Xilinx Industrial Electric Drives & Motor Control

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June 2019, Japan

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Trends in Drives and Motor Control

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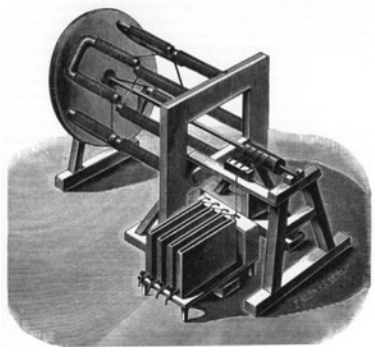
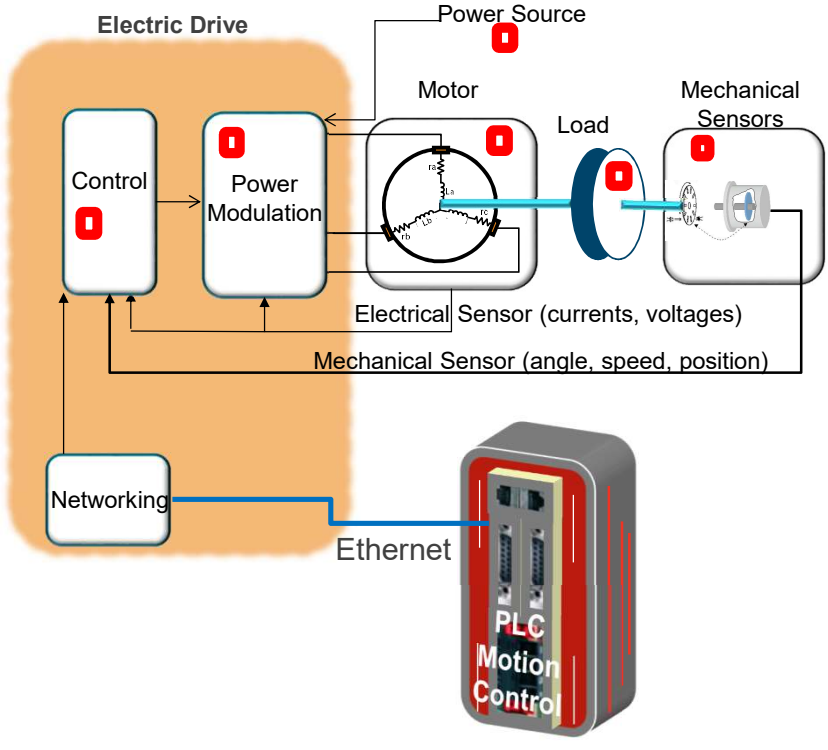
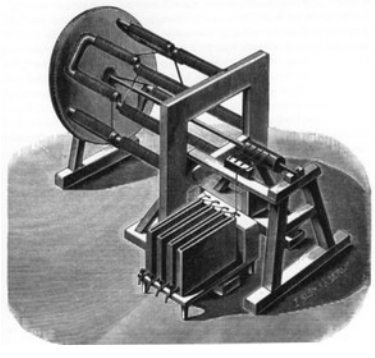
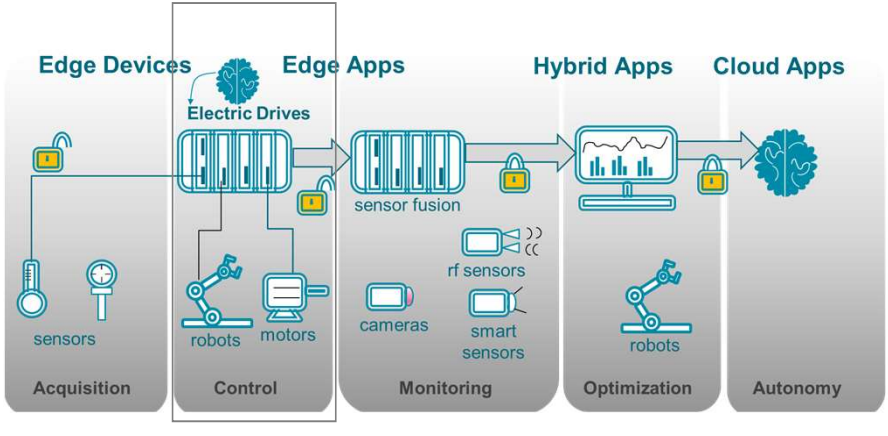
Six Key Elements of Traditional Electric Drives





Industrie 4.0 and IIoT: Electric Drives are Edge Devices





Today's Distributed Industrial Architectures
Industrie 4.0 / Industrial IoT

Electric Drives are expected to do more in Era of Industrie 4.0 / Industrial IoT:
IT-OT Convergence

