

88 CCC



Cromemco

Specialists in computer peripherals

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88-CCC

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 Im sai 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 Im sai 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 pin 6 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:

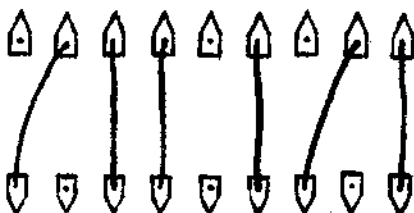
| | | | | | | <u>PORT ADDRESSES (OCTAL)</u> | | |
|---|---|---|---|---|---|-------------------------------|--------|--------|
| | | | | | | Port A | Port B | Port C |
| | R | R | R | R | R | 000 | 001 | 002 |
| | L | R | R | R | R | 004 | 005 | 006 |
| | R | L | R | R | R | 010 | 011 | 012 |
| | L |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

| <u>Bit #</u> | | <u>Description</u> |
|--------------|-------|--|
| 0 | } LSB | Auxiliary output to select one of sixteen Cyclops Cameras or for other user defined functions. |
| 1 | | |
| 2 | | |
| 3 | | |
| 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.

| <u>Bit #</u> | | <u>Description</u> |
|--------------|-------|--|
| 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 | | |
| 6 | | Not used. |
| 7 | | Not used. |

