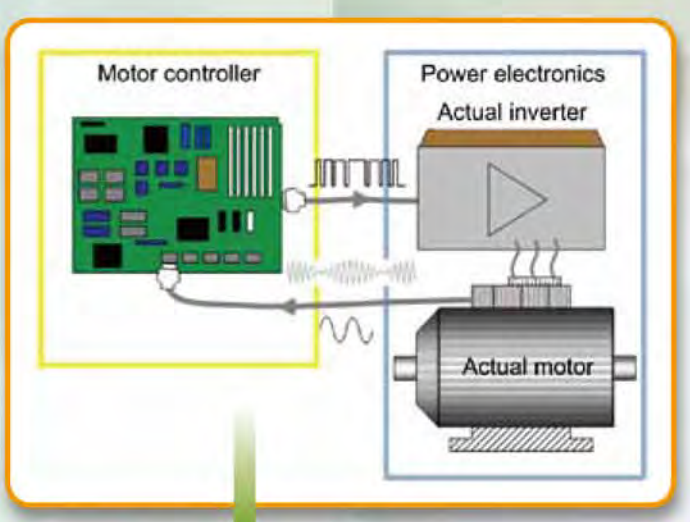
Electric vehicles (EV) and hybrid vehicles (HEV)

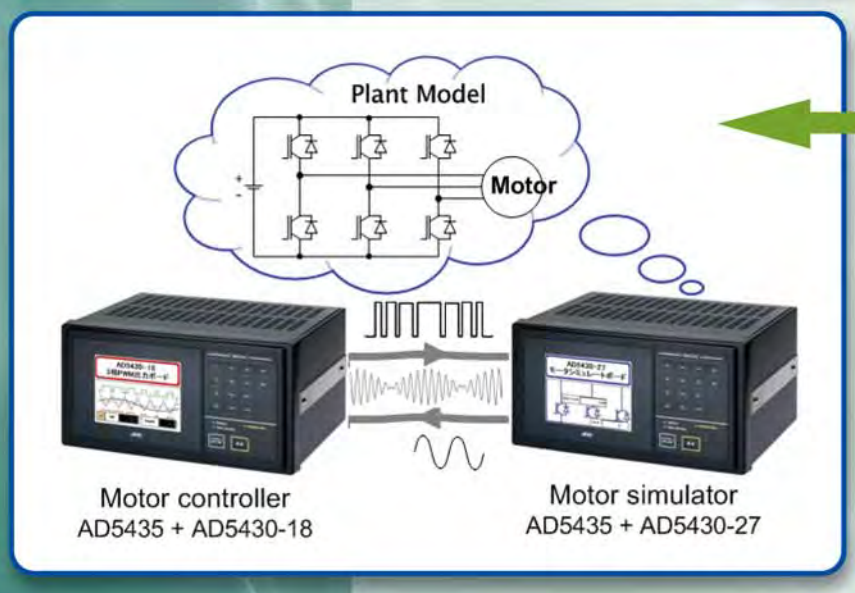
Motor Simulation

Electric Motor Simulation for Vehicles

Features

- Simulating a permanent magnet synchronous motor (PMSM)
- High-speed control with a maximum control speed of 1 μs through FPGA
- Can also be used with the Real-Time Rapid Prototype controller





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■ **This system is a Hardware-In-the-Loop Simulation (HILS) system for motor controller development.**
■ **The system runs in a Real-Time environment and communicates with real signals.**
■ **Users can change the motor characteristics and the motor control algorithm.**

