88 CCC

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INTRODUCTION

The Cromemco 88-CCC Cyclops Camera Controller is designed to provide high-speed Direct Memory Access (DMA) from a Cromemco Altair Cyclops Camera (model 88-ACC) to an Altair 8800 or Imsai 8080 computer. By using direct memory access a picture can be loaded very quickly from the camera with a minimum of software overhead. The Cyclops Camera Controller together with the Altair Cyclops Camera and your microcomputer now provide for the first time anywhere a low-cost computerized system for measurement, recognition, and control.

ASSEMBLY

The 88-CCC is built on two circuit boards designed to plug directly into an Altair 8800 or Imsai 8080 computer. A 16-conductor ribbon cable, with DIP plugs on each end, is provided to interconnect the two circuit boards. The circuit boards are of the highest quality complete with solder-resist mask, a silk-screened legend mask to show component placement and gold-plated edge contacts.

If you purchased your 88-CCC as a kit (model 88-CCC-K) you will find assembly straightforward. IC sockets are provided for all ICs, and the printed legend mask on each circuit card shows precisely where each part is placed. All DIP ICs should be oriented in their sockets with pin one toward the lower left corner of the board.

A complete parts list for the 88-CCC is given on the last page of this manual.

Inter-board Connection

IC sockets should be installed in the upper right-hand corner position of both board 1 and board 2. The 16-conductor ribbon cable provided can then be used to interconnect the two boards. Be sure that pin 1 of the socket on board 1 is connected to pin 1 on board 2, pin 2 to pin 2, etc.

Port Address Selection

Port select jumper wires should be installed on 88-CCC Board 2 as shown with the silk-screened legend mask on the board. The jumper wires can be connected in other ways to change the port address selection (this is described in detail on the following pages.)

Output connection

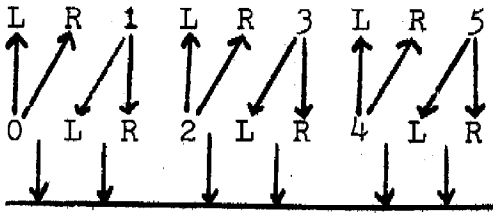
A 16-pin DIP socket on 88-CCC Board 1 (near the upper left corner of the board) is used to connect the 88-CCC to the Altair Cyclops Camera. Pins 1 to 4 connect to pins 1 to 4 of the connector on the rear of the Altair Cyclops Camera. Pin 6 connects to pin6 of the camera. Pin 8 connects to pin 8 of the camera. No connection need be made to pin 5, 7, or 9 of the Altair Cyclops Camera.

88-CCC PORT ADDRESS SELECTION

Communication between the 88-CCC and the Altair computer takes place through three output ports and one input port. These are: output port A, output port B, output port C, and input port A. Six jumper wires are used on the component side of Board 2 to select the port addresses.

One end of one jumper wire is soldered to pad 0 and the other end either to pad L or pad R immediately above pad 0. One end of a second jumper wire is soldered to pad 1 and the other end either to pad L or pad R immediately below pad 1. The remaining four jumper wires are connected similarly as shown in the diagram below.

Since one end of each of the jumper wires can connect to either the corresponding pad on the left (L) or on the right (R) there are a total of 64 possible different ways to connect the jumper wires. Each of these 64 different ways assigns different port addresses to port A, port B, and port C. This is shown in the table below:



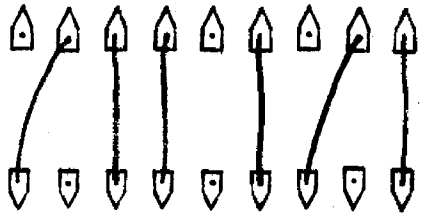
						PORT ADDRESSES (OCTAL)		
						Port A	Port B	Port C
R	R	R	R	R	R	000	001	002
L	R	R	R	R	R	004	005	006
R	L	R	R	R	R	010	011	012
L	L	R	R	R	R	014	015	016
* R	R	L	R	R	R	020	021	022
L	R	L	R	R	R	024	025	026
R	L	L	R	R	R	030	031	032
L	L	L	R	R	R	034	035	036
R	R	R	L	R	R	040	041	042
L	R	R	L	R	R	044	045	046
R	L	R	L	R	R	050	051	052
L	L	R	L	R	R	054	055	056
R	R	L	L	R	R	060	061	062
L	R	L	L	R	R	064	065	066
R	L	L	L	R	R	070	071	072
L	L	L	L	R	R	074	075	076
R	R	R	R	L	R	100	101	102
L	R	R	R	L	R	104	105	106
R	L	R	R	L	R	110	111	112
L	L	R	R	L	R	114	115	116
R	R	L	R	L	R	120	121	122
L	R	L	R	L	R	124	125	126
R	L	L	R	L	R	130	131	132

(Cont.)

