

**CROMEMCO ZPU**



**Cromemco**

Specialists in computer peripherals

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# CROMEMCO Z-80 CPU

## Assembly Instructions

If you purchased your Cromemco Z-80 CPU as a kit, you will find that the assembly is easy and can be completed in about one evening. All components are inserted from the component side of the pc board (the side with the white printed legend) and soldered to the opposite side. Be sure to use high-quality rosin core solder for the assembly and a fine-tipped low wattage soldering iron.

To ease assembly, the printed legend on the pc board shows the exact position and orientation of every component. The following step-by-step instructions are presented to guide your assembly:

( ) Solder in position the  $\frac{1}{4}$ -watt 5% carbon film resistors:

R1	1K	(brown-black-red)
R2	1K	(brown-black-red)
R3	180	(brown-grey-brown)
R4	180	(brown-grey-brown)
R5	270	(red-violet-brown)
R6	270	(red-violet-brown)
R7	10K	(brown-black-orange)
R8	390	(orange-white-brown)
R9	330	(orange-orange-brown)
R10	330	(orange-orange-brown)
R11	1K	(brown-black-red)
R12	100	(brown-black-brown)
R13	180	(brown-grey-brown)
R14	100	(brown-black-brown)
R15	330	(orange-orange-brown)
R16	330	(orange-orange-brown)
R17	560	(green-blue-brown)

Z-80 CPU Assembly Instructions. (cont.)

- ( ) Solder in position sockets for all ICs (except the voltage regulators IC1 and IC2). Also install IC sockets for the two dual-in-line resistor packages, RN1 and RN2, and install an IC socket at position J1 to accept a connection from the front panel.
  
- ( ) Install the 26 capacitors as shown on the pc board. WHEN INSTALLING THE 10 mfd TANTALUM CAPACITORS MAKE CERTAIN THAT THE + END OF THE CAPACITOR IS ORIENTED AS SHOWN ON THE PC BOARD.
  
- ( ) Solder in position the single-in-line resistor network (RN3) noting that the indentation marking pin 1 of the package should be oriented toward the top of the pc board.
  
- ( ) Solder in position the single-in-line resistor network RN4 noting that the indentation marking pin 1 of the package should be oriented toward the left of the pc board.
  
- ( ) Install Q1, a 2N3904 transistor, with the flat side facing the top of the pc board.
  
- ( ) Next install the heatsink and voltage regulator ICs (IC1 and IC2) in the upper left-hand corner of the pc board. Take care that none of the leads of the regulators touches the side of the opening in the heat sink.
  
- ( ) Solder in position the speed-select control switch just to the right of the heatsink.
  
- ( ) Solder in position the 8.0000 MHz crystal just to the right

Z-80 CPU Assembly Instructions. (cont.)

of the control switch. To mechanically secure the crystal you may solder a short piece of #24 wire to the hole on one side of the crystal, pull the wire tightly over the top of the crystal through the hole on the opposite side and solder it in place.

- ( ) Solder in position the four-position mini-dip jump address select switch on the right side of the pc board. The arrow showing the closed or "on" position of the switch should point to the right.
  
- ( ) Install all ICs and the dual-in-line resistor networks in their sockets. For the Z-80 (IC5) pin #1 oriented towards the lower left corner of the board. Pin #1 of all other ICs is oriented towards the upper left corner of the board. TAKE SPECIAL CARE TO SEE THAT EACH IC IS INSERTED IN THE PROPER SOCKET, THAT EACH IC IS ORIENTED PROPERLY, AND THAT EVERY PIN OF EVERY IC HAS PROPERLY ENTERED THE SOCKET.

This completes the construction of the Cromemco Z-80 CPU board. Carefully inspect your work before proceeding. Take particular care to see that there are no inadvertent solder bridges between pads you have soldered and adjacent areas of foil.

## OPERATING INSTRUCTIONS

The Cromemco ZPU is an S-100 bus CPU (Central Processing Unit) using the powerful Z-80 microprocessor. This CPU is used in Cromemco computers and is also a plug-in replacement for the CPU card used in the Imsai 8080 and Altair 8800 computers.

The Cromemco ZPU has an exclusive set of features to increase the power of your total computing system. Most important, the ZPU was designed from the outset for reliable operation at 4MHz clock rate - twice the speed of most microcomputer systems. The ZPU also offers an on board wait state generator, optional independent selection of M1 wait states, power on jump capability, address mirroring circuitry, refresh address mirroring circuitry, and other features all discussed in this section.

Power-on jump. Power-on jump may be used if you wish to have your computer jump to any 4K boundary in memory following reset. The address of the 4K boundary is selected by the four position slide-switch on the right side of the ZPU card. This option is enabled by a foil trace connecting the two pins marked "jump enable" on the ZPU card. It can be disabled by cutting this trace.

