ADC-816, ADC-826 Ultra-Fast 10-Bit A/D Converters

DATEL

FEATURES

- **10-Bit resolution**
- **800 Nanoseconds or 1.25 microseconds conversion time**
- **6 Input ranges**
- **Unipolar and bipolar operation**
- **Programmable output coding**

GENERAL DESCRIPTION

DATEL's ADC-816 and ADC-826 are very high speed 10-bit successive approximation A/D converters, realized as miniature thick and thin-film hybrids. Both models have identical specifications except for conversion time. The ADC-826 has a maximum conversion time of 1.4 microseconds. The ultra-fast ADC-816 offers a maximum conversion time of only 800 nanoseconds.

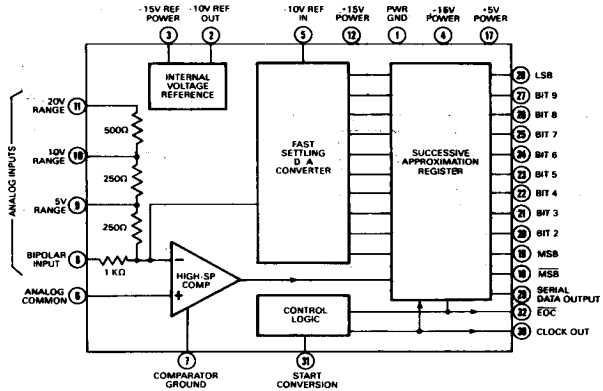
These converters feature six analog input voltage ranges: 0 to −5V dc, 0 to −10V dc, 0 to −20V dc, ±2.5V dc, ±5V dc and ±10V dc. Selection of input range is accomplished by simple external pin connection.

Output data is available in parallel or serial form by external connection. Data is coded as straight binary for unipolar operation and as either offset binary or two's complement for bipolar operation. Two's complement is available in the parallel output mode only and is selected by pin connection.

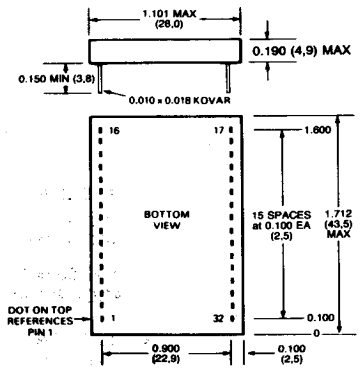
Specifications shared by both models include maximum nonlinearity of ±½ LSB and differential nonlinearity of ±½ LSB maximum.

These converters are functionally complete units requiring a minimum of passive external components for operation. Each unit is composed of a high-speed comparator, an ultra-fast settling D/A converter, a precision voltage reference, successive approximation register, clock generator and control logic circuits. The combination of unique design and the latest hybrid fabrication technology allows this level of performance to be achieved in a miniature hermetically sealed 32-pin ceramic DIP package.

Both models require ±15V dc and +5V dc supplies, and are available in versions for the 0 to +70°C or −55 to +125°C operating temperature ranges.



MECHANICAL DIMENSIONS



*NOTE: PINS HAVE 0.025 INCH STANDOFF FROM CASE, ±0.01"

INPUT/OUTPUT CONNECTIONS

PIN	FUNCTION	PIN	FUNCTION
1	POWER COM	17	+5V POWER
2	REF OUT	18	$\overline{\text{MSB}}$ 1
3	REF POWER	19	MSB 1
4	−15V POWER	20	BIT 2
5	REF IN	21	BIT 3
6	SIG COM	22	BIT 4
7	COMPARATOR COM.	23	BIT 5
8	BIP IN	24	BIT 6
9	5V IN	25	BIT 7
10	10V IN	26	BIT 8
11	20V IN	27	BIT 9
12	+15V POWER	28	LSB 10
13	NC	29	SERIAL DATA OUT
14	NC	30	CLOCK OUT
15	NC	31	START
16	NC	32	$\overline{\text{EOC}}$

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ABSOLUTE MAXIMUM RATINGS	
Positive Supply, pin 12	+16V dc
Negative Supply, pin 4	−16V dc
Logic Supply, pin 17	+7V dc
Logic Inputs	+7V dc
Analog Inputs	± Twice selected analog input range

FUNCTIONAL SPECIFICATIONS

Typical at +25°C, ±15V dc and +5V dc supplies, unless otherwise noted.

