

**D+7AI/O™**



**Cromemco**

Specialists in computer peripherals

2432 Charleston Rd., Mountain View, CA 94043 • (415) 964-7400

## ASSEMBLY INSTRUCTIONS

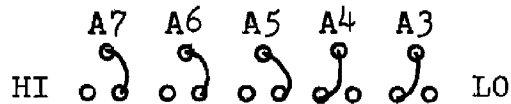
If you purchased your D+7A I/O module as a kit, you will find the assembly to be straightforward. The location and value of every component is printed directly on the D+7A printed circuit card to facilitate assembly. The components are simply inserted as shown and soldered into position. Be sure to use a low-wattage soldering iron and high quality rosin-core solder.

### STEP BY STEP INSTRUCTIONS

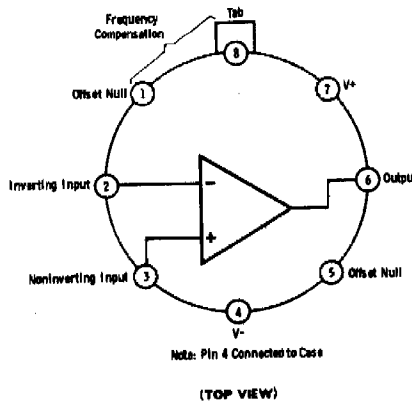
- ( ) Install all IC sockets. Notice that IC sockets are used for all ICs except the voltage regulators (IC3 and IC 27). All 8-pin ICs are mounted side-by-side in 16 pin sockets.
- ( ) Install all resistors. The resistor color codes are shown below:

|          |                    |
|----------|--------------------|
| 10 ohms  | brown-black-black  |
| 100 ohms | brown-black-brown  |
| 150 ohms | brown-green-brown  |
| 180 ohms | brown-gray-brown   |
| 220 ohms | red-red-brown      |
| 560 ohms | green-blue-brown   |
| 1K       | brown-black-red    |
| 1.2K     | brown-red-red      |
| 2.2K     | red-red-red        |
| 2.4K     | red-yellow-red     |
| 2.7K     | red-violet-red     |
| 4.7K     | yellow-violet-red  |
| 5.1K     | green-brown-red    |
| 10K      | brown-black-orange |
| 18K      | brown-gray-orange  |
| 100K     | brown-black-yellow |
- ( ) Install the calibration potentiometers R8, R12, R16, and R22. Note that R8 is 25K while R12, R16, and R22 are each 500 ohms.
- ( ) Install all six diodes in place. Take care that the banded (cathode) end of each diode is oriented as shown on the pc board.
- ( ) Install transistor Q1 (a 2N3906). The flat side of the transistor should face the top of the pc board.
- ( ) Install the two voltage regulator ICs with a heatsink mounted between the regulator and the pc board. Note that IC3 is a LM340T-5 or 7805 and that IC27 is a LM320T-5.0 or 7905. BE CAREFUL NOT TO INTERCHANGE THESE TWO ICs.
- ( ) Install the two inductors L1 and L2.

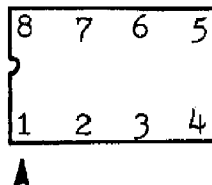
- ( ) Install the capacitors in the positions shown on the pc board. When installing the tantalum capacitors C2, C42, C43, and C55 take special care to see that the "+" end of each capacitor is oriented as shown on the pc board.
- ( ) Install the five jumper wires to select the eight consecutive addresses used for the I/O ports of the D+7A module. We recommend the ports 030 (octal) through 037 (octal). The jumper wires (located just above IC 30) should be installed in this manner for this address selection:



- ( ) Install the ICs in their sockets taking care to see the pin 1 of each IC is engaged in the pin position marked by the arrow on the pc board. When installing the ICs in the metal TO-5 style case note that the metal tab denotes pin 8 of the IC as shown below:



The leads of these ICs should be shaped into two rows of four and inserted in the IC socket in this order:

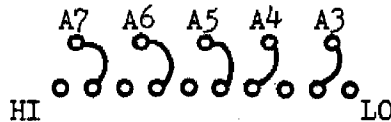


- ( ) Carefully inspect your work. Make certain that all ICs are oriented properly and that every pin of every IC is properly engaged in its socket. Carefully inspect your soldering for cold solder joints or accidental solder bridges. Construction is now complete.

