



# Wide Temperature Range 12-Bit IC D/A Converter

## AD DAC85/AD DAC87

### 1.1 Scope.

T-51-09-12

This specification covers the device requirements for a high performance 12-bit hybrid digital-to-analog converter. (The monolithic version is detailed on page 619.)

### 1.2 Part Number.

The complete part number per Table 1 of this specification is as follows:

| Device | Part Number           |
|--------|-----------------------|
| -1     | AD DAC85MILCBI-V/883B |
| -2     | AD DAC85MILCBI-I/883B |
| -3     | AD DAC87CBI-V/883B    |
| -4     | AD DAC87CBI-I/883B    |

### 1.2.3 Case Outline.

See Appendix 1 of General Specification ADI-H-1000: package outline: DH-24A.

### 1.3 Absolute Maximum Ratings. ( $T_A = +25^\circ\text{C}$ unless otherwise noted)

|                                                    |                 |
|----------------------------------------------------|-----------------|
| Positive Supply Voltage $V_{CC}$ to Digital Return | +18V            |
| Negative Supply Voltage $V_{EE}$ to Digital Return | -18V            |
| Positive Supply Voltage $V_{DD}$ to Digital Return | +7V             |
| Digital Input Voltage to Digital Return            | 0V to $V_{DD}$  |
| Output Short Circuit Duration (to Ground Only)     | 25ms            |
| Junction Temperature                               | +175°C          |
| Storage Temperature Range                          | -65°C to +150°C |
| Lead Temperature (Soldering 10sec)                 | +300°C          |

### 1.5 Thermal Characteristics.

Thermal Resistance  $\theta_{JC} = 7^\circ\text{C/W}$   
 $\theta_{JA} = 37^\circ\text{C/W}$

