

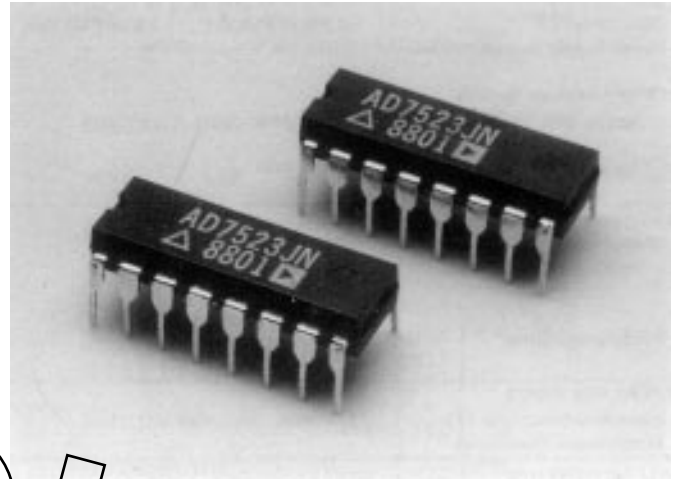
AD7523

FEATURES

Low Cost
Fast Settling: 100ns
Low Power Dissipation
Low Feedthrough: $\frac{1}{2}$ LSB @ 200kHz
Full Four-Quadrant Multiplying

APPLICATIONS

Battery Operated Equipment
Low Power, Ratiometric A/D Converters
Digitally Controlled Gain Circuits
Digitally Controlled Attenuators
CRT Character Generation
Low Noise Audio Gain Control

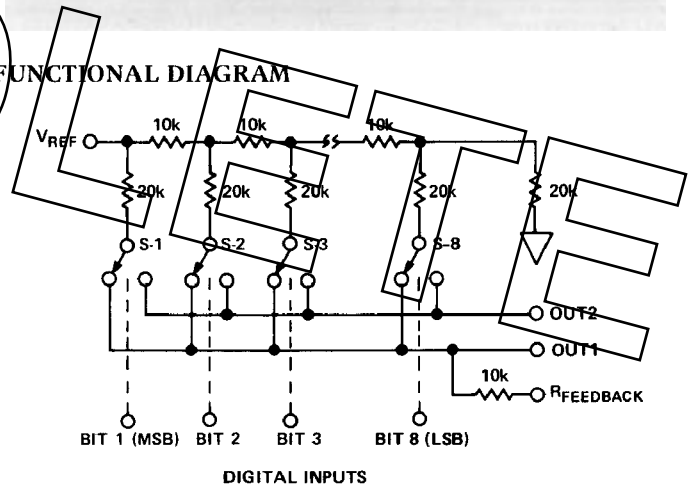


GENERAL DESCRIPTION

The AD7523 is a low cost, monolithic multiplying digital-to-analog converter packaged in a 16-pin DIP. The device uses an advanced monolithic, thin-film-on-CMOS technology to provide 8-bit resolution with accuracy to 10-bits and very low power dissipation.

The AD7523's excellent multiplying characteristics and low cost allow it to be used in a wide ranging field of applications such as: low noise audio gain control, CRT character generation, motor speed control, digitally controlled attenuators, etc.

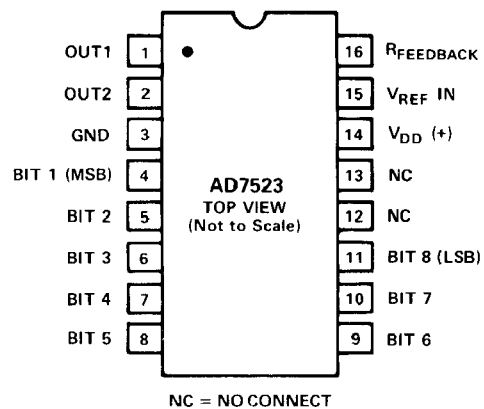
FUNCTIONAL DIAGRAM



ORDERING INFORMATION

Model	Linearity	Package	Operating Temperature Range
AD7523JN	$\pm 1/2$ LSB	16 pin Plastic	0 to +70°C
AD7523KN	$\pm 1/4$ LSB		
AD7523LN	$\pm 1/8$ LSB		

