ADI Pressure Transmitter Solutions

Industrial Pressure Transmitter System Theory and Typical Architecture

A pressure transmitter can measure flow rate, pressure, level, and so on. Principles of a pressure sensor used in it, which are the piezoresistance effect type, the capacitance type, and the micro resonator type, are diverse. Diaphragms of a single silicon crystal are used as pressure receiving elements in each type. With a multiple piezoresistive gauge sensor for application to intelligent pressure transmitter, it can measure three quantities (i.e., differential and static pressure and the temperature).

In general, a pressure transmitter could be powered by a battery, a line power, or a loop power and consist of power supplies, pressure/temperature sensors, signal conditioning, ADC, processors, display, keyboard, logic I/Os, and multiple communications like 4 mA to 20 mA, HART, RS-485/RS-422/RS-232, PROFIBUS, Modbus, and foundation.

Industrial Pressure Transmitter System Design Considerations and Major Challenges

To have an appropriate pressure transmitter system design, designers must consider many different system requirements including accuracy, zero drift, temperature, and static pressure compensation.

- Characteristic compensation needs to be considered by means of temperature and static pressure signals, in addition to the differential pressure signal.
- Preventive maintenance function to detect sensor aging deterioration or any abnormality.
- Pressure transmitter product maximum range ability can be as high as 200:1, and the upper limit even up to 15,000 psi.
- Measurement accuracy can be high as 0.04% of full-scale range, which often requires a 16-bit to 24-bit analog-to-digital converter.
- Connectivity to different field buses like HART, PROFIBUS, Modbus, foundation, RS-485/RS-422/RS-232, wireless HART, and so on. Isolation might be needed between sensors, conditioning circuits, system power supply, communication, and I/O; isolation grade varies from 1 kV to 2.5 kV.
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- Both battery and loop-powered differential pressure transmitters require carefully selected ultralow power components like MCU, ADCs, and references.

Industrial site temperature environments are quite complex, even atrocious. Low temperature drift coefficient and low power consumption are very important for differential pressure transmitters to endure wide working temperature ranges. ADI offers the perfect portfolio of precision amplifiers, precision references, precision analog-to-digital converters, and low power ARM® Cortex™-M3 core microprocessors.

Besides that, EMC interference immunity under low power systems is also a big challenge for pressure transmitters, such as surge, EFT, and ESD. High level ESD immunity components offered by ADI greatly help to improve reliability and robustness.

