Marinchip Systems M9900 CPU

Assembly Instructions

by John Walker

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Table of contents

Table of contents

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1. General Notes

The M9900 CPU kit uses a very complex and dense printed circuit board. In many areas of the board, the high parts density prevents use of the large component pads used on many simple kits. Improper soldering technique can easily create solder bridges which will render the kit inoperable. These solder bridges are very hard to find after the kit is built, so extreme care should be taken while soldering not to create them, and to inspect each solder joint after it is made to check for possible bridges. This kit is not recommended as one's first attempt at kit construction: if you are unsure of your soldering technique, have a more experienced friend help you build the kit. Alternatively, you can return the kit to Marinchip Systems with a check for $150, and we will send you an assembled unit.

1.1. Soldering Technique

The soldering iron used to assemble this kit should not exceed sixty watts, and the tip of the iron should not be larger than 1/16 inch. A thermostatically controlled iron is desirable, but not essential. High quality resin core solder is supplied with the kit. The quantity supplied should suffice.

Before soldering a connection, make sure the iron tip is clean and well tinned. Use of a "solder sponge" makes this easy to insure. To make a connection, touch the tip of the solder to the tip of the iron and make a tiny bead of solder on the iron tip. Push this bead and the iron tip against the pad where the component is to be soldered. Allow the joint to heat for several seconds, then apply the solder to the JOINT (NEVER to the iron). The solder should melt and flow into the hole. The hole should fill, and a small amount of solder should flow up the component lead on the component side of the board. If a joint is properly made, a small concave fillet of solder should be formed on both sides of the board. If too much solder is used, forming a large blob, there is a high risk that solder bridges will form between the joint soldered and adjacent traces. The solder mask applied to the board is intended to prevent this, but you should give it all the help you can. After finishing a joint, let it cool for several seconds before moving the board. Inspect the joint: it should be smooth, shiny, and not bridge to any other trace or pad. If the joint is dull or granular, it is a "cold solder joint" caused by either insufficient heat or moving the joint before the solder solidified. Cold joints may be corrected by reheating with the soldering iron, applying a TINY additional bit of solder. If a bridge forms, it may be removed by any of the popular solder

removal tools, such as a vacuum solder sucker, a metal braid solder wick, or a soldering iron with attached bulb. If none of these tools are available, a bridge may be removed by holding the board up in the air, solder side down, and applying the iron to the joint. The solder will melt and flow down the iron, clearing the bridge. The joint them may be resoldered. If you use this technique be careful with the soldering iron, as it is all too easy to stab yourself with a hot soldering iron. One such experience can dull the joy of kitbuilding for a very long time.

All of the above is simply the technique we have found to work best in soldering double sided boards with plated through holes. There are many other techniques that work equally well, and you should not change your technique if it has worked well for you in the past. Remember, though, that the M9900 CPU is very intolerant of error: virtually any bad solder joint or bridged trace will render the kit totally inoperable, with your only option to return it to Marinchip Systems for repair. Time spent carefully soldering and inspecting your work will be a valuable investment in a CPU that will serve you reliably for many years to come.

2. Incoming Inspection

In the following steps you will unpack the kit, check off the parts against the parts list, and inspect the parts for physical damage. It will speed the construction process if you sort the parts by type and place them in different piles as you check them off.

If any part is lost or damaged, write Marinchip Systems giving the description of the part, whether it was lost or damaged, and if damaged, how. A replacement part will be shipped by return mail. Do not send the damaged part, but keep it until you receive the replacement. Marinchip Systems may ask you to ship the damaged part back.

2.1. Printed Circuit Board

Unwrap the printed circuit board. Inspect it for any obvious damage, then look closely at the board to check for bad etching. The printed circuit boards are inspected several times during the manufacturing process, but an additional look is worthwhile, especially since parts will cover most of the traces on the front of the board.

The side of the board silk-screened with the parts location is referred to as the component side, and the other side, without screening, as the solder side. All parts are installed on the component side, and their leads are soldered on the solder side.

2.2. Components

Open the component bags and check off the components against the following list.

Check	Quantity	Description
( )	4	Resistor, 15 Ohms, 1/4 W (brown-green-black)
( )	1	Resistor, 330 Ohms, 1/4 W (orange-orange-brown)
( )	26	Resistor, 1000 Ohms, 1/4 W (brown-black-red)
( )	6	Resistor, 4700 Ohms, 1/4 W (yellow-violet-red)
( )	2	Resistor, 22000 Ohms, 1/4 W (red-red-orange)
( )	1	0.47 microhenry inductor. Note: this looks like a resistor. It has a broad silver band,

then gold-yellow-violet.