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Hold On!
Why Use Xilinx for Motor Control when uC/DSP works fine?

designlines INDUSTRIAL CONTROL

News & Analysis

TI Claims to Obsolete FPGAs for Embedded Apps

Pairs C2000 with fast current loop for industrial apps

R. Colin Johnson
7/6/2017 02:41 PM EDT
3 comments

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LAKE WALES, Fla. — Texas Instruments claims to have made the field-programmable gate array obsolete for embedded industrial applications such as servo-motor control. As the world's largest industrial-semiconductor manufacturer, TI may be uniquely positioned to make that judgment, but that doesn't necessarily mean FPGAs are going away.

- Key elements of claim

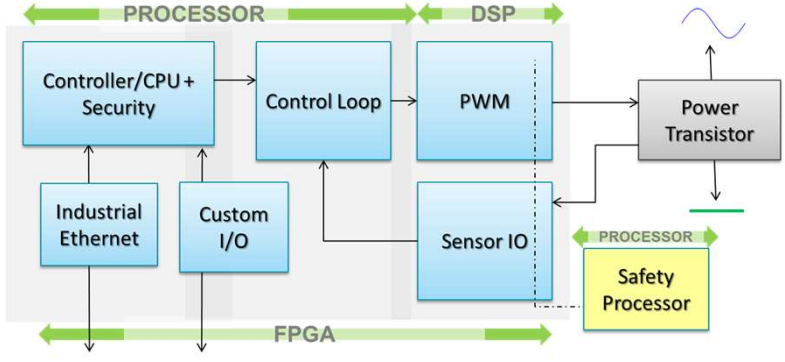
  - **What** New software enables current-loop performance <1uS for field-oriented control processing, previously the domain of FPGAs

  - **Why** Energy efficiency in motors is a driver of innovation, and current-loop performance—torque response—is the fundamental [determinant] of motor drive performance."

6 Reasons for Xilinx-based Approach for Drives & Motor Control

Era of IIoT: OT replaced by IT-OT Convergence(1/6)

- **Motor Control is now more than motor control**
  - Connectivity
  - Cybersecurity (w/HW root of trust)
  - Functional Safety
  - More/Diverse Inputs
  - Vision-guided Motion (Robotics)
  - Human Machine Interface (simple or complex HMI)



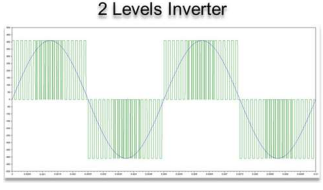
- **Most Overlooked Benefit of Zynq SoCs for Industrial Control**
  - OT functions need isolation from IT functions (i.e. Mixed Criticality)
    - e.g. control loop needs to be immune from network interrupt
  - Lowest latency between IT and OT tasks due to tight coupling between PS and PL

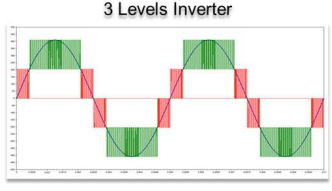
Increasing Complexity demands Flexibility & Scalability (2/6)

- **Robotics and Factory Automation driving growth of multi-axis drives**
  - Span single to multi-axis drives without increasing the CPU burden
- **Easy System Exploration**
  - Develop and Evolve in new control algorithms in SW
  - Optimize to HW using automated tools
  - Faster time to market
- **Customized Platforms**
  - External components change (quantity or precision of ADC, sensors) handle all interfaces

Performance with Determinism (3/6)

- **Fastest Loops Closure (up to 40x faster than uC at fraction of clock speed)**
  - Including option for three-level inverter control (e.g. Silicon Carbide)



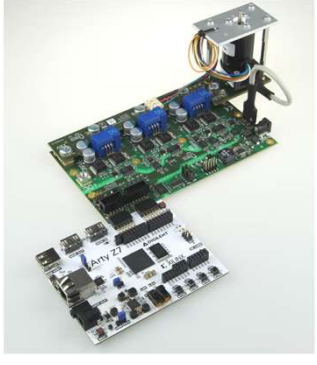


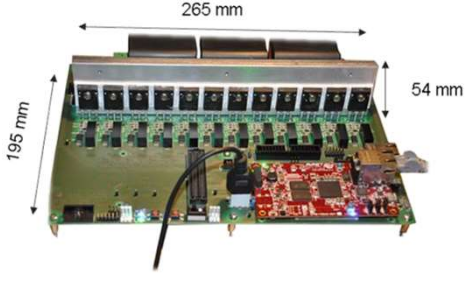
- **Deterministic Loop Closure**
  - Immune from side effects of feature creep, network traffic, user-added apps, HMI inputs
  - Determinism and low jitter achieved through offloading key functions to PL

