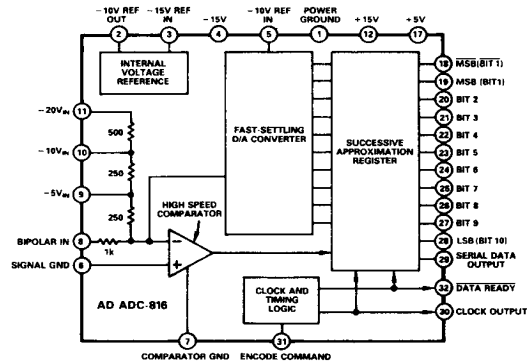
Ultra High-Speed 10-Bit A/D Converters

AD ADC-816

FEATURES
10-Bit Resolution
800ns Conversion Time
Six Input Ranges
Unipolar and Bipolar Operation

APPLICATIONS
Data Acquisition Systems
Radar Systems
Analytical Instruments
Real-Time Waveform Analysis

AD ADC-816 FUNCTIONAL BLOCK DIAGRAM



GENERAL DESCRIPTION

The AD ADC-816 A/D Converter is an ultra high-speed successive approximation converter capable of 10 bits of resolution with a conversion time of only 800ns.

It is a thin-film hybrid, hermetically packaged in a 32-pin DIP. Three models span temperature ranges of 0 to +70°C, −25°C to +85°C, and −55°C to +125°C.

The design offers the user flexibility in both input and output configurations. Six different analog inputs are available with strap options: 0V to −5V; 0V to −10V; 0V to −20V; ±2.5V; ±5V; and ±10V. Output data are available in either serial or parallel format, also with external connections.

The AD ADC-816 can be incorporated into a wide variety of circuit and system applications with a minimum of external components and design effort. When used with the HTC-0300, HTC-0300A, HTC-0500, or other Analog Devices' high-performance track-and-hold units, the AD ADC-816 A/D can be a cost-effective solution for a broad range of digitizing problems.

Model number suffixes designate the various temperature ranges. The AD ADC-816KD operates over a range of 0 to +70°C; the AD ADC-816BD is for −25°C to +85°C; and the AD ADC-816SD is for use in operating environments between −55°C and +125°C.

PIN DESIGNATIONS

PIN	FUNCTION	PIN	FUNCTION
1	POWER GROUND	17	+5V POWER
2	−10V REFERENCE OUT	18	$\overline{\text{MSB (BIT 1)}}$
3	−15V REFERENCE IN	19	MSB (BIT 1)
4	−15V POWER	20	BIT 2
5	−10V REFERENCE IN	21	BIT 3
6	SIGNAL GROUND	22	BIT 4
7	COMPARATOR GROUND	23	BIT 5
8	BIPOLAR INPUT	24	BIT 6
9	−5V ANALOG INPUT	25	BIT 7
10	−10V ANALOG INPUT	26	BIT 8
11	−20V ANALOG INPUT	27	BIT 9
12	+15V POWER	28	LSB (BIT 10)
13	NC	29	SERIAL DATA OUT
14	NC	30	CLOCK OUTPUT
15	NC	31	ENCODE COMMAND
16	NC	32	$\overline{\text{DATA READY}}$ OUTPUT

POWER GROUND (PIN 1), SIGNAL GROUND (PIN 6), AND COMPARATOR GROUND (PIN 7) MUST BE CONNECTED TOGETHER AND TO LOW-IMPEDANCE GROUND FOR PROPER OPERATION. MAKE CONNECTIONS AS CLOSE TO DEVICE AS POSSIBLE.

This four-page data summary contains key specifications to speed your selection of the proper solution for your application. Additional information on this product can be obtained from your local sales office.

SPECIFICATIONS (typical at +25°C with nominal power supplies, unless otherwise noted)