( )	1	51 picofarad mica capacitor
( )	17	0.1 microfarad ceramic disc capacitor
( )	6	1.5 microfarad tantalum capacitor
( )	9	22 microfarad tantalum capacitor
( )	18	Socket, IC, 14 pins
( )	4	Socket, IC, 16 pins
( )	15	Socket, IC, 20 pins
( )	1	Socket, IC, 64 pins. Note: other connectors may be substituted for the 64 pin socket. They will be identified if the substitution is made.
( )	1	IC, voltage regulator, 79M05 (TO5 metal can)
( )	1	IC, voltage regulator, 78M12 (TO5 metal can)
( )	1	IC, voltage regulator, 323K (TO3 metal can)
( )	2	IC, 74LS00
( )	3	IC, 74LS04
( )	2	IC, 74LS08
( )	1	IC, 74LS10
( )	2	IC, 74LS11
( )	1	IC, 74LS20
( )	1	IC, 7425
( )	1	IC, 74LS32
( )	5	IC, 74LS74
( )	1	IC, 74LS138
( )	1	IC, 74LS148
( )	10	IC, 74LS241
( )	1	IC, 74LS279
( )	1	IC, 74LS362
( )	4	IC, 74LS373
( )	1	IC, TMS9900
( )	8	Diode, 1N4001
( )	2	Transistor, A5T3391
( )	2	Mounting wafer, TO5
( )	1	Heat sink, TO3
( )	2	Bolt, 6-32 X 3/8
( )	2	#6 lockwasher
( )	2	6-32 nut
( )	1	Heat shrinkable tubing
( )	1	Roll of solder
( )	7	Precut jumper wires

3. Board Assembly

3.1. Resistors

In the following steps you will install the resistors on the printed circuit board. To install a resistor, bend the leads at 90 degrees so that the resistor may be placed in the holes on the component side and will fit tightly against the board. Push the resistor down against the board, and bend the leads out on the solder side of the board to hold the resistor in place. Turn the board over and solder each lead. Then, holding the lead with your hand, cut the lead close to the board. If you do not hold the lead while cutting it, it will fly and possibly wind up in your eye. If you grasp the lead too soon after soldering, you may burn your hand: this is an indication you are not waiting long enough for the solder to solidify. Many builders prefer to install several resistors, then solder all of them and clip all the leads in one pass. Whether or not this is done is left to the builder.

The orientation of resistors is unimportant: the circuit will work regardless of which way they are installed. However, the finished kit will look much more professional if all the resistors are installed the same way. On resistors mounted vertically, the gold tolerance band should be toward the bottom (closest to the gold fingers on the edge connector). On resistors mounted horizontally, the gold band should be toward the right.

3.1.1. 15 Ohm Resistors

The following resistors are 15 Ohm (brown-green-black). They are all mounted near the middle of the board to the left of the TMS9900 position (location 7H).

( ) R25
( ) R26
( ) R27
( ) R28

3.1.2. 330 Ohm Resistor

The single 330 Ohm (orange-orange-brown) resistor is installed in the lower left corner of the board (location 1A).

( ) R19

3.1.3. 1000 Ohm Resistors

In the following steps you will install 1000 Ohm (brown-black-red) resistors. The first group are along the bottom of the board paralleling the edge connector (locations 1D to 1H).

( ) R2
( ) R3
( ) R4
( ) R5
( ) R6
( ) R8
( ) R9
( ) R10
( ) R11
( ) R12
( ) R13
( ) R14
( ) R15
( ) R16
( ) R17
( ) R18

The following 1000 Ohm (brown-black-red) resistor is installed at location 2C in the lower left corner of the board.

( ) R20

Now you will install a 1000 Ohm (brown-black-red) resistor at the top of the board from locations 9C to 9D. This resistor is installed diagonally as indicated by the silkscreen on the board. The lead at position 9C should be bent at a sharp angle, and the resistor fit into the board. The length of bare lead extending to the hole at 9D should be noted, and a length of the heat-shrinkable tubing should be cut. The tubing should be cut slightly longer than the lead, as it will shrink in length as well as diameter. Fit the tubing over the straight long lead, and heat it with either a soldering iron or a match. If a match is used, be sure not to actually touch the flame to the tubing, as it will char. The tubing should shrink tightly around the lead. Then bend the lead to the proper length and install the resistor:

( ) R21

The following two 1000 Ohm (brown-black-red) resistors are installed at location 4M in the middle of the board to the right

of the TMS9900 space.

