



3 Digit DPM Module

AD2023

FEATURES

Third Generation I^2L LSI Design
 Multiplexed Seven Segment Output Version
 Character Serial BCD Output Version
 Balanced Differential Input
 Low Power: +5V @ 0.1 Watts (Converter Only)
 Small Size 2" x 2" x 0.4" (51x51x10.2mm)
 Wide Operating Temperature Range to Extremes of -40°C
 and $+100^{\circ}\text{C}$ Available Upon Special Request
 Low Cost

APPLICATIONS

LED, LCD, Beckman, etc. Display, Digital Panel Meters
 (DPMs), Particularly Where Available Front Panel Meters
 Prohibits Use of Traditional DPMs.
 ADC Requirements

GENERAL DESCRIPTION

The AD2023 is a low cost, 3 digit DPM module containing all the circuitry, except gain adjust pot, to drive three external display digits. The AD2023, with seven segment output, and the AD2023/B, with character serial BCD output, enable the user to drive any type of digital display.

Packaged in a small 2" x 2" x 0.4" module and requiring only +5V power, the AD2023 and AD2023/B address DPM needs where available front panel space is limited.

The module, utilizing an I^2L LSI design, minimizes component count. Most of the analog and digital circuitry is implemented on a single proprietary chip. The design is similar to and is based on the same I^2L device as the highly successful AD2026 DPM. And all of the high AD2026 standards for quality and reliability are retained.

AD2023 (WITH SEVEN SEGMENT OUTPUT)

The AD2023 can drive a 3 digit LED (light emitting diode) display. Except for the display which is wired directly to the segment output pins of the module and a gain pot, all the circuitry is self contained (an optional offset pot can also be used if desired). The AD2023 drives any size and type of currently available LED display (for application assistance see Page 3, Figure 3).

AD2023/B (WITH BCD OUTPUT)

With appropriate decoder driver, the AD2023/B character serial BCD output unit can drive a variety of different displays . . . ie., LED, LCD, Beckman, etc. . Only decoder driver, gain adjust pot, display and digit drivers when necessary are needed to complete the DPM.



EXCELLENT PERFORMANCE

The AD2023 measures inputs from -99mV to $+999\text{mV}$ with an accuracy of 0.1% of reading ± 1 digit. Zero shift is $\pm 0.5\text{mV}$ over the full operating temperature range, resulting in the same performance as a DPM with auto zero. The balanced differential input rejects common mode voltages up to 200mV, enough to eliminate most ground loop problems.

Automatic polarity indication is provided by using the MSD (most significant digit) to indicate negative inputs. With the AD2023, automatic overrange indication for inputs greater than $+999\text{mV}$ is displayed as $\square\square\square$ and for inputs less than -99mV , as $---$. The AD2023/B overload indication is BCD output code 1011 for all digits for inputs greater than $+999\text{mV}$ and 1010 for all digits for inputs less than -99mV .

WIDE TEMPERATURE RANGE

Wide temperature range modules, for extreme environment applications, are available upon special request. Operating temperature extremes of -40°C and $+100^{\circ}\text{C}$ and storage temperature of -55°C and $+125^{\circ}\text{C}$ allow the user to apply the AD2023 in environments where conventional DPMs cannot be used. Wide temperature range displays are also currently available from several vendors. (For further information consult factory.)

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 Tele: 924491 Cables: ANALOG NORWOODMASS

SPECIFICATIONS

(typical @ +25°C and +5V dc unless otherwise noted)

ANALOG INPUT

- Configuration: Limited bipolar, balanced differential input.
- Full Scale Input Range: -99mV to +999mV
- Automatic Polarity
- Input Impedance: 100M Ω
- Bias Current: 110nA
- Over Voltage Protection: $\pm 15V$ (Inputs to Ground)

AD2023 DISPLAY OUTPUTS

- Display Current: 46mA/segment multiplexed
- Positive Overload Indication: $\square \square \square$
- Negative Range Overload Indication: ---
- Digit Select Outputs: Supply Voltage, 5.5V (max)
 I_{OUT} , 480mA (max pk)

