TI DSPs
HARDWARE and BLOCK CODING CONCEPTS
with Simulink or PSIM

Serhat Özküçük from METU PowerLab

Content

First hour

1. TI DSP Family
2. C2000 Series - DRV8312EVM

Second Hour

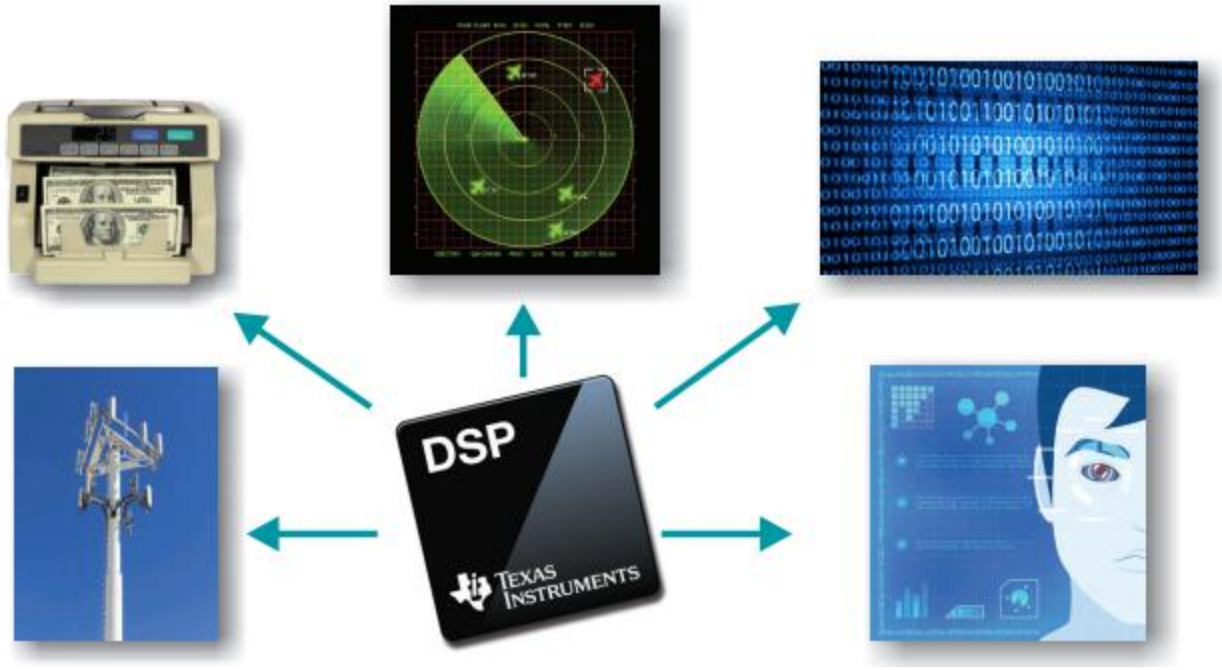
3. Applications (Insta-Spin – Insta-Motion)
4. Matlab/Simulink and PSIM Interface

DSP (Overview)

Digital Signal Processor (DSP)

- small
- low power
- smart

Multi-core compute platform



✓Voice & image recognition
✓Real-time data analytics
✓Control
… endless

TI DSP Family - Applications

	MSP Microcontrollers	C2000™ Microcontrollers	Sitara™ ARM® Cortex®-A Processors	AWR and IWR mmWave Sensors	C5000™ / C6000™ Digital Signal Processors	Jacinto™ Automotive Processors	SimpleLink™ Wireless Microcontrollers
Audio							
Automotive							
Communications							
Industrial							
Medical							
Security							
Video							
Wireless							
Key feature	Ultra-low power	Real-time control	Scalable performance with robust peripheral options	High-accuracy single-chip sensor with processor	Scalable performance from ultra-low power to high performance	ADAS and infotainment systems	Easy-to-use, low-power connectivity

TI – DSP Family : Low Power MCUs

- MSP 430
  - Offer the lowest power consumption and the perfect mix of integrated peripherals with a common ecosystem for a wide range of sensing and measurement applications.

- SimpleLink
  - Offers the broadest portfolio of 32-bit ARM-based micro-controllers with industry-leading features including low power, robustness and integrated security to support more than ten differentiated wired and wireless protocols including Bluetooth® low energy, Sub-1 GHz and Wi-Fi®. Each device offers IoT developers a number of features to uniquely solve their problems, whether capturing high-precision 16-bit analog signal, enabling more security.

Low-Power MCUs MSP430™ Microcontrollers

Ultra-Low-Power, 16-Bit Microcontrollers for Sensing and Measurement Applications

Key Applications

- Intelligent sensors and control
- Consumer electronics
- Test & measurement
- Utility metering
- Portable medical and instrumentation
- Security systems

Series	Capacitive-Sensing MCUs	Value-Line Sensing MCUs		Performance-Sensing MCUs		Other MSP430 MCUs	
Family	MSP430FR25x/FR26x	MSP430FR2xx/FR4x	MSP430G2x/i2x	MSP430FR5x/FR6x	MSP430F5x/F6x	MSP430F2x/F4x	MSP430F1x
Max speed (MHz)	16	16	16	16	25	16	16
FRAM (max KB)	16	16	56	256	512	120	120
SRAM (max KB)	4	4	4	8	67	8	10
GPIOs	15–19	16–64	4–32	17–83	29–90	14–80	10–48
ADC	●	●	●	●	●	●	●
DAC					●	●	●
Comparator		●	●	●	●	●	●
Timer	●	●	●	●	●	●	●
UART	●	●	●	●	●	●	●
I²C	●	●	●	●	●	●	●
SPI	●	●	●	●	●	●	●
Multiplier	●	●	●	●	●	●	●
DMA				●	●	●	●
Op Amp		●			●	●	●
LCD		●		●	●	●	
RTC	●	●		●	●	●	
1.8-V I/O					●		
CRC	●	●		●	●		
USB					●		
AES				●	●		

Low-Power MCUs MSP430™ Microcontrollers

Ultra-Low-Power, 16-Bit Microcontrollers for Sensing and Measurement Applications

Key Features

- Ultra-low-power (ULP) architecture enables battery life > 20 years
- 100 µA/MHz active mode
- 700 nA RAM retention
- 450 nA RTC mode
- 7 low-power modes
- Instantaneous wakeup

Integrated intelligent peripherals to add analog functions and advanced functions including:

- Capacitive touch
- Ultrasonic sensing
- Low-energy vector math engine
- 8- to 12-bit ADC
- Transimpedance amplifier (TIA)
- DMA (Direct Memory Access)
- AES256 (Advanced Encryption Standard)

SimpleLink

Solutions Low-Power Wireless Connectivity

Key Benefits

- Single software foundation
  - •SDK based on common foundation of drivers, frameworks and libraries
  - •Pre-integrated TI-RTOS kernel already deployed in thousands of products across multiple applications
  - •POSIX (IEEE Standard)-compliant API (Application Programming Interface) ensures compatibility with numerous third-party software components

Product	MSP432™	CC3120	CC3220	CC2640R2F	CC1350	CC1310
MCU type	Host MCU	Network processor	Wireless MCU	Wireless MCU	Wireless MCU	Wireless MCU
Application	✔	–	✔	✔	✔	✔
Wireless stack + RF	–	✔	✔	✔	✔	✔
Wireless technology	Connectivity with SDK plug-ins	Wi-Fi®	Wi-Fi	*Bluetooth*® low energy	Sub-1 GHz + Bluetooth low energy	Sub-1 GHz
Key differentiation	Capture analog signals at up to 16 ENOB using ADC14	Network processor with integrated all Wi-Fi and Internet protocols	Wi-Fi CERTIFIED™ single-chip MCU with enhanced security	Lowest power BT4.2 and BT5 Flash-based solution, auto qualified	World's first dual-band wireless MCU	Low power and longest range to achieve 20 kms on a coin cell
SimpleLink SDK compatible	✔	✔	✔	✔	✔	✔

SimpleLink Portfolio Development Kits

MSP-EXP432P401R	CC3220SF-LAUNCHXL	LAUNCHXL-CC2640R2
• SimpleLink MSP432 LaunchPad™ kit • Integrated 14-bit ADC • Host MCU	• SimpleLink CC3220 LaunchPad kit • Wi-Fi support • Wireless MCU	• SimpleLink CC2640R2F LaunchPad kit • Bluetooth low energy support • Wireless MCU

LAUNCHXL-CC1350	LAUNCHXL-CC1310	CC3120BOOST
• SimpleLink CC1350 LaunchPad kit • Sub-1 GHz + Bluetooth low energy support • Wireless MCU	• SimpleLink CC1310 LaunchPad kit • Sub-1 GHz support • Wireless MCU	• SimpleLink CC1350 BoosterPack™ plug-in module • Sub-1 GHz + Bluetooth low energy support • Wireless MCU

TI – DSP Family : Performance MCUs

- C2000
  - Real-Time Control
  - 32-bit MCUs are based on the industry-leading C28x CPU. This CPU features a powerful signal processing engine capable of addressing demanding closed loop tasks thereby giving designers the means to improve system efficiency, reliability and flexibility.

Performance MCUs

C2000™ Real-Time Control Microcontrollers
Performance MCUs for Applications Needing Low-Latency Closed-Loop Control

Applications

- Digital motor control (white goods, industrial drives, medical)
- Digital power supplies (telecom and serv-er rectifiers, wireless base-stations, UPS)
- Renewable energy (solar, wind, fuel cells)
- Intelligent LED lighting
- Automotive (HEV/EV, electric power steering, driver’s assistance radar, wip-ers, HVAC, pumps)
- Power line communications (PLC)

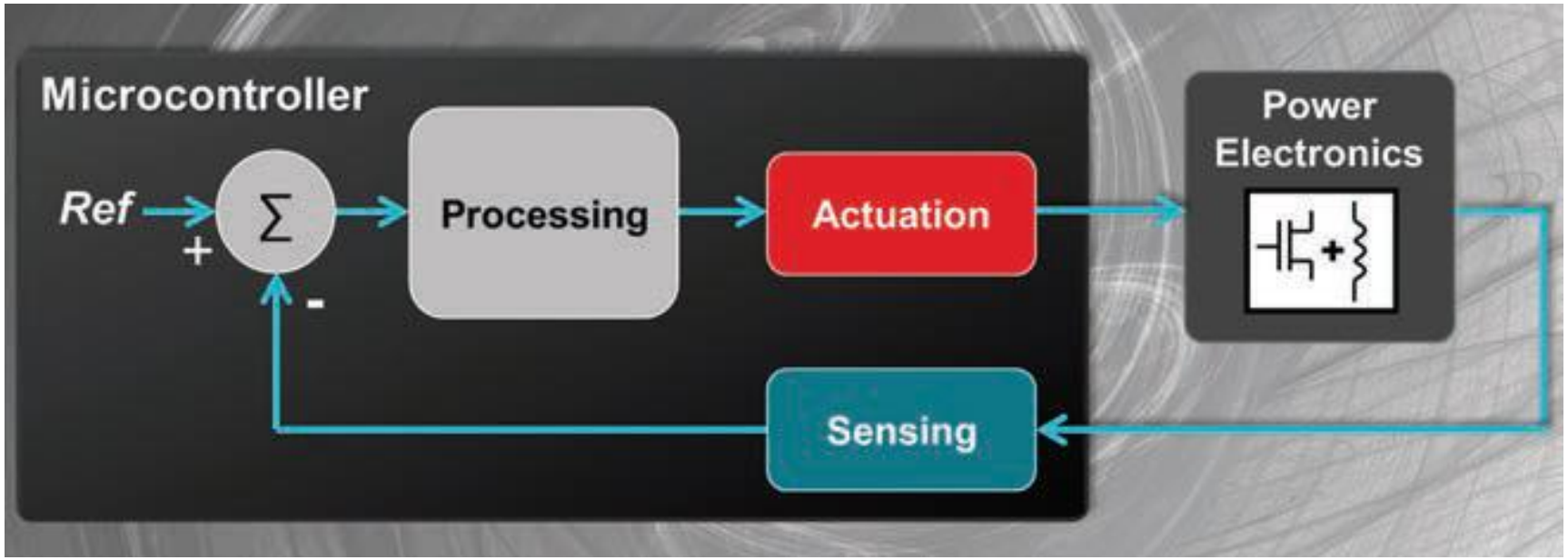
Performance MCUs

C2000™ Real-Time Control Microcontrollers
Performance MCUs for Applications Needing Low-Latency Closed-Loop Control

Built for Real-Time Control Optimized architecture for

- **processing**,
- **sensing**,
- **actuation**

to increase closed-loop performance.



Performance MCUs

C2000™ Real-Time Control Microcontrollers
Performance MCUs for Applications Needing Low-Latency Closed-Loop Control

Processing

- More performance per MHz with 32-bit C28x DSP core optimized for complex single-cycle operations common to control theory
- Meet the demands of a wide range of applications with optimized processing options from 40 MIPS to 800 MIPS of performance
- Add functionality with the Control Law Accelerator (CLA) processing engine. Great for controlling multiple motors, power stages and more
- Accelerate complex control theory and signal processing, such as trigonometric math, FFTs, and complex math, with built-in hardware accelerators

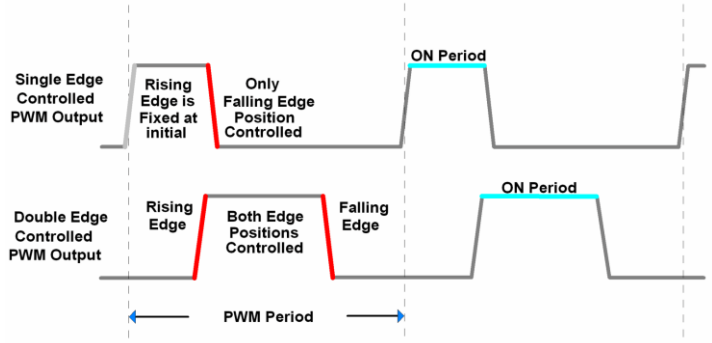
MIPS : Million instructions per second

Performance MCUs

C2000™ Real-Time Control Microcontrollers

Performance MCUs for Applications Needing Low-Latency Closed-Loop Control

Actuation



- Achieve higher system performance with micro edge positioning of PWM outputs, including support of PWM phase, duty cycle and period
- Control a variety of applications and power-stage topologies with ultra-configurable PWM generation
- Support even complex peak current mode control of power stages through ramp-generation logic and integrated analog comparators

Performance MCUs

C2000™ Real-Time Control Microcontrollers
Performance MCUs for Applications Needing Low-Latency Closed-Loop Control

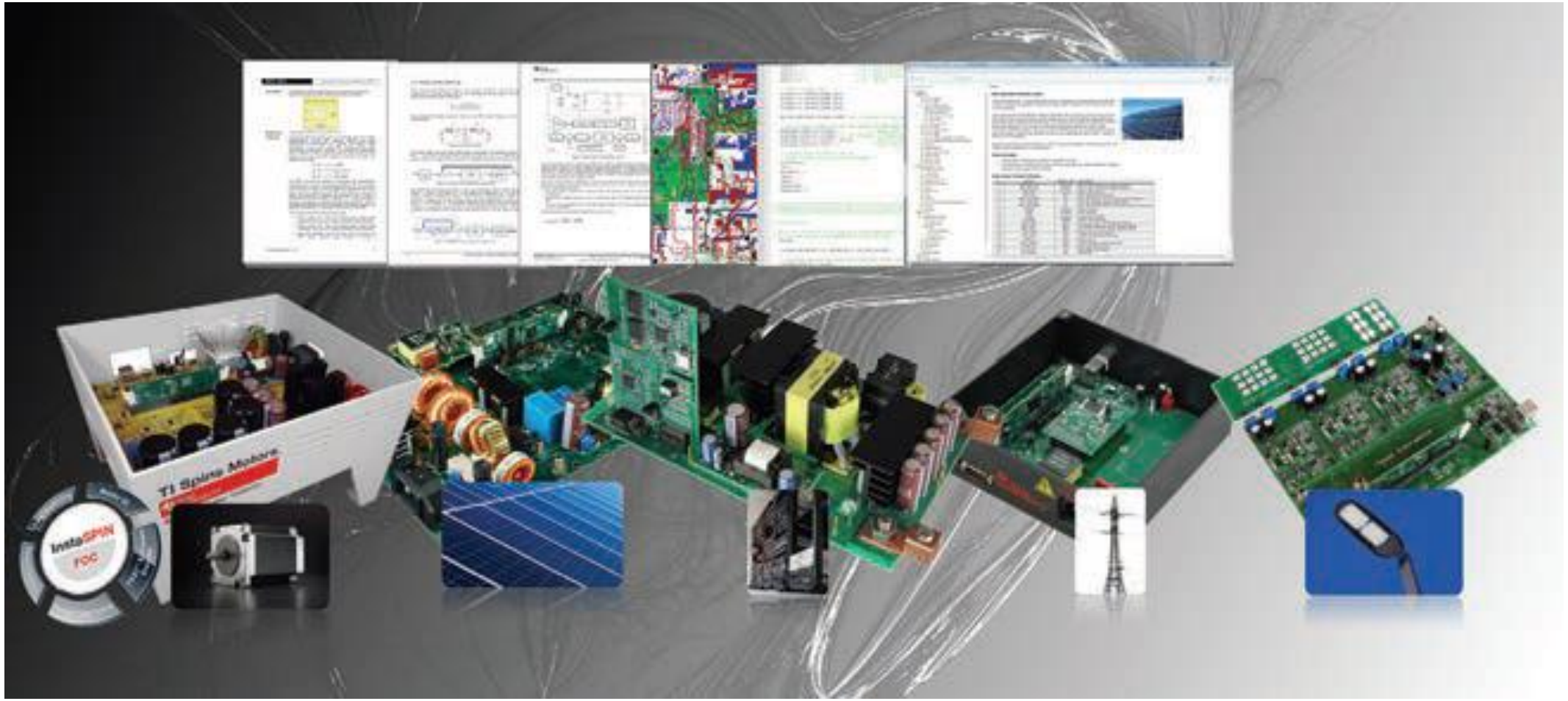
Sensing

- Accurately sample signals with 12-bit and 16-bit analog-to-digital converters (ADC)
- Run systems at high frequencies with ADC conversion rates up to 12.5 MSPS
- Protect systems better with responsive analog comparators – 30 ns response time
- Interface with high-performance external sensors using C2000 high resolution captures

Performance MCUs

C2000™ Real-Time Control Microcontrollers

Performance MCUs for Applications Needing Low-Latency Closed-Loop Control



http://www.ti.com/microcontrollers/c2000-real-time-control-mcus/design-development.html

TI – DSP Family : Sitara Processors

- Sitara
  - TI's Sitara processors are optimized, scalable solutions with a broad portfolio of ARM Cortex-A8, Cortex-A9 and Cortex-A15 solutions. Sitara processors help innovators create a variety of feature-rich, low-power applications. These devices provide robust peripheral support including 3D graphics and industrial communications protocols among others, giving customers flexibility in design. Bringing together flexible hard-ware solutions with robust software tools enables customers using **Sitara** processors to create inspiring ARM designs that start to bridge the gap between high-end MCUs and low-end ARM processor-based devices.