When the jump enable pins are connected together, a hardware jump instruction is automatically executed following a reset (the run switch of your computer must also be activated if it is in stop mode). For computers with front panel switches and indicators you can see how this works by pressing the stop switch on your computer front panel and then raising the reset switch. The number C3 (303 octal) should appear on the computer data lights. This is the op code of the hardware jump instruction. Now press the examine next switch on the front panel; all zeros

## Operating Instructions (cont.)

will appear on the data lights indicating the low order 8 bits of the jump address. Now press the examine next switch again; the high order 8 bits of the jump address will now appear on the data lights. The low order four bits will indicate zeros. The high order four bits will correspond to the setting of the four position jump address switch.

The power-on jump circuitry allows the ZPU to be used in S-100 bus systems without any front-panel controls whatsoever (e.g. in the Cromemco Z-2 computer). When power is turned on program execution automatically begins at the location in memory selected by the four-position slide switch.

If your computer has both "reset" and "examine" front panel controls note that the function of each of these switches is affected when the automatic jump feature is enabled. Following reset the first instruction executed is not the instruction at location zero in memory, but rather is the instruction generated on the ZPU card causing a jump to the location specified by the jump address switch. After a reset (assuming that the computer is stopped) the examine switch must be activated twice in order to examine a memory location: once to clear the automatic jump and a second time to perform the actual examine operation.

The automatic jump feature is a very useful one. In Cromemco computers, for example, the Z-80 monitor is designed to reside in PROM at position E000 in memory space. The jump address switch is set so that the computer automatically jumps to the monitor following reset. To do this, switch positions A15, A14, A13 on the jump address switch are set to the "1" position and A12 is set to the "0" position.

## Operating Instructions (cont.)

Address mirror selection. One characteristic of the 8080 microprocessor is that the 8 bits specifying the address of an input or output port are repeated in both the low order 8 bits and the high order 8 bits of the address bus. Although this characteristic is not inherent to the newer Z-80 microprocessor, our ZPU card is designed to mimic this behavior through the address mirror circuitry. This is to assure compatibility of our ZPU card when up-dating older 8080 systems.

The address mirror circuitry is automatically enabled by the short piece of pc board foil running between the "AM" pad and the "ON" pad on the ZPU card between IC7 and IC8 on the card. In the event you wish to disable this circuitry this short piece of foil should be severed, and a small jumper wire should be installed connecting the "AM" pad to the "OFF" pad.

Refresh enable. When using certain types of dynamic memory boards that require that the refresh address provided by the Z-80 is mirrored in the higher order address bits, a jumper wire should be installed between the two pads labeled "RFSH ENAB". Normally no jumper wire is installed here.

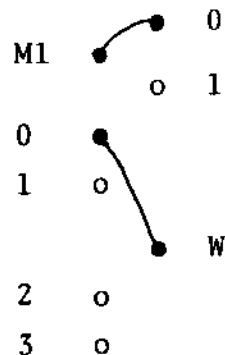
4 MHz Operation. To switch from 2 MHz operation to 4 MHz operation simply flick the speed select switch on the ZPU from the 2 MHz to the 4 MHz position. Notice that the line previously labeled the "stack" line on the S-100 computer bus is now used as the 4 MHz indicator line. If you use the ZPU in an Altair or IMSAI computer your stack light will be on for 4 MHz operation and off for 2 MHz operation. (This indicator light is labeled "4MHz" on the front panel of the Cromemco Z-1 computer.) All Cromemco products are designed for reliable operation at either 2 MHz or 4 MHz clock frequencies.

## Operating Instructions (cont.)

Wait state selection. The ZPU features an on board wait state generator to insert optional wait states between the T2 and T3 cycles of each machine cycle. This is particularly useful if you desire 4 MHz processor speed using memory boards designed for slower 2 MHz operation.

If your memory boards have a true access time of 500 nanoseconds or faster they may be used without wait states at 2 MHz operation. If your memory boards have a true access time of 250 nanoseconds or faster they may be used without wait states at 4 MHz operation.

In each of these cases foil traces on the pc board select zero wait states as follows: one trace from pin M1 to pin 0; one trace from pin W to pin 0. This is shown in the figure below:



PC board traces select zero wait states.

