FPGAs Provide Programmability and Performance for Next Generation Motor Control

Drives – Today versus Tomorrow

Industry studies indicate that close to 2/3rds of the energy consumed in a factory floor is from motor-driven equipment*. Controlling these motors with high-performance motor drives significantly improves the efficiency of these motors, thus lowering energy consumption. Better control also means one can select a smaller, more efficient motor for the same task – reducing the cost of the equipment.

Today's drives are typically multi-chip solutions; a high speed Digital Signal Processor (DSP) for fast math-intensive computation, an Application-Specific Integrated Circuit (ASIC) for industrial networking, and a processor to run the slower control loops and do all the other interfacing and I/O. But these drives typically run in a slow processor with fixed point control loops. They mainly support a single axis. Flexibility of design is primarily from software optimization.

The trend for next generation drives calls for a more integrated solution – that brings together the performance of an embedded dual-processor system, DSP blocks capable of floating point computation, and the scalability to add multiple motors in the same drive, thus lowering the cost per motor.

FPGAs are the ideal solution for these next generation drives– as programmability provides the ability to integrate more functions for additional flexibility and scalability. FPGAs also execute multiple operations in parallel, unlike MCU and DSP which are sequential machines, i.e. they execute one instruction at a time. The parallel nature of FPGA operation allows for higher speed computations therefore improving control performance.

FPGAs Enable High Performance in Motor Control

FPGAs are a good fit for high end motor control because of the high performance motor control algorithms that can be implemented in a FPGA due to the inherent parallelism of the FPGA operation. In contrast, Micro Controller Units (MCUs) and DSPs, being sequential machines, have a tough time keeping up when very high-speed runtime updates are needed in certain motor control algorithms, or when a number of motors need to be simultaneously controlled (multi-axis).

FPGAs Offer the Flexibility of Multifunction Integration

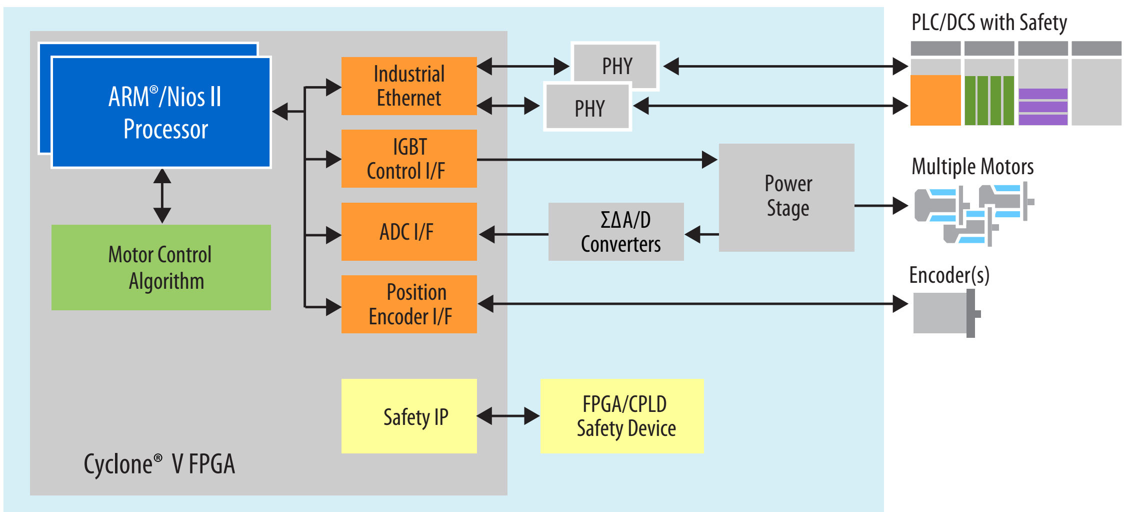
FPGAs are an even more compelling choice when more than just the motor control functions need to be implemented in a controller. For example, a drive manufactured for deployment in a modern factory often needs to communicate with other equipment – such as a PLC (Programmable Logic Controller) – mostly via industrial Ethernet protocols like EtherCAT, SERCOS III and Ethernet Powerlink. FPGAs can easily be used to implement one or multiple interfaces alongside the motor control implementation in one chip, unlike ASSPs which have to be dedicated to specific tasks, thus saving you BOM cost, power and board space. Another example of integration is the addition of a Human Machine Interface (HMI) along with the previously integrated Industrial Ethernet and Motor Control interfaces, to realize three different functions in an FPGA. Adding PLC functionality to the same device truly showcases multifunction integration – something that MCUs find hard to do.

