

## Product Bulletin

# Motor Control Foundation Software

As motor systems evolve with advanced features like sensorless alternating current (AC) induction vector control, “current-shaped” switched-reluctance control, and permanent magnet synchronous motor (PMSM) field oriented control, motor control designers are relying more and more on TI’s TMS320C2000™ digital signal controllers and the extensive suite of motor-control-focused hardware and software

solutions to help them get their designs to market faster with more customized features, better performance and lower cost for virtually any type of motor.

Developed as easy-to-use libraries, TI’s foundation software for motor control includes:

- Highly optimized math/trigonometric functions
- ezFIR filter design package (available as a MathWorks MATLAB® script)

### Key Benefits

- Application- and motor-specific software reduces development time
- Modular approach allows for customization of system
- Software test bench facilitates early validation of software
- Free software downloads reduces system development time and costs

- Highly optimized, high-precision mathematical Function Library for C/C++ programmers

### Proven Control Development Tools

To accelerate the development process and reduce the time-to-market, TI offers a full suite of proven and reusable software tools that work seamlessly with TI and third-party hardware tools:

#### Code Composer Studio™ (CCStudio) Development Tools

- Provides a fully integrated development environment (IDE) supporting C2000™ digital signal controllers
- Open architecture extends IDE functionality by seamlessly plugging-in additional specialized tools

#### DSP/BIOS™ Kernel

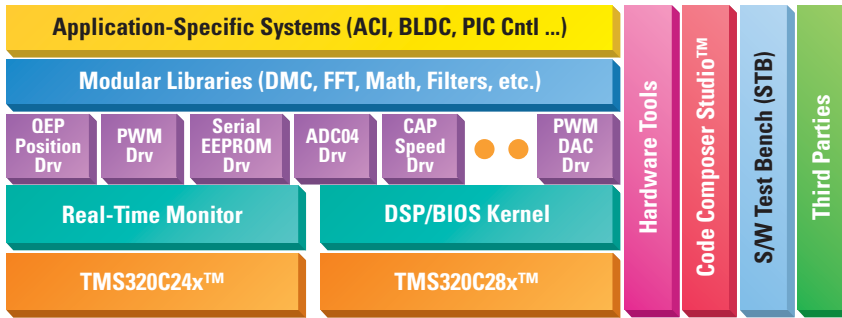
- Eliminates the need to develop and maintain custom operating systems or control loops
- Multi-threading enables real-time applications to be cleanly partitioned, easier to maintain, and new functionality can be added without disrupting real-time response
- Compatible with the Chip Support Library for controller peripherals and tightly integrated into CCStudio.

### TI Motor Control Solutions Are Ideal for a Variety of Applications Including White Goods, Industrial and Automotive



TI provides a number of hardware and software solutions for virtually any type of motor including alternating current (ACI), brushless direct current (BLDC), permanent magnet synchronous motor (PMSM) and switched reluctance (SR) motors with single- and three-phase as well as sensed and sensorless techniques.

## TI's Modular Software Approach for Motor Control Systems



TI's software development tools for digital signal controllers allows faster development times with application-specific systems and modular libraries, ease-of-use with CCStudio and the Software Test Bench (STB); and differentiated features utilizing TI third-party software.

### The Modular Approach for Control Design

TI has developed a number of powerful software modules designed specifically for the C2000™ platform of digital signal controllers. These modules are typically used in computationally intensive real-time applications where optimal execution speed is critical. By using these routines, designers can achieve execution speeds considerably faster than equivalent code written in standard ANSI C language. In addition to providing ready-to-use DSP functions, TI's modular approach can significantly shorten your application development time.

