CROMEMCO ZPU

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-qual-
ity 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 ¼-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)

( ) 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 fac-
    ing 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

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

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.)

<u>Address mirror selection</u>. One characteristic of the 8080 micro-
processor 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 characteris-
tic 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 compatability 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.

<u>Refresh enable</u>. 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
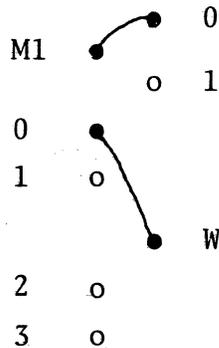ENAB". Normally no jumper wire is installed here.

<u>4 MHz Operation</u>. To switch from 2 MHz operation to 4 MHz opera-
ation 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 opera-
tion 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 opera-
tion. 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:

```
                              •   0
        M1  •
                          o   1

         0  •
         1  o
                      •   W

         2  o
         3  o
```

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:

J1
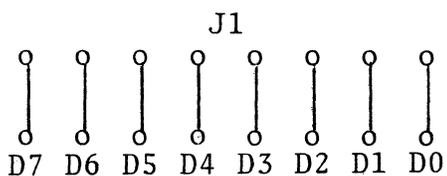
D7 D6 D5 D4 D3 D2 D1 D0
Arrangement of data
lines on J1 of ZPU
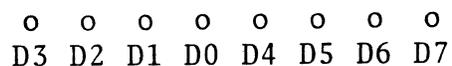
o o o o o o o o
D3 D2 D1 D0 D4 D5 D6 D7
Arrangement of data lines
on Molex connector of Altair
CPU card.

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 1C 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 re-
place 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 re-
turned 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.