INPUTS		
Analog Input Ranges	unipolar[1]	0 to −5V, 0 to −10V, 0 to −20V
	bipolar	±2.5V, ±5V, ±10V
	reference	−9.5V to −10.5V
Input Impedance[2]	5V range	312Ω
	10V range	625Ω
	20V range	1.25 KΩ
	bipolar input	1 KΩ
	reference (pin 5)	2 KΩ
Start Conversion		2V min. to 5.5V max. positive pulse with duration of 25 nsec. min. Rise and fall times typical 10 nsec. Logic "1" resets converter. Logic "0" initiates conversion. Loading: 1 TTL load.

OUTPUTS	
Parallel Output Data	11 Parallel lines of data (10 binary bits + $\overline{MSB}$) held until next conversion command. V_{OUT} ("0") ≤ +0.4V. V_{OUT} ("1") ≥ +2.4V. Loading: 2 TTL loads
Coding[3], unipolar	Straight Binary
bipolar[4]	Offset Binary, Two's Complement
Serial Output Data	NRZ successive decision pulses out, MSB first, at internal clock frequency Loading: 4 TTL loads.
End of Conversion ($\overline{EOC}$)	Conversion Status Signal. Output is logic high during reset and conversion, low when conversion is complete. Loading: 4 TTL loads.
Clock Output	Train of positive going, 0 to +5V, 30 nsec. pulses.
Clock Frequency ADC-816MC/MM	14.6 MHz
ADC-826MC/MM	8.1 MHz
Reference Output, Voltage	−10.00V ±0.02V
Current	0 to +20 mA (sink only)
Impedance	10Ω max. f_O ≤ 10 MHz

PERFORMANCE	
Resolution	10 bits
Conversion Time[5], ADC-816MC	800 nsec. max.
ADC-826MC/MM	1.4 μsec. max.
Nonlinearity	±½ LSB max.
Differential Nonlinearity[6]	±½ LSB max.
Gain Error[7], before adjustment, unipolar	±0.3% of FSR max.[8]
bipolar	±0.2% of FSR max.
Zero Error, before adjustment, unipolar	±0.2% of FSR max.
Offset Error, before adjustment, bipolar	±0.1% of FSR max.
Gain Tempco[9], unipolar	±37 ppm/°C max.
bipolar	±28 ppm/°C max.
Zero Tempco, unipolar	±12 ppm/°C max.
bipolar	±23 ppm/°C max.
Conversion Time Tempco	±0.1%/°C
Reference Output Tempco	±20 ppm/°C max.
Power Supply Rejection	±0.008%/% supply
No missing codes	Over operating Temp. Range

POWER REQUIREMENTS	
Analog Supply, pin 12	+15V dc ±1V dc at 106 mA max.
pin 4	−15V dc ±1V dc at 60 mA max.
Reference Supply, pin 3	−15V dc ±0.5V dc at 34 mA max.
Logic Supply, pin 17	+5V dc ±0.25V dc at 80 mA max.
Power Dissipation	1.7 watts typical, 2.9 watts max.

PHYSICAL/ENVIRONMENTAL	
Operating Temp. Range Suffix C	0°C to +70°C
Suffix M	−55°C to +125°C
Storage Temperature Range	−65°C to +150°C
Package Type	32-pin hermetically sealed Ceramic DIP
Pins	0.010 x 0.018 inch gold plated Kovar
Weight	0.8 ounces (23 grams)

FOOTNOTES:

1. Bipolar input must be tied to ground.
2. Resistance tolerance is −30%, +50%, ±50 ppm/°C.
3. All coding is inverted analog.
4. Two's Complement Binary available for parallel output only.
5. Maximum conversion time is specified at full rated operating temperature. The ADC-816MM has a maximum conversion time of 900 nanoseconds at full rated operating temperature. See Technical note 3 for 25°C conversion time.
6. Tested over full rated operating temperature range.
7. Includes Zero Error.
8. FSR is Full-Scale Range.
9. Includes internal reference Tempco. Given as a maximum for 5V FSR, these values improve by 10% for 10V FSR, and by 20% for 20V FSR.