### Motor-Control-Specific Software Modules

- Forward and Inverse Clarke/Park Transforms
- BLDC-Specific PWM Drivers
- Leg Current Measurement Drivers
- BLDC Commutation Triggers
- ACI Speed and Rotor Position Estimators
- PID Controllers
- Extended-Precision PID Controllers

### Signal Processing Library Modules

- FIR (Generic Order) Filter
- FIR (10th order) Filter
- FIR (20th order) Filter
- FIR Using Circular Buffers
- 128-, 256- and 512-Point Complex and Real FFTs

### Fixed-Point Trigonometric and Log Routine Modules

- Fixed-Point Sine, Cosine and Tangent Routines
- Square Root
- Logarithmic Functions
- Reciprocal calculation

### Peripheral & Communication Driver Modules

- SCI (UART) Packet Driver
- Virtual SPI Drivers
- Virtual I<sup>2</sup>C Drivers
- Serial EEPROM Drivers
- GPIO Driver

### Fixed-Point Virtual Floating-Point 32-Bit Math Library Modules

- Multiply
- Divide
- Multiply with Rounding
- Multiply with Rounding and Saturation
- Square Root Root
- Sine and Cosine

### Signal Generator Function Modules

- Sinewave Generators
- Ramp Waveform Generators
- Trapezoidal Profile Generators

## Software Test Bench: Real-Time Module Evaluation

The Software Test Bench (STB) helps designers to evaluate specific software modules by allowing them to passing variables or data to the module and evaluate the results. Where possible, the module under evaluation is made to interact with other modules such as signal generators, which can provide input stimulus and data-logging modules or EVM-DAC drivers to examine a module's response in a real-time environment.

STB runs as a CCStudio project on TMS320C2000™ EVM and eZdsp™ hardware platforms.

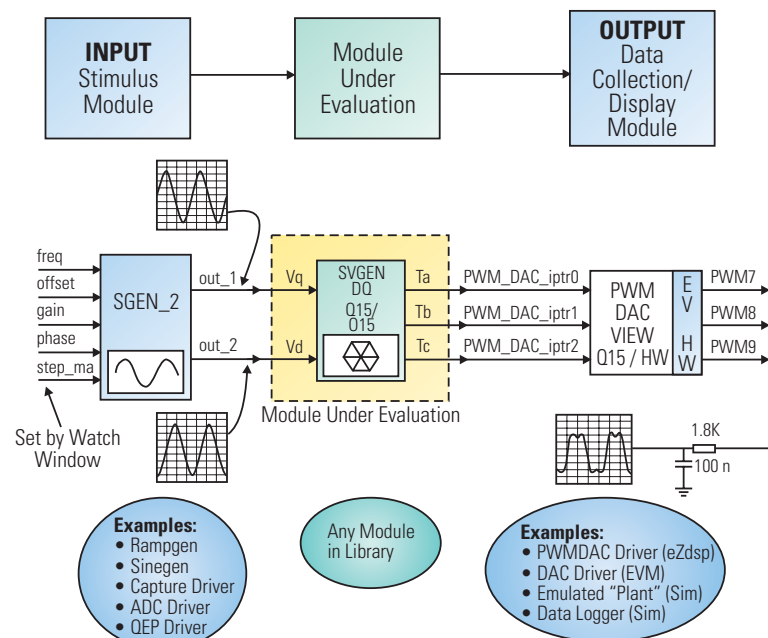
### Hardware Development Tools

TI offers a full range of hardware development tools designed to help you design your system quickly and efficiently. For more information, visit [www.ti.com/mcdevboards](http://www.ti.com/mcdevboards)

### TI's Third Party Network

Application-specific software is available from the extensive group of TI Third Party Network companies. This software allows digital control developers to easily evaluate and design products integrating TI's TMS320C24x™ and

## Software Test Bench: STB



Examples of input stimulus and output data that the Software Test Bench processes in order to simulate a real-time environment.

TMS320C28x™ controllers. For more information, visit [www.ti.com/3p](http://www.ti.com/3p)

## DMCLib: The Building Blocks to Motor Control

The digital motor control library, DMCLib, is TI's extensive free application-specific software that covers almost any type of motor and allows designers to virtually eliminate the need for writing extensive code while quickly and efficiently adding the core functionality like Proportional, Integral, Derivative (PID) controllers, Clarke and Park transforms and pulse width modulation (PWM) drivers to their design.

