Multichannel Analog Input Modules for PLC Equipment

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TEXAS INSTRUMENTS

Introduction

A Programmable Logic Controller (PLC) is a ruggedized computer modified system specifically for manufacturing process control, such as automated assembly lines, robotic machines, and other high reliability control which requires flexible programming and fault diagnostics.

PLCs are often comprised of many different types of input modules to monitor real world parameters or receive analog or digital input command signals from other PLCs, central control computers, or human interface devices.

The Analog Input Module (AIN) is a key subsystem in the PLC. AINs come in many variations to condition real world physical parameters, such as, Temperature, Pressure, Force, or Strain. Typically, these AIN inputs are command signals in both voltage (e.g. ±10V) and current form (e.g. 4-20mA).

A Multi-Channel AIN is often preferred for its flexibility, space-efficiency and power- efficiency when compared to many single channel, dedicated input modules. As seen in Figure 1 below, multiple channels share processing, analog inputs, backplane power and communication.

Different Multi-Channel, AIN architectures will be compared for optimum system configuration.

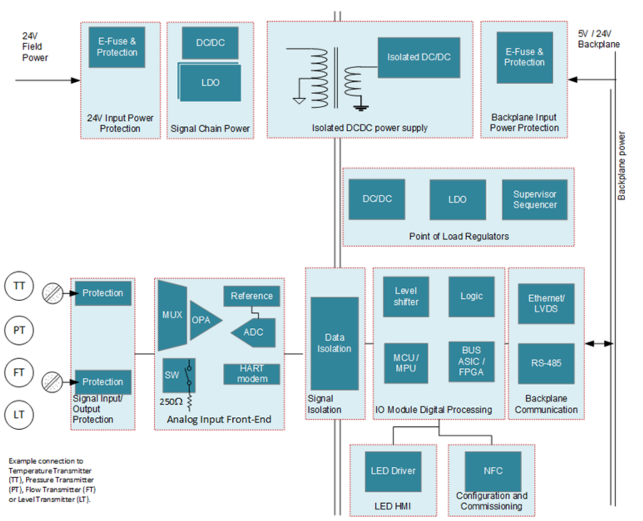

Figure 1. Reference Diagram for Multi-Channel AIN

AIN Architecture Overview

Four different, typical architectures for a multi-channel AIN are to be reviewed: Channel-to-Channel Isolated, Simultaneous Sampling, Multiplexed Inputs with Integrated MUX, and Multiplexed Inputs with External MUX. For more detailed information on these systems, visit the TI website for Analog Input Modules.

Channel-to-Channel Isolated

For high-voltage isolation (usually in the kV range), channel-to-channel isolated modules are used. See Figure 2 for an overview of this architecture. This approach yields very high common mode rejection (CMR), and high voltage isolation since the channels do not share ground. Generally in Channel-to-Channel Isolated modules, each channel uses a separate AFE (Analog Front End), ADC (Analog-to-Digital Converter), data isolator and isolated power.

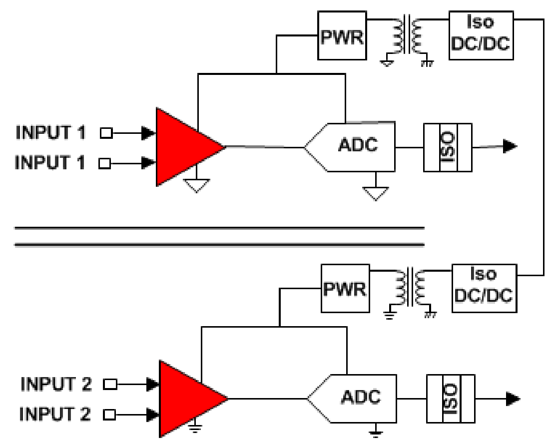

Figure 2. Channel-to-Channel Isolated

Simultaneous Sampling

For very high bandwidth systems, or if accurate measurement of the phase relation between channels is required, simultaneous sampling is used. A typical end application for this would be motor control or power monitoring. The Simultaneous Sampling architecture, shown in Figure 3 below, is used to achieve accurate signal when minimal phase shift between the inputs is essential. The ADS8578S is a 14-Bit, High Speed, 8-Channel, Simultaneous-Sampling ADC with Bipolar Inputs from a Single Supply. In addition it has an integrated reference and reference buffer.

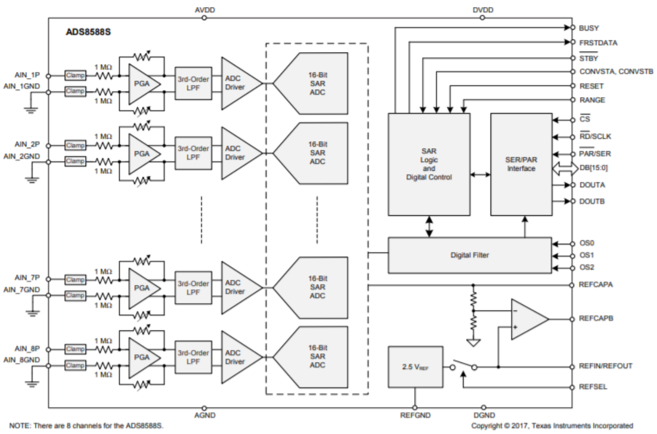

Figure 3. Simultaneous Sampling

Multiplexed Inputs with Integrated MUX

The remaining two Multi-Channel AIN modules use multiplexed-inputs. An integrated MUX and ADC solution is shown below in Figure 4. This type of solution is suitable for lower power and smaller footprint requirements. With any level of integration comes performance trade-offs based on process constraints to get the best of the analog and the best of the mixed signal.

