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Hardware

- **DS1403 Processor**
  - **DS1514 FPGA Board**
    - Xilinx® Kintex-7 FPGA which can be programmed by the user
  - **DS1553 Piggyback Board**
    - 8 A/D channels with 10 MHz sample rate and adjustable voltage range
    - 2 D/A channels with 10 MHz update rate and ±20 V voltage range
    - 8 digital single-ended or differential 5V input channels
    - 24 digital single-ended 5 V output channels
    - 4 RS485 digital differential bi-directional channels
    - 1 resolver IC with 16 bit position resolution and 500 kHz update rate

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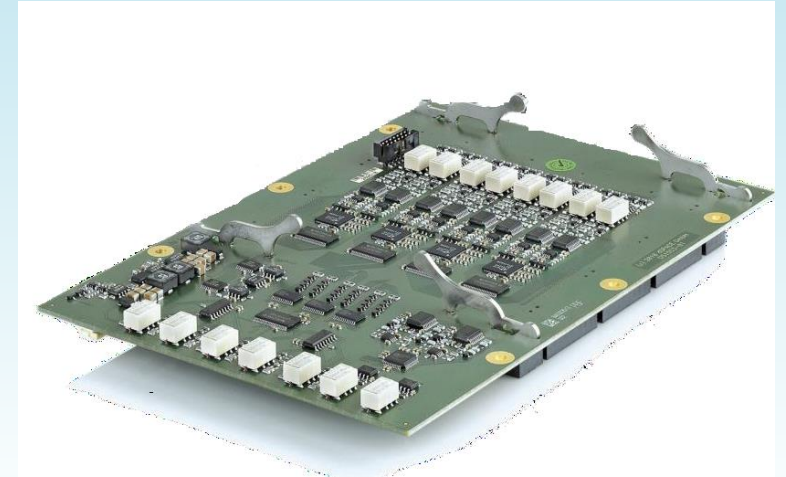
ACMC Motor Control Demo (Scalexio)

Hardware

- RapidPro Power Unit
- Motor: 4 pole Permanent Magnet Machine
- Load: Electric Load
- DC Link Voltage up to 60V

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ACMC Motor Control Demo (Scalexio)

Configuration Desk

- XSG based FPGA firmware for 1514 and piggyback board 1553

- Position Encoder (Input)
  - Hall Encoder
  - Incremental

- Analog to Digital Converters (Input)
  - 4X ADC with PT1 Filters (3x Current, 1x DC Link Voltage)

- FPGA and Processor based Current Controller
  - PM machine Vector Control (Id, Iq)

- FPGA Based Space Vector Modulator and PWM Generation(Output)

