

# Analog Devices Programmable Logic Controllers (PLCs) Solutions

## Industry PLC System Theory and Typical Architecture

Comprised of power supplies, CPUs, and multiple analog and digital I/O modules, a PLC system controls, actuates, and monitors complex machine variables. The PLC is designed for multiple inputs and outputs arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact.

A PLC system comprises power supplies, control and communication modules, and a variety of analog input, analog output, digital input, and digital output modules.

## Industry PLC System Design Considerations and Major Challenges

To have an appropriate PLC system design, designers must consider many different system requirements including accuracy, bandwidth, and input range.

- Analog input types and ranges can be as small as  $\pm 10$  mV for TC (Thermocouple) and RTD and as large as  $\pm 10$  V for actuator controllers—or 4 mA to 20 mA currents in process control systems.
- Analog output types and ranges typically include  $\pm 5$  V,  $\pm 10$  V, 0 V to 5 V, 0 V to 10 V, 4 mA to 20 mA, and 0 mA to 20 mA. Sometimes over range capability is required.
- The resolution and accuracy of the input/output modules typically range from 12 bits to 16 bits, with 0.1% accuracy over the industrial temperature range.
- Connectivity to different field BUS.
- Isolation—between system power module and low power electronics; between input and output; and between I/O and the central control unit. The isolation grade varies from 1 kV to 2.5 kV.
- Analog input/output and power supply input protection: fault condition voltage or current and EMC considerations including electrical surge, fast pulse transient, and ESD.
- Power efficiency, thermal management, and heat dissipation will become an increasingly important issue for miniaturized devices as they attempt to reduce board size.

In addition, more channels or nodes need to be placed within the same space, requiring dense systems. Therefore, the form factor has to be reduced to accommodate this. This means smaller housings where power and heat management become a challenge, requiring solutions in intelligent power management via integrated dynamic power control.

