ANALOG DEVICES

LC²MOS 14-Bit µP Compatible DAC

AD7536

FEATURES

- Full 4-Quadrant Multiplication without External Resistors
- All Grades 14-Bit Monotonic over the Full Temperature Range
- Low Output Leakage (<20nA) over the Full Temperature Range
- Low Gain Temperature Coefficient, 2ppm/°C

APPLICATIONS

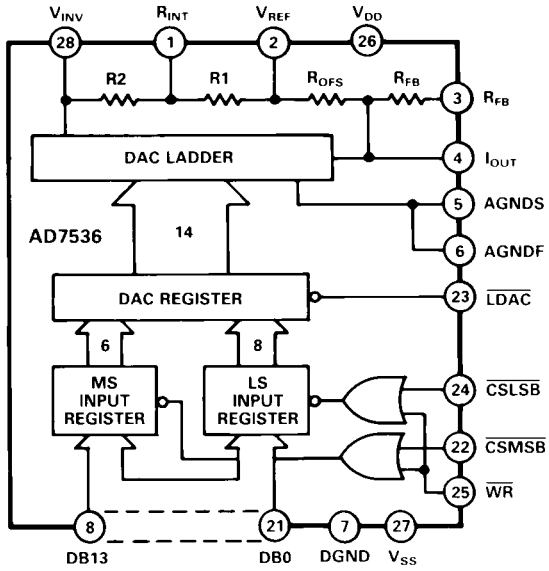
- Control and Measurement in High Temperature Environments
- Digital Audio
- Precision Servo Control
- All Microprocessor Based Control Systems

GENERAL DESCRIPTION

The AD7536 is a 14-bit monolithic CMOS D/A converter. The part is laser trimmed and specified as a dedicated bipolar DAC. The resistors needed for 4-quadrant multiplication are contained on the chip. Thus, the user requires only the AD7536, a voltage reference and two op-amps for bipolar operation. The AD7536 has the same low leakage configuration (patent pending) as the other members of the 14-bit CMOS DAC family. The excellent output leakage current characteristics also ensure exceptional stability of linearity and gain error over the full temperature range.

The device is speed compatible with most microprocessors and accepts TTL or 5V CMOS logic level inputs. There is standard Chip Select and Memory Write logic for easy interfacing. The AD7536 has full protection against CMOS "latch-up" phenomena and does not require the use of external Schottky diodes or the use of a FET Input op-amp.

FUNCTIONAL BLOCK DIAGRAM

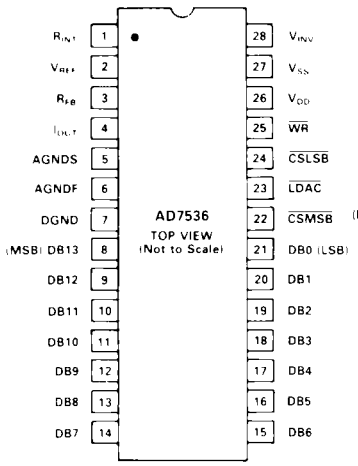


PRODUCT HIGHLIGHTS

1. Bipolar Operation
   The AD7536 gives the user 4-Quadrant Multiplication without any external resistors.
2. Guaranteed Monotonicity
   14-bit monotonicity is guaranteed over the full temperature range for all grades.
3. Low Output Leakage
   The device has excellent output leakage current characteristics at all temperatures.

PIN CONFIGURATIONS

DIP



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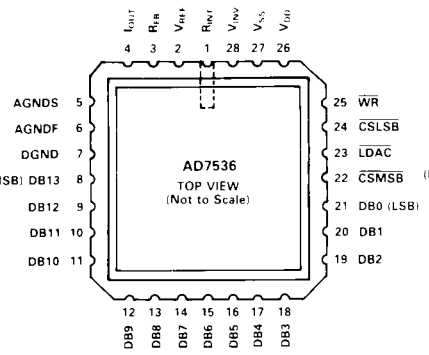

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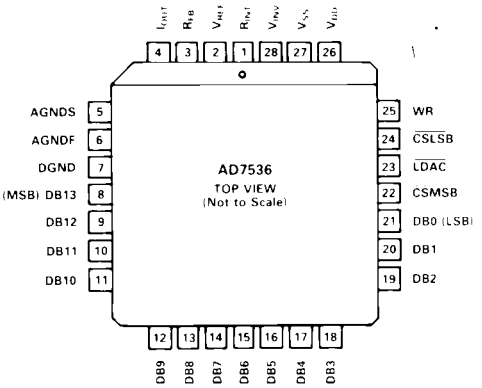

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AD7536—SPECIFICATIONS[1] (V_{DD} = +11.4V to +15.75V[2], V_{REF} = +10V, $+V_{PIN4}$ = V_{PIN5} = 0V, V_{SS} = −300 mV. All specifications T_{min} to T_{max} unless otherwise stated. See Figure 6 for Suggested Specification Circuit[3])

