DAC-7523, DAC-7533, DAC-7541

Monolithic 8-, 10-, and 12-Bit Multiplying D/A Converters

FEATURES

- 8-, 10-, and 12-Bit resolution
- 150 Nanoseconds settling time — DAC-7523
- 4-Quadrant multiplication
- Low gain and linearity tempco's
- Single supply operation
- DTL/TTL/CMOS-compatible
- Industry standard pin-out

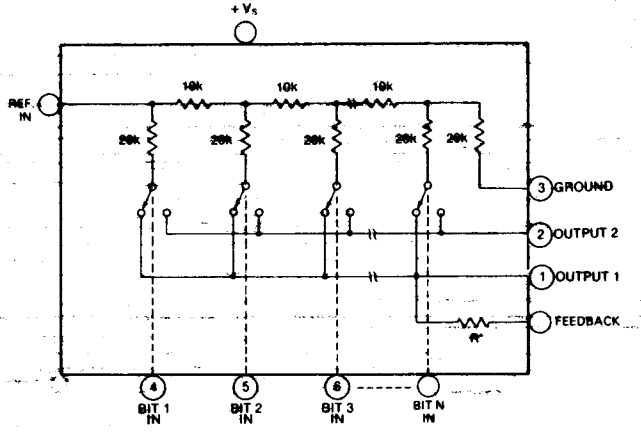
DESCRIPTION

DATEL'S DAC-7523, DAC-7533 and DAC-7541 are monolithic 8-, 10-, and 12-bit multiplying digital-to-analog converters. These devices use advanced thin-film-on-CMOS technology to fabricate a highly stable thin-film R-2R resistor ladder network and NMOS SPDT switches. CMOS level shifters provide low power DTL/ TTL/CMOS compatible operation. All that is required for most voltage output applications are an external voltage or current reference and output operational amplifier. All models are capable of four quadrant multiplication and the inputs are fully static protected.

Important features include a settling time for the DAC-7523, DAC-7533 and DAC-7541 of 150 nanoseconds, 600 nanoseconds and 1 microsecond respectively to ± ½ LSB maximum. Maximum linearity error tempco is 2 ppm/°C and feedthrough error is ± ½ LSB maximum. Power supply rejection is as low as 0.005% of FSR/%. The devices require only a single supply for operation. Power supply range is +5V dc to +15V dc.

The combination of low cost, four quadrant multiplication, full input protection and low power dissipation make these devices an ideal choice for many applications including digitally controlled gain circuits, attenuators, CRT character generation, programmable power supplies, motor speed controls and low noise audio gain control circuits.

The DAC-7523 and DAC-7533 are packaged in 16-pin plastic cases with the DAC-7541 being packaged in an 18 pin plastic case. All models are specified for operation over the commercial, 0°C to +70°C temperature range.



INPUT/OUTPUT CONNECTIONS

DAC-7523

PIN	FUNCTION
1	OUTPUT 1
2	OUTPUT 2
3	GROUND
4	BIT 1 (MSB)
5	BIT 2
6	BIT 3
7	BIT 4
8	BIT 5
9	BIT 6
10	BIT 7
11	BIT 8 (LSB)
12	N.C.
13	N.C.
14	V_S
15	REFERENCE IN
16	FEEDBACK

DAC-7533

PIN	FUNCTION
1	OUTPUT 1
2	OUTPUT 2
3	GROUND
4	BIT 1 (MSB)
5	BIT 2
6	BIT 3
7	BIT 4
8	BIT 5
9	BIT 6
10	BIT 7
11	BIT 8
12	BIT 9
13	BIT 10 (LSB)
14	V_S
15	REFERENCE IN
16	FEEDBACK

DAC-7541

PIN	FUNCTION
1	OUTPUT 1
2	OUTPUT 2
3	GROUND
4	BIT 1 (MSB)
5	BIT 2
6	BIT 3
7	BIT 4
8	BIT 5
9	BIT 6
10	BIT 7
11	BIT 8
12	BIT 9
13	BIT 10
14	BIT 11
15	BIT 12 (LSB)
16	V_S
17	REFERENCE IN
18	FEEDBACK

ABSOLUTE MAXIMUM RATINGS	DAC-7523	DAC-7533	DAC-7541
Supply Voltage, (V_S)	*	+17V	*
Logic Input Voltage Range	*	V_S to GND	*
Reference Input Voltage Range	*	±25V	*
Output Voltage Compliance	−0.3V to V_S	−0.3V to V_S	−100mV to V_S

FUNCTIONAL SPECIFICATIONS

Typical at 25°C, +15V Supply, +10V Reference unless otherwise noted.

