DATEL

ADC-574A 12-Bit A/D Converter With Microprocessor Interface

PRODUCT DATA SHEET

FEATURES

- **Microprocessor compatible**
- **12-Bit resolution**
- **Full 8- or 16-Bit microprocessor bus interface**
- **150 Nanosecond bus access time**
- **25 Microsecond maximum conversion time**
- **No missing codes over temperature**

GENERAL DESCRIPTION

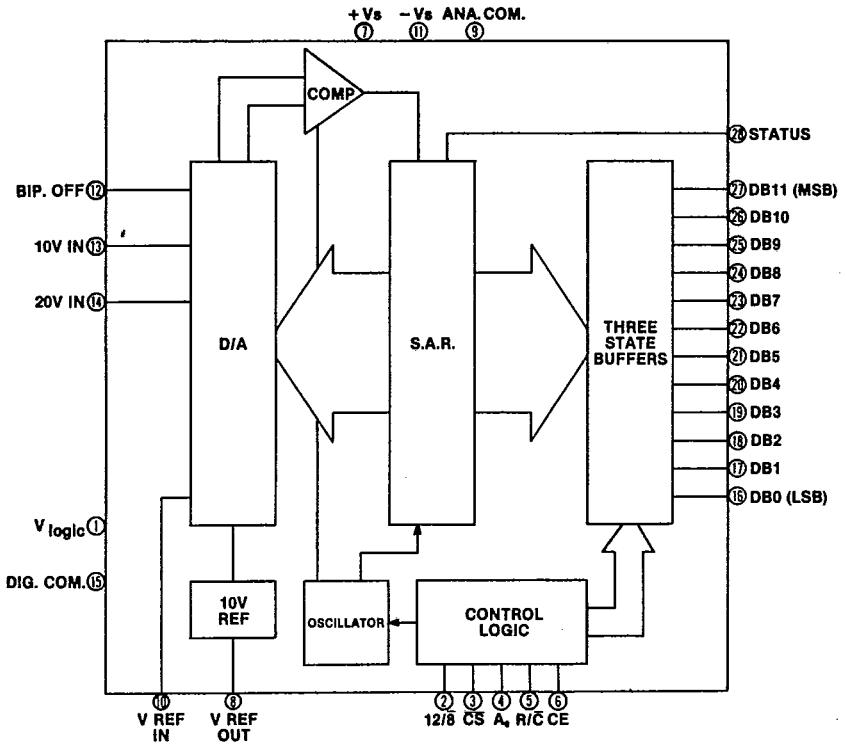
DATEL's ADC-574A is a low-cost, self-contained, 12-bit A/D converter designed for direct interface to an 8-, 12-, or 16-bit microprocessor bus. The device includes a +10V dc reference, clock, three-state outputs and digital interface circuit which allows direct connection to the microprocessor address bus and control lines. Using the successive approximation technique, the ADC-574A completes a 12-bit conversion to ±½ LSB in 25 microseconds. Four user selectable input ranges are provided: 0 to +10V, 0 to +20V, ±5V and ±10V dc. Laser trimming guarantees specified linearity, gain, and offset accuracy.

The ADC-574A is implemented with advanced bipolar and CMOS integrated circuits, resulting in excellent performance at a low cost. The comparator, reference and required amplifiers are fabricated using a linear bipolar process for maximum speed and reduced offset and drift over temperature. The SAR, 12-bit decoded D/A converter, control logic, switches and buffers are fabricated using CMOS processing to achieve low power consumption. The voltage comparator used in the ADC-574A features high PSRR plus a high speed current-mode latch that provides precise decisions down to 0.1 LSB of input drive.

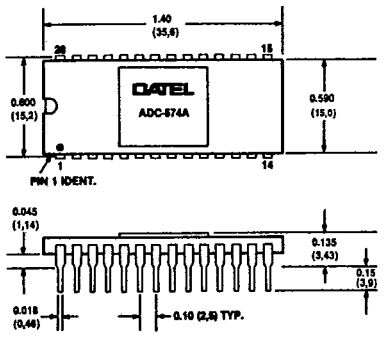
Other important features include low noise due to current-mode signal transmission between I.C.'s, precision buried zener reference, a bus access time of 150 nanoseconds, and no missing codes over temperature.