PORT ADDRESS SELECTION (CONTINUED)

JUMPER WIRE CONNECTION						PORT ADDRESSES		
L	L	L	R	L	R	134	135	136
R	R	R	L	L	R	140	141	142
L	R	R	L	L	R	144	145	146
R	L	R	L	L	R	150	151	152
L	L	R	L	L	R	154	155	156
R	R	L	L	L	R	160	161	162
L	R	L	L	L	R	164	165	166
R	L	L	L	L	R	170	171	172
L	L	L	L	L	R	174	175	176
R	R	R	R	R	L	200	201	202
L	R	R	R	R	L	204	205	206
R	L	R	R	R	L	210	211	212
L	L	R	R	R	L	214	215	216
R	R	L	R	R	L	220	221	222
L	R	L	R	R	L	224	225	226
R	L	L	R	R	L	230	231	232
L	L	L	R	R	L	234	235	236
R	R	R	L	R	L	240	241	242
L	R	R	L	R	L	244	245	246
R	L	R	L	R	L	250	251	252
L	L	R	L	R	L	254	255	256
R	R	L	L	R	L	260	261	262
L	R	L	L	R	L	264	265	266
R	L	L	L	R	L	270	271	272
L	L	L	L	R	L	274	275	276
R	R	R	R	L	L	300	301	302
L	R	R	R	L	L	304	305	306
R	L	R	R	L	L	310	311	312
L	L	R	R	L	L	314	315	316
R	R	L	R	L	L	320	321	322
L	R	L	R	L	L	324	325	326
R	L	L	R	L	L	330	331	332
L	L	L	R	L	L	334	335	336
R	R	R	L	L	L	340	341	342
L	R	R	L	L	L	344	345	346
R	L	R	L	L	L	350	351	352
L	L	R	L	L	L	354	355	356
R	R	L	L	L	L	360	361	362
L	R	L	L	L	L	364	365	366
R	L	L	L	L	L	370	371	372
L	L	L	L	L	L	374	375	376

* For compatibility with Cromemco software we recommend this port assignment: Port A - 020; Port B - 021; Port C - 022. For this port assignment connect the address selection jumper wires as shown in this diagram:



Viewed from component side of Board 2.

88-CCC Control Words

As stated previously, communication between the 88-CCC and the Altair computer takes place through three output ports and one input port. The addresses assigned to these ports are user selectable, as described in the previous section. The storing of the video information from the Cyclops Camera does not take place through these control ports, but rather occurs through Direct Memory Access.

The information transferred through each input/output port is called a control word. In this section we describe the control word format, and discuss precisely how the control words are used.

Output Control Word A

Control Word A, which is output to port A, contains 8 bits to communicate the following information to the 88-CCC interface board:

Bit #		Description
0	LSB	Auxiliary output to select one of sixteen Cyclops Cameras or for other user defined functions.
1		
2		
3	MSB	
4		Not used.
5		For control of the bias light in the Cyclops Camera. High logic level for lights on. Low logic level for lights off.
6		Not implemented on 88-CCC REV 1. Reserved for possible future use in enabling interrupt circuitry.
7		When high, 88-CCC is signaled to store one frame of a picture in memory using Direct Memory Access.

Input Control Word A

Input Control Word A, at input port A, is used to echo Output control word A. Bit 7 is high during frame store but is reset to 0 following the completion of a frame store. The user thus has two options for detecting the completion of a frame store: 1) By having the 88-CCC generate an interrupt (bit 6 of output control word A must be high to enable the interrupt generation) or 2) By polling bit 7 of input control word A.

