MICRO NETWORKS

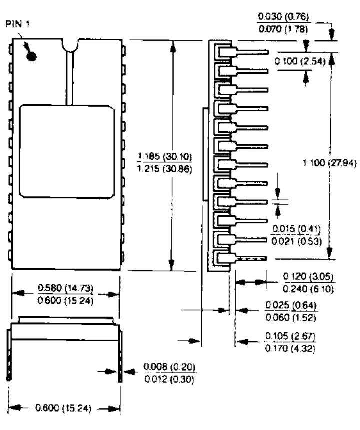
DAC80

LOW-COST MONOLITHIC, 12-Bit D/A CONVERTERS

FEATURES

- **Low-Cost Single-Chip Design**
- **Current or Voltage Output**
- **Complete With Internal Reference and Output Op Amp (V Models)**
- **±½LSB Linearity and Monotonicity Guaranteed Over Temperature**
- **Fast Settling: 3μsec (V Models) 300nsec (I Models)**
- **±12V to ±15V Supplies**
- **345mW Power Consumption**
- **24-Pin Side-Brazed Ceramic DIP**
- **Multisourced**

24 PIN SIDE-BRAZED DIP



Dimensions in Inches (millimeters)

DESCRIPTION

The Micro Networks DAC80 is a complete, single-chip, low-cost, 12-bit D/A converter. It represents the most recent monolithic implementation of the venerable hybrid DAC80 that has long been an industry standard. The popularity of this proven product is due to its low cost; its multisource availability; its guaranteed performance over temperature; its optional current or voltage output; its fast settling time; and its ability to operate from either ±12V or ±15V supplies. This latest design employs an on-chip buried-zener reference for low noise; the newest thin-film fabrication and laser-trimming techniques for tight accuracy and linearity guaranteed over temperature; a proprietary reference-buffer circuit that permits fully specified operation over a wide supply range; and an on-chip output op amp for current-to-voltage conversion and fast settling.

These D/A's are TTL voltage compatible; however, they draw low enough logic currents to be driven from CMOS logic. ±½LSB linearity and monotonicity for 12-bits are guaranteed over the full 0°C to +70°C operating temperature range. Output settling time for a 20V step to ±½LSB is 4μsec maximum. A 2mA step typically settles in 300nsec.

DAC80 is packaged in a 24-pin, side-brazed, ceramic DIP and requires supplies that can range from ±12V to ±15V. On-chip, laser trimmed, thin-film, range resistors allow users to select output voltage ranges of ±2.5V, ±5V, ±10V, 0 to +5V or 0 to +10V and output current ranges of ±1mA or 0 to −2mA. The Micro Networks monolithic DAC80 is a pin-for-pin, functionally equivalent replacement for earlier hybrid versions of this device except that it no longer requires a +5V supply. Some other monolithic DAC80's are not exact replacements. The DAC80 "Z" model is no longer a necessary ordering option as all models now operate from ±12V to ±15V supplies. For −25°C to +85°C or −55°C to +125°C operation, please see the Micro Networks DAC85 or DAC87.

Model	Input Code	Output Mode	Power Supplies
DAC80-CBI-V	Complementary Binary	Voltage	±12V/±15V
DAC80-CBI-I	Complementary Binary	Current	±12V/±15V

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DAC80 LOW-COST MONOLITHIC 12-Bit D/A CONVERTERS

ABSOLUTE MAXIMUM RATINGS

Operating Temperature Range	−25°C to +85°C
Specified Temperature Range	0°C to +70°C
Storage Temperature Range	−65°C to +150°C
+Vcc Supply (Pin 22)	0 to +18 Volts
−Vcc Supply (Pin 14)	0 to −18 Volts
Digital Inputs (Pins 1-12)	−1 to +18 Volts
Analog Output	(Note 1)

ORDERING INFORMATION

PART NUMBER —— DAC80-CBI-X

Select "V" suffix for voltage output or "I" suffix for current output.