TECHNICAL NOTES

1. Use of good high frequency circuit board layout techniques is required for rated performance. The power common (pin 1), comparator common (pin 7), and signal common (pin 6) are not connected internally, and therefore must be connected externally as directly as possible, through a low resistance, low inductance path. The extensive use of a ground plane for all common connections is highly recommended. Also, it is recommended that the analog and digital supplies, although they are internally bypassed with 0.033 μF capacitors, be additionally bypassed externally at the supply pins with 1 μF electrolytic capacitors.
2. The digital outputs are not buffered from their internal application and so are sensitive to unusual loading or long lines. Terminate these outputs with normal TTL inputs not more than 3 inches from the data output pin. Analog inputs must be non-reactive such that leads should be short and purely resistive. The reactive component of any analog input source, as seen at the analog input pin, should be less than 0.3% of the analog input resistance at that pin, for frequencies below 20 MHz.
3. Conversion time is measured from the rising edge of a 40 nanosecond start input pulse to the falling edge of the $\overline{EOC}$ output. The conversion time is factory set at +25°C for the ADC-816MC/MM at 750 nanoseconds and 1.25 microseconds for the ADC-826MC/MM. The worst case conversion time at the maximum rated operating temperature is given as a maximum specification.
4. To use the internal reference, the reference supply pin (pin 3) must be connected to the −15V supply. If the reference supply pin (pin 3) is disconnected or grounded, the internal reference will be disabled at a power saving of approximately 200 mW.

5. Serial output data is available in NRZ format successive decision pulses, MSB first, in straight binary or offset binary coding. Synchronization of the serial output data is achieved through the use of the clock output (pin 30). This same clock output also controls the output register such that at the rising edge of the output clock the previous data bit may be clocked out. However, there will be no clock edge to clock out the LSB. A Serial DATA Recovery circuit is diagrammed on the applications page that will correct this.
6. These converters have a case-to-ambient thermal resistance of 22°C per watt. At temperatures above +70°C, an air flow of at least 400 linear feet per minute is recommended. To operate at elevated temperatures it is recommended that the converter be mounted directly to the circuit board (without the use of a mounting socket) and that good thermal contact be established between the case bottom and the circuit board ground plane by use of a silicone thermal joint compound such as Wakefield Type 120 or equivalent.
7. Applications of these converters that require the use of a sample-hold may be satisfied by DATEL's model SHM-HU, an ultra-fast hybrid unit featuring 25 nanoseconds acquisition time and a ±2.5V input range.

APPLICATIONS

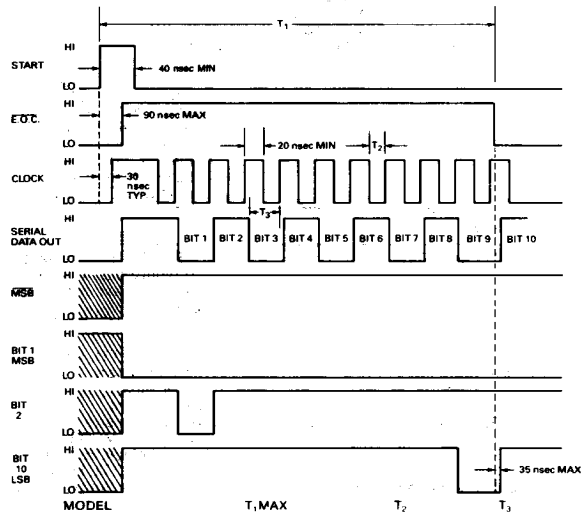
CALIBRATION PROCEDURE

1. Connect the converter as shown in the applicable connections diagram. A trigger pulse of between 40 nanoseconds and 100 nanoseconds is applied to the start conversion input (pin 31) at the rate of 200 kHz.
2. **Zero and Offset Adjustments**
   Apply a precision voltage reference source between the appropriate input for the selected full scale range and ground. Adjust the output of the reference source to the value shown in the Calibration Table for the unipolar zero adjustment (0 – ½ LSB) or the bipolar offset adjustment (+FS-½ LSB). Adjust the appropriate timing potentiometer so that the output code flickers equally between X0000 00000 and X0000 00001. The MSB indicated by X will be 0 for straight binary and offset binary coding or 1 for two's complement output coding.
3. **Full Scale Adjustment**
   Set the output of the voltage reference source used in step 2 to the value shown in the Calibration Table for the unipolar or bipolar gain adjustment (–FS + 1½ LSB). Adjust the gain trimming potentiometer so that the output code flickers equally between X1111 11111 and X1111 11110. The MSB indicated by X, will be 1 for straight binary and offset binary coding or coding or 0 for two's complement output coding.