Parameter	Units	AD ADC-816KD	AD ADC-816BD	AD ADC-816SD
RESOLUTION (FS = Full Scale)	Bits	10	*	*
	%FS	0.1	*	*
LSB WEIGHT				
5V p-p FS	mV	4.88	*	*
10V p-p FS	mV	9.76	*	*
20V p-p FS	mV	19.53	*	*
ACCURACY				
Nonlinearity	LSB, max	± 1/2	*	*
Differential Nonlinearity	LSB, max	± 1/2	*	*
Monotonicity		Guaranteed	*	*
Nonlinearity Over Operating Temperature Range	LSB	1/2	*	<1
DYNAMIC CHARACTERISTICS				
Conversion Time	ns, max[1]	800	*	900[2]
Conversion Time Tempco	%/°C (max)	± 0.06 (0.07)	*	*
INPUT CHARACTERISTICS				
Analog Voltage Ranges				
Unipolar[3]				
Input Pin 9	V, p-p FS	5	*	*
Input Pin 10	V, p-p FS	10	*	*
Input Pin 11	V, p-p FS	20	*	*
Bipolar				
Inputs Pins 8 and 9	V, p-p FS	± 2.5	*	*
Inputs Pins 8 and 10	V, p-p FS	± 5	*	*
Inputs Pins 8 and 11	V, p-p FS	± 10	*	*
– 10V Reference Input (Pin 5)	V (max)	– 10 (± 0.2)	*	*
Impedance				
Unipolar 5V Input	Ω	250	*	*
Unipolar 10V Input	Ω	500	*	*
Unipolar 20V Input	Ω	1000	*	*
Bipolar Input	Ω	1000	*	*
Reference	Ω	2000	*	*
Gain Error Before Adjustment				
Unipolar	% of FS	0.3	*	*
Bipolar	% of FS	0.2	*	*
Gain Error vs. Temperature				
Unipolar	ppm/°C max	± 37	*	*
Bipolar	ppm/°C max	± 28	*	*
Zero Error Before Adjustment				
Unipolar	% of FS	0.2	*	*
Zero Error vs. Temperature				
Unipolar	ppm/°C max	± 1/2	*	*
Offset Error Error Before Adjustment				
Bipolar	% of FS	0.1	*	*
Offset Error vs. Temperature				
Bipolar	ppm/°C max	± 23	*	*
Reference Output Tempco	ppm/°C max	± 20	*	*
ENCODE COMMAND INPUT[4]				
Logic Levels,	V (max)	"0" = + 0.4 (+ 0.8)	*	*
TTL-Compatible	V, min (max)	"1" = + 2.0 (+ 5.5)	*	*
Loading	TTL Loads	1	*	*
Rise and Fall Times	ns	10	*	*
Width	ns, min	40	*	*
Frequency	MHz	1.25	*	1.14
DIGITAL OUTPUT CHARACTERISTICS				
Parallel				
@ Pins 19–28 + Pin 18	Bits	11 (10 + $\overline{\text{MSB}}$)	*	*
Time Skew	ns, max	5	*	*
Format	Non-Return-to-Zero (NRZ)		*	*
Series				
@ Pin 29	Bits	11 (10 + $\overline{\text{MSB}}$)	*	*
Timing	Successive decision pulses with MSB (or $\overline{\text{MSB}}$) first; at internal clock frequency		*	*
Format	Non-Return-to-Zero (NRZ)		*	*
Coding[5]				
Unipolar Input	Binary (BIN)		*	*
Bipolar Input	Offset Binary (OBN) or 2's Complement (2SC)[6]		*	*
Logic Levels,	V, max	"0" = + 0.4	*	*
TTL-Compatible	V, min	"1" = + 2.4	*	*
Loading	TTL Loads	2	*	*

Parameter	Units	AD ADC-816KD	AD ADC-816BD	AD ADC-816SD
CLOCK OUTPUT				
Format		Series Train	*	*
Amplitude				
Minimum/Maximum	V	0/+5	*	*
Width	ns (min)	25 (20)	*	*
Frequency	MHz	14.3	*	*
REFERENCE OUTPUT[7]				
Voltage	V (max)	10 (±0.02)	*	*
Current (sink only)	mA	0 to +20	*	*
Impedance	Ohms, max	10	*	*
DATA READY OUTPUT				
Signal Status		Logic "1" during reset and conversion	*	
		Logic "0" when conversion is complete	*	*
Logic Levels,	V, max	"0" = +0.4	*	*
TTL-Compatible	V, min	"1" = +2.4	*	*
Loading	TTL Loads	4	*	*
Rise and Fall Times	ns, max	5	*	*
POWER REQUIREMENTS[8]				
+15V ±2% (Pin 12, Power)	mA, max	105	*	*
−15V ±3% (Pin 4, Power)	mA, max	25	*	*
−15V ±3% (Pin 3, Reference)	mA, max	35	*	*
+5V ±5% (Pin 17)	mA, max	180	*	*
Power Consumption[9]	W, max	2.9	*	*
Power Supply Rejection Ratio				
(PSSR) for Rated Supplies	LSB, max	1/2	*	
TEMPERATURE RANGE				
Operating[10]	°C	0 to +70	−25 to +85	−55 to +125
Storage	°C	−65 to +150	*	*
THERMAL RESISTANCE[11]				
Junction to Air, θja				
(Free Air)	°C/W	32	*	*
Junction to Case, θjc	°C/W	13	*	*
MTBF[12]				
Mean Time Between Failures	Hours			1.65×10^5