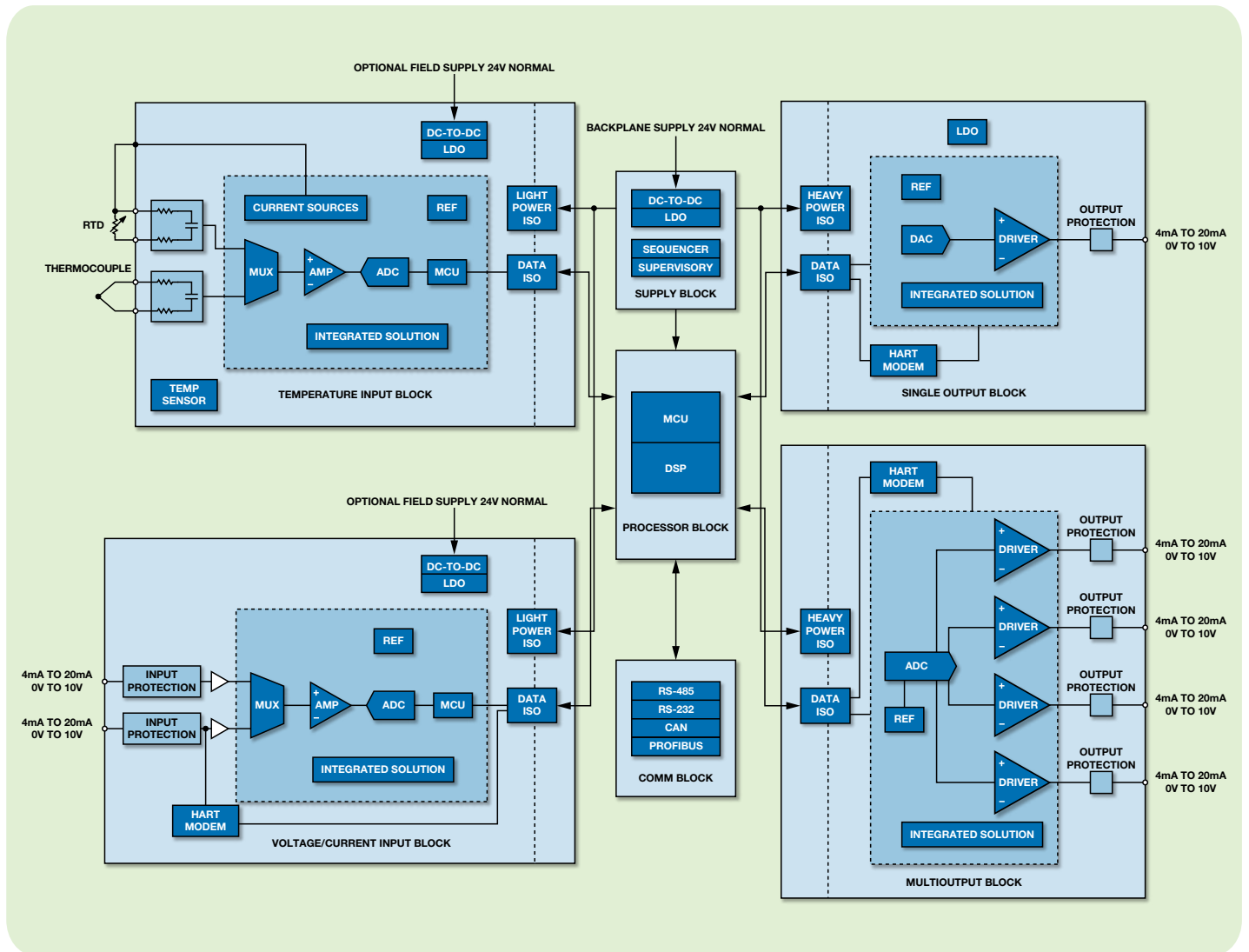
Historically, the large number of high performance discrete components required to implement these I/O systems resulted in large and expensive implementations. Recently, advances in integration have allowed system designers to migrate to smaller, lower power, lower cost solutions, with performance approaching these larger systems. The challenge moving forward is to continue to drive the integration of these solutions while increasing their performance and diagnostic capabilities.

ADI offers market tailored solutions to aid in the design process. These solutions feature our industry-leading technologies and offer a range of design options—from implementation of discrete components to fully integrated solutions, and everything in between.

## Total Solutions from ADI

Leverage ADI's amplifier, data conversion, signal processing, and power technology expertise for high resolution, low noise industry PLC systems.

## Main Signal Chain



Note: the signal chains above are representative of a PLC application system. The technical requirements of the blocks vary, but the products listed in the table are representative of ADI's solutions that meet some of those requirements.

## Product Table List

Analog Input	Analog Output	Isolator	Others
<b>ADC</b> AD779x/AD7685/AD7192/AD7194/ AD7606/AD7606-4/AD7606-6/AD7176-2/ AD7173-8/AD7688/AD7988-1/AD7988-5 <b>AMP</b> ADA4096-4/ADA4096-2/AD8422/ AD8226/AD8275/AD8276/AD8475 <b>MUX</b> ADG5208/ADG5408/AD508F/AD509F Integrated Solution ADuCM360/ADuCM361/ADuC7060/ ADuC7061	<b>DAC</b> AD5683R/AD5660/AD5686/AD5684R/ AD5689R/AD5668/AD5628/AD5629R Voltage/Current Driver AD5750-2/AD5749/AD5748/AD5750 Integrated Solution AD5420/AD5410/AD5422/AD5412/ AD5755/AD5735/AD5757/AD5737 <b>HART</b> AD5700/AD5700-1	Light Power Isolator ADuM540x/ADuM521x/ADuM524x Heavy Power Isolator ADuM347x/ADuM3190 Data Isolator ADuM140x/ADuM144x ADuM128x/ADuM3481	Power Supply ADP2441/ADP1720/ADP5070/ADP7182/ ADP2360/ADP1621 Comm Interface ADM2587E/ADM2482E/ADM2490E/ ADM305x/ADM325xE/ADM3101E