Parameter	AD7536JN AD7536AQ	AD7536KN AD7536BQ	AD7536SQ	AD7536TQ	Units	Test Conditions/Comments
ACCURACY						
Resolution	14	14	14	14	Bits	1LSB = $2V_{REF}/2^{14}$
Relative Accuracy	±2	±1	±2	±1	LSB max	All grades guaranteed monotonic over temperature.
Differential Nonlinearity	±1	±1	±1	±1	LSB max	
Gain Error	±16	±8	±16	±8	LSB max	Measured using internal R_{FB} and includes effects of leakage current and gain T.C.
Offset Error	±4	±4	±4	±4	LSB max	Error due to mismatch between R_{FB} and offset resistor. It also includes leakage current to I_{OUT} and is measured when DAC is loaded with all 0's.
Gain Temperature Coefficient[4], ΔGain/ΔTemperature	±5	±5	±5	±5	ppm/°C max	Typical Value is 2ppm/°C
Offset Temperature Coefficient[4] ΔOffset/ΔTemperature	±5	±2.5	±5	±2.5	ppm/°C max	Typical Value is 1ppm/°C
INPUT RESISTANCES						
V_{REF} Input Resistance, Pin 2	3	3	3	3	kΩ min	Typical Input Resistance = 6kΩ
	13	13	13	13	kΩ max	
V_{INV} Input Resistance, Pin 28	2	2	2	2	kΩ min	Typical Input Resistance = 4kΩ
	8	8	8	8	kΩ max	
DIGITAL INPUTS						
V_{IH} (Input High Voltage)	2.4	2.4	2.4	2.4	V min	
V_{IL} (Input Low Voltage)	0.8	0.8	0.8	0.8	V max	
I_{IN} (Input Current)						
+ 25°C	±1	±1	±1	±1	μA max	V_{IN} 0V or V_{DD}
T_{min} to T_{max}	±10	±10	±10	±10	μA max	
C_{IN} (Input Capacitance)[4]	7	7	7	7	pF max	
POWER SUPPLY						
V_{DD} Range	11.4/15.75	11.4/15.75	11.4/15.75	11.4/15.75	V_{min}/V_{max}	Specification guaranteed over this range.
V_{SS} Range	200/ 500	200/ − 500	200/ 500	200/ − 500	mV min/mV max	
I_{DD}	4	4	4	4	mA max	All digital inputs V_{IL} or V_{IH}
	500	500	500	500	μA max	All digital inputs 0V or V_{DD}
Power Supply Rejection ΔGain/ΔV_{DD}	±0.02	±0.02	±0.02	±0.02	% per % max	ΔV_{DD} = V_{DD} max − V_{DD} min

AC PERFORMANCE CHARACTERISTICS

These characteristics are included for Design Guidance only and are not subject to test. (V_{DD} = +11.4V to +15.75V, V_{REF} = +10V, V_{PIN4} = V_{PIN5} = 0V, V_{SS} = 0V OR −300mV, See Figure 6 for Suggested Specification Circuit[3]).

Parameter	T_A = 25°C	T_A = T_{min}, T_{max}	Units	Test Conditions/Comments
Current Settling Time	1.5	–	μs max	To 0.003% of full scale range. I_{OUT} load = 100Ω, C_{EXT} = 13pF. DAC register alternately loaded with all 1's and all 0's. Typical value of Settling Time is 0.8μs.
Digital-to-Analog Glitch Impulse	50	–	nV-sec typ	Measured with V_{REF} = 0V. I_{OUT} load = 100Ω, C_{EXT} = 13pF. DAC register alternately loaded with all 1's and all 0's.
Multiplying Feedthrough Error[5]	4	–	mV p-p typ	V_{REF} = ±10V, 1kHz sine wave DAC register loaded with 10 0000 0000 0000
Output Capacitance				
C_{OUT} (Pin 4)	260	260	pF max	DAC register loaded with all 1's
C_{OUT} (Pin 4)	130	130	pF max	DAC register loaded with all 0's
Output Noise Voltage Density (10Hz – 100kHz)	50	–	nV/$\sqrt{Hz}$ typ	Measured between R_{FB} and I_{OUT}

NOTES

[1]Temperature range as follows: JN, KN Versions: 0 to + 70°C
AQ, BQ Versions: − 25°C to + 85°C
SQ, TQ Versions: − 55°C to + 125°C

[2]Specifications are guaranteed for a V_{DD} of + 11.4V to + 15.75V. At V_{DD} = 5V, the device is fully functional with degraded specifications.

[3]Only the D.U.T. (i.e., AD7536) is subjected to full temperature conditions.

[4]Guaranteed by Product Assurance testing.

[5]Feedthrough can be further reduced by connecting the metal lid on the ceramic package to DGND.

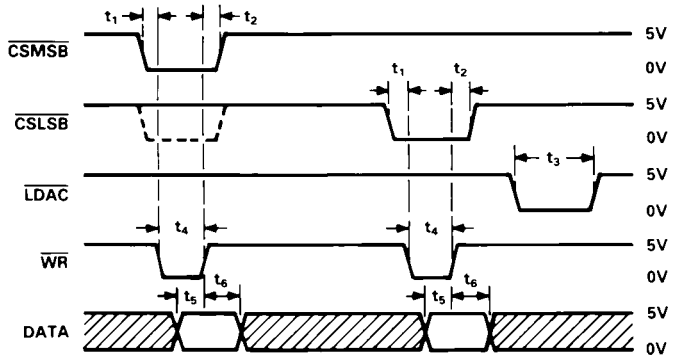
Specifications subject to change without notice.

TIMING CHARACTERISTICS

(V_{DD} = +11.4V to +15.75V, V_{REF} = +10V, $V_{PIN4} = V_{PIN5}$ = 0V, V_{SS} = 0V or −300mV
All specifications T_{min} to T_{max} unless otherwise stated. See Figure 1 for Timing Diagram.)

Parameter	Limit at T_A = 25°C	Limit at T_A = 0 to +70°C T_A = −25°C to +85°C	Limit at T_A = −55°C to +125°C	Units	Test Conditions/Comments
t_1	0	0	0	ns min	$\overline{CSMSB}$ or $\overline{CSLSB}$ to $\overline{WR}$ Setup Time
t_2	0	0	0	ns min	CSMSB or CSLSB to $\overline{WR}$ Hold Time
t_3	170	200	240	ns min	LDAC Pulse Width
t_4	170	200	240	ns min	Write Pulse Width
t_5	140	160	180	ns min	Data Setup Time
t_6	20	20	30	ns min	Data Hold Time

Specifications subject to change without notice.



NOTES
1. ALL INPUT SIGNAL RISE AND FALL TIMES MEASURED FROM 10% TO 90% OF +5V. $t_r = t_f$ = 20ns.
2. TIMING MEASUREMENT REFERENCE LEVEL IS $\frac{V_{IH} + V_{IL}}{2}$
3. IF $\overline{LDAC}$ IS ACTIVATED PRIOR TO THE RISING EDGE OF $\overline{WR}$, THEN IT MUST STAY LOW FOR t_3 OR LONGER AFTER $\overline{WR}$ GOES HIGH.