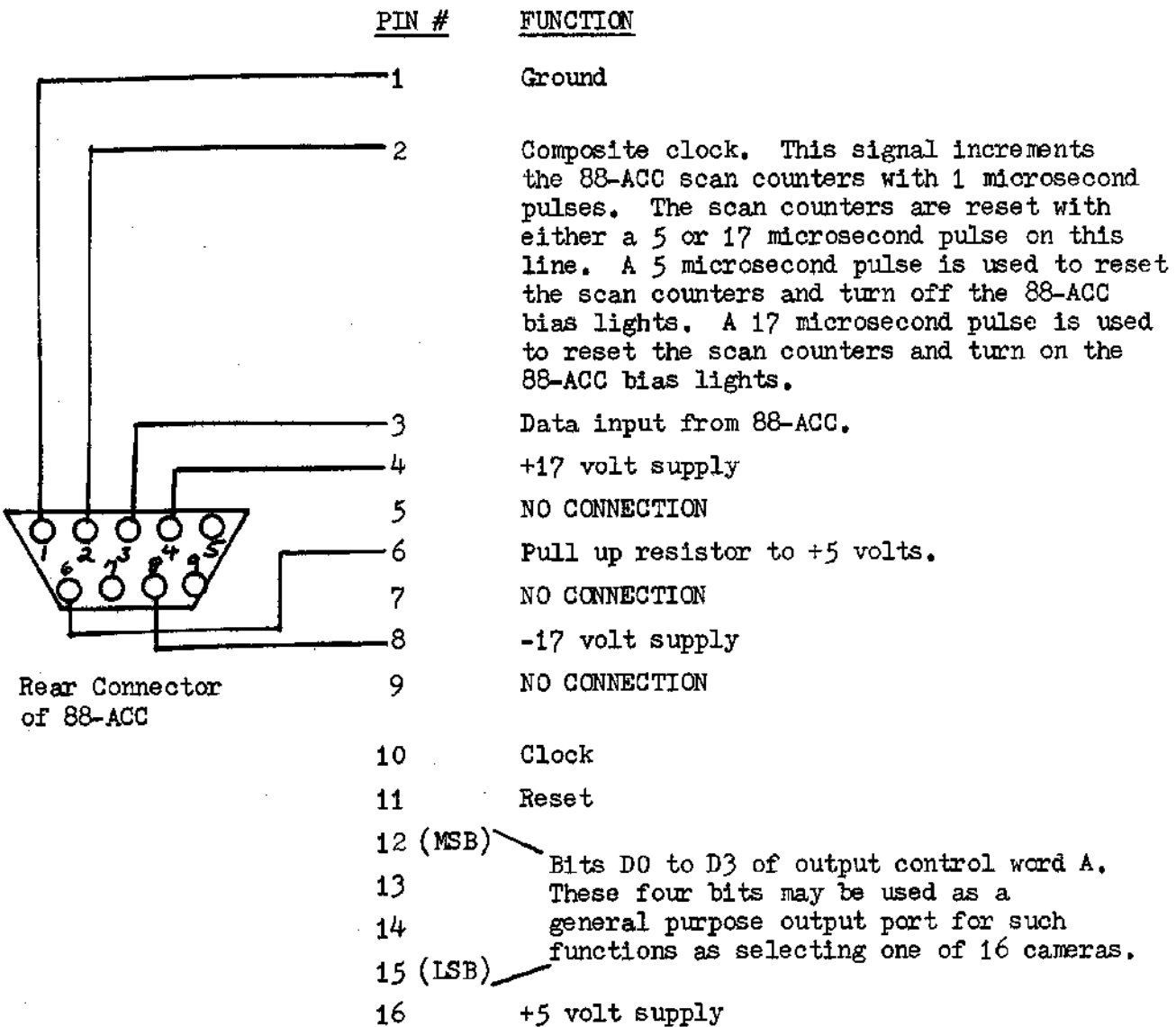
Output Control Word C

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 these 16 pins is as follows:



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.

| <u>MEMORY LOCATION</u> | <u>INSTRUCTION</u> | <u>COMMENTS</u> |
|------------------------|--------------------|--|
| 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 port 022 |
| 003 | 022 | |
| 004 | 076 (MVIA) | Control word B is moved into the accumulator and output to port |
| 005 | 017 | 021 to specify that 15 fields per |
| 006 | 323 (OUT) | frame will be stored with a 2 msec |
| 007 | 021 | spacing between fields. |
| 010 | 076 (MVIA) | Control word A is moved into the accumulator and output to port 020 |
| 011 | 200 | |
| 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).

| <u>MEMORY LOCATION</u> | <u>INSTRUCTION</u> | <u>COMMENTS</u> |
|------------------------|--------------------|----------------------------|
| 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 | These instructions |
| | 000 | are to initialize |
| | 016 | counters. |
| | 000 | |
| | 026 | |
| | 000 | |
| | 000 | |
| | 000 | NOPs |
| | 000 | |
| | 000 | |
| | 000 | |

PROGRAM CCC-2 (Continued)

| <u>MEMORY LOCATION</u> | <u>INSTRUCTION</u> | <u>COMMENTS</u> |
|------------------------|--------------------|-------------------|
| 051 | 170 | |
| | 376 | |
| | 040 | |
| | 312 | Test to see if |
| | 200 | register B = 32. |
| | 000 | |
| | 171 | |
| | 376 | |
| | 004 | Test to see if |
| | 312 | register C = 4. |
| | 145 | |
| | 000 | |
| | 172 | |
| | 376 | |
| | 010 | Test to see if |
| 312 | register D = 8. | |
| 140 | | |
| 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)

| <u>Memory Location</u> | <u>Instruction</u> | <u>Comments</u> |
|------------------------|--------------------|---------------------|
| 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

| <u>Memory Location</u> | <u>Op Code</u> | <u>Mnemonic</u> | <u>Comments</u> |
|----------------------------|--|---|--|
| 000 | 076 213 323 016 076 000 323 017 076 040 323 022 076 013 323 021 076 200 | MVI A OUT MVI A OUT MVI A OUT MVI A OUT MVI A | Set start of Dazzler picture display at 5.5K Set Dazzler for 32X32 mode black and white display Set 88-CCC to start storing Cyclops data at location 4K in memory Set 88-CCC to collect 12 fields from the Cyclops camera at 2 ms. spacing Command to start storing Cyclops picture in memory. |
| 024 | 323 020 333 020 346 200 302 024 000 303 100 000 | OUT INP ANI JNZ JMP | Poll port 020 to see if picture storage is complete. Jump back if not through. Go to the start of the packing program when picture storage is 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 | 061 000 020 041 000 000 071 174 | LXI SP LXI H DAD SP MOV A, H | Set SP to camera data start point. Clear H,L SP to HL H to A |
|-----|--|---|---|

Software CCC-3 Continued

| | | | |
|-----|-----|---------|-------------------------------------|
| 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 | |

Software CCC-3 Continued

| | | | |
|-----|-----|---------|----------------------------------|
| 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 $\frac{1}{4}$ watt resistor (R1)
1 - 560 ohm $\frac{1}{4}$ 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 μ F disc ceramic 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.

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 μ F disc capacitors

Please report any shortages immediately to our sales office:
CROMEMCO, ONE FIRST STREET, LOS ALTOS, CALIFORNIA, 94022
(415) 941-2967

Cronemco 88-000™

BOARD 1

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