

PROGRAMMABLE LOGIC CONTROLLER (PLC) SOLUTIONS



Theory and Typical Architecture for Industrial PLC Systems

Comprised of power supplies, CPUs, and multiple analog and digital I/O modules, a PLC system controls, actuates, and monitors complex machine variables. It is designed for multiple input and output arrangement, 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.

Industrial PLC System Design Considerations and Major Challenges

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

- ▶ Analog input types and ranges, which can be as small as ± 10 mV for TC (thermocouple) and RTD and as large as ± 10 V for actuator controllers, or 4 mA to 20 mA currents in process control systems.
- ▶ Analog output types and ranges typically include ± 5 V, ± 10 V, 0 V to 5 V, 0 V to 10 V, 4 mA to 20 mA, and 0 mA to 20 mA. Overrange capability may be required.
- ▶ The resolution and accuracy of the input/output modules, typically ranging from 12 to 16 bits, with 0.1% accuracy over the industrial temperature range.
- ▶ Connectivity to a different fieldbus.
- ▶ Isolation between the system power module and low power electronics, between the input and output, and between the I/O and 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 and fast pulse transients and ESD.
- ▶ Power efficiency, thermal management, and heat dissipation will become increasingly important issues for miniaturized devices as they attempt to reduce board size.

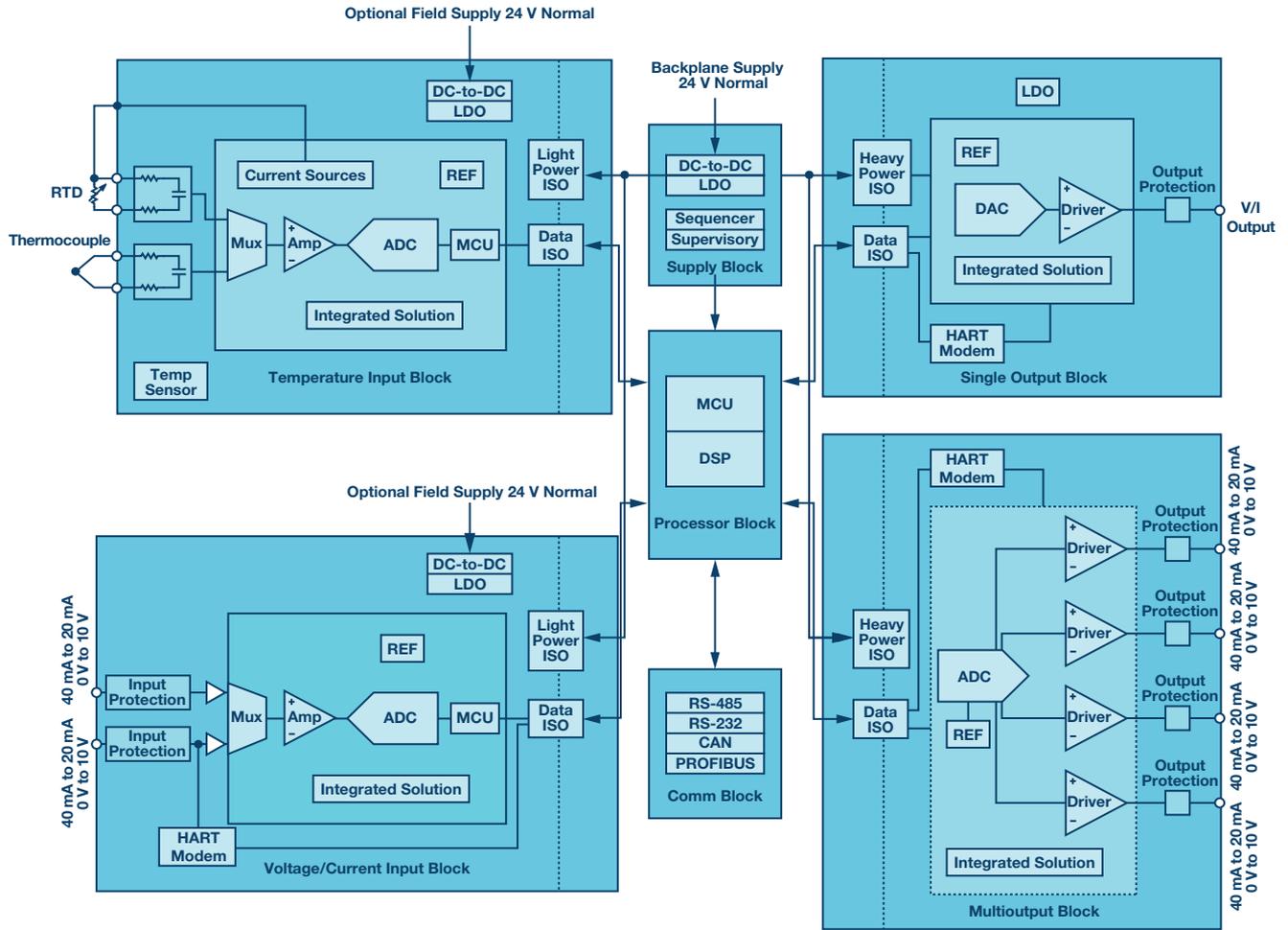
In addition, more channels or nodes need to be placed within the same space, requiring dense systems. Therefore, the form factor has to be reduced to accommodate this. This means smaller housings where power and heat management become a challenge, requiring solutions in intelligent power management via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