Figure 1. AD7536 Timing Diagram

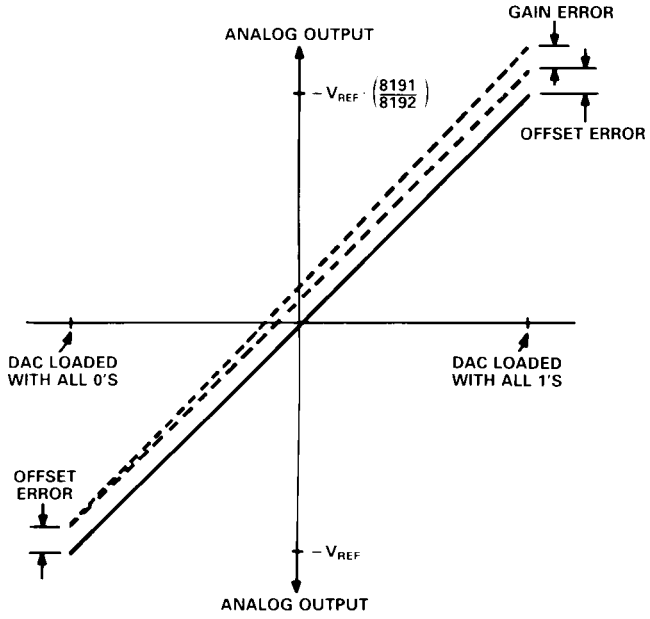


Figure 2. AD7536 Transfer Function

ORDERING INFORMATION

Model	Temperature Range	Relative Accuracy	Full Scale Error	Package Options*
AD7536JN	0°C to +70°C	±2LSB	±16LSB	N-28
AD7536KN	0°C to +70°C	±1LSB	±8LSB	N-28
AD7536JP	0°C to +70°C	±2LSB	±16LSB	P-28A
AD7536KP	0°C to +70°C	±1LSB	±8LSB	P-28A
AD7536AQ	−25°C to +85°C	±2LSB	±16LSB	Q-28
AD7536BQ	−25°C to +85°C	±1LSB	±8LSB	Q-28
AD7536SQ	−55°C to +125°C	±2LSB	±16LSB	Q-28
AD7536TQ	−55°C to +125°C	±1LSB	±8LSB	Q-28
AD7536SE	−55°C to +125°C	±2LSB	±16LSB	E-28A
AD7536TE	−55°C to +125°C	±1LSB	±8LSB	E-28A

NOTE
*E = Leadless Ceramic Chip Carrier; N = Plastic DIP; P = Plastic Leaded Chip Carrier; Q = Cerdip; R = SOIC.

PRICING (100+)$

AD7536JN	$18.95
AD7536KN	$28.45
AD7536AD	$28.95
AD7536BD	$38.45
AD7536SD	$80.70
AD7536TD	$113.05

ABSOLUTE MAXIMUM RATINGS

(T_A = 25°C unless otherwise stated)

V_{DD} (pin 26) to DGND	−0.3V, +17V
V_{SS} (pin 27) to AGND	−15V, +0.3V
V_{REF} (pin 2) to AGND	±25V
V_{INV} (pin 28) to AGND	±25V
R_{INT} (pin 1) to AGND	±25V
R_{FB} (pin 3) to AGND	±25V
Digital Input Voltage (pins 8–25) to DGND	−0.3V, V_{DD}
V_{PIN4} to DGND	−0.3V, V_{DD}
AGND to DGND	−0.3V, V_{DD}
Power Dissipation (Any package)	
To +75°C	1000mW
Derates above +75°C	10mW/°C
Operating Temperature Range	
Commercial Plastic (JN, KN versions)	0 to +70°C
Industrial Ceramic (AQ, BQ versions)	−25°C to +85°C
Extended Ceramic (SQ, TQ versions)	−55°C to +125°C
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 secs)	+300°C

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

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.

TERMINOLOGY

LEAST SIGNIFICANT BIT (LSB)

This is the analog weighting of 1 bit of the digital word in a DAC. For the AD7536 1LSB = $\frac{2V_{REF}}{2^{14}}$

RELATIVE ACCURACY

Relative accuracy or end point nonlinearity is a measure of the maximum deviation from a straight line passing through the end-points of the DAC transfer function. It is measured after adjusting for both endpoints (i.e., Offset and Gain Error are adjusted out) and is normally expressed in Least Significant Bits or as a percentage of full scale range.

DIFFERENTIAL NONLINEARITY

Differential nonlinearity is the difference between the measured change and the ideal 1LSB change between any two adjacent codes. A specified differential nonlinearity of +1LSB max over the operating temperature range ensures monotonicity.

GAIN ERROR

Gain error is a measure of the output error between an ideal DAC and the actual device output with all one's loaded after offset error has been adjusted out. Gain error is adjustable to zero with an external potentiometer.

OFFSET ERROR

Offset error is a measure of the mismatch between R_{FB} and the internal offset resistor, R_{OFS}. It also includes the leakage component from the DAC (see Figure 8). It is present for all codes and is expressed in Least Significant Bits.

DIGITAL-TO-ANALOG GLITCH IMPULSE

The amount of charge injected from the digital inputs to the analog output when the inputs change state is called Digital-to-Analog Glitch Impulse. This is normally specified as the area of the glitch in either pA-secs or nV-secs depending upon whether the glitch is measured as a current or voltage. It is measured with V_{REF} = AGND.

OUTPUT CAPACITANCE

This is the capacitance from I_{OUT} to AGND.

LEAKAGE CURRENT

Leakage current flows into I_{OUT} from the 14-bit DAC when all the DAC switches are off. It contributes to the Linearity, Gain and Offset error (see Figure 8).

MULTIPLYING FEEDTHROUGH ERROR

This is the ac error due to capacitive feedthrough from V_{REF} terminal to I_{OUT} with DAC register loaded with 10 0000 0000 0000.

