ANALOG DEVICES

AHEAD OF WHAT'S POSSIBLE™

SERVO MOTOR CONTROL SOLUTION

Application Introduction

For motor control solutions, Analog Devices offers a complete product portfolio including data converters, amplifiers, embedded processors, *i*Coupler® digital isolators, a variety of power management devices, and real-time network communication solutions. Enhanced performance and system integration enable innovative design topologies, which add value and help differentiate our customers' connected motion control systems, with faster processors to run more complex algorithms, high performance analog-to-digital converters (ADCs) to support a better performance current loop, real-time Ethernet multiprotocol switches, and more. Servo drive solutions are associated with attaining the highest performance and accuracy capable in a motion system. In most cases the end solution is a connected motion control (CMC) system or robot system that operates with high precision and where control of absolute position, optimum torque alignment, and multiaxis synchronization is required. Analog Devices offers a complete solution covering all key components in the signal chain.

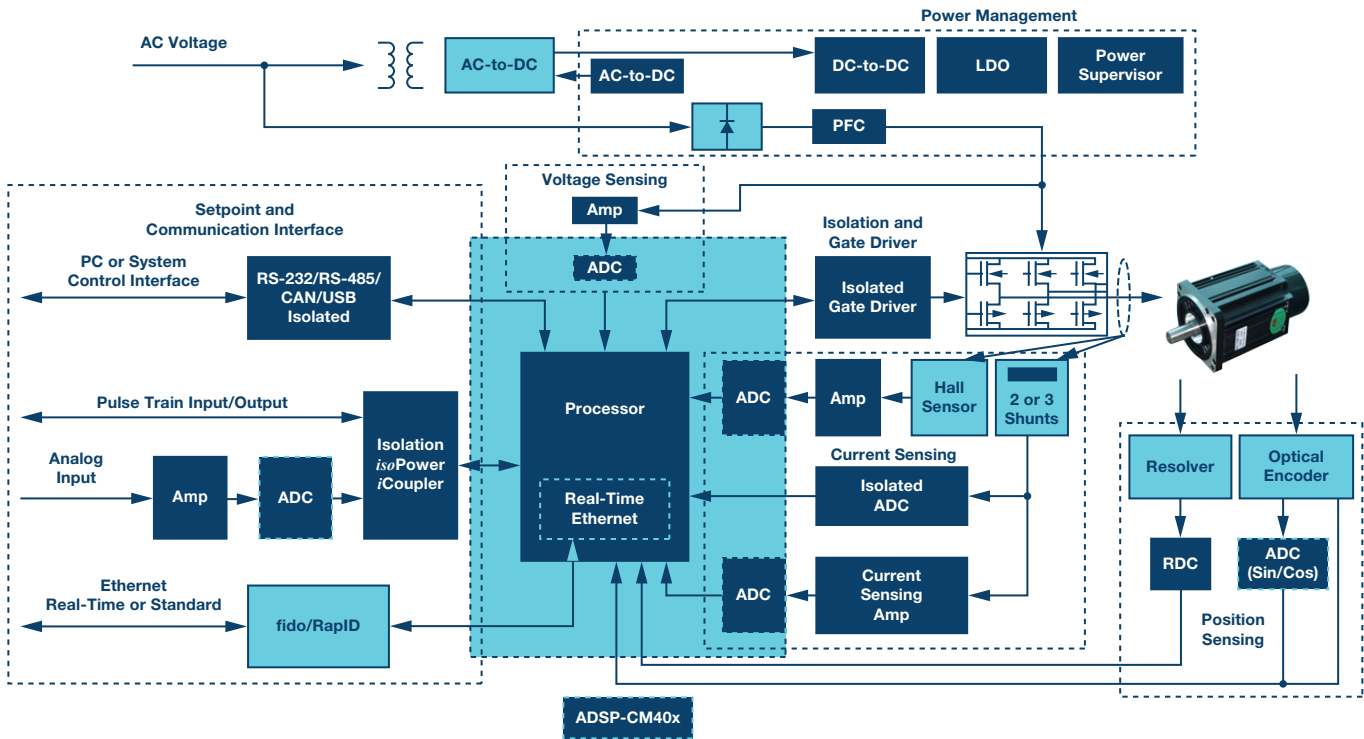## System Design Considerations and Major Challenges

- High precision current and voltage detection are needed to support speed and torque control performance. Servo control needs a minimum of 12-bit ADC performance, multiple input channels, and simultaneous sampling. ADI has a full family of products to support customer needs.