PIN CONFIGURATION



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SPECIFICATIONS (V_{DD} = +15V, V_{REF} = +10V unless otherwise noted)

PARAMETER	T _A = +25°C	T _A = T _{min} to T _{max}	TEST CONDITION
STATIC ACCURACY			
Resolution	8 Bits min	8 Bits min	
Nonlinearity ¹			V _{OUT1} = V _{OUT2} = 0V
AD7523JN	±1/2LSB max (±0.2% FSR max)	±1/2LSB max (±0.2% FSR max)	
AD7523KN	±1/4LSB max (±0.1% FSR max)	±1/4LSB max (±0.1% FSR max)	
AD7523LN	±1/8LSB max (±0.05% FSR max)	±1/8LSB max (±0.05% FSR max)	
Monotonicity	Guaranteed over T _{min} to T _{max}		V _{OUT1} = V _{OUT2} = 0V
Gain Error ^{1,2,3}	-1.5% of FSR min, +1.5% of FSR max	-1.8% of FSR min, +1.8% of FSR max	Digital Inputs = V _{INH} V _{DD} = +14V to +15V Digital Inputs = V _{INH}
Power Supply Rejection (Gain) ^{1,2}	0.02% per % max	0.03% per % max	
Output Leakage Current			V _{OUT1} = V _{OUT2} = 0V, V _{REF} = ±10V
I _{OUT1} (pin 1)	±50nA max	±200nA max	Digital Inputs = V _{INL} V _{OUT1} = V _{OUT2} = 0V, V _{REF} = ±10V
I _{OUT2} (pin 2)	±50nA max	±200nA max	Digital Inputs = V _{INH}
DYNAMIC PERFORMANCE			
Output Current			To 0.2% FSR, Load = 100Ω
Settling Time ⁴	150ns max	200ns max	Digital Inputs = V _{INH} to V _{INL} or V _{INL} to V _{INH} Digital Inputs = V _{INL} V _{REF} = 20V p-p, 200kHz sinewave
Feedthrough Error ⁴	±1/2LSB max	±1LSB max	
REFERENCE INPUT			
Input Resistance (pin 15)	5kΩ min, 20kΩ max		V _{OUT1} = V _{OUT2} = 0V
Temperature Coefficient		-500ppm/°C max	
ANALOG OUTPUTS⁴			
Output Capacitance			Digital Inputs = V _{INH}
C _{OUT1} (pin 1)	100pF max	100pF max	
C _{OUT2} (pin 2)	30pF max	30pF max	Digital Inputs = V _{INL}
C _{OUT1} (pin 1)	30pF max	30pF max	
C _{OUT2} (pin 2)	100pF max	100pF max	
DIGITAL INPUTS			
Logic Thresholds			
V _{INH}	+14.5V min	+14.5V min	
V _{INL}	+0.5V max	+0.5V max	
Input Leakage Current			V _{IN} = 0V or +15V
I _{IN} (per input)	±1μA max	±1μA max	
Input Capacitance			
C _{IN} ⁴	4pF max	4pF max	
Input Coding	Unipolar Binary of Offset Binary (see next page)		
POWER REQUIREMENTS			
V _{DD} Range	+5V min, +16V max	+5V min, +16V max	Device Functionality. Accuracy is tested and guaranteed only at V _{DD} = +15V
I _{DD}	100μA max	100μA max	Digital Inputs = V _{INH} or V _{INL}

NOTES:

¹ FSR is Full Scale Range.

² Using internal feedback resistor, Full Scale Range (FSR) is equal to (V_{REF} - 1LSB) in the unipolar circuit on the next page.

³ Max gain change from +25°C to T_{min} or T_{max} is ±0.3% FSR.

⁴ Guaranteed by design. Not subject to test.

Specifications subject to change without notice.