Output Control Word B

To understand the use of control word B it is first necessary to understand how the Cyclops Camera encodes gray-scale information. The photodiodes of the Cyclops C-1024 image sensor are used in what is called charge-storage mode. What this means is that the capacitance of each diode is charged to some voltage level just prior to taking a frame of the picture. The voltage across each diode is decreased as light falls on the diode.

The entire array of 1024 photodiodes may be scanned up to 15 times during a single frame of the picture. (The precise number of times is set by Control Word B). Each scan produces a single field of the picture. Each field consists of 1024 bits of information which is stored in 128 bytes of memory. Each bit of the field corresponds to one of the photodiodes in the image sensor. If sufficient light has fallen on a particular diode to drop its voltage below a threshold value, the corresponding bit in the field is a 1. If the voltage on the diode is still above threshold the corresponding bit in the field is a 0.

The time delay between subsequent fields determines the coarseness of gray-scale quantization. This time delay is also set by Control Word B.

Bit #		Description
0	LSB	Specifies the number of fields to be stored in memory. 128 bytes of memory are required for each field
1		
2		
3	MSB	
4	LSB	Specifies the number of 2 - millisecond increments separating each field.
5	MSB	
6		Not used.
7		Not used.

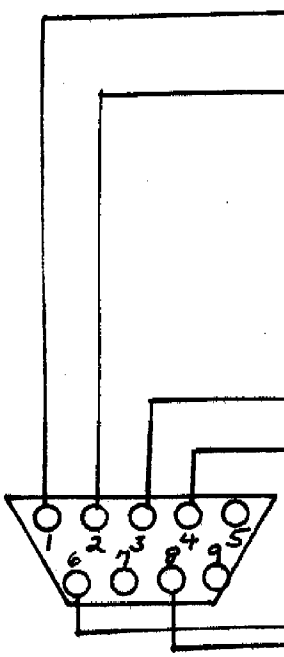
Output Control Word C

The eight bits of Control Word C set the starting address in memory for the DMA frame store. The starting address is as shown below, where D0 through D7 are the eight bits of the control word:

A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
0	D7	D6	D5	D4	D3	D2	D1	D0	0	0	0	0	0	0	0

CYCLOPS CAMERA AND OUTPUT CONNECTION

A sixteen pin DIP socket on 88-CCC Board 1 is used for connection to the Altair Cyclops camera and for auxiliary connections. The pin assignment for thses 16 pins is as follows:



Rear Connector of 88-ACC

PIN #	FUNCTION
1	Ground
2	Composite clock. This signal increments the 88-ACC scan counters with 1 microsecond pulses. The scan counters are reset with either a 5 or 17 microsecond pulse on this line. A 5 microsecond pulse is used to reset the scan counters and turn off the 88-ACC bias lights. A 17 microsecond pulse is used to reset the scan counters and turn on the 88-ACC bias lights.
3	Data input from 88-ACC.
4	+17 volt supply
5	NO CONNECTION
6	Pull up resistor to +5 volts.
7	NO CONNECTION
8	-17 volt supply
9	NO CONNECTION
10	Clock
11	Reset
12 (MSB)	Bits D0 to D3 of output control word A. These four bits may be used as a general purpose output port for such functions as selecting one of 16 cameras.
13	
14	
15 (LSB)	
16	+5 volt supply

SOFTWARE SUPPORT

PROGRAM: CCC-1

TO INITIALIZE PORTS AND STORE A SINGLE FRAME OF 15 FIELDS IN MEMORY

To understand the operation of the 88-CCC Cyclops Camera Controller, it is important to understand the operation of this program. The program assumes that the preferred address selection is used (i.e. port A = 020, port B = 021, and port C = 022). The program should be loaded using the switches on the front panel of the Altair starting at memory location 000 000.

MEMORY LOCATION	INSTRUCTION	COMMENTS
000	076 (MVIA)	Moves immediate into the accumulator
001	001	the starting address of where the picture is to be stored in memory. Here the starting address is chosen to be at 000 200.
002	323 (OUT)	The starting address is now output from the accumulator to output
003	022	port 022
004	076 (MVIA)	Control word B is moved into the
005	017	accumulator and output to port
006	323 (OUT)	021 to specify that 15 fields per
007	021	frame will be stored with a 2 msec spacing between fields.
010	076 (MVIA)	Control word A is moved into the
011	200	accumulator and output to port 020
012	323 (OUT)	to begin the storing of a single
013	020	frame of the picture.
014	333 (INP)	Input port 020 is now polled to
015	020	determine whether the frame store
016	346 (ANI)	is complete
017	200	
020	302 (JNX)	
021	014	
022	000	
023	303 (JMP)	After the picture is stored the
024	023	program remains in this loop until
025	000	program execution is stopped by activating the "STOP" switch on the Altair front panel.