AD2023/B DATA/DISPLAY OUTPUTS

- Negative Indication: BCD code 1010 during MSD
- Positive Overload Indication: BCD code 1011 for all digits
- Negative Overload Indication: BCD Code 1010 for all digits
- Output Loading: $I_{OL} = 8mA @ V_{OUT} \leq 0.5V$
 $I_{OL} = -400\mu A @ V_{OUT} \geq 2.7V$
- Digit Select Outputs: Supply Voltage, 5.5V (max)
 I_{OUT} , 100mA (max pk)

ACCURACY

- 0.1% reading ± 1 digit
- Resolution: 1mV
- Linearity: ± 1 Bit
- Temperature Range¹: -10°C to +70°C operating
-55°C to +125°C storage
- Temperature Coefficient: Gain: 50ppm/°C
Zero: 10 μV /°C (essentially auto zero)
- Warm Up Time to Rated Accuracy: Instantaneous
- Settling Time to Rated Accuracy: 0.3 second for full input voltage swing
- Input Offset Voltage: $\pm 0.3mV$ (max)

COMMON MODE REJECTION (1k Ω source imbalance, dc to 1kHz)

- 50dB

COMMON MODE VOLTAGE

- $\pm 200mV$

CONVERSION RATE

- Normal: 4 conversions per second
- High Speed (H.S.): 48 to 168 conversion per second

CONTROL INPUTS

- \overline{Hold} (1LSTTL Load). Logic "0" or grounding disables internal or external trigger and last conversion is held. Logic "1" allows for normal operation.
- High Speed: Logic "0" on the \overline{Hold} pin (18) and connecting the H.S. pin (20) to +5V, the module will convert 48 to 168 times per second.
- Lamp Test - Logic "0" on the Lamp Test pin (15) will turn all segments on in the positive range only.

GAIN ADJUST

- A 5k multturn pot connected from the gain pin (22) to ground provides the full scale adjustment. This pot is user supplied.

EXTERNAL ZERO ADJUST (OPTIONAL)

- A 10k Ω pot across the zero terminals and the center arm to +5V the user can externally adjust zero offset.

POWER INPUT

- Converter: +5V $\pm 5\%$, 0.1 watts typ.; 0.16 watts max
- Display: +4.75V to +5.5V @ 1.3 watts typ

SIZE

- Module 2" x 2" x 0.4" (51 x 51 x 10.2mm)

WEIGHT

- 1 ounce (28.4 grams)

ORDERING GUIDE

- AD2023: Multiplexed seven segment output
- AD2023/B: Character serial BCD output
- AC2623: Mounting card with gain and zero adjusts
- AC2625: Mounting card with gain and zero adjusts and three $\frac{1}{2}$ " high LEDs

¹ Guaranteed

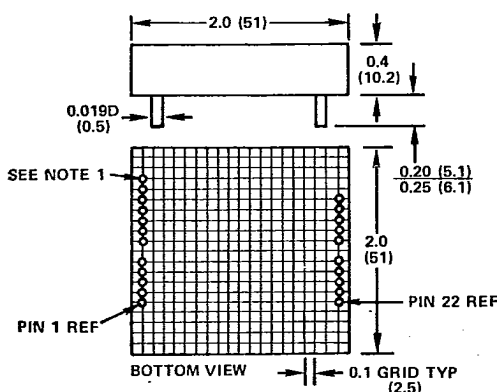
Specifications subject to change without notice.

OUTLINE DIMENSIONS AND PIN CONFIGURATIONS

Dimensions shown in inches and (mm).