Sitara Processors

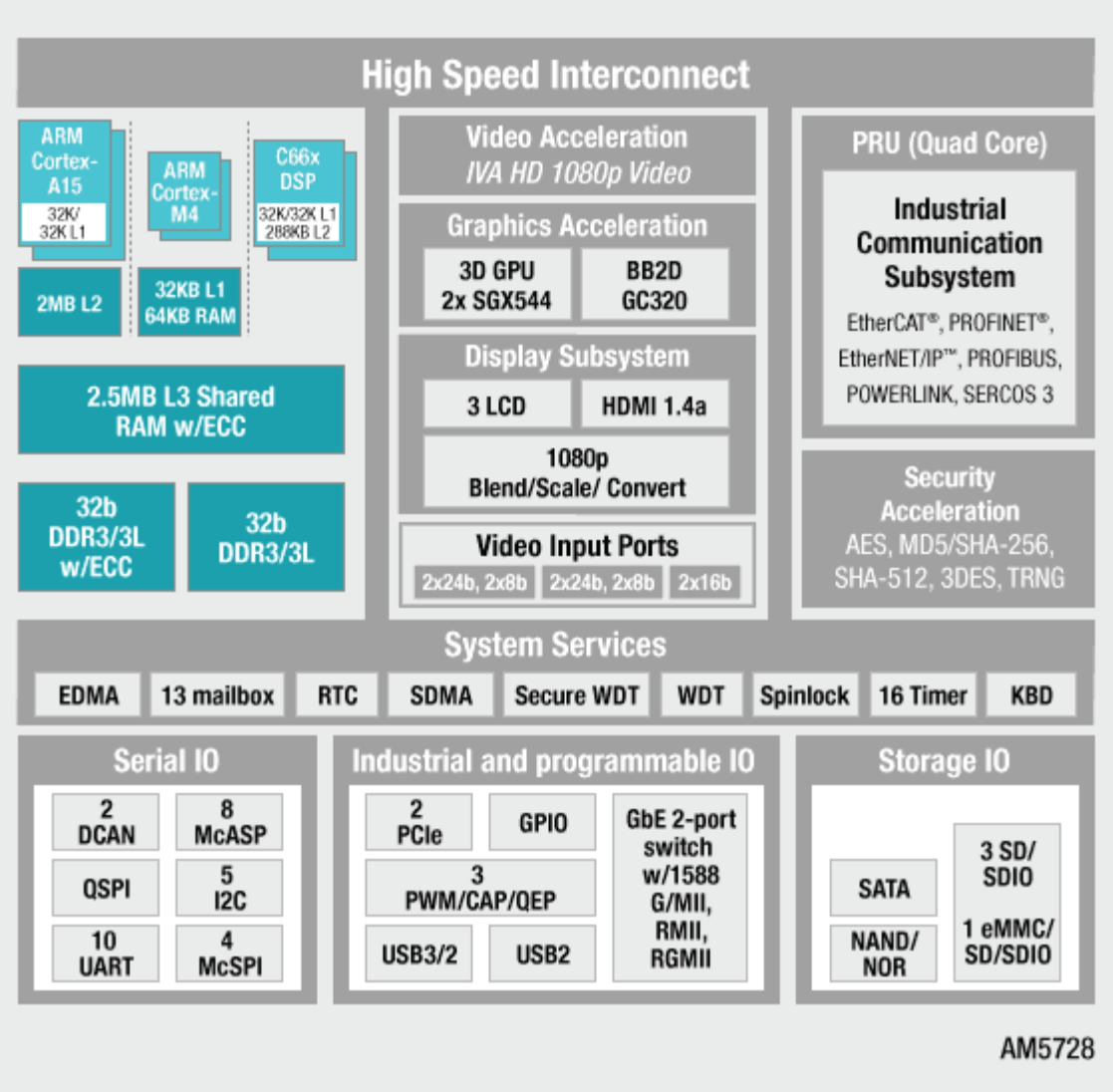
Highly Integrated; Scalable From 300 MHz to 1.5 GHz with 3D Graphics

Specifications

- ARM® Cortex®-A8 and Cortex-A15 processors
- Optional high-performance 3D graphics accelerator
- Optional Programmable Real-time Unit and Industrial Communication Sub-System (PRU-ICSS)
- Robust display options
- Optimized for low-power applications
- Linux®, Android™, RTOS and StarterWare™ software

Targeted Applications

- Factory automation and control, human machine interface, medical, portable data terminals



TI – DSP Family : C5000-C6000

- C5000, C6000
  - The ultra-low-power C5000 fixed-point DSPs offer processors with active core power below 0.15 mW/MHz, great for battery-powered applications. The C6000 family features fixed and floating point DSPs starting at 200 MHz and going as high as 1.25 GHz. The KeyStone multicore family of products use our highest performance floating point C66x DSP core as well as ARM Cortex-A15 CPUs in high-performance system-on-chips (SoCs) that deliver nearly 200 GFLOPS of performance for less than 20 W. Whether you are developing a battery powered audio processing system, a higher-performance signal processing machine or systems in between, the breadth of the TI DSP processor portfolio provides a likely alternative for your project.

FLOPS: Floating point process capability per second

C5000, C6000

Ultra-Low Power, Floating-Point and High-Performance Signal Processing

Targeted Applications

- AUDIO A/V receivers and soundbars Professional audio equipment Voice assistant and user interface
- RADIO AND COMMUNICATIONS Land mobile radio First responder communications
- DEFENSE AND AEROSPACE Radar systems Communications systems Flight control systems
- GRID INFRASTRUCTURE Power quality monitoring Signal analysis Grid communications
- MACHINE VISION Optical inspection equipment Robotic guidance systems Process control

TI – DSP Family : Jantino Automotive Processors

- Jacinto

  - From entry-level to premium system-on-chips (SoCs), TI offers a wide range of innovative auto-motive processors for the modern automobile. With a scalable architecture across Infotainment and ADAS solutions, TI provides maximum optimization for automotive OEMs and Tier 1 customers.

  - ADAS applications:

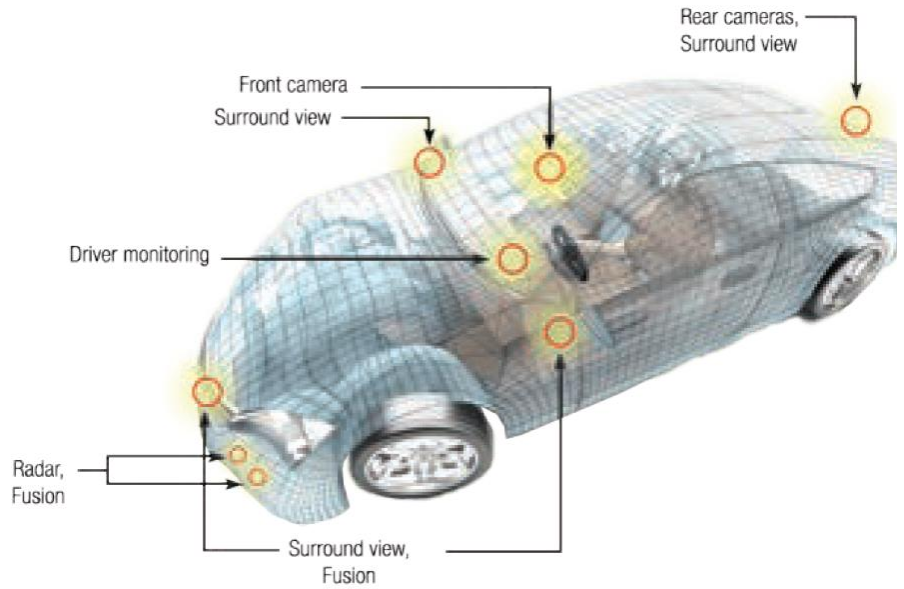
Front camera

Surround view/rear camera

Fusion

Radar

Driver monitoring



ADAS: Advanced Driver Assistance Systems

Development Kits, Software and Tools

Comprehensive, Easy-to-Use Development Kits, EVMs, Software and Tools

Development kits & Evaluation modules:

TI embedded family	Featured development kits
MSP430™ MCUs	MSP-EXP430FR5994 LaunchPad™ kit and MSP-EXP430FR4133 LaunchPad kit. See ti.com/msp for complete listing.
SimpleLink™ MCUs	SimpleLink LaunchPad development kits: MSP-EXP432P401R, CC3220SF-LAUNCHXL, LAUNCHXL-CC2640R2, LAUNCHXL-CC1350, and LAUNCHXL-CC1310. See ti.com/simplelink
C2000™ MCUs	Delfino™ LaunchPad Kits: F28379D, F28377S Piccolo™ LaunchPad Kits: F28027, InstaSPIN-MOTION See ti.com/c2000 for a complete listing
Sitara™, DSP and multicore processors	Starter kits for low-cost application development: TMDSSK3358, TMDXSK437x Evaluation module for high-performance Sitara processors: TMDSEVM572X Evaluation module for the C66x DSP: TMDSEVM6678
mmWave sensors	Evaluation modules for the mmWave sensor portfolio: IWR1443BOOST, IWR1642BOOST, AWR1243BOOST, AWR1443BOOST and AWR1642BOOST
Automotive processors	TDAx ADAS tools and EVMs and DRAx Infotainment tools and EVMs

Development Kits, Software and Tools

Comprehensive, Easy-to-Use Development Kits, EVMs, Software and Tools

Software:

TI embedded family	Primary software
MSP430 MCUs	**MSP430Ware** is a collection of resources to create and build MSP430 MCU code. MSPWare is available as a component of Code Composer Studio™ IDE desktop and cloud versions, or as a standalone package.
SimpleLink MCUs	The **SimpleLink SDK** is a single software development environment for SimpleLink MCUs that offers flexible software and tool options, 100 percent code reuse and unprecedented scalability for IoT applications.
C2000 MCUs	**controlSUITE™** for C2000™ microcontrollers is a cohesive set of software infrastructure, tools and documentation designed to minimize system development time. Further simplifying design efforts, **powerSUITE** for digital power designers and **DesignDRIVE** for industrial drive designers is included.
Sitara, DSP and multicore processors	**Processor SDK** is a unified software platform for TI's processors providing easy setup and fast out-of-the-box access to benchmarks and demos for Linux®, RT-Linux, TI-RTOS and Android™ operating systems.
mmWave sensors	**mmWave SDK** is a software platform for the TI mmWave Sensing Portfolio, providing the building blocks, demonstrations/examples, tools and documentation to begin development.
Automotive processors	Processor SDK Automotive is the foundational software development platform for TI's Jacinto **DRAx** and **TDAx** family of Infotainment and ADAS SoCs.

Development Kits, Software and Tools

Comprehensive, Easy-to-Use Development Kits, EVMs, Software and Tools

Development Tools:

TI embedded family	Featured development tools
MSP430 MCUs	MSP-FET debugger, EnergyTrace™ energy-based code analysis tool
SimpleLink MCUs	SimpleLink Academy training modules, TI Resource Explorer
C2000 MCUs	XDS110 Debug probe, UniFlash Flash programmer
Sitara, DSP and multicore processors	Clock tree tool, Pin MUX tool, Power estimation tool
mmWave sensors	mmWave sensing estimator, mmWave demo visualizer

Development Kits, Software and Tools

Comprehensive, Easy-to-Use Development Kits, EVMs, Software and Tools

Code Composer Studio™ (CCS)

is a free integrated development environ-ment (IDE) that supports TI's Microcontroller and Embedded Processors portfolios. CCS IDE comprises a suite of tools used to develop and debug embedded applications.

CCS includes

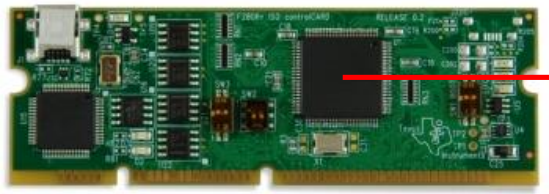
- C/C++ compiler
- Source code editor
- Project build environment
- Debugger
- Profiler

TI also supports Energia, an open-source and community-driven Integrated Development Environment (IDE) and software framework with its microcontroller portfolio.

TI C2000 Series – DRV8312EVM

BLDC/PMSM MOTOR - DRIVER BOARD - DSP BOARD

TI C2000 Series DRV8312EVM

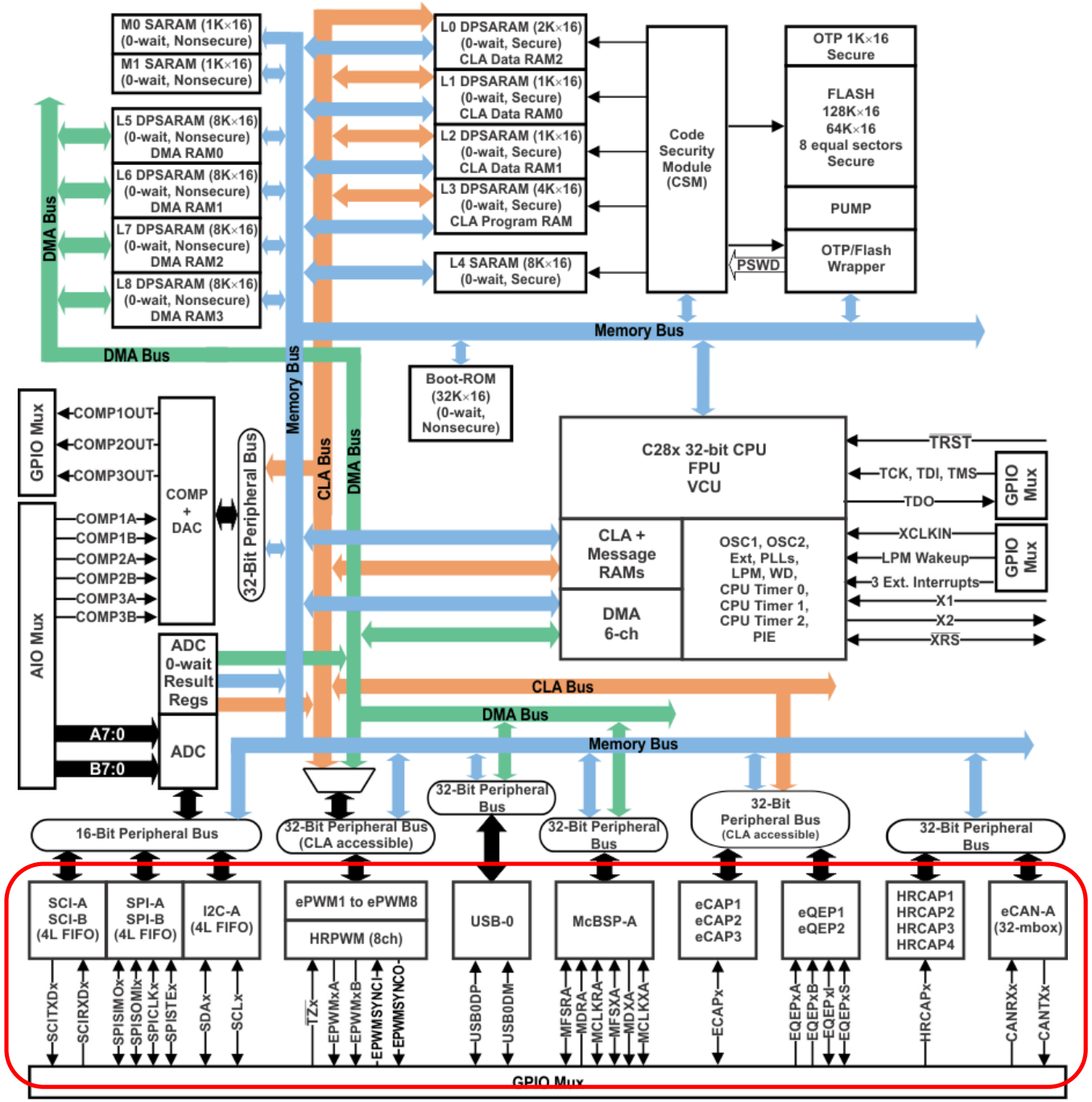


- DSP BOARD

  Piccolo - TMDSCNCD28069MISO controlCARD

- DSP

  TMS320F28069M, Piccolo™ 32-bit MCU with 90 MHz, FPU, VCU, 256 KB Flash, CLA, InstaSPIN-MOTION



TI C2000 Series DRV8312EVM

- DRV8312

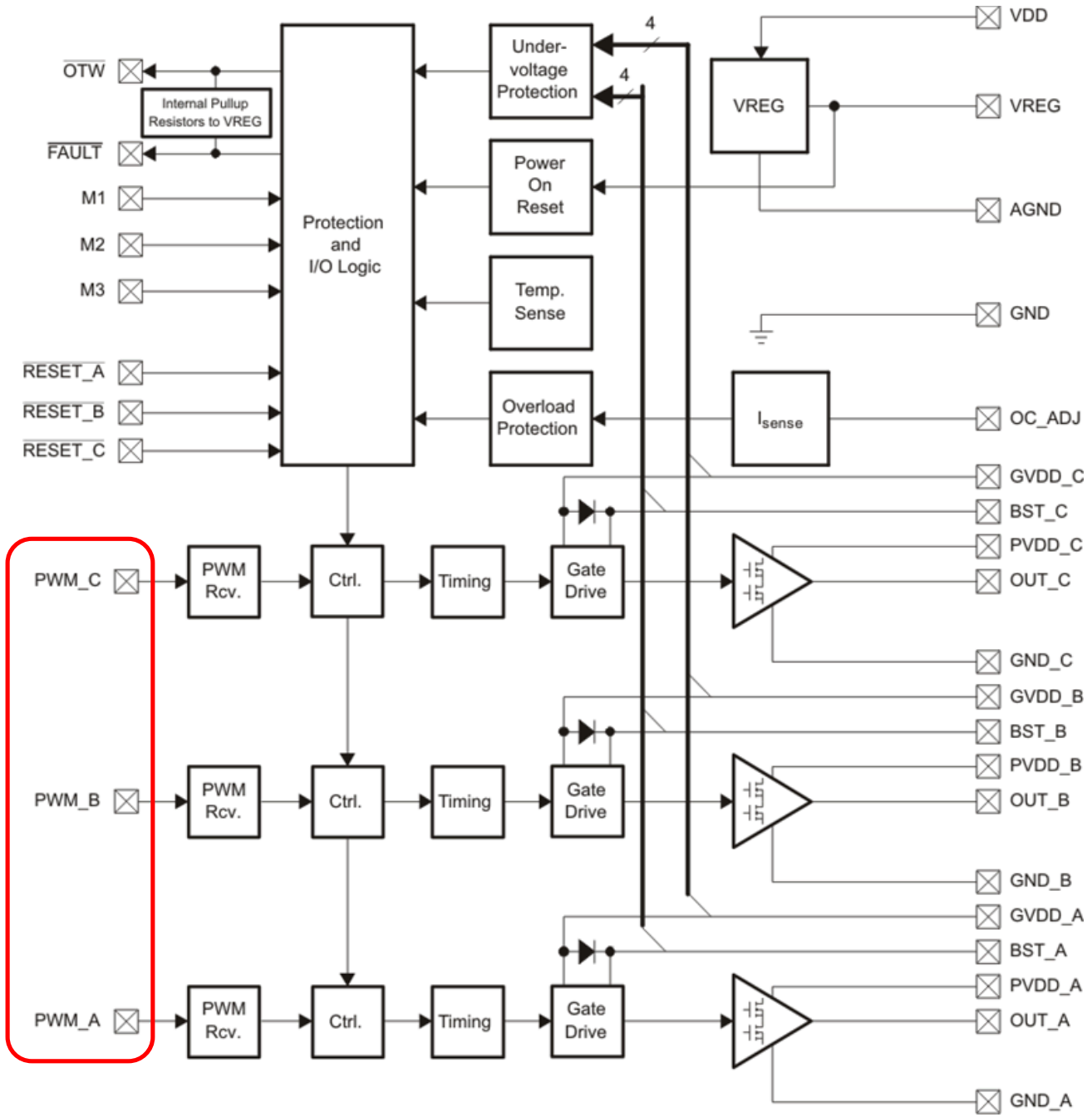
  6.5A three phase brushless DC motor driver with inrush protection (PWM ctrl)

  PWM Operating Frequency up to 500 kHz.

  Integrated Self-Protection Circuits Including Undervoltage, Overtemperature, Overload, and Short Circuit.

