ANALOG DEVICES

LC²MOS
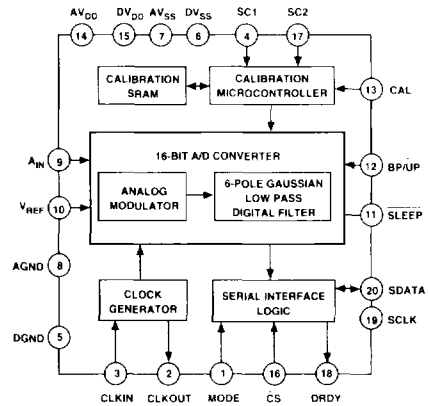# 16-Bit A/D Converter

AD7701

FEATURES
Monolithic 16-Bit ADC
0.0015% Linearity Error
On-Chip Self-Calibration Circuitry
Programmable Low Pass Filter
0.1 Hz to 10 Hz Corner Frequency
0 V to +2.5 V or ±2.5 V Analog Input Range
4 kSPS Output Data Rate
Flexible Serial Interface
Ultralow Power

APPLICATIONS
Industrial Process Control
Weigh Scales
Portable Instrumentation
Remote Data Acquisition

FUNCTIONAL BLOCK DIAGRAM

GENERAL DESCRIPTION
The AD7701 is a 16-bit ADC which uses a sigma-delta conversion technique. The analog input is continuously sampled by an analog modulator whose mean output duty cycle is proportional to the input signal. The modulator output is processed by an on-chip digital filter with a six-pole Gaussian response, which updates the output data register with 16-bit binary words at word rates up to 4 kHz. The sampling rate, filter corner frequency and output word rate are set by a master clock input that may be supplied externally, or by a crystal-controlled on-chip oscillator.

The inherent linearity of the ADC is excellent, and end-point accuracy is ensured by self-calibration of zero and full scale which may be initiated at any time. The self-calibration scheme can also be extended to null system offset and gain errors in the input channel.

The output data is accessed through a flexible serial port, which has an asynchronous mode compatible with UARTs and two synchronous modes suitable for interfacing to shift registers or the serial ports of industry-standard microcontrollers.

CMOS construction insures low power dissipation, and a power down mode reduces the idle power consumption to only 10 μW.

PRODUCT HIGHLIGHTS
1. The AD7701 offers 16-bit resolution coupled with outstanding 0.0015% accuracy.
2. No missing codes ensures true, usable, 16-bit dynamic range, removing the need for programmable gain and level-setting circuitry.

3. The effects of temperature drift are eliminated by on-chip self-calibration, which removes zero and gain error. External circuits can also be included in the calibration loop to remove system offsets and gain errors.
4. A flexible synchronous/asynchronous interface allows the AD7701 to interface directly to UARTs or to the serial ports of industry-standard microcontrollers.
5. Low operating power consumption and an ultralow power standby mode make the AD7701 ideal for loop-powered remote sensing applications, or battery-powered portable instruments.

ORDERING GUIDE

Model	Temperature Range	Linearity Error (% FSR)	Package Options*
AD7701AN	40°C to +85°C	0.003	N-20
AD7701BN	40°C to +85°C	0.0015	N-20
AD7701AR	40°C to +85°C	0.003	R-20
AD7701BR	40°C to +85°C	0.0015	R-20
AD7701ARS	40°C to +85°C	0.003	RS-28
AD7701AQ	-40°C to +85°C	0.003	Q-20
AD7701BQ	-40°C to +85°C	0.0015	Q-20
AD7701SQ	-55°C to +125°C	0.003	Q-20
AD7701TQ	-55°C to +125°C	0.0015	Q-20

*N = Plastic DIP; Q = Cerdip; R = SOIC. For outline information see Package Information section.

AD7701–SPECIFICATIONS

(T_A = +25°C; AV_{DD} = DV_{DD} = +5 V; AV_{SS} = DV_{SS} = −5 V; V_{REF} = +2.5 V; f_{CLKIN} = 4.096 MHz; Bipolar Mode: MODE = +5 V; A_{IN} Source Resistance = 750 Ω[1] with 1 nF to AGND at A_{IN}, unless otherwise noted.)