- In systems using shunts as current sampling, the quality of a current feedback signal has significant impacts on servo performance. ADI offers the industry's best solutions based on our isolated Σ-Δ modulators.

- Position detection performance is key for servo control. Increased demand for motor control and efficiency is shifting technologies from analog to digital.

- With the development of industrial Ethernet and the improvement of position detection accuracy, servo systems increasingly rely on serial communication absolute encoders. To help meet this need, ADI offers communication transceivers with *i*Coupler digital isolators. ADI provides support for different communication protocols such as EnDat, Biss, Nikon, and Tamagawa.

- For applications where safety and protection are priorities, isolation technology is used on signal isolation and gate drivers. ADI's *i*Coupler digital isolator products provide support for high voltage safety isolation.

- The reliability and safety of servo systems rely on IGBT drive circuit performance. ADI's IGBT gate driver solutions are integrated with full IGBT protections to provide a simpler and more reliable design choice.

- High performance processors, like DSPs, are used to implement vector control and sensorless control.

- Real-time Ethernet and motion control network connectivity with multiprotocol support are important to motion control systems.

- Less distortion at a servo's power input end can be achieved by using integrated power factor correction (PFC) devices for design simplicity consideration.

- For industrial applications, designers are futureproofed by long-term availability and reliability products.

- The industry trend is to change from standard induction machines to permanent magnet motors; this means system designers need to introduce higher efficiency and flexible algorithms for induction motor (IM) motion and permanent magnet synchronous motor (PMSM) motion.

- High performance real-time industry control networks enable better synchronization of multiple motors.

ADI Solution Value Proposition

For industrial designers building motion-based systems with the goal of substantially lower power consumption and high efficiency, ADI provides components and full signal chain integration to enable the rapid design of these systems. ADI demonstrates differentiation in the areas of feedback and sensing, isolation, power management, interfaces, embedded processing, and communications—areas where ADI products offer best-in-class performance and quality while enabling a low overall system cost. ADI's broad technology mix, including world-class isolation, processors, converters, and mixed-signal front ends, equips design engineers with compelling technologies to cover current and future needs for any connected solution.

System Block Diagram and Signal Chain

Current Sensing	Voltage Sensing	Position Sensing	Setpoint
Isolated ADCs AD7400A/AD7401A/AD7402/ AD7403/AD7405 Amplifiers AD8418/AD8417/AD8212/ AD8479/AD8027/AD8602 ADCs AD7266/AD7367/AD7606-4	ADCs AD7266/AD7352/AD7356/AD7903 Isolated ADCs AD7400A/AD7401A	RDCs AD2S1205/AD2S1210 Amplifiers AD8662 Encoder ADCs AD7266/AD7264/AD7903	Amplifiers AD8676/AD8221/AD8226/ADA4096-2 ADCs AD7680/AD7663/AD7606-4
Processors	**Isolation and Gate Drivers**	**Communications Interfaces**	**Power Management**
ADSP-CM408F/ADSP-CM419F	Isolation ADuM1411/ADuM1311/ ADuM141E/ADuM130E Gate Drivers ADuM4223/ADuM3223/ADuM7223/ ADuM4135/ADuM4136 DC-to-DC ADuM5000/ADuM6000	RS-232 ADM3251E RS-485 ADM2486/ADM2484E/ADM2483/ ADM2582E/ADM2587E/ADM2682E/ ADM2687E/ADM485E CAN ADM3053/ADM3051 USB ADuM4160 LVDS ADN4650 Real-Time Ethernet Switches fido5100/fido5200	Micropower Management Units ADP5134/ADP2119 Linear Regulators ADP151/ADP7102 Supervisory ADM6339/ADM13307/ADM708 DC-to-DC ADP1051 PFC ADP1047