( ) R32
( ) R33

The following six 1000 Ohm (brown-black-red) resistors are installed at the very right of the board in the middle (locations 4V to 6V).

( ) R34
( ) R35
( ) R36
( ) R37
( ) R38
( ) R39

3.1.4. 4700 Ohm Resistors

In the following steps you will install the 4700 Ohm (yellow-violet-red) resistors. Be very careful not to confuse the 0.47 microhenry inductor for one of these resistors. The inductor has a wide silver band, and is the only thing in the kit that looks as it does. There are six 4700 Ohm (yellow-violet-red) resistors.

The following two 4700 Ohm (yellow-violet-red) resistors are installed in the cluster of 1000 Ohm resistors already installed at the bottom left part of the board (locations 1G and 1H).

( ) R1
( ) R7

The following 4700 Ohm (yellow-violet-red) resistor is installed at location 6G.

( ) R24

The following two 4700 Ohm (yellow-violet-red) resistors are installed at location 7H, just above the left top corner of the TMS9900 location.

( ) R29
( ) R30

The following 4700 Ohm (yellow-violet-red) resistor in installed at location 7N.

( ) R31

3.1.5. 22000 Ohm Resistors

The following two 22000 Ohm (red-red-orange) resistors are installed at location 7E.

( ) R22
( ) R23

3.2. Diode Installation

Now you will install the eight diodes to the right of the 9900 position at location 5M and 5N. The diodes must be installed with the banded end toward the top of the board (away from the gold edge connector). The technique for installing diodes is identical to that used for resistors.

( ) CR1
( ) CR2
( ) CR3
( ) CR4
( ) CR5
( ) CR6
( ) CR7
( ) CR8

3.3. Inductor Installation

The 0.47 microhenry inductor is installed next. This part looks like a resistor, but has a wide silver band. The complete color code is (wide silver-gold-yellow-violet). The inductor should be installed at location 6F. The silk screen at this location identifies two sets of holes as L/C1. The inductor should be installed in the bottom set of holes (those closest to the edge connector fingers). The inductor is installed horizontally.

( ) L1

3.4. Integrated Circuit Socket Installation

In the following steps you will install the sockets for the integrated circuits. There are three kinds of small sockets, which have, respectively, 14, 16, and 20 pins. There is also a huge socket for the TMS9900. The small sockets are keyed for the

location of pin 1 of the IC by having one corner of the inside of the socket filled in. Examine the sockets close-up to see this indication. When you install a socket, you must align the filled-in corner with the pin 1 indication on the board. Pin 1 is indicated on the silk-screen on the component side by a triangle near the pin. For all sockets installed with the long dimension vertical, pin 1 is the upper left pin. For sockets installed with the long dimension horizontal, pin 1 is the lower left pin.

To install a socket, carefully insert the socket into the holes provided in the printed circuit board. Make sure that all pins go into the holes and none are bent under. It is very hard to remove a socket if it is improperly installed. Whenever you install a socket, make sure the socket you are installing has the correct number of pins for the location you are installing it in. Once the socket is inserted, hold it against the board with your thumb, and flip the board over. With tweezers or sharp nosed pliers, bend two corner pins out. This will hold the socket close to the board as it is initially soldered in. Then solder the other two corner pins (the ones you did not bend over). Then, unbend the two other corner pins. Now press the socket against the board with your thumb, and briefly reheat the two pins you soldered in. You will feel the socket snap into close contact with the board. Then you may solder the rest of the pins in place. The corner pins should be reheated last of all, and a tiny bit more solder applied.

The above procedure will guarantee that the sockets are seated tightly against the board and will insure a professional quality finished board.

3.4.1. 14 Pin Sockets

First, you will install the eighteen sockets with 14 pins. Refer to the above procedure for installation of each socket. On the check off steps below, each socket will be called out by its coordinates on the board, and the IC designation for the socket being installed. Make sure you double check the pin 1 indicator before soldering each socket in place.

Check	Location	IC type
( )	3A	74
( )	5A	74
( )	6A	74
( )	8A	74
( )	7C	10
( )	5C	32

Check		
( )	3C	08
( )	1C	00
( )	7D	04
( )	5D	04
( )	8E	74
( )	8G	11
( )	8L	7425
( )	9M	00
( )	8M	20
( )	9P	08
( )	8P	04
( )	7P	11

3.4.2. 16 Pin Sockets

In the following steps you will install the four 16 pin sockets. Make sure you double check the pin 1 indication on each socket you install before you solder it in.