## OPERATING INSTRUCTIONS

### Introduction

The Cromemco D+7A module allows you to input and output analog signals with your computer as easily as digital signals. Five port address jumper wires on the D+7A board are used to select the port addresses of the eight (one digital and seven analog) I/O ports. The suggested selection is to use port 030 (octal) as the digital I/O port and ports 031 through 037 (octal) as the seven analog I/O ports. The jumper wires located just above IC30 on the D+7A board should be connected in the following way for this address selection:



### Connector pin assignments

The analog I/O channels, the parallel digital I/O channel, and several power supply voltages are brought to the edge connector on the top of the D+7A module. These contacts are gold-plated for high reliability. The following chart shows the detailed pin assignment for this connector:

| CONNECTOR PIN ASSIGNMENTS |         |         |                       |
|---------------------------|---------|---------|-----------------------|
| COMPONENT SIDE            | PIN No. | PIN No. | SOLDER SIDE           |
| ANALOG GROUND             | A       | 1       | ANALOG GROUND         |
| ANALOG INPUT              | 7 B     | 2       | ANALOG OUTPUT         |
|                           | 6 C     | 3       | 6                     |
|                           | 5 D     | 4       | 5                     |
|                           | 4 E     | 5       | 4                     |
|                           | 3 F     | 6       | 3                     |
|                           | 2 H     | 7       | 2                     |
| ANALOG INPUT              | 1 J     | 8       | ANALOG OUTPUT         |
| -12V REGULATED            | K       | 9       | +12V REGULATED        |
| ANALOG GROUND             | L       | 10      | ANALOG GROUND         |
| -17V UNREGULATED          | M       | 11      | +17V UNREGULATED      |
| -5V REGULATED             | N       | 12      | +5V REGULATED         |
| INPUT STB                 | P       | 13      | OUTPUT STB            |
| PARALLEL INPUT BIT 7      | R       | 14      | PARALLEL OUTPUT BIT 7 |
|                           | 6 S     | 15      | 6                     |
|                           | 5 T     | 16      | 5                     |
|                           | 4 U     | 17      | 4                     |
|                           | 3 V     | 18      | 3                     |
|                           | 2 W     | 19      | 2                     |
|                           | 1 X     | 20      | 1                     |
| PARALLEL INPUT BIT 0      | Y       | 21      | PARALLEL OUTPUT BIT 0 |
| DIGITAL GROUND            | Z       | 22      | DIGITAL GROUND        |

PC BOARD

### Twos complement representation

The analog I/O channels use twos complement notation for ease of representing both positive and negative voltages. The least significant bit represents a 20 millivolt increment. The analog voltage range on both input and output is from -2.56 volts to +2.54 volts. For example, the following 8-bit codes are used to represent these analog voltages:

|          |             |
|----------|-------------|
| 01111111 | +2.54 volts |
| 00000001 | +0.02 volts |
| 00000000 | 0 volts     |
| 11111111 | -0.02 volts |
| 10000000 | -2.56 volts |

### Calibration procedure

Two potentiometers are used for calibration of the A/D converter (R12 and R22) and two potentiometers are used for calibration of the D/A converter (R8 and R16). Calibration of the A/D converter must be done before calibration of the D/A converter.

To calibrate the A/D converter, known voltages must be applied to any one of the seven analog input channels (for example analog channel 7, port 037, on contact "B" of the top edge connector). Now enter and execute the following program with your computer to input from analog port 7 (port 037 octal) and output to digital port 030 (octal):

```
000 000 333 (input)           Note: output port 030
000 001 037 (port 037)       is used here since it
000 002 323 (output)        is available on D+7A.
000 003 030 (port 030)      IMSAI 8080 users may find
000 004 303 (jump)          output port 377 on the
000 005 000 (000)           front panel more convenient
000 006 000 (000)           to use.
```

While this program is executing apply a +2.54 volt signal to pin B of the top edge connector and adjust R12 for a output of 011111 on pins 14 to 21 of the digital output port. Now apply a -2.56 volt signal to pin B and adjust R22 for an output of 1000000 on pins 14 to 21. Since R12 and R22 interact, you may need to repeat the above procedure once or twice.