Key Product Technologies

| Part Number	Description	Key Features	Benefit
Amplifiers			
AD8479	Very high common-mode voltage precision difference amplifier	±600 V common-mode voltage range, rail-to-rail output, 90 dB minimum CMRR, 130 kHz bandwidth	Supports very high voltage, excellent ac and dc performance
AD8418	High voltage, high resolution current shunt amplifier	Bidirectional, zero-drift, initial gain of 20 V/V, high common-mode voltage range −2 V to +70 V typical, CMRR 86 dB dc to 10 kHz	Supports high voltage, excellent ac and dc performance
ADCs			
AD7266	Simultaneous, 12-bit SAR ADC	Dual, 12-bit, 3-channel ADC, throughput rate, 2 MSPS, 70 dB SNR at 50 kHz input frequency, accurate on-chip reference, 2.5 V ±0.2% maximum at 25°C, 20 ppm/°C maximum, dual conversion with read 437.5 ns, 32 MHz SCLK	Multichannel, simultaneous, and SAR ADC
AD7401A	Isolated Σ-Δ modulator	Up to 20 MHz external clock, second-order modulator, 16-bit no missing codes, 83 dB SNR typical, on-board digital isolator, on-board reference	Isolated, high accuracy ADC
AD7403	Isolated Σ-Δ modulator	Up to 20 MHz external clock, second-order modulator, 16-bit no missing codes, 88 dB SNR typical, on-board digital isolator, on-board reference	Isolated, high accuracy ADC
Processors			
ADSP-CM408F	ARM® Cortex®-M4	240 MHz ARM Cortex-M4, 384 kB SRAM and 2 MB flash memory, dual, 16-bit SAR ADCs and 14 bits of accuracy, 2.6 MSPS, integrated sinc filters, MAC, USB	240 MHz, Cortex-M4, floating-point core and high performance ADC and sinc filters
ADSP-CM419F	Dual core ARM mixed signal processor	240 MHz ARM Cortex-M4 with floating-point unit with up to 160 kB zero wait state ECC SRAM, 100 MHz ARM Cortex-M0 supervisor core with 32 kB zero wait state ECC SRAM	Dual core, highest embedded ADC, sinc filter, FFT, and other MATH functions
RDC			
AD2S1210	Resolver-to-digital converter	3125 rps maximum tracking rate (10-bit resolution), ±2.5 arc minutes of accuracy, 10-/12-/14-/16-bit resolution, set by user, parallel and serial 10-bit to 16-bit data ports	High accuracy
Isolation			
ADuM4135	Gate driver	Isolated IGBT gate driver, 4 A peak drive output capability, 500 V rms or 1200 V_{DC} working voltage, −40°C to +125°C	Desaturation protection, soft-shutdown on fault, Miller clamp output with gate sense input, isolated fault and ready functions
ADuM4223	Gate driver	4 A peak output current, high frequency operation, 1 MHz, high-side and low-side isolation, 537 V peak and 800 V peak for differential input, −40°C to +125°C	High-side and low-side isolation, high temperature operation: −40°C to +125°C
ADuM141E	PWM isolator	3.0 kV rms/3.75 kV rms quad digital isolators, 150 Mbps maximum guaranteed data rate, backward compatibility	High common-mode transient immunity, 100 kV/µs, low propagation delay, 13 ns maximum for 5 V operation
ADuM4190	Isolated error amplifier	High stability, isolation voltage, 5 kV rms reinforced, 400 kHz bandwidth, 1% accuracy over the full temperature range	Compatible with Type II or Type III compensation networks
ADN4652	LVDS isolator	5 kV rms/3.75 kV rms LVDS isolator, up to 600 Mbps switching with low jitter, 4.5 ns maximum propagation delay	Multiple dual-channel configurations
Interface			
ADM485E	RS-485/RS-422 transceiver	Half- or full-duplex, 2.5 Mbps, 5 V operation	±15 kV IEC ESD protected, pin-compatible with SN75716B
ADM3065E	RS-485/RS-422 transceiver	Half- or full-duplex, 50 Mbps, 5 V or 3.3 V operation	3.0 V to 5.5 V, ±12 kV IEC ESD protected
ADM2587E	Isolated RS-485/RS-422 transceiver	Half- or full-duplex, 500 kbps, 5 V or 3.3 V operation	RS-485 with integrated isolated dc-to-dc converter; ±15 kV ESD protection, open- and short-circuit, fail-safe receiver inputs
ADM3053	Isolated CAN transcerver	Signal and power isolated, 1 Mbps data rate	Signal and power isolated in one single-chip
fido5200	Real-time Ethernet switch	Supporting PROFINET, EtherNet/IP®, Modbus/TCP, Powerlink, Sercos III, and EtherCAT	IEEE 802.3, 10 Mbps/100 Mbps, half- and full-duplex, IPv6 and IPv4 communication, two independent Ethernet ports, 1 MII and 1 RMII interface per port support for all industrial protocols
Power Management			
LTM8032	DC-to-DC converter	36 V, 2 A dc-to-dc µModule® regulator	EN 55022B compliant, Class B
ADP1047	Digital power factor correction controller	Flexible, single phase, digital power factor correction (PFC) controller, true rms ac power metering, enhanced dynamic response, switching frequency spread spectrum for improved EMI	Digital controller and true rms ac power metering