Pin	Function	Description
1	R_{INT}	Contact point for internal resistors R1 and R2 which perform the inverting function on V_{REF} with external op-amp. See Figure 3.
2	V_{REF}	Reference input to the DAC. It is internally connected to R_{OFS} and R1. See Figure 3.
3	R_{FB}	Feedback resistor. Used to close the loop around an external op-amp.
4	I_{OUT}	Current Output Terminal.
5	A_{GNDS}	Analog ground sense line. Reference point for external circuitry. This pin should carry minimal current.
6	A_{GNDF}	Analog ground force line; carries current from internal analog ground connections. A_{GNDF} and A_{GNDS} are tied together internally.
7	DGND	Digital Ground
8	DB13	Data Bit 13. DAC MSB
9	DB12	Data Bit 12
10	DB11	Data Bit 11
11	DB10	Data Bit 10
12	DB9	Data Bit 9
13	DB8	Data Bit 8
14	DB7	Data Bit 7
15	DB6	Data Bit 6
16	DB5	Data Bit 5
17	DB4	Data Bit 4
18	DB3	Data Bit 3
19	DB2	Data Bit 2
20	DB1	Data Bit 1
21	DB0	Data Bit 0. DAC LSB
22	$\overline{CSMSB}$	Chip Select Most Significant (MS) Byte. Active LOW input.
23	$\overline{LDAC}$	Asynchronous Load DAC input. Active LOW.
24	$\overline{CSLSB}$	Chip Select Least Significant (LS) Byte. Active LOW input.
25	$\overline{WR}$	Write input. Active LOW.

$\overline{CSMSB}$	$\overline{CSLSB}$	$\overline{LDAC}$	$\overline{WR}$	Operation
0	1	1	0	Load MS Input Register
1	0	1	0	Load LS Input Register
0	0	1	0	Load MS and LS Input Registers
1	1	0	X	Load DAC Register from Input Registers
0	0	0	0	All Registers are transparent
1	1	1	X	No operation
X	X	1	1	No operation

NOTE X = Don't Care

26	V_{DD}	Power supply input. Specifications apply for $V_{DD} = +12V \pm 5\%$ to $+15V \pm 5\%$.
27	V_{SS}	Bias pin for High Temperature Low Leakage configuration. To implement low leakage system, the pin should be at a negative voltage. See Figure 5 or 6 for recommended circuitry.
28	V_{INV}	This pin must be connected to the output of the external inverting op-amp. See Figure 3.

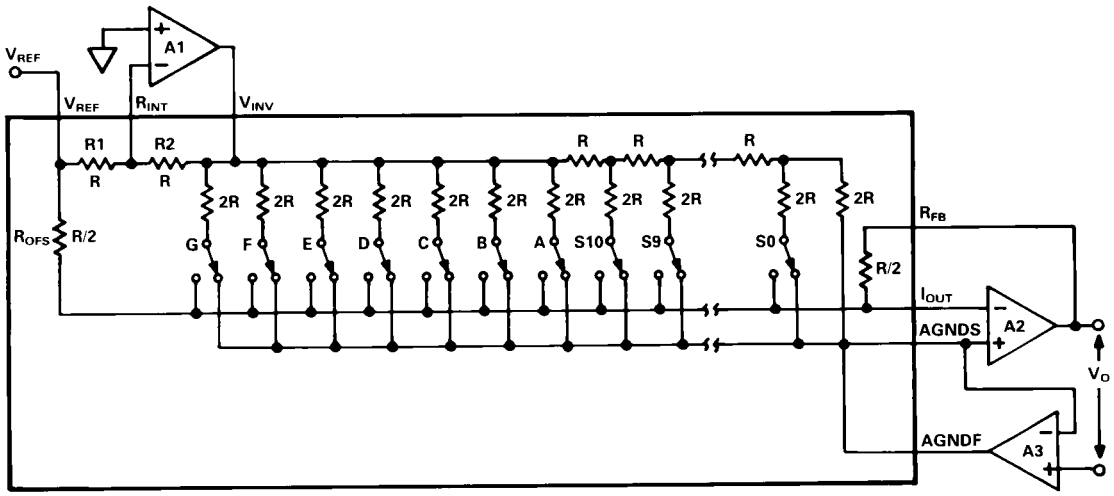


Figure 3. Simplified Circuit Diagram of the AD7536 D/A Section Showing Connection of External Op-Amps

CIRCUIT INFORMATION – D/A SECTION

Figure 3 is a simplified circuit diagram of the AD7536 D/A section and it also shows the external op-amp connection. The device is a 14-bit DAC with three extra resistors on chip for bipolar operation. It is configured so that the coding is Offset Binary. The 14-bit DAC consists of an R-2R ladder for the lower eleven bits (switches S0–S10). The three MSB's are decoded to drive switches A–G sequentially. Each of these carries an equally weighted current which is also equal to the current in the R-2R ladder. R_{OFS} has the same magnitude as R_{FB} so that the output is offset by a constant $-V_{REF}$. R1 and R2 (together with external op-amp A1) invert V_{REF} and apply it to the 14-bit DAC (V_{INV}). See Table I for complete Offset Binary Code Table.

To eliminate any slight variations in analog ground potential with changing code, there are two analog ground pins. AGNDF sinks all the current flowing through the switches to ground while AGNDS is used as a reference point with minimal current flowing in it. Figure 3 shows A3 maintaining AGNDS at Signal Ground. The connection of AGNDS and AGNDF may be changed depending on required system accuracy and output drive requirements (see Figures 5 and 6).

EQUIVALENT CIRCUIT ANALYSIS

Figure 4 shows an equivalent output circuit for the analog section of the AD7536 D/A converter. The current source $I_{LEAKAGE}$ is composed of surface and junction leakages. The resistor R0 denotes the equivalent output resistance of the DAC and associated resistors. This varies with input code. C_{OUT} is the capacitance due to the current steering switches and varies from about 90pF to 180pF (typical values) depending on the digital input. $g(V_{REF}, N)$ is the Thevenin equivalent voltage generator due to the reference input voltage, V_{REF}, and the circuit transfer function, N.