SOFTWARE SUPPORT

PROGRAM: CCC-2

TO DISPLAY A FRAME OF 15 FIELDS ON A TELETYPE

This program begins with program CCC-1 to store 15 fields in the computer memory. CCC-1 is modified to have a higher starting address so that data is not written over the program. CCC-1 is further modified to end not in a loop, but rather in a jump to the beginning of the display program (at location 000 030).

MEMORY LOCATION	INSTRUCTION		COMMENTS
000	076		
	002		
	323		
	022		
	076		
	017		
	323		
	021		
	076		This is the
	200		modified version
	323		of program CCC-1
	020		
	333		
	020		
	346		
	200		
	302		
	014		
	000		
	303		
	030		
	000		
030	061	LXI SP	
	377		These two bytes should
	000		indicate the top of memory
	041	LXI H,L	
	200		
	000		
	006		
	000		These instructions
	016		are to initialize
	000		counters.
	026		
	000		
	000		
	000		NOPs
	000		
	000		
	000		

PROGRAM CCC-2 (Continued)

MEMORY LOCATION	INSTRUCTION	COMMENTS
051	170	
	376	
	040	
	312	Test to see if
	200	register B = 32.
	000	
	171	
	376	
	004	
	312	Test to see if
	145	register C = 4.
	000	
	172	
	376	
	010	
	312	Test to see if
	140	register D = 8.
	000	
073	315	
	230	
	000	
	173	
	007	
	137	
	332	Jump on carry to
	130	type a space.
	000	
	303	Otherwise jump to
	120	type a dot.
	000	

The following are subroutines to the main program:

120	076	
	056	
	323	
	001	Subroutine to type
	024	dot.
	303	
	065	
	000	
	076	
	102	
	323	Subroutine to type
	001	space.
	024	
	303	
	065	
	000	

PROGRAM CCC-2 (Continued)

Memory Location	Instruction	Comments
140	053	
	014	
	303	
	042	
	000	
	315	
	230	
	000	
	076	
	015	
	323	
	001	
	315	
	230	
	000	
	076	
	012	
	323	Return carriage
	001	and line feed.
	004	
	021	
	010	
	000	
	031	
	303	
	040	
	000	
200	315	
	230	
	000	
	076	
	012	
	323	Generate a linefeed
	001	between fields.
	315	
	230	
	000	
	076	
	012	
	323	
	001	
	303	
	036	
	000	
230	333	
	000	
	346	Test input port 000
	002	until teletype
	312	is ready, then
	230	return.
	000	
	311	

SOFTWARE SUPPORT

PROGRAM: CCC-3

PROGRAM FOR CYCLOPS DISPLAY WITH THE CROMEMCO DAZZLER

Memory location	Op Code	Mnemonic	Comments
000	076	MVI A	Set start of Dazzler picture
	213		display at 5.5K
	323	OUT	
	016		
	076	MVI A	Set Dazzler for 32X32 mode
	000		black and white display
	323	OUT	
	017		
	076	MVI A	Set 88-CCC to start storing Cyclops
	040		data at location 4K in memory
	323	OUT	
	022		
	076	MVI A	Set 88-CCC to collect 12 fields
	013		from the Cyclops camera at 2 ms.
	323	OUT	spacing
	021		
	076	MVI A	Command to start storing Cyclops
	200		picture in memory.
024	323	OUT	
	020		
	333	INP	Poll port 020 to see if picture
	020		storage is complete.
	346	ANI	
	200		
	302	JNZ	Jump back if not through.
	024		
	000		
	303	JMP	Go to the start of the packing
	100		program when picture storage is
	000		complete.

