High Precision, High Speed, 17-Bit Integrating A/D Converter

In a Hybrid, 40-pin Dual-In-Line Package

Introduction

The AH30217 is an ultra-high-resolution 17-bit integrating A/D converter in a hybrid, 40-pin, dual-in-line package. Performing up to 300 conversions per second, the AH30217 ensures accurate conversions by effectively eliminating internal drifts using a four-phase triple-slope integrating conversion scheme and an autozero before each conversion. The AH30217 features TTL-compatible data and controls, making it easy to integrate into a system. Furthermore, the hybrid package minimizes the amount of valuable printed circuit board real estate required to deliver this level of performance.

The AH30217 is particularly suited for high precision data acquisition and control systems used in industrial process control. In such harsh environments, data conversion is plagued by many problems, including common mode voltages and ground-loops. However, the differential inputs and autozero of the AH30217 eliminate these and similar problems, freeing users from having to locate millivolt level errors in their systems. Furthermore, the AH30217 has an absolute accuracy adjustable to within ±0.0025% FSR, a differential linearity of ±0.2 ppm FSR, and a relative accuracy of ±7.5 ppm FSR, assuring meaningful 17-bit information. The AH30217 is the A/D converter of choice for high resolution industrial data acquisition systems.

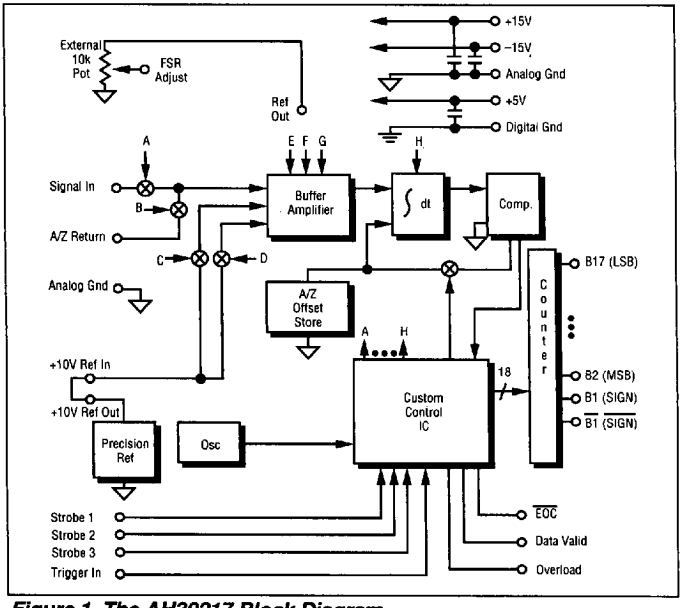
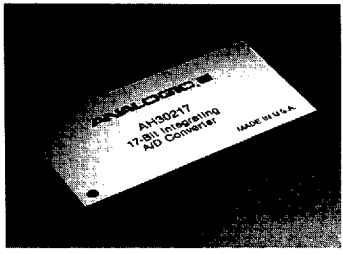


Figure 1. The AH30217 Block Diagram



Features

- ❑ Ultra-High Resolution (17 Bits)
- ❑ High Speed (300 Conversions/Second)
- ❑ Hybrid 40-pin DIP
- ❑ High Input Impedance (1000 MΩ)
- ❑ Excellent Differential Linearity (±0.2 ppm FSR)
- ❑ Autozero Before Each Conversion
- ❑ High Absolute Accuracy (±0.0025% FSR)
- ❑ Low Input Current (50 nA @ 100 Conversions/Second)
- ❑ TTL Compatibility
- ❑ Low Power (600 mW)
- ❑ Ratiometric Measurements Using External Reference
- ❑ External System Offset Compensation

Applications

- ❑ High Resolution Data Acquisition and Control Systems
- ❑ Precision Chemical Process Control Systems
- ❑ Gas Chromatography
- ❑ High Resolution Laboratory and R&D Systems
- ❑ Analytical Instrumentation
- ❑ High Precision Automatic Test Equipment
- ❑ Precision Pharmaceutical Mixing and Grading Systems

AH30217

Specifications[1]

ANALOG INPUT

Input Configuration
Differential (see Figure 5) [2]

Input Range
±10V (±15V without damage) [3]

Input Impedance
1000 MΩ Min., 50 pF Max.