UNIPOLAR RANGE	ADJUST.	INPUT VOLTAGE
0 To –5V	Zero	–2.4 mV
	Gain	–4.9927V
0 To –10V	Zero	–4.9 mV
	Gain	–9.9854V
0 To –20V	Zero	–9.8 mV
	Gain	–19.9707V

BIPOLAR RANGE	ADJUST.	INPUT VOLTAGE
±2.5V	Offset	±2.4975V
	Gain	–2.4927V
±5V	Offset	±4.9951V
	Gain	–4.9854V
±10V	Offset	±9.9902V
	Gain	–9.9707V

TIMING DIAGRAM FOR ADC-816, ADC-826



MODEL	T1 MAX	T2	T3
ADC-816MC/MM	800 n sec	44 n sec	23-64 n sec
ADC-826MC/MM	1.4 μ sec	100 n sec	79-114 n sec

CODING TABLES

UNIPOLAR OPERATION

INPUT RANGE			STRAIGHT BINARY		
0 to –20V	0 to –10V	0 to –5V	MSB		LSB
–19.9805	–9.9902V	–4.9951	1111	11	1111
–17.5000	–8.7500	–4.3750	1110	00	0000
–15.0000	–7.5000	–3.7500	1100	00	0000
–10.0000	–5.0000	–2.5000	1000	00	0000
–5.0000	–2.5000	–1.2500	0100	00	0000
–2.5000	–1.2500	–0.6250	0010	00	0000
–0.0198	–0.0098	–0.0049	0000	00	0001
0.0000	0.0000	0.0000	0000	00	0000

BINARY OPERATION

INPUT RANGE			OFFSET BINARY			TWO'S COMPLEMENT		
±10V	±5V	±2.5V	MSB		LSB	MSB		LSB
–9.9805	–4.9902	–2.4951	1111	11	1111	0111	11	1111
–7.5000	–3.7500	–1.8750	1110	00	0000	0110	00	0000
–5.0000	–2.5000	–1.2500	1100	00	0000	0100	00	0000
0.0000	0.0000	0.0000	1000	00	0000	0000	00	0000
+5.0000	+2.5000	+1.2500	0100	00	0000	1100	00	0000
+7.5000	+3.7500	+1.8750	0010	00	0000	1010	00	0000
+9.9805	+4.9902	+2.4951	0000	00	0001	1000	00	0001
+10.0000	+5.0000	+2.5000	0000	00	0000	1000	00	0000

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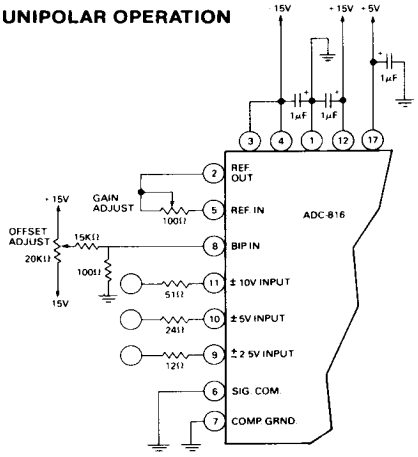
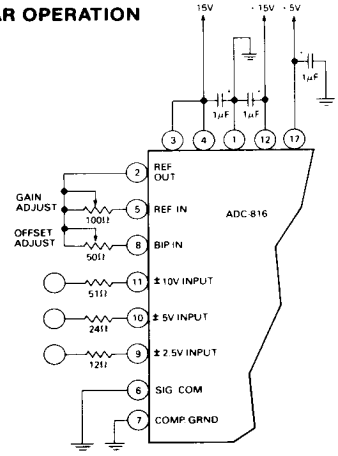
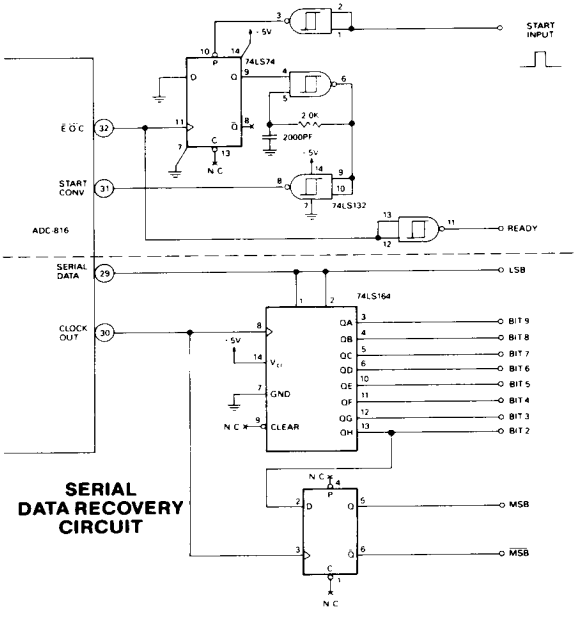
UNIPOLAR OPERATION