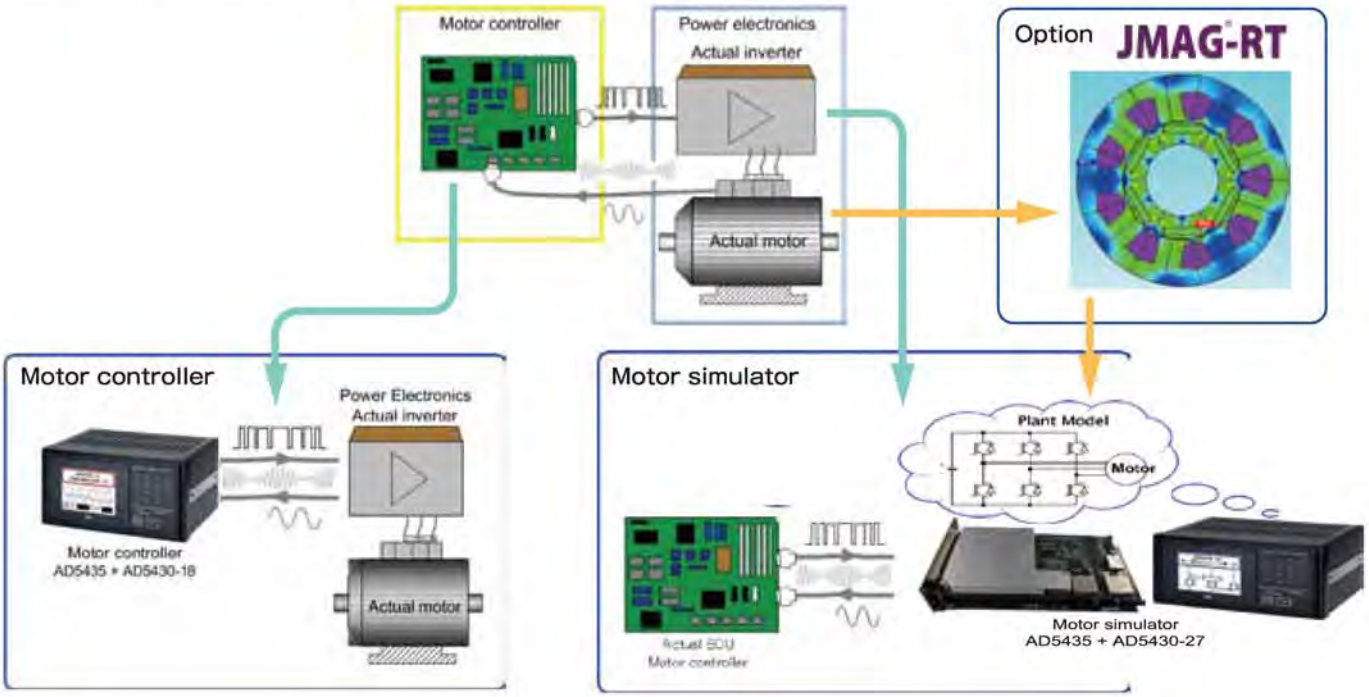
Motor controller development

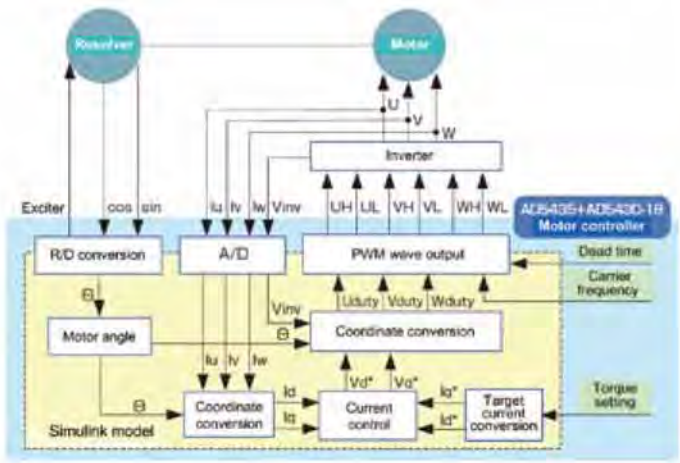
Motor controller development using a HILS system has the advantage that no-actual motors or power supply systems are necessary, since all the target hardware is simulated virtually.
A&D's motor HILS system provides virtual motor environments for developing, designing and validating motor controllers.

