

CIO-DAC08-I and CIO-DAC16-I

User's Manual



**MEASUREMENT
COMPUTING™**

Revision 3
October, 2000

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1 INTRODUCTION

The CIO-DAC-series boards are available in either eight-channel or 16-channel versions and with either voltage or current (I) outputs. In this manual, the current output (I) boards are described and are referred to generically as CIO-DAC##-I unless a specific board is being described.

Analog current outputs are from dual-DAC AD7237s with each output buffered by 2N2222 transistors.

The analog outputs are controlled by writing a digital control and data word as two bytes (actually a data byte and a data nibble along with a nibble containing channel information) to two control registers. The control register is double-buffered so a DAC's output is not updated until both bytes (first low byte, then high byte) are written.

The CIO-DAC08-I and CIO-DAC16-I have a bank of nine address DIP switches. (See Figure 2-1.) There are no other switches or jumpers.

2 SOFTWARE INSTALLATION

An installation program labeled *InstaCal*[™] is on the disk shipped with the board. This program will guide you through board configuration and switch settings. Refer to the *Software Installation Manual* for complete instructions regarding installing and using *InstaCal*. If you decide not to use *InstaCal* as a guide, the information required for configuring the board is provided in the following section.

3 HARDWARE INSTALLATION

3.1 Initial Board Setup

The CIO-DAC##-I has only one bank of switches for setting the base address which must be set before installing the board in your computer. The *InstaCal* calibration and test program included with the CIO-DAC##-I will show how these switches are to be set. Run the program before you open your computer.

The CIO-DAC##-I is setup at the factory as follows:

BASE ADDRESS 300h (768 decimal) Same as data sheet.

3.2 Selecting the Base Address

Unless there is already a board in your system that uses address 300h (768 decimal), leave the switches as they are set at the factory.

In the following examples, the board (CIO-DAC08-I or CIO-DAC16-I) are set for a base address of 300h (768 decimal).

NOTE: Use the white numbers on the PCB, not those on the switch.

Certain address are used by the PC, others are free and can be used by the CIO-DAC##-I and other expansion boards.

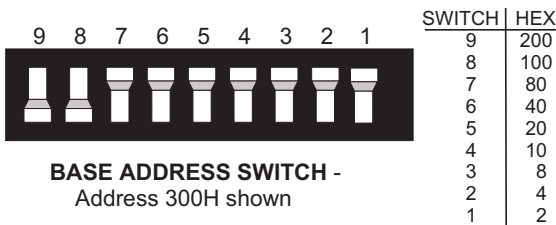


Figure 3-1. Base Addresses- CIO-DAC08-I, CIO-DAC16-I

Table 3-1. PC I/O Addresses

HEX RANGE	FUNCTION	HEX RANGE	FUNCTION
000-00F	8237 DMA #1	2C0-2CF	EGA
020-021	8259 PIC#1	2D0-2DF	EGA
040-043	8253 TIMER	2E0-2E7	GPIB (AT)
060-063	8255 PPI (XT)	2E8-2EF	SERIAL PORT
060-064	8742 CONTROLLER (AT)	2F8-2FF	SERIAL PORT
070-071	CMOS RAM & NMI MASK	300-30F	PROTOTYPE CARD
080-08F	DMA PAGE REGISTERS	310-31F	PROTOTYPE CARD
0A0-0A1	8259 PIC #2 (AT)	320-32F	HARD DISK (XT)
0A0-0AF	NMI MASK (XT)	378-37F	PARALLEL PRINTER
0C0-0DF	8237 #2 (AT)	380-38F	SDLC
0F0-0FF	80287 NUMERIC CO-P (AT)	3A0-3AF	SDLC
1F0-1FF	HARD DISK (AT)	3B0-3BB	MDA
200-20F	GAME CONTROL	3BC-3BB	PARALLEL PRINTER
210-21F	EXPANSION UNIT (XT)	3C0-3CF	EGA
238-23B	BUS MOUSE	3D0-3DF	CGA
23C-23F	ALT BUS MOUSE	3E8-3EF	SERIAL PORT
270-27F	PARALLEL PRINTER	3F0-3F7	FLOPPY DISK
2B0-2BF	EGA	3F8-3FF	SERIAL PORT

The CIO-DAC##-I BASE ADDRESS switch can be set for address in the range of 000-3FEh so it should not be hard to find a free address area for your board. If not using IBM prototyping cards or any other board which occupies these addresses, 300-31Fh are free to use. Address not specifically listed, such as 390-39Fh, are free.

3.3 Installing the CIO-DAC##-I in the Computer

1. Turn PC power off.
2. Remove the cover of your computer. Please be careful not to dislodge any of the cables installed on the boards in your computer as you slide the cover off.
3. Locate an empty expansion slot in your computer.
4. Push the board firmly down into the expansion bus connector. If it is not seated fully it can fail to work and could short circuit the PC bus power onto a PC bus signal. This could damage the motherboard in your PC as well as the board.

3.4 Cabling to the CIO-DAC##-I

The CIO-DAC##-I connector is accessible through the PC/AT expansion bracket. The connector is a standard 37-pin D-type male connector. A mating female connector, such as the C37FF-2, is available from Measurement Computing.