NOTES:

1. PINS 10, 11, 12 AND 15 NOT ON MODEL AD2023/B



AD2023

1 DISP. POWER	22 GAIN ADJUST
2 MSD	21 ZERO ADJUST
3 NSD	20 H.S.
4 LSD	19 ZERO ADJUST
5 DISP. GND	18 HOLD
6 A	17 ANALOG HI
7 B	16 ANALOG LO
8 C	15 LAMP TEST
9 D	14 CONV. POWER
10 E	13 CONV. GND
11 F	
12 G	

AD2023/B

1 DISP. POWER	22 GAIN ADJUST
2 MSD	21 ZERO ADJUST
3 NSD	20 H.S.
4 LSD	19 ZERO ADJUST
5 DISP. GND	18 HOLD
6 A	17 ANALOG HI
7 B	16 ANALOG LO
8 C	14 CONV. POWER
9 D	13 CONV. GND

Applying the AD2023

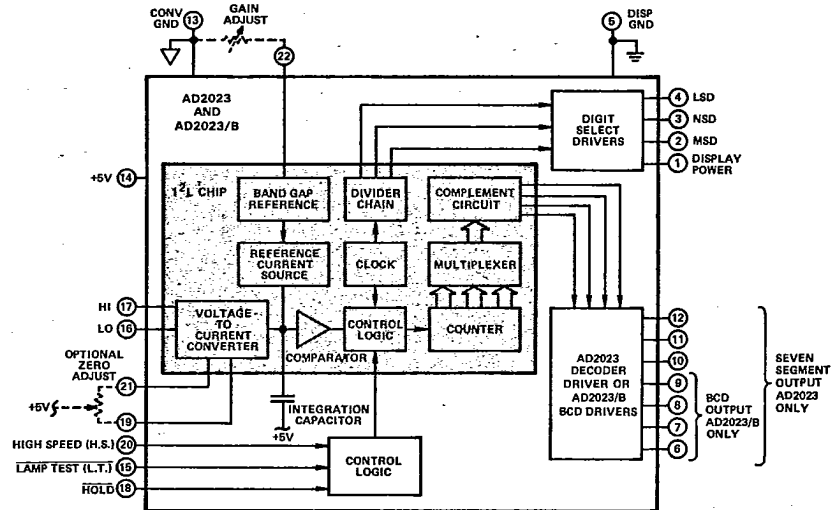


Figure 1. Block Diagram

MOUNTING CARDS

To make AD2023 evaluation easy, two accessory mounting cards are available. Both are $4\frac{1}{2} \times 4$ " (114.3x101.6mm) printed circuit cards. One comes equipped with gain and zero adjust pots and is suitable for use with the AD2023 or AD2023/B. The other also includes $\frac{1}{2}$ " high LED display and is used with the AD2023. 3.4 square inches of breadboarding area is also provided on the two accessory cards. Interconnect is via standard 44 pin card edge connector.

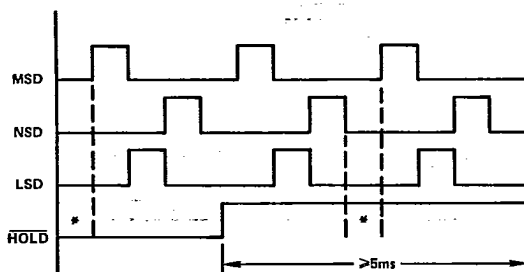
APPLYING THE AD2023

Description of Operation

The AD2023 and AD2023/B Block Diagram is shown in Figure 1. The two versions are functionally identical except at the data output section. In the AD2023 the 4 BCD lines from the I²L Chip are fed into a Decoder Driver and presented on pins 6 through 12 in seven segment output form for use with LED displays. The BCD lines in the AD2023/B model are processed through BCD Drivers and are presented on pins 6 through 9 in a Character Serial BCD format.

Signal input, user supplied Gain adjust and optional Zero adjust connections are applied directly to the chip. Hold, High Speed conversion and Lamp Test are implemented via Control Logic circuitry.

Most of the Analog to Digital conversion takes place within the chip which feeds Character Serial data to a seven segment decoder driver (AD2023) or BCD line drivers (AD2023/B). The appropriate digit is identified via three digit select lines.