Input Current
50 nA @ 100 conversions/second

DIGITAL INPUTS

Logic Levels
Logic "0"
0.8V Max.

Logic "1"
2.0V Min.

Trigger Pulse Width [4]
0.1 µs Min., Negative edge starts conversion

Control Inputs
STROBE 1
Active Low, Strobes B10-B17

STROBE 2
Active Low, Strobes B2-B9

STROBE 3
Active Low, Strobes B1 and $\overline{B1}$

DIGITAL OUTPUTS

Data Outputs
16 data bits, SIGN (B1), $\overline{SIGN}$ ($\overline{B1}$)

Fan-Out
2 LSTTL Loads Max.

Output Coding
Sign Magnitude [5]

Output Voltage
Logic "0"
0.4V Max.

Logic "1"
2.4V Min.

$\overline{EOC}$
Active Low

Data Valid
Active High

Overload
Active High

DYNAMIC CHARACTERISTICS

Conversion Rate
0-300 conversions/second, controlled by external command

Signal Integration Time
512 µs

Conversion Technique
4-phase, triple-slope integrating analog-to-digital conversion, autozeroed before each conversion

TRANSFER CHARACTERISTICS

Resolution
16 bits plus sign

Relative Accuracy
±12 ppm FSR Max.

Differential Linearity
±0.2 ppm FSR (±3σ)

Noise
10 µV RMS Max.

Absolute Accuracy
±0.005% FSR, without adjustment;
±0.0025% FSR Max., adjusted

STABILITY (0°C TO 70°C)

Offset Voltage
±3 µV/°C Max.

Gain
±6 ppm/°C Max.

Supply Rejection
Offset
15 ppm/% Max.

Gain
15 ppm/% Max.

Warm-Up Time
5 Min.

POWER REQUIREMENTS [6]

Supply Range
±15V Supplies
14.5V Min., 15.5V Max.

+5V Supply
4.75V Min., 5.25V Max.

+15V Current Drain
20 mA

–15V Current Drain
16 mA

+5V Current Drain
10 mA

Power Consumption
600 mW

ENVIRONMENTAL & MECHANICAL

Temperature Range
Rated Performance
0°C to 70°C

Storage
–25°C to +85°C

Relative Humidity
0 to 95% non-condensing up to 70°C

Dimensions
1.1" x 2.2" x 0.3", 40-pin triple DIP

SPECIAL FEATURES

Ratiometric Measurements
+10V ±10% external reference may be used in place of internal reference and connected to REF IN

External System Offset Compensation
±10 mV Max., may be compensated. Connect to A/Z RTN.

NOTES:

1. All specifications guaranteed at 25°C unless otherwise noted. Supplies are ±15V and +5V.
2. Maximum common mode voltage input is ±10 mV.
3. Other input ranges are available. Consult factory.
4. Trigger is locked out when the conversion starts until the end of conversion.
5. Consult factory for other output coding.
6. Analogic highly recommends the use of linear power supplies with its high performance, high resolution A/D converters. However, if system requirements provide only a +5V supply and limited space, the use of the Analogic SP7015 DC-to-DC converter will provide a low noise solution which will not degrade the AH30217 performance.

Specifications subject to change without notice.

Principles of Operation

The innovative quadraphasic design of the AH30217 completes a conversion in four phases. This technique is depicted in Figures 1 and 2. The four phases are: the autozeroing (AZ); signal integration (∫x); integration of ref high (∫ ref hi); and integration of ref low (∫ ref lo). Timing signals for each of the phases are coordinated in a custom IC in response to various digital and analog input signals. When not in a conversion mode, the converter is placed automatically into its autozero phase. The autozero phase of the unit is considered part of the conversion time and is included in the time when $\overline{EOC}$ is high. The function of the autozero time is to ensure that the memory capacitor is charged to compensate for any internal drifts and any external offsets introduced at the module pin connections.

The falling edge of trigger causes the timing counters (internal to the custom IC) to be reset to zero. At this time the analog circuitry is changed from autozero to integrating the unknown input voltage. Subsequent triggers are locked out. The input signal (and any stored AZ offset) is integrated for a period of approximately 512 µs.

Program control then shifts the unit into Phase 2, where the input signal is replaced by a high current, opposite polarity reference. This discharges the integrating capacitor at a high rate as shown in Figure 2. During this phase, the output counters are incremented beginning with B9 counting up to B1 (MSB).