Several cabling and screw termination options are available from Measurement Computing.

DFCON-37	D connector, D shell and termination pins to construct your own cable
C37FF-2	2 foot (and longer) ribbon cable with 37 pin D female connectors
C37FFS-5	5 foot shielded round cable with molded ends housing 37-pin female connectors. Also in 10 ft.
CIO-MINI37	37-position, 4 X 4-in. screw terminal board
CIO-TERMINAL	4 X 16-in. screw terminal board with on-board prototyping area.
CIO-SPADE 50	A screw terminal board that accepts spade lugs with on-board area for prototyping circuitry.

3.5 Testing the Installation

You can test the installation of the CIO-DAC##-I using InstaCal. Select the Test option to vary the output voltages and monitor them with a Volt Meter.

3.6 Signal Connection- Current Loop

The basic CIO-DAC##-I current output circuit is shown in Figure 3-2. Loop power is from an external power supply. The supply voltage is from 6V to 36V, with 24V or 36V being typical choices.

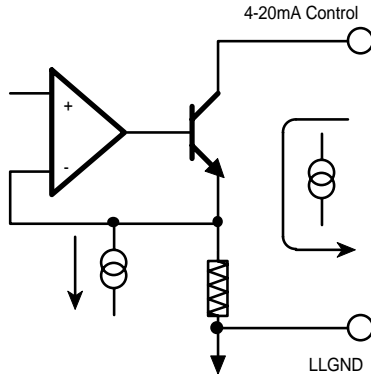


Figure 3-2. Basic Current Loop

The 4 to 20 mA loop can be configured with either a floating power supply (Figure 3-3) or a floating load (Figure 3-4).

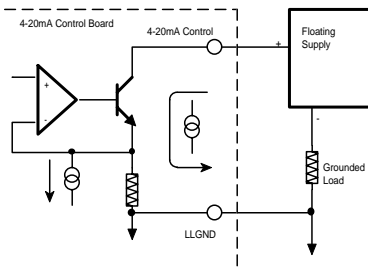


Figure 3-3. I-Loop, Floating Supply

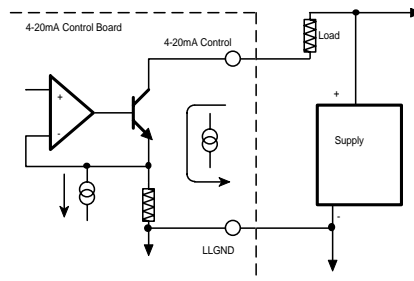


Figure 3-4. I-Loop, Floating Load

3.7 Connector Diagram

The CIO-DAC##-I connector is a 37-pin D-type connector accessible from the rear of the PC through the expansion backplate (Figures 3-5, 3-6).

The connector accepts female 37-pin, D-type connectors, such as those on the C37FF-2, 2-foot cable with connectors.

If frequent changes to signal connections or signal conditioning is required, refer to the information on the CIO-TERMINAL, CIO-SPADE50 and CIO-MINI37 screw terminal boards in the Measurement Computing catalog.

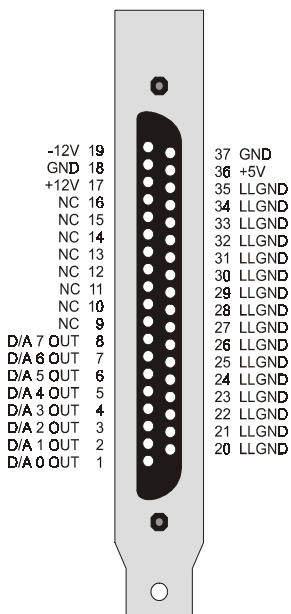
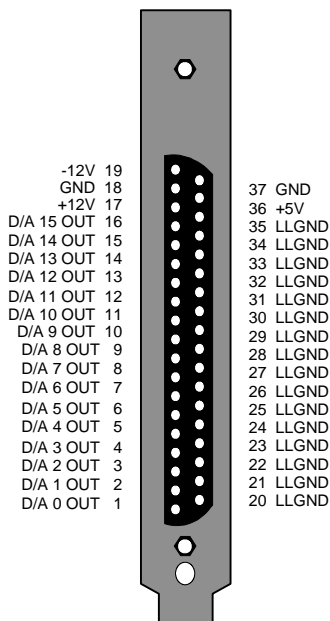


Figure 3-5. CIO-DAC16-I Connector

Figure 3-6. CIO-DAC08-I Connector

4 REGISTER ARCHITECTURE

The CIO-DAC##-I is a simple board to understand. All control and data is read/written with simple I/O read and write commands. No interrupt or DMA control software is required. Thus, the board's outputs are easy to control directly from BASIC, C or PASCAL.

The CIO-DAC##-I has two control and analog output registers.

The first address, or BASE ADDRESS, is determined by the setting of a bank of switches on the board.

The register descriptions all follow the format:

7	6	5	4	3	2	1	0
A7	A6	A5	A4	A3	A2	A1	A0

the numbers along the top row are the bit positions within the 8-bit byte and the numbers and symbols in the bottom row are the functions associated with each bit.