## AD DAC85/AD DAC87 — SPECIFICATIONS

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| Test                                                                                  | Symbol             | Device         | Design Limit<br>+25°C<br>(-55°C to<br>+125°C) | Sub<br>Group<br>1 | Sub<br>Group<br>2, 3 | Sub<br>Group<br>4 | Test Condition <sup>1,2</sup>                                                                    | Units        |
|---------------------------------------------------------------------------------------|--------------------|----------------|-----------------------------------------------|-------------------|----------------------|-------------------|--------------------------------------------------------------------------------------------------|--------------|
| Logic Levels                                                                          |                    |                |                                               |                   |                      |                   |                                                                                                  |              |
| Digital Input High                                                                    | V <sub>IH</sub>    | -1, 2, 3, 4    | 2.0                                           |                   |                      | 2.0               |                                                                                                  | + V min      |
| Digital Input Low                                                                     | V <sub>IL</sub>    | -1, 2, 3, 4    | 0.8                                           |                   |                      | 0.8               |                                                                                                  | + V max      |
| Digital Input High Current                                                            | I <sub>IH</sub>    | -1, 2, 3, 4    | 1                                             |                   |                      | 1                 | V <sub>IH</sub> = 5.0V                                                                           | - μA min     |
|                                                                                       |                    |                | 250                                           |                   |                      | 250               |                                                                                                  | + μA max     |
| Digital Input Low Current                                                             | I <sub>IL</sub>    | -1, 2, 3, 4    | 10                                            |                   |                      | 10                | V <sub>IL</sub> = +0.8V                                                                          | - μA min     |
|                                                                                       |                    |                | 100                                           |                   |                      | 100               |                                                                                                  | + μA max     |
| Gain Error <sup>3</sup>                                                               | A <sub>E</sub>     | -1, 2          | 0.3                                           | 0.3               |                      |                   | Input Bits = 0000 0000 0000<br>To Input Bits = 1111 1111 1111<br>Unipolar V <sub>FSR</sub> = 10V | ± % FSR max  |
|                                                                                       |                    | -3, 4          | 0.2                                           |                   |                      | 0.2               |                                                                                                  |              |
| Gain Error Drift                                                                      | TCA <sub>E</sub>   | -1, 2          | 20                                            |                   | 20                   |                   | Input Bits = 0000 0000 0000<br>Unipolar = 0 to +10V                                              | ± ppm/°C max |
|                                                                                       |                    | -3, 4          | 25                                            |                   | 25                   |                   | Unipolar = 0 to +10V                                                                             |              |
| Unipolar Offset                                                                       | V <sub>OS</sub>    | -1, 2          | 0.15                                          | 0.15              |                      |                   | Input Bits = 1111 1111 1111<br>Unipolar V <sub>FSR</sub> = 10V                                   | ± % FSR max  |
|                                                                                       |                    | -3, 4          | 0.10                                          |                   |                      | 0.10              |                                                                                                  |              |
| Unipolar Offset Drift                                                                 | TC <sub>VOS</sub>  | -1, 2, 3, 4    | 3                                             |                   | 3                    |                   | Input Bits = 1111 1111 1111<br>Unipolar V <sub>FSR</sub> = 10V                                   | ± ppm/°C max |
| Bipolar Offset                                                                        | B <sub>POE</sub>   | -1, 2          | 0.15                                          | 0.15              |                      |                   | Input Bits = 1111 1111 1111                                                                      | ± % FSR max  |
|                                                                                       |                    | -3, 4          | 0.10                                          |                   |                      | 0.10              |                                                                                                  |              |
| Bipolar Offset Drift                                                                  | TCB <sub>POE</sub> | -1, 2, 3, 4    | 10                                            |                   | 10                   |                   | Input Bits = 1111 1111 1111                                                                      | ± ppm/°C max |
| Unipolar Zero Error<br>Current Output                                                 | I <sub>OS</sub>    | -2, 4          | 3                                             | 3                 |                      |                   | Input Bits = 1111 1111 1111                                                                      | μA max       |
| Bipolar Zero Error<br>Current Output                                                  | I <sub>BPZE</sub>  | -2, 4          | 3                                             | 3                 |                      |                   | Input Bits = 0111 1111 1111                                                                      | μA max       |
| Bipolar Gain Error<br>Current Output                                                  | I <sub>BPGE</sub>  | -2, 4          | 0.96                                          |                   |                      | 0.96              | Input Bits = 0000 0000 0000                                                                      | - μA max     |
|                                                                                       |                    |                | 1.04                                          |                   |                      | 1.04              |                                                                                                  | - μA min     |
| Bipolar Offset Error<br>Current Output                                                | I <sub>BPOE</sub>  | -2, 4          | 0.96                                          |                   |                      | 0.96              | Input Bits = 1111 1111 1111                                                                      | + μA min     |
|                                                                                       |                    |                | 1.04                                          |                   |                      | 1.04              |                                                                                                  | + μA max     |
| Unipolar Gain Error<br>Current Output                                                 | I <sub>OGGE</sub>  | -2, 4          | 2.3995                                        |                   |                      | 2.3995            | Input Bits = 0000 0000 0000                                                                      | - μA min     |
|                                                                                       |                    |                | 1.5995                                        |                   |                      | 1.5995            |                                                                                                  | - μA max     |
| Bipolar Zero Error                                                                    | B <sub>PZ</sub>    | -1, 2          | 0.15                                          | 0.15              |                      |                   | Input Bits = 0111 1111 1111                                                                      | ± % FSR max  |
|                                                                                       |                    | -3, 4          | 0.10                                          |                   |                      | 0.10              |                                                                                                  |              |
| Compliance Voltage                                                                    | C <sub>V</sub>     | -2, 4          | 2.5                                           |                   |                      |                   |                                                                                                  | - V min      |
|                                                                                       |                    |                | 10                                            |                   |                      |                   |                                                                                                  | + V max      |
| Differential Linearity Error                                                          | D <sub>LE</sub>    | -1, 2, 3, 4    | 1/2                                           | 1/2               |                      |                   | (Abbreviate Codes Test)                                                                          | ± LSB max    |
| Differential Linearity Error<br>T <sub>A</sub> @ T <sub>min</sub> to T <sub>max</sub> | TCD <sub>LE</sub>  | -1, 2<br>-3, 4 | 1.0                                           |                   | 1.0                  |                   | (Abbreviate Codes Test)<br>(Monotonic Over<br>Temperature Range)                                 | ± LSB max    |
| Linearity Error                                                                       | LE                 | -1, 2, 3, 4    | 0.5                                           | 0.5               |                      |                   | (Abbreviate Codes Test)                                                                          | ± LSB max    |
| Linearity Error<br>T <sub>A</sub> @ T <sub>min</sub> to T <sub>max</sub>              | TC <sub>LE</sub>   | -1, 2, 3, 4    | 0.75                                          |                   | 0.75                 |                   | (Abbreviate Codes Test)                                                                          | ± LSB max    |
| Positive Summation Error                                                              | E <sub>PE</sub>    | -1, 2, 3, 4    | 0.50                                          | 0.50              |                      |                   |                                                                                                  | ± LSB max    |
| Negative Summation                                                                    | E <sub>NE</sub>    | -1, 2, 3, 4    | 0.50                                          | 0.50              |                      |                   |                                                                                                  | ± LSB max    |
| Positive Summation<br>Error Drift                                                     | E <sub>PETC</sub>  | -1, 2, 3, 4    | 0.75                                          |                   | 0.75                 |                   |                                                                                                  | ± LSB max    |
| Negative Summation<br>Error Drift                                                     | E <sub>NETC</sub>  | -1, 2, 3, 4    | 0.75                                          |                   | 0.75                 |                   |                                                                                                  | ± LSB max    |
| Reference Output Error                                                                | V <sub>REF</sub>   | -1, 3          | 126                                           |                   |                      | 126               | V <sub>REF</sub> = 6.3V                                                                          | ± mV max     |