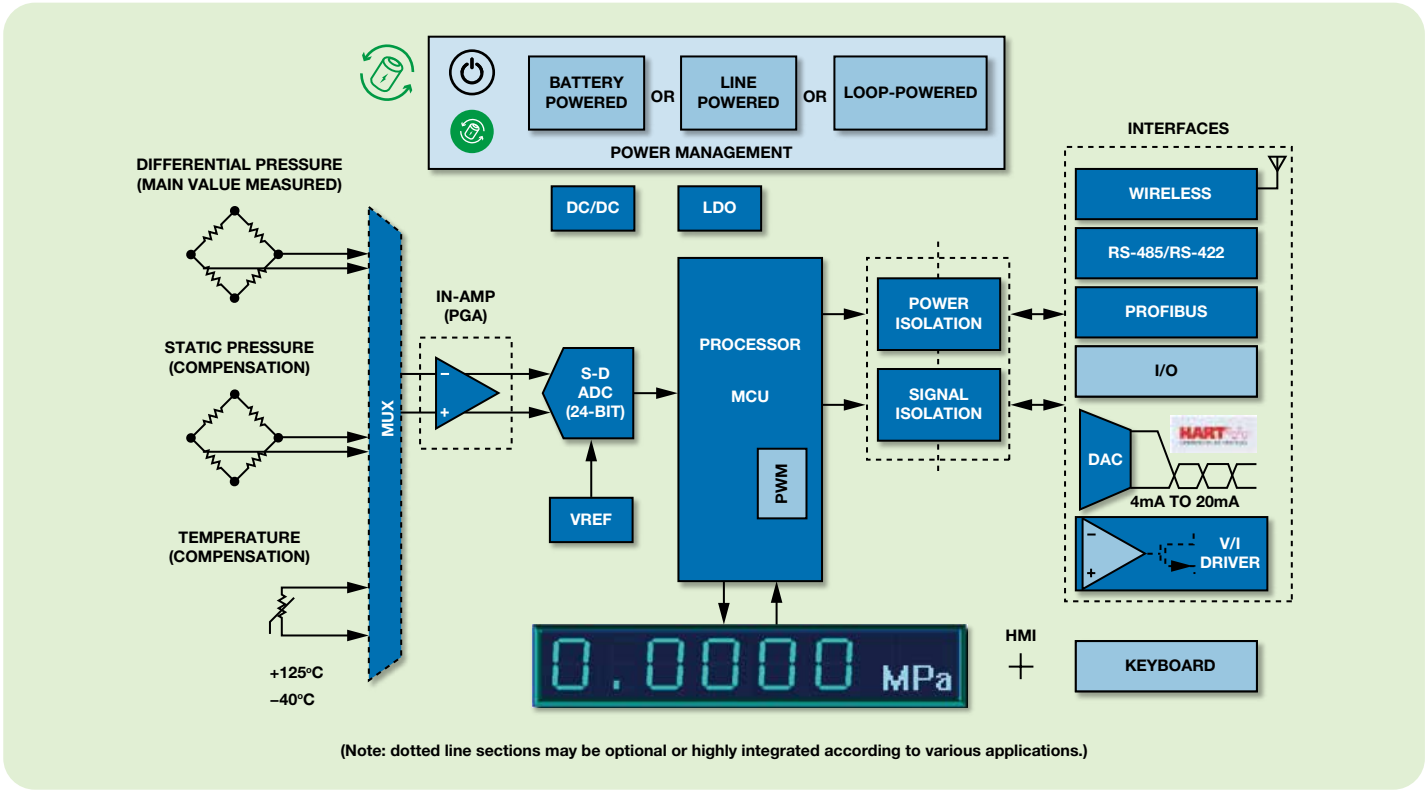
In addition, limited space inside the pressure transmitter is requiring dense systems. Therefore, the form factor has to be reduced to accommodate this. Recently, advances in integration have allowed system designers to migrate to smaller, lower power, lower cost solutions, with performance approaching those of 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

