

# MAXIM

## CMOS 8 Bit Multiplying D/A Converter

**MX7523**

### General Description

The MX7523 is high performance multiplying 8 bit digital-to-analog converter (DAC). Low power CMOS technology and low cost make it suitable for a wide range of analog data acquisition and control applications.

Thin-film resistors assure 8 bit resolution with up to 10 bit linearity (L grade) over the full operating temperature range. In addition, all digital inputs are compatible with CMOS logic levels.

Maxim's MX7523 is electrically and pin compatible with the Analog Devices AD7523 and is available in a standard width 16-lead DIP as well as small outline package.

### Applications

- Automatic Test Equipment
- Digital Calibration Systems
- Battery Powered Instruments
- Audio Gain Control
- Digitally Controlled Filters
- Programmable Power Supplies
- Motion Control Systems

### Features

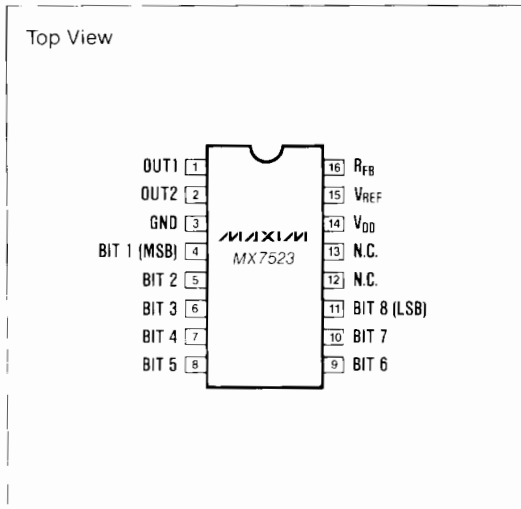
- ◆ 8, 9 and 10 Bit Linearity
- ◆  $\pm 1.5\%$  Untrimmed Gain Accuracy
- ◆ Guaranteed Monotonic
- ◆ Low Feedthrough 1/2LSB at 200kHz
- ◆ Low Power Consumption
- ◆ CMOS Compatible Logic Inputs
- ◆ Widely Second Sourced

### Ordering Information

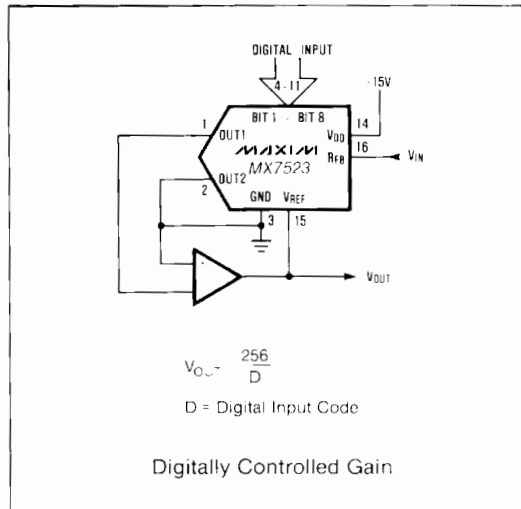
PART	TEMP RANGE	PACKAGE*	ERROR
MX7523JN	0°C to +70°C	Plastic DIP	1/2LSB
MX7523KN	0°C to +70°C	Plastic DIP	1/4LSB
MX7523LN	0°C to +70°C	Plastic DIP	1/8LSB
MX7523JCWE	0°C to +70°C	Small Outline	1/2LSB
MX7523KCWE	0°C to +70°C	Small Outline	1/4LSB
MX7523LCWE	0°C to +70°C	Small Outline	1/8LSB

\* All devices — 16 lead packages

### Pin Configuration



### Typical Operating Circuit



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## ABSOLUTE MAXIMUM RATINGS

V <sub>DD</sub> to GND	-0.3V, +17V	Storage Temperature	-65°C to +150°C
V <sub>REF</sub> to GND	±25V	Lead Temperature (Soldering 10 secs)	+300°C
R <sub>FB</sub> to GND	±25V	Power Dissipation to +70°C	
Digital Input Voltage to GND	-0.3V, V <sub>DD</sub>	Plastic DIP	670mW
Output Voltage (OUT1, OUT2) (Note 1)	-0.3V, V <sub>DD</sub>	Small Outline	450mW
Operating Temperature	0°C to +70°C		

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS

(T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, V<sub>DD</sub> = +15V, V<sub>REF</sub> = +10V, V<sub>OUT1</sub> = V<sub>OUT2</sub> = GND, unless otherwise specified)