When the integrating capacitor has been discharged to a preset level, the program control begins Phase 3. The high current reference is replaced by a low current reference, and the low bit counters beginning with B16 (LSB) are incremented. This phase continues until the integrating capacitor is discharged to its initial value.

The unit is then set to the Phase Zero mode. After a fixed time which allows the autozero loop to stabilize, the $\overline{EOC}$ is brought low ending the conversion. At this time the output data is valid and remains valid until the end of the next conversion. Appropriate delays are introduced between phases to eliminate conversion errors which could result from the settling of the program-switching circuits.

The sign magnitude data word is tri-stated by means of three strobe inputs, allowing the AH30217 to interface to an 8-bit microprocessor bus. Strobe 1 enables B10-B17; Strobe 2 enables B2-B9; Strobe 3 enables B1 and $\overline{B1}$.

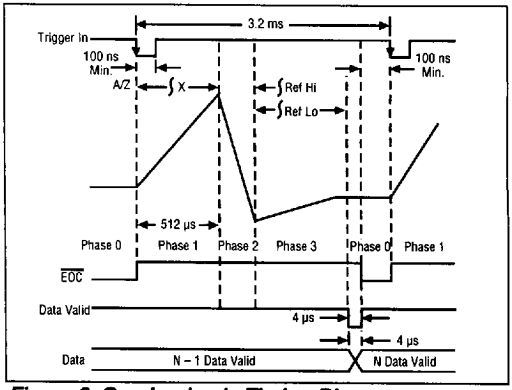


Figure 2. Quadraphasic Timing Diagram.

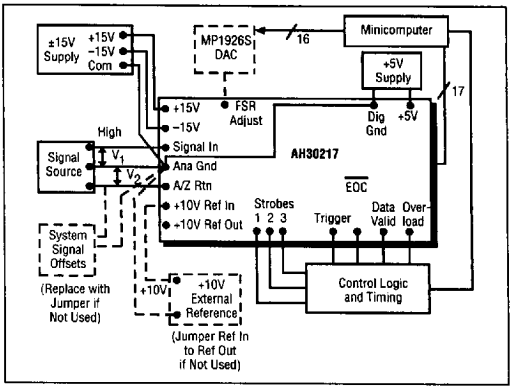


Figure 3. Connecting Power & Signals to AH30217.

Using the AH30217

As shown in Figure 3, the AH30217 is connected to the signal source, a trigger command, three sources of power (+5 VDC and ±15 VDC), and an optional external reference. The second signal input may be used to remove common mode voltages or to introduce corrections to the input signal to compensate for other system errors. Note that the rising edge of Data Valid can be used to latch the data from the AH30217. The optional digital-to-analog converter is used to calibrate +FS and –FS as described below; a potentiometer can be used instead.

The Overload pin goes high when the input voltage exceeds the full scale range of the A/D converter. This occurs beyond the ±10V input range of the AH30217.

Output Coding and Trim Procedure

Figure 4 shows the output coding of the AH30217 A/D converter. The coding format is sign magnitude. The AH30217 can be calibrated using an external potentiometer connected to FSR Adjust as shown in Figure 1 or using a digital-to-analog converter connected to FSR Adjust as shown in Figure 3.

The example below demonstrates the trim procedure. Measure the voltage required to obtain a reading of 1111111111111111/0 (where the LSB is alternating equally between 0 and 1). Measure the voltage required to obtain a reading of 0111111111111111/0. Add the two voltages together and divide the sum by two. Add this voltage to the ideal positive and negative full scale voltages — 1/2 LSB (±9.999847V – 0.000076V = ±9.999771V), and use one of these voltages as the input voltage. The appropriate digital code (1111111111111111/0 or 0111111111111111/0) should be obtained by varying the FSR Adjust potentiometer.

Example of Trim Procedure:

1111111111111111/0	+9.999420V
0111111111111111/0	–0.000530V
	–0.000110V
–0.000110V ÷ 2 =	–0.000055V
±9.999847V – 0.000076V =	±9.999771V
+9.999771V – 0.000055V =	+9.999716V
–9.999771V – 0.000055V =	–9.999826V
1111111111111111/0	+9.999716V
0111111111111111/0	–9.999826V

Truth Table

Input Voltage		Digital Outputs	
Sign Magnitude	Sign	MSB	LSB
+9.999847V	1	1111111111111111	
0.000000V	1	0000000000000000	
–9.999847V	0	1111111111111111	

Figure 4. AH30217 Output Coding.