Total Solutions from ADI

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.

With system expertise in industrial applications and leading technologies in amplifiers, data converters, signal processing, and power management, ADI offers best-in-class solutions for high resolution, low noise industrial PLC system designs.



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.

Analog Input Devices		Analog Output Devices		Isolators		Other Devices	
ADCs	AD779x/AD7124/ AD7177-2/AD7606/ AD7606-4/AD7606-6/ AD7176-2/AD7173-8/ AD7689/ADAS3022/ AD7988-1/AD7988-5	DACs	AD5683R/AD5660/ AD5686/AD5684R/ AD5689R/AD5668/ AD5628/AD5629R/ AD5761/AD5721	Light Power Isolators	ADuM540x/ADuM521x/ ADuM524x/ADuM5000	Power Supplies	ADP2441/ADP2442/ ADP1720/ADP5070/ ADP5073/ADP5074/ ADP7182/ADP1621
Amplifiers	ADA4096-2/ ADA4096-4/AD8422/ AD8226/AD8275/ AD8276/AD8475	Voltage/Current Drivers	AD5750-2/AD5749/ AD5748/AD5750	Heavy Power Isolators	ADuM347x/ADuM3190	Communication Interfaces	ADM2587E/ADM2482E/ ADM2490E/ADM305x/ ADM325xE/ADM3101E
Muxes	ADG5208F/ADG5209F/ ADG5408/ADG5412F/ ADG508F/ADG509F	Integrated Solutions	AD5420/AD5410/ AD5422/AD5412/ AD5755/AD5735/ AD5757/AD5737	Data Isolators	ADuM140x/ADuM144x/ ADuM128x/ADuM3481		
Integrated Solutions	ADuCM360/ ADuCM361/ADuC7060/ ADuC7061	HART	AD5700/AD5700-1				