The combination of low cost and two chip reliability make the ADC-574A an excellent choice for applications in military and industrial data acquisition systems, electronic test and scientific instrumentation and process control systems.

The ADC-574A is available for operation over the commercial, 0°C to +70°C temperature range and the military, −55°C to +125°C temperature range. All models are packaged in 28-pin, hermetically sealed ceramic DIP's.



MECHANICAL DIMENSIONS INCHES (MM)



INPUT/OUTPUT CONNECTIONS

PIN	FUNCTION	PIN	FUNCTION
1	V_{logic}, +5V	15	DIG. COMMON
2	12/$\overline{8}$, DATA MODE SELECT	16	DB0 (LSB)
3	$\overline{CS}$, CHIP SELECT	17	DB1
4	A_0, BYTE ADDRESS/SHORT CYCLE	18	DB2
5	R/$\overline{C}$, READ/CONVERT	19	DB3
6	CE, CHIP ENABLE	20	DB4
7	+V_S, (+15V)	21	DB5
8	REFERENCE OUT	22	DB6
9	ANALOG COMMON	23	DB7
10	REFERENCE IN	24	DB8
11	−V_S, (−15V)	25	DB9
12	BIPOLAR OFFSET	26	DB10
13	10V IN	27	DB11 (MSB)
14	20V IN	28	STS, STATUS

ADC-574A

ABSOLUTE MAXIMUM RATINGS	
Analog Supply Voltage (Pins 7, 11)	±16.5V
Logic Supply Voltage (Pin 1)	0V to +7V
Analog Common (Pin 9) to Digital Common (Pin 15)	±1V
Digital Control Inputs (Pins 2–6) to Digital Common	−0.5V to V_{logic} +0.5V
Analog Inputs (Pins 10, 12, 13) to Analog Common	±16.5V
20V Input (Pin 14) to Analog Common	±24V
Ref. Out (Pin 8) Short Circuit Duration	Indefinite to common momentary to V_S
Chip Temperature: ADC-574A,J,K,L	100°C
ADC-574A,S,T,U	150°C
Package Dissipation	1000 mW
Lead Temperature, soldering	300°C, 10 seconds
Thermal Resistance, Junction-to-Ambient	60°C/W

FUNCTIONAL SPECIFICATIONS

Typical at 25°C, ±15V dc (or ±12V dc) and +5V dc supply voltage, unless otherwise noted.

DESCRIPTION	
ANALOG INPUTS	
Input Voltage Range, unipolar	0 to +10V, 0 to +20V
bipolar	±5V, ±10V
Input Impedance, 10V range	5 KΩ ±25%
20V range	10 KΩ ±25%
ANALOG OUTPUTS[1]	
Internal Reference, voltage	+10.00V ±0.1V max.
current	2.0 mA max.
DIGITAL INPUTS[2]	
Logic Levels: logic "1"	+2.4V min. to +5.5V max.
logic "0"	−0.5V min. to +0.8V max.
Loading: logic current, min.	−5 μA
max.	+5 μA
Capacitance	5 pF
DIGITAL OUTPUTS[3]	
Logic Levels: logic "0" (I sink, 1.6 mA)	+0.4V max.
logic "1" (I source, 500 μA)	+2.4V min.
Leakage (high impedance state)	−5 μA min. to +5 μA max.
Capacitance	5 pF
POWER REQUIREMENTS	
Analog Supply Voltage Range	±11.4V to ±16.5V
Logic Supply Voltage Range	+4.5V to +5.5V
Supply Current max, Analog Supply	+15 mA, −28 mA
Logic Supply	+15 mA
Power Consumption ($\pm V_S$ = ±15V), max.	720 mW
PHYSICAL/ENVIRONMENTAL	
Operating Temperature Range: ADC-574A,J,K,L	0°C to +70°C
ADC-574A,S,T,U	−55°C to +125°C
Storage Temperature Range	−65°C to +150°C
Package Type	28 pin side brazed ceramic DIP