## Main Product Introduction

Function Block	Part Number	Description	Key Features	Benefits
TC/RTD Input	<i>ADC</i>			
	AD779x	16-bit/24-bit, 4 SPS to 500 SPS, $\Sigma$ - $\Delta$ ADC	Low power (300 $\mu$ A to 450 $\mu$ A), internal PGA, ref, clock, buffer, simultaneous 50 Hz/60 Hz rejection	Very low power dissipation 450 $\mu$ A max
	<i>Integrated Solution</i>			
	ADuCM360/ ADuCM361	ARM <sup>®</sup> Cortex™-M3 microcontroller	Integrated dual/single 24-bit $\Sigma$ - $\Delta$ ADC; UART, I <sup>2</sup> C, and 2 $\times$ SPI serial I/O; 16-bit PWM controller; 19-pin multifunction GPIO port; 128 kB flash/EE memory, 8 kB SRAM	ADuCM360/ADuCM361 is designed for direct interfacing to external precision sensors in both wired and battery-powered applications
4 mA to 20 mA/ 0 V to 10 V Input	<i>ADC</i>			
	AD719x	Multi-channel, 4.8 kHz, ultralow noise, 24-bit $\Sigma$ - $\Delta$ ADC	RMS noise: 11 nV at 4.7 Hz (gain = 128), up to 22 noise-free bits (gain = 1) programmable gain (1 to 128) output data rate: 4.7 Hz to 4.8 kHz. AD7194 with integrated PGA	2 differential/4 pseudo differential, 8 differential/16 pseudo differential input channels
	AD7606/ AD7606-4/ AD7606-6	4-channel/6-channel/8-channel, $\pm$ 10 V simultaneous sampling	Bipolar input ranges with single 5 V power supply, serial and parallel interface. >90 dB SNR	$\pm$ 10 V full input range, 1 m $\Omega$ impedance, synchronous sampling
	AD7173-8	Fast settling, highly accurate, low power, 8-channel/16-channel, multiplexed ADC	Fast and flexible output rate: 1.25 SPS to 31.25 kSPS; channel scan data rate: 6.21 kSPS/6.21-channel (161 $\mu$ s settling); performance specifications: 17.5 noise free bits at 31.25 kSPS; 23 noise free bits at 1.25 SPS; INL: $\pm$ 3 ppm/FSR	30 kSPS data rate; high free noise resolution; 4 GPIO
	<i>AMP</i>			
	ADA4096-2/ ADA4096-4 with OVP	Dual/quad micropower operation and rail-to-rail input and output ranges	Low power: 60 $\mu$ A per amplifier typical; unity-gain bandwidth 800 kHz typ @ V <sub>SY</sub> = $\pm$ 15 V; 550 kHz typ @ V <sub>SY</sub> = $\pm$ 5 V; 465 kHz typ @ V <sub>SY</sub> = $\pm$ 1.5 V; low offset voltage: 300 $\mu$ V maximum	Input overvoltage protection, 32 V above and below the supply rails; unity-gain stable
	<i>MUX</i>			
	ADG508F/ ADG509F with OVP	ADG508F comprising eight single channels/ADG509F comprising four differential channels	Low on resistance (270 $\Omega$ typical); fast switching times: T <sub>ON</sub> 230 ns maximum; T <sub>OFF</sub> 130 ns maximum; low power dissipation (3.3 mW maximum)	OVP; TTL and CMOS compatible inputs
Isolator	<i>Power Isolator</i>			
	ADuM521x	Dual-channel digital isolators with isoPower <sup>®</sup> integrated, isolated power	Integrated isolated DC/DC converter; regulated 5 V/30 mA output; dual dc to 100 Mbps (NRZ) signal isolation channels; precise timing characteristics: 2 ns maximum pulse width distortion; high common-mode transient immunity: > 25 kV/ $\mu$ s	Small package; integrated power isolation
	ADuM347x	PWM controller and transformer driver with quad-channel isolators	Isolated PWM controller; integrated transformer driver; regulated adjustable output: 3.3 V to 24 V; 2 W output power; 70% efficiency; quad dc-to-25 Mbps signal isolation channels; soft start function at power-up; thermal shutdown, 2.5 kV rms isolation	High output power; adjustable oscillator frequency; high temperature operation
	<i>Data Isolator</i>			
	ADuM144x	Quad-channel digital isolator, 3.75 kV rms	1.8 V/3.3 V level translation, high temp operation: 125°C, high data rate: dc to 10 Mbps (NRZ)	Bidirectional communication, low power operation
	ADuM128x	Dual-channel digital isolator, 3 kV rms	Up to 100 Mbps data rate (NRZ); low propagation delay: 20 ns typical; 3 V to 5 V level translation; high common-mode transient immunity: > 25 kV/ $\mu$ s	Bidirectional communication, low power operation
ADuM3481	Quad-channel digital isolator, 3.75 kV rms	1.8 V to 5 V level translation, high temp operation: 125°C, high data rate: dc to 25 Mbps (NRZ)	Bidirectional communication, low power operation	