Table 1. (Continued on next page)

REV. C

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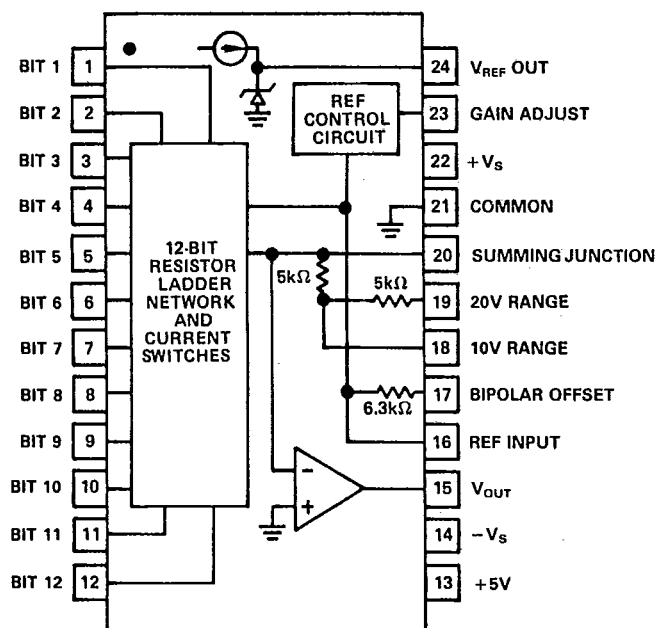
| Test                                                                            | Symbol             | Device   | Design Limit<br>+25°C<br>(-55°C to<br>+125°C) | Sub<br>Group<br>1 | Sub<br>Group<br>2,3 | Sub<br>Group<br>4 | T-51-09-12                                                                                  |                       |
|---------------------------------------------------------------------------------|--------------------|----------|-----------------------------------------------|-------------------|---------------------|-------------------|---------------------------------------------------------------------------------------------|-----------------------|
|                                                                                 |                    |          |                                               |                   |                     |                   | Test Condition <sup>1,2</sup>                                                               | Units                 |
| Reference Output<br>Temperature Coefficient                                     | TCV <sub>REF</sub> | -1<br>-3 | (20)<br>(10)                                  |                   | 20<br>10            |                   |                                                                                             | ± ppm/°C max          |
| Settling Time                                                                   | t <sub>SL</sub>    | -1,3     | 7                                             |                   |                     |                   | Settling Time to ±0.01%<br>FSR for FSR Change<br>(2kΩ  500pF with 10k<br>Feedback Resistor) | μs max                |
|                                                                                 | t <sub>SL</sub>    | -1,3     | 3                                             |                   |                     |                   | Small Signal Change<br>(1LSB) Settling within<br>1/2LSB                                     | μs max                |
|                                                                                 | t <sub>SL</sub>    | -2,4     | 300                                           |                   |                     |                   | Settling Time to ±0.01%<br>of FSR for FSR Change<br>10 to 100Ω Load                         | ns typ                |
|                                                                                 | t <sub>SL</sub>    | -2,4     | 1                                             |                   |                     |                   | For 1kΩ Load                                                                                | μs typ                |
| +5V Supply Current Drain                                                        | +I <sub>D</sub>    | -1,2,3,4 | 20                                            |                   |                     | 20                |                                                                                             | + mA max              |
| +15V Supply Current Drain                                                       | +I <sub>CC</sub>   | -1,2,3,4 | 20                                            |                   |                     | 20                |                                                                                             | + mA max              |
| -15V Supply Current Drain                                                       | +I <sub>EE</sub>   | -1,2,3,4 | 35                                            |                   |                     | 35                |                                                                                             | - mA max              |
| Power Supply Gain<br>Sensitivity Δ Gain                                         | PSRR               | -1,3     | 0.003                                         |                   |                     | 0.003             | +5V, +15V, -15V; Supplies<br>±5% Variation                                                  | ±%/FS/%V <sub>S</sub> |
| Power Supply Gain<br>Sensitivity Δ Gain<br>T <sub>min</sub> to T <sub>max</sub> | TCPSRR             | -1,3     | (0.03)                                        |                   |                     |                   | +5V, +15V, -15V; Supplies<br>±5% Variation                                                  | ±%/FS/%V <sub>S</sub> |