To calibrate the D/A converter, a voltmeter must be used to measure the output voltage at any one of the seven analog output ports (say analog port 7, port 037, on contact "2" of the top edge connector). Now enter and execute the following program:

```
000 000 076 (load immediate accumulator)
000 001 177 (01111111)
000 002 323 (output)
000 003 037 (to port 037)
000 004 303 (jump)
000 005 000 (000)
000 006 000 (000)
```

While the above program is executing adjust R16 for an output voltage on pin 2 of +2.54 volts. Now modify the above program so that the second byte, 177, is replaced by "000". Execute this modified program and adjust R8 so that the output voltage on pin 2 is zero. Calibration is now complete.

### Applications

The D+7A I/O module from Cromemco is one of the most versatile computer interfaces yet developed. Simple "input" and "output" instructions in your software are all that are required to input and output 8 bits of analog information. A/D conversion time is a fast 5 microseconds. Some of the most popular applications of the D+7A include joystick interfaces, oscilloscope graphics, music and voice synthesis, and process control. We at Cromemco would be interested to hear of your applications of the D+7AI/O module.

## ADDENDUM

### D+7A TIMING

Conversion time for the D+7A A-to-D converter is 5 microseconds. To assure complete conversion before allowing the processor to proceed, the READY line is held down for 5.5 microseconds, i.e. 11 wait states, whenever data is input from one of the seven analog input ports. The ready line is also held down for 5.5 microseconds when data is output to one of the seven analog output ports to assure adequate time for settling of the analog sample and hold amplifier.

### USING THE D+7A WITH THE CROMEMCO DAZZLER

If the Cromemco Dazzler is being used to display a picture when the D+7A is used to input or output analog data, a small modification must be made to REV B and REV B-1 series of the Dazzler to avoid flashes in the picture. The modification is simply to remove pin 10 of Dazzler IC 29 (a 7400 IC). No modification is required to REV C Dazzlers.

### NEW JOYSTICK CONSOLE

Cromemco is pleased to announce a new joystick console (model JS-1) designed specifically to interface to your computer using the D+7A interface. In fact two such consoles can be completely interfaced using just one D+7A board. Each console consists of a two-axis joystick, four push-button control switches, and a speaker with amplifier. The JS-1 kit is available for \$65. Assembled for \$95. See our ad on page 1 of the November 1976 issue of BYTE magazine for complete details.

### SERVICE

Should your D+7A require repair, servicing, or calibration you may return it to Cromemco, 2432 Charleston, Mountain View, California, 94043 along with payment of our fixed service fee of \$35. We will service and calibrate your D+7A module and return it postpaid.

Units returned without the \$35 service fee will be returned freight collect and will not be serviced.

We reserve the right to decline servicing any unit that has been subject to abnormal electrical or mechanical abuse or that has been modified from the original design. All our kits are supplied with IC sockets and we will not repair boards unless these IC sockets are used.

D+7A PARTS LIST

- 1) Voltage regulators and hardware.
  - IC3 - LM340T-5.0 (7805)
  - IC27- LM320T-5.0 (7905)
  - 2 - 6-32 X 3/8 screws
  - 2 - 6-32 nuts
  - 2 - #6 lock washers
  - 2 - Heatsinks
  