INPUTS	DAC-7523	DAC-7533	DAC-7541
Resolution	8 Bits	10 Bits	12 Bits
Coding, Unipolar Operation	*	Straight Binary	*
Coding, Bipolar Operation	*	Offset Binary	*
Logic Threshold, Bit ON ("1"), min.	*	2.4V	*
Logic Threshold, Bit OFF ("0"), max.	*	0.8V	*
Logic Input Current, max.[1]	*	±1μA	*
Input Capacitance, max.	*	4 pF	*
Reference Input Voltage Range	*	±10V	*
Reference Input Resistance[2]	*	10 kΩ	*
OUTPUTS			
Output Voltage Compliance	*	−100 mV to V_S	*
Output Capacitance, output 1, max.[3]	100 pF	100 pF	100 pF
Output Capacitance, output 2, max.[3]	30 pF	35 pF	60 pF
Output Capacitance, output 1, max.[4]	30 pF	35 pF	60 pF
Output Capacitance, output 2, max.[4]	100 pF	100 pF	200 pF
PERFORMANCE			
Non Linearity, max.[5]	*	±½ LSB	*
Non Linearity Tempco, max.[5]	*	2 ppm/°C	*
Gain Error, max.[6]	±1.5% of FSR	±1.4% of FSR	±0.3% of FSR
Gain Error Tempco, max.[6]	10 ppm FSR/°C	15 ppm FSR/°C	15 ppm FSR/°C
Output Leakage Current, max.[7]	*	±50 nA	*
Output Current Settling Time, max.[8]	150 nsec.	600 nsec.	1 μsec.
Feedthrough Error, max.[9]	*	±½ LSB	*
Power Supply Rejection	0.02% FSR/%	0.005% FSR/%	0.01% FSR/%
POWER REQUIREMENTS			
Power Supply Voltage Range	*	+5V to +16V	*
Power Supply Current, max.	100 μA	2 mA	2 mA
PHYSICAL/ENVIRONMENTAL			
Operating Temp. Range	*	0°C to +70°C	*
Storage Temp. Range	*	−65°C to +150°C	*
Package Type, Plastic	16-Pin DIP	16-Pin DIP	18-Pin DIP

*Same specification as listed for DAC-7533

FOOTNOTES:

1. For input voltage = 0V or +15V.
2. All digital inputs tied high, OUTPUT 1 tied to ground.
3. All digital inputs high.
4. All digital inputs low.
5. Using internal feedback resistor.
6. Using internal feedback resistor. Specification for DAC-7523 only is maximum.
7. Accuracy not guaranteed unless outputs at ground potential.
8. Either output. Specified to ±½ LSB for a full scale change. Load resistance = 100Ω
9. Reference voltage = ±10V, 200 kHz for DAC-7523, 100 kHz for DAC-7533, and 10 kHz for DAC-7541. All digital inputs low.

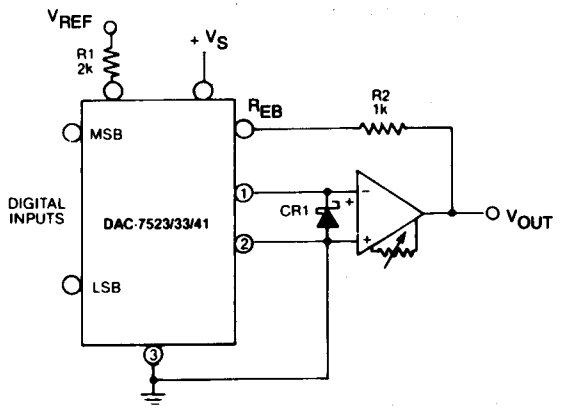
TECHNICAL NOTES

1. The digital control inputs are zener protected, however, permanent damage may occur to unconnected units under high electrostatic fields. All unused devices should be kept in conductive foam at all times.