PERFORMANCE	574AJ	574AK	574AL	574AS	574AT	574AU
Resolution	12 Bits					
Unipolar Offset, max.[6]	±2 LSB					
Conversion Time, max.	25 μsec.					
Full Scale Calibration Error, max.:[7]	0.3% of F.S.					
at 25°C	0.5%	0.4%	0.35%	0.8%	0.6%	0.4%
over temp.[8]	0.22%	0.12%	0.05%	0.5%	0.25%	0.12%
over temp.[9]	±1 LSB	±½ LSB	±½ LSB	±1 LSB	±½ LSB	±½ LSB
Linearity Error, max. (over temp)[4]	11 Bits	12 Bits	12 Bits	11 Bits	12 Bits	12 Bits
Differential Linearity[5]	±10 LSB	±4 LSB	±4 LSB	±10 LSB	±4 LSB	±4 LSB
Bipolar Offset, max.[6]						
Tempco:[10]						
Unipolar Offset	10 ppm/°C	5 ppm/°C	5 ppm/°C	5 ppm/°C	2.5 ppm/°C	2.5 ppm/°C
Bipolar Offset	10 ppm/°C	5 ppm/°C	5 ppm/°C	10 ppm/°C	5 ppm/°C	2.5 ppm/°C
Full Scale Calibration	45 ppm/°C	25 ppm/°C	10 ppm/°C	50 ppm/°C	25 ppm/°C	12.5 ppm/°C
Power Supply Rejection:[11]						
$+V_S$ = 13.5V to 16.5V or +11.4V to +12.6V	±2 LSB	±1 LSB	±1 LSB	±2 LSB	±1 LSB	±1 LSB
$+V_{logic}$ = +4.5V to +5.5V	±½ LSB	±½ LSB	±½ LSB	±½ LSB	±½ LSB	±½ LSB
$-V_S$ = −16.5V to −13.5V or −12.6V to −11.4V	±2 LSB	±1 LSB	±1 LSB	±2 LSB	±1 LSB	±1 LSB

FOOTNOTES:

1. Available for external loads. External load should not change during conversion. When supplying an external load and operating on ±12V supplies, a buffer amplifier must be provided for the reference output.
2. Logic Inputs — CE, $\overline{CS}$, $R\overline{C}$, A_0, 12/$\overline{8}$.
3. Logic Outputs — DB11-DBO, STS.
4. For -55°C to +125°C, ADC-574 AS, AT, AU linearity error = ±1 LSB.
5. Maximum resolution for which no missing codes is guaranteed. Specification for 25°C and over temperature.
6. Adjustable to zero.
7. With 50 Ω fixed resistor from REF OUT to REF IN. Adjustable to zero.
8. No adjustment at 25°C.
9. With adjustment at 25°C.
10. Guaranteed maximum change. Tmin to Tmax (using internal reference).
11. Maximum change in full scale calibration.

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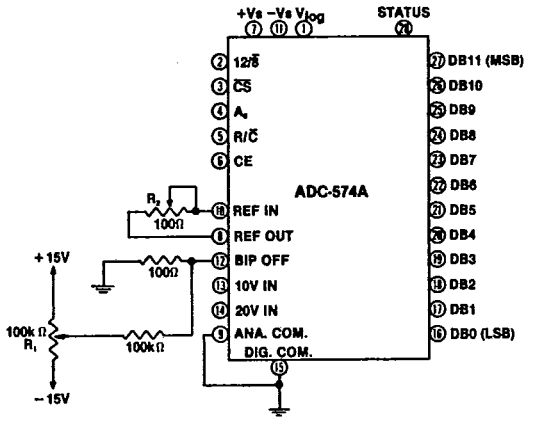
ADC-574A