*CONVERSION TAKES PLACE HERE
NOTE: OVERLAP MAY OCCUR BETWEEN DIGITS

Figure 2. Timing Diagram

The Timing Diagram, Figure 2, shows that the Hold input may be used as a pseudo-trigger provided the trigger pulse is $\geq 5\text{ms}$ (insures at least 1 conversion). A conversion can only be initiated when all three digit lines are low and the Hold line is high. As shown, the sequence of digits is MSD, LSD, and NSD.

Led Display DPM

The total requirement to construct a LED display DPM using the AD2023 is shown in Figure 3.

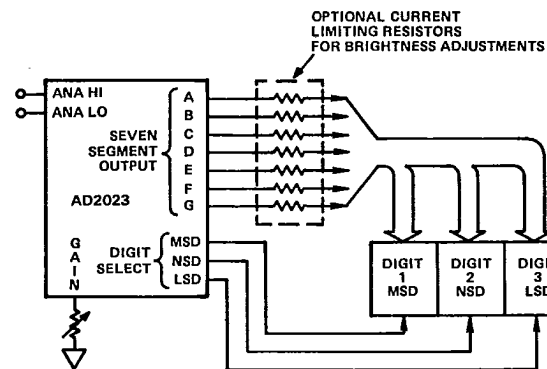


Figure 3. AD2023 with LED Interface

LCD Display DPM

Construction of LCD display DPM requires only an AD2023, LCD driver and the LCDs.

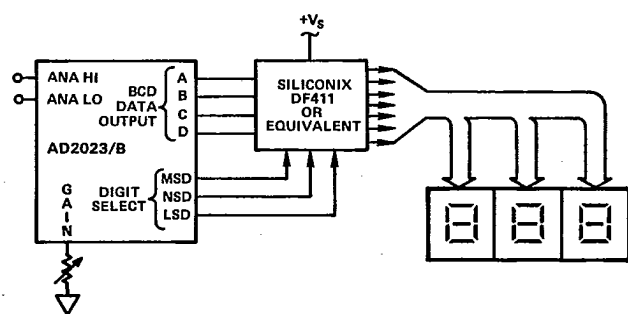


Figure 4. AD2023/B with LCD Interface

Beckman Display DPM

If a Beckman Gas Discharge Display is desired added components are: three displays, one DD700 Decoder Driver and three High Voltage Anode Drivers.

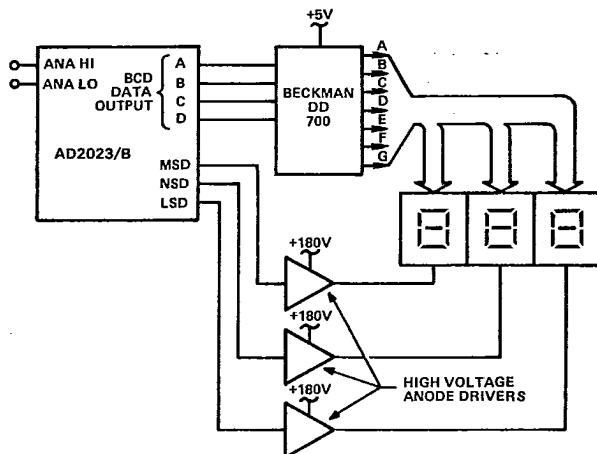


Figure 5. AD2023/B with Beckman Interface

BCD Output DPM

In some cases the AD2023/B may be the choice even when LED display is to be used. This permits the AD2023/B BCD output to drive other devices as well as the display and display can be used to show converted data directly and/or processed data. Figure 6 shows a BCD output DPM with LED displays. It is possible to obtain BCD outputs in this fashion when using other displays as well.