   Unused digital inputs must be connected to V_S or ground for proper operation of the device. Voltages higher than V_S or less than ground should not be applied to any terminal except V_{ref} or damage may occur.
2. Static performance of these devices depends on output 1 and output 2 (Pins 1 and 2) being exactly at ground potential (Pin 3).
3. The output amplifier should be selected to have a low input bias current (typically less than 75 nA), and a low drift (depending on the temperature range). The voltage offset of the amplifier should be nulled (typically less than ±200 μV). A bias current compensation resistor in the output amplifier's non-inverting input (when used) can cause a variable offset. To prevent this, the non-inverting input should be connected directly to ground with a low resistance wire.
4. To prevent ground loop problems, connect all pins going to ground to a common point using separate connections.
5. The power supply used should have a low noise level and should not have any transients which exceed +17V.
6. If gain adjustment is required, low tempco (approximately 50 ppm/°C) resistors or trim-pots should be selected.

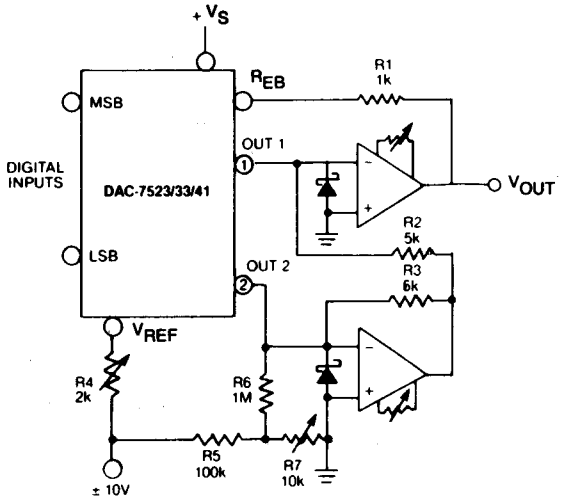
CODING AND CALIBRATION

CONNECTION-UNIPOLAR MODE



NOTES: Do not use R1 and R2 if gain adjustment is not required.
CR1 (HP5082-2811 or euivalent) protects the D/A from negative transients and is necessary only with certain high speed amplifiers.

CONNECTION—BIPOLAR MODE



NOTES: R5, R6 and R7 are used to adjust Vout = 0v at input 1000.
Do not use R1 and R4 if gain adjust is not required.
R2 and R3 should be 0.01% low-TCR resistors.

CALIBRATION

UNIPOLAR MODE

ZERO ADJUST — Set all digital inputs to logic low and adjust the zero adjust trimpot of the output operational amplifier to 0V.

GAIN ADJUST — Set all digital inputs to logic high and adjust R1 and R2 for an output equal to: Vout = Vref (N-1)/N, where "N" equals: 256 (DAC-7523), 1024 (DAC-7533), 4096 (DAC-7541).

BIPOLAR MODE

OFFSET ADJUST — Set all digital inputs to logic high and adjust the output of A2 (with A2 offset adjust trimpot) for 0V. Set MSB "Bit 1" high and all others low and adjust the output of A1 (with A1 offset adjust trimpot) for 0V. Adjust R7 for 0V at Vout.

GAIN ADJUST — Set all digital input's to logic high and adjust Vout for: Vout = Vref (N-X)/X using R1 and R4. Where "N" = 255 (DAC-7523), 1023 (DAC-7533) or 4095 (DAC-7541); and "X" = 128 (DAC-7523), 512 (DAC-7533) or 2048 (DAC-7541).

CODING TABLES

UNIPOLAR CODING TABLE

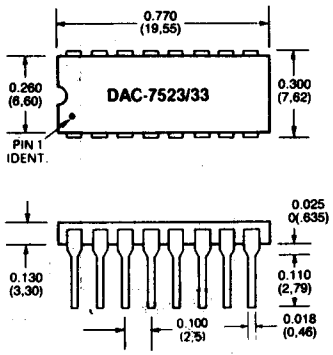
INPUT CODE MSB LSB	ANALOG OUTPUT
111 111	$-V_{REF}$ +1 LSB
110 000	$-0.75\ (V_{REF})$
100 000	$-0.5\ (V_{REF})$
010 000	$-0.25\ (V_{REF})$
000 000	0V