- **No stand-alone Processor can match both simultaneously**
  - Highest Efficiency with an Zynq SoC approach

Xilinx Offers Range of Solutions for Any User (4/6)

- **Beginner to Advanced kits**





SDx™ Environments

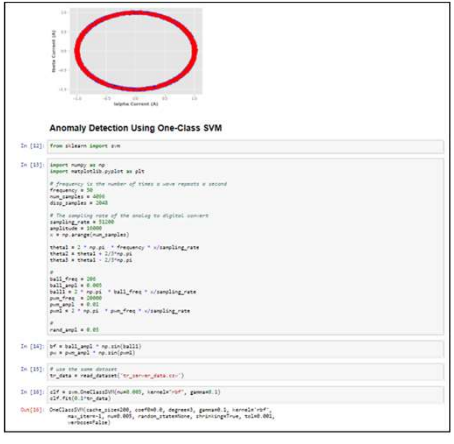
SDSoC™ Environment

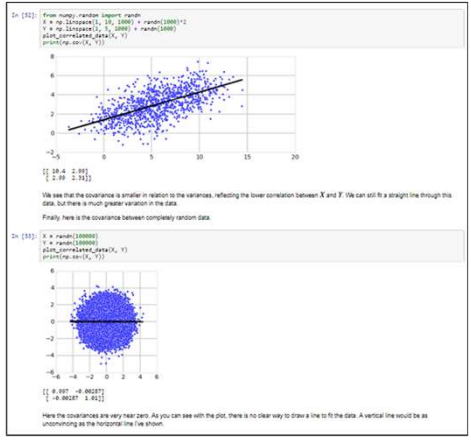
- **Available in HDL / C / Matlab / Python / Labview / GUI**
  - Pick the perfect productivity language for YOU
  - Automated Data Mover Creation with SDSoC (Part of SDx Environments)

Intelligent Motor Control (5/6)

PYNQ™ Framework

- **Python productivity for Extreme Edge Analytics – Cloud Compute at the Edge**
  - Anomaly Detection for Predictive Maintenance via Numpy and Scikit-learn, many other capabilities





- **PYNQ**
  - Visit pynq.io for more information on the PYNQ Framework and the SPYN Motor Control Design

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Lowest Total Cost of Ownership (6/6)

- **BOM Costs are just the beginning**
  - Integrate 2 to 6 or more major components into one
- **Simplified PCB and Inventory Management**
  - Footprint compatible options
- **Development Costs**
  - e.g. Functional Safety, Cybersecurity certification
  - System level Debug simplification
  - Code re-use

- **Flexible Interfacing to changing Companion Chips (sensors, displays, memories)**
- **Highest Quality, Wide Environments (up to +125C), and Long Lifecycle (15+ years)**
- **Responsive and Stable Technical Support**

Case Study from SPS IPC Drives : Kollmorgen

- **Xilinx Zynq is the SoC for Kollmorgen AKD Servo Drives**
- ***"The tremendous integration enabled by Zynq boosts control performance and encompasses safety, multiple communication buses, a display for easy setup and diagnosis and all relevant encoder types."***

- **Value of Zynq and Zynq UltraScale+ SoCs**
  - Lowest latency between IT and OT tasks through integration
  - Functional Safety
  - Networking over Industrial Standards
  - HMI
  - Improved diagnostic, logging, resilience
  - Fast development time through platforms
  - Precision loop calculations replacing DSP
  - OT functions isolated from IT functions

Additional Case Study: STÖBER

- **Xilinx Zynq is the SoC for Stober's SI6 Drive Controllers**
- ***"4 axes, 16 or 97? A single SI6 drive controller can control up to two axes. Thanks to the modular system, the number of motors or axes to be controlled can be freely scaled. The SI6 drive controller is the most compact solution on the market."***

- **Value of Zynq and Zynq UltraScale+ SoCs**
  - Compact and economical solution for multi axis control
  - EtherCAT or PROFINET, programmable through firmware
  - HIPERFACE DSL One Cable
  - PLe (Cat 4) / SIL 3 Safety following EN 13849-1
  - Safety over EtherCAT (FSoE)
  - OT functions isolated from IT functions

Next Steps

Is Xilinx the Best Fit for Your Application?