TECHNICAL NOTES

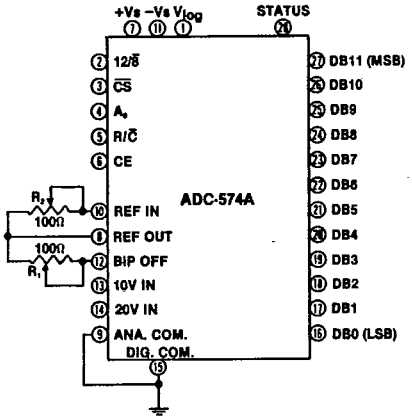
1. The ADC-574A may interface directly to a microprocessor which can take full control of each conversion, or the device can be operated in the "stand alone" mode (controlled only by the R/$\overline{C}$ input). Full control consists of selecting an 8- or 12-bit conversion cycle, initiating the conversion and reading the output data when ready. The data may be read 12 bits at once or 8 followed by 4 in a left-justified format. There are five control inputs (12/$\overline{8}$, $\overline{CS}$, A_0, R/$\overline{C}$ and CE) and all are TTL/CMOS compatible. (See ADC-574A, Control Input Truth Table.)
2. A conversion is initiated by a logic transition on any of the three inputs: CE, $\overline{CS}$, R/$\overline{C}$. One, two, or all three may be dynamically controlled. The nominal delay for each of the three inputs is the same and if necessary, all three may change states simultaneously. If it is required that a particular input controls the start of conversion, the other two should be set up at least 50 nanoseconds earlier. (See Start Convert Timing.)
3. To read the output data, four conditions must be met (or the output buffers will remain in high impedance state): R/$\overline{C}$ taken high, STS low, CE high and $\overline{CS}$ low. When this is accomplished, the data lines are activated according to the state of the 12/$\overline{8}$ and A_0 inputs. (See START CONVERT, READ CYCLE TIMING and APPLICATION.)
4. The analog signal source driving the ADC-574A's input will see a nominal load of 5 KΩ (10V range) or 10 KΩ (20V range). However, the other end of these input resistors may change 400 mV with each bit decision, causing sudden changes in current at the analog input. Therefore, the signal source must maintain its output voltage while supplying these step changes in load current which occur at 1.6 microsecond intervals. This requires low output impedance and fast settling by the signal source. If a sample/hold is required to precede the converter, DATEL's SHM-20 is recommended.
5. The power supply used should be low noise and well regulated. Voltage spikes on these lines can affect accuracy. If a switching supply is used, the outputs should be carefully filtered to assure "noise free" dc voltage to the converter. Decoupling capacitors should be used on all power supply pins; the +5V dc supply decoupling capacitor should be connected directly from $+V_{logic}$ (Pin 1) to digital common (Pin 15). The $\pm V_S$ (Pins 7, 11) should be decoupled directly to analog common (Pin 9). It is recommended that a 10 μF tantalum type in parallel with a 0.1 μF ceramic type be used for decoupling.
6. The use of good circuit board layout techniques is required for rated performance. It is recommended that a double sided printed circuit board with a ground plane on the component side is used. Other techniques, such as wire-wrapping or point-to-point wiring on vectorboard will have an unpredictable effect on accuracy. Sensitive analog signals should be routed between ground traces and kept away from digital lines. If analog and digital lines must cross, they should do so at right angles.

TYPICAL CONNECTIONS



ADC-574A, UNIPOLAR CONFIGURATION

NOTES: The trimpots shown are for calibration of offset and gain. If adjustment is not required in unipolar; replace R_2 with a 50Ω, 1% metal film resistor, omit the network on Pin 12 and connect Pin 12 to Pin 9. In bipolar; either R_1, or R_2 or both can be replaced by 50Ω, 1% metal film resistors.



ADC-574A, BIPOLAR CONFIGURATION

CODING TABLES

INPUT RANGE		OUTPUT CODING		
0 to + 10V	0 to + 20V	MSB		LSB
+10.000	+20.0000	1111	1111	1111
+9.9963	+19.9927	1111	1111	111Ø*
+5.0012	+10.0024	1000	0000	000Ø*
+4.9988	+9.9976	Ø000	0000	000Ø*
+4.9963	+9.9927	0111	1111	111Ø*
+0.0012	+0.0024	0000	0000	000Ø*
0.0000	+0.0000	0000	0000	0000

INPUT RANGE		OUTPUT CODING		
±5V	±10V	MSB		LSB
+5.0000	+10.0000	1111	1111	1111
+4.9963	+9.9927	1111	1111	111Ø*
+0.0012	+0.0024	1000	0000	000Ø*
-0.0012	-0.0024	Ø000	0000	000Ø*
-0.0037	-0.0073	0111	1111	111Ø*
-4.9988	-9.9976	0000	0000	000Ø*
-5.0000	-10.0000	0000	0000	0000

*Voltages shown are theoretical values for the transitions indicated. Ideally, in the continuous conversion mode, the output bits indicated as Ø will change from "1" to "0" or "0" to "1" as the input voltage passes through the level indicated.