  High-Efficiency Power Stage (up to 97%) With Low RDS(on) MOSFETs (80 mΩ at TJ = 25°C)

  Operating Supply Voltage up to 50 V (70-A Absolute Maximum)

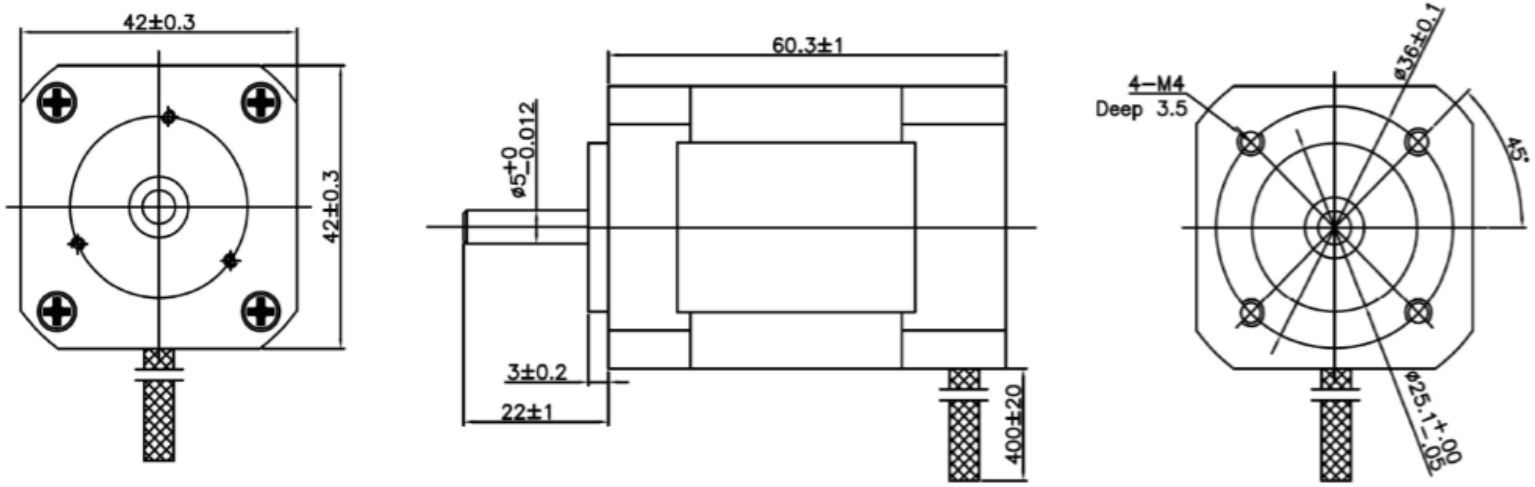


TI C2000 Series DRV8312EVM

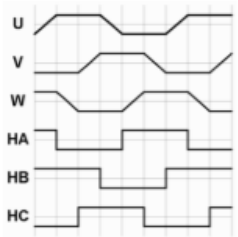
- MOTOR (BLDC)

  DT4260-24-055-04H-PT 24VDC 4000RPM 1814-0067MOTOR (telcointercon)

REV	DESCRIPTION	BY	DATE
A	Update hall sensor voltage	Jim	02/18/14

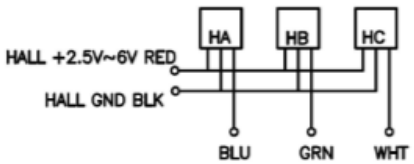


CCW COMMUTATION: VIEWED FROM OUTPUT SHAFT

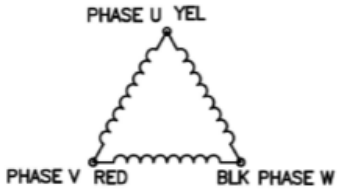


HALL SENSORS: DRV5013AD
(CUSTOMER SUPPLIED MATERIAL)

HALL CONNECTING



THREE−PHASE CONNECTING



NUMBER OF POLES	8
LINE TO LINE RESISTANCE	0.8±10%ohms @20°C
LINE TO LINE INDUCTANCE	1.2±20%mH
NOMINAL VOLTAGE	24V
NOLOAD SPEED	6000±10%RPM
NOLOAD CURRENT	< 0.5A @25°C
RATED TORQUE	0.125N.m
RATED SPEED	4000±10%RPM
PEAK TORQUE	0.38N.m
TORQUE CONSTANT	0.0355N.m/A
BACK EMF	2.71±10%Vrms/Krpm
ROTOR INERTIA	48 g.cm^2
WEIGHT	0.45 Kg

WIRING DIAGRAM

UL1430 AWG20#			UL1430 AWG26#				
PHASE U	PHASE V	PHASE W	HALL +2.5~6V	HALL A	HALL B	HALL C	HALL GND
YEL	RED	BLK	RED	BLU	GRN	WHT	BLK

Approved by(print): Ross Eisenbeis

Signature: Ross Eisenbeis

Title: TI Applications Eng.

Date: 4/24/2014

UNLESS OTHERWISE SPECIFIED:		NAME	DATE
TOLERANCES : DECIMALS: .X ±0.5 ANGULAR: .XX ±0.25 ±0°30' .XXX ±0.1	DRAWN		
UNIT: mm DO NOT SCALE DRAWING	REVIEW	J.C.	02/18/14
MATERIAL:	ENG APPR.	J.C.	02/18/14
WEIGHT:			
PROJECTION: THIRD ANGLE			

TELCO MOTION

TITLE: NEMA 17 BLDC

SIZE	PART. NO.	REV
	DT4260−24−055−04H−TI	A

SCALE: STAGE: SHEET:1 OF 1

InstaSPIN - Motion

InstaSPIN-MOTION features

Identify inertia

- Uses inertia to provide the most accurate system control across a wide range of inertia change
- The SpinTAC intertia estimator automatically measures system inertia by spinning the motor and measuring feedback

Simple tuning

- Single coefficient tuning to quickly test and tune your control from soft to stiff response
- Reduce complexity and system tuning time in multi-variable PID based systems with single gain (bandwidth) that works across the entire variable speed, position and load range of an application
- A single parameter tunes both position and speed

Disturbance rejection

- SpinTAC controller automatically rejects disturbances caused by:
  - cycle transitions
  - changing loads
  - environmental disturbances
- Maximize control and recover more quickly than a PI controller, with less oscillation, and minimal over/undershoot

Execute motion profiles

- SpinTAC runs on the processor to create smooth configurable trajectories between two positions/speeds
- The Motion Engine automatically generates the best curve to satisfy the user-entered jerk and acceleration constraints for each move

Plan trajectories

- Quickly build various states of motion (point A to point B) and tie them together with state based logic (hold for time, wait for interrupt, move to state C or D based on logic, etc.) in minutes
- Directly embed the trajectories into the C code on the microcontroller

Software architectures

Example projects are designed in a modular structure to demonstrate the flexibility of adding InstaSPIN-MOTION features to your application. Architectures include:

- Sensorless speed control
- Sensored speed control
- Sensored position (servo) control

1.1.3 InstaSPIN-FOC Block Diagrams

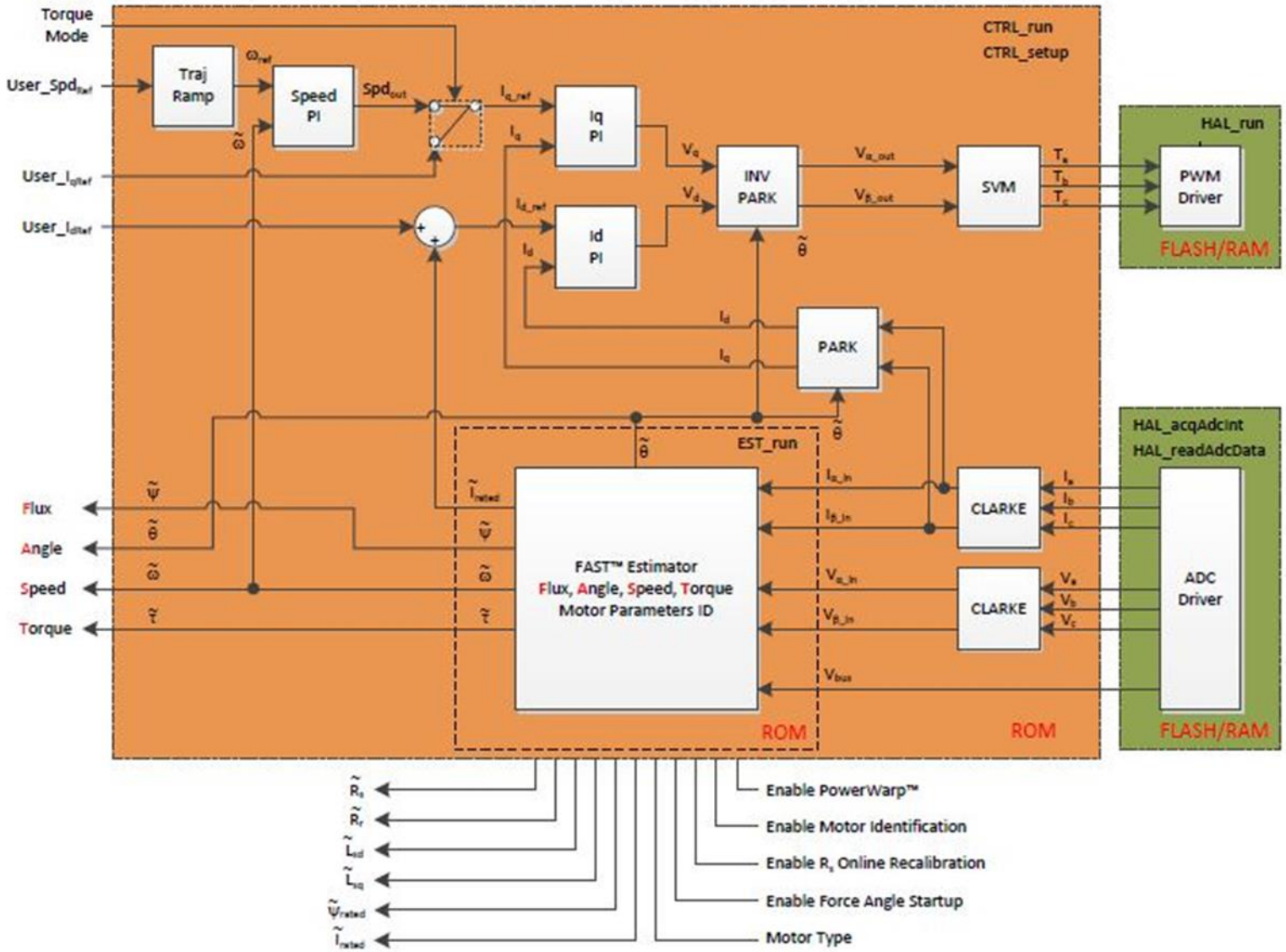
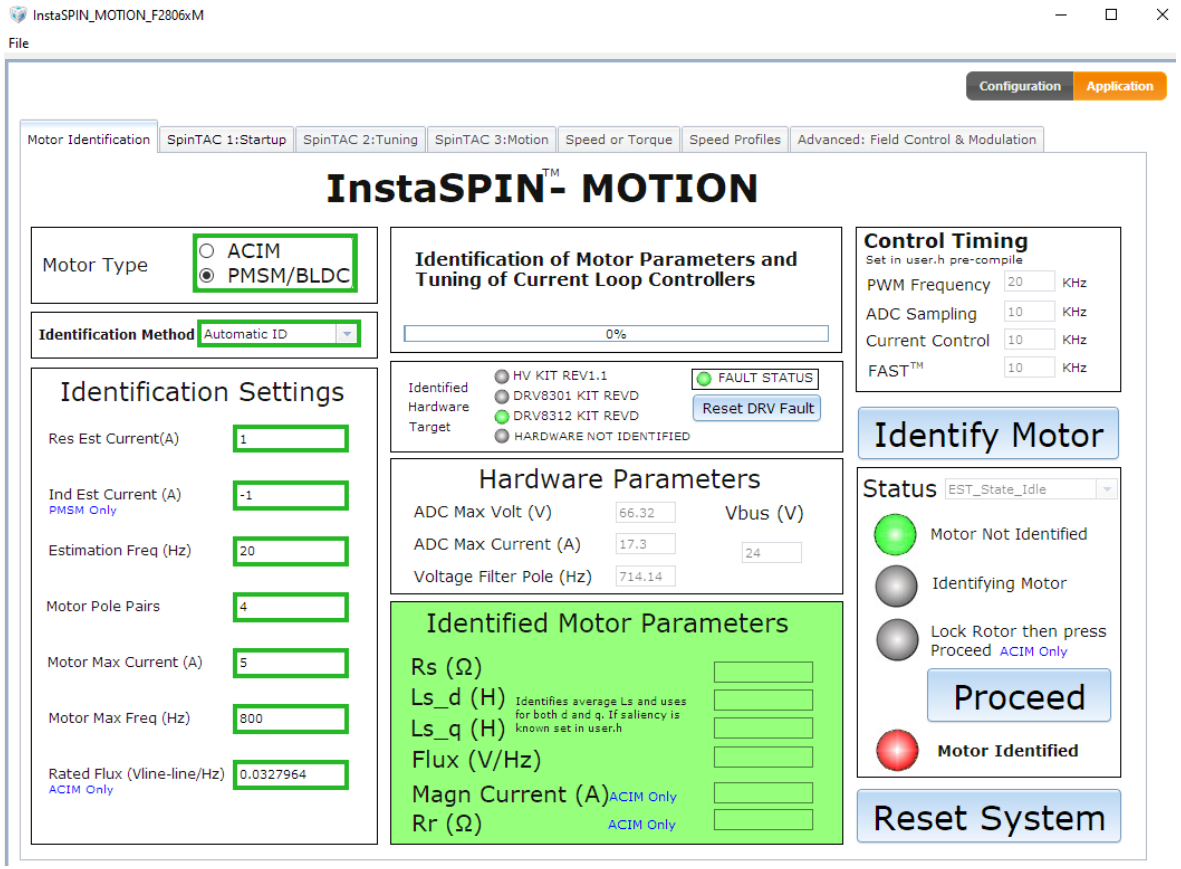
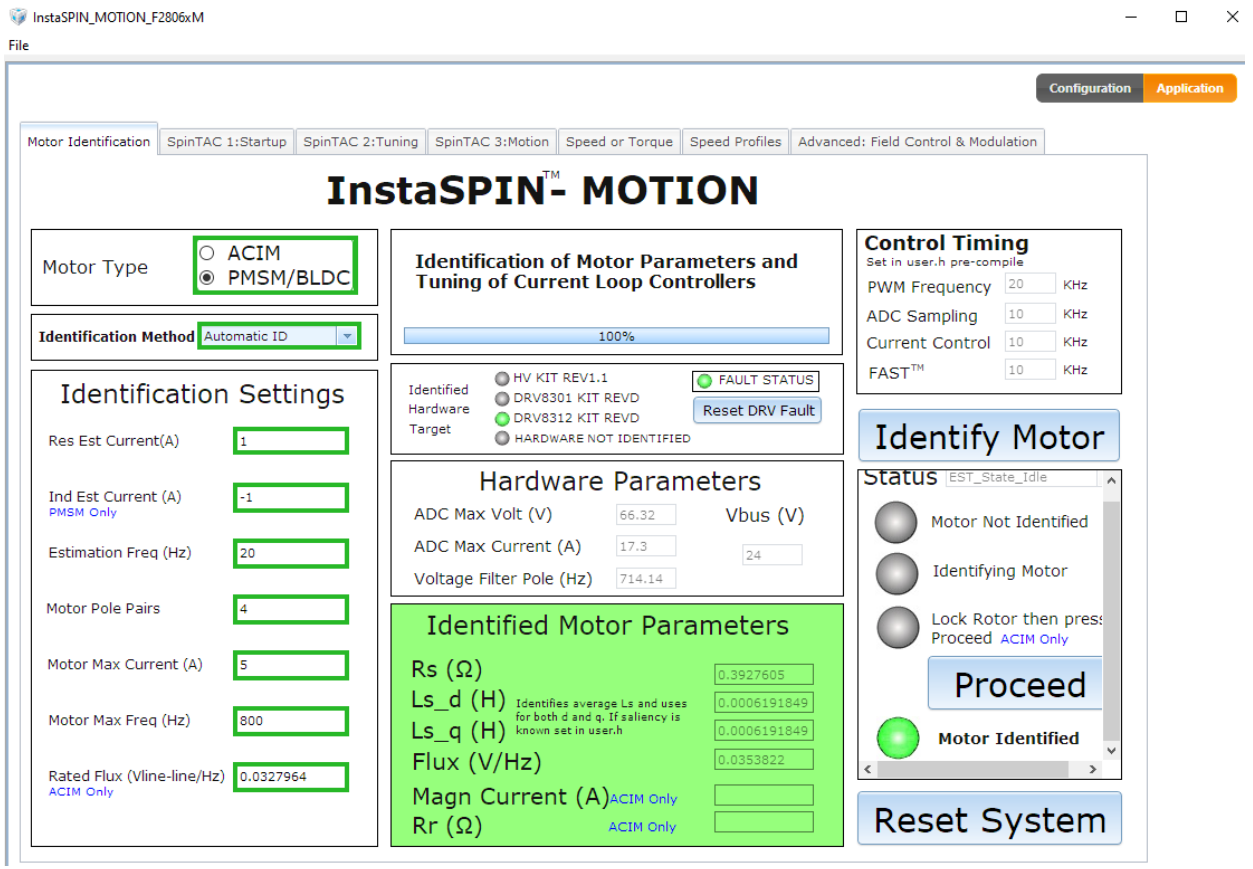


Figure 1-2. i. Block Diagram of Entire InstaSPIN-FOC Package in ROM (except F2802xF devices)

InstaSPIN - Motion





Motor Identification | SpinTAC 1:Startup | SpinTAC 2:Tuning | SpinTAC 3:Motion | Speed or Torque | Speed Profiles | Advanced: Field Control & Modulation

SpinTAC by LineStream

Version: 2 . 2 . 1

SpinTAC is a
High-Performance Controller
that replaces PI control

It uses advanced control techniques and is
Tuned with one parameter
In a matter of minutes

You ony have to tune it once and SpinTAC performs across a
Wide Operating Range

To begin, ***check the limits and click "Estimate Motor Inertia".*** After SpinTAC is Enabled, move the tab "SpinTAC 2: Tuning".

1 Limits

Motor Ready

Ramp Time: 10 [sec]

0.1 ≤ 10 ≤ 25.0

Iq Limit: 4 [A]

0 < 4 ≤ 5

Speed: 2400 [RPM]

0 < 2400 ≤ 12000

2 Run

Estimate Motor Inertia

Your motor will spin a few times as SpinTAC estimates the motor inertia

Status

Zero Speed

Identifying

Not Identified

Identified

Results

Inertia: 0.023306

10^{-3}[A·s/RPM]

Friction: 0.086775

10^{-3}[A·s/RPM]

SpinTAC Enabled

SpinTAC by LineStream

Version: 2 . 2 . 1

Motor Identified

Motor Running

Start/Stop

Disable SpinTAC

Reverts to Speed PI and Ramp Reference on "Speed or Torque" tab

One Minute Tuning

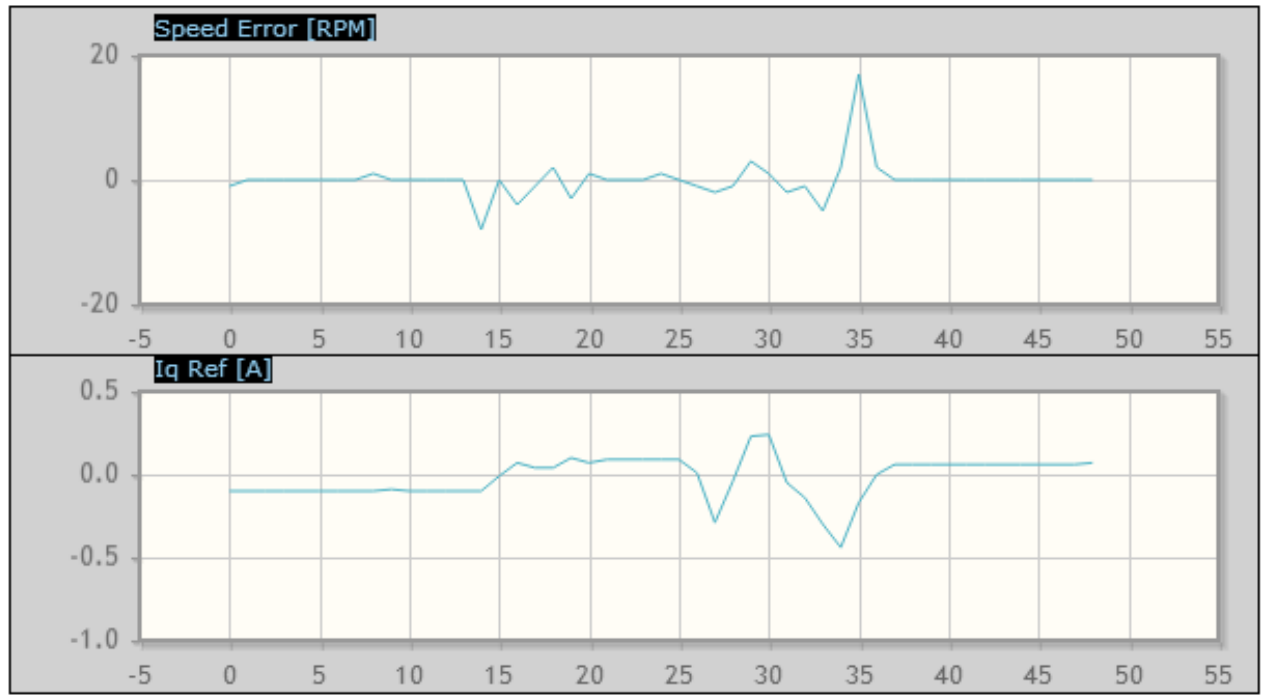
1 **Set the Target Speed to zero.**

2 **Increase the bandwidth** until you are satisfied with the tightness or the motor becomes unstable