Reference Design and Demo Boards

HV MPC Platform
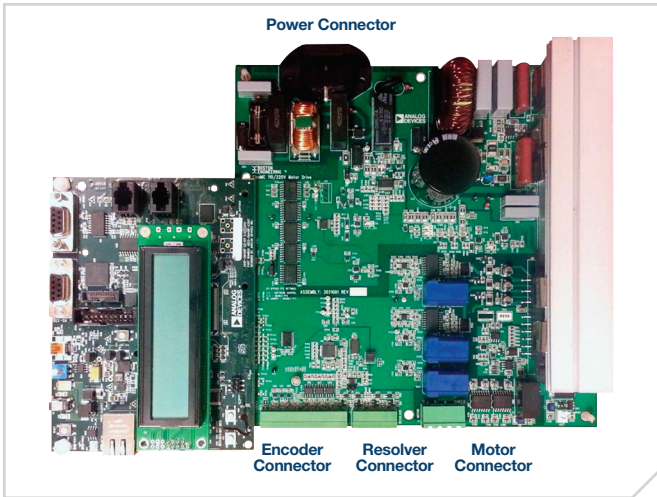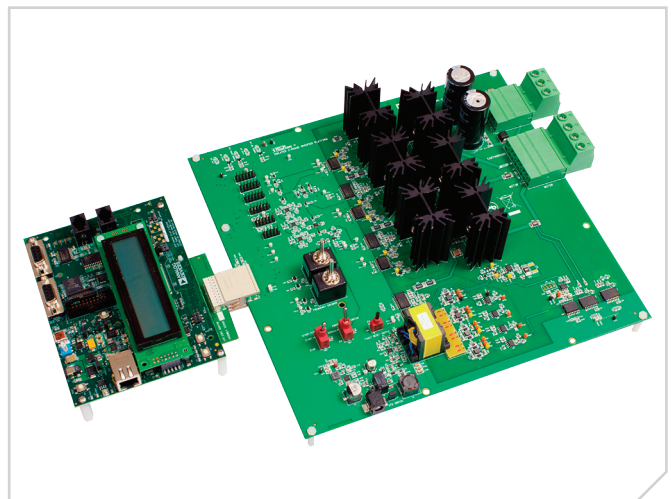

Design by Boston Engineering.