Output coding is straight binary for unipolar and offset binary for bipolar.

DATEL

ADC-574A

CALIBRATION

UNIPOLAR CALIBRATION

Offset Adjust

Apply an input of + ½ LSB (+1.22 mV for the 10V range; +2.44 mV for the 20V range). Adjust the offset trimpot (R_1) until the first code transition flickers between 0000 0000 0000 and 0000 0000 0001.

Gain Adjust

Apply 1½ LSB's below the nominal full-scale (+9.9963V for the l0V range; +19.9927V for the 20V range). Adjust the gain trimpot (R_2) so that the output flickers between 1111 1111 1110 and 1111 1111 1111.

BIPOLAR CALIBRATION

Offset Adjust

Apply ½ LSB above negative full-scale (−4.9988V for the ±5V range; −9.9976V for the ±10V range.) Adjust the offset trimpot (R_1) so that the output flickers between 0000 0000 0000 and 0000 0000 0001.

Gain Adjust

Apply 1½ LSB's below positive full scale (+4.9963V for the ±5V range; +9.9927V for the ±10V range). Adjust the gain trimpot (R_2) so that the output flickers between 1111 1111 1110 and 1111 1111 1111.

TIMING CONTROL

The variety of the ADC-574A's control modes (as shown in the "CONTROL INPUTS TRUTH TABLE") allow for simple interface in most system applications.

The output signal STS indicates the status of the device; high during a conversion, and low at the completion of a conversion. During a conversion (STS output high), the output buffers remain in the high impedance state and data cannot be read. A start convert during conversion will not reset the converter or reinitiate a conversion. However, if A_0, changes state after a conversion begins, an additional start convert pulse will latch the new state of A_0, causing a wrong cycle length for that conversion.

Control Inputs Truth Table

CE	$\overline{CS}$	R/$\overline{C}$	12/$\overline{8}$	A_0	OPERATION
0	X	X	X	X	None
X	1	X	X	X	None
0-1	0	0	X	0	Initiate 12-bit conversion
0-1	0	0	X	1	Initiate 8-bit conversion
1	1-0	0	X	0	Initiate 12-bit conversion
1	1-0	0	X	1	Initiate 8-bit conversion
1	0	1-0	X	0	Initiate 12-bit conversion
1	0	1-0	X	1	Initiate 8-bit conversion
1	0	1	1	X	Initiate 12-bit conversion
1	0	1	0	0	Enable's 8 MSB's only
1	0	1	0	1	Enable's 4 LSB's plus 4 trailing zeroes

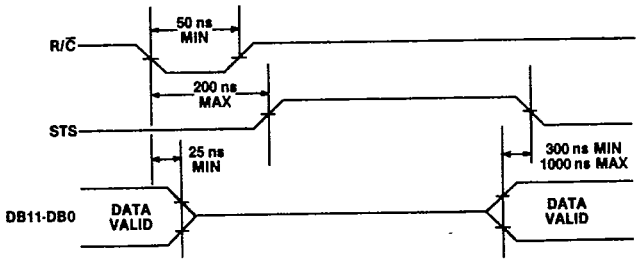
TIMING AND OPERATION

Stand-Alone Mode Timing

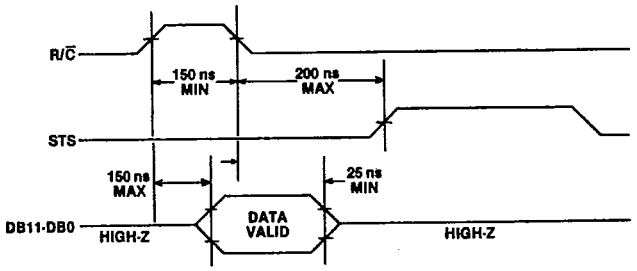
For stand-alone operation, all that is required is a single control line to R/$\overline{C}$. CE and 12/$\overline{8}$ are tied high, $\overline{CS}$ and A_0 are tied low, and the output appears in words of 12 bits.

The R/$\overline{C}$ signal may have any duty cycle within the limits shown in the diagrams below.