3 **Try a few speeds** to make sure the bandwidth settings works across your operating range

Target Speed: 0 [RPM]

Motor Speed: 0 [RPM]



Bandwidth Tuning

[rad/s]

SpinTAC Speed Controller Enable

Enable PI Speed Controller Kp: 8 Ki: 0.08

Motor Identification | SpinTAC 1:Startup | SpinTAC 2:Tuning | SpinTAC 3:Motion | Speed or Torque | Speed Profiles | Advanced: Field Control & Modulation

SpinTAC by LineStream

Version: 2 . 2 . 1

Motor Identified

Motor Running

Start/Stop

Disable SpinTAC

Reverts to Speed PI and Ramp Reference on the "Speed or Torque" tab

Motion Profiler

Choose a curve type and acceleration/jerk limits

Set a target speed and hit Enter

Motion profiles will automatically be generated and sent to the controller

Note: To use the SpinTAC Profile Generator with a standard PI Controller, click "Enable" on the PI Speed Controller below the graphs

Profile Types

- ○ Trapezoidal Curve
- ○ sCurve
- ◉ stCurve *(Smoothest) *Linestream Proprietary*

Profile Limits

Acceleration Limit:

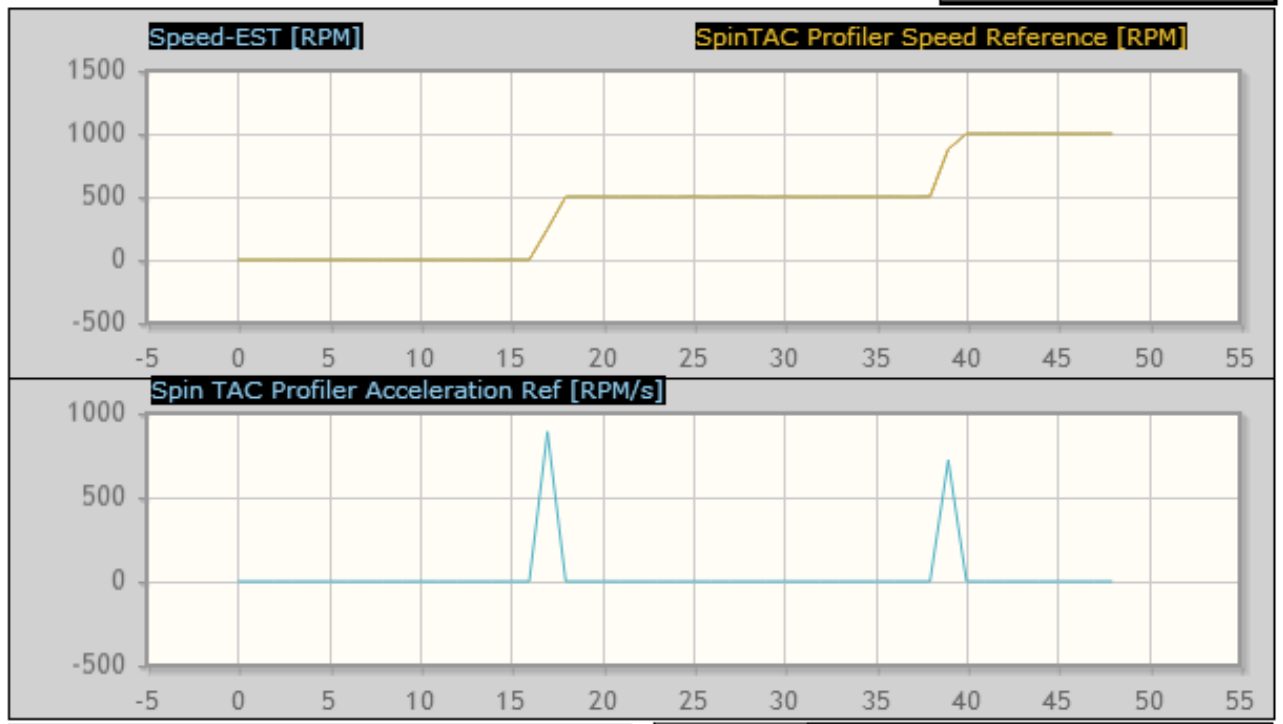
30 ≤ 1200 ≤ 12000 [RPM/s]

Jerk Limit:

0.03 ≤ 2.40 ≤ 192.0([KRPM/s²]

Start Speed	Motor Speed	Target Speed
1000	1001	1000
[RPM]	[RPM]	[RPM]

Profile Time: 0 [Sample Counts]



SpinTAC Profiler + SpinTAC Speed Controller — Enable

Enable — SpinTAC Profiler + PI Speed Controller

Motor Identification | SpinTAC 1:Startup | SpinTAC 2:Tuning | SpinTAC 3:Motion | Speed or Torque | Speed Profiles | Advanced: Field Control & Modulation

Speed Mode

Speed Reference (RPM) 1735

-20000 -10000 0 10000 20000

Max Acceleration (RPM/s) 1200

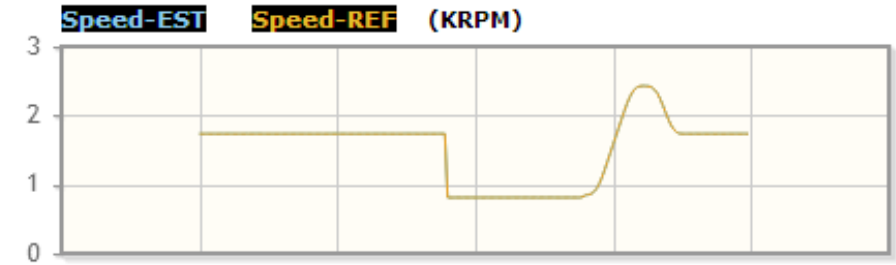
0 1600 3200 4800 6400 8000

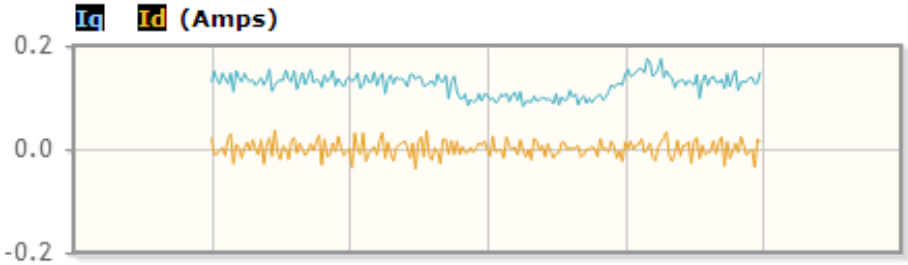
Speed Loop Tuning

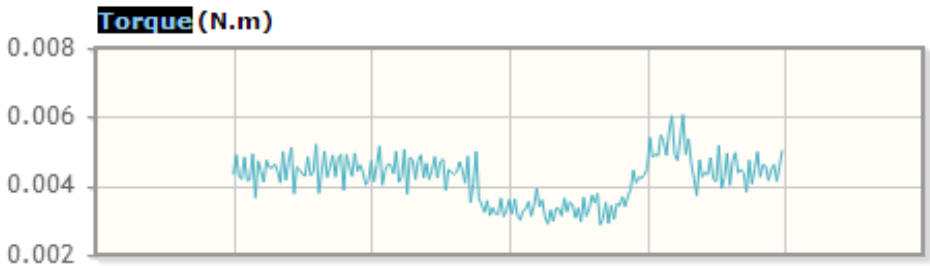
To Enable SpinTAC, go to "SpinTAC 1" tab. Switching is allowed only in "Speed+Torque" mode or when motor is stopped

PI Control ENB Kp: 8 Ki: 0.08

SpinTAC Control ENB Bandwidth:[rad/s] 39.94







Estimated Speed (RPM) 1734

Target Speed (RPM) 1735

Vbus (V) 24

Direction

Start-Up

0.3919

Rs ReCal: Disable / Enable

Offset ReCal: Disable / Enable

Force Angle Start: Disable / Enable

ENB Speed+Torque

ENB Torque

Ready, Motor Identified

Motor Running

DRV FAULT STATUS

Start/Stop

Torque Mode

Torque Reference Iq (pu)

-1.00 0.00 1.00

0.0

Current Control

Iq PI Control: Kp 0 6 12 18 24 30 (0.3225); Ki 0.0 0.1 0.2 0.3 0.4 0.5 (0.0634)

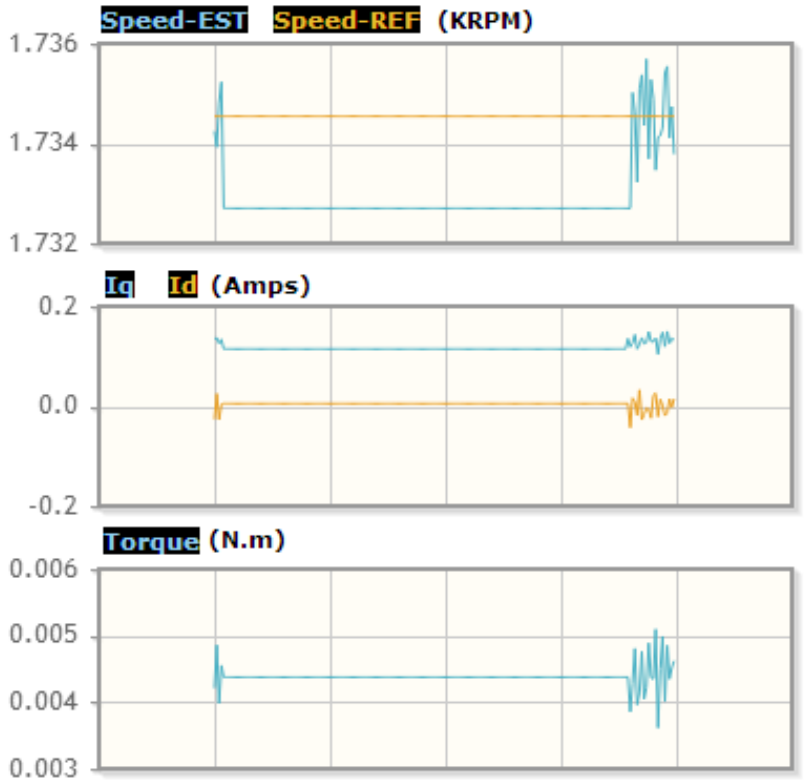
Id PI Control: Kp 0 6 12 18 24 30 (0.3225); Ki 0.0 0.1 0.2 0.3 0.4 0.5 (0.0634)

ACIM PowerWarp™ - Minimum Current Use At All Times

Motor Identification | SpinTAC 1:Startup | SpinTAC 2:Tuning | SpinTAC 3:Motion | Speed or Torque | Speed Profiles | Advanced: Field Control & Modulation

STAIRCASE SPIN

	Speed RPM	Acceleration RPM/s	Ramp + Hold Time Seconds
Target 1	1500	220	20
Target 2	2500	220	20
Target 3	3500	262	23
Target 4	4500	275	23
Target 5	5500	281	31
Target 6	6500	262	23
Target 7	7000	240	25
Deceleration to 0 RPM		50	



Estimated Speed (RPM)

Target Speed (RPM)

Vbus (V)
24

Direction

Speed Loop Tuning

To Enable SpinTAC, go to "SpinTAC 1" tab. Switching is allowed only in "Speed+Torque" mode or when motor is stopped

PI Control ENB — Kp: 8 — Ki: 0.08

SpinTAC Control ENB — Bandwidth:[rad/s] 39.94

ENB Staircase Spin

ENB Agitate / Speed Reversal

Ready, Motor Identified

Motor Running

DRV FAULT STATUS

Start/Stop

Start-Up

0.3919

Rs ReCal: (o) Disable (•) Enable

Offset ReCal: (•) Disable ( ) Enable

Force Angle Start: (•) Disable ( ) Enable

AGITATE / SPEED REVERSAL

RPM cw/ccw	Acceleration RPM/s	Ramp + Hold Time Seconds
580	580	5

Deceleration RPM/s	Coast Time Seconds	Ramp Time Seconds
580		2

Motor Identification | SpinTAC 1:Startup | SpinTAC 2:Tuning | SpinTAC 3:Motion | Speed or Torque | Speed Profiles | Advanced: Field Control & Modulation

Field Control

Max Negative Id Allowed (A)

-2

Auto Field Weakening

Manual Field Weakening (-) or Boosting(+) OR

Id Reference (A)

-14.0 -8.4 -2.8 2.8 8.4 14.0

-2.2

PI Control - Generates IdRef

0.0 6.0 12.0 18.0 24.0 30.0

3.1

Kp

0.0 0.1 0.2 0.3 0.4 0.5

0.27

Ki

SVM Modulation

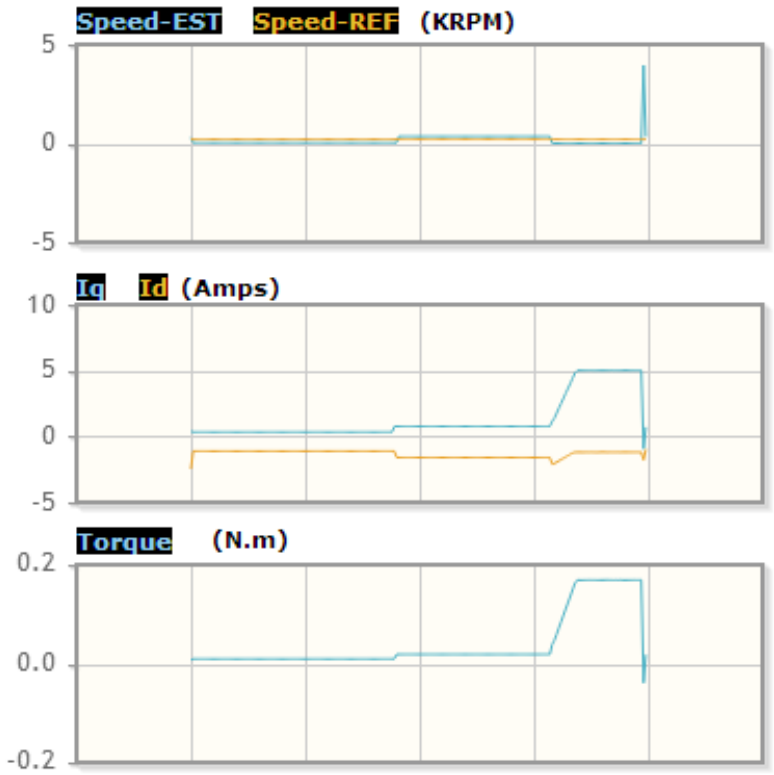
1.15

[Max Duty Cycle, 1.15 default]

0.00 to 1.00: Perfect Sinusoidal
1.00 to 1.15: Quasi-Sinusoidal
1.15 to 2.00: Trapezoidal

For use by EXPERTS only in conjunction with other tabs & modes

WARNING Damage may be done to your motor or power stage WARNING



Estimated Speed (RPM)

0

Target Speed (RPM)

0

Vbus (V)