SPECIFICATIONS (T_A = +25°C, ±Vcc = ±15V unless otherwise indicated)

DIGITAL INPUTS	MIN.	TYP.	MAX.	UNITS
Resolution		12		Bits
Logic Coding (Note 2): Voltage Output Current Output		CSB,COB CSB,COB		
Logic Levels: Logic "1" Logic "0"	+2.0 0		+16.5 +0.8	Volts Volts
Logic Currents: Logic "1" (V_{IH} = +2.4V) Logic "0" (V_{IL} = +0.4V)			+20 −180	μA μA
ANALOG OUTPUTS (VOLTAGE MODEL)				
Output Voltage Ranges	±2.5, ±5, ±10, 0 to +5, 0 to +10			Volts
Output Current	±5			mA
Output Impedance		0.05		Ω
ANALOG OUTPUTS (CURRENT MODEL)				
Output Current Ranges		±1, 0 to −2		mA
Output Impedance: Unipolar Range Bipolar Range	4.6 2.6	6.6 3.2	8.6 3.7	kΩ kΩ
Compliance Voltage	±2.5			Volts
TRANSFER CHARACTERISTICS (Note 3)				
Integral Linearity Error (0°C to +70°C)		±¼	±½	LSB
Differential Linearity Error (0°C to +70°C)		±½	±¾	LSB
Temperature Range For Guaranteed Monotonicity	0		+70	°C
Unipolar Offset Error (Notes 4, 5) Bipolar Offset Error (Notes 4, 6) Gain Error (Notes 4, 7)		±0.05 ±0.05 ±0.1	±0.15 ±0.15 ±0.3	%FSR %FSR %
DRIFT SPECIFICATIONS (Note 8)				
Total Bipolar Drift (Note 9)		±10	±25	ppm of FSR/°C
Total Error (0°C to +70°C) (Note 10): Unipolar Bipolar		±0.08 ±0.06	±0.15 ±0.12	%FSR %FSR
Unipolar Offset Drift Bipolar Offset Drift		±1 ±5	±3 ±15	ppm of FSR/°C ppm of FSR/°C
Gain Drift: Including Internal Reference Excluding Internal Reference		±15 ±5	±30 ±10	ppm/°C ppm/°C
DYNAMIC CHARACTERISTICS				
Settling Time (Note 11) Voltage Output: With 10kΩ Feedback With 5kΩ Feedback For 1 LSB Change		 3 2 1	 4 3	 μsec μsec μsec
Settling Time (Note 11) Current Output: For 10Ω to 100Ω Loads For 1kΩ Load		 300 1		 nsec μsec
Slew Rate (Voltage Models)	±10	±5		V/μsec

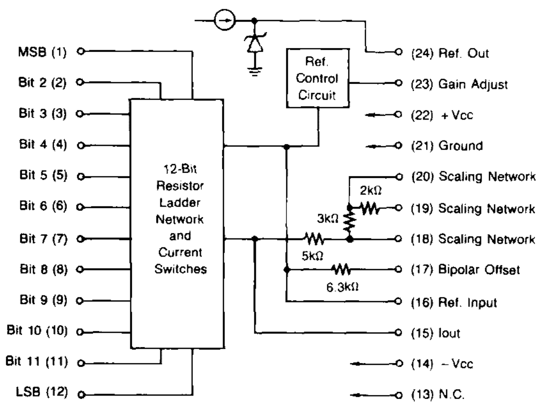
INTERNAL REFERENCE	MIN.	TYP.	MAX.	UNITS
Internal Reference: Voltage Accuracy Drift External Current		+6.3 ±1 ±10	 ±20 2.5	Volts % ppm/°C mA
POWER SUPPLIES				
Power Supply Range: +Vcc Supply −Vcc Supply	+11.4 −11.4	+15 −15	+16.5 −16.5	Volts Volts
Power Supply Rejection: +Vcc Supply −Vcc Supply		±0.002 ±0.002		%FSR/%Supply %FSR/%Supply
Current Drains: +Vcc Supply −Vcc Supply		+8 −15	+12 −20	mA mA
Power Consumption		345	480	mW

SPECIFICATION NOTES:

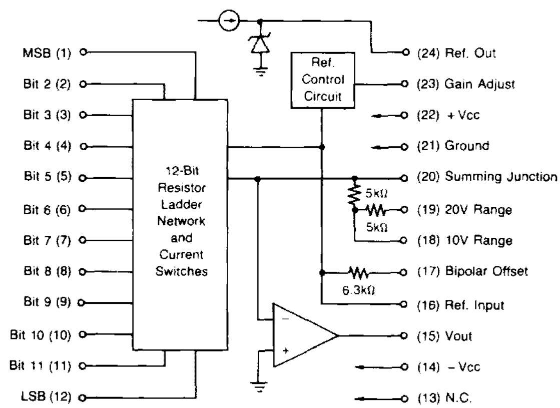
1. The DAC80's output is short-circuit protected and units can withstand a sustained short to ground or either power supply.
2. CSB=Complementary Straight Binary. COB=Complementary Offset Binary. See Digital Input Coding table for details.
3. FSR stands for full scale range and is equivalent to the nominal peak-to-peak voltage (current) of the selected output range. FSR=5 volts for 0 to +5V and ±2.5V output ranges. FSR=10 volts for 0 to +10V and ±5V output ranges etc.. For a 12-bit converter, 1LSB=0.024%FSR.
4. Initial offset and gain errors are adjustable to zero with user-optional, external, trimming potentiometers.
5. Unipolar offset error is the difference between the actual and the ideal output when operating on a unipolar output range with a digital input of 1111 1111 1111.
6. Bipolar offset error is the difference between the actual and the ideal output when operating on a bipolar output range with a digital input of 1111 1111 1111.
7. Gain error is defined as the error in the slope of the converter transfer function. It is expressed as a percentage and is equivalent to the deviation (divided by the ideal value) between the actual and the ideal value for the full output voltage or current span from the 1111 1111 1111 output to the 0000 0000 0000 output.
8. To maintain published drift specifications, current output models must use internal feedback resistors.
9. Includes gain, offset and linearity drifts.
10. With initial gain and offset errors adjusted to zero at +25°C.
11. Settling time specified for an FSR step settling to ±0.01%FSR (±½LSB).

BLOCK DIAGRAMS and PIN DESIGNATIONS

(Current Models)



(Voltage Models)



Current Models

1	Bit 1 (MSB)	24	Ref. Out (+6.3V)
2	Bit 2	23	Gain Adjust
3	Bit 3	22	+Vcc Supply
4	Bit 4	21	Ground
5	Bit 5	20	Scaling Network
6	Bit 6	19	Scaling Network
7	Bit 7	18	Scaling Network
8	Bit 8	17	Bipolar Offset
9	Bit 9	16	Ref. Input
10	Bit 10	15	Output Current
11	Bit 11	14	−Vcc Supply
12	Bit 12 (LSB)	13	N.C.

Voltage Models

1	Bit 1 (MSB)	24	Ref. Out (+6.3V)
2	Bit 2	23	Gain Adjust
3	Bit 3	22	+Vcc Supply
4	Bit 4	21	Ground
5	Bit 5	20	Summing Junction
6	Bit 6	19	20V Range
7	Bit 7	18	10V Range
8	Bit 8	17	Bipolar Offset
9	Bit 9	16	Ref. Input
10	Bit 10	15	Output Voltage
11	Bit 11	14	−Vcc Supply
12	Bit 12 (LSB)	13	N.C.

APPLICATIONS INFORMATION

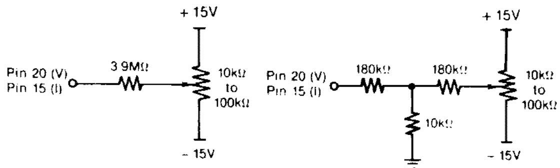
LAYOUT CONSIDERATIONS—Proper attention to layout and decoupling is necessary to obtain specified accuracy and speed from the DAC80. The unit's ground (pin 21) must be tied to circuit analog ground as close to the package as possible, preferably through a large analog ground plane underneath the package. Power supplies should be decoupled with tantalum or electrolytic and ceramic capacitors located close to the unit. For optimum performance, 1μF tantalums paralleled with 0.01μF ceramic capacitors should be used. Coupling between analog and digital signals should be minimized to avoid noise pickup. Short jumpers should be used when tying the Reference Output (pin 24) to the Reference Input (pin 16) and when tying the Bipolar Offset (pin 17) to the Summing Junction (pin 20, V models) or Output (pin 15, I models) for bipolar operation. If external gain and offset adjustments are to be used, the series resistors and trim pots should be located as close to the unit as possible.