ABSOLUTE MAXIMUM RATINGS

(T_A = +25°C unless otherwise stated)

V _{DD} to GND	-0V to +17V
V _{REF} to GND	±25V
Digital Input Voltage (V _{IN}) to GND	-0.3V to V _{DD} + 0.3V
V _{OUT1} , V _{OUT2} to GND	-0.3V to V _{DD}

Power Dissipation (Package)

To +70°C	670mW
Derate above +70°C by	8.3mW/°C
Operating Temperature Range	0 to +70°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (Soldering, 10sec)	+300°C

CAUTION:

ESD (Electro-Static Discharge) sensitive device. The digital control inputs are diode protected; however, permanent damage may occur on unconnected devices subject to high energy electrostatic fields. Unused devices must be stored in conductive foam or shunts. The protective foam should be discharged to the destination socket before devices are removed.



BASIC OPERATION

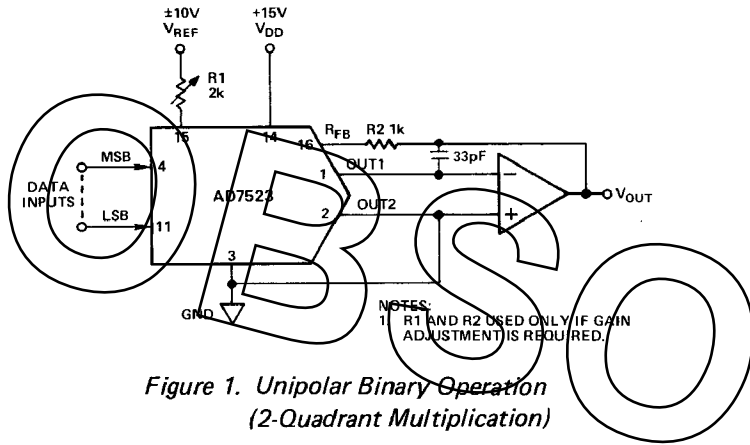


Figure 1. Unipolar Binary Operation (2-Quadrant Multiplication)

DIGITAL INPUT ANALOG OUTPUT

MSB	LSB	ANALOG OUTPUT
1	1	$-V_{REF} \left(\frac{255}{256} \right)$
1	0	$-V_{REF} \left(\frac{129}{256} \right)$
1	0	$-V_{REF} \left(\frac{128}{256} \right) = -\frac{V_{REF}}{2}$
0	1	$-V_{REF} \left(\frac{127}{256} \right)$
0	0	$-V_{REF} \left(\frac{1}{256} \right)$
0	0	$-V_{REF} \left(\frac{0}{256} \right) = 0$

Note: $1\text{LSB} = (2^{-8})(V_{REF}) = \left(\frac{1}{256} \right) (V_{REF})$

Table I. Unipolar Binary Code Table

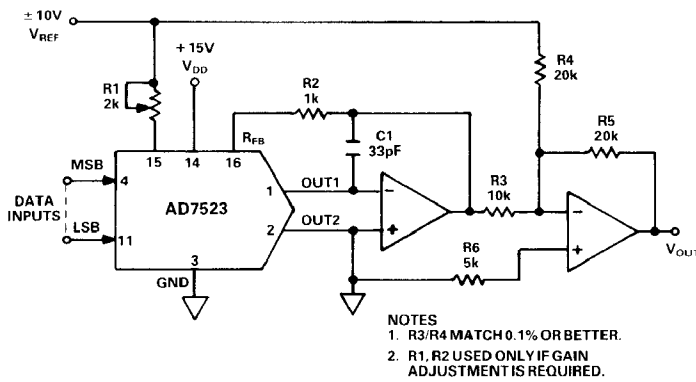


Figure 2. Bipolar (4-Quadrant) Operation

DIGITAL INPUT ANALOG OUTPUT

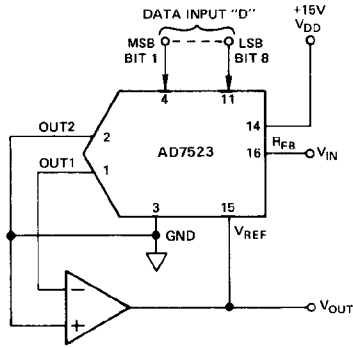
MSB	LSB	ANALOG OUTPUT
1	1	$-V_{REF} \left(\frac{127}{128} \right)$
1	0	$-V_{REF} \left(\frac{1}{128} \right)$
1	0	0
0	1	$+V_{REF} \left(\frac{1}{128} \right)$
0	0	$+V_{REF} \left(\frac{127}{128} \right)$
0	0	$+V_{REF} \left(\frac{128}{128} \right)$