- Extras
  - FPGA Scope
  - Overcurrent Protection (I2t Protection)
  - Automatic Position Sensor Offset Calibration
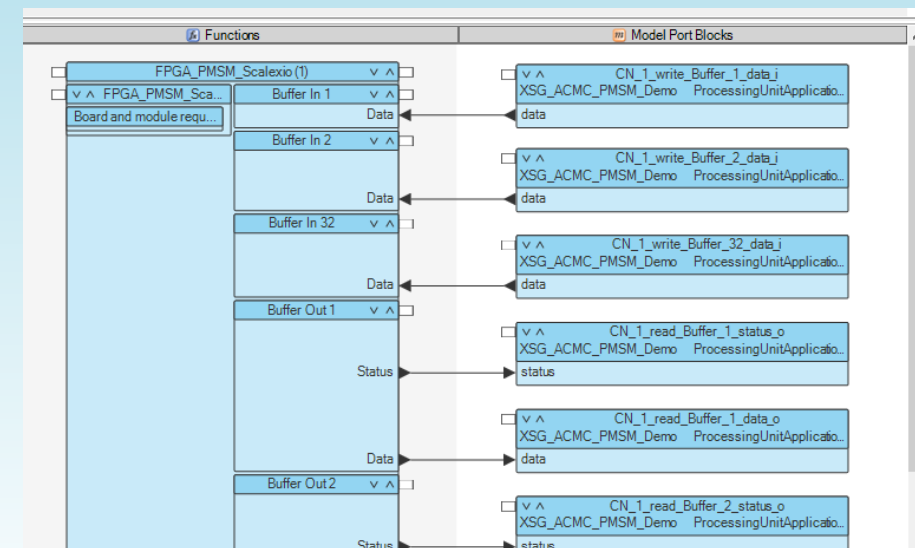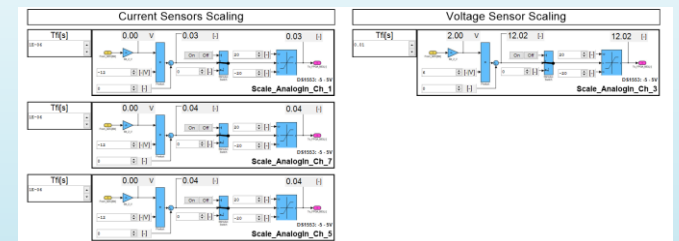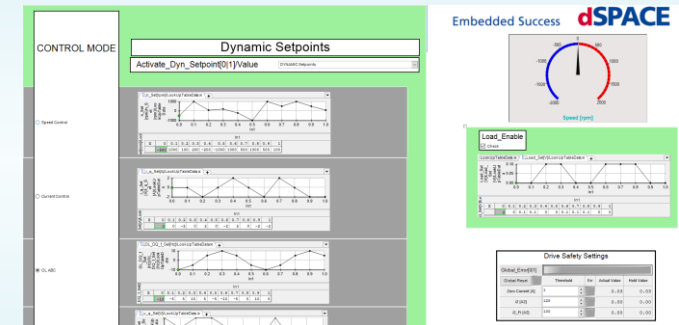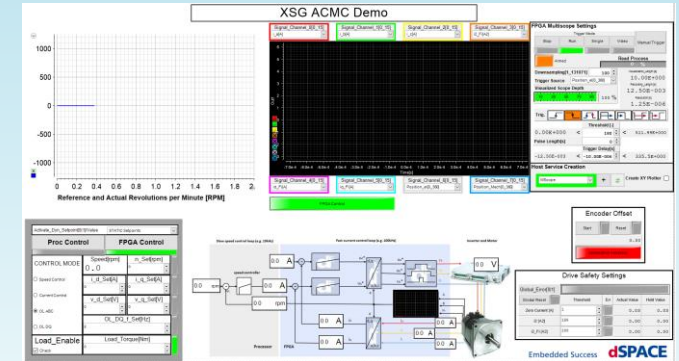
Communication (FPGA & Processor)

- Buffer Communication
  - Buffer 1(Base Task)
    - FPGA Scope, Version Information, Current Controller and Sensor Parameters
  - Buffer 2 (Controller task)
    - Setpoints from Speed Control or Processor based Current control
  - Buffer 32 (Scale IO)
    - Scaling Factors ADC and PT1 Filter time constant

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ACMC Motor Control Demo (Scalexio)
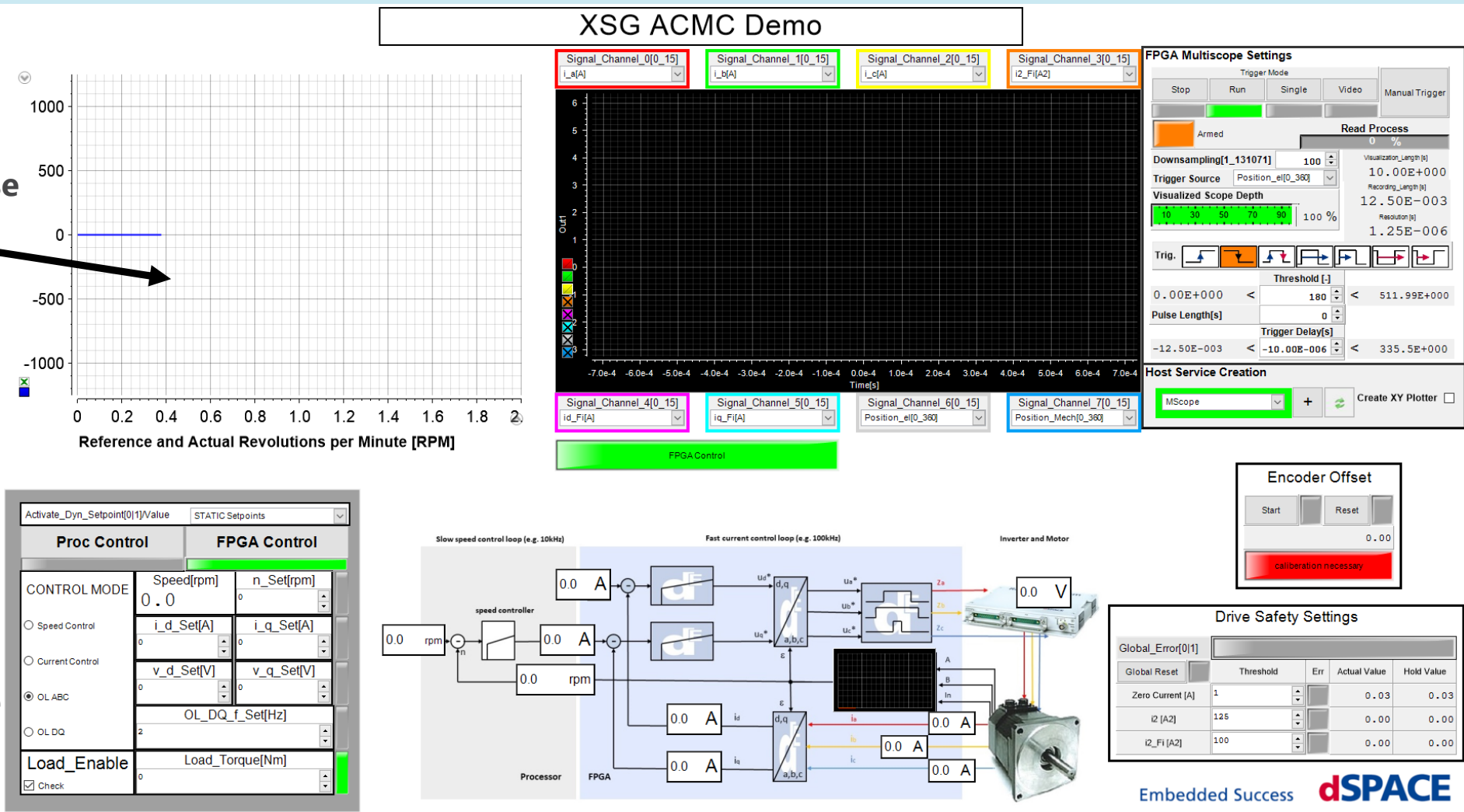