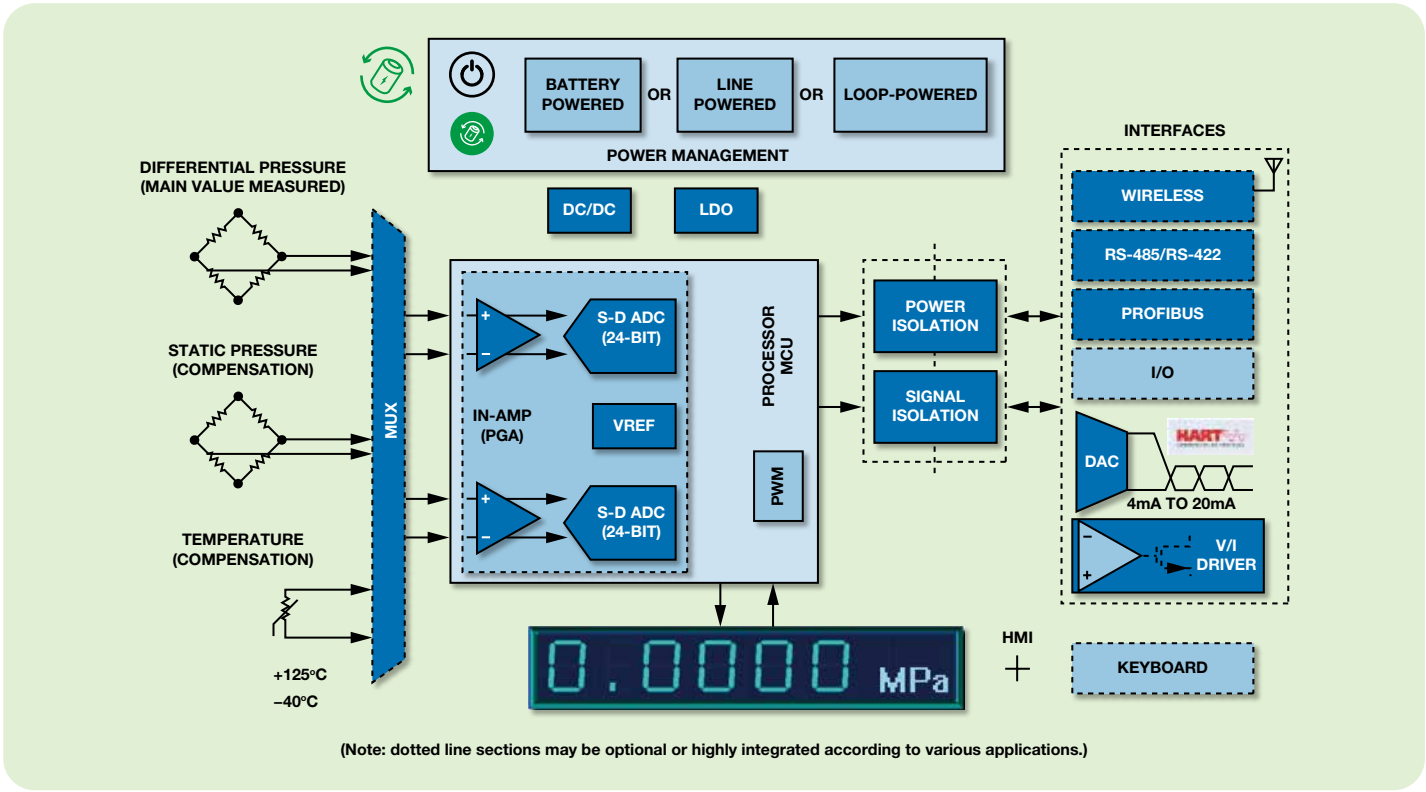
ADI's amplifier, data conversion, signal processing, communications, and power technology and expertise provide leverage for high resolution, low noise, and low power industry pressure transmitter systems.

Signal Chain for Discrete Signal Conditioning



Note: The signal chains above are representative of the system block diagram of a signal chain for discrete signal conditioning design. The technical requirements of the blocks vary, but the products listed in the table below are representative of ADI's solutions that meet some of those requirements.