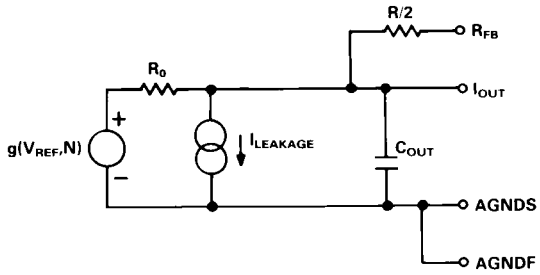


Figure 4. AD7536 Equivalent Analog Output Circuit

CIRCUIT INFORMATION – DIGITAL SECTION

The digital inputs are designed to be both TTL and 5V CMOS compatible. All logic inputs are static protected MOS gates with typical input currents of less than 1nA. Internal input protection is achieved by an on-chip distributed diode from DGND to each MOS gate. To minimize power supply currents, it is recommended that the digital input voltages be driven as close as possible to 0 and 5V logic levels.

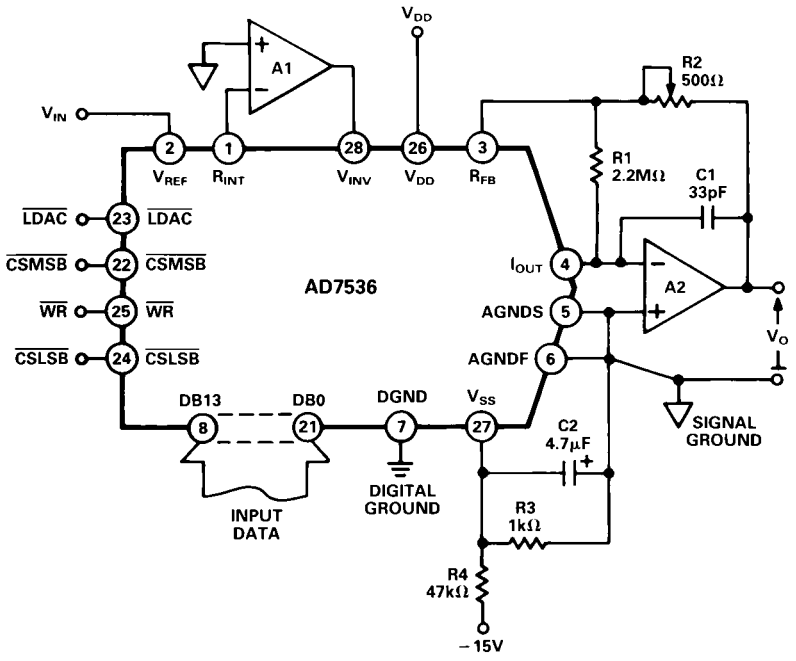


Figure 5. AD7536 Operation

BIPOLAR OPERATION
(4-Quadrant Multiplication)

Figure 5 shows the AD7536 connected for bipolar operation. Specified accuracy is attained without the need for expensive closely matched external resistors. R1 and R2 provide an optional gain adjustment and capacitor C1 helps prevent overshoot and ringing when high-speed op-amps are used. The −300mV bias voltage for V_{SS} is derived from R3, R4 and C2. Op-amp A3 (Figure 3 and Figure 6) is omitted from Figure 5. AGNDS and AGNDF are externally shorted to Signal Ground.

Table I shows the Offset Binary Code Table obtained with the circuit of Figure 5. It should be noted that the user can get a 2's Complement transfer function by inverting the MSB of the DAC word.

Binary Number in DAC Register MSB LSB	**Analog Output V_{OUT}**
11 1111 1111 1111	$+V_{IN}\left(\frac{8191}{8192}\right)$
10 0000 0000 0001	$+V_{IN}\left(\frac{1}{8192}\right)$
10 0000 0000 0000	0V
00 0000 0000 0001	$-V_{IN}\left(\frac{8191}{8192}\right)$
00 0000 0000 0000	$-V_{IN}\left(\frac{8192}{8192}\right) = -V_{IN}$

Table I. Offset Binary Code Table for AD7536

OFFSET AND GAIN ADJUSTMENT FOR FIGURE 5.

Offset Adjustment

1. Adjust offset of amplifier A1 so that potential at R_{INT} is <10μV with respect to Signal Ground.
2. Load DAC register with 10 0000 0000 0000.
3. Adjust offset of amplifier A2 until V_O = 0V (<10μV).

Gain Adjustment

1. Load DAC register with all 1's.
2. Trim potentiometer R2 so that $V_O = +V_{IN}\frac{(8191)}{(8192)}$

For high-temperature applications, resistors and potentiometers should have a low Temperature Coefficient. In many applications, because of the excellent Offset Error, Full Scale Error and Gain T.C. specifications of the AD7536, trimming of the Offset and Gain is not necessary.