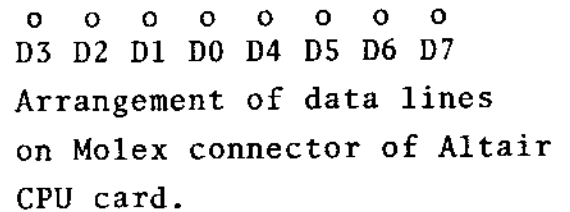
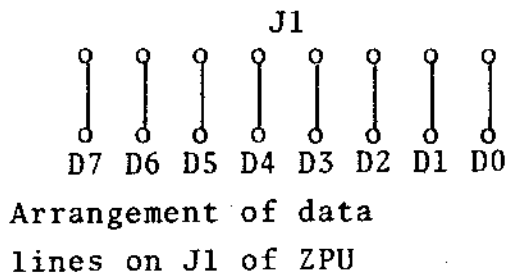
A jumper from pin W may be used to select 0, 1, 2, or 3 wait states on every machine cycle. At 2 MHz operation each wait state is 500 nanoseconds long. At 4 MHz operation each wait state is 250 nanoseconds long. The M1 jumper may be used to select one additional wait state on M1 cycles only if you so choose. Before installing such jumper wires the foil traces selecting zero wait states must be cut.



Operating Instructions (cont.)

Installation in Altair or Imsai Computers

If you are using an IMSAI computer the cable from the front panel may be plugged directly into socket J1 on the ZPU card. For the Altair computer a DIP plug must be installed in place of the Molex connector on the front panel cord; in doing this be aware that the data lines are not arranged sequentially on the Altair connector but are sequential on the ZPU card as shown:



## ZPU PARTS LIST

### CAPACITORS

C1 10 uF Tantalum  
C2 .001 disc ceramic  
C3 .005 disc ceramic  
C4 .005 disc ceramic  
C5 0.1 disc ceramic  
C6 10 uF Tantalum  
C7 150 pF disc ceramic  
C8 56 pF disc ceramic  
C9 10 uF Tantalum  
C10 10 uF Tantalum  
C11 - C24 0.1 disc ceramic  
C25 150 pF disc ceramic  
C26 .05 disc ceramic

### INTEGRATED CIRCUITS

IC1, IC2 LM340T-5 (or 7805)  
IC3 74164  
IC4 74157  
IC5 Z-80 (4MHz Version)  
IC6 74LS04  
IC7 74LS10  
IC8 7400  
IC9 7474  
IC10 7404  
IC11 74367  
IC12 74367  
IC13 74367  
IC14 74367  
IC15 74LS04  
IC16 74157  
IC17 74LS10  
IC18 7400  
IC19 7474  
IC20 74LS04  
IC21 7474  
IC22 7408  
IC23 74367  
IC24 74367  
IC25 74367  
IC26 74367  
IC27 74367  
IC28 74S133  
IC29 74164  
IC30 7474  
IC31 74LS04  
IC32 7400  
IC33 74LS04  
IC34 74LS00  
IC35 74LS02  
IC36-41 74367  
IC42 7408  
IC43 74LS04

### RESISTORS

R1 1K  
R2 1K  
R3 180  
R4 180  
R5 270  
R6 270  
R7 10K  
R8 390  
R9 330  
R10 330  
R11 1K  
R12 100  
R13 180  
R14 100  
R15 330  
R16 330  
R17 560

RN1 4.7K resistor network (DIP)  
RN2 1K resistor network (DIP)  
RN3 1K resistor network (SIP)  
RN4 1K resistor network (SIP)

### OTHER

Q1 2N3904 transistor  
X1 8 MHz crystal  
SW1 Speed select switch  
SW2 Jump address switch  
Heatsink  
6-32 screws and nuts (4 each)  
24 gauge wire  
40 pin IC socket (1)  
14 pin IC sockets (22)  
16 pin IC sockets (21)  
Printed circuit board

### SOFTWARE

Cromemco Z-80 Monitor  
(paper tape)

### DOCUMENTATION

Z-80 Monitor Manual  
ZPU Instruction Manual  
Z-80 CPU Technical Manual

### WARRANTY

Your factory-built ZPU is warranted against defects in materials and workmanship for a period of 90 days from the date of delivery. We will repair or replace products that prove to be defective during the warranty period provided that they are returned to Cromemco. No other warranty is expressed or implied. We are not liable for consequential damages.

Should you factory-built ZPU fail after the warranty period, it will be repaired provided that it is returned to Cromemco, for a fixed service fee. We reserve the right to refuse to repair any product that in our opinion has been subject to abnormal electrical or mechanical abuse. The service fee is currently \$35 and is subject to change.

Your assembled ZPU kit will be repaired, provided that it is returned to Cromemco, for a fixed service fee. We reserve the right to refuse repair of any kit that in our opinion has not been assembled in a workmanlike manner or has been subject to abnormal electrical or mechanical abuse. Payment of the service fee must accompany the returned merchandise. The service fee is currently \$35 and is subject to change.