Control Desk

- Controller Layout
  - Speed Control (Processor Based)
  - Current Control (FPGA and Processor based)
  - Over Current Protection
  - Automatic Position Sensor Offset Caliberation
- Dynamic Setpoint
  - Lookup table based Speed Current (Iq) Open loop Voltage and Frequency setpoints
- ADC
  - Scaling factor for ADC
  - Filter Time Constants
- System Information
  - Library Version number and Task turnaround time information

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ACMC Motor Control Demo (Scalexio)

FPGA Scope

Speed Response Plotter

Setpoint Input & Control Mode

Offset Caliberation

Over Current Protection

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ACMC Motor Control Demo (Scalexio)

Dynamic Setpoint

Speed [rpm]

Current (Iq) [A]

Frequency (f) [Hz]

Voltage (Vq)[V]

Load [Nm]

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Folder Structure

- **Configuration**
  - XSG_ACMC_Demo.zip (Configuration Desk back up project)
- **Instrumentation**
  - XSG_ACMC_PMSM_Demo.zip (Control Desk back up project)
- **Simulation**
  - _ControlPMSM (Controller Parameter)
  - IniFiles (IO Initilization Parameter)
  - Model (Simulink Model)
  - XSG_ACMC_PMSM_rtiFPGA (Firmware Files)
  - go.m (Matlab Script)
- **Documentation**

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ACMC Motor Control Demo (Workflow to Edit Demo Model)

Simulink Demo

- **Step 1**
  - The Xilinx system generator should be opened and thereafter Demo folder /Simulation should be selected.
 - go.m should be executed and corresponding Simulink File is opened by the script.
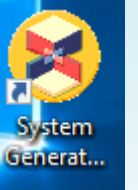
- **Step 2**
  - Configuration Desk –Implementation version should be opened
  - XSG_ACMC_Demo.zip Configuration Desk Back up project should be opened.
  - Platform, if need, must be registered.
  - Add Simulink Model to Configuration Desk and Analyze Model

- **Step 3**
  - Any conflicts that may appear in Configuration Desk must be resolved
  - A test build needs to be performed.
  - The test build should generate a SDF file successfully.

