

D+7AI/O™



Cromemco

2432 Charleston Rd.
Mountain View, CA 94043

ASSEMBLY INSTRUCTIONS

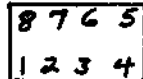
The location and value of every component is printed directly on the printed circuit card of the D+7AI/O to facilitate assembly. Simply insert the components into place and solder them in position. Note that IC sockets are used for all ICs (except the voltage regulators IC3 and IC27). All 8-pin ICs are mounted side-by-side in 16-pin sockets.

When inserting the 3130 ICs take care to insert the IC pins in the proper socket locations. Note the following pin designations on these ICs:



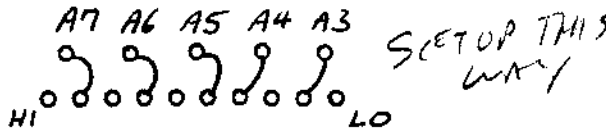
3130 pinout (or 3140)
(Bottom view)

Shape the leads of the 3130 ICs into two rows of four, inserting the IC leads into the socket in this order:



Orientation of 3130 leads
in socket (Top view)

Five jumper wires are used 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 are installed just above IC30 in the following way for this address selection:



ASSEMBLY NOTES:

- 1) R23 is a 5.1K resistor. It is labeled incorrectly as a 4.7K resistor on the printed circuit board.
- 2) The voltage regulator ICs may look physically similar but they are NOT interchangeable. IC27 in the lower corner of the board is a LM320T-5.0. IC3 in the upper corner is a LM340T-5.0.
- 3) When installing the diodes take care that the banded (cathode) end is oriented properly.
- 4) When installing the 10uF tantalum filter capacitors (C42,43,2,55) take care that the + end is oriented as shown on the board.
- 5) The ICs are packed in conductive foam to protect them from damage due to static electricity. After removing the ICs from the foam take care in handling them to prevent accidental damage.
- 6) R13 is a 2.4K resistor, not 2.2K as marked on the pc board.

When the port address jumper wires are installed as shown above, port 030 serves as an 8-bit parallel input port and as an 8-bit parallel output port. Ports 031,032,033,034,035,036, and 037 serve as analog input ports and output ports. All I/O ports are connected through the 44-pin connector on the top edge of the D+7A board. The table printed with the schematic diagram shows the detailed port assignment.

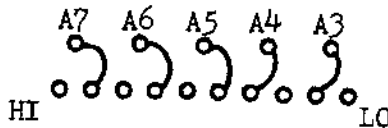
Calibration of the D+7A module is straightforward. The gain and zeroing of the A/D converter is accomplished by inputting known voltages from any one of the seven analog inputs and adjusting R12 and R22 respectively for a proper digital input (in twos complement). D/A gain and zeroing is accomplished by outputting to any one of the analog output channels, measuring the output with an accurate voltmeter, and adjusting R16 and R8 respectively. Adjustment of the A/D converter (R12 and R22) must be done before adjustment of the D/A converter (R8 and R16).

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

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 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	
	5 D	4	
	4 E	5	
	3 F	6	
	2 H	7	
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	
	5 T	16	
	4 U	17	
	3 V	18	
	2 W	19	
	1 X	20	
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):

0000 - DB
IF A
DB
18
0000
0000

TO FRONT PANEL

```
000 000 333 (input)
000 001 037 (port 037)
000 002 323 (output)
000 003 030 (port 030)
000 004 303 (jump)
000 005 000 (000)
000 006 000 (000)
```

Note: output port 030 **18** is used here since it is available on D+7A. IMSAI 8080 users may find output port 377 on the **FP** front panel more convenient 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 (0111111)
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 eleven 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 ample time for settling of the analog sample-and-hold amplifier.

USING D+7A WITH THE CROMEMCO DAZZLER

If the Cromemco Dazzler Color Graphics Interface is being used to display a picture when D+7A is used to input or output analog data, a small modification must be made to the current version (REV B) of the Dazzler to avoid flashes in the picture. The modification is simply to remove pin 10 of Dazzler IC 29 (a 7400).