24

Direction

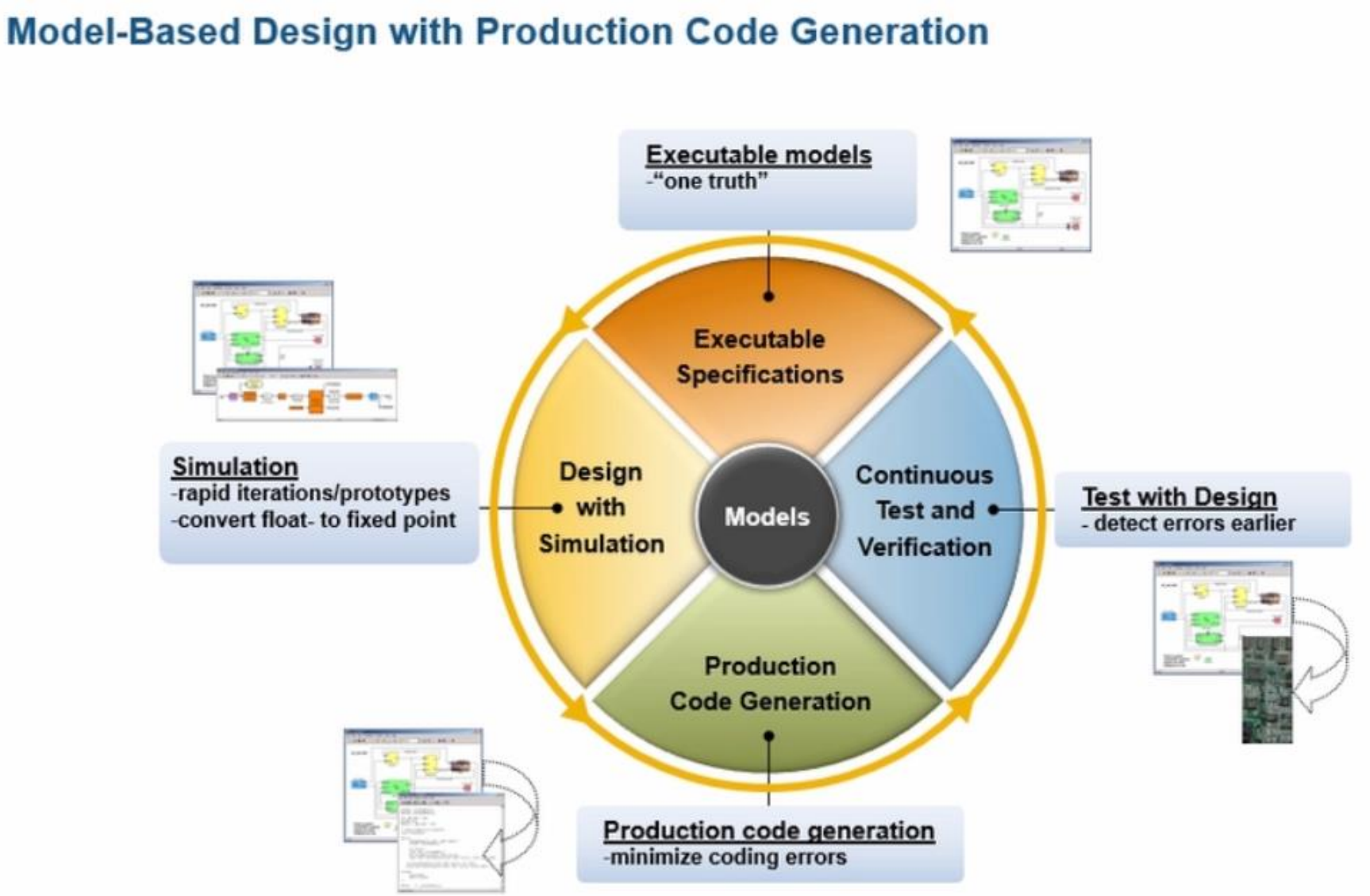
Motor Identified

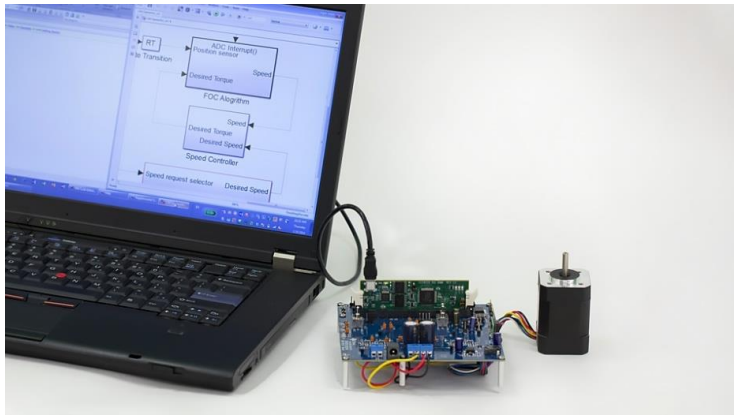
Motor Running

DRV Fault Status

Start/Stop

Model Based Design – Matlab/Simulink





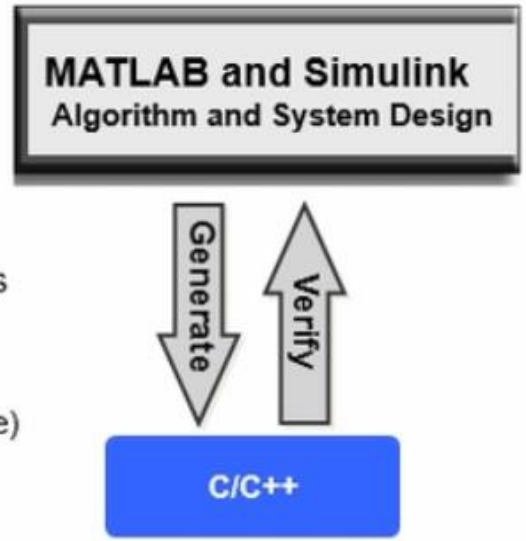
Model Based Design – Matlab/Simulink

C/C++ Coders

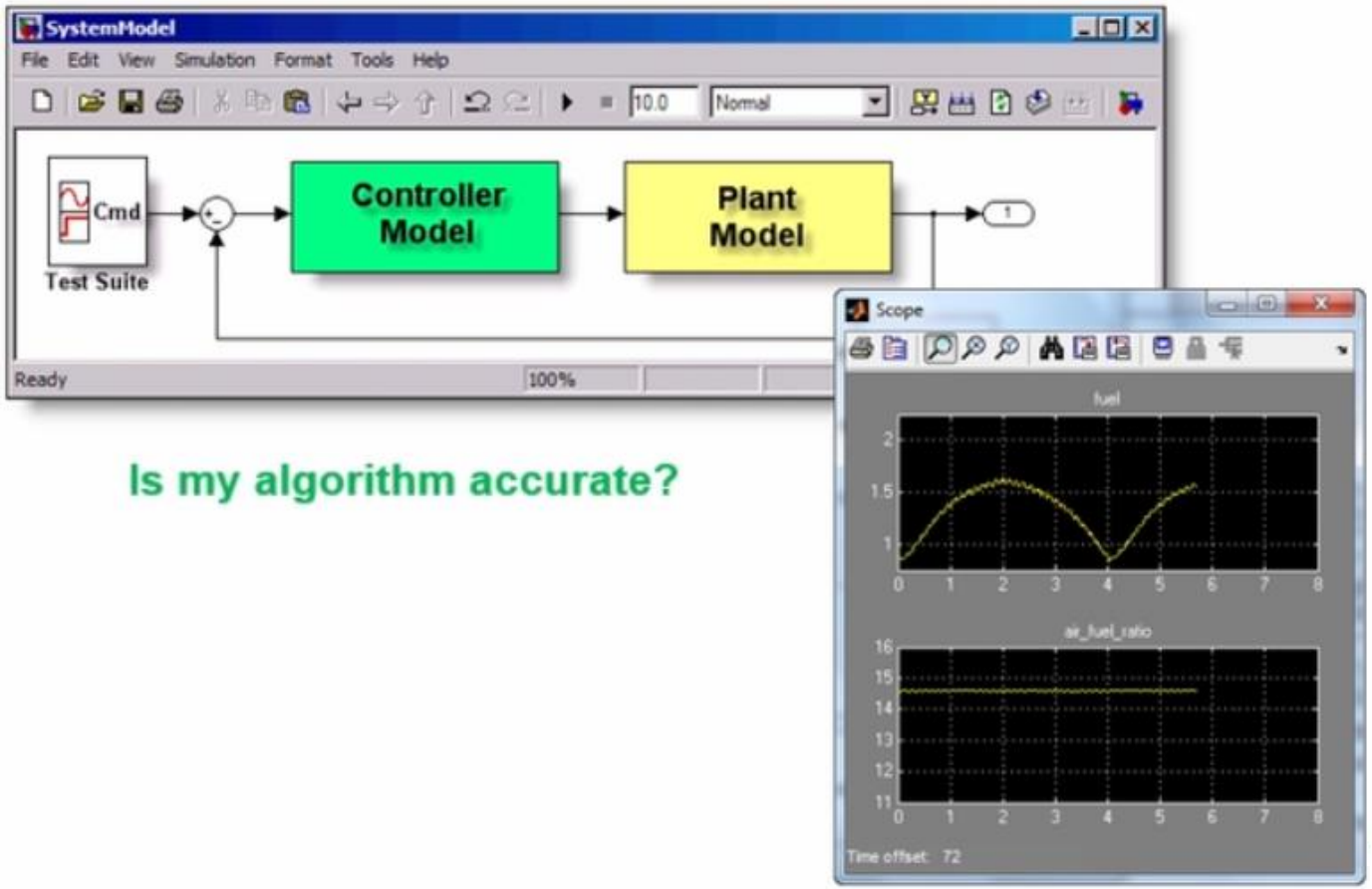
MATLAB Coder - Code from MATLAB
- Portable code for numerical algorithms
- Desktop applications (standalone, library)

Simulink Coder - Code from Simulink
- Portable code for algorithms plus real-time framework
- Real-time machines for RP/HIL (e.g., Simulink Real-Time)

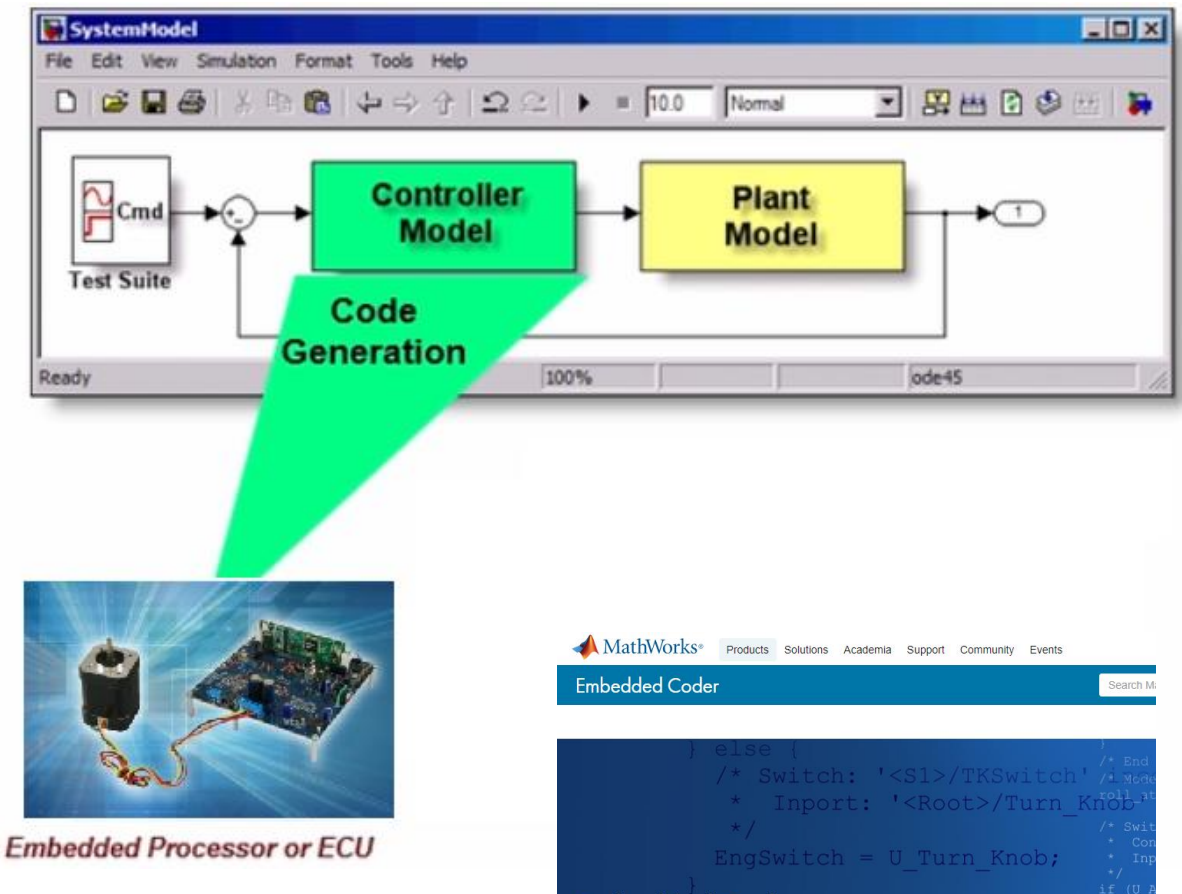
Embedded Coder – Production code
- Extends ML Coder and SL Coder for embedded processors
- MCUs and DSPs (from 8-bit devices to multicore SoCs)
  - Code optimization (portable code and processor-specific)
  - Code verification (software- and processor-in-the-loop, trace)
  - Code profiling (tasks and functions)
  - Code customization (data, functions, files)
  - Embedded targets (board initialization, I/O blocks, scheduler)
  - Certification (ISO-26262, IEC 61508, etc.)



Model Based Design – Matlab/Simulink



Is my algorithm accurate?

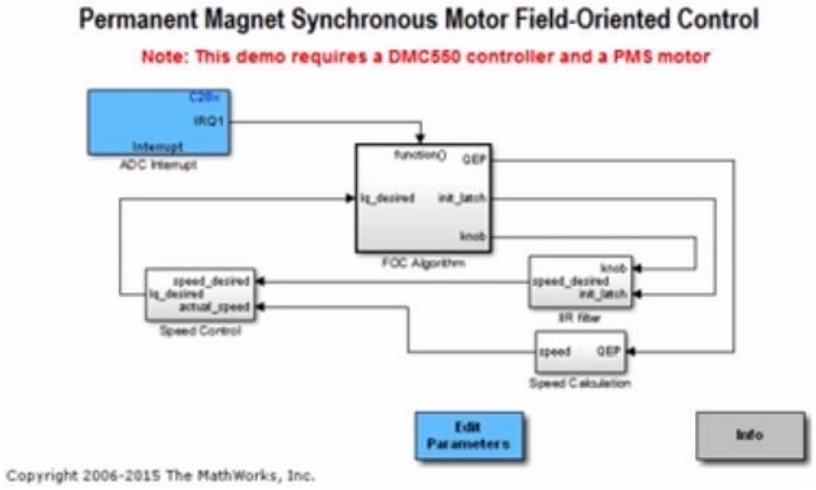


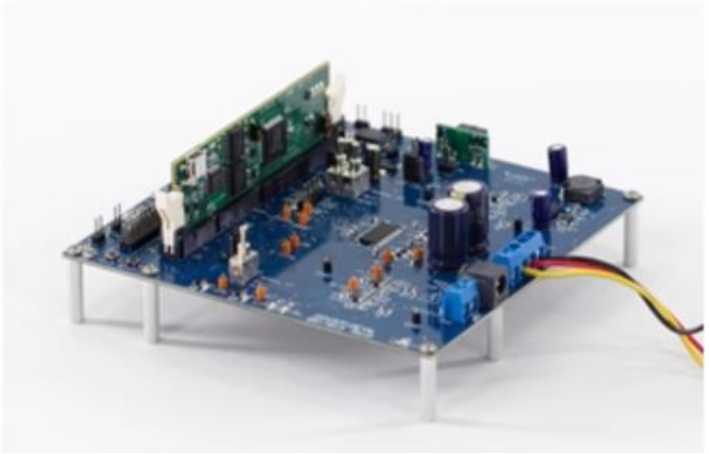
Embedded Processor or ECU

Design with Simulation

Embedded Coder support for TI C2000 Motor Control kits.

- TI F28027 Launchpad + DRV8301 (FX + Video)
- TI F28069 Launchpad + 2 x DRV8301 (FX + Video)
- ControlCard + DRV8312 (Shipping example)
- DM550 + eZdsp (Shipping example)
- High voltage motor control kit (available on demand)





Design with Simulation

Model : Double
Embedded Processor : Single

Bu ayarlar Matlab/Simulink'te tasarlanan sistemin donanım üzerinde düzgün çalışmasını sağlıyor. Bu uyumsuzluklar

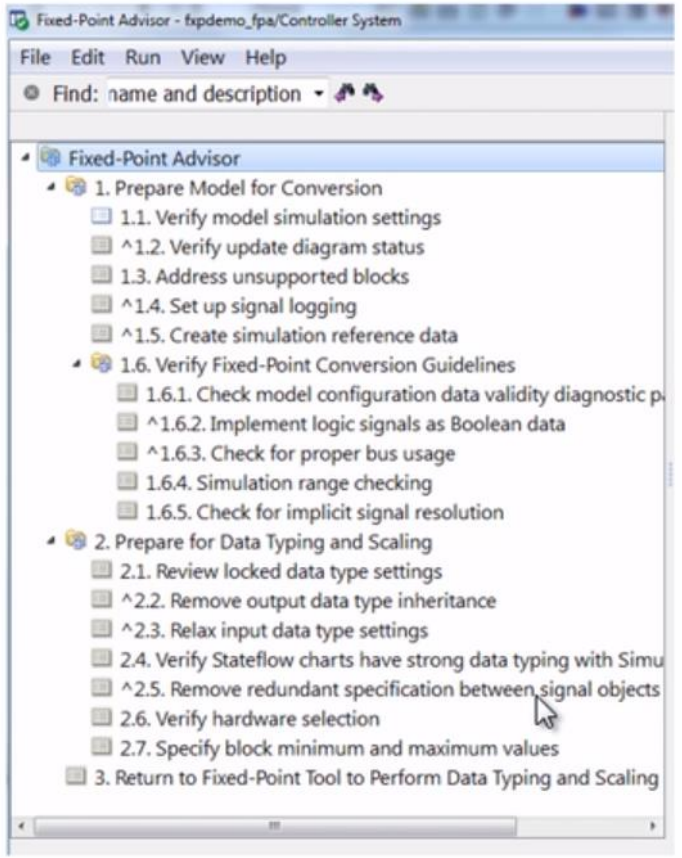
- Interger types
- Floating points
- Input/Output Ranges
- Execution ranges

Olabilir.

Float- to Fixed-Point Conversion

- Overflow/underflow
- Code optimizations
- Simulation ranges
- Derived ranges
  - Design-range scaling

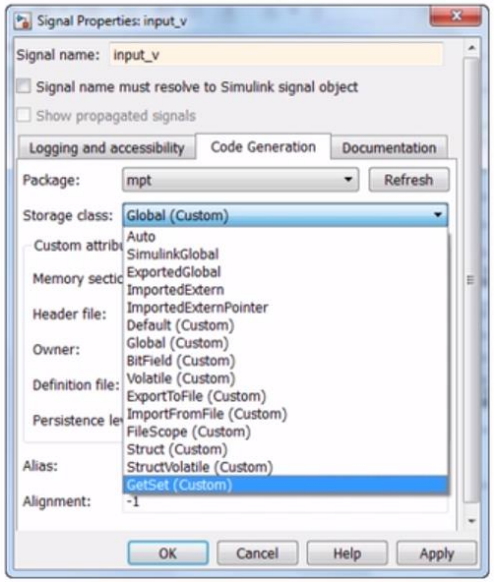
>>fxpdemo_fpa



Design with Simulation

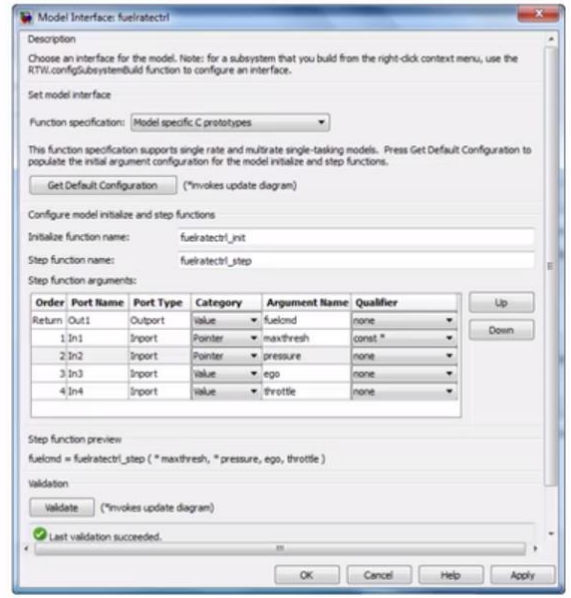
Data Specification

- Name
- Storage class
- Alias (typedef)
- Comments



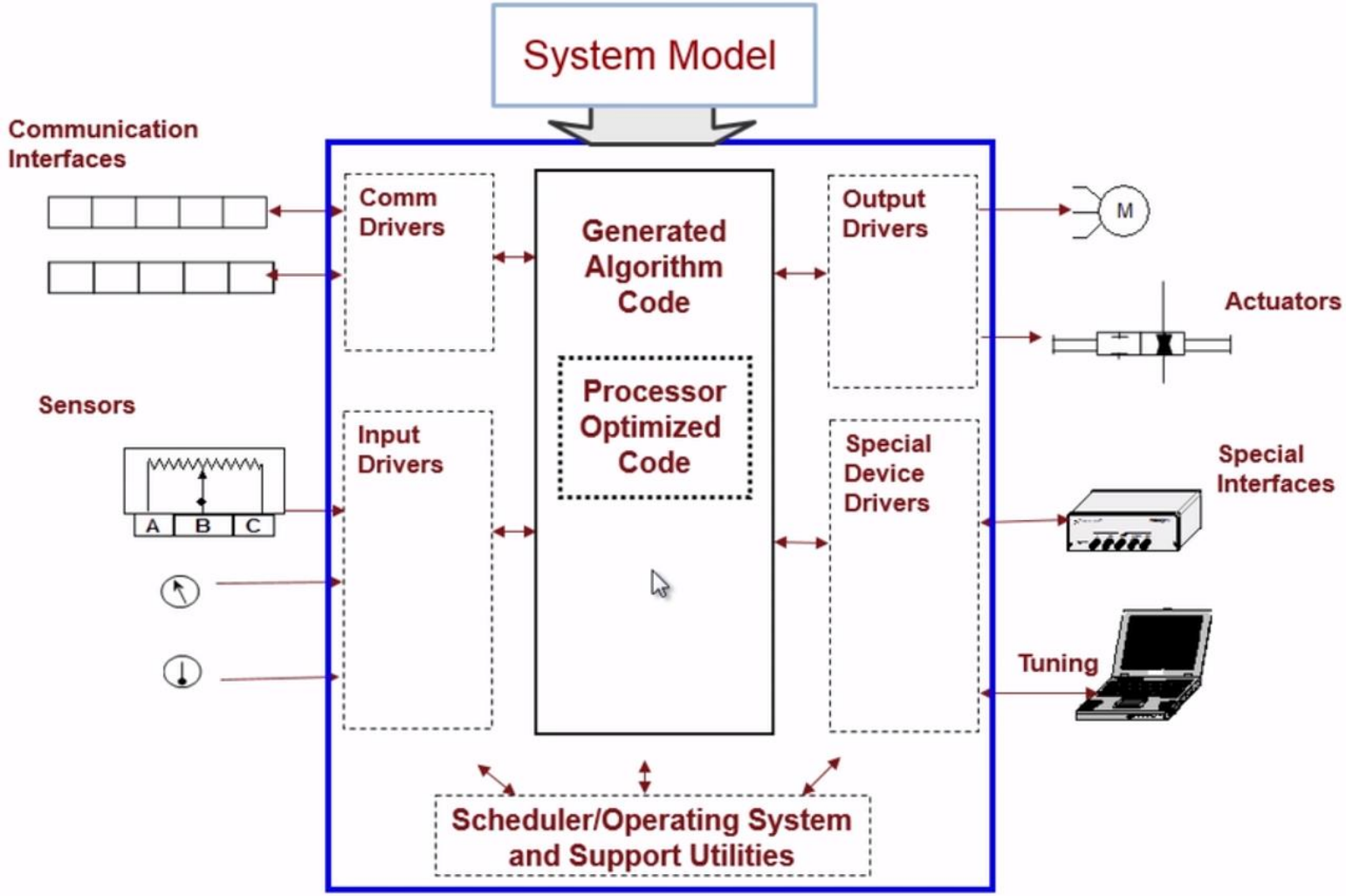
Function Interface Specification

- Function Name
- Argument Name
- Pass by value
- Pass by reference
- Qualifier



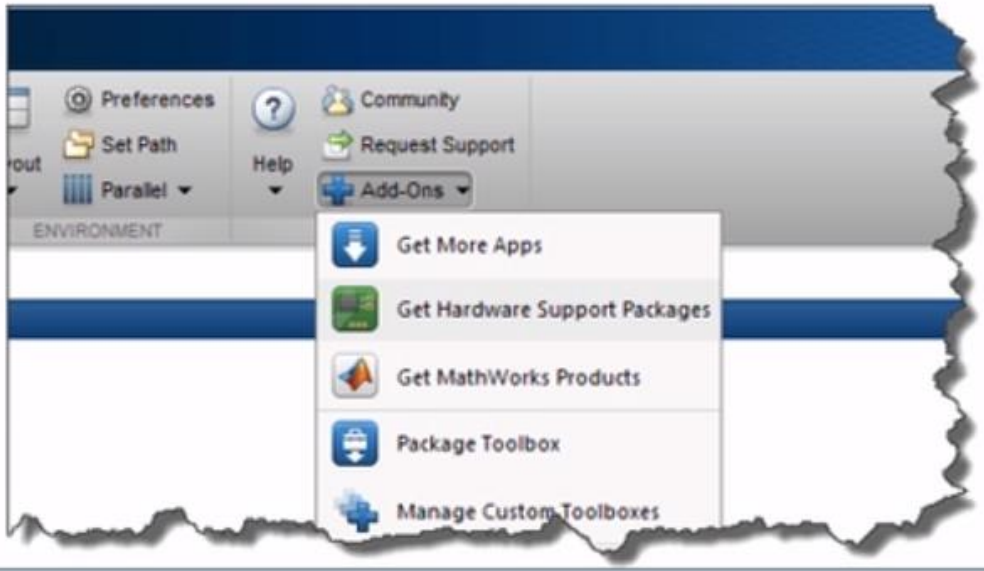
Design with Simulation

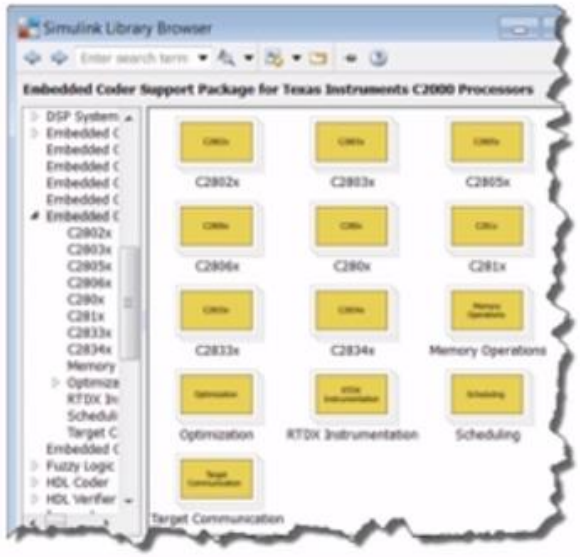
- Algorithm code
- Processor Optimization