## Main Product Introduction (Continued)

Function Block	Part Number	Description	Key Features	Benefits
Power Supply	ADP2441	Synchronous step-down dc-to-dc regulator	Wide input voltage range of 4.5 V to 36 V, maximum load current of 1 A, adjustable output down to 0.6 V, $\pm 1\%$ output voltage accuracy	Pulse skip mode at light load for power saving, adjustable switching frequency of 300 kHz to 1 MHz
	ADP5070	Switching regulator	Wide input range from 2.85 V to 15 V; programmable output support $\pm 15$ V output (+15 V/100 mA from 3.3 V input; -15 V/65 mA from 3.3 V input); $-40^{\circ}\text{C}$ to $+125^{\circ}\text{C}$ operation range	With independent positive and negative output
Comm Interface	ADM2490E	Isolated RS-485/RS-422	Full/half duplex, 5 V/3.3 V operation, 16 Mbps, $\pm 8$ kV ESD	High speed, multipoints transmission line
	ADM305x	CAN transceiver	5 V operation on VCC; complies with ISO 11898 standard; high speed data rates up to 1 Mbps; short-circuit protection on CANH and CANL against shorts to power/ground in 24 V systems	Thermal shutdown protection; low current standby mode
	ADM325xE	Isolated RS-232 driver/receiver	5 V/3.3 V supply, 460 kbps, 2.5 kV isolation	Isolated, single channel with high ESD protection
Single Analog Output	<i>DAC</i>			
	AD5683R	low power, single-channel, 16-bit buffered voltage out DACs	High relative accuracy (INL): $\pm 2$ LSB maximum at 16 bits; low drift, 2.5 V reference: 2 ppm/ $^{\circ}\text{C}$ typical; selectable span output: 2.5 V or 5 V	High drive capability: 20 mA; low power: 1.2 mW at 3.3 V; robust 4 kV ESD protection
	<i>Voltage Current Driver</i>			
	AD5750-2	Single-channel current/voltage output driver	Current output range : 0 mA to +24 mA, +4 mA to +20 mA; 0 V to +5 V, 0 V to +10 V, $\pm 5$ V, and $\pm 10$ V with 20% overrange; flexible serial interface, on-chip output fault detection	Low cost, precision voltage/current output drivers with hardware or software programmable
<i>Integrated Solution</i>				
	AD5422/AD5412/ AD5420/AD5410	Single-channel, 16-bit/12-bit, current/voltage output DAC	$I_{\text{OUT}}$ ranges: 0 mA/+4 mA to +20 mA, 0 mA to +24 mA, $V_{\text{OUT}}$ ranges: 0 V to +5 V, 0 V to +10 V, $\pm 5$ V, $\pm 10$ V and 10% overrange, $\pm 0.01\%$ FSR TUE, $\pm 3$ ppm/ $^{\circ}\text{C}$ output drift; on-chip output fault detection; on-chip $V_{\text{REF}}$	Easy to deploy solution, integrated features in a compact package, AD5422/AD5412 simplifies factory process control and industrial system design
Multiple Analog Output	<i>DAC</i>			
	AD5686/AD5684R	Quad, 16-bit/12-bit <i>nanoDAC</i> <sup>®</sup> with on-chip reference and SPI interface	High relative accuracy (INL): $\pm 2$ LSB, low drift 2.5 V reference 2 ppm/ $^{\circ}\text{C}$ ; total unadjusted error (TUE): 0.1% of FSR maximum; offset error: 1.5 mV maximum; gain error: 0.1% of FSR maximum; high drive capability: 20 mA, 0.5 V from supply rails	Rail-to-rail, voltage output DAC: the device includes a 2.5 V, 2 ppm/ $^{\circ}\text{C}$ , internal reference (enabled by default), and a gain select pin giving a full-scale output of 2.5 V (gain = 1) or 5 V (gain = 2)
	<i>Integrated Solution</i>			
	AD5755/AD5735 AD5757/AD5737	Quad-channel, 16-bit/12-bit, current/voltage output DAC with dynamic power control	Dynamic power control for thermal management, voltage or current output on the same pin, $I_{\text{OUT}}$ range: 0 mA/+4 mA to +20 mA, or 0 mA to +24 mA, $V_{\text{OUT}}$ range: 0 V to +5 V, 0 V to +10 V, $\pm 5$ V, $\pm 10$ V, $\pm 6$ V, $\pm 12$ V; on-chip reference	Industry's first data converter with dynamic power control functionality, which provides energy saving and enhances the reliability of process control I/O systems operations
HART	AD5700/AD5700-1	Half-duplex/full-duplex HART modem with internal oscillator	HART-compliant fully integrated FSK modem, 1200 Hz and 2200 Hz sinusoidal shift frequencies, 115 $\mu\text{A}$ maximum supply current in receive mode, integrated receive band-pass filter, minimal external components required, 1.71 V to 5.5 V power supply/0.5% precision internal oscillator	Lowest power consumption; smallest package; high integration; high driver capability