BIPOLAR CODING TABLE

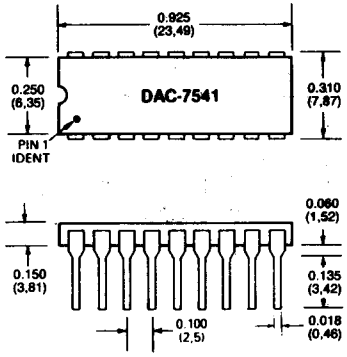
INPUT CODE MSB LSB	ANALOG OUTPUT
111 111	$-V_{REF}$ +1 LSB
110 000	$-0.5\ (V_{REF})$
100 000	0
010 000	$+0.5\ (V_{REF})$
000 000	V_{REF}

MECHANICAL DIMENSIONS
INCHES (mm)

16-PIN DIP CERAMIC PACKAGE

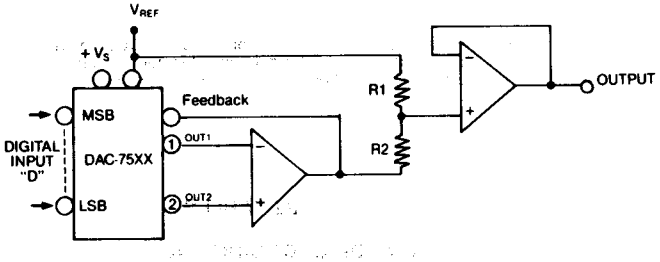


18-PIN DIP CERAMIC PACKAGE



TYPICAL CONNECTION AND APPLICATION

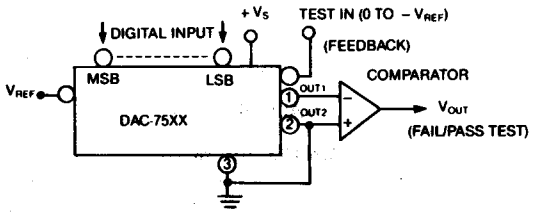
MODIFIED SCALE FACTOR AND OFFSET



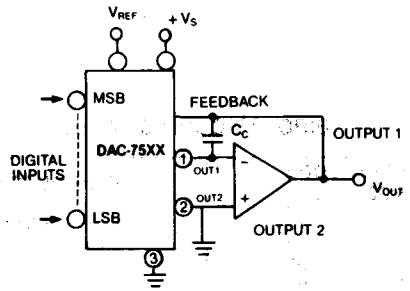
$$\text{OUTPUT} = V_{REF}\left|\left(\frac{R2}{R1+R2}\right) - \left(\frac{R1 \times D}{R1+R2}\right)\right|$$

$$\text{WHERE: } D = \frac{\text{BIT 1}}{2^1} + \frac{\text{BIT 2}}{2^2} + \ldots \frac{\text{BIT N}}{2^N}$$

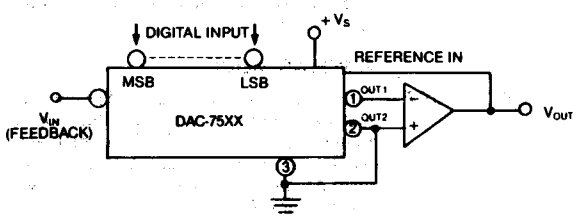
DIGITALLY CONTROLLED LIMIT DETECTOR



TYPICAL CONNECTION WITH COMPENSATION CAPACITOR



DIGITALLY CONTROLLED GAIN



$$V_{OUT} = V_{IN}/D$$

WHERE:

$$D = \frac{\text{BIT 1}}{2^1} + \frac{\text{BIT 2}}{2^2} + \ldots \frac{\text{BIT N}}{2^N}$$

The output amplifier should be selected carefully in order to maintain the dynamic performance of the D/A. In low speed or static applications, AC specifications of the op-amp are not critical. However, in high speed applications slew-rate, settling time, open loop gain and gain/phase margin specifications should be selected for the desired performance.

A compensation capacitor C_C should be used when a high speed operational amplifier is used on the output.

ORDERING INFORMATION

MODEL NO.	RESOLUTION
DAC-7523	8 Bits
DAC-7533	10 Bits
DAC-7541	12 Bits