Note: $1\text{LSB} = (2^{-7})(V_{REF}) = \left(\frac{1}{128} \right) (V_{REF})$

Table II. Bipolar (Offset Binary) Code Table

APPLICATIONS

DIVIDER (DIGITALLY CONTROLLED GAIN)



EQUATIONS

$$V_{OUT} = -\frac{V_{IN}}{D}$$

$$A_v = \frac{V_{OUT}}{V_{IN}} = -\frac{1}{D} \quad \text{where: } A_v = \text{Voltage Gain}$$

and where:

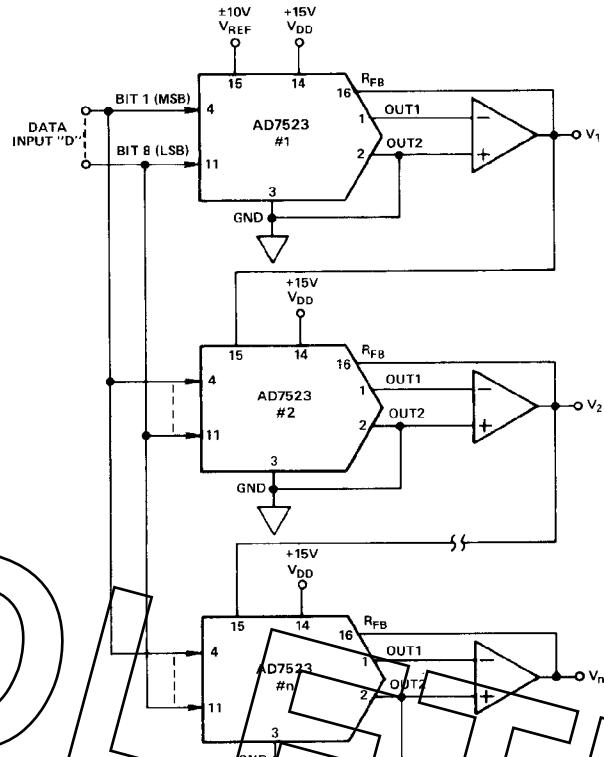
$$D = \frac{BIT\ 1}{2^1} + \frac{BIT\ 2}{2^2} + \dots + \frac{BIT\ 8}{2^8}$$

(BIT N = 1 or 0)

EXAMPLES

- D = 00000000, $A_v = -A_{OP}$ (OP AMP)
- D = 00000001, $A_v = -\frac{256}{256}$
- D = 10000000, $A_v = -\frac{256}{128} = -2$
- D = 11111111, $A_v = -\frac{256}{255}$

POWER GENERATION



CIRCUIT EQUATIONS

$$V_1 = -(V_{REF})(D^1)$$

$$V_2 = +(V_{REF})(D^2)$$

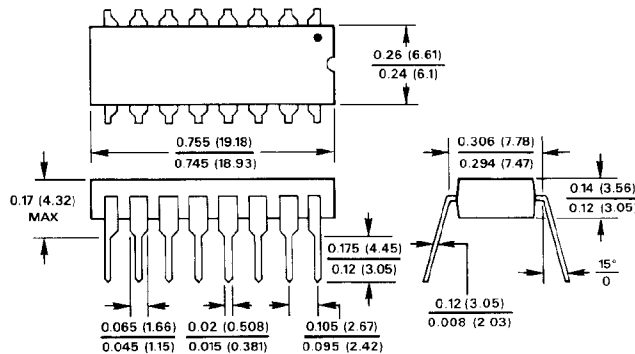
$$V_n = -(V_{REF})(D^n), \text{ n an odd integer}$$

$$V_n = +(V_{REF})(D^n), \text{ n an even integer}$$

OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).

16 PIN PLASTIC DIP



1. LEAD NO. 1 IDENTIFIED BY DOT OR NOTCH
2. LEADS ARE SOLDER PLATED KOVAR OR ALLOY 42.