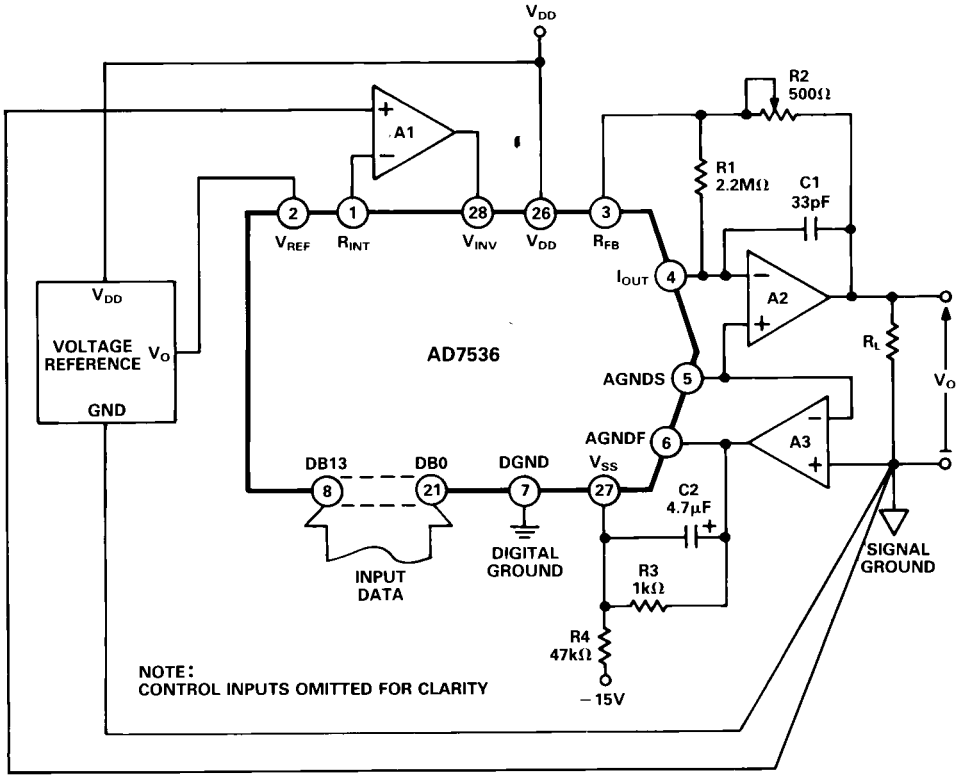


Figure 6. AD7536 Operation with Forced Ground

GROUNDING CONSIDERATIONS

In the circuits of Figures 5 and 6, with V_{REF} = +10V, 1LSB has a value of 1.2mV. So, factors which are not important in less accurate systems must, in this case, be given careful consideration. Among these, the whole question of grounding is crucial. Voltage reference ground, the I_{OUT} pin on the DAC, the noninverting pin of A1 and SIGNAL GROUND must all be at the same potential. Note that in Figure 5, AGNDS and AGNDF are externally shorted and A3 is not used. Voltage drops due to bond wire resistance are not compensated for in this circuit. This means that an extra linearity error of less than 0.1LSB is added to the DAC linearity error. If the user wishes to eliminate this extra error, then the circuit of Figure 6 should be used.

Here, A3 is used to maintain AGNDS at Signal Ground potential. I_{OUT} is also at Signal Ground potential. By using the Force, Sense technique all switch contacts on the DAC are at exactly the same potential and any error due to bond wire resistance is eliminated. If A3 is not a low offset voltage (<100μV) op-amp, it should be trimmed with a potentiometer until the voltage at AGNDS is <10μV with respect to SIGNAL GROUND. Figure 7 shows how the circuit of Figure 5 might be be laid out. Gain trim components R1 and R2 have been omitted for clarity. Note how the input to V_{REF} (pin 2) is shielded to reduce ac feedthrough while the digital inputs are shielded to minimize digital feedthrough.

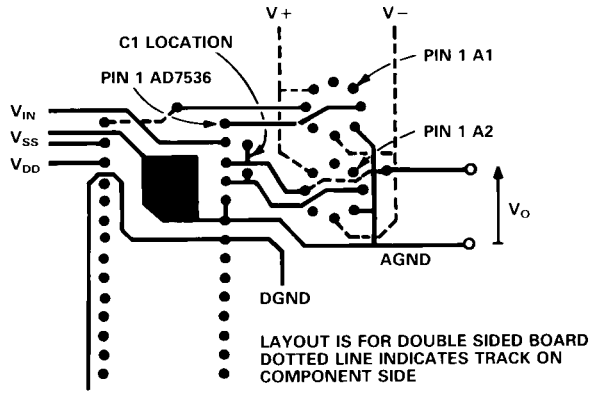


Figure 7. Suggested Layout for AD7536 Circuit of Figure 5

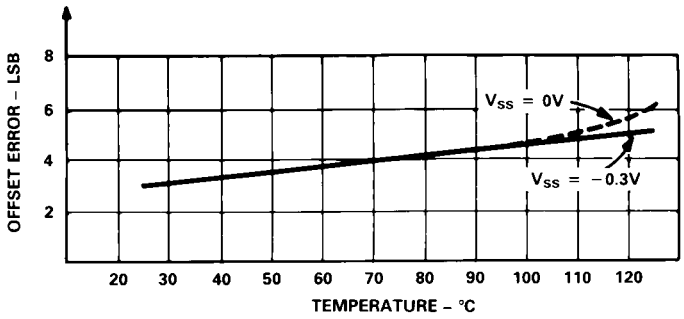


Figure 8. Typical Graph of Offset Error vs. Temperature With and Without Low Leakage Configuration

LOW LEAKAGE CONFIGURATION

Leakage current in CMOS D/A converters has two components. Current leaks from V_{DD} into the I_{OUT} line and is present at all DAC codes. There is also leakage across the off switches in the DAC. The polarity of this current depends on V_{INV} and its magnitude is related to the code in the DAC register. At high temperatures (above 90°C) it is normal for the leakage current to increase dramatically. By its nature it will affect all critical dc parameters (Linearity Error, Gain Error and Offset Error). The AD7536 features a leakage reduction configuration (patent pending) to keep the leakage current low (typically <10nA) over an extended temperature range. This ensures that the DAC maintains its 25°C performance very well at temperatures up to 125°C.

The AD7536 can be operated with or without the leakage reduction configuration. If V_{SS} (pin 27) is tied to AGND, then the DAC will exhibit normal output leakage current at high temperatures. To use the low leakage facility, V_{SS} should be tied to −0.3V as in Figures 5 and 6. The current taken by V_{SS} is very low (<10μA) allowing a simple resistor divider (R3, R4) to produce the required −300mV from −15V. The capacitor C2 in parallel with R3 is an integral part of the low leakage configuration and must be 4.7μF or greater. Figure 8 is a plot of Offset Error versus temperature for both conditions. It clearly shows the improvement when the low leakage configuration is used.

OP-AMP SELECTION

In choosing an amplifier to be used with the AD7536, three parameters are of prime importance. These are:

1. Input Offset Voltage (V_{OS})
2. Input Bias Current (I_B)
3. Offset Voltage Drift (TC V_{OS}).

To maintain specified accuracy with V_{REF} at 10V, A1 and A2 of Figures 5 and 6 must have V_{OS} <100μV and I_B <10nA. It is important that the amplifier Open Loop Gain, A_{VOL}, be sufficiently large to keep V_{OS} <100μV for the full output voltage range. For a maximum output of 10V, A_{VOL} must be greater than 100,000.