## Motor-Specific Software Solutions

TI provides a number of free software downloads designed to speed system development for virtually all motor types including alternating current induction

(ACI), brushless direct current (BLDC) and permanent magnet synchronous motors (PMSM) with single- and three-phase as well as sensed and sensorless techniques.

TI's modular software is available today, free of charge at [www.ti.com/c2000appsw](http://www.ti.com/c2000appsw)

## Get Started Today

TI offers an array of training courses either online or in a city near you, including:

- **Online Training**  
These free downloadable courses include overviews of C2000™ controllers, as well as more advanced technical sessions
- **Seminar Series**  
The three-hour control module offers design engineers and engineering managers an in-depth technical review of innovative, easy to implement, real-time solutions that address

the multitude of challenges facing control system developers

- **One-Day Workshops**  
One-day workshops are designed to offer attendees introductory training on C2000 digital signal controllers through the use of the development tools and hands-on lab exercises.
- **Multi-Day Workshops**  
The multi-day workshops are designed for engineers who need to sharpen their design and development skills. These workshops usually last three to five days and include significant hands-on sections emphasizing the demonstration and application of techniques and skills. TI workshops are given by TI's Technical Training Staff and are highly effective in helping developers implement their DSP designs quickly.  
More information on training is available at [www.ti.com/training](http://www.ti.com/training)

## Motor-Specific Software Solutions [www.ti.com/c2000appsw](http://www.ti.com/c2000appsw)

System	Motor Type	Sensored	Sensorless	Description	C24x™ DSP	C28x™ DSP
ACI1-1	1 ph AC Induction	•		Tacho I/P VHz / SinePWM/ Closed Loop (CL) Speed PID	•	
ACI3-1	3 ph AC Induction	•		Tacho I/P VHz / SinePWM / CL Speed PID	•	•
ACI3-2	3 ph AC Induction		•	MRAS (Speed Estimator) VHz / SinePWM / CL Speed PID	•	
ACI3-3	3 ph AC Induction	•		Tacho I/P FOC / SinePWM / CL Current PID for D, Q / CL Speed PID	•	•
ACI3-4	3 ph AC Induction		•	Direct Flux Estimator + Speed Estimator FOC / SinePWM / CL Current PID for D, Q / CL Speed PID	•	•
PMSM3-1	3 ph Permanent Magnet Synch	•		QEP FOC / SinePWM / CL Current PID for D, Q / CL Speed PID	•	•
PMSM3-2	3 ph Permanent Magnet Synch		•	SMO (Sliding Mode Observer) Position Estimator FOC / SinePWM / CL Current PID for D, Q / CL Speed PID	•	•
PMSM3-3	3 ph Permanent Magnet Synch	•		Resolver / FOC / CL Current PID for D, Q / CL Speed PID		•
PMSM3-4	3 ph Permanent Magnet Synch	•		QEP / FOC / Position Control		•
BLDC3-1	3 ph Trapezoidal Brushless DC	•		3 Hall Effect I/P Trapezoidal / CL Loop Current PID / CL Speed PID	•	•
BLDC3-2	3 ph Trapezoidal Brushless DC		•	BEMF / Zero Crossing Detection Trapezoidal / CL Loop Current PID / CL Speed PID	•	•
DCMOTOR	Brushed DC	•		Speed & Position / QEP without Index		•
Digital Motor Control Library	All Motor Types	•	•	Component Modules for Motor-Specific Applications	•	•

Motor-specific software downloads available today, free of charge, that allow designers to develop solutions for both sensed and sensorless control systems.

# TI Worldwide Technical Support

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## Internet

### TI Semiconductor Product Information Center Home Page

[support.ti.com](http://support.ti.com)

### TI Semiconductor KnowledgeBase Home Page

[support.ti.com/sc/knowledgebase](http://support.ti.com/sc/knowledgebase)

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