Am6082

Complete 12-Bit Microprocessor Compatible DAC

PRELIMINARY DATA

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DISTINCTIVE CHARACTERISTICS

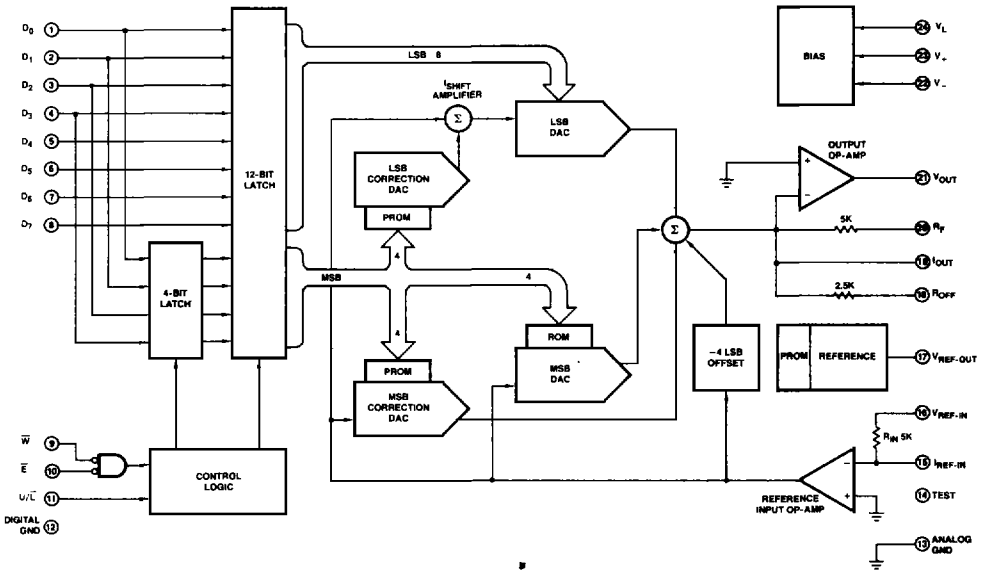
- True 12-bit absolute accuracy with no external adjustments
- Self-contained, no external components required
- Internal latches for easy interface to 8-bit buses
- Interfaces with 8-bit and 16-bit μPs
- Ultra fast data latch eliminates timing problems
- High-speed
  - 100ns settling time current output
  - 500ns settling time voltage output
- True 12-bit performance-monotonic with 12-bit DNL over temperature
- Output ranges: 0 to +10V, −5 to +5V

FUNCTIONAL DESCRIPTION

The Am6082 is a true monolithic 12-bit digital-to-analog converter that contains data latches, output op-amp, voltage reference, application resistors, and all trimming required for 12-bit absolute accuracy with no external components. The data latches and control circuitry allow the device to appear as a memory location to a microprocessor or computer system, while high-speed processing and design give 1/2 LSB voltage settling in less than 1μs.

The device is PROM-trimmed for offset, linearity, full-scale calibration and full-scale tempco at the factory.

BLOCK DIAGRAM



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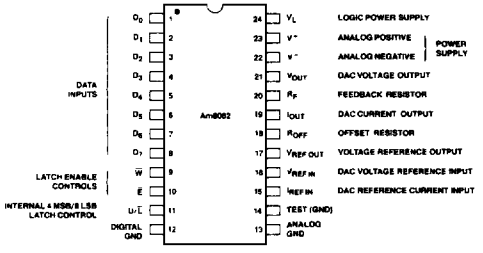
ORDERING INFORMATION

Order Number	Package Type	Temperature Range
Am6082DM	Hermetic DIP	−55 to +125°C
Am6082DC	Hermetic DIP	0 to 70°C
Am6082PC	Plastic	0 to 70°C

CONNECTION DIAGRAM – Top View

D-24-1

P-24-1



Note: Pin 1 is marked for orientation. 03590A-2

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MAXIMUM RATINGS (Above which useful life may be impaired)

Storage Temperature	−65 to +150°C
Lead Temperature (Soldering, 60sec)	300°C
Logic Supply Voltage (V_L pin)	−0.5 to +6.0V
Analog Positive Supply Voltage (V+ pin)	−0.5 to +16.5V
Analog Negative Supply Voltage (V− pin)	+0.5 to −16.5V
Analog Current Outputs (V_{OUT}, $V_{REF-OUT}$ pins)	±25mA
Digital, Status, and Analog Inputs (D_0-D_7, E, U/L, V_{REF-IN}, I_{REF-IN}, I_{OUT}, R_{OFF}, R_F pins)	±5mA