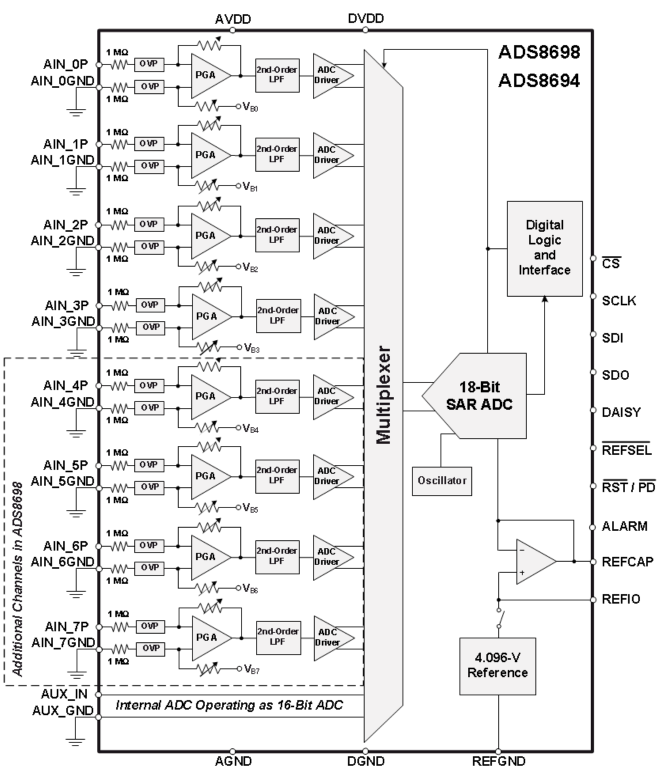

Figure 4. Multiplexed Inputs with Integrated MUX

Multiplexed Inputs with External MUX

One of the most common approaches when designing for maximum flexibility of performance and cost uses discrete Op Amps, an ADC and MUX as shown in Figure 5 below. This is a common approach when flexibility for performance and cost is preferred. Each analog input signal scaling can be custom tailored for a specific type and range of signal as well as desired noise and frequency filtering. This signal chain uses a drive op amp circuit after the MUX into the ADC, and possibly an ADC reference buffer. A MUX-Friendly amplifier such as the OPAx189 or OPAx192 can be used after the MUX, such as MUX36S08 or MUX36D04, to switch between channels to accomplish fast settling time. If a reference buffer is needed, see TI's 20MHz, high-precision OPA320.

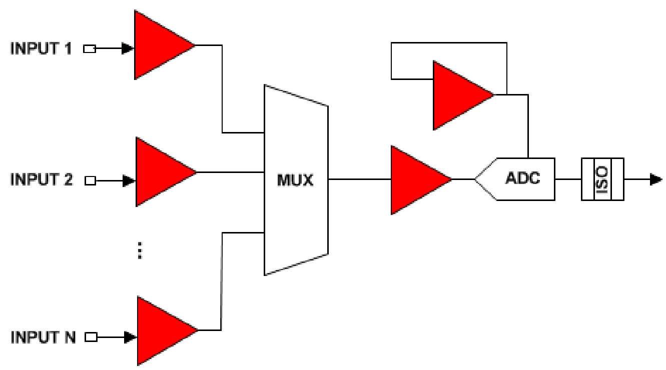

Figure 5. Mutiplexed Inputs with External MUX

Table 1. Referenced Devices

Device	Feature
OPA189	MUX-Friendly, Zero-Drift, 36V, 14MHz, 3µV offset, 5.2nV/√Hz noise
OPA192	MUX-Friendly, E-Trim, 36V, 10MHz, 25µV offset, 5.5nV/√Hz noise
OPA388	MUX-Friendly, Zero-Drift, Zero-Crossover, 5V, 10MHz, 5µV offset, 7nV/√Hz noise
OPA320	Zero-Crossover, 5V, 20MHz, 0.9pA bias current, 150µV offset, 8.5nV/√Hz noise
ADS8588S	16-Bit High-Speed 8-Channel Simultaneous-Sampling ADC
MUX36S08	36-V, Low-Capacitance, Low-Leakage-Current, Precision, Analog Multiplexers
MUX36D04	

Table 2. Related Documentation

Literature number: Description
SBOT040: MUX-Friendly Precision Op Amps
SBOA182B: Zero-Drift Amps: Features and Benefits
SBOA181A: Zero-Crossover Amps: Features and Benefits
SBOT037A: Offset Correction: Laser Trim, e-Trim, and Chopper

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