Signal Chain for Integrated Signal Conditioning



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Main Product Introduction

Device	Description	Key Features	Benefits
ADC			
AD7780/ AD7781	20-bit/24-bit, 1-channel, PGA, sigma-delta ADC	Low power 500 μA maximum, 10 Hz to 16.7 Hz, 1 to 128 PGA, p-p resolution over 17 bits	Cost very competitive + easy to use
AD7787/ AD7788/ AD7789/ AD7790/ AD7791	16-bit/24-bit, 1-channel/ 2-channel, sigma-delta ADC	Ultralow power from 80 μA to 160 μA max, 9.5 Hz to 120 Hz, 50 Hz/60 Hz rejection	Ultralow power + small package
AD7796/ AD7797/ AD7798/ AD7799	16-bit/24-bit, 1-channel/ 3-channel, sigma-delta ADC with PGA	Low power 500 μA maximum, 4.17 Hz to 470 Hz, PGA 1 to 128, reference, low noise	Low power + highly integrated with PGA
Processor/MCU			
ADuCM360/ ADuCM361	Analog microcontroller (ARM Cortex-M3 core)	Dual 24-bit Σ-Δ ADC (ADuCM360), single 24-bit Σ-Δ ADC (ADuCM361) programmable ADC output rate (3.5 Hz to 3.906 kHz), 12-bit DAC, programmable current sources, temperature sensor, internal reference, 4 ppm/°C, 16 MHz cortex, 128 kB flash, 8 kB RAM core consumes 290 μA/MHz, power-down mode: 4 μA (wake-up timer active)	Ultra low power, high precision, leading integration chip solution
ADuCRF101	Analog microcontroller (ARM Cortex-M3 with RF transceiver)	Embedded ISM band RF transceiver (862 MHz to 928 MHz and 431 MHz to 464 MHz); Cortex-M3 32-bit processor, 16 MHz; 190 μA /MHz, Cortex in active mode; 1.6 μA, in power-down mode, MCU memory and transceiver memory retained; 128 kB/64 kB flash/EE memory, 16 kB/8 kB SRAM; 6-channel, 14-bit or 12-bit ADC	Ultralow power, highly integrated with both RF transceivers and analog channels
ADUC7060/ ADUC7061	Analog microcontroller (ARM7TDMI® core)	24-bit, 8 kSPS ADC, up to 10 ADC channels; 1-channel, 14-bit voltage DAC outputs; 16-bit, 6-channel PWM; on-chip voltage reference ±10 ppm/°C and temperature sensor; programmable sensor excitation current sources, 200 μA to 2 mA; up to 14 GPIO pins	High resolution, low power, and abundant resources
AMP			
AD8422	Instrumentation amplifier	Bandwidth = 2.2 MHz; V_{os} = 0.36 mV ; V_{NOISE} density = 88 nV/√Hz; I_B = 1 nA; gain control interface = resistor; I_Q = 330 μA; RRO	Third-generation AD620
AD8236	Instrumentation amplifier	Bandwidth = 23 kHz; V_{os} = 3.5 mV ; V_{NOISE} density = 76 nV/√Hz; I_B = 10 pA ; gain control interface = resistor, I_{cc} = 50 μA	Ultralow power and competitive price
AD8237	Instrumentation amplifier	Bandwidth = 200 kHz; V_{os} = 75 μV; drift 0.3 μV/°C; gain error: 0.005%, gain drift 0.5 ppm/°C; I_B <1 nA; single-supply: 1.8 V to 5.5 V; I_Q = 150 μA	Low offset voltage, zero drift, low power, and cost effective
AD8556/ AD8557	Instrumentation amplifier	Bandwidth = 2 MHz; V_{os} = 12 μV; V_{NOISE} density = 32 nV/√Hz; I_B = 25 nA; gain control interface = digital	Good for fine tuning an analog transmitter
AD8276	Difference amplifier	Bandwidth = 550 kHz; V_{os} = 200 μV; V_{NOISE} density = 70 nV/√Hz; low supply current: 200 μA maximum per channel, rugged input overvoltage protection	Price competitive output solution for analog interface
DAC			
AD5410/ AD5420	Current source DAC	12-bit/16-bit resolution; 0 mA to 24 mA ±0.01% FSR TUE; ±3 ppm/°C typical output drift; on-chip reference (10 ppm/°C maximum)	Universal output DAC and support HART communication
AD5421	Current source DAC	16-bit resolution; 3.2 mA to 24 mA; NAMUR-compliant alarm; TUE error: 0.05% maximum; on-chip reference TC: 4 ppm/°C maximum an range: 5.5 V to 52 V	Loop-powered universal output DAC and support HART
AD5412/ AD5422	Current source and voltage output DACs	12-bit/16-bit resolution; 0 mA to 24 mA ±0.01% FSR TUE; ±10 V with 10% overrange ±0.01% FSR TUE; on-chip reference (10 ppm/°C maximum)	Universal output with both voltage and current
AD5660	*nano*DAC®	Single 16-bit, 5 ppm/°C on-chip reference; tiny 8-lead SOT-23/MSOP packages	Tiny package and high performance
AD693	Loop-powered sensor transmitter	Loop-powered operation, instrumentation amplifier front end, precalibrated 30 mV or 60 mV input spans, precalibrated PT 100 interface, precalibrated output spans, 4 mA to 20 mA unipolar, 12 ± 8 mA bipolar	A complete monolithic low-level, V-I, loop signal conditioner