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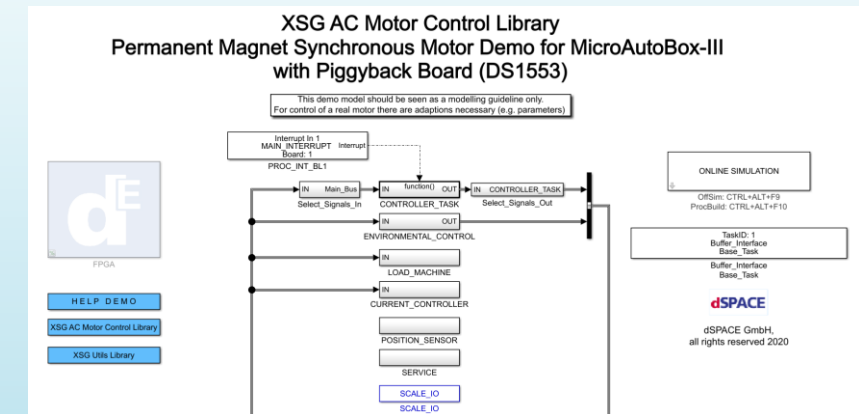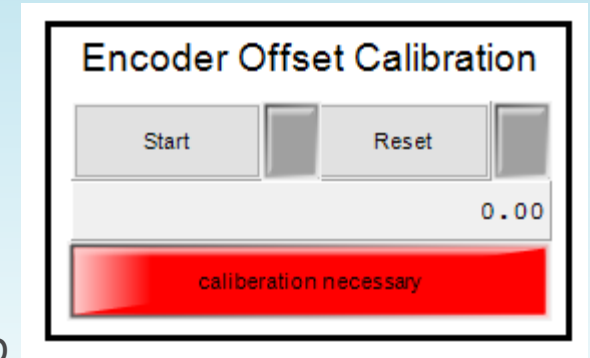
ACMC Motor Control Demo (WorkFlow)

Control Desk Before Start

- **Step 4**
  - XSG_ACMC_PMSM_Demo.zip Control Desk Back up Project must be loaded.
  - The Platform connection is checked SDF file provided with the control Desk backup experiment is loaded.
  - Note SDF file generated in Step 3 can be loaded if needed by navigating to Configuration desk project build Folder.

- **Step 5**
  - Check the encoder offset calibration instrument if it shows drive ready
  - If not then press **Start** on the Instrument.
  - Check if the Drive safety status is OK (Global Error LED is NOT Red)

NOTE: During Encoder Calibration make sure Processor Control is active.

See Slide No 6

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ACMC Motor Control Demo (WorkFlow)

Control Desk Before Start Contd..

- **Step 6**
  - The Scaling Factors of ADC from the ADC Layout must be checked
  - Scaling Factor for Current sensors RapidPro Setup is usually -12
  - Scaling Factor for DC link Voltage is usually 6. (Note that the scaling factor is not same for all ADC)
  - Sensor PT1 Filter values, if necessary, should be adjusted

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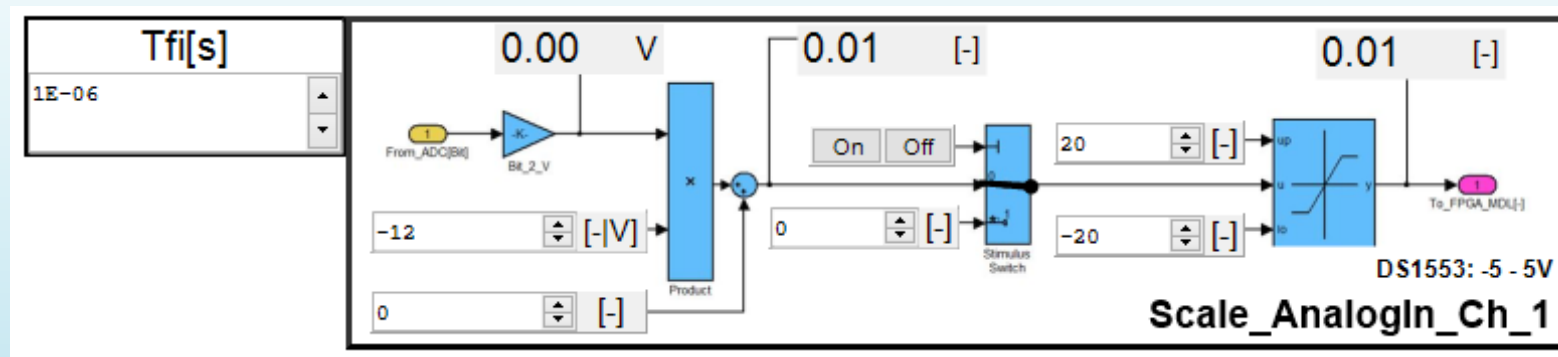
ACMC Motor Control Demo (WorkFlow)

Control Desk Static Setpoints

- **Step 7**
  - Demo is ready for operation.
  - Different Control Modes and set points from the Controller layout can be set.
  - FPGA based Current Control or Processor based Current Control can be selected.
  - Dynamic setpoints can be set using Dynamic setpoint layout

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Control Desk Dynamic Setpoints

- **Step 7**
  - Different Control Modes can be selected in the Dynamic setpoints layout.
  - Setpoint tables have Values that can be edited using the table editor tool
  - Default time period of the entire cycle is 20 Seconds and can be changed in Real time from Control Desk

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Control Desk Extra – FPGA Scope

- **FPGA Scope can show signals directly from FPGA**

  - FPGA Scope measures various signals within the FPGA and displays them on control Desk at FPGA clock. For Example: 12.5 nS in case of MABX.