BIPOLAR OPERATION

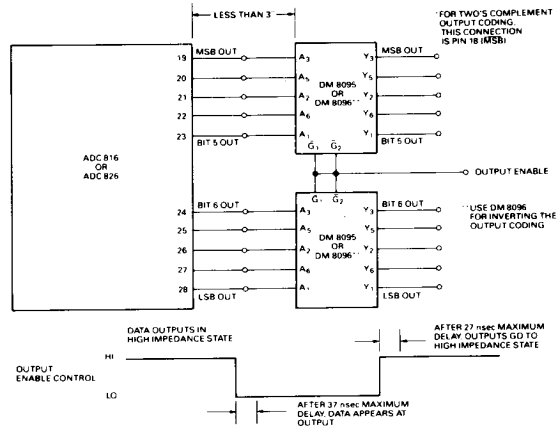


UNCONDITIONAL/START CIRCUIT



SERIAL DATA RECOVERY CIRCUIT

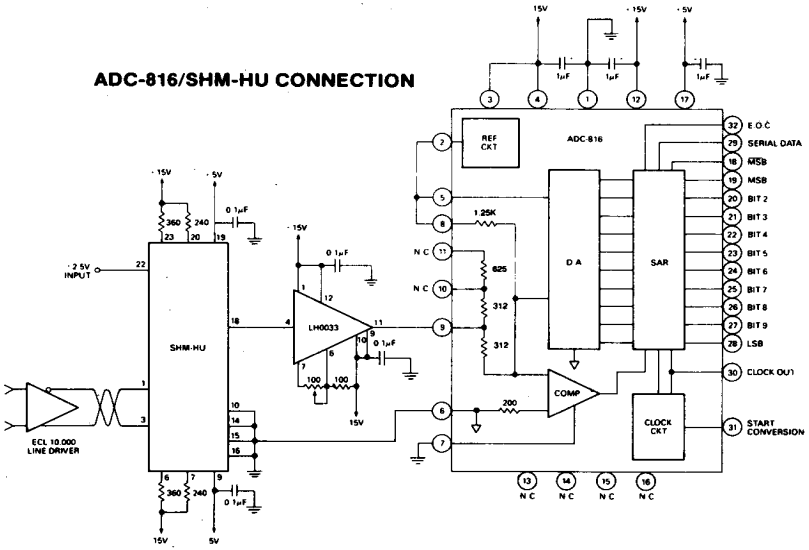
HIGH SPEED THREE-STATE OUTPUT BUFFER GROUND PLANE LAYOUT



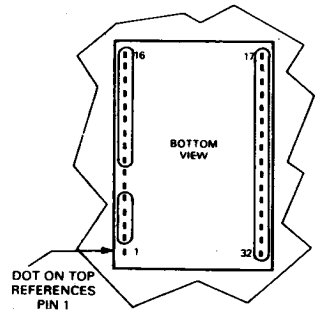
The Unconditional Start Circuit, shown for the ADC-816/826 insures the initiation of a conversion cycle upon the application of one start pulse of 40 nanoseconds minimum pulse width regardless of converter status.

The serial data output of the ADC-816/826 is converted into parallel form, with the addition of an $\overline{\text{MSB}}$ output, by the Serial Data Recovery circuit. Users should refer to technical note No. 2 on the loading of the ADC-816/826 digital outputs when using these circuits.

ADC-816/SHM-HU CONNECTION



GROUND PLANE LAYOUT



When the ADC-816 or ADC-826 is configured as shown here with DATEL's SHM-HU hybrid sample-hold, a ±2.5V input step can be acquired to 0.1% accuracy in 30 nanoseconds and held to within 40 μV while the A/D conversion takes place. Use of the SHM-HU reduces the time over which the input signal is averaged to a few nanoseconds (an A/D converter without a sample-hold averages the analog input signal over the total conversion time of the A/D).

ORDERING INFORMATION

MODEL NO.	OPERATING TEMP. RANGE
ADC-816MC	0°C To +70°C
ADC-816MM	−55°C To +125°C
ADC-826MC	−0°C To +70°C
ADC-826MM	−55°C To +125°C

ACCESSORIES

Part Number	Description
DILS-2	Mating Socket (2 per converter)
TP20K, TP100, TP50	Trimming Potentiometers

For military devices compliant to MIL-STD-883, consult DATEL.