Main Product Introduction (Continued)

Part Number	Description	Temperature	Benefits
HART Modem			
AD5700/ AD5700-1	Low power HART modem	HART-compliant, fully integrated FSK modem, 1200 Hz and 2200 Hz sinusoidal shift frequencies, 115 μA max in receive mode. Integrated receive band-pass filter, optional clocking configurations, buffered HART output, 2 V to 5.5 V power supply	Lowest power, smallest footprint, on-chip oscillator
Ref			
ADR29x	Voltage references	Initial accuracy: ±0.08% (maximum) maximum temperature coefficient: 8 ppm/°C; supply current 15 μA maximum	Super low quiescent current: 15 μA (maximum)
ADR3412	Low power reference	1.2 V precision output, supply current: 100 μA max, low noise (<10 Hz): 8 μVp-p typ. Supply range: 2.3 V to 5.5 V, long term stability: 30 ppm/1000 hrs @ 50°C	Low power, small package
Isolator			
ADuM1100	Single channel digital isolators	2.5 kV rms; very low power operation, 3 V/5 V level translation; high data rate: dc to 100 Mbps (NRZ)	Lowest power operation choice
ADuM140x	Quad channel digital isolators	2.5 kV rms; low power operation, 3 V/5 V level translation; high data rate: dc to 90 Mbps (NRZ), output enable function	High data rate: dc to 90 Mbps (NRZ), low power operation
ADuM744x	Quad channel digital isolators	1 kV rms isolation rating, low power operation; bidirectional communication, up to 25 Mbps data rate (NRZ), 3 V/5 V level translation	Low power operation and competitive price
ADuM540x	Quad channel isolators with integrated dc-to-dc converter	IsoPower integrated, isolated dc-to-dc converter, regulated 3.3 V or 5.0 V output, up to 500 mW output power, high temperature operation: 105°C	Highly integrated isolation for both signal and power
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	More than 2 W output capability with good efficiency and 200 kHz to 1 MHz adjustable oscillator frequency
Interface			
ADM2582/ ADM2587E	Isolated RS-485/RS-422	Half- or full-duplex, 16 M/ 500 kbps, 5 V or 3.3 V operation	Integrated isolated dc-dc ±15 kV ESD
ADM2483	Isolated RS-485 transceiver with integrated transformer driver	Half-duplex, 16 Mbps, integrated oscillator driver for external transformer, 5 V or 3.3 V operation, 50 nodes on bus	Low power operation and competitive price
ADM2485	Isolated RS-485 transceiver with integrated transformer driver	Half-duplex, 16 Mbps, Integrated oscillator driver for external transformer, 5 V or 3.3 V operation, 50 nodes on bus	PROFIBUS compliant
Temp Sensor			
TMP05	Temperature sensor	±1°C accurate, 12-bit digital, PWM output interface, operation from 3 V to 5.5 V	Small package with competitive price
ADT75	Temperature sensor	±1°C accurate, 12-bit digital, SMBus/I²C-compatible interface, operation from 3 V to 5.5 V, over temperature indicator	Good performance with competitive price
Wireless			
ADF7023	ISM band FSK/GFSK/OOK/ MSK/GMSK transceiver IC	Frequency bands, 862 MHz to 928 MHz, 431 MHz to 464 MHz; ultralow power; ISM band, data rates supported, 1 kbps to 300 kbps, single-ended and differential power amplifiers	ISM band; data rate 1 kbps to 300 kbps; very low power consumption
Mux			
ADG759	Multiplexers	4-channel/8-channel, 1.8 V to 5.5 V supply; 3 Ω maximum on resistance, 100 pA leakage current, up to 30 mA continuous current	Very low leakage current, cost competitive