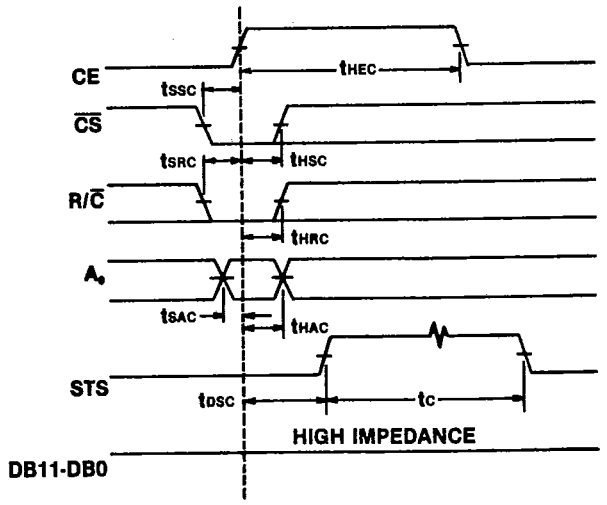
The data may be read when R/$\overline{C}$ is high unless STS is also high indicating a conversion is in progress.



Outputs Enabled After Conversion



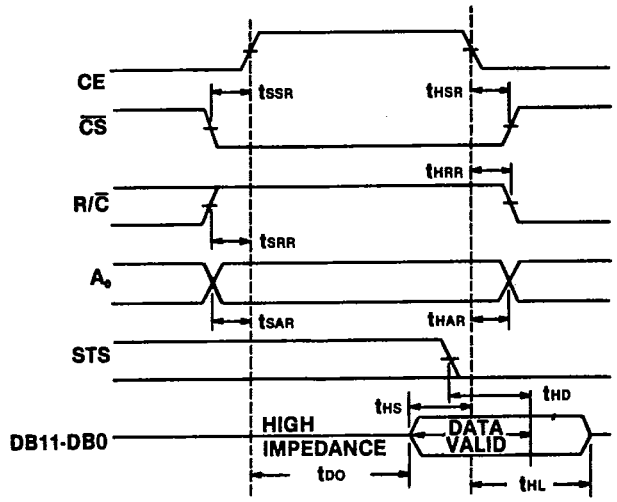
Outputs Enabled With R/$\overline{C}$ High



Start Convert Timing

A read operation in most applications begins after the conversion is complete and STS is low. For earliest access to the data however, the read should begin no later than ($t_{DD} + t_{HS}$) before STS goes low. (See Technical Note 3.)

ADC-574A



Read Cycle Timing

Read Mode

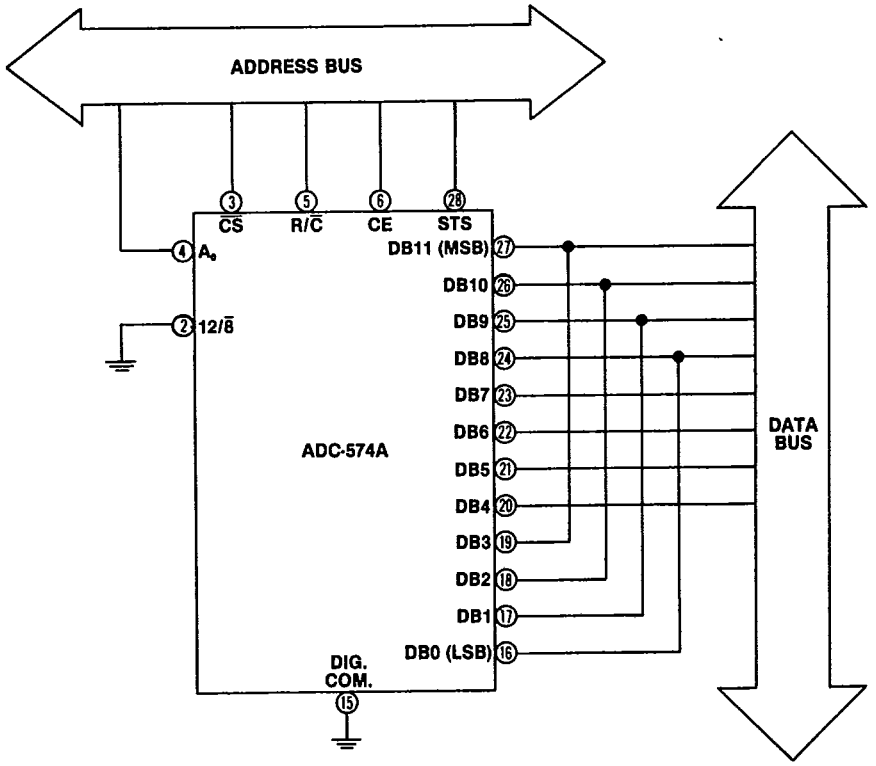
Symbol	Parameter	Min.	Typ.	Max.
t_{DD}	Access Time from CE	—	75 nS	150 nS
t_{HD}	Data Valid after CE Low	25 nS	35 nS	—
t_{HL}	Output Float Delay	—	100 nS	150 nS
t_{SSR}	$\overline{CS}$ to CE Setup	50 nS	0	—
t_{SRR}	R/$\overline{C}$ to CE Setup	0	0	—
t_{SAR}	A_0 to CE Setup	50 nS	25 nS	—
t_{HSR}	$\overline{CS}$ Valid after CE Low	0	0	0
t_{HRR}	R/$\overline{C}$ High after CE Low	0	0	0
t_{HAR}	A_0 Valid after CE Low	50 nS	25 nS	—
t_{HS}	STS Delay after Data Valid	300 nS	500 nS	1000 nS