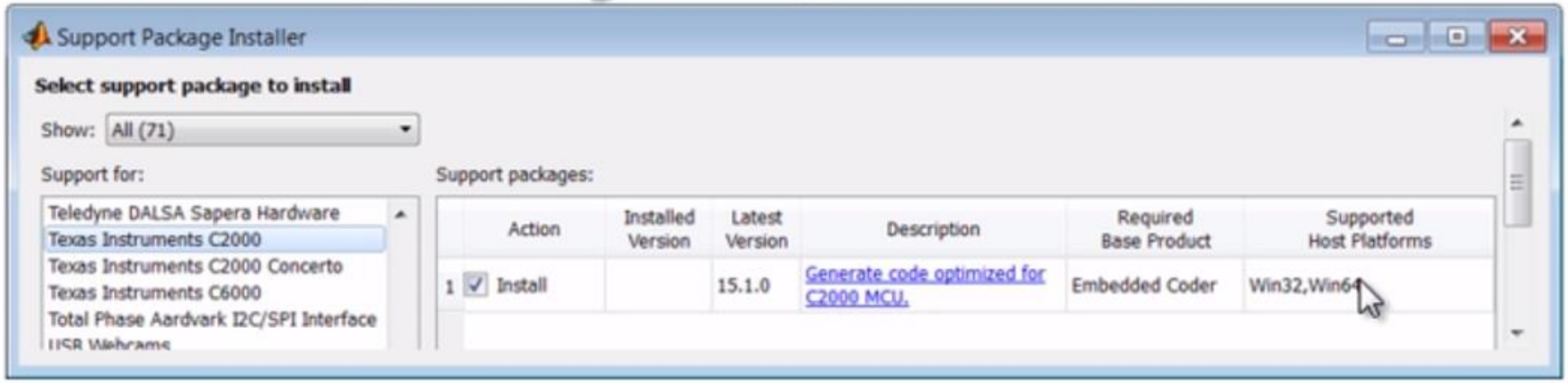


Design with Simulation

Embedded Coder Hardware Support Packages



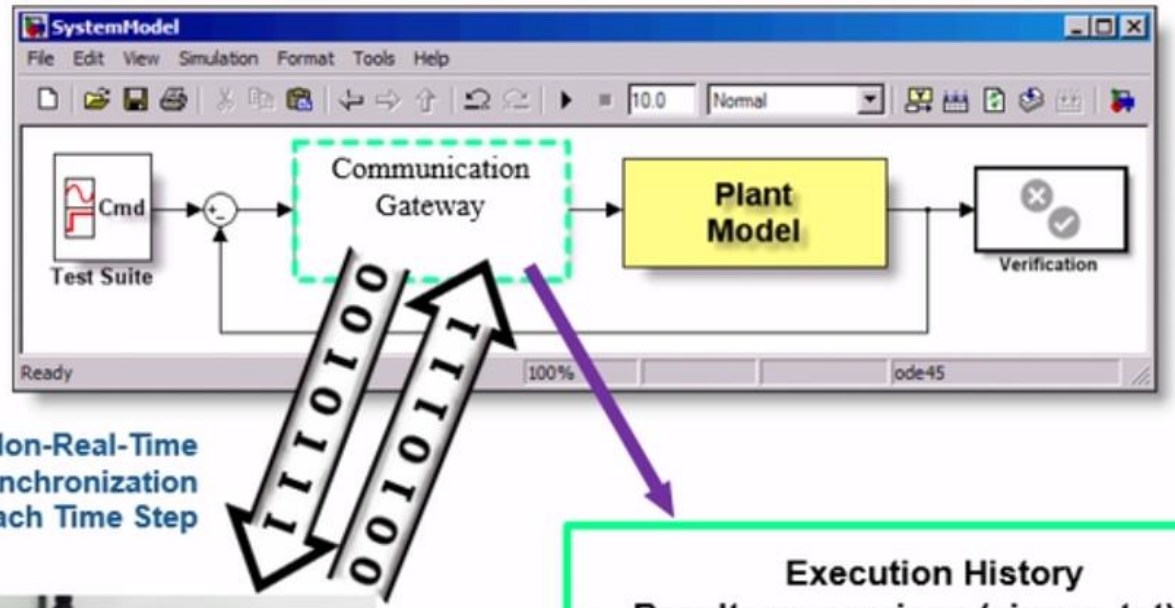




Design with Simulation

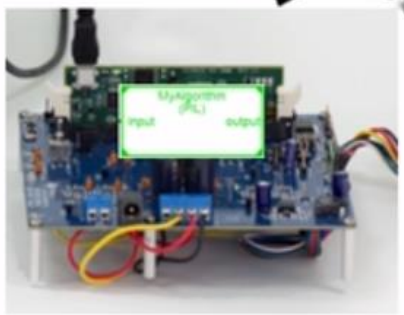
Processor-in-the-Loop (PIL)

Verify algorithms



Supported devices

- Piccolo F2802x/3x/5x/6x (07x in progress)
- Delfino F2833x/32x (F2837x in progress)
- Fixed-point F280x/1x
- Concerto (F28M35/M36)

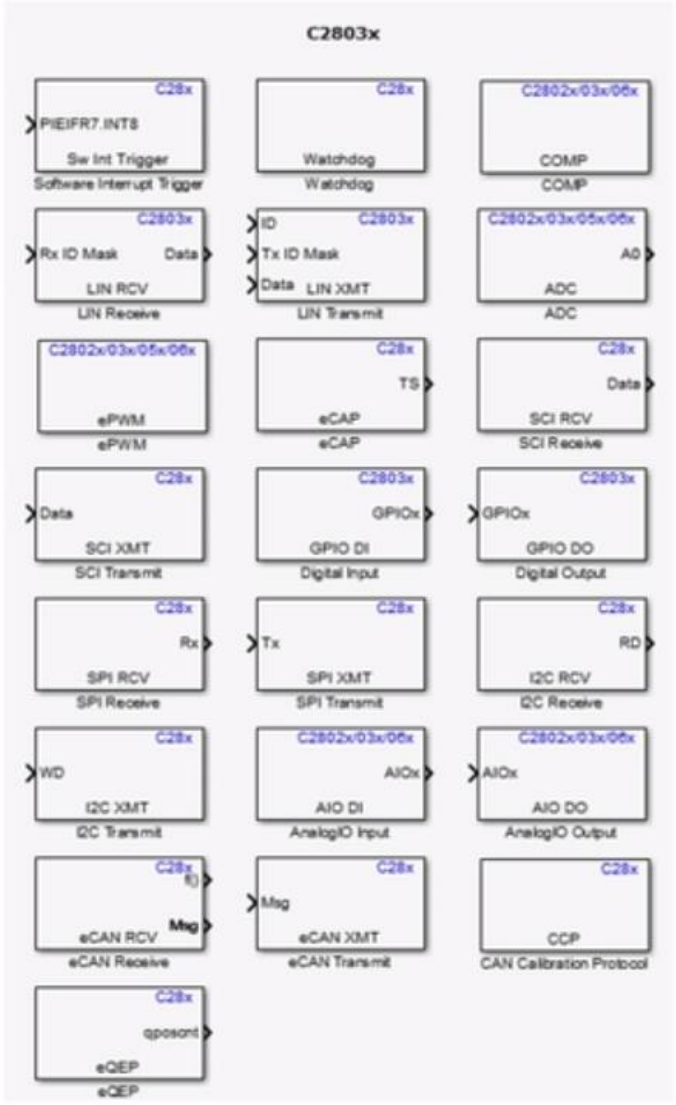


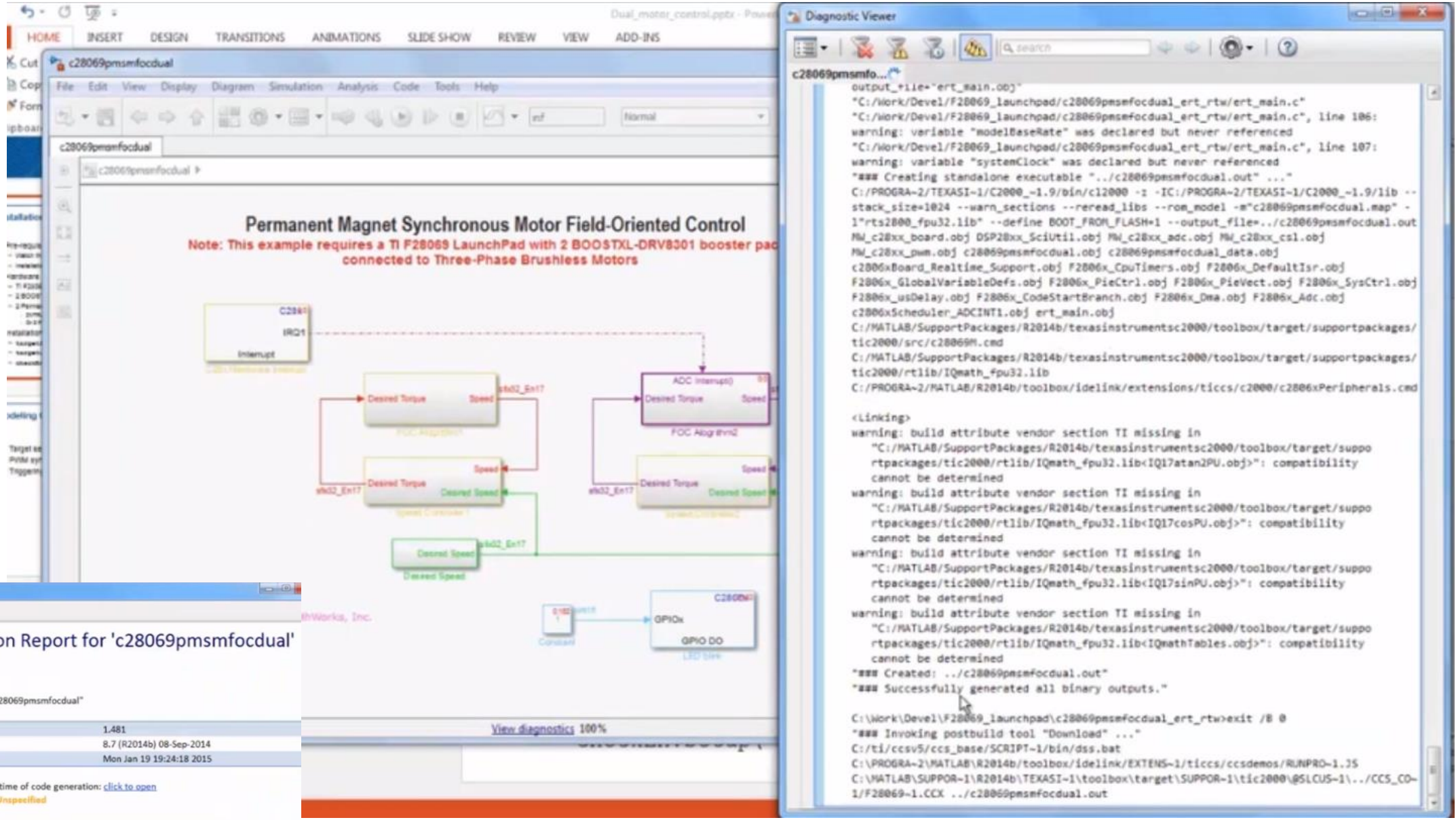
Design with Simulation

Supported TI C2000 drivers

- ADC, AIO, Comparator,
- GPIO, eQEP, ePWM, eCAP,
- eCAN, I2C, SCI, SPI, LIN
- Watchdog, DMA.

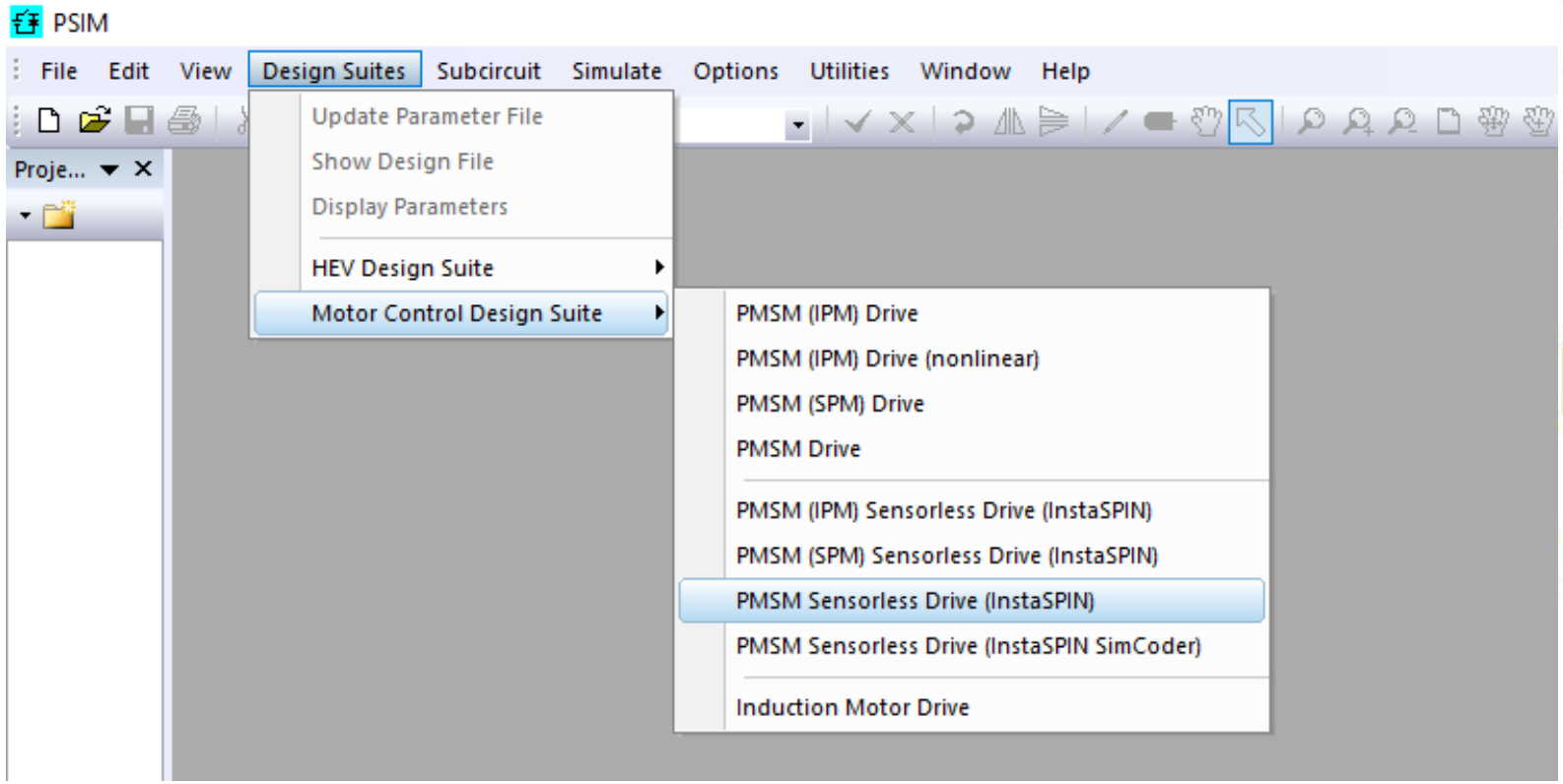
- Motor control position sensing
  - Optical encoder (using eQEP)
  - Hall sensors (using eCAP)
  - Sensorless (Using SMO)