To write to or read from a register in decimal or HEX, the following weights apply:

Table 4-1. Register Bit Weights

BIT POSITION	DECIMAL VALUE	HEX VALUE
0	1	1
1	2	2
2	4	4
3	8	8
4	16	10
5	32	20
6	64	40
7	128	80

In summary form, the registers and their function are listed in the following table.

Table 4-2. Register Map

ADDRESS	WRITE FUNCTION	READ FUNCTION
BASE + 0	D/A Least Significant Byte	None
BASE + 1	D/A Most Significant Nibble and Channel address	None

These two registers control all of the DACs on the CIO-DAC##-I. The first register, BASE + 0, contains the least significant eight bits of D/A code and is written *first*.

BASE + 0

7	6	5	4	3	2	1	0
D5	D6	D7	D8	D9	D10	D11	D12 (LSB)

The second register contains the most significant four bits of D/A code and the four bits that determine which channel the data will be sent to. This register is written to *second*. A write to this register updates the output of the selected D/A with all 12 bits of the D/A code contained in the two registers.

BASE + 1

7	6	5	4	3	2	1	0
CH3	CH2	CH1	CH0	D1 (MSB)	D2	D3	D4

D12: 1 Data bits

CH3:0 Channel value (0000 = channel 0, 0101 = channel 5, etc.)

Updating the output of a particular DAC channel is a matter of calculating the code for the output value desired and combining it with the channel number.

To calculate the data code, you first select the output you desire, then apply a transfer function to that value. The transfer function for code = output is:

$$FSI / 4095 * CODE = \text{Current Out} + 4 \text{ mA} \quad \text{or} \quad CODE = \text{Current Out} - 4 / 16 * 4095$$

Full scale current (FSI) is not 20 mA, it is 20 - 4 or 16 mA. Use this in the equation above.

For Example:

If CODE = 0, current output = 4 mA

If CODE = 4095, current output = 20 mA

After calculating the code required for the D/A data, combine it with the code required for the channel number.

For example, to set the output on channel 3 to 11.890625mA:

$$\text{CODE} = 11.890625\text{mA} - 4 / 16 * 4095 = 2020$$

The digital code for 2020 is 0111 1110 0100.

To this, you would add the value for channel 3 (0011) as the upper nibble for the second register.

The end result is 0011 0111 1110 0100.

This is written to the registers as:

BASE + 0: 228 (or E4 hex)

BASE + 1: 55 (or 37 hex)

5 SPECIFICATIONS

POWER CONSUMPTION

CIO-DAC16-I	
+5V supply	320 mA typical, 500 mA max
+12V supply	150 mA typical, 190 mA max
-12V supply	100 mA typical, 130 mA max
CIO-DAC08-I	
+5V supply	320 mA typical, 500 mA max
+12V supply	75 mA typical, 100 mA max
-12V supply	50 mA typical, 65 mA max

ANALOG OUTPUT

D/A type	AD7237
Resolution	12 bits
Number of channels	
CIO-DAC16-I	16 Current Outputs
CIO-DAC08-I	8 Current Outputs
Output Range	4 to 20mA
Voltage compliance	6 to 36V
D/A pacing	Software paced
Data transfer	Software
Offset error	Adjustable to zero
Gain error	Adjustable to zero
Differential nonlinearity	± 1 LSB max
Integral nonlinearity	± 1 LSB max
Monotonicity	Guaranteed monotonic to 15 bits over temperature
Gain drift (DAC)	± 15 ppm/ $^{\circ}$ C max
Bipolar offset drift (DAC)	± 5 ppm/ $^{\circ}$ C max
Unipolar offset drift (DAC)	± 3 ppm/ $^{\circ}$ C max
Throughput	System dependant
Settling time (Full scale step to .01%)	12 μ s typ, 19 μ s max
Miscellaneous	Double buffered output latches DAC output state on power up and reset undefined

ENVIRONMENTAL

Operating temperature range	0 to 70 $^{\circ}$ C
Storage temperature range	-40 to 100 $^{\circ}$ C
Humidity	0 to 90% non-condensing

EC Declaration of Conformity

We, Measurement Computing Corp., declare under sole responsibility that the product:

<u>CIO-DAC16-I</u>	<u>ISA-Type Current output card</u>
<u>CIO-DAC08-I</u>	<u>ISA-Type Current output card</u>
Part Number	Description

to which this declaration relates, meets the essential requirements, is in conformity with, and CE marking has been applied according to the relevant EC Directives listed below using the relevant section of the following EC standards and other normative documents:

EU EMC Directive 89/336/EEC: Essential requirements relating to electromagnetic compatibility.

EU 55022 Class B: Limits and methods of measurements of radio interference characteristics of information technology equipment.

EN 50082-1: EC generic immunity requirements.

IEC 801-2: Electrostatic discharge requirements for industrial process measurement and control equipment.

IEC 801-3: Radiated electromagnetic field requirements for industrial process measurements and control equipment.

IEC 801-4: Electrically fast transients for industrial process measurement and control equipment.

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