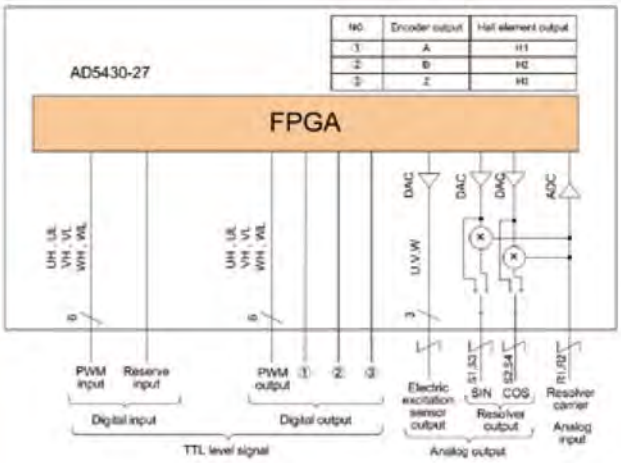
Features of motor HILS

A&D's Real-Time platform enables users to configure both the motor simulator and the motor controller.

- **Motor simulator**
  A&D's Real-Time platform has external interface boards. Actual motor signals such as PWM I/O, current sensor output, resolver carrier input, and resolver angle output (SIN, COS) can be handled in Real-Time. Our Real-Time platform utilizes FPGA, that has a low latency response which is suitable for motor simulation.
- **Motor controller**
  The motor control model is synchronized with the resolver rotation signal which means the model process does not operate in time base but angle base. This reproduces realistic behavior of motor controllers.
- **Motor model**
  A simulation model is based on dq transformation permanent magnet synchronous motor (PMSM) model.
  A space harmonics model can be added on to dq transformation PMSM motor model as an option. Also, space harmonics model can be linked to JMAG™ for achieving more realistic motor simulation.







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Motor Simulation

Electric Motor Simulation for Vehicles

Application examples

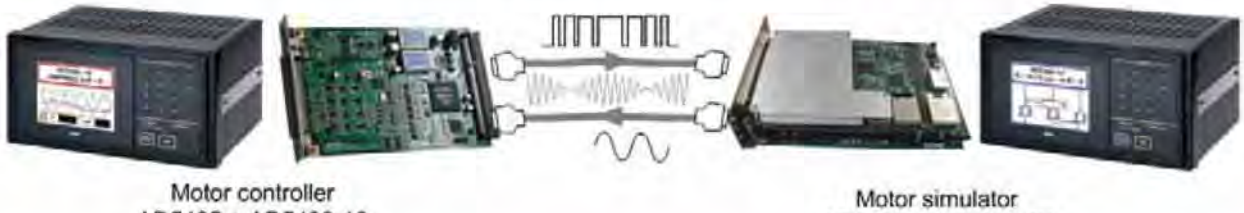
Motor controller development

- **Rapid Prototyping (RPT) application**
  The Real-Time Rapid Prototyping (RT-RPT) controller can be used as a motor controller unit and connected to actual motors.
  Since control algorithm can be changed easily with the MATLAB/Simulink™ model, interface signals to actual hardware can also be configured easily.
- **HILS application**
  Connect an actual motor controller to a motor simulator.
  Users can develop a motor controller without actual motor hardware so development of motor and controller can proceed in parallel. This also reduces the high cost of running actual motors, including facility costs, and provides a safe engineering environment.
- **Software-In-the-Loop Simulation (SILS) application**
  Use the RT-RPT controller as a motor controller unit and connect to a motor simulator.
  A motor control engineer can start development and design of a motor controller at their desk without any power supply facilities or hardware. Since both the motor controller and motor simulator are working virtually, this approach is used at early phases of development. Since both systems are connected by actual physical signals, a controller prototype made from this system has seamless interface to an actual motor.
  (Users can connect the RT-RPT system to actual hardware without any problems)

Real-Time controller

Motor controller development

- **AD5435**
  Main unit of the RT-RPT controller has seven option board slots for enhancing the system.
- **AD5430-18**
  Specialized option board for motor control application
- **AD5430-27**
  Specialized option board for motor simulation
  High precision calculation and low latency speed are realized by using FPGA.