## NOTES

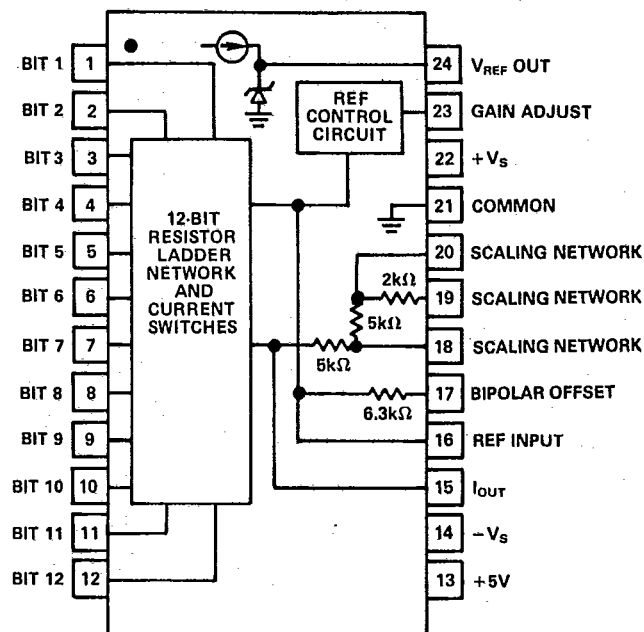
<sup>1</sup>T<sub>A</sub> = +25°C and ±V<sub>S</sub> = ±15V unless otherwise specified.<sup>2</sup>V<sub>SS</sub> = ±15V, V<sub>D</sub> = +5V unless otherwise noted.<sup>3</sup>Adjustable to zero.

Table 1.

## 3.2.1 Functional Block Diagram and Terminal Assignments.



Device - 1 or 3

Voltage Model Functional Diagram  
and Pin Configuration

Device - 2 or 4

Current Model Functional Diagram  
and Pin Configuration

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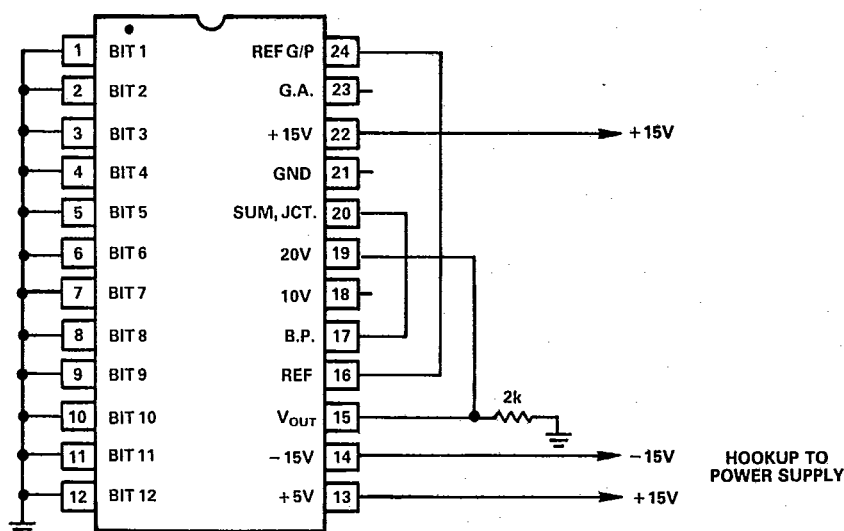
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**3.2.4 Microcircuit Technology Group.**

This microcircuit is covered by technology group (I).

**4.2.1 Life Test/Burn-In Circuit.**

Steady state life test is per MIL-STD-883 Method 1005. Burn-in is per MIL-STD-883 Method 1015 test condition (B).