NOTES
[1]Measured from leading edge Encode Command to trailing edge $\overline{\text{Data Ready}}$; use trailing edge to strobe output data into external circuits.
[2]AD ADC-816SD maximum conversion time shown is at full operating temperature.
[3]Bipolar input (Pin 8) must be tied to ground.
[4]Logic "1" resets converter; logic "0" initiates conversion.
[5]All coding is inverted analog.
[6]Two's Complement available for parallel output only.
[7]To use internal reference, connect −15V REFERENCE IN (Pin 3) to −15V POWER (Pin 4); and −10V REFERENCE OUT (Pin 2) to −10V REFERENCE IN (Pin 5). To use external reference, leave Pins 2 and 3 open or grounded; connect external reference to Pin 5. If Pin 3 is left open or grounded, internal reference is disabled and power decreases approximately 200mW.
[8]Bypass power supplies with 1μF electrolytic capacitors and 0.1μF ceramic capacitors as close to supply pins as possible.
[9]Power dissipation shown is based on 0V analog input.
[10]Minimum air flow of 400 linear feet per minute (LFPM) is recommended for operating temperatures above +70°C. At elevated temperatures, unit should be mounted directly to printed circuit board (PCB) without a socket; good thermal contact must be maintained between bottom of device and PCB.
[11]Maximum junction temperature is +150°C.
[12]Calculated for "SD" version using MIL-HNBK 217; Ground Fixed; +70°C case temperature.
*Specifications same as AD ADC-816KD.
Specifications subject to change without notice.

ABSOLUTE MAXIMUM RATINGS

Positive Supply (Pin 12) . . . . . **+16V dc**
Negative Supply (Pins 3 & 4) . . . . . **−16V dc**
Logic Supply (Pin 17) . . . . . **+7V dc**
Logic Inputs . . . . . **+7V dc**
Analog Inputs . . . . . **±2 × Selected Analog Input Range**

UNIPOLAR OPERATION

ANALOG INPUT			DIGITAL OUTPUT	
0 to −20V	0 to −10V	0 to −5V	MSB	LSB
−19.9805	−9.9902	−4.9951	1 111 111 111	
−17.5000	−8.7500	−4.3750	1 110 000 000	
−15.0000	−7.5000	−3.7500	1 100 000 000	
−10.0000	−5.0000	−2.5000	1 000 000 000	
−5.0000	−2.5000	−1.2500	0 100 000 000	
−2.5000	−1.2500	−0.6250	0 010 000 000	
−0.0198	−0.0098	−0.0049	0 000 000 001	
0.0000	0.0000	0.0000	0 000 000 000	

BIPOLAR OPERATION

ANALOG INPUT			DIGITAL OUTPUT	
			Offset Binary	2's Complement
±10V	±5V	±2.5V	MSB LSB	$\overline{\text{MSB}}$ LSB
−9.9805	−4.9902	−2.4951	1 111 111 111	0 111 111 111
−7.5000	−3.7500	−1.8750	1 110 000 000	0 110 000 000
−5.0000	−2.5000	−1.2500	1 100 000 000	0 100 000 000
0.0000	0.0000	0.0000	1 000 000 000	0 000 000 000
+5.0000	+2.5000	+1.2500	0 100 000 000	1 100 000 000
+7.5000	+3.7500	+1.8750	0 010 000 000	1 010 000 000
+9.9805	+4.9902	+2.4951	0 000 000 001	1 000 000 001
+10.0000	+5.0000	+2.5000	0 000 000 000	1 000 000 000