Main Product Introduction

Function Block	Part Number	Description	Features	Benefit	
TC/RTD Input Devices	<i>ADCs</i>				
	AD779x	16-/24-bit, 4 SPS to 500 SPS, Σ - Δ ADC	Low power (300 μ A to 450 μ A), internal PGA, ref, clock, buffer, simultaneous 50 Hz/60 Hz rejection	Very low power dissipation 450 μ A max	
	AD7124	24-bit, multichannel, low power, low noise, Σ - Δ ADC	Three power modes; low power: 24 nV rms at 1.17 SPS, gain = 128 (255 μ A typical); output data rate: full power: 9.38 SPS to 19,200 SPS; programmable gain (1 to 128); band gap reference with 15 ppm/ $^{\circ}$ C drift maximum (65 μ A)	High integration, diagnostic functions	
	<i>Integrated Solution</i>				
	ADuCM360/ ADuCM361	ARM [®] Cortex [®] -M3 microcontroller	Integrated dual/single 24-bit Σ - Δ ADC; UART, I ² C and 2 \times SPI serial I/O; 16-bit PWM controller; 19-lead multifunction GPIO ports; 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 Devices	<i>ADCs</i>				
	AD719x	Multichannel, 4.8 kHz, ultralow noise, 24-bit Σ - Δ 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; AD714 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 Ω 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 (161 μ 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	
	ADAS3022	8-channel, 16-bit, 1 MSPS SAR ADC	High input common-mode rejection: >100 dB; on-chip 4.096 V reference and buffer; differential input voltage range: \pm 24.576 V maximum	>500 M Ω input impedance	
	AD7689	8-channel, 16-bit, SAR ADC, single power supply	INL: \pm 0.4 LSB typical, \pm 1.5 LSB maximum; dynamic range: 93.8 dB; SINAD: 92.5 dB at 20 kHz; THD: $-$ 100 dB at 20 kHz; single-supply 2.3 V to 5.5 V operation with 1.8 V to 5.5 V logic interface	Throughput 250 kSPS	
	AD7177-2	32-bit, 10 kSPS, Σ - Δ ADC with 100 μ s settling and true rail-to-rail buffers	32-bit data output; fast and flexible output rate: 5 SPS to 10 kSPS; performance specifications: 19.1 noise free bits @ 10 kSPS; 24.6 noise free bits @ 5 SPS; 85 dB filter rejection of 50 Hz and 60 Hz with 50 ms settling	32-bit, low noise, multichannel	
	<i>Amplifiers</i>				
		AD8422	Rail-to-rail instrumentation amplifier	330 μ A maximum quiescent current; 8 nV/ \sqrt Hz maximum input voltage noise at 1 kHz; excellent ac specifications: 80 dB minimum CMRR @ 10 kHz (G = 1); high precision dc performance 150 dB minimum CMRR (G = 1000); wide supply range: 4.6 V to 36 V single-supply, \pm 2.3 V to \pm 18 V dual supply; gain range: 1 to 1000	High precision, low power, low noise
		ADA4096-2/ ADA4096-4 with OVP	Dual/quad micropower operation and rail-to-rail input and output ranges	Low power: 60 μ A per amplifier typical; unity-gain bandwidth 800 kHz typ @ $V_{SY} = \pm$ 15 V; 550 kHz typ @ $V_{SY} = \pm$ 5 V; 465 kHz typ @ $V_{SY} = \pm$ 1.5 V; low offset voltage: 300 μ V maximum	Input overvoltage protection, 32 V above and below the supply rails; unity-gain stable
	<i>Muxes</i>				
		ADG5412F	Four independent single-pole/single-throw (SPST) switches	4 kV human body model (HBM) ESD rating; low on resistance (10 Ω); \pm 5 V to \pm 25 V dual-supply operation; 5 V to 44 V; single-supply operation; fully specified @ \pm 15 V, \pm 20 V, +5 V, +12 V, and +36 V	With overvoltage protection and power-off protection
	ADG5208F/ ADG5209F	ADG5208F and ADG5209F are 8:1 and dual 4:1 analog multiplexers	Overvoltage protection up to $-$ 55 V and +55 V; low on capacitance: ADG5208F: 20 pF; ADG5209F: 14 pF	Overvoltage protection	
	ADG508F/ ADG509F	ADG508F comprising eight single channels/ ADG509F comprising four differential channels	Low on resistance (270 Ω typical); fast switching times: T_{ON} 230 ns maximum; T_{OFF} 130 ns maximum; low power dissipation (3.3 mW maximum)	Overvoltage protection; TTL and CMOS-compatible inputs	