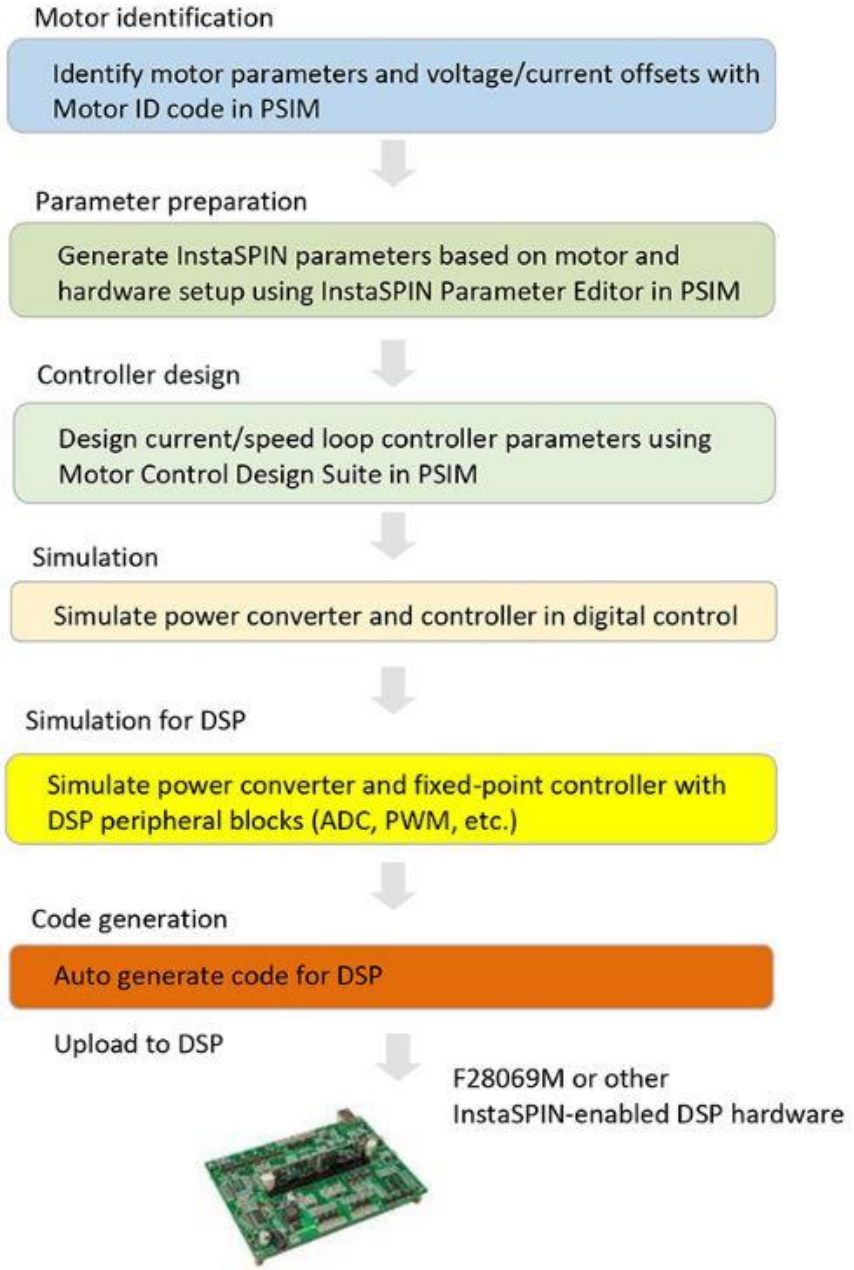


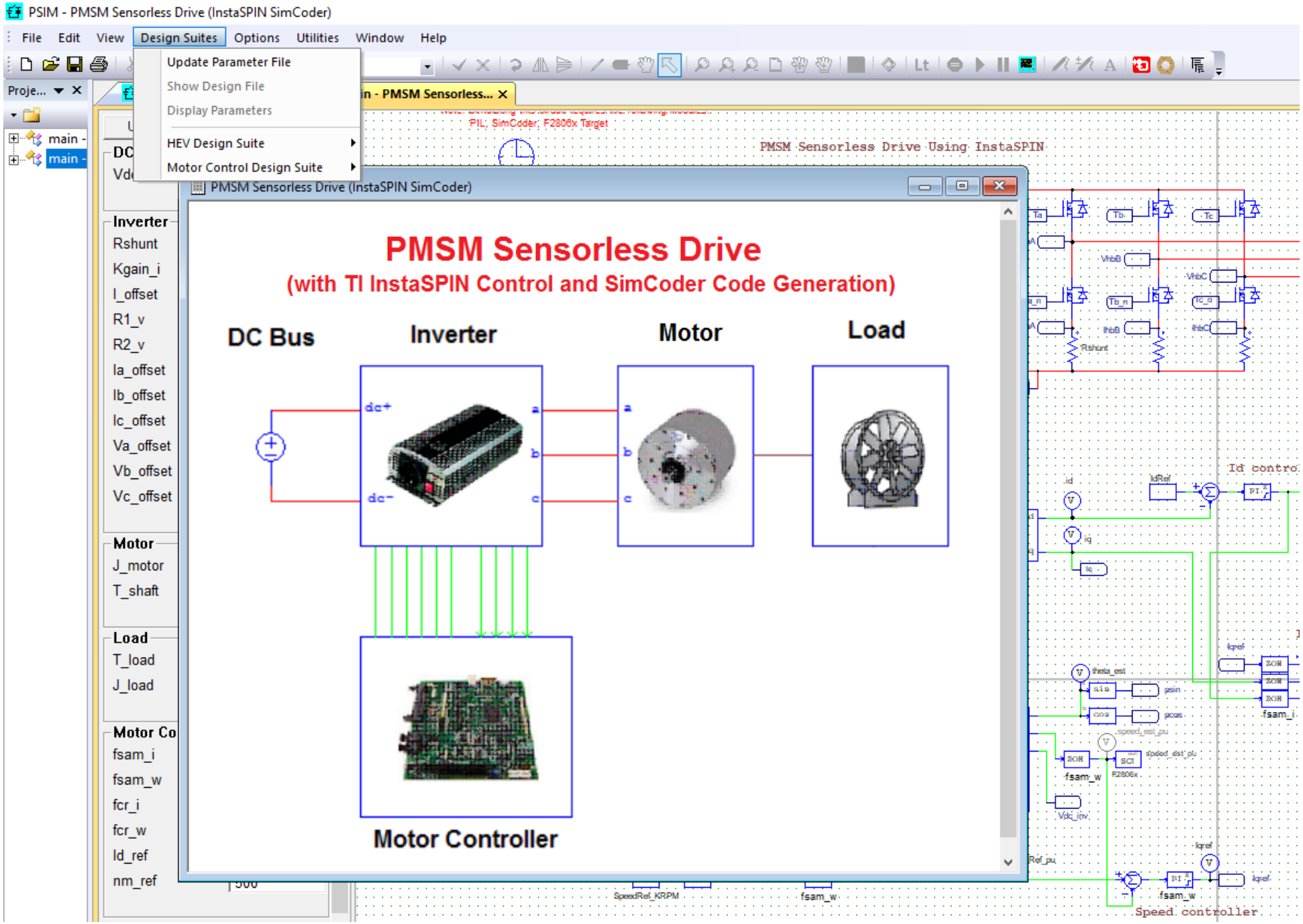

Permanent Magnet Synchronous Motor Field-Oriented Control
Note: This example requires a TI F28069 LaunchPad with 2 BOOSTXL-DRV8301 booster pac
connected to Three-Phase Brushless Motors
Diagnostic Viewer
Code Generation Report for 'c28069pmsmfocdual'
Summary
Code generation for model "c28069pmsmfocdual"
Model version 1.481
Simulink Coder version 8.7 (R2014b) 08-Sep-2014
C source code generated on Mon Jan 19 19:24:18 2015
"### Successfully generated all binary outputs."

Model Based Design - PSIM

- Need PSIM full professional version 10, 11 or 12.






PSIM - PMSM Sensorless Drive (InstaSPIN SimCoder)
File
Edit
View
Design Suites
Options
Utilities
Window
Help
Update Parameter File
Show Design File
Display Parameters
HEV Design Suite
Motor Control Design Suite
PMSM Sensorless Drive (InstaSPIN SimCoder)
PMSM Sensorless Drive
(with TI InstaSPIN Control and SimCoder Code Generation)
DC Bus
Inverter
Motor
Load
dc+
dc-
a
b
c
Motor Controller
Inverter
Rshunt
Kgain_i
I_offset
R1_v
R2_v
Ia_offset
Ib_offset
Ic_offset
Va_offset
Vb_offset
Vc_offset
Motor
J_motor
T_shaft
Load
T_load
J_load
fsam_i
fsam_w
fcr_i
fcr_w
Id_ref
nm_ref
PMSM Sensorless Drive Using InstaSPIN
Speed controller

PSIM - main - PMSM Sensorless.psimsch

File Edit View Design Suites Subcircuit Elements Simulate Options Utilities Window Help

Proje...

main -

main - PMSM Sensorless...

Update Parameter File

DC Bus

Vdc	24

Inverter

Rshunt	7m
Kgain_i	-10
I_offset	1.65
R1_v	62k
R2_v	4.99k

Motor

J_motor	4.8u
T_shaft	0.05

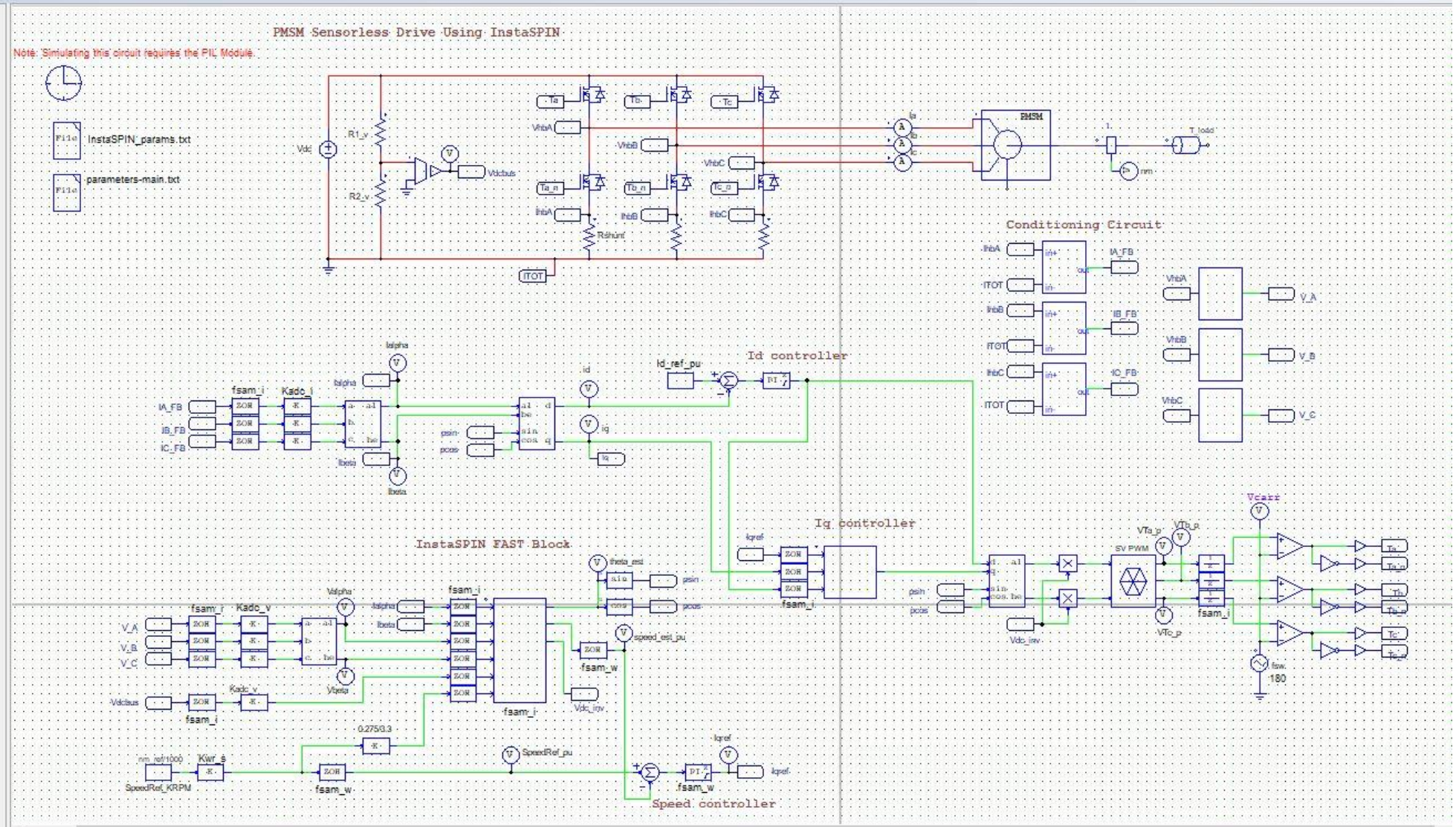
Load

T_load	0
J_load	4u

Motor Controller

fsam_i	15k
fsam_w	1k
fcr_i	1k
fcr_w	25
Id_ref	0
nm_ref	500

Update Parameter File



Simulation Message

PSIM - main - PMSM Sensorless (F28069).psimsch

File Edit View Design Suites Subcircuit Elements Simulate Options Utilities Window Help

Proje...

main - PMSM Sensorless.psi...

main - PMSM Sensorless...

Update Parameter File

DC Bus

Vdc	24

Inverter

Rshunt	7m
Kgain_i	-10
I_offset	1.65
R1_v	62k
R2_v	4.99k
Ia_offset	0.997648
Ib_offset	1.00098
Ic_offset	0.998795
Va_offset	0.49609
Vb_offset	0.4954
Vc_offset	0.4964

Motor

J_motor	4.8u
T_shaft	0.05

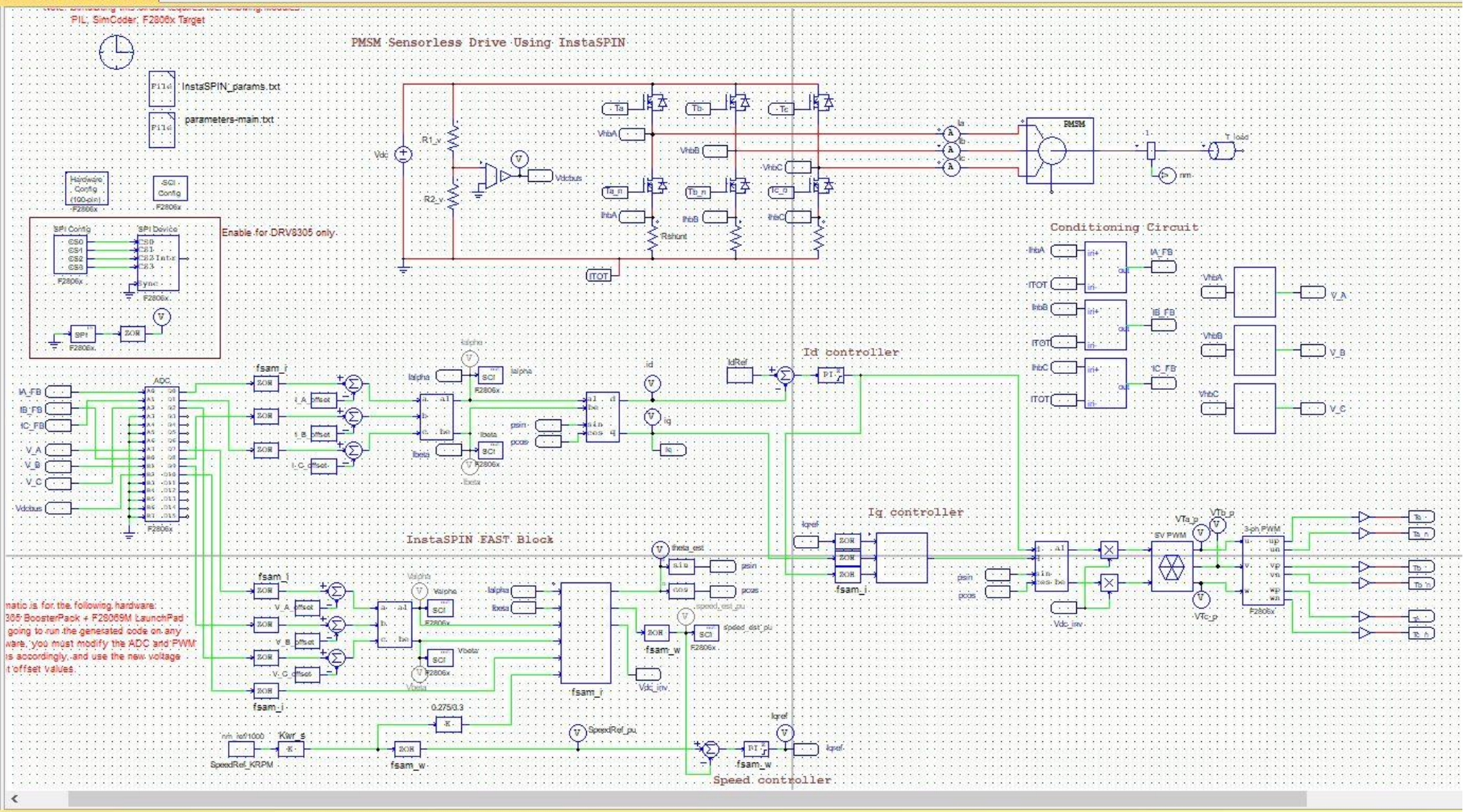
Load

T_load	0
J_load	4u

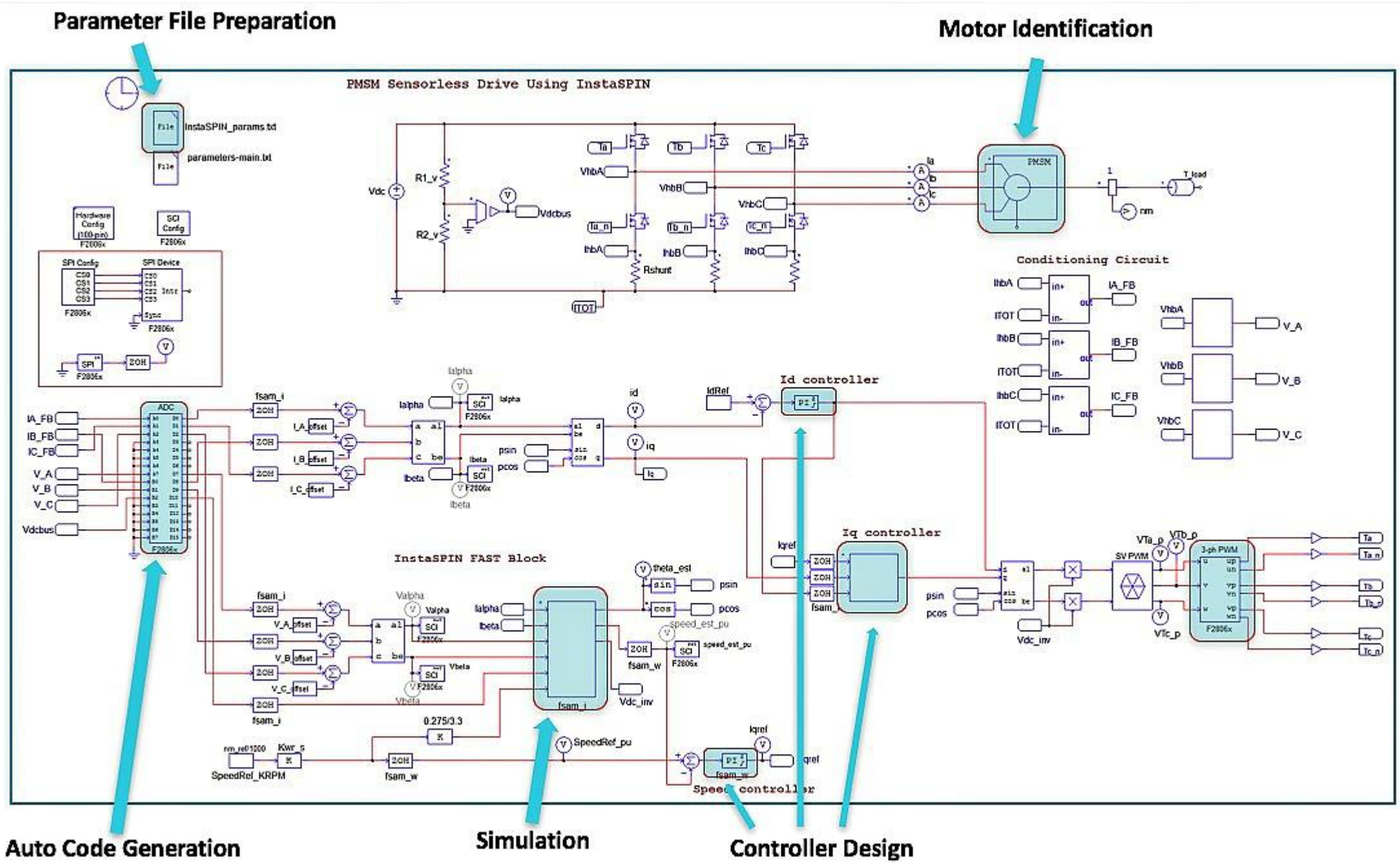
Motor Controller

fsam_i	15k
fsam_w	1k
fcr_i	1k
fcr_w	25
Id_ref	0
nm_ref	500

Update Parameter File



Simulation Message


Parameter File Preparation
Motor Identification
PMSM Sensorless Drive Using InstaSPIN
InstaSPIN_params.txt
parameters-main.txt
Conditioning Circuit
Id controller
Iq controller
InstaSPIN FAST Block
Auto Code Generation
Simulation
Controller Design

PSIM - C:\Powersim\PSIM12.0.3_TrialX64\examples\SimCoder\F2806x Target\TI DRV8312 PMSM InstaSPIN Lab11\DRV8312 PMSM InstaSPIN Lab11 (F28069) (C code)\DRV8312 P

File Edit Options Window Help

Project View

DRV8312 PMSM InstaSPIN Lab11 (F28069)