Convert Mode

Symbol	Parameter	Min.	Typ.	Max.
t_{DSC}	STS Delay From CE	—	100 nS	200 nS
t_{HEC}	CE Pulse Width	50 nS	30 nS	—
t_{SSC}	$\overline{CS}$ to CE Setup	50 nS	20 nS	—
t_{HSC}	$\overline{CS}$ Low during CE High	50 nS	20 nS	—
t_{SRC}	R/$\overline{C}$ to CE Setup	50 nS	0	—
t_{HRC}	R/$\overline{C}$ Low during CE High	50 nS	20 nS	—
t_{SAC}	A_0 to CE Setup	0	0	0
t_{HAC}	A_0 Valid during CE High	50 nS	20 nS	—
t_C	Conversion Time, 12 bit cycle	15 µS	20 µS	25 µS
	8 bit cycle	10 µS	13 µS	17 µS

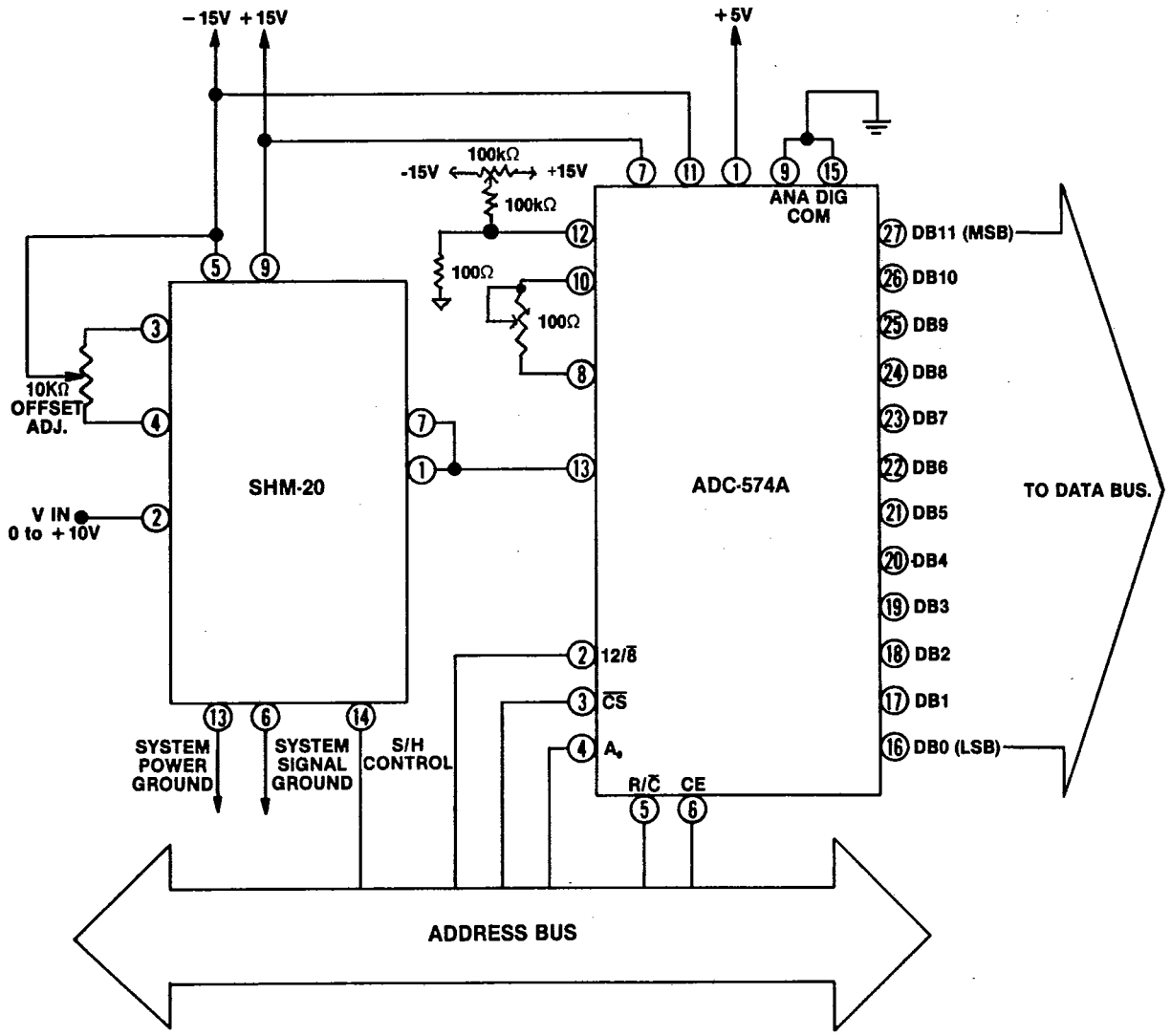
Interface To An 8-Bit Data Bus

The 12/$\overline{8}$ input will be tied either high or low in most applications. With 12/$\overline{8}$ high, all 12 output lines become active simultaneously for interface to a 12- or 16-bit data bus. A_0 is ignored. Taking 12/$\overline{8}$ low organizes the output in two 8-bit bytes, which are selected one at a time by A_0. This allows an 8-bit data bus to be connected as shown above. A_0 is normally tied to the LSB of the address bus for storing the converter's output in two consecutive memory locations. This two byte format is called "left justified data" for which a decimal point is assumed to the left of byte 1. In addition, A_0 may be toggled at any time without damage to the converter. Break-before-make switching is guaranteed between two data bytes, which assures that the outputs strapped together as shown are never enabled at the same time.