Main Product Introduction (Continued)

Device	Description	Key Features	Benefits
Power			
ADP2441	Step-down dc-to-dc regulator	Wide input voltage range of 4.5 V to 36 V, 1 A max, high efficiency of up to 94%, ±1% ACC, adjustable switching frequency. 300 kHz to 1 MHz, external soft start, overcurrent protection	Wide input range up to 36 V, high efficiency, small package
ADP160	Linear regulator	2.2 V to 5.5 V input, 150 mA load current, 560 nA quiescent current, 195 mV @ 150 mA dropout voltage, PSRR 72 dB @ 100 Hz	Extremely low quiescent current, high PSRR, low dropout voltage
ADP2108	Switching regulator	5.5 V input, 600 mA, 3 MHz, 18 μA quiescent current, 100% duty cycle, 1 μH inductor, SOT-23 package	Tiny solution size, small quiescent current, and high light load efficiency
ADP1720	Linear regulator	Supply range: 4 V to 28 V, low light load current: 28 μA at 0 μA load, low dropout: 275 mV @ 50 mA, initial accuracy: ±0.5%, enable logic control or logic control enabled, current and thermal overload protection	Low power consumption

Reference Circuits

- Fully Isolated Input Module Based on the AD7793 24-Bit Σ-Δ ADC and the ADuM5401 Digital Isolator (CN0066)—*www.analog.com/CN0066*
- 4 mA to 20 mA Loop-Powered Temperature Monitor Using the ADuC7060/ADuC7061 Precision Analog Microcontroller (CN0145)—*www.analog.com/CN0145*
- Simplified 16-Bit, 4 mA to 20 mA Output Solution Using the AD5420 (CN0098)—*www.analog.com/CN0098*
- Weigh Scale Design Using the AD7781 20-Bit Sigma-Delta ADC with Internal PGA (CN0108)—*www.analog.com/CN0108*
- Precision Weigh Scale Design Using the AD7791 24-Bit Sigma-Delta ADC with External ADA4528-1 Zero-Drift Amplifiers (CN0216)—*www.analog.com/CN0216*
- Complete 4 mA to 20 mA Loop-Powered Field Instrument with HART Interface (CN0267)—*www.analog.com/CN0267*
- Complete 4 mA to 20 mA HART Solution with Additional Voltage Output Capability (CN0278)—*www.analog.com/CN0278*
- Complete 4 mA to 20 mA HART Solution (CN0270)—*www.analog.com/CN0270*
- 4 mA to 20 mA Loop-Powered Temperature Monitor Using the ADuC7060/ADuC7061 Precision Analog Microcontroller (CN0145)—*www.analog.com/CN0145*
- Complete Closed-Loop Precision Analog Microcontroller Thermocouple Measurement System with 4 mA to 20 mA Output (CN0300)—*www.analog.com/CN0300*

For more needs about pressure transmitters, please contact ADI.

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What ADI Can Provide to Customers

- **ADC**
  - ADIsimADC—*www.analog.com/zh/ADIsimADC*
  - Σ-Δ ADC register configuration assistant—*www.analog.com/SigmaDeltaRegisterConfigurationAssistant*
- **DAC**
  - ADIsimDAC—*www.analog.com/ADIsimDAC*
- **Amp**
  - ADIsimOpAmp—*www.analog.com/ADIsimOpAmp*
  - ADIsimDiffAmp—*www.analog.com/ADIsimDiffAmp*
- **Power**
  - ADIsimPower—*www.analog.com/ADIsimPower*
- **Processor**
  - Emulation tools and some software

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