ELECTRICAL CHARACTERISTICS

(V+ = 15V ±5%, V− = −15V ±5%, V_L = 5V ±5%, T_A = 0 to +70°C)

Parameters	Description	Test Conditions	Min	Typ	Max	Units
	Resolution/Monotonicity		12	12	12	Bits
DNL	Differential Nonlinearity	T_A = 25°C		1/2	1	LSB
NL	Nonlinearity	T_A = 25°C		±0.3	±1	LSB
	Zero Scale Error	T_A = 25°C		0.3	±1	LSB
	Full-Scale Gain Error	T_A = 25°C		0.3	±1	LSB
t_{IS}	Current Settling Time	To 1 LSB Output op-amp not used R_L = 100Ω		100		ns
t_{VS}	Voltage Settling Time	To 1 LSB R_F applied to output op-amp		500		ns
t_{PHL}, t_{PLH}	Propagation Delay			35		ns
Reference						
V_{REF}	Reference Voltage	I_{REF} = 0.5mA		2.5		Volts
$\Delta V_{REF}/\Delta T_A$	Temperature Stability			0.08		LSB/°C
$\Delta V_{REF}/\Delta V_S$	Line Regulation			0.005		%/Volt
$\Delta V_{REF}/\Delta I_{REF}$	Load Regulation	0.5mA ≤ ΔI_{REF} ≤ 4mA		0.1%		%/mA
I_{REF} max	Current Limit			15		mA
Output Op-Amp						
V_{OS}	Input Offset Voltage			±3		mV
$\Delta V_{OS}/\Delta T_A$	V_{OS} Tempco			4		µV/°C
A_V	Voltage Gain			15		V/mV
$\Delta V/\Delta t$	Slew Rate			70		V/µs
BW	3dB Bandwidth			13		MHz
V_{SW}	Output Voltage Swing	R_L ≥ 2KΩ		+12 −6		Volts
I_O	Output Current			±25		mA
Data Latches						
V_H	Input HIGH Voltage		2.0			Volts
V_L	Input LOW Voltage				0.8	Volts
I_{IH}	Input HIGH Current	V_{IN} = 2.7V		±2.0		µA
I_{IL}	Input LOW Current	V_{IN} = 0.4V		±2.0		µA
t_{DS}	Data Setup Time		20			ns
t_{DH}	Data Hold Time		0			ns
t_{PW}	Latch Enable Pulse Width		12			ns
t_{CS}	Control Setup Time		20			ns

ELECTRICAL CHARACTERISTICS (Cont.)

(V^+ = 15V ±5%, V^- = −15V ±5%, V_L = 5V ±5%, T_A = 0 to +70°C)

Parameters	Description	Test Conditions	Min	Typ	Max	Units
General Characteristics						
I^+	Analog Positive Supply Current			4		mA
I^-	Analog Negative Supply Current				20	mA
I_{LS}	Logic Supply Current				35	mA
P_{DISS}	Power Dissipation				550	mW

FUNCTIONAL PIN DESCRIPTION

D_0-D_7 **Data Inputs**
LSBs 0 to 7 are loaded into the internal latches through D_0-D_7 when U/L = 0. MSBs 8 to 11 are loaded by lines D_0-D_3 when U/L = 1.

$\overline{W}$, $\overline{E}$ **Latch Enable Inputs**
Active low.

U/$\overline{L}$ **Controls Loading of Internal Latches**
A write into the four MSBs is done first, then a second write of eight LSBs causes all twelve *internal latches to be loaded.*

TEST The user should ground this pin, it is used for programming the DAC at the factory.

I_{OUT} **DAC Current Output**
Clamped to a diode voltage bidirectionally from analog ground.

V_{OUT} **DAC Voltage Output**
An internal feedback resistor must be connected around the op-amp to produce a voltage output.

R_F **A 5K Resistor to I_{OUT}**
When connected to V_{OUT} the output voltage varies 0 to 10V.

R_{OFF} **A 2.5K Resistor to I_{OUT}**
When connected to $V_{REF-OUT}$ it offsets the output by half scale.

$V_{REF-OUT}$ **An Internally Developed Voltage Reference**
Tempco optimized to compensate for the internal DAC.