DRV8312 PMSM InstaSPIN L... | C:\Powersim\PSIM12.0.3...

```
/*****************************************************************************
// This code is created by SimCoder Version 12.0.3 for F2806x Hardware Target
//
// SimCoder is copyright by Powersim Inc., 2009-2019
//
// Date: January 27, 2020 17:17:31
*****************************************************************************/
#define GLOBAL_Q 24
long GlobalQ = GLOBAL_Q;      // Used for legacy GEL & Graph Debug.
#include "IQmathLib.h"
#include "PS_bios.h"
#define  GetCurTime() PS_GetSysTimer()
#define  PWM_IN_CHECK     // To lower PWM value setting time, comment out this line if PWM duty cycle values are strictly limited in the range.



#include "include/clarke.h"
#include "include/est.h"
#include "include/ctrl_obj.h"
#include "include/ctrl_states.h"
#include "include/est_Flux_states.h"
#include "include/est_Ls_states.h"
#include "include/est_Rr_states.h"
#include "include/est_Rs_states.h"
#include "include/est_states.h"
#include "include/est_Traj_states.h"
#include "include/filter_fo.h"
#include "include/ipark.h"
#include "include/math.h"
#include "include/motor.h"
#include "include/offset.h"
#include "include/park.h"
#include "include/pid.h"
#include "include/stdint.h"
#include "include/svgen.h"
#include "include/traj.h"
#include "include/types.h"
#include "include/userParams.h"
#include "include/ctrl.h"
#include "user.h"



interrupt void Task();
interrupt void Task_1();
void TaskS2();
```

Simulation Message

Project View | Library Browser

Ready

Type here to search

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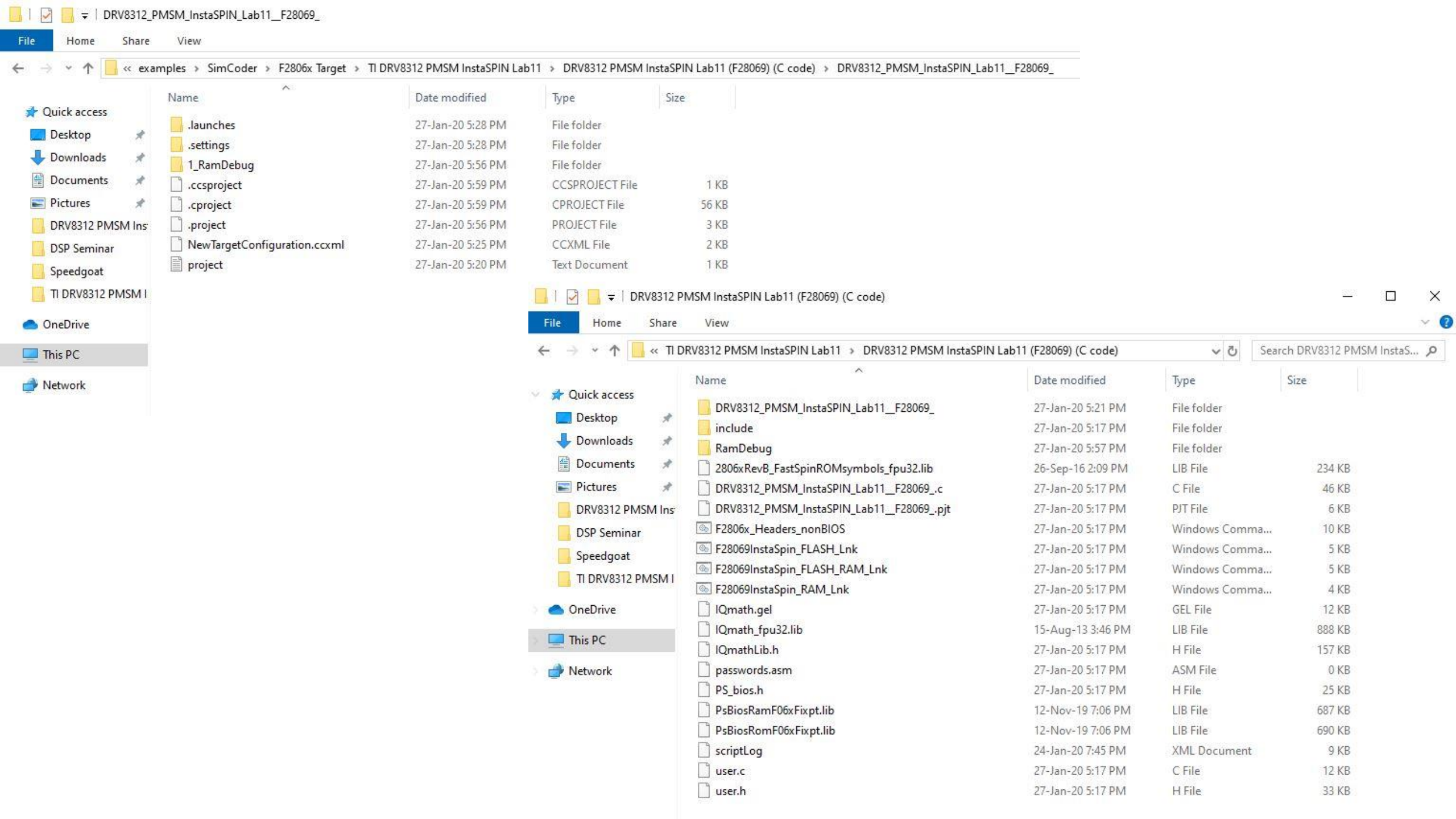
DRV8312_PMSM_InstaSPIN_Lab11__F28069_
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« examples › SimCoder › F2806x Target › TI DRV8312 PMSM InstaSPIN Lab11 › DRV8312 PMSM InstaSPIN Lab11 (F28069) (C code) › DRV8312_PMSM_InstaSPIN_Lab11__F28069_
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.launches 27-Jan-20 5:28 PM File folder
.settings 27-Jan-20 5:28 PM File folder
1_RamDebug 27-Jan-20 5:56 PM File folder
.ccsproject 27-Jan-20 5:59 PM CCSPROJECT File 1 KB
.cproject 27-Jan-20 5:59 PM CPROJECT File 56 KB
.project 27-Jan-20 5:56 PM PROJECT File 3 KB
NewTargetConfiguration.ccxml 27-Jan-20 5:25 PM CCXML File 2 KB
project 27-Jan-20 5:20 PM Text Document 1 KB
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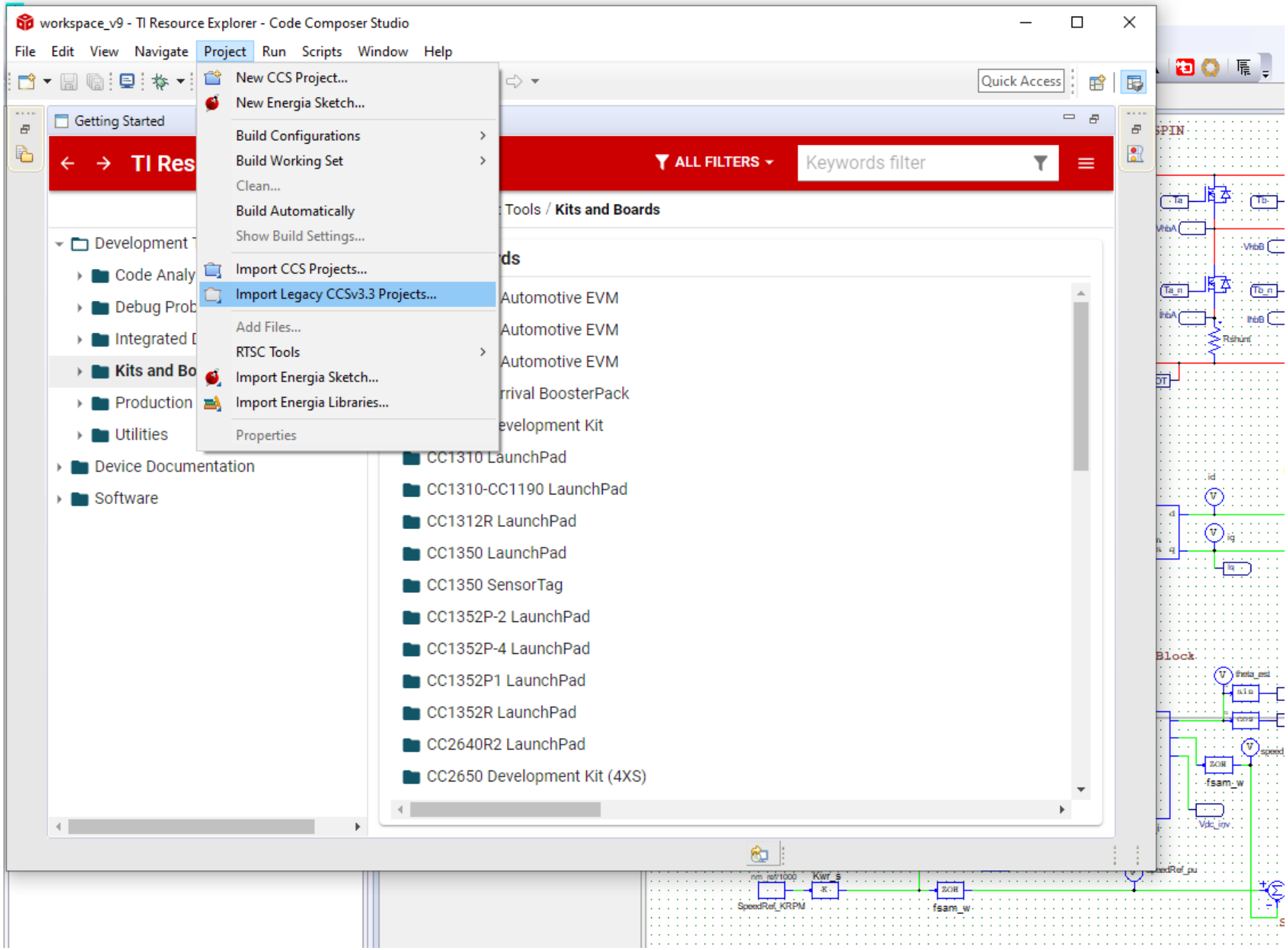
DRV8312_PMSM_InstaSPIN_Lab11__F28069_ 27-Jan-20 5:21 PM File folder
include 27-Jan-20 5:17 PM File folder
RamDebug 27-Jan-20 5:57 PM File folder
2806xRevB_FastSpinROMsymbols_fpu32.lib 26-Sep-16 2:09 PM LIB File 234 KB
DRV8312_PMSM_InstaSPIN_Lab11__F28069_.c 27-Jan-20 5:17 PM C File 46 KB
DRV8312_PMSM_InstaSPIN_Lab11__F28069_.pjt 27-Jan-20 5:17 PM PJT File 6 KB
F2806x_Headers_nonBIOS 27-Jan-20 5:17 PM Windows Comma... 10 KB
F28069InstaSpin_FLASH_Lnk 27-Jan-20 5:17 PM Windows Comma... 5 KB
F28069InstaSpin_FLASH_RAM_Lnk 27-Jan-20 5:17 PM Windows Comma... 5 KB
F28069InstaSpin_RAM_Lnk 27-Jan-20 5:17 PM Windows Comma... 4 KB
IQmath.gel 27-Jan-20 5:17 PM GEL File 12 KB
IQmath_fpu32.lib 15-Aug-13 3:46 PM LIB File 888 KB
IQmathLib.h 27-Jan-20 5:17 PM H File 157 KB
passwords.asm 27-Jan-20 5:17 PM ASM File 0 KB
PS_bios.h 27-Jan-20 5:17 PM H File 25 KB
PsBiosRamF06xFixpt.lib 12-Nov-19 7:06 PM LIB File 687 KB
PsBiosRomF06xFixpt.lib 12-Nov-19 7:06 PM LIB File 690 KB
scriptLog 24-Jan-20 7:45 PM XML Document 9 KB
user.c 27-Jan-20 5:17 PM C File 12 KB
user.h 27-Jan-20 5:17 PM H File 33 KB


workspace_v9 - TI Resource Explorer - Code Composer Studio
File Edit View Navigate Project Run Scripts Window Help
New CCS Project...
New Energia Sketch...
Build Configurations
Build Working Set
Clean...
Build Automatically
Show Build Settings...
Import CCS Projects...
Import Legacy CCSv3.3 Projects...
Add Files...
RTSC Tools
Import Energia Sketch...
Import Energia Libraries...
Properties
Quick Access
Getting Started
ALL FILTERS
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Development
Code Analy
Debug Prob
Integrated
Kits and Bo
Production
Utilities
Device Documentation
Software
Automotive EVM
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CC1310 LaunchPad
CC1310-CC1190 LaunchPad
CC1312R LaunchPad
CC1350 LaunchPad
CC1350 SensorTag
CC1352P-2 LaunchPad
CC1352P-4 LaunchPad
CC1352P1 LaunchPad
CC1352R LaunchPad
CC2640R2 LaunchPad
CC2650 Development Kit (4XS)
SPIN
Block
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SpeedRef_KRPM
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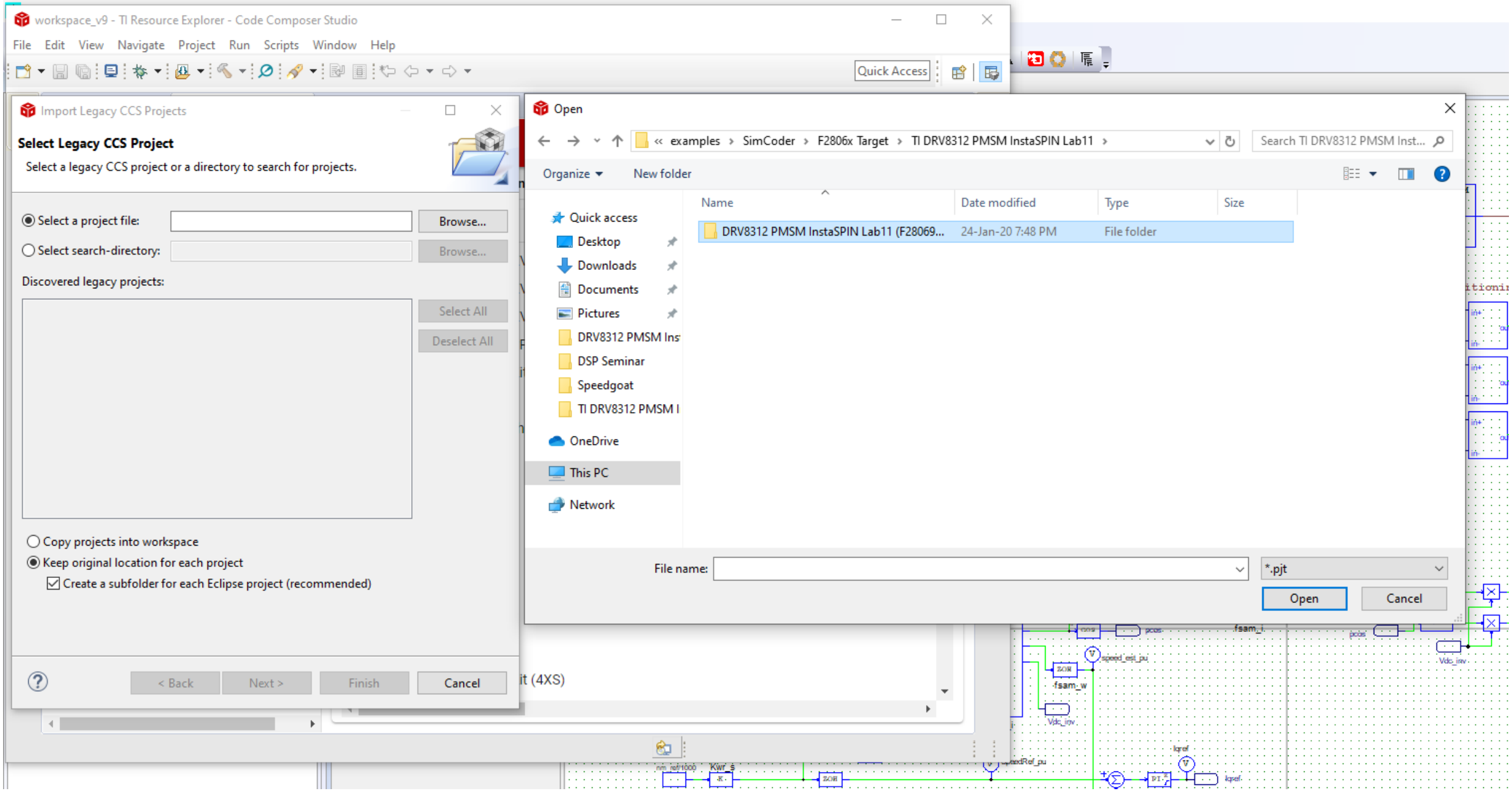
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Select Legacy CCS Project
Select a legacy CCS project or a directory to search for projects.
Select a project file:
Browse...
Select search-directory:
Browse...
Discovered legacy projects:
Select All
Deselect All
Copy projects into workspace
Keep original location for each project
Create a subfolder for each Eclipse project (recommended)
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Next >
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« examples › SimCoder › F2806x Target › TI DRV8312 PMSM InstaSPIN Lab11 ›
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24-Jan-20 7:48 PM
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File name:
*.pjt
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workspace_v9 - DRV8312_PMSM_InstaSPIN_Lab11__F28069_/DRV8312_PMSM_InstaSPIN_Lab11__F28069_.c - Code Composer Studio

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Quick Access

Debug

DRV8312_PMSM_InstaSPIN_Lab11__F28069_ [Code Composer Studio - Device Debugging]
- Texas Instruments XDS100v2 USB Debug Probe_0/C28xx (Suspended)
  - Task() at DRV8312_PMSM_InstaSPIN_Lab11__F28069_.c:1,024 0x008C7A
  - main() at DRV8312_PMSM_InstaSPIN_Lab11__F28069_.c:1,341 0x008C3D
  - updateGlobalVariables(struct EST_Obj_ *)() at user.c:149 0x00A343
  - _ProcSciWaitStart() at DRV8312_PMSM_InstaSPIN_Lab11__F28069_.c:207 0x008809
  - 0x3A8A08 (no symbols are defined)
- Texas Instruments XDS100v2 USB Debug Probe_0/CLA_0 (Disconnected : Unknown)

Variables | Expressions | Registers

Name	Type	Value	Location
fADC1_1	long	-228724238	0x0000009E@Data
fADC1_10	long	531299264	0x000000B6@Data
fADC1_12	long	-935963584	0x000000B2@Data
fADC1_13	long	66600	0x000000A2@Data
fADC1_15	long	-285126	0x000000AA@Data
fADC1_5	long	-285126	0x000000A6@Data
fADC1_7	long	-931939200	0x000000AE@Data
fC10	long	79936	0x0000008E@Data
fC11	long	79966	0x00000090@Data

DRV8312_PMSM_InstaSPIN_Lab11__F28069_.c

```
1 /*********************************************************************************
2 // This code is created by SimCoder Version 12.0.3 for F2806x Hardware Target
3 //
4 // SimCoder is copyright by Powersim Inc., 2009-2019
5 //
6 // Date: January 27, 2020 17:17:31
7 *********************************************************************************/
8 #define GLOBAL_Q 24
9 long GlobalQ = GLOBAL_Q;      // Used for legacy GEL & Graph Debug.
10 #include    "IQmathLib.h"
11 #include    "PS_bios.h"
12 #define GetCurTime() PS_GetSysTimer()
13 #define PWM_IN_CHECK    // To lower PWM value setting time, comment out this line if PWM duty cycle values are strictly limited in the range.
14
15
16
17 #include    "include/clarke.h"
18 #include    "include/est.h"
19 #include    "include/ctrl_obj.h"
20 #include    "include/ctrl_states.h"
21 #include    "include/est_Flux_states.h"
22 #include    "include/est_Ls_states.h"
23 #include    "include/est_Rr_states.h"
24 #include    "include/est_Rs_states.h"
25 #include    "include/est_states.h"
26 #include    "include/est_Traj_states.h"
27 #include    "include/filter_fo.h"
28 #include    "include/ipark.h"
29 #include    "include/math.h"
```

Console

CDT Build Console [DRV8312_PMSM_InstaSPIN_Lab11__F28069_]

```
**** Build of configuration 1_RamDebug for project DRV8312_PMSM_InstaSPIN_Lab11__F28069_ ****

"C:\\ti\\ccs930\\ccs\\utils\\bin\\gmake" -k -j 12 all -O

gmake[1]: 'C:/Powersim/PSIM12.0.3_TrialX64/examples/SimCoder/F2806x Target/TI DRV8312 PMSM InstaSPIN Lab11/DRV8312 PMSM InstaSPIN Lab11 (F28069) (C code)/DRV8312_PMSM_InstaSPIN_Lab11__F28069_/../RamDebug/DRV8312_PMSM_InstaSPIN_Lab11__F28069_.out' is up to date.

**** Build Finished ****
```

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Thanks for your attention.