Microsemi Motor Control Solutions

White Paper

June 2014

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Motor control solutions are widely used in several market segments in various forms and sizes. Whether it is a small motor in an implantable medical device or a large motor in an industrial plant, precise control of motor speed and torque delivered is a critical requirement for many applications. The reliability of motors and controllers is essential to ensure a safe operating environment. It is common to find multiple motors employed in a single application with all the motors being synchronously operated or being dependent on each other to perform a complex task.

Microsemi® offers motor control solutions that can deliver precise control of multi-axis motors. Sensor-less field oriented control (FOC) of brushless DC motors (BLDC) and permanent synchronous magnets motor (PMSM) requires complex algorithms to be developed. While microcontrollers and DSPs have traditionally been used for developing these algorithms, these devices cannot keep up with increasing demands of multi-axis motor control requirements. Building these complex algorithms in hardware-based FPGA designs is known to give higher performance and better reliability.

Microsemi offers algorithmic blocks that can be easily integrated together to create custom multi-axis motor control solutions according to the end-user requirements with ease and efficiency. IP blocks such as Clarke and Park transformations, proportional integral (PI) controllers, space vector pulse width modulation (PWM), state observer angle estimation, speed calculation, hall/encoder/resolver-based angle calculation are available in the Microsemi motor control solutions catalog. These IP blocks are coded in HDL and have been tested on Smartfusion®2 SoC FPGA devices.

Reference designs are available that demonstrate six-axis motor control solution implemented in a single Smartfusion®2 M2S010 SoC FPGA. The M2S010 device has 12000 logic elements, 21 18Kb-RAM blocks and 22 DSP blocks, and comes in FG484, VF400, VF256, and FCS325 package sizes.

An FOC closed loop control of BLDC/PMSM motor consists of reading instantaneous motor phase currents, doing appropriate transformations, computing speed, adjusting for reference speed and torque settings by using PI controllers, computing new angle increment value, generating new space vector pulse width modulation (SVPWM) values and updating appropriate PWM registers with these new values.

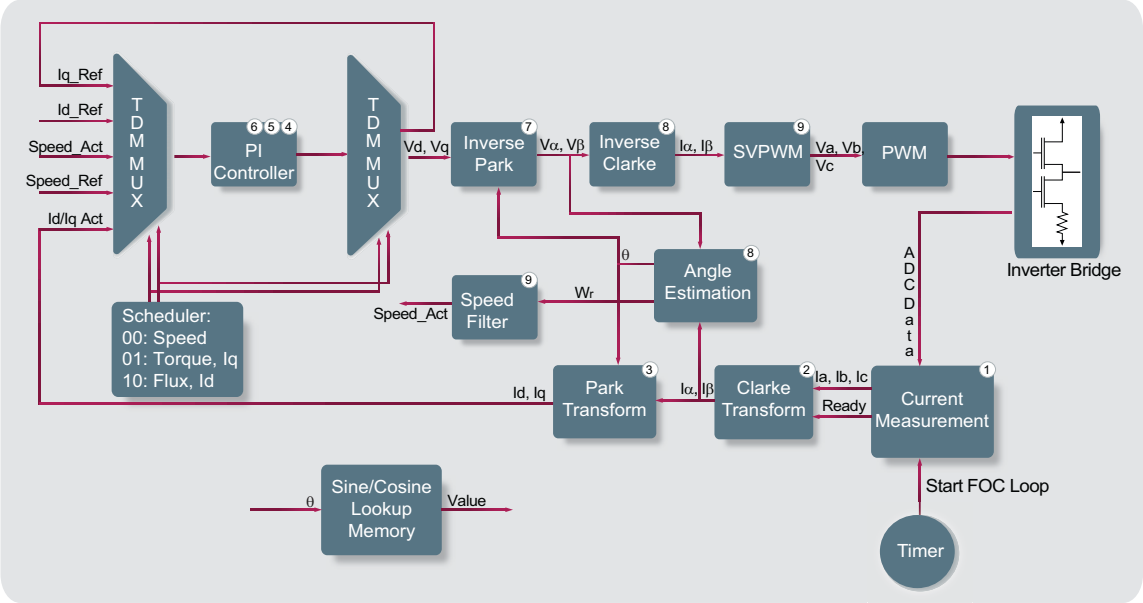

Figure 1: **Sensorless Field Oriented Control Implementation in Smartfusion2 FPGA Device**

The execution time required for such an FOC loop in an M2S010 device is around six microseconds (µs). To scale for six-axis FOC control, each FOC loop is time-division multiplexed within a single M2S010 device to complete all six loops within a 50µs time window. Each of the six motors can be individually controlled using this technique for different reference speeds and torque requirements. This solution is completely implemented in the FPGA fabric leaving the microprocessor sub-system (MSS) of the SmartFusion®2 device available for other tasks, such as running a communication protocol stack or to provide human-machine interface.

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