- ☑ **DC, BLDC, PMSM (AC), Stepper**
- ☑ **Single or Multi-axis Drives (Servo, Variable Frequency, Variable Speed)**
- ☑ **Targeting High Efficiency**
- ☑ **Fast Loop Closure Performance**
- ☑ **Diverse and Futureproof Networking Support Desired**
  - ☑ Without impact to Motor Control Performance
- ☑ **Cybersecurity and/or Functional Safety a Priority**
- ☑ **Planning for on-board Predictive Maintenance or other Analytics-driven functionality**
- ☑ **Compact Size for end product Preferred through System Integration**
- ☑ **Developing a Scalable Embedded Platform that spans multiple Products**
- ☑ **Reduces Total Cost of Ownership**

Finding the Right Starting Point (Trenz or Qdesys)

- **Current motor control design with DSP/Processor looking to modernize**
  - Trapped in legacy paradigm
  - Current solution running out of steam
  - Interested in benefits of FPGA

Electric Drives Demonstration Platform (EDDP) available through Trenz

Software Upgradable to SPYN Starter Kit (at no charge)

Software Upgradable to Predictive Maintenance (At no charge – Release EW'19)

- **New to Motor Control and FPGA**
  - Looking for Quick Start

- **Experienced on Motor Control and FPGA, but not together**

Standard & Advanced Controls
Zynq-7000 based Three Level Inverter (TLIMOT)
- Silicon-Carbide Technology
- Fast control loop through Zynq
- Optimal design for size, cost, EMI & more
- Complete with exhaustive IP, design services

New Users: Electric Drives Demonstration Platform

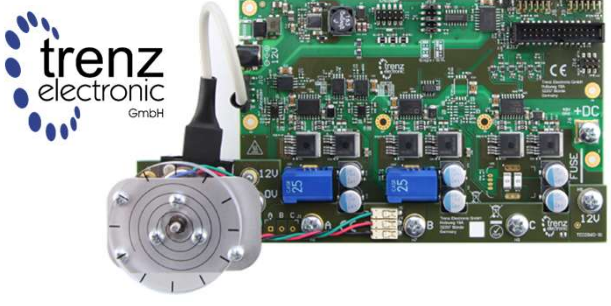
- Design Methodology Predicated on Open Source & Ease of Use
- EDDP takes complete advantages of **Xilinx Zynq SoCs**
- Platform offers two different flows to build motor control solutions
  - Xilinx SDSoC Design Flow
  - Xilinx Vivado HLS Design Flow

EDDP KIT

2

3

1



Three simple steps to get started!
EDDP Demo Video

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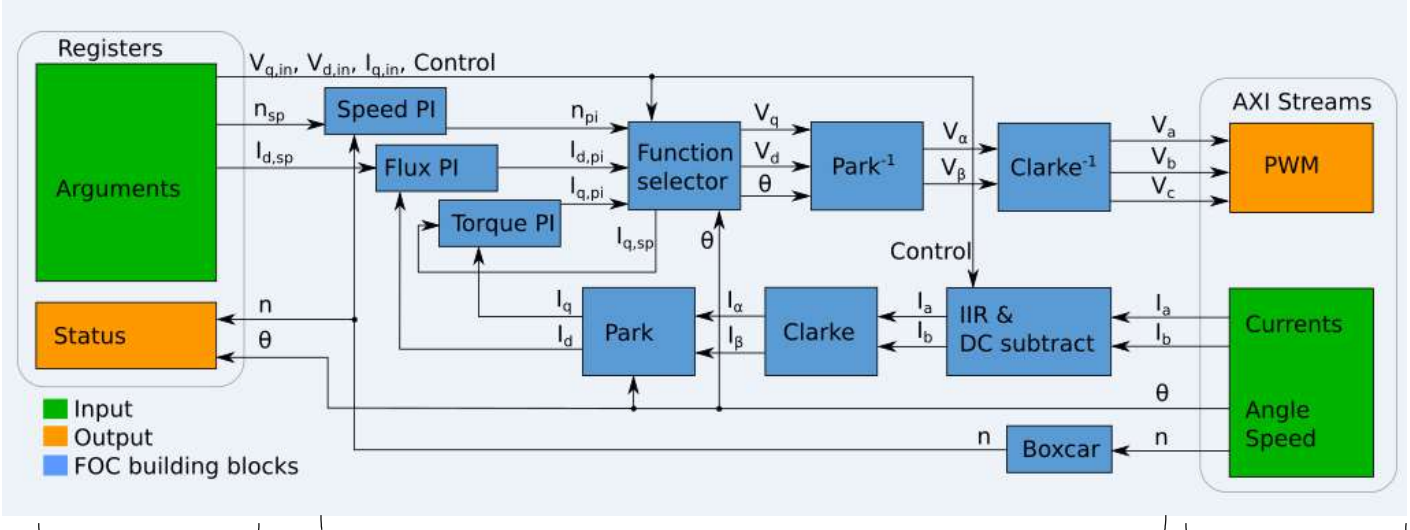
Open Source FOC Algorithm Included with EDDP