Function Block	Part Number	Description	Features	Benefit
Isolators	<i>Power Isolators</i>			
	ADuM5000	2.5 kV, Isolated dc-to-dc converter	isoPower® integrated, isolated dc-to-dc converter; regulated 3.3 V or 5 V output; up to 500 mW output power; safety and regulatory approvals	Isolated; high output power
	ADM2587E/ ADM2582E	Signal and power isolated RS-485 transceiver with ±15 kV ESD protection	Isolated RS-485/RS-422 transceiver, configurable as half- or full-duplex; isoPower integrated isolated dc-to-dc converter; complies with ANSI/TIA/EIA-485-A-98 and ISO 8482:1987; ADM2582E data rate: 16 Mbps; ADM2587E data rate: 500 kbps; high common-mode transient immunity: >25 kV/μs	Integrated signal and power isolated data transceiver
	ADuM521x	Dual-channel digital isolators with isoPower integrated, isolated power	Integrated isolated dc-to-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/μs	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 Isolators</i>			
	ADuM14xx	Quad-channel digital Isolator, 3.75 kV rms	1.8 V/3.3 V level translation, high temperature operation: 125°C, high data rate: dc to 10 Mbps (NRZ)	Bidirectional communication, low power operation
	ADuM12xx	Digital isolator, 3 kV rms	Up to 100 Mbps data rate (NRZ); low propagation delay: 20 ns typical; 2.7 V to 5 V level translation; high common-mode transient immunity: >25 kV/μs	Low dynamic power consumption; low propagation delay: 20 ns (typical)
	ADuM3481	Quad-channel digital Isolator, 3.75 kV rms	1.8 V to 5 V level translation, high temperature operation: 125°C, high data rate: dc to 25 Mbps (NRZ)	Bidirectional communication, low power operation
	Power Supplies	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, ±1% output voltage accuracy
ADP2442		36 V, 1 A, synchronous, step-down, dc-to-dc regulator with external clock synchronization	Wide input voltage range from 4.5 V to 36 V; high efficiency of up to 94%; ±1% output voltage accuracy adjustable switching frequency from 300 kHz to 1 MHz external synchronization from 300 kHz to 1 MHz	Wide input voltage, high efficiency, small package
ADP5073/ ADP5074		1.2 A, dc-to-dc inverting regulator	Wide input voltage range: 2.85 V to 15 V; adjustable negative output to $V_{in} - 39$ V; integrated 1.2 A main switch; 1.2 MHz/2.4 MHz switching frequency with optional external frequency synchronization from 1.0 MHz to 2.6 MHz	Inverting regulator, small package
ADP5070		Switching regulator	Wide input range from 2.85 V to 15 V; programmable output support ±15 V output (+15 V/100 mA from 3.3 V input; -15 V/65 mA from 3.3 V input); -40°C to +125°C operation range	Independent positive and negative output
Communication Interfaces	ADM2490E	Isolated RS-485/RS-422	Full-/half-duplex, 5 V/3.3 V operation, 16 Mbps, ±8 kV ESD	High speed, multipoint transmission line
	ADM305x	CAN transceiver	5 V operation on V_{CC} ; 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 Devices	<i>DACs</i>			
	AD5761/ AD5721	Multiple range, 16-/12-bit, bipolar/unipolar, voltage output DACs	Eight software-programmable output ranges: 0 V to 5 V, 0 V to 10 V, 0 V to 16 V, 0 V to 20 V, ±3 V, ±5 V, ±10 V, -2.5 V to +7.5 V; 5% overrange; total unadjusted error (TUE): 0.1% FSR maximum; guaranteed monotonicity: ±1 LSB maximum	Bipolar/unipolar; low noise
	AD5683R	Low power, single-channel, 16-bit buffered voltage out DACs	High relative accuracy (INL): ±2 LSB maximum at 16 bits; low drift, 2.5 V reference: 2 ppm/°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 20mA; 0 V to 5 V, 0 V to 10 V, ±5 V, and ±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 Solutions</i>				
AD5422/ AD5412/ AD5420/ AD5410	Single-channel, 16-/12-bit, current/voltage output DAC	I_{OUT} ranges: 0 mA/4 mA to 20 mA, 0 mA to 24 mA, V_{OUT} ranges: 0 V to 5 V, 0 V to 10 V, ±5 V, ±10 V, and 10% overrange, ±0.01% FSR TUE, ±3 ppm/°C output drift; on-chip output fault detection; on-chip V_{REF}	Easy to deploy solution, integrated features in a compact package, AD5422/AD5412 simplifies factory process control and industrial system design	

