MICRO NETWORKS

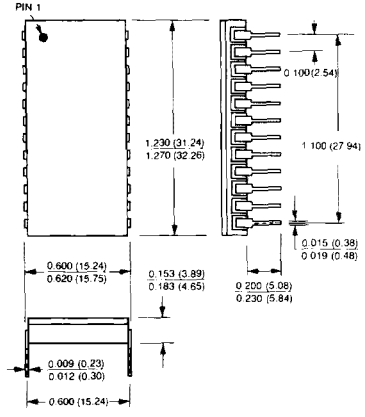
DAC71

INDUSTRY-STANDARD
16-Bit
D/A CONVERTER

FEATURES

- 16-Bit Resolution
- Complete With Internal Reference and Output Op Amp (V Models)
- Current or Voltage Output
- ±0.003%FSR Linearity Guaranteed
- 14-Bit Monotonicity Guaranteed Over Temperature
- Fast Settling:
  10μsec (V Models)
  1μsec (I Models)
- 24-Pin Side-Brazed DIP
- Multisourced

24-PIN SIDE-BRAZED DIP



Dimensions in Inches (millimeters)

DESCRIPTION

DAC71 is a 16-bit hybrid digital-to-analog converter in a small, 24-pin, dual-in-line package. This high-resolution D/A includes an internal reference and is available in both voltage and current output models. The DAC71 offers a guaranteed maximum linearity error of ±0.003%FSR at +25°C and guarantees 14-bit monotonicity over temperature.

Utilizing the most advanced functional laser trimming techniques, DAC71 eliminates the need for external trimpots, and all parameters are specified without adjustment. Optional gain and offset adjustment points are available for applications requiring greater accuracy.

All models of DAC71 have complementary binary coded inputs. Units are available with output voltage ranges of 0 to +10V or ±10V or output current ranges of ±1mA or 0 to −2mA. Devices operate from ±15V power supplies; consume 525mW; and are direct pin-for-pin replacements for DAC71 devices from other manufacturers.

DAC71 is the ideal choice for applications requiring high resolution, small size and low cost. Typical applications include robotics, high-resolution servo and control systems, high-accuracy function generation and precision instrumentation.

Model Number	Input Code	Output Mode
DAC71-COB-V	Complementary Offset Binary	−10V to +10V
DAC71-CSB-V	Complementary Straight Binary	0 to +10V
DAC71-COB-I	Complementary Offset Binary	−1mA to +1mA
DAC71-CSB-I	Complementary Straight Binary	0 to −2mA

MICRO NETWORKS
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DAC71 INDUSTRY-STANDARD 16-Bit D/A CONVERTER

ABSOLUTE MAXIMUM RATINGS

Operating Temperature Range	0°C to +70°C
Storage Temperature Range	−65°C to +150°C
Positive Supply (+Vcc, Pin 23)	0 to +18 Volts
Negative Supply (−Vcc, Pin 19)	0 to −18 Volts
Digital Inputs (Pins 1-16)	−0.5 to +18 Volts

ORDERING INFORMATION

PART NUMBER — DAC71-CSB-V

Select "COB" suffix for Complementary Offset Binary coding or "CSB" suffix for Complementary Straight Binary coding.

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

SPECIFICATIONS (T_A = +25°C, ±Vcc = ±15V, unless otherwise indicated) (Note 1)