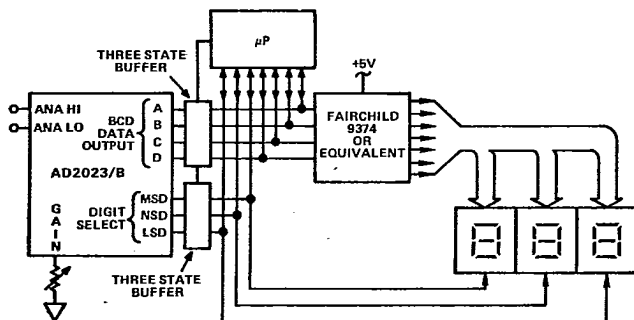


Figure 6. AD2023/B with LED/μP Interface

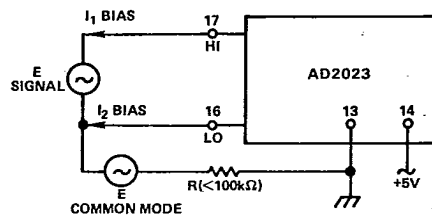
Input Wiring Connections

Figure 7.

Connect to AD2023 as per above for balanced differential input as shown. The common mode loop MUST provide a return path for Bias Currents (I_1 Bias, I_2 Bias) internal to the AD2023. The resistance (R) of this path must be less than 100kΩ. CAUTION: Total Common Mode Voltage between Pins 13 and 16 must not exceed 200mV.

For single ended input, connect Pin 13 to Pin 16.

Accessory Cards

As shown in Figures 8 and 9, two cards are available, the AC2623 with Gain and Zero Pots and the AC2625 with Gain Pot, Zero Pot and three seven segment LED displays. Both versions come complete with solder pads, power buss tracks and other features to allow for easy breadboarding. Right angle connectors for mounting LEDs perpendicular to the P.C. board are available and accessory card is laid out to be able to receive these connectors. Connectors are available from Augat 6x51-73-161 and Aries Electronics 34-6823-90.

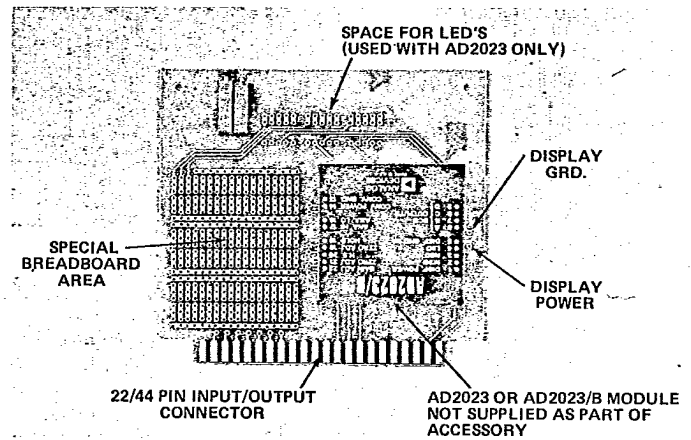


Figure 8. AC2623

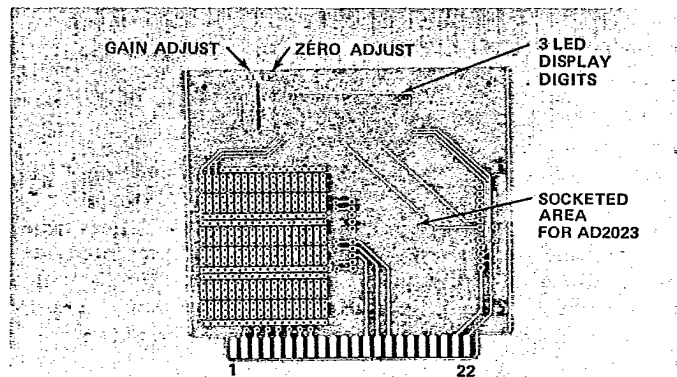


Figure 9. AC2625

1	A
2	B
3	C
4	D
5	E
6	F
7	G
8	H
9	J ANALOG HIGH
10	K ANALOG LO
11	L LAMP TEST
12	M CONV. POWER
13	N POWER GND.
14	P SEG G
15	Q SEG F
16	R SEG E
17	S SEG D (BCD D)
18	T SEG C (BCD C)
19	U SEG B (BCD B)
20	V SEG A (BCD A)
21	W DISPLAY GND.
22	X LSD
	Y NSD
	Z

Figure 10. Accessory Card Pin Connections