

# Dual-Axis Motor Control on a Single SoC FPGA

Superior Performance, Reliability, Safety, Security and Integration Made Easy

## Summary

Microchip's motor control solution is designed specially to meet the challenging industrial requirements of performance, reliability and safety in an easy-to-use environment. We offer a modular Intellectual Property (IP) portfolio, tools, reference designs, kits and software to control motors such as Permanent-Magnet Synchronous Motor (PMSM)/Brushless DC (BLDC) and stepper motors.

## Reference Design Features

- Motor control algorithms implemented in FPGA fabric
- Scalability to a multi-axis motor drive design
- Design flexibility with modular IP suite
- Deterministic, high-precision, low-power, reliable and secure
- Robust sensorless solution—supports 100K RPM or more
- Integration of system functions to lower Total Cost of Ownership (TCO)
- Low latency of 1  $\mu$ s for Field-Oriented Control (FOC) loop from ADC measurement to PWM generation

## IP Modules

- Space Vector Modulation (SVM)
- Three-phase PWM
- FOC transformation IPs (Clarke, Park, Inverse Clarke and Inverse Park)
- PI controller
- Rate limiter
- Position and speed estimator
- Encoder, HALL and resolver interface

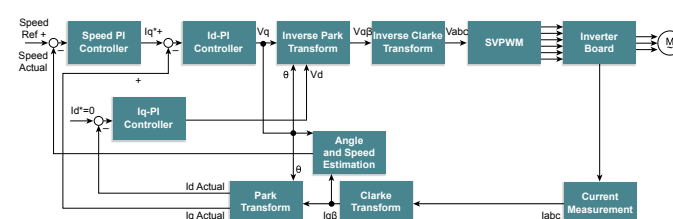
## Motors and Algorithms

Motor	Algorithm
PMSM/BLDC	FOC sensorless
	FOC with HALL
	FOC with encoder
	FOC with resolver
Stepper	Microstepping

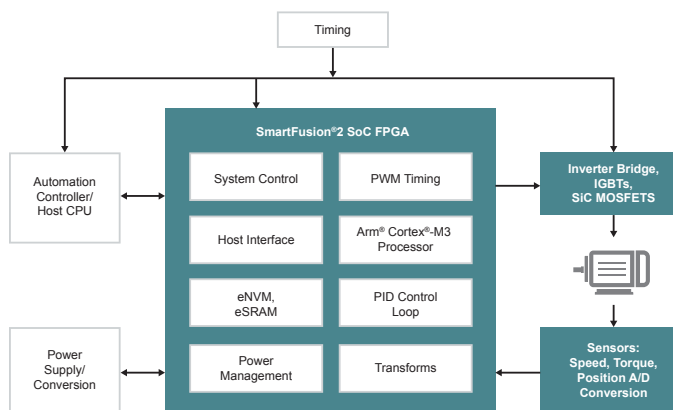
## Fully Modular IP Suite

- Quick plug-and-play approach to implement algorithms
- Easy porting and customization through blockbased approach
- Precise algorithm for angle estimation in sensorless FOC
- PWM with dead time protection and delay time insertion
- IP blocks are coded for efficient use of FPGA resources
- IP blocks tested in simulations and on actual hardware
- IPs available as MATLAB models; VHDL Verilog code for FPGA

## Motor Control Block Diagram



## Solutions for Motor Control Block Diagram



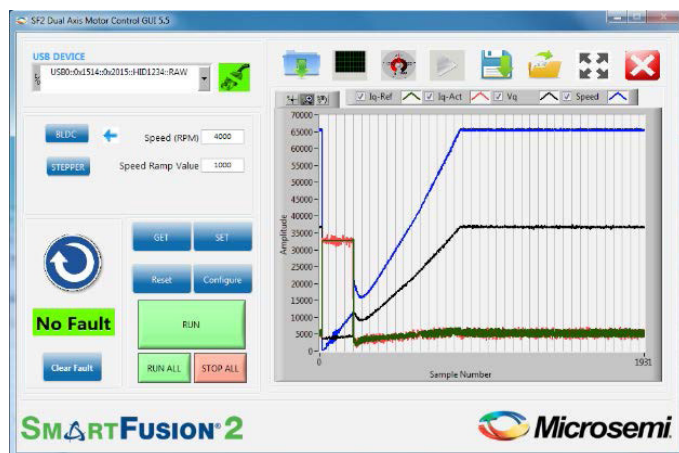
## High-Performance, Reliable and Secured Motor Control Solution

SmartFusion<sup>®</sup>2 SoC-FPGA-based solution is an ideal reference platform for developing high-performance, reliable and secured dual-axis motor control applications. The solution includes algorithms such as sensorless FOC, FOC with HALL, FOC with encoder and FOC with resolver for PMSM/BLDC motors. The position control algorithm of the stepper motor supports up to 1024 micro-steps.

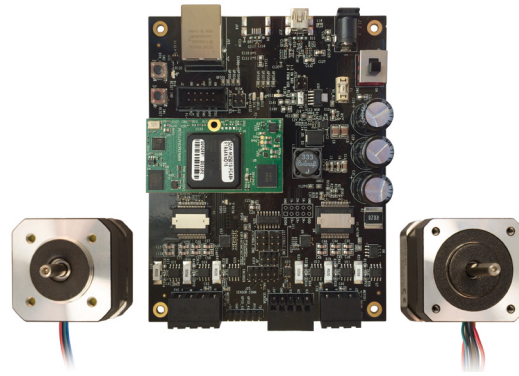
The SmartFusion2 Motor Control GUI allows for the dynamic tuning of parameters, such as reference speed, Kp/Ki gains of PI controllers, and viewing internal signals for debugging. The kit also supports various communication interfaces, including Ethernet, CAN, USB and others. SmartFusion2 SoC FPGAs feature stronger design security than other FPGAs and include Differential Power Analysis (DPA) resistant anti-tamper measures using technology licensed from Cryptography Research Incorporated (CRI). The security architecture was designed with a layered approach in mind, building on top of a foundation of secure hardware.

Microchip offers a one-stop shop with a portfolio of complementary products to meet your motor control needs. Microchip's product portfolio includes FPGAs, SiC diodes/MOSFETs, power modules, timing, PoE/Midspans, sensors and more.

## Software GUI for Motor Control



## Dual-Axis Motor Control Board



## Additional Reference Designs Available on Request

- Motor control designs for space applications featuring <https://www.microsemi.com/product-directory/space-system-managers/3708-position-motor-controller-ic> LX7720 space grade motor driver and <https://www.microsemi.com/product-directory/rad-tolerant-fpgas/3576-rtg4> RTG4 as a controller.
- Six axis motor control board with a <https://emcraft.com/products/255> M2S010 Emcraft SOM

## Ordering Information

For questions and feedback write to [fpga.motorcontrol@microchip.com](mailto:fpga.motorcontrol@microchip.com)

SmartFusion2 Dual-Axis Motor Control Starter Kit	SF2-MC-STARTER-KIT
RTL source code for Motor Control IP cores	MCSOLCores-RM

For more information:

[www.microsemi.com/applications/motor-control](http://www.microsemi.com/applications/motor-control)