Motor controller
AD5435 + AD5430-18

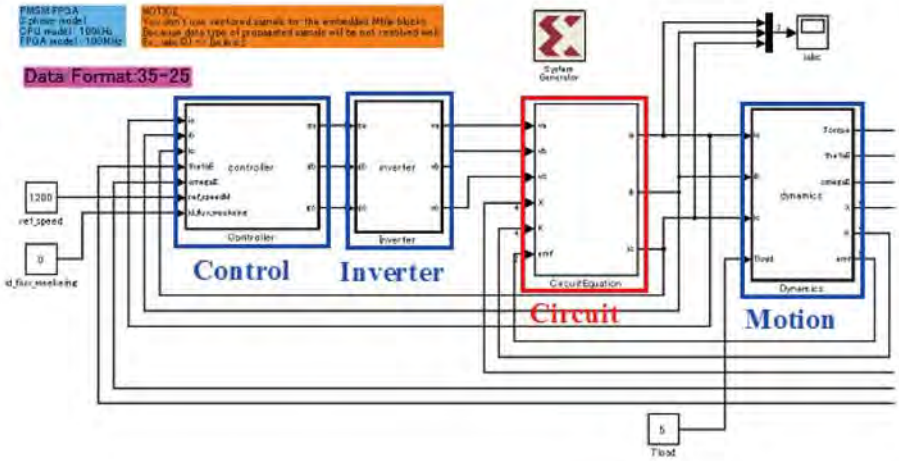
Motor simulator
AD5435 + AD5430-27

Software package

The RT-RPT controller system comes with a control program, so the system can be used immediately.
Also, users are able to modify the software such as the control algorithm and GUI interface for customization.

Included:

- **Control source code (MATLAB/Simulink™ Model)**
  Includes MATLAB/Simulink™ add-on compiling environment
  (Please prepare MATLAB/Simulink™ and the ISE environment of Xilinx separately.)
- **GUI building software tool**
  Design application software (VirtualDSPConsole) is included.



AD5435 Specifications

Memory	SDRAM 512 MB
OS	RTOS
Display	5 .7 inch color TFTLCD (with backlight)
Operation interface	Resistive touch screen　Customizable function keys
I/O slots	For AD5430 series I/O board 7 slots
PMC interface	For A&D link or FlexRay: 1 slot (option)
Peripheral connections	Ethernet, 100 base – T　FTP server function
Power specifications	AC power specification (AD5435A) 85 to 264 V
	DC power specification (AD5435) 12 V (6 to 18 Vpp) or 24 V (16 to 36 Vpp)
Power consumption	100 VA (AC or DC power)
Operation temperature range	5 to 40 ℃
Operation humidity range	5 to 90 % R.H. non-condensing
Dimensions	318 (W) * 230 (D) * 168 (H) mm
Weight	About 6 .5 kg (chassis only)

Control Board (AD5430-18) Specifications

Resolver input	R/D converter	AU6802NI (made by Tamagawa Seiki)
	Transformation ratio	0.286 / 0.5
	Output impedance	10 Ω or less
	Output excitation signal	10 kHz / 20 kHz
	Maximum angle speed	240,000 rpm
Analog input	Number of channels	4
	Signal format	Differential signal
	Sampling frequency	40 kHz (maximum) Can synchronize with PWM carrier wave.
	Input range	± 5 V
	Resolution	16 bit
PWM output	Number of control axes	6
	Output format	Differential (UH, VH, WH, UL, VL, WL)
	Output voltage	0 to 5 V
	Carrier wave	Triangular wave, 20 kHz (maximum)

Simulation Board (AD5430-27) Specifications

Digital input	Input level	TTL (Single end)
	Number of channels	7
	Resolution	20 ns
	Response	9 ns
	Number of channels	4
Digital output	Output level	TTL (Single end)
	Number of channels	9
	Resolution	20 ns
	Response	12 ns
	Number of channels	9
Analog output	Output level	Differential
	Number of channels	5
	Output range	± 12 Vpp (FS)
	Output current	10 mA
	Output impedance	1Ω
	Resolution	14 bit
	Sampling	50 MHz (Max)
	Conversion	Settling 250 ns
Analog input	Input level	Differential
	Number of channels	1
	Input range	± 24 Vpp (FS)

⚠ Safety Warning! ●For proper use, read the instruction manuals carefully before use.

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●Appearances and/or specifications subject to change for improvement without notice.
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