- 2) IC sockets
  - 10 - 14 pin
  - 17 - 16 pin
  
- 3) Integrated Circuits
  - IC 1 - 74175
  - IC 2 - 74175
  - IC 4 - 3130 or 3140
  - IC 5 - 3130 or 3140
  - IC 6 - 3130 or 3140
  - IC 7 - 3130 or 3140
  - IC 8 - 4051
  - IC 9 - LM301
  - IC 10 - 72710 or 72810
  - IC 11 - MC1408L8
  - IC 12 - 7442
  - IC 13 - 74LS02
  - IC 14 - AM2502PC
  - IC 15 - 74367
  - IC 16 - 3130 or 3140
  - IC 17 - 3130 or 3140
  - IC 18 - 4051
  - IC 19 - 3130 or 3140
  - IC 20 - 310
  - IC 21 - 4066
  - IC 22 - 74LS30
  - IC 23 - 74LS08
  - IC 24 - 74LS10
  - IC 25 - 74LS157
  - IC 26 - 74367
  - IC 28 - 7474
  - IC 29 - 74LS04
  - IC 30 - 74LS04
  - IC 31 - 74LS32
  - IC 32 - 74LS04
  - IC 33 - 74LS157
  - IC 34 - 74367

4) Resistors and discrete semiconductors

- R1 - 1k
- R2 - 1k
- R3 - 1k
- R4 - 1k
- R5 - 1k
- R6 - 1k
- R7 - 1k
- R8 - 25k pot
- R9 - 100k
- R10 - 2.7k
- R11 - 2.2k
- R12 - 500 pot
- R13 - 2.4k
- R14 - 560
- R15 - 560
- R16 - 500 pot
- R17 - 2.7k
- R18 - 2.7k
- R19 - 220
- R20 - 2.7k
- R21 - 18k
- R22 - 500 pot
- R23 - 5.1k
- R24 - 1.2k
- R25 - 2.4k
- R26 - 4.7k
- R27 - 1k
- R28 - 560
- R29 - 10
- R30 - 10
- R31 - ~~100~~ 1k
- R32 - 1k
- R33 - 4.7k
- R34 - 1k
- R35 - 4.7k
- R36 - 4.7k
- R37 - ~~100~~ 220
- R38 - ~~150~~ 220
- R39 - 560
- R40 - 4.7k
- R41 - 560
- R42 - 560
- R43 - 560
- R44 - 10k
- D 1 - 1N914
- D 2 - 1N914
- D 3 - 1N914
- D 4 - 1N5242
- D 5 - 1N5242
- D 6 - 1N914
- Q 1 - 2N3906

D+7A PARTS LIST (CONTINUED)

5) Capacitors

C 1 - 0.1  
C 2 - 10 uF tantalum  
C 3 - 0.1  
C 4 - 0.1  
C 5 - 150  
C 6 - 150  
C 7 - .01  
C 8 - .01  
C 9 - .01  
C 10 - .01  
C 11 - .01  
C 12 - .01  
C 13 - .01  
C 14 - .01  
C 15 - 180  
C 16 - 0.1  
C 17 - 0.1  
C 18 - 39  
C 19 - 0.1  
C 20 - 0.1  
C 21 - 18  
C 22 - 0.1  
C 23 - 0.1  
C 24 - 0.1  
C 25 - 150  
C 26 - 150  
C 27 - 0.1  
C 28 - .0022  
C 29 - .0022  
C 30 - .0022  
C 31 - .0022  
C 32 - .01  
C 33 - 150  
C 34 - 0.1  
C 35 - 0.1  
C 36 - 150  
C 37 - 150  
C 38 - 680  
C 39 - 680  
C 40 - 0.1  
C 41 - 0.1  
C 42 - 10 uF tantalum  
C 43 - 10 uF tantalum  
C 44 - .0022  
C 45 - .0022  
C 46 - .0022  
C 47 - 0.1  
C 48 - 150  
C 49 - 0.1  
C 50 - 0.1

C 51 - 0.1  
C 52 - 0.1  
C 53 - 150  
C 54 - 0.1  
C 55 - 10 uF tantalum  
C 56 - 0.1  
C 57 - 0.1  
C 58 - 150  
C 59 - 150  
C 60 - 150  
C 61 - 150