In the Forced Ground configuration of Figure 6, one can use an AD OP-07 for amplifier A3, without any external adjustment for V_{OS}. In low frequency or fixed reference applications where fast output settling time is not required, the AD OP-07 is also recommended for A1 and A2. Because of its low V_{OS} no external potentiometers are needed. For faster settling time, one can use the AD544 series of op-amps.

Offset Voltage Drift and Bias Current drift are critical parameters for operation over a wide temperature range. The AD OP-07, AD OP-27 and AD OP-37 all exhibit very low offset drift while the AD544 has very low bias current drift. Table II summarizes the important specifications of the op-amps mentioned above.

Op-Amp	Input Offset Voltage (V_{OS})	Input Bias Current (I_B)	Offset Voltage Drift (TC V_{OS})	Settling Time to 0.003% FS
AD544L	500μV	25pA	5μV/°C	5μs
AD OP-07H	75μV	3nA	0.6μV/°C	50μs typ
AD OP-27CH	100μV	80nA	0.6μV/°C	6μs typ
AD OP-37CH	100μV	80nA	0.6μV/°C	1μs typ
HA-2620	4mV	35nA	20μV/°C	0.8μs typ

Table II. Guide to Op-Amp Selection

MICROPROCESSOR INTERFACING

AD7536 – 8086A INTERFACE

The versatility of the AD7536 loading sturcture allows interfacing to both 8- and 16-bit microprocessor systems. Figure 9 shows the 8086 16-bit processor interfacing to a single device. In this circuit the double buffering feature of the DAC is not used. AD0-AD13 of the 16-bit data bus are connected to the DAC data bus (DB0-DB13). The 14-bit word is written to the DAC in one MOV instruction and the analog output responds immediately. In this example the DAC address is D000. A software routine for Figure 9 is given in Table III. In a multiple DAC system the double buffering of the AD7536 allows the user to simultaneously update all DAC's. In Figure 10, a 14-bit word is loaded to the Input Registers of each of the DACs in sequence. Then, with one instruction to the appropriate address, CS4 (i.e., $\overline{\text{LDAC}}$) is brought low, updating all the DACs simultaneously.

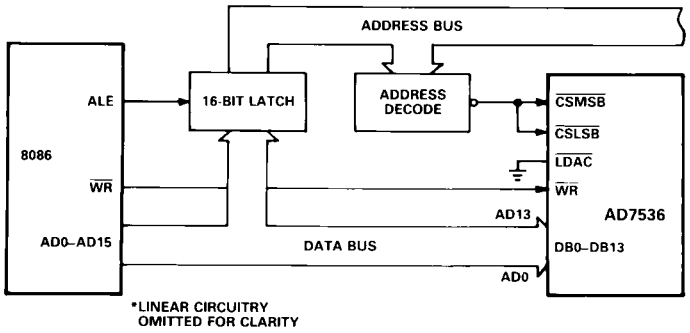


Figure 9. AD7536 – 8086 Interface Circuit

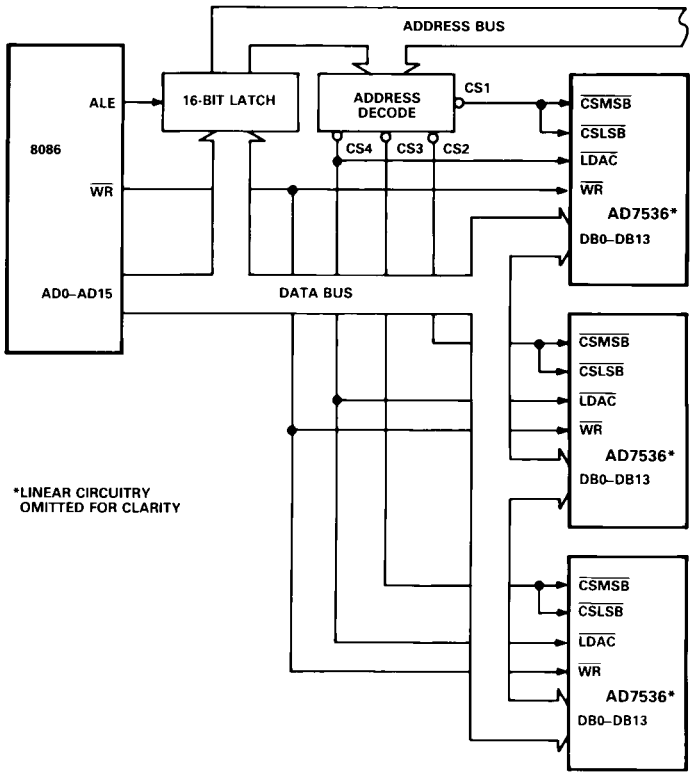


Figure 10. AD7536 – 8086 Interface: Multiple DAC System

ASSUME DS: DACLOAD, CS : DACLOAD
DACLOAD SEGMENT AT 000

00	8CC9	MOV CX, CS	: DEFINE DATA SEGMENT REGISTER EQUAL
02	8ED9	MOV DS, CX	: TO CODE SEGMENT REGISTER
04	BF00D0	MOV DI, # D000	: LOAD DI WITH D000
07	C705"YZWX"	MOV MEM,# YZWX"	: DAC LOADED WITH WXYZ
0B	EA0000		: CONTROL IS RETURNED TO THE
0E	00FF		MONITOR PROGRAM

Table III. Sample Program for Loading AD7536 from 8086

AD7536 – MC68000 INTERFACE

Interfacing between the MC68000 and the AD7536 is accomplished using the circuit of Figure 11. The following routine writes data to the DAC input registers and then outputs the data via the DAC register.

```
01000  MOVE.W    #W,D0       The desired DAC data, W, is
                              loaded into Data Register 0.
                              W may be any value between 0
                              and 16383 (decimal) or 0 and
                              3FFF (hexademical).
       MOVE.W    D0,$E000    The data W is transferred
                              between D0 and the DAC
                              Register.
       MOVE.B    #228,D7     Control is returned to the System
                              Monitor Program using these tow
       TRAP      #14         instructions.
```