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
 - 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 - 100
 - R30 - 100
 - R31 - 100
 - R32 - 1k
 - R33 - 4.7k
 - R34 - 1k
 - R35 - 4.7k
 - R36 - 4.7k
 - R37 - 180
 - R38 - 150
 - 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

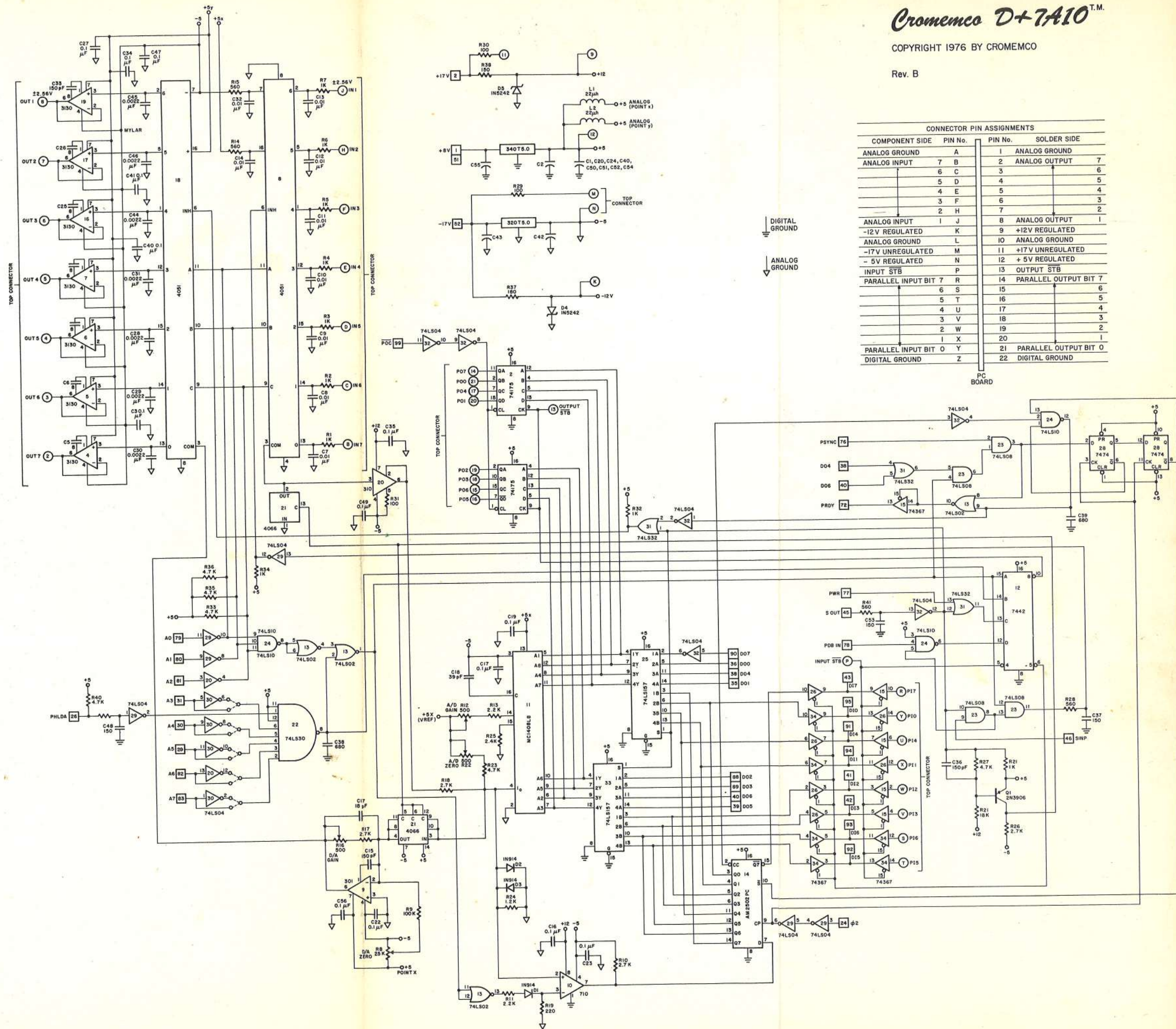
7) Connector assembly

Dual 22 contact connector,
hood, assembly hardware.

8) Miscellaneous

Printed circuit board.
Assembly and operating
instructions.

*C60 and C61 are incorrectly
labeled C55 and C56 on the
pc board.



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	
	5 D	4	
	4 E	5	
	3 F	6	
	2 H	7	
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	
	5 T	16	
	4 U	17	
	3 V	18	
	2 W	19	
	1 X	20	
PARALLEL INPUT BIT 0	Y	21	PARALLEL OUTPUT BIT 0
DIGITAL GROUND	Z	22	DIGITAL GROUND

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