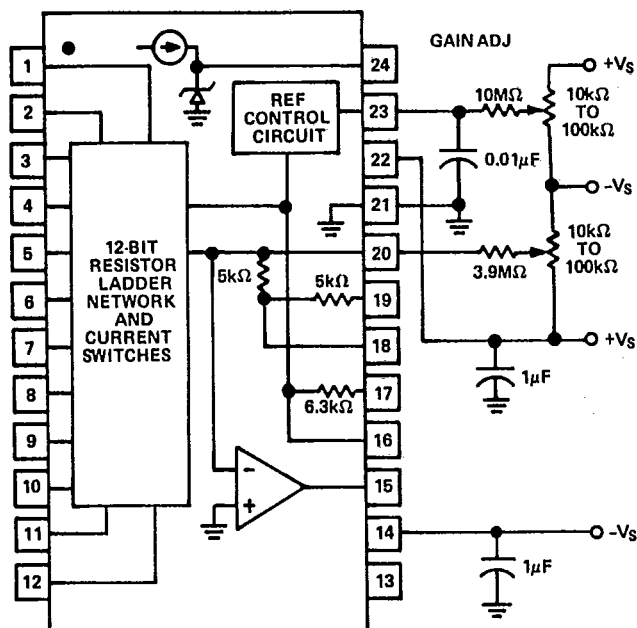


| Output Range | Digital Input Codes | Connect Pin 15 to | Connect Pin 17 to | Connect Pin 19 to | Connect Pin 16 to |
|--------------|---------------------|-------------------|-------------------|-------------------|-------------------|
| $\pm 10V$    | COB or CTC          | 19                | 20                | 15                | 24                |
| $\pm 5V$     | COB or CTC          | 18                | 20                | N.C.              | 24                |
| $\pm 2.5V$   | COB or CTC          | 18                | 20                | 20                | 24                |
| 0 to +10V    | CSB                 | 18                | 21                | N.C.              | 24                |
| 0 to +5V     | CSB                 | 18                | 21                | 20                | 24                |
| 0 to +10V    | CCD                 | 19                | N.C.              | 15                | 24                |

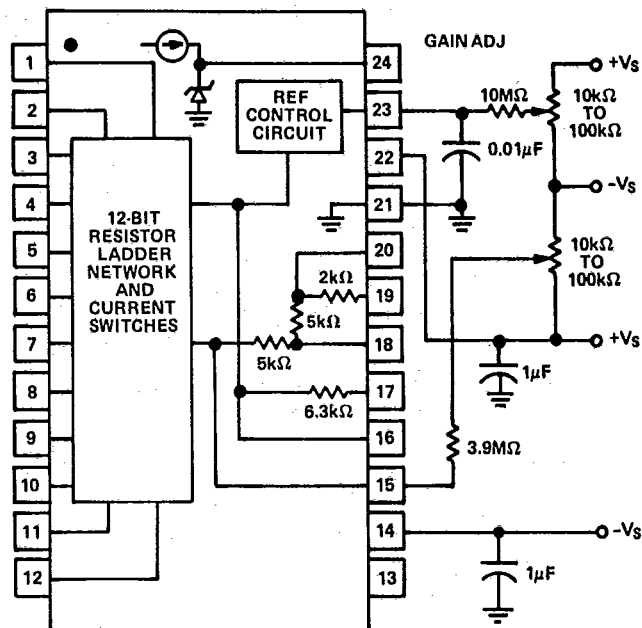
Table 2. Digital Input/Analog Output

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Device - 1 or 3

External Adjustment and Voltage  
Supply Connection Diagram

Device - 2 or 4

External Adjustment and Voltage  
Supply Connection Diagram

| Digital Input     |                         | Analog Output |           |           |           |
|-------------------|-------------------------|---------------|-----------|-----------|-----------|
| 12 Bit Resolution |                         | Voltage*      |           | Current   |           |
| MSB               | LSB                     | 0 to +10V     | ±10V      | 0 to -2mA | ±1mA      |
| CBI Model         | 0 0 0 0 0 0 0 0 0 0 0 0 | +9.9976V      | +9.9951V  | -1.9995mA | -0.9995mA |
|                   | 0 1 1 1 1 1 1 1 1 1 1 1 | +5.0000V      | 00000V    | -1.0000mA | 0.0000mA  |
|                   | 1 0 0 0 0 0 0 0 0 0 0 0 | +4.9976V      | -0.0049V  | 0.488mA   | +1.000mA  |
|                   | 1 1 1 1 1 1 1 1 1 1 1 1 | 0.0000V       | -10.0000V | 0.0000mA  | 0.488μA   |
|                   | 1LSB                    | 2.44mV        | 4.88mV    | -0.9995mA | +0.0005mA |

\*To obtain values for other binary ranges 0 to +5V range: divide 0 to +10 values by 2;  
 ±5V range: divide ±10V range values by 2; ±2.5V range: divide ±10V range values by 4.

Table 3. Output Voltage Range Connections-Voltage