ADC-574A

FAST A/D WITH SAMPLE HOLD



Fast A/D With Sample Hold

The above diagram shows the ADC-574A configured for unipolar (0 to + 10V) operation. Preceding the ADC-574A is DATEL's SHM-20, a 1 microsecond precision sample/hold. All sample/hold amplifiers are compatible with the ADC-574A; however, many will require an additional wide-band buffer amplifier to reduce their output impedance.

ORDERING INFORMATION

MODEL	TEMPCO
ADC-574AJ	45 ppm/°C
ADC-574AK	25 ppm/°C
ADC-547AL	10 ppm/°C
ADC-574AS	50 ppm/°C
ADC-574AT	25 ppm/°C
ADC-574AU	12.5 ppm/°C

ACCESSORIES

Part Number	Description
TP100 or TP100K	Trimming Potentiometers

11 CABOT BOULEVARD, MANSFIELD, MA 02048/TEL. (617) 339-9341/TWX 710-346-1953/TLX 951340/FAX (617) 339-6356 DS-0036
• Santa Ana, CA (714)835-2751 • Sunnyvale, CA (408) 733-2424 • Los Angeles, CA (213) 933-7256
• OVERSEAS: DATEL (UNITED KINGDOM) TEL. BASINGSTOKE (256) 469085 • DATEL (FRANCE) TEL. (1) 4602-5711
• DATEL (GERMANY) TEL. (89) 530741 • DATEL (JAPAN) TOKYO TEL. (3) 779-1030 • DATEL (JAPAN) OSAKA TEL. (6) 354 2025
• DATEL (THE NETHERLANDS) TEL. (71) 895300