Input Connections to the AH30217

Input Signals: The AH30217 encodes the difference between two input signals (Figure 5). By providing a differential input, the AH30217 eliminates small system ground-loop voltages (up to 10 mV), common mode voltages, and minor system offsets. Use the 3-wire input configuration as illustrated in Figure 5.

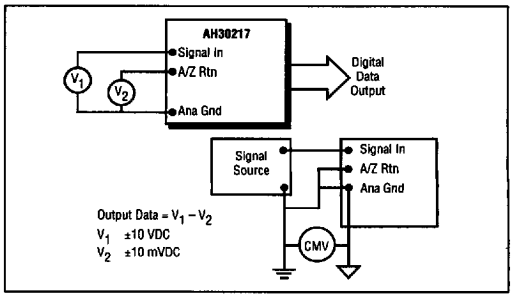


Figure 5. Connecting Input Signals to Remove CMV.

Reference: True ratiometric measurements may be made with the AH30217 by replacing the internal reference with a 10 VDC external reference. Remove the jumper between pin terminals REF OUT and REF IN and connect +10 VDC ±10% between REF IN and ANA RTN.

Typical Application

The AH30217, when connected as shown in Figure 7, provides wide dynamic range. In this application the output of a Gas Chromatograph is connected to a programmable gain amplifier (PGA). The output of the PGA is input to the AH30217, and the selected gain is indicated by three output bits from the PGA.

Once the gain has been properly set and sufficient time has been allotted after $\overline{EOC}$ for autozero, the control logic issues a convert command to the AH30217. When the $\overline{EOC}$ signal is obtained, valid 20-bit data digitizing a 21-bit input dynamic range is available at the output. In this system the AH30217 A/Z RTN is jumpered to Analog GND, and any common mode voltage between source, system, and measuring system grounds is rejected in the PGA.

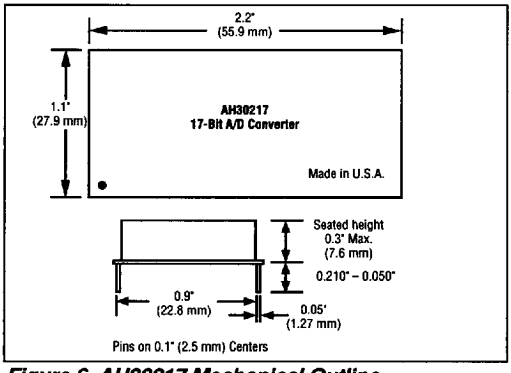


Figure 6. AH30217 Mechanical Outline.

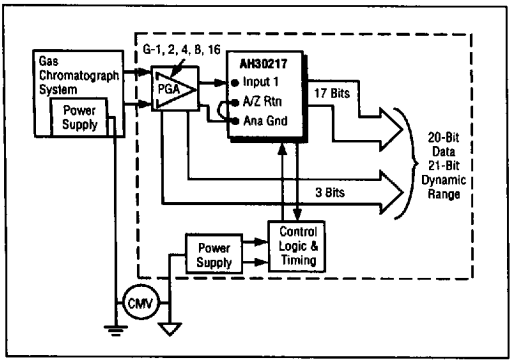


Figure 7. Typical AH30217 Application.

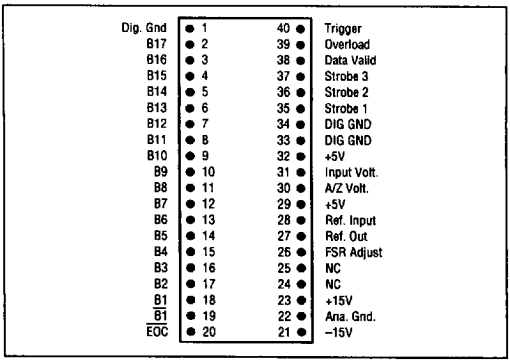


Figure 8. AH30217 Pinout.

Ordering Guide

17-Bit Integrating A/D Converter
Specify **AH30217P Plastic Package**
Specify **AH30217C Ceramic Package**

DC to DC Converter
Specify **SP7015**

For full scale ranges other than ±10V, or for output coding other than sign magnitude, or for signal integration times other than 512 µs, or for conversion rates greater than 300 per second, consult factory.

3