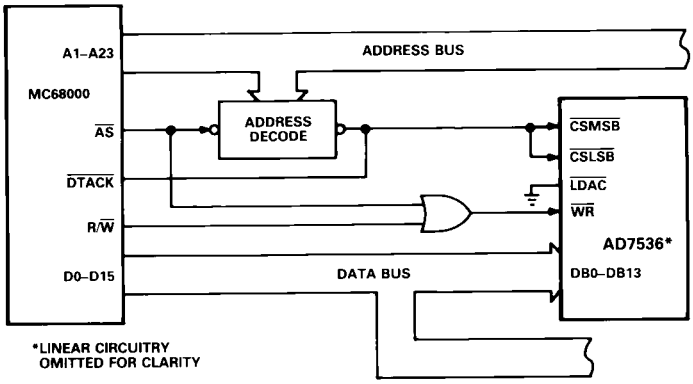


Figure 11. AD7536 – MC68000 Interface

AD7536 – Z80 INTERFACE

Though the AD7536 is ideally suited for use either with 16-bit microprocessors or in stand-alone applications, it can also be interfaced to 8-bit processor systems. Figure 12 is an interface circuit for the popular Z80 microprocessor.

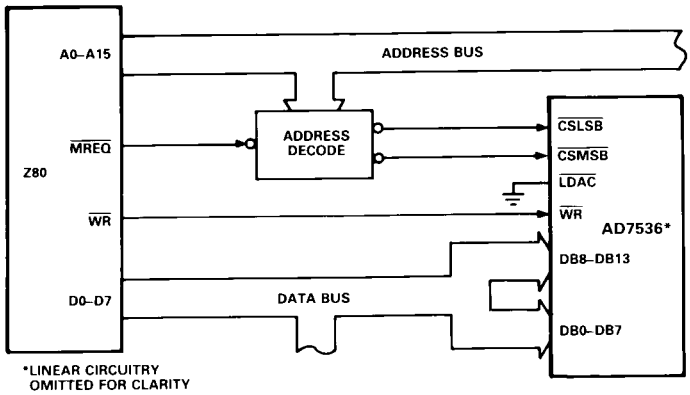


Figure 12. AD7536 – Z80 Interface

DIGITAL FEEDTHROUGH

In the preceding interface configurations, most digital inputs to the AD7536 are directly connected to the microprocessor bus. Even when the device is not selected, these inputs will be constantly changing. The high frequency logic activity on the bus can feed through the DAC package capacitance to show up as noise on the analog output. To minimize this Digital Feedthrough isolate the DAC from the noise source. Figure 13 shows an interface circuit which physically isolates the DAC from the bus. One may also use other means, such as peripheral interface devices, to reduce the Digital Feedthrough.

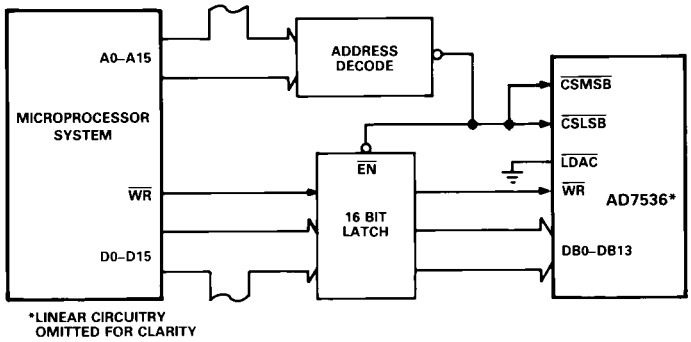
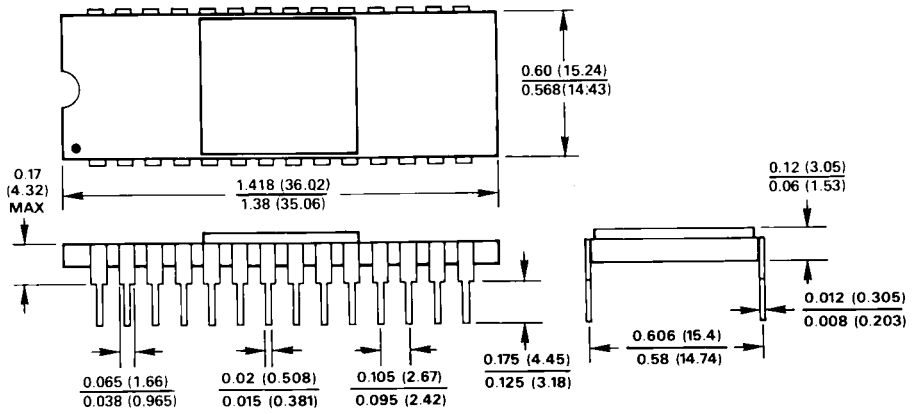


Figure 13. AD7536 Interface Circuit Using Latches to Minimize Digital Feedthrough

MECHANICAL INFORMATION
OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).

28-PIN CERAMIC DIP (SUFFIX D)



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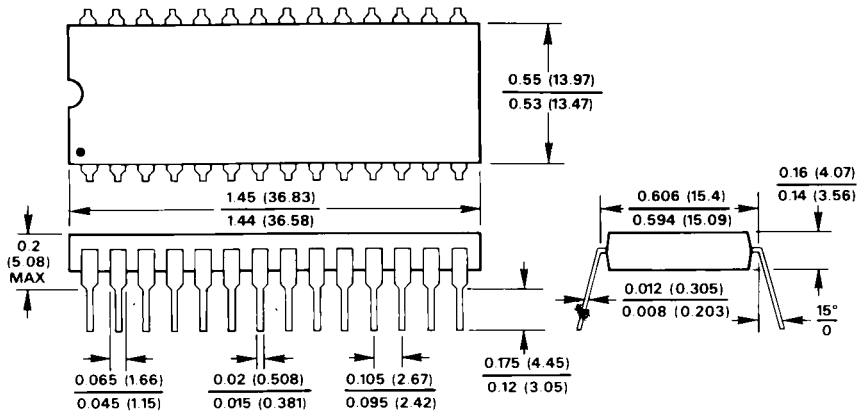
LEADS ARE GOLD PLATED (50 MICROINCHES MIN) KOVAR OR ALLOY 42

28-PIN PLASTIC DIP (SUFFIX N)



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