Parameter	A, S Versions[2]	B, T Versions[2]	Units	Test Conditions/Comments
STATIC PERFORMANCE				
Resolution	16	16	Bits	
Integral Nonlinearity				
T_{MIN} to T_{MAX}		±0.0007	% FSR typ	
	±0.003	±0.0015	% FSR max	
Differential Nonlinearity				
T_{MIN} to T_{MAX}	±0.125	±0.125	LSB typ	Guaranteed No Missing Codes
	±0.5	±0.5	LSB max	
Positive Full-Scale Error[3]	±0.13	±0.13	LSB typ	
	±0.5	±0.5	LSB max	
Full-Scale Drift[1]	±1.2 (±2.3 S Version)	±1.2 (±2.3 T Version)	LSB typ	
Unipolar Offset Error[1]	±0.25	±0.25	LSB typ	
	±1	±1	LSB max	
Unipolar Offset Drift[1]	±1.6 (+3/ 25 S Version)	±1.6 (+3/ 25 T Version)	LSB typ	
Bipolar Zero Error[3]	±0.25	±0.25	LSB typ	
	±1	±1	LSB max	
Bipolar Zero Drift[1]	±0.8 (+1.5/ 12.5 S Version)	±0.8 (+1.5/ 12.5 T Version)	LSB typ	
Bipolar Negative Full-Scale Error[3]	±0.5	±0.5	LSB typ	
	±2	±2	LSB max	
Bipolar Negative Full-Scale Drift[1]	±0.6 (±1.2 S Version)	±0.6 (±1.2 T Version)	LSB typ	
Noise (Referred to Output)	0.1	0.1	LSB rms typ	
DYNAMIC PERFORMANCE				
Sampling Frequency, f_S	f_{CLKIN}/256	f_{CLKIN}/256	Hz	
Output Update Rate, f_{OUT}	f_{CLKIN}/1024	f_{CLKIN}/1024	Hz	
Filter Corner Frequency, f_{-3dB}	f_{CLKIN}/409,600	f_{CLKIN}/409,600	Hz	
Settling Time to ±0.0007% FS	507904/f_{CLKIN}	507904/f_{CLKIN}	sec	For Full-Scale Input Step
SYSTEM CALIBRATION				Applies to Unipolar and
Positive Full-Scale Overrange	V_{REF} + 0.1	V_{REF} + 0.1	V max	Bipolar Ranges. After Cali-
Positive Full-Scale Overrange	V_{REF} + 0.1	V_{REF} + 0.1	V max	bration, If A_{IN} > V_{REF}, the
Negative Full-Scale Overrange	(V_{REF} + 0.1)	(V_{REF} + 0.1)	V max	Device Will Output All 1s.
Maximum Offset Calibration Range[5, 6]				If A_{IN} < 0 (Unipolar) or
Unipolar Input Range	(V_{REF} + 0.1)	(V_{REF} + 0.1)	V max	V_{REF} (Bipolar), the Device
Bipolar Input Range	0.4 V_{REF} to +0.4 V_{REF}	0.4 V_{REF} to +0.4 V_{REF}	V max	Will Output All 0s.
Input Span[7]	0.8 V_{REF}	0.8 V_{REF}	V min	
	2 V_{REF} + 0.2	2 V_{REF} + 0.2	V max	
ANALOG INPUT				
Unipolar Input Range	0 to +2.5	0 to +2.5	Volts	
Bipolar Input Range	±2.5	±2.5	Volts	
Input Capacitance	10	10	pF typ	
Input Bias Current[1]	1	1	nA typ	
LOGIC INPUTS				
All Inputs Except CLKIN				
V_{INL}, Input Low Voltage	0.8	0.8	V max	
V_{INH}, Input High Voltage	2.0	2.0	V min	
CLKIN				
V_{INL}, Input Low Voltage	0.8	0.8	V max	
V_{INH}, Input High Voltage	3.5	3.5	V min	
I_{IN}, Input Current	10	10	μA max	
LOGIC OUTPUTS				
V_{OL}, Output Low Voltage	0.4	0.4	V max	I_{SINK} = 1.6 mA
V_{OH}, Output High Voltage	DV_{DD} − 1	DV_{DD} − 1	V min	I_{SOURCE} = 100 μA
Floating State Leakage Current	±10	±10	μA max	
Floating State Output Capacitance	9	9	pF typ	

Specifications subject to change without notice.