AXI_Lite



1 Processor interface

7 algorithmic components

2 I/O components

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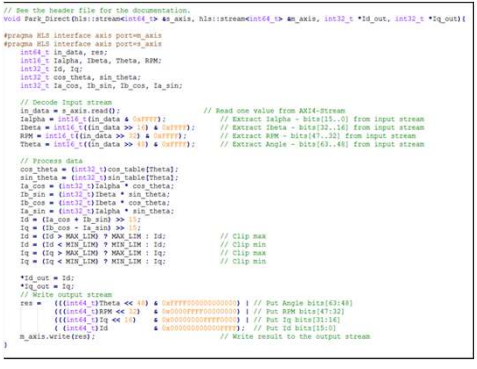
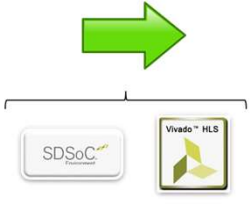
Algorithm translates in C code and compiled in RTL

Algorithm in C/C++



Xilinx Tools



RTL Design

> **Tools:** SDSoC and Vivado HLS enabled motor control algorithm written in C/C++ code to be made into hardware implementation

Advanced Users: Modular Motor Control IP (1/2)

- **Basic building blocks**
  - Fifteen control functions, all modular
  - DSP48 centric
  - Dynamic operation with minimum footprint
- **Start/finish LEGO mechanism**
  - Extensible concept
  - Full parallelism
- **High precision DSP capability**
  - 48bit operations, 18bit precision
- **Up to 40 times faster than µC at slower clock speed**
- **Available today**
  - One-time fee, perpetual for the customer
  - no limit in number of projects, no royalties for product

QDESYS
S/W for Embedded Systems

FULLY DOCUMENTED IP

Xilinx-exclusive Motor Control IP for Performance and Extensibility

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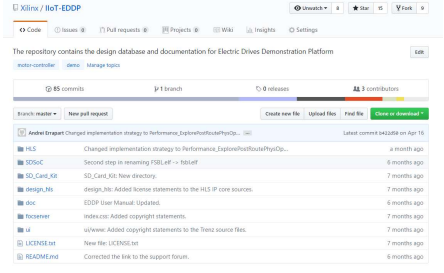
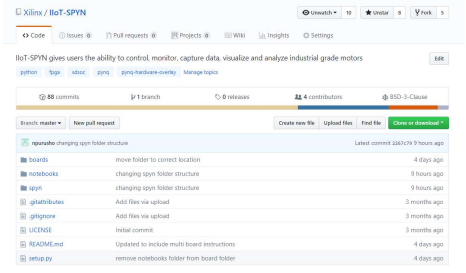
Explore EDDP and SPYN Resources



EDDP GitHub
https://github.com/Xilinx/IIoT-EDDP



SPYN GitHub
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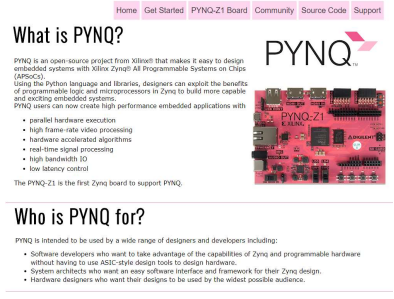

PYNQ GitHub
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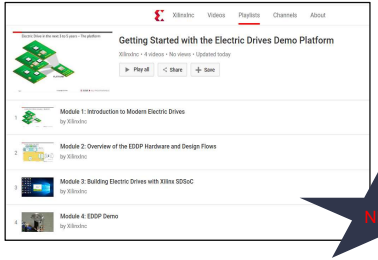

NEW

Watch Webinar
ON DEMAND

Watch Webinar 2
ON DEMAND

YouTube Videos:
Getting Started with the Electric Drives Demo
SPYN Quick Take Video on YouTube

Xilinx.com Videos:
Available in English (xilinx.com)
Chinese (china.xilinx.com)
Japanese (japan.xilinx.com)
SPYN Quick Take Video on Xilinx.com

Hardware Kit for
EDDP and SPYN

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White
Paper

NEW

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Drives & Motor
Control Flyer

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Adaptable.
Intelligent.

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