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	
<b>DC ACCURACY</b>							
Resolution			8			Bits	
Nonlinearity (Note 2)		0.2% FSR = 1/8LSB	J		±1.5	LSB	
		0.1% FSR = 1/4LSB	K		±1.0		
		0.05% FSR = 1/8LSB	L		±1.0		
Monotonicity			Guaranteed				
Gain Error (Note 2, 3)		Digital Inputs = V <sub>INH</sub>	T <sub>A</sub> = +25°C T <sub>MIN</sub> to T <sub>MAX</sub>		±1.5 ±1.8	% FSR	
Power Supply Rejection (Note 2)	PSRR	V <sub>DD</sub> = +14V to +15V	T <sub>A</sub> = +25°C T <sub>MIN</sub> to T <sub>MAX</sub>		0.02 0.03	%/V <sub>DD</sub>	
Output Leakage Current		OUT1, Digital Inputs = V <sub>INL</sub>	T <sub>A</sub> = +25°C T <sub>MIN</sub> to T <sub>MAX</sub>		±50 ±200	nA	
		OUT2, Digital Inputs = V <sub>INH</sub>	T <sub>A</sub> = +25°C T <sub>MIN</sub> to T <sub>MAX</sub>		±50 ±200		
			T <sub>A</sub> = +25°C		5		10
V <sub>REF</sub> Input Resistance	R <sub>REF</sub>	T <sub>A</sub> = +25°C					
V <sub>REF</sub> Resistance Tempco		(Note 4)			-500	ppm/°C	
<b>AC PERFORMANCE (Note 4)</b>							
Output Current Settling Time to 0.2% of FSR		R <sub>L</sub> = 100Ω, Digital Inputs = V <sub>INH</sub> to V <sub>INL</sub> and V <sub>INL</sub> to V <sub>INH</sub>	T <sub>A</sub> = +25°C T <sub>MIN</sub> to T <sub>MAX</sub>		150 200	ns	
Feedthrough Error		Digital Inputs = V <sub>INL</sub> , V <sub>REF</sub> = 20V <sub>P-P</sub> , 200 KHz	T <sub>A</sub> = +25°C T <sub>MIN</sub> to T <sub>MAX</sub>		±1.5	LSB	
Output Capacitance	C <sub>OUT</sub>	Digital Inputs = V <sub>INH</sub>	OUT1		100	pF	
			OUT2		30		
		Digital Inputs = V <sub>INL</sub>	OUT1		30		
			OUT2		100		
<b>DIGITAL INPUTS</b>							
Logic HIGH Threshold	V <sub>INH</sub>			+14.5		V	
Logic LOW Threshold	V <sub>INL</sub>				-0.5	V	
Input Leakage Current		Digital inputs = 0V or +15V			±1	μA	
Input Capacitance, (Note 4)					4	pF	
Input Coding		Unipolar Operation (Table 1) Bipolar Operation (Table 2)				Binary Offset Binary	
<b>POWER REQUIREMENTS</b>							
Power Supply Range	V <sub>DD</sub>	Accuracy not guaranteed over this range.		+5	+16	V	
Power Supply Current	I <sub>DD</sub>	Digital inputs = V <sub>INH</sub> or V <sub>INL</sub>			100	μA	

**Note 1:** V<sub>OUT1, 2</sub> may exceed the Absolute Maximum voltage rating if the current is limited to 30mA or less.

**Note 2:** Using internal feedback resistor (R<sub>FB</sub>). Full scale range (FSR) = -(V<sub>REF</sub> - 1LSB) in unipolar mode.

**Note 3:** Maximum gain change from +25°C to T<sub>MIN</sub> or T<sub>MAX</sub> is ±0.3% FSR.

**Note 4:** Guaranteed by design but not 100% tested.

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**MX7523**

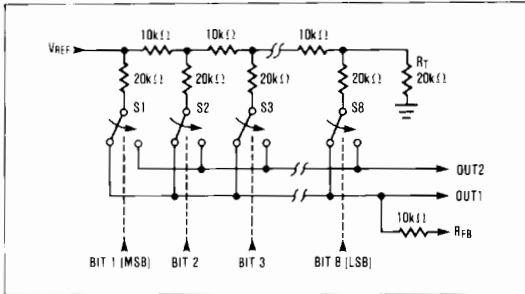
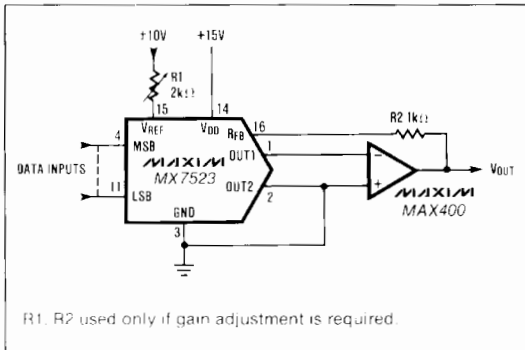
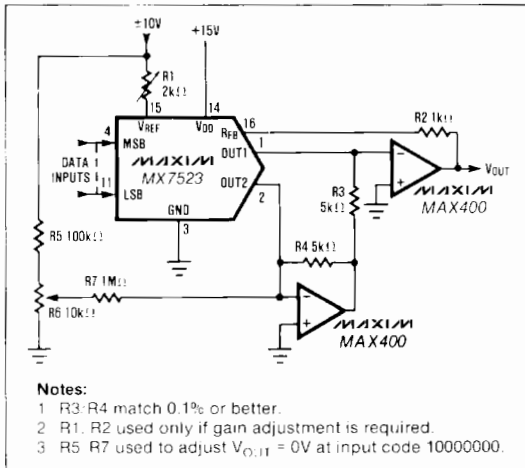


Figure 1. MX7523 Functional Diagram



R1, R2 used only if gain adjustment is required.