REFERENCE OUTPUT—The DAC80 contains an internal +6.3V ±1% voltage reference, and the units are actively laser trimmed to operate from this reference. Therefore, though the user has the option of using an external reference, for specified operation, the Reference Output (pin 24) must be connected to the Reference Input (pin 16). If the internal reference is used to drive an external load, it should be buffered if the load current will exceed 2.5mA.

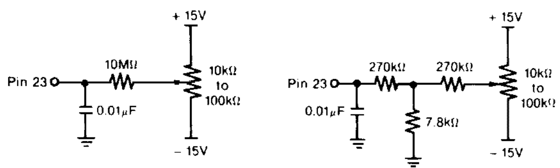
±12V OPERATION—All DAC80 models can operate over the entire power supply range of ±11.4V to ±16.5V. Even with supply levels dropping to ±11.4V, the DAC80 can swing a full ±10V range, provided the load current is limited to ±2.5mA. With power supplies greater than ±12V, the DAC80 output can be loaded up to ±5mA over the entire ±Vcc range.

OPTIONAL GAIN AND OFFSET ADJUSTMENTS—The DAC80 will operate as specified without external adjustments. If desired, however, absolute accuracy error can be reduced to ±½LSB by following the trimming procedure described below. Adjustments should be made following warmup, and to avoid interaction, the offset adjustment must be made before the gain adjustment. Multiturn potentiometers with TCR's of 100ppm/°C or less are recommended to minimize drift with temperature. Series resistors can be ±20% carbon composition or better. If these adjustments are not used, pins 20 and 23 should be connected as described elsewhere (do not ground).

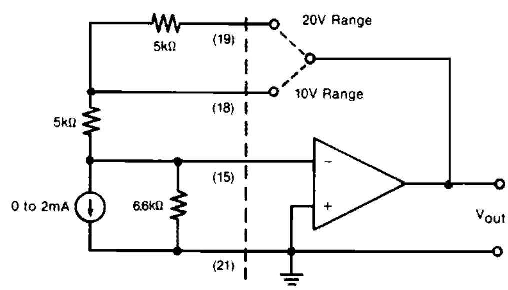
OFFSET ADJUSTMENT—Connect the offset potentiometer to pin 20 for voltage output models or pin 15 for current output models and apply all "1's" to the digital inputs. Adjust the potentiometer until the analog output is equal to the appropriate value for unipolar or bipolar output ranges as listed in the Digital Input Coding table.



GAIN ADJUSTMENT—Connect the gain potentiometer as shown and apply all "0's" to the digital inputs. Adjust the potentiometer until the analog output is equal to the appropriate value listed in the Digital Input Coding table.



DRIVING EXTERNAL OP AMPS
(I Out Models)



OUTPUT RANGE SELECTION

Output Range	Connect Pin 15 to	Connect Pin 17 to	Connect Pin 19 to	Connect Pin 16 to
±10V	19	20	15	24
±5V	18	20	N.C.	24
±2.5V	18	20	20	24
0 to +10V	18	21	N.C.	24
0 to +5V	18	21	20	24
±1mA	17	15	N.C.	24
0 to −2mA	N.C.	21	N.C.	24

DIGITAL INPUT CODING

Digital Input	Voltage Output					Current Output	
MSB LSB	0 to +5V	0 to +10V	±2.5V	±5V	±10V	0 to −2mA	±1mA
0000 0000 0000	+4.9988	+9.9976	+2.4988	+4.9976	+9.9951	−1.9995	−0.9995
0000 0000 0001	+4.9976	+9.9951	+2.4976	+4.9951	+9.9902	−1.9990	−0.9990
0111 1111 1111	+2.5000	+5.0000	0.0000	0.0000	0.0000	−1.0000	0.0000
1000 0000 0000	+2.4988	+4.9976	−0.0012	−0.0024	−0.0049	−0.9995	+0.0005
1111 1111 1110	+0.0012	+0.0024	−2.4988	−4.9976	−9.9951	−0.0005	+0.9995
1111 1111 1111	0.0000	0.0000	−2.5000	−5.0000	−10.0000	0.0000	+1.0000