## Process Control Reference Circuit

Reference Circuit ID	Description
CN0278	Isolated, 4-channel, thermocouple/RTD temperature measurement system with 0.5°C accuracy
CN0310	24-bit, 250 kSPS single-supply data acquisition system
CN0251	24-bit, 4.7 Hz, 4-channel, analog data acquisition system
CN0255	16-bit, 100 kSPS, single-supply, low power data acquisition system
CN0254	16-bit, 250 kSPS, 8-channel, single-supply, isolated data acquisition system
CN0325	PLC/DCS universal analog input using either 4-pin or 6-pin terminal block
CN0270	Complete 4 mA to 20 mA HART solution
CN0321	Fully isolated, single-channel voltage and 4 mA to 20 mA output with HART
CN0233	16-bit, isolated, industrial voltage and current output DAC with isolated DC-DC supplies

For more industry PLC applications and products information, please visit:

[www.analog.com/processcontrol-plc](http://www.analog.com/processcontrol-plc)

For the complete PLC demo system, please visit:

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### What ADI Can Provide to Customers

- **PLC**
  - Demo board
- **ADC**
  - ADIsimADC™
  - $\Sigma$ - $\Delta$  ADC Register Configuration Assistant
- **DAC**
  - ADIsimDAC
- **AMP**
  - ADIsimOpAmp™
  - ADIsimDiffAmp™
- **Power**
  - EVB ADIsimPower

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