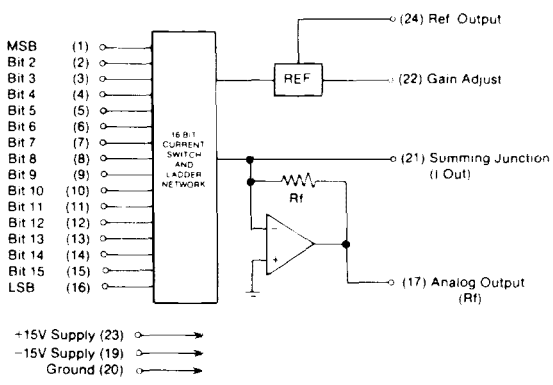
DIGITAL INPUTS	MIN.	TYP.	MAX.	UNITS
Logic Levels: Logic "1" Logic "0"	+2.4		 +0.8	Volts Volts
Input Currents: Logic "1" (V_{IH} = +2.7V) Logic "0" (V_{IL} = +0.4V)		+40 −1.0		µA mA
ANALOG OUTPUTS (VOLTAGE MODELS)				
Voltage Models (Note 2): DAC71-CSB-V DAC71-COB-V		0 to +10 ±10		Volts Volts
Output Current	±5			mA
Output Impedance		0.15		Ω
Short Circuit Duration		Indefinite to Ground		
ANALOG OUTPUTS (CURRENT MODELS)				
Current Models (Note 2): DAC71-CSB-I DAC71-COB-I		0 to −2 ±1		mA mA
Compliance Voltage		±2.5		Volts
Output Impedance: Unipolar Bipolar		4 2.45		kΩ kΩ
TRANSFER CHARACTERISTICS (Note 3)				
Linearity Error			±0.003	%FSR
Temperature Range For 14-Bit Monotonicity	0		+70	°C
Unipolar Offset Error (Notes 4, 5): DAC71-CSB-V DAC71-CSB-I			±0.1 ±0.1	%FSR %FSR
Bipolar Offset Error (Notes 4, 6): DAC71-COB-V DAC71-COB-I			±0.1 ±0.1	%FSR %FSR
Gain Error (Notes 4, 7): Voltage Output Current Output		±0.05 ±0.05	±0.1 ±0.1	% %
DRIFT SPECIFICATIONS (Notes 3, 8)				
Unipolar Offset Drift: DAC71-CSB-V DAC71-CSB-I			±10 ±10	ppm of FSR/°C ppm of FSR/°C
Bipolar Offset Drift: DAC71-COB-V DAC71-COB-I			±15 ±40	ppm of FSR/°C ppm of FSR/°C
Gain Drift: Voltage Models Current Models			±20 ±45	ppm/°C ppm/°C
DYNAMIC CHARACTERISTICS				
Settling Time (Voltage Models): 20V Step to ±0.003%FSR 1 LSB Step (Note 10)		5 3	10	µsec µsec
Slew Rate (Voltage Models)		±10		V/µsec
Settling Time (Current Models) 1mA Step to ±0.003%FSR: 10Ω to 100Ω Load 1kΩ Load			1 3	µsec µsec

REFERENCE OUTPUT	MIN.	TYP.	MAX.	UNITS
Internal Reference: Voltage		+6.3		Volts
Tempco		±10		ppm/°C
External Current	±1.5	±2.5		mA
POWER SUPPLIES				
Power Supply Range: +15V Supply	+14.55	+15.00	+15.45	Volts
−15V Supply	−14.55	−15.00	−15.45	Volts
Power Supply Rejection: +15V Supply		±0.001		%FSR/%Vs
−15V Supply		±0.001		%FSR/%Vs
Current Drain: +15V Supply		+18	+35	mA
−15V Supply		−17	−30	mA
Power Consumption		525	975	mW

SPECIFICATION NOTES:

1. Unless otherwise indicated, listed specifications apply for all DAC71 models.
2. DAC71 is available in both voltage output (DAC71-CSB-V, DAC71-COB-V) and current output (DAC71-CSB-I, DAC71-COB-I) models.
3. FSR stands for full scale range and is equal to the peak-to-peak voltage of the selected output range. For the ±10V output range, FSR is 20 Volts, and 1LSB is ideally equal to 300μV. For the 0 to +10V range, FSR is 10 Volts, and 1LSB is ideally equal to 150μV.
4. Initial offset and gain errors are adjustable to zero with user-optional, external trimming potentiometers.
5. Unipolar offset error is defined as the difference between the actual and the ideal output voltage with a digital input of 1111 1111 1111 1111.
6. Bipolar offset error is defined as the difference between the actual and the ideal output voltage with a digital input of 1111 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 1111 output to the 0000 0000 0000 0000 output.
8. Drift specifications apply over the 0°C to +70°C temperature range for all models.
9. Specified with gain and offset errors adjusted to zero at +25°C.
10. LSB step is for 14-bit resolution.

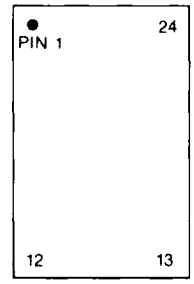
BLOCK DIAGRAM



Note:
Current Output models do not include output op amp

Rf = 5K(CSB), 10K(COB)

PIN DESIGNATIONS



1	Bit 1 (MSB)	24	Vref Out
2	Bit 2	23	+15V Supply
3	Bit 3	22	Gain Adjust
4	Bit 4	21	Summing Junction (I Out for Current Out)
5	Bit 5	20	Ground
6	Bit 6	19	−15V Supply
7	Bit 7	18	N.C.
8	Bit 8	17	Vout R_F for Current Out)
9	Bit 9	16	Bit 16 (LSB)
10	Bit 10	15	Bit 15
11	Bit 11	14	Bit 14
12	Bit 12	13	Bit 13