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



**Notes:**

- 1 R3-R4 match 0.1% or better.
- 2 R1, R2 used only if gain adjustment is required.
- 3 R5-R7 used to adjust  $V_{O,11} = 0V$  at input code 10000000.

Figure 3. Bipolar (4-Quadrant) Operation

Table 1. Unipolar Binary Code Table

DIGITAL INPUT		ANALOG OUTPUT
MSB	LSB	
1	1 1 1 1 1 1 1 1	$-V_{REF} \left( \frac{225}{256} \right)$
1	0 0 0 0 0 0 0 1	$-V_{REF} \left( \frac{129}{256} \right)$
1	0 0 0 0 0 0 0 0	$-V_{REF} \left( \frac{128}{256} \right) = -\frac{V_{REF}}{2}$
0	1 1 1 1 1 1 1 1	$-V_{REF} \left( \frac{127}{256} \right)$
0	0 0 0 0 0 0 0 1	$-V_{REF} \left( \frac{1}{256} \right)$
0	0 0 0 0 0 0 0 0	$-V_{REF} \left( \frac{0}{256} \right) = 0$

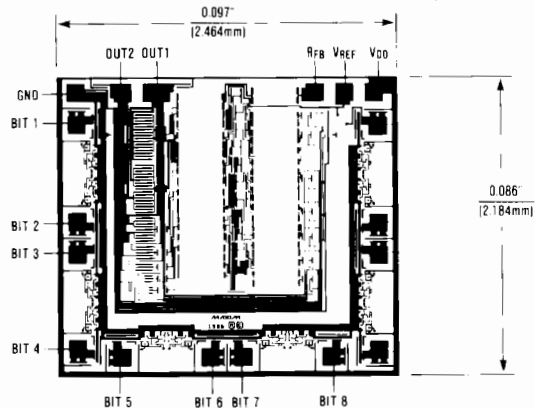
Note:  $1\text{LSB} = (2^{-8})(V_{REF}) = \left( \frac{1}{256} \right) (V_{REF})$

Table 2. Bipolar (Offset Binary) Code Table

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

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

## Chip Topography



**MX7523**

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## Package Information

**Plastic DIP  
PLASTIC  
DUAL-IN-LINE  
PACKAGE  
(0.300 in.)**

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	—	0.200	—	5.08
A1	0.015	—	0.38	—
A2	0.125	0.175	3.18	4.45
A3	0.055	0.080	1.40	2.03
B	0.016	0.022	0.41	0.56
B1	0.045	0.065	1.14	1.65
C	0.008	0.012	0.20	0.30
D1	0.005	0.080	0.13	2.03
E	0.300	0.325	7.62	8.26
E1	0.240	0.310	6.10	7.87
e	0.100	—	2.54	—
eA	0.300	—	7.62	—
eB	—	0.400	—	10.16
L	0.115	0.150	2.92	3.81

PKG.	DIM	PINS	INCHES		MILLIMETERS	
			MIN	MAX	MIN	MAX
P	D	8	0.348	0.390	8.84	9.91
P	D	14	0.735	0.765	18.67	19.43
P	D	16	0.745	0.765	18.92	19.43
P	D	18	0.885	0.915	22.48	23.24
P	D	20	1.015	1.045	25.78	26.54
N	D	24	1.14	1.265	28.96	32.13

21-0043A

**Wide SO  
SMALL-OUTLINE  
PACKAGE  
(0.300 in.)**

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.093	0.104	2.35	2.65
A1	0.004	0.012	0.10	0.30
B	0.014	0.019	0.35	0.49
C	0.009	0.013	0.23	0.32
E	0.291	0.299	7.40	7.60
e	0.050		1.27	
H	0.394	0.419	10.00	10.65
L	0.016	0.050	0.40	1.27

DIM	PINS	INCHES		MILLIMETERS	
		MIN	MAX	MIN	MAX
D	16	0.398	0.413	10.10	10.50
D	18	0.447	0.463	11.35	11.75
D	20	0.496	0.512	12.60	13.00
D	24	0.598	0.614	15.20	15.60
D	28	0.697	0.713	17.70	18.10

21-0042A

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