V_{REF-IN} **DAC Reference Input**
2.5 volts in scales to 2.0mA output current.

I_{REF-IN} **DAC Current Reference Input**
0.5mA in scales to 2.0mA output current.

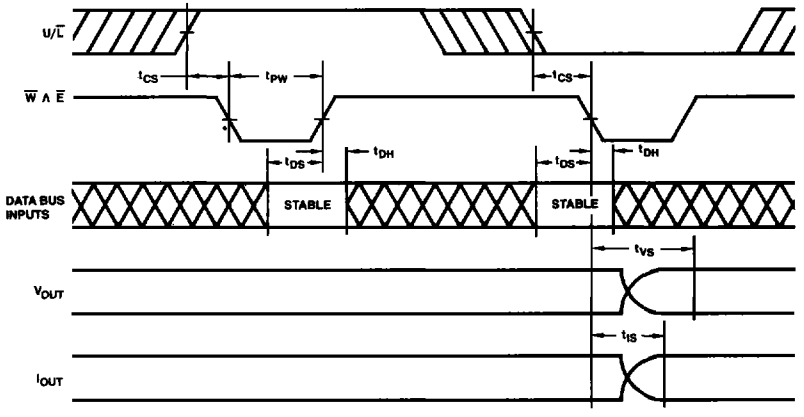
ANALOG GND **Analog Signal Ground Reference**
It should not be different from digital ground by more than ±100mV. Up to 3mA flows in this ground.

DIGITAL GND **Logic Supply Ground**

V+, V− 13 to 16 volts in magnitude, filtered.

V_L Should be 4.5 to 5.5 volts.

SWITCHING WAVEFORMS



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THEORY OF OPERATION

The Am6082 is composed of two DACs, a MSB DAC with 15 equal value current segments each worth 1/16 of the full scale current, and an 8-bit binary LSB DAC. The upper 4 bits of data are routed to a ROM within the MSB DAC, which controls the number and physical distribution of the segment currents used. The 4 MSB bits are also used to set up a correction code on a correction DAC, which injects a compensating current into I_{OUT} to minimize output errors. In addition, the LSB DAC is PROM adjusted to interpolate accurately between adjacent MSB segment values.

Since an 8-bit data bus is used to transfer 12-bits of code, two write cycles are required. The four MSBs are written into the MSB latch using pins $D_0 - D_3$ as data inputs when controls $U/\overline{L}$, $\overline{W}$ and $\overline{E}$ are all LOW. The eight LSBs are loaded through pins $D_0 - D_7$ when $U/\overline{L}$ is HIGH and both $\overline{W}$ and $\overline{E}$ are LOW. The D/A output starts immediately on the second write.

The output op-amp is specifically designed for fast settling in the inverting mode. When the R_F feedback resistor is used, the op-amp functions as a current to voltage converter, converting the DAC output current to a voltage between 0 and 10V. R_{OFF} is included to allow a bipolar (−5 to +5V) output.

APPLICATIONS INFORMATION

The Am6082 is a monolithic high speed digital-to-analog converter, with a current settling time of 100ns and a voltage settling time of under 1μs to 0.01% of full scale. It contains an output op-amp, a precision voltage reference application resistors, it is trimmed for 12-bit absolute accuracy without the need for external components and allows easy interfacing to 8- and 16-bit microprocessors.

Unlike most conventional 12-bit DACs, which are laser trimmed, the Am6082 is PROM trimmed at the factory for linearity, voltage offset, full scale tempco and gain. The internal precision voltage reference and its tempco are also PROM trimmed. Since gain and offset are factory trimmed, no external adjustments are necessary.

REFERENCE INPUTS

An internal voltage reference is provided via the $V_{REF\ OUT}$ pin. However, the Am6082 may also use an external voltage or current reference through the $V_{REF\ IN}$ or $I_{REF\ IN}$ inputs respectively. $V_{REF\ IN}$ is connected to $I_{REF\ IN}$ through an internal 5K resistor. The internal reference is used by connecting $V_{REF\ OUT}$ (pin 17) to $V_{REF\ IN}$ (pin 16) to provide a 0.5mA reference current (see Figure 1).

VOLTAGE OUTPUTS

The Am6082 provides either a voltage or a current output. The current output may be taken directly from the I_{OUT} pin, however, if a voltage output is desired, the output op-amp is used with the on chip scale resistors to provide unipolar or bipolar outputs.