LV MPC Platform
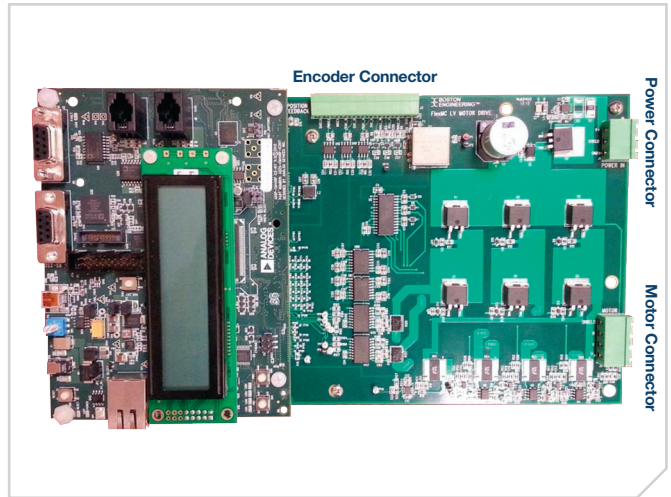
Design by Boston Engineering.
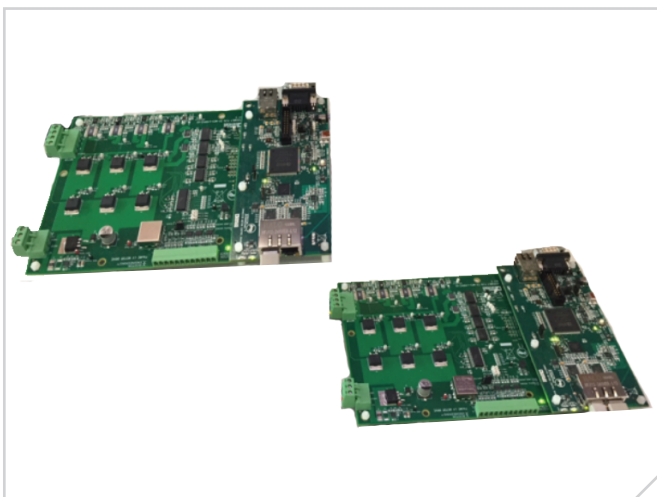
ADI Servo Development Platform
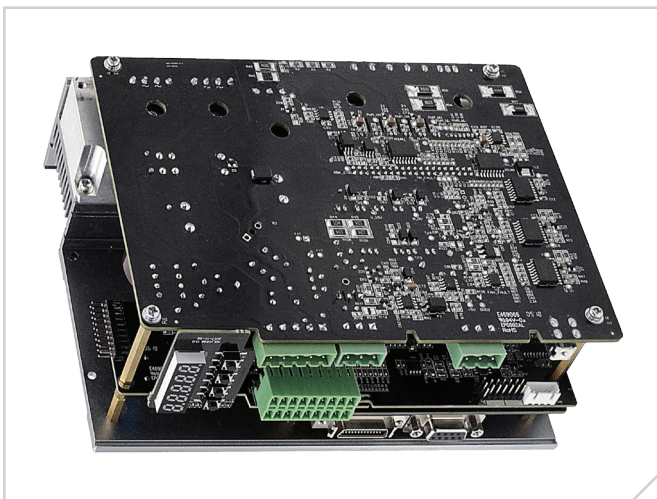
Design by ADI.

Isolated Inverter Platform

Design by ADI.

EtherCAT Connected Motion Control Platform

Design by ADI.

Dual Motor, Dual Axis Servo Drive Demo

Design by third party.

Design Resources

▶ MATLAB® Simulink support—complete scalability and flexibility
  - High level system block level development with functional block definition
  - Alignment with functionality of each element
  - Complete flexibility of design flow and structure

▶ FOC, vector control, sensorless controllers, and standard motion control libraries

▶ Absolute encoder interface solutions

▶ Reference design including PCB, SCH, documents, and source code examples

▶ MPC platform and EZ-KIT®

Third Party—Boston Engineering

▶ ADI servo development platform

Circuits from the Lab® Reference Circuits for Motor Control

Reference circuits are subsystem-level building blocks that have been engineered and tested for quick and easy system integration.

▶ Novel Analog-to-Analog Isolator Using an Isolated Sigma-Delta Modulator, Isolated DC-to-DC Converter, and Active Filter—*analog.com/en/CN0185*

▶ High Current Driver for the AD2S1210 Resolver-to-Digital Reference Signal Output—*analog.com/en/CN0192*

▶ High Performance, 10-Bit to 16-Bit Resolver-to-Digital Converter—*analog.com/en/CN0276*

▶ High Voltage, High Precision Current Sensing with Output Level Shifting Using the AD8210 Current Sense Amplifier and the AD8274 Difference Amplifier—*analog.com/en/CN0116*

▶ 500 V Common-Mode Voltage Current Monitor—*analog.com/en/CN0218*

▶ H-Bridge Driver Circuit Using Isolated Half-Bridge Drivers—*analog.com/en/CN0196*

▶ More reference circuits are available *analog.com/circuits*

EtherCAT Connected Motion Control Platform

▶ Complete SW framework for EtherCAT communication and multiaxis motion control

▶ Synchronization from network master to I/Os on slaves

▶ Support of all EtherCAT synchronization modes

▶ EtherCAT cycle time down to 100 µs

▶ Easy certification

▶ No royalties

▶ Tightly integrated solution

▶ Release is distributed through STARweb
  - *starweb.ad.analog.com/default/AES/latest/*
  - Get folder named: EtherCAT based connected motion (PROD)
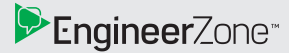 - Available for ADI internal users

More Detail on the ADI Motion Control Web Site:
analog.com/en/motion-control

Technical Support

Engage with the Analog Devices technology experts in our online support community. Ask your tough design questions, browse FAQs, or join a conversation.

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