Function Block	Part Number	Description	Features	Benefit
Multiple Analog Output Devices	<i>DACs</i>			
	AD5686/AD5684R	Quad, 16-/12-bit <i>nanoDAC</i> ® with on-chip reference and SPI interface	High relative accuracy (INL): ± 2 LSB, low drift 2.5 V reference 2 ppm/°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/°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 Solutions</i>			
	AD5755/AD5735/AD5757/AD5737	Quad-channel, 16-/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_{OUT} range: 0 mA/4 mA to 20 mA, or 0 mA to 24 mA, V_{OUT} range: 0 V to 5 V, 0 V to 10 V, ± 5 V, ± 10 V, ± 6 V, ± 12 V; on-chip reference	Industry's first data converter with dynamic power control functionality that provides energy savings and enhances the reliability of process control I/O system operation
HART	AD5700/AD5700-1	Half-duplex HART modem/half-duplex HART modem with internal oscillator	HART-compliant fully integrated FSK modem, 1200 Hz and 2200 Hz sinusoidal shift frequencies, 115 μ 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

Reference Circuit ID	Description
CN-0278	Isolated, 4-channel, thermocouple/RTD temperature measurement system with 0.5°C accuracy
CN-0310	24-bit, 250 kSPS single-supply data acquisition system
CN-0251	24-bit, 4.7 Hz, 4-channel, analog data acquisition system
CN-0255	16-bit, 100 kSPS, single-supply, low power data acquisition system
CN-0254	16-bit, 250 kSPS, 8-channel, single-supply, isolated data acquisition system
CN-0325	PLC/DCS universal analog input using either 4-pin or 6-pin terminal block
CN-0270	Complete 4 mA to 20 mA HART solution
CN-0321	Fully isolated, single-channel voltage and 4 mA to 20 mA output with HART
CN-0233	16-bit, isolated, industrial voltage and current output DAC with isolated dc-to-dc supplies
CN-0267	Complete 4 mA to 20 mA looped power field instrument with HART interface
RD_ADuC7061	Low power 4-wire pressure transmitter

For More Industry PLC Applications and Products Information, Please Visit:

www.analog.com/en/process-control

For the Complete PLC Demo System, Please Visit:

www.analog.com/en/plc-demo

Online Support
Community



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

Visit ez.analog.com

**Analog Devices, Inc.
Worldwide Headquarters**

Analog Devices, Inc.
One Technology Way
P.O. Box 9106
Norwood, MA 02062-9106
U.S.A.
Tel: 781.329.4700
(800.262.5643, U.S.A. only)
Fax: 781.461.3113

**Analog Devices, Inc.
Europe Headquarters**

Analog Devices, Inc.
Ott-Aicher-Str. 60-64
80807 München
Germany
Tel: 49.89.76903.0
Fax: 49.89.76903.157

**Analog Devices, Inc.
Japan Headquarters**

Analog Devices, KK
New Pier Takeshiba
South Tower Building
1-16-1 Kaigan, Minato-ku,
Tokyo, 105-6891
Japan
Tel: 813.5402.8200
Fax: 813.5402.1064

**Analog Devices, Inc.
Asia Pacific Headquarters**

Analog Devices
5F, Sandhill Plaza
2290 Zuchongzhi Road
Zhangjiang Hi-Tech Park
Pudong New District
Shanghai, China 201203
Tel: 86.21.2320.8000
Fax: 86.21.2320.8222

©2016 Analog Devices, Inc. All rights reserved. Trademarks and registered trademarks are the property of their respective owners. Ahead of What's Possible is a trademark of Analog Devices. BR14571-0-7/16(A)

analog.com



AHEAD OF WHAT'S POSSIBLE™