Unipolar Operation is shown in Figure 1a. To operate the Am6082 in the voltage output range of 0 to 10V, connect the voltage output of the op-amp V_{OUT} (pin 21) to the feedback resistor R_F (pin 20). The voltage reference output $V_{REF\ OUT}$ (pin 17) should be connected to the voltage reference input $V_{REF\ IN}$ (pin 16).

In Bipolar Operation, the Am6082 may be operated with a ±5V output by connecting the voltage reference output $V_{REF\ OUT}$ (pin 17) to both the reference voltage input $V_{REF\ IN}$ (pin 16) and to the offset resistor R_{OFF} (pin 18). See Figure 1b. Tie V_{OUT} and R_F together as before.

GROUNDING CONSIDERATIONS

Special attention should be paid to system grounding because digital signals can couple into the analog circuits and cause output errors. The Am6082 provides separate analog and digital ground pins which should not be connected together at the chip. As a rule, provide separate ground returns for analog and digital circuits and connect all grounds together at one point, preferably at the power supply. This will minimize interference from ground currents.

INTERFACING

The Am6082 will interface with most microprocessors with a minimum of decoding and timing logic. In most cases, the chip enable control $\overline{E}$ may be driven from an address decoder and the write control $\overline{W}$ may be connected directly to a μP memory write or an I/O write pin (see Figure 2).

TWO'S COMPLEMENT NOTATION

The Am6082 may be operated with a two's complement input format. This is accomplished by inverting the most significant bit, as shown in Figure 3. The exclusive OR of the MSB and the $\overline{U}$/L control will give the correct result.

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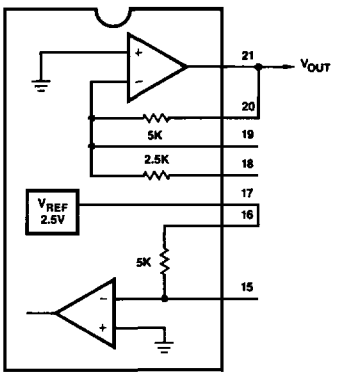
Figure 1.

a) Unipolar (0 to 10V Output) Operation



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b) Bipolar (−5 to +5V Output) Operation

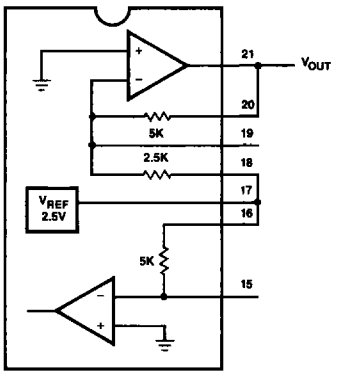

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Figure 2. Microprocessor Interfacing

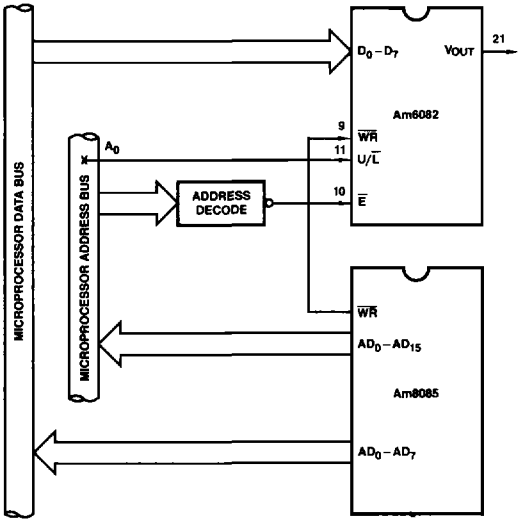

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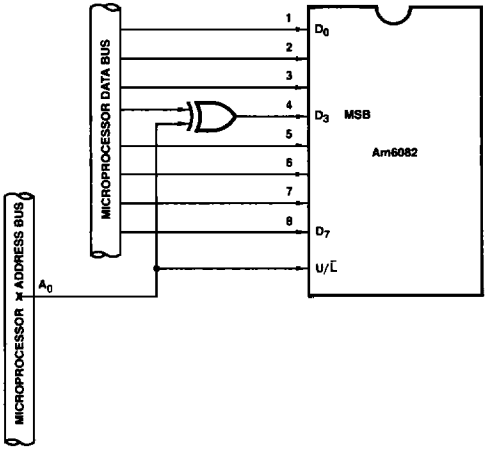
Figure 3. Two's Complement Operation



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