* IEA World Energy Outlook

FPGAs Can Bring Specialized Functionality to Regular MCU Implementations

Motor-drive manufacturers have traditionally used MCU or DSP for motor control. MCU / DSP, while good at low-cost motor control, run out of horsepower to implement functions like Fast Fourier Transform (FFT). FFT transforms information from the time-domain to the frequency-domain, so that instead of observing the amplitude of signals over time, the amplitude of frequency components in the signal is observed. This helps to identify unwanted frequencies that can cause vibrations and interfere with precise speed control or cause resonance and vibrations that reduce the life of a motor assembly. FPGAs can be easily programmed to suppress and reduce the unwanted frequencies to provide smoother speed control and increase motor longevity.

Drive-on-a-Chip: Cyclone® V or Cyclone® V SoC FPGAs with High-Performance Processors, Motor Control Algorithm, I/O Logic, Industrial Ethernet Protocols, and Safety Elements



SoC FPGA Enables Smart Partitioning of Motor Control Algorithms

Today, FPGAs are available that incorporate one or more embedded processors in addition to the regular FPGA fabric. This class of FPGA is known as a SoC (System-on-Chip) FPGA. An example is the Altera Cyclone V SoC. Using the embedded processors cores in the Altera Cyclone V SoC, to implement those components of a motor control algorithm where the update frequency is low, while using the FPGA fabric to accelerate components where a high update frequency will benefit the control loop, enables optimum usage of SoC resources and provides a best-of-both-worlds benefit to you. A great example of a portion of a motor control algorithm that can benefit from being implemented in fast FPGA fabric is Field Oriented Control (FOC). You could use the FPGA portion of a SoC FPGA to accelerate your FOC algorithm, while using the embedded processor for slower control loops, enabling you to retain much of the structure of your older MCU based code.

Altera offers Motor Control Intellectual Property (IP) and 'Drive-on-Chip' Reference Designs, for both single-axis and multi-axis motor control, supporting the Altera Cyclone® IV, Cyclone V and Cyclone V SoC devices, including drive system debug tools. Intellectual property includes various motor control blocks like Pulse Width Modulation (PWM), Field Oriented Control (FOC) and Vibration Suppression that can simply be copied into a new FPGA design to enable those functions. Motor Control reference designs are ready made motor control systems that can be programed into an FPGA to assist with learning about FPGA-based motor control, or they can also be used to implement your own motor control system. Altera's Drive-on-Chip reference design, as the name suggests, is a complete motor drive controller implemented in a single Altera FPGA.

Motor Control Power Boards, supporting motors up to 400V are also available for both single-axis and multi-axis drive systems.

Altera Motor Control IP Offerings:

1. Field Oriented Control (FOC)
2. Pulse Width Modulator (PWM)
3. Sigma-Delta ADC Interface
4. DC-Link Voltage Monitor
5. Drive on Chip System Monitor
6. Encoder Interface IP
7. Vibration Suppression (FFT, Peak Detection, Notch Filter)

Want to Know More?

Visit our website or call your local Altera sales representative today to learn more about how Altera FPGAs can help you enable your Motor Control.
http://www.altera.com/end-markets/industrial/motor-control/ind-motor-control.html

Altera Corporation
101 Innovation Drive
San Jose, CA 95134
USA
www.altera.com

Altera European Headquarters
Holmers Farm Way
High Wycombe
Buckinghamshire
HP12 4XF
United Kingdom
Telephone: (44) 1494 602000

Altera Japan Ltd.
Shinjuku i-Land Tower 32F
6-5-1, Nishi-Shinjuku
Shinjuku-ku, Tokyo 163-1332
Japan
Telephone: (81) 3 3340 9480
www.altera.co.jp

Altera International Ltd.
Unit 11- 18, 9/F
Millennium City 1, Tower 1
388 Kwun Tong Road
Kwun Tong
Kowloon, Hong Kong
Telephone: (852) 2 945 7000
www.altera.com.cn

SS-1064