** Comment: the purpose of the following routine is to repack the Cyclops picture into a format so that it will be properly displayed on a TV screen by the Dazzler TV interface. **

100	061	LXI SP	Set SP to camera data start point.
	000		
	020		
	041	LXI H	Clear H,L
	000		
	000		
	071	DAD SP	SP to HL
	174	MOV A, H	H to A

```
110     346         ANI         Strip bit count
        340
        017         RRC
        306         ADI
        014
        107         MOV B,A
        174         MOV A,H
        346         ANI
        037
        147         MOV H,A
        353         XCHG
        041         LXI H
        000
        000
        071         DAD SP
        051         DAD H
        322         JNC
        134
        000
        043         INX H
        051         DAD H
        322         JNC
        141
        000
        043         INX H
        174         MOV A,H
        346         ANI
        001
        366         ORI
        026
        147         MOV H,A     HL now has byte address for picture
        170         MOV A,B     location corresponding to packing
        346         ANI         start in DE.
        020
        076         MVI A
        017
        302         JNZ
        161
        000
        076         MVI A
        340
        246         ANA M
        167         MOV M,A
        170         MOV A,B
        346         ANI
        360
        017         RRC
        017         RRC
        017         RRC
        017         RRC
        117         MOV C,A
        032         LDAX DE     Get camera data from DE
        014         INR C
```

```
175     017         RRC
        015         DCR C
        302         JNZ
        175
        000
        322         JNC
        211
        000
        170         MOV A,B
        346         ANI
        020
        076         MVI A
        020
        302         JNZ
        217
        000
        076         MVI A
        001
        206         ADD M
        167         MOV M,A
        005         DCR B
        076         MVI A
        200
        203         ADD E
        137         MOV E,A
        076         MVI A
        000
        212         ADC D
        127         MOV D,A
        170         MOV A,B
        346         ANI
        017
        302         JNZ             Jump if need more camera frames.
        163
        000
        041         LXI H
        000
        000
        071         DAD SP
        174         MOV A,H
        306         ADI
        040
        147         MOV H,A
        322         JNC
        254
        000
        043         INX H
        371         SPHL
        175         MOV A,L
        376         CPI
        200
        332         JC
        107
        000
        303         JMP             Jump back to the beginning.
        000
        000
```

ERRATUM

There is a foil error on 88 CCC Board 1 REV 1. In particular address line A8 (edge connector contact 84) and line A9 (edge contact 34) are interchanged. If A8 and A9 are used to address memory during the DMA operation the picture will not be stored sequentially but will be jumbled by the interchange of A8 and A9. For many applications this will have no effect on system performance (e.g. security systems). There are one of two possible fixes to correct the interchange of A8 and A9: 1) on 88 CCC Board 1 cut the foil leading to edge contact 84 and contact 34. Jumper the wire that use to go to 84 to 34, and the wire that use to go to 34 to 84. OR 2) No foil cuts are necessary if in your software you correct for A8 and A9 being reversed during picture storage. Since most applications require considerable software anyway, this software fix may be more desireable for some people.

88-CCC-K Packing List

88-CCC Board 1

3 - 7404
6 - 7475
3 - 7493
1 - 7408
1 - 74151
1 - 7420
2 - 7483
2 - 74193
4 - 7474
1 - 7402
3 - 74367

1 - 1N914

1 - 1.5K ¼ watt resistor (R1)
1 - 560 ohm ¼ watt resistor (R2)

1 - LM 340 T- 05
1 - Heatsink
1 - 6-32 X 3/8 screw
1 - 6-32 nut

2 - Filter capacitors (Note polarity when inserting)

9 - 0.1 uF disc ceramic capacitors

88-CCC Board 2

4 - 7474
3 - 7430
2 - 7493
3 - 7400
2 - 7402
4 - 7475
1 - 74164
1 - 7410
3 - 7405
2 - 7404
3 - 74367

1 - LM 340T - 5
1 - Heatsink
1 - 6-32 X 3/8 screw
1 - 6-32 nut

2 - Filter capacitors (note polarity)

9 - 0.1 uF disc capacitors

IC SOCKETS

24 16 pin
34 14 pin

Other

16-conductor ribbon cable jumper with DIP plugs on both ends. (For inter-board connection)

16-pin DIP plug to plug into the "TO CYCLOPS" socket.

88-CCC Manual.

Please report any shortages immediately to our sales office:

CROMEMCO, ONE FIRST STREET, LOS ALTOS, CALIFORNIA, 94022

(415) 941-2967

Cromemco 88 - CCC™

BOARD I