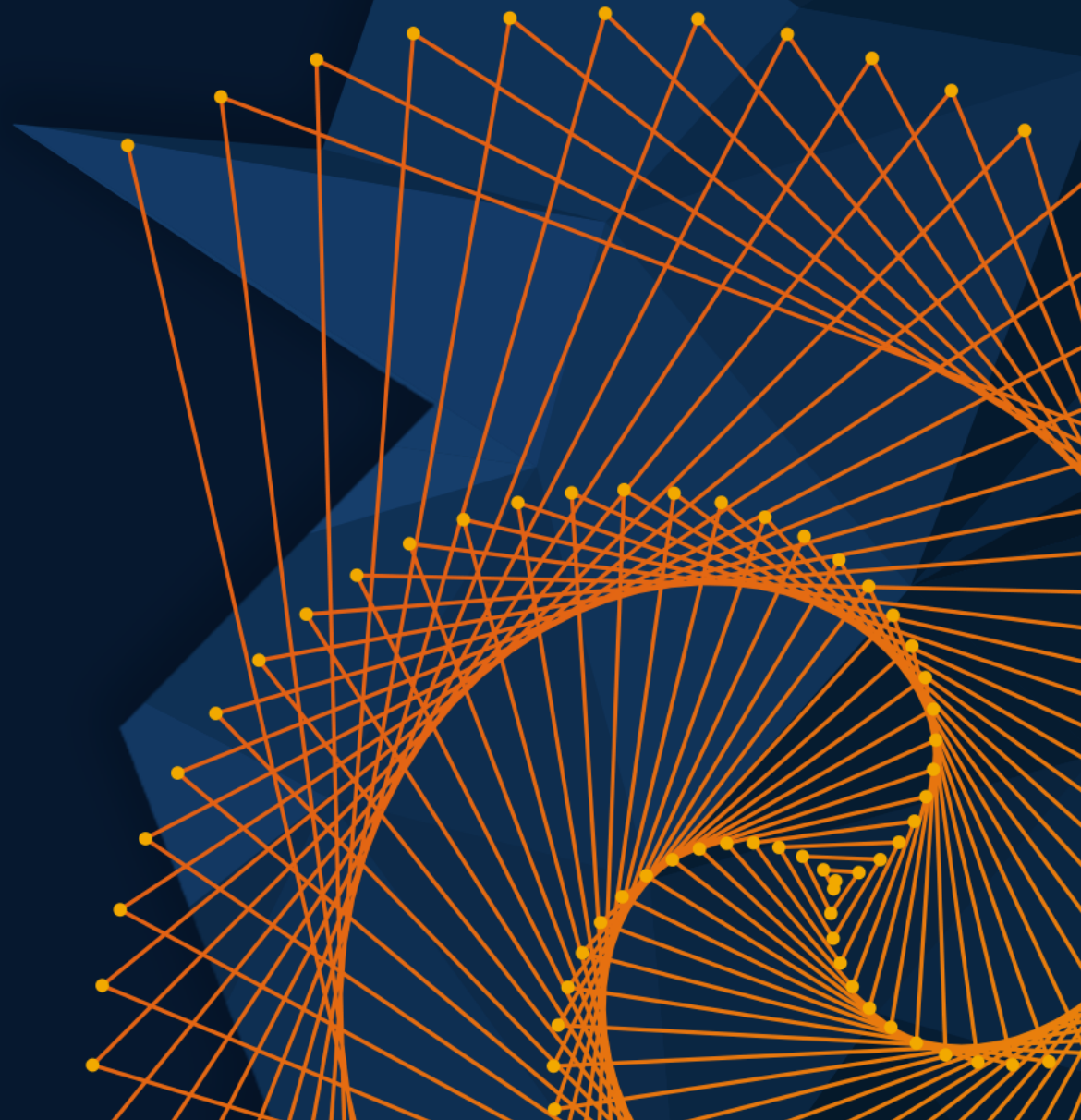
- Solution overview
  - mathworks.com/ti - TI landing page on mathworks.com
  - TI C2000 landing page on mathworks.com
  - Getting Started with Embedded Coder Support Package for TI C2000 Processors Video (11:00)
- Application development walk throughs
  - Developing Solar Inverter Control with Simulink, Part 3: Designing the MPPT Algorithm and Generating Production Code for the TI C2000 Microcontroller Video (9:15)
  - Field-Oriented Control of PMSMs with Simulink and Motor Control Blockset, Part 3: Field-Oriented Control: Deploying Code to a Microcontroller Video (6:42)
  - How to Develop DC-DC Converter Control in Simulink, Part 6: Automatic Code Generation and Conclusions Video (12:01)
  - Adding MCU Peripheral Modeling in Motor Control Using SoC Blockset Video (8:02)
  - Multicore Motor Control Using SoC Blockset Video (6:01)
  - Regional: 中文 (3), Italiano (3), Français (2)
- More info on TI.com
  - TI.com Design Resources Folder: MATHW-3P-SLEC by MathWorks, Inc. | TI.com
- Advanced FAQ and support on MathWorks.com
  - FAQ: TI C2000 Hardware Support Package - MATLAB Answers - MATLAB Central (mathworks.com)
  - MATLAB Answers for forum-style tech support
  - Live tech support for paid commercial customers





MATLAB EXPO

Thank you



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