AD ADC-816 Coding Tables

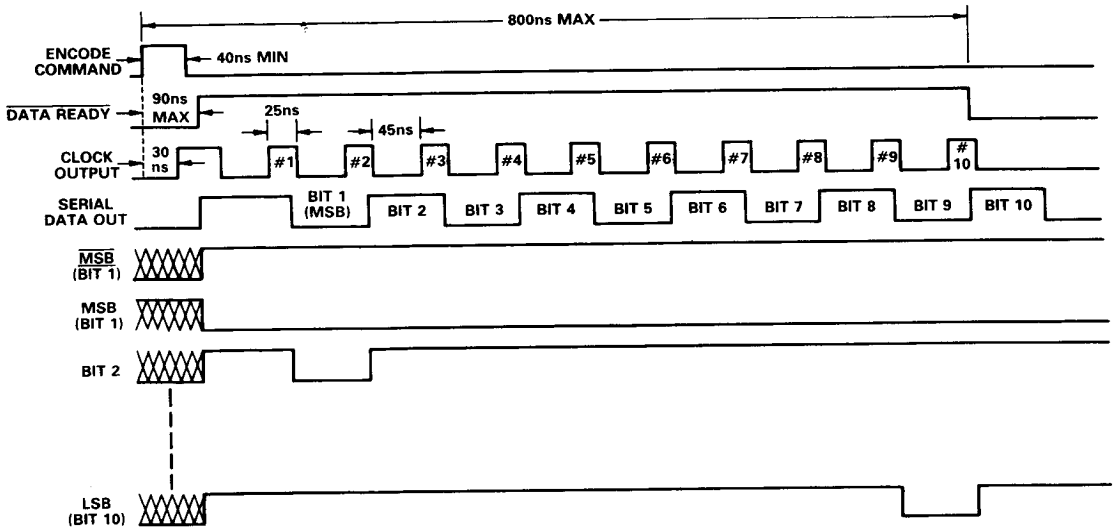


Figure 1. AD ADC-816KD/BD Timing Diagram

AD ADC-816 TIMING

Refer to Figure 1, AD ADC-816KD/BD Timing Diagram.

As shown elsewhere in this data sheet, operating temperatures for the AD ADC-816KD and AD ADC-816BD are 0 to +70°C and −25°C to +85°C, respectively. The operating temperature for the AD ADC-816SD is −55°C to +125°C. These differences in temperature cause slight differences in timing among the three models of converters, but all times are referenced to the leading edge of the ENCODE COMMAND pulse supplied by the user.

For the AD ADC-816SD, the maximum time of 800ns shown to the falling edge of the $\overline{\text{DATA READY}}$ pulse is 900ns; these intervals are the maximum times if operating at the maximum word rate, with an encode command no wider than 70ns. In addition to this change in conversion time, spacing between CLOCK OUTOUT pulses increases from a typical 45ns to 55ns.

Figure 1 illustrates timing intervals for the KD and BD devices. In the diagram, ENCODE COMMAND width is 45ns, and this becomes the width of the set-up pulse which occurs before clock pulse #1.

The serial output data are in NRZ format with the MSB appearing first, and are synchronized by using the CLOCK OUTPUT pulses at Pin 30. The trailing (negative-going) edge of each clock pulse is recommended for use as a strobe to clock out its associated bit information.

Delaying the clock pulses 15ns-20ns before using them as strobes will help assure sufficient set-up time for the serial data output to stabilize. For users who prefer positive-edge triggering, the clock pulses can be inverted via additional logic circuits and the trailing edges of those pulses could still be used as strobes.

Input connections for the AD ADC-816 are shown in Figure 2 (Unipolar Operation) and Figure 3 (Bipolar Operation).

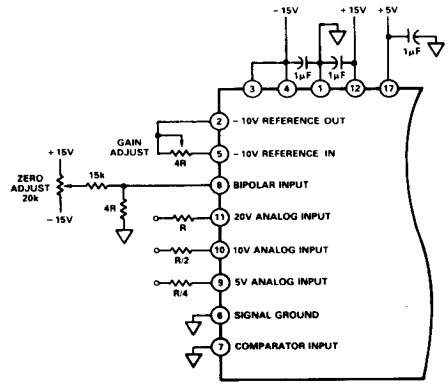


Figure 2. Unipolar Operation

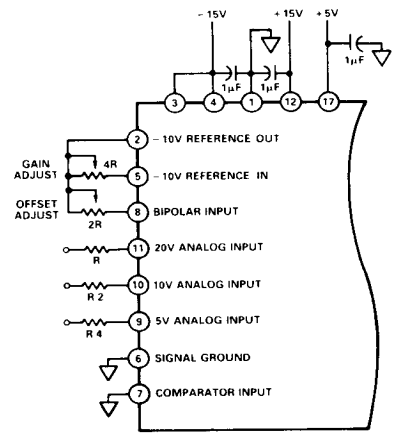


Figure 3. Bipolar Operation