INPUT LOGIC CODING

Digital Input MSB LSB	Voltage Output (Volts) CSB	Voltage Output (Volts) COB	Current Output (mA) CSB	Current Output (mA) COB
0000 0000 0000 0000	+9.99985	+9.99969	−1.99997	−0.99997
0000 0000 0000 0001	+9.99970	+9.99939	−1.99994	−0.99994
0111 1111 1111 1111	+5.00000	0.00000	−1.00000	0.00000
1000 0000 0000 0000	+4.99985	−0.00031	−0.99997	+0.00003
1111 1111 1111 1110	+0.00015	+9.99969	−0.00003	+0.99997
1111 1111 1111 1111	0.00000	−10.00000	0.00000	+1.00000

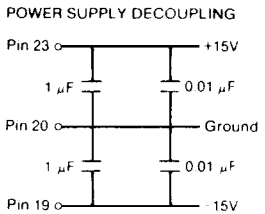
CODING NOTES

1. CSB=Complementary straight binary for unipolar output ranges.
2. COB=Complementary offset binary for bipolar output ranges.
3. For FSR=20V, 1 LSB=300μV
4. For FSR=10V, 1 LSB=150μV
5. For FSR=2mA, 1 LSB=30nA

APPLICATIONS INFORMATION

LAYOUT CONSIDERATIONS—Proper attention to layout and decoupling is necessary to obtain specified accuracy from DAC71. The unit's ground connection (pin 20) must be tied to circuit analog ground as close to the package as possible, preferably through a large ground plane underneath the package.

Power supplies should be decoupled with tantalum or electrolytic type capacitors located close to the unit. For optimum performance, 1μF capacitors paralleled with 0.01μF ceramic capacitors should be used as shown in the following diagrams.



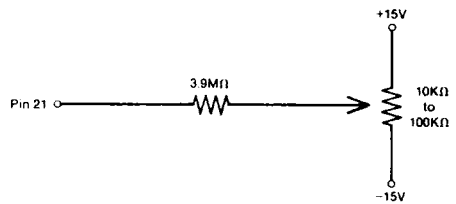
Coupling between analog and digital signals should be minimized to avoid noise pickup. If external gain and offset adjustments are to be used, the series resistors should be located as close to the unit as possible.

DAC71 has a guaranteed linearity specification of 14 bits. If the 16-bit resolution of the device is not required, bit 15 (pin 15) and bit 16 (pin 16) should be connected to +5V through a single 1kΩ resistor.

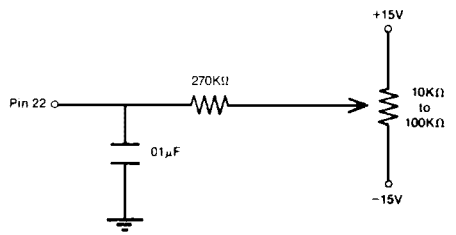
High resolution devices such as DAC71 present unique layout problems. Grounding and contact resistance become a matter of critical importance. A 16-bit converter with a 10V FSR has an LSB value of 150μV. Assuming a 5mA load, series wiring and contact resistance of only 30mΩ will throw the output off 1LSB. In terms of system layout, the impedance of #18 wire is approximately 0.064Ω/ft. Assuming 0 contact resistance, less than 6 inches of wire could produce a 1LSB error in the analog output. Careful layout and the use of external trim potentiometers for gain and offset can eliminate many potential sources of error.

OPTIONAL GAIN AND OFFSET ADJUSTMENTS—DAC71 will operate as specified without external adjustment. If desired, however, gain and offset errors can be trimmed with potentiometers. 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 should be ±20% carbon composition or better and must be located as close as possible to the package to prevent noise pickup. A 0.01μF ceramic capacitor should be connected from gain adjust (pin 22) to ground.

OFFSET ADJUSTMENT—Connect the offset potentiometer as shown and apply all "1's" to the digital inputs. Adjust the potentiometer until the analog output is equal to zero volts for unipolar output ranges or minus full scale voltage for bipolar output ranges.



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 maximum positive voltage for the chosen output range as shown in the Coding table.



REFERENCE OUTPUT—All DAC71 models contain an internal +6.3V voltage reference. The reference output (pin 24) may be used to drive an external load. A buffer amplifier is recommended if external load current exceeds 1.5mA.

OUTPUT COMPLIANCE VOLTAGE—Compliance voltage is the maximum voltage swing allowed on the output of the current models while maintaining specified accuracy. DAC71 is specified for a compliance voltage swing of ± 2.5V, and an absolute maximum range of 5V is permitted without damage to the device.