6) Inductors

L1 - 22 uH  
L2 - 22 uH

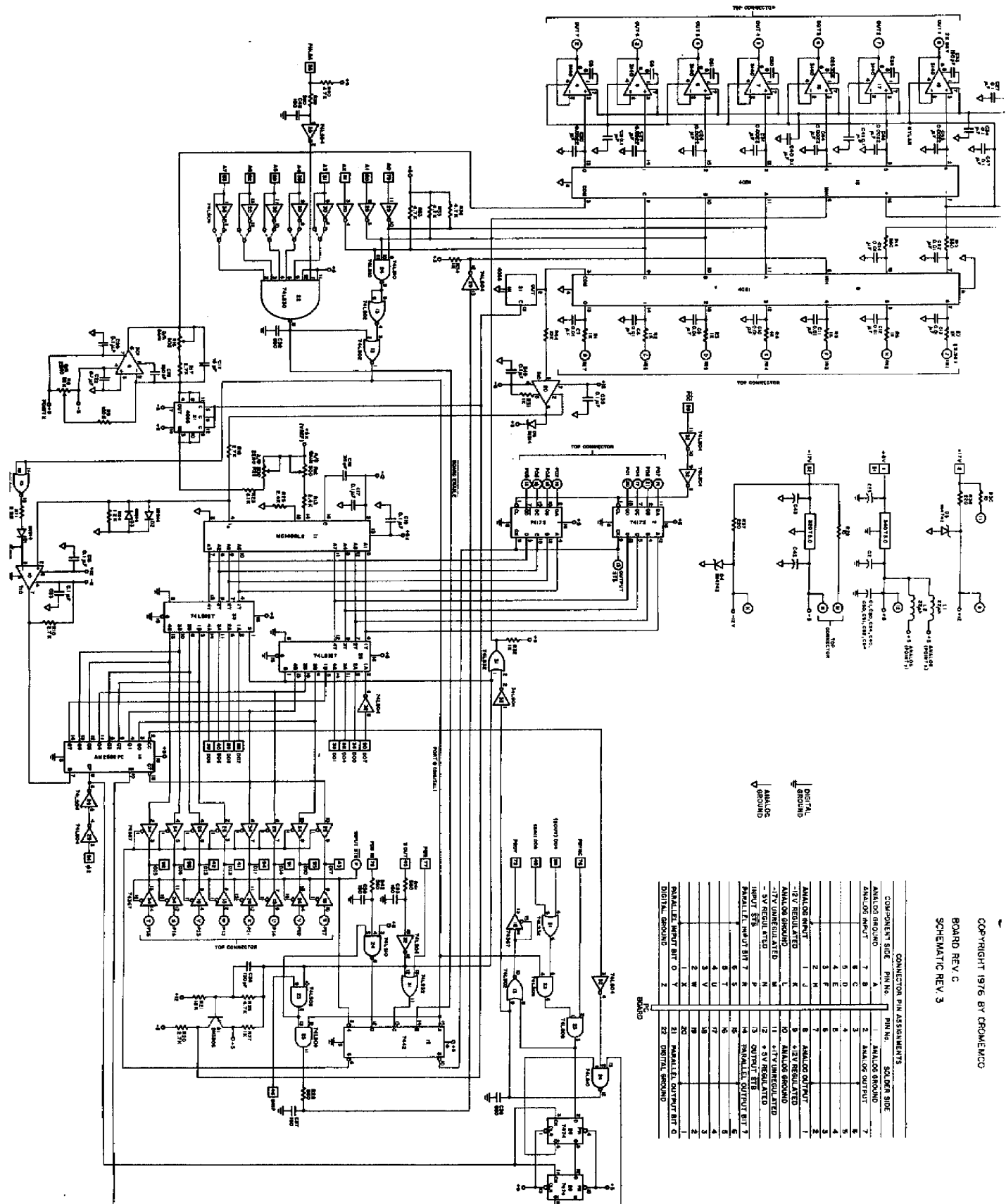
7) Connector assembly

Dual 22 contact connector,  
hood, assembly hardware.

8) Miscellaneous

Printed circuit board.  
Assembly and operating  
instructions.  
Schematic diagram.





CONNECTOR PIN ASSIGNMENTS

| COMPONENT SIDE | PIN NO. | SOLDER SIDE   |
|----------------|---------|---------------|
| ANALOG GROUND  | A       | ANALOG GROUND |
| ANALOG INPUT   | 7       | ANALOG OUTPUT |
|                | 8       |               |
|                | 9       |               |
|                | 10      |               |
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DIGITAL  
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