  - The measurement can be triggered using signals mapped on the scope or from the Processor.

  - For more details on the scope refer to

    XSG_Utils Documentation

  - **NOTE: LED underneath the scope shows which control mode is currently on FPGA or Processor.**

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ACMC Motor Control Demo (Extras)
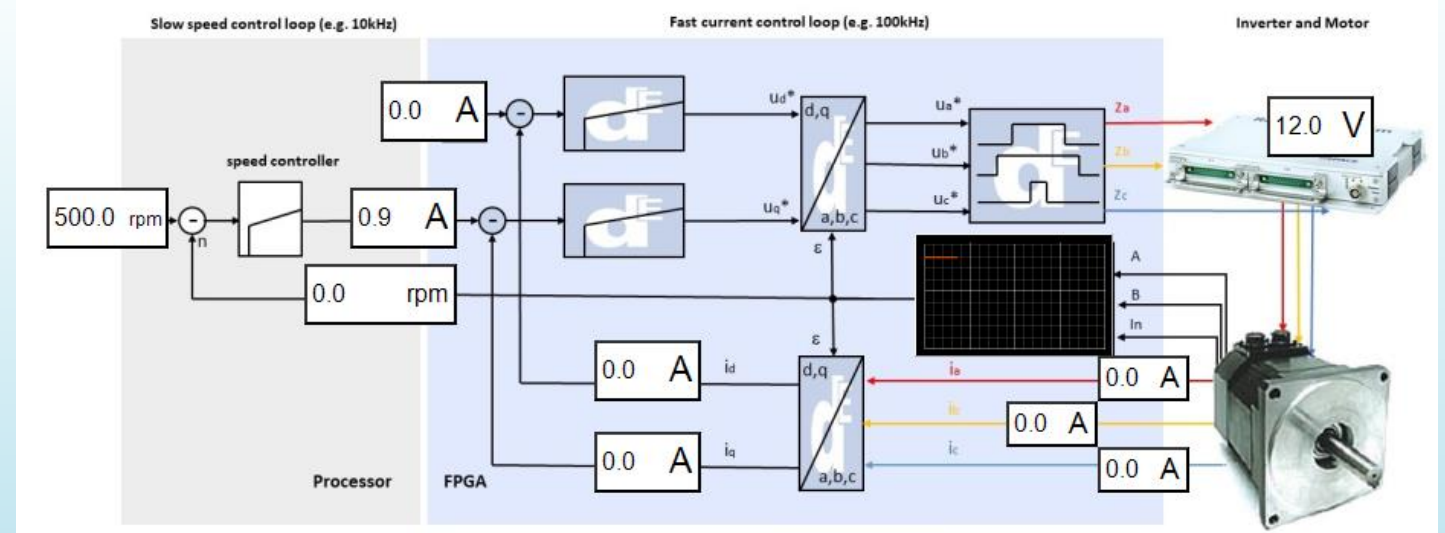
Control Desk Extra Drive Safety

- Drive Safety Instrument can Protect the motor against
  - Zero Current Error (If one or more ADCs are faulty)
  - i2 protection (Protects against exceeding maximum rated motor current)
  - i2_Fi (Protects against high current applied to motor for a long period of time)
- Actual Value on the instrument Shows the real time values
- Hold Values show values when error occurs.

Drive Safety Settings				
Global_Error[0|1]				
Global Reset	Threshold	Err	Actual Value	Hold Value
Zero Current [A]	1		0.01	0.01
i2 [A2]	125		0.00	0.00
i2_Fi [A2]	100		0.00	0.00

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ACMC Motor Control Demo (WorkFlow)

Control Desk Extra Overview Diagram

- Overview diagram shows the current state of the motor inverter setup i.e. 3 phase currents DC link voltage. D and q currents and various set points

- Speed Control of the motor is always in Processor. However the current control loop can be Processor based or FPGA based.

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Important Information!

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