Check	Location	IC type
( )	3D	148
( )	4D	279
( )	7M	138
( )	1V	none (socket entirely within ground plane)

The last 16 pin socket you installed is used to hold the front panel connector found in certain S-100 mainframes. No IC is installed in that location. The nomenclature "241" above the socket refers to the vertical 20 pin position above the socket you just installed. The socket at 1V is soldered to the ground plane, and a small soldering iron may not provide enough heat to solder this socket normally. If extended heating will not produce a satisfactory connection, a larger iron may be used with caution.

3.4.3. 20 Pin Sockets

In the following steps you will install the fifteen sockets with 20 pins. Double check the pin 1 orientation of each socket before soldering it in place.

Check	Location	IC type
( )	2D	373
( )	7F	362
( )	5F	241

( )	2F	241
( )	5H	241
( )	3H	241
( )	5J	241
( )	3J	241
( )	5P	241
( )	5R	241
( )	5T	373
( )	2M	373
( )	2P	241
( )	2R	373
( )	2T	241

3.4.4. 64 Pin Socket

If a 64 pin socket is provided to mount the TMS9900, install it in the area indicated for the TMS9900. The pin 1 indication on this socket is an inside corner cut off one of the pin rails. This should be mounted aligned with the pin 1 indication on the silk screen. The pin 1 notch should be in the upper left corner of the socket when the board is held with the component side up and the edge connector fingers toward you.

Several other types of mounting are also used for the TMS9900. If your kit contains alternate mounting hardware, instructions for its use will be packed with the mounting hardware.

( ) TMS9900 socket

3.5. Capacitor Installation

In the following steps you will install one mica capacitor, two kinds of tantalum electrolytic capacitors, and the ceramic disc capacitors.

3.5.1. 51 picofarad Mica Capacitor

The 51 picofarad mica capacitor should be located. It should be marked with "51", and is the only part in the kit of its kind. It is installed at location 6F on the board in the set of holes marked L/C1. Install the 51 picofarad capacitor above the 0.47 microhenry inductor installed previously.

( ) C1 51 Picofarad

3 5.2. 1.5 microfarad Tantalum Capacitors

Separate the six 1.5 microfarad tantalum capacitors. These capacitors superficially resemble the 22 microfarad capacitors, but are smaller and marked with "1.5". One lead on each capacitor is marked with a plus sign (+). This lead will be referred to as the plus lead, and MUST be installed in the hole marked with a plus sign (+) on the printed circuit board. Failure to install the capacitor properly will cause it to EXPLODE when power is applied to the board. Severe damage can be done to the printed circuit board, computer motherboard, and power supply, not to mention to the nerves of the builder. Because of the dire consequences of improperly installing one of these capacitors, check the plus lead orientation before inserting the capacitor, after inserting it in the board and before soldering, and after soldering it in place. As a final check, each capacitor called out below will give the "Plus lead orientation". The directions given will indicate where the plus lead on the capacitor will point when the board is held component side up with the edge connector toward you.

With care now, you should install the 1.5 microfarad tantalum capacitors.

Check	Part	Location	Plus lead orientation
( )	C7	1A	Left
( )	C6	1A	Top
( )	C5	9A	Left
( )	C4	9A	Bottom
( )	C2	8E	Right
( )	C16	9V	Left

3.5.3. 22 microfarad Tantalum Capacitors

Next you will install the 22 microfarad tantalum capacitors. Each capacitor will be marked with "22", and with a plus sign (+) on the plus lead. The same cautions mentioned in the preceding paragraph apply to installing these capacitors: these will also EXPLODE if installed backward. Follow the procedure you used for the 1.5 microfarad capacitors in installing these 22 microfarad capacitors.

Check	Part	Location	Plus sign orientation
( )	C8	2A	Top left. (The capacitor

			goes in the large hole on the periphery of the circle, not the small hole nearest the plus sign.)
( )	C9	8B	Bottom
( )	C3	9B	Right
( )	C10	1F	Bottom
( )	C12	7H	Bottom
( )	C13	4M	Bottom
( )	C14	4Q	Bottom
( )	C15	6V	Bottom. (The capacitor goes between the hole in the large top foil and the hole between the two rightmost 1000 Ohm (brown-black-red) resistors.)

Now you will install C11. Because of a clearance problem with certain ICs only discovered after laying out the board, you will not be installing this capacitor where indicated at location 4H on the board. Instead, install the capacitor in the two holes indicated by the oval to the left of the C11 circle (location 4G). The capacitor will be installed with the plus lead to the left.

Check	Part	Location	Plus lead orientation
( )	C11	4G	Left

3.5.4. 0.1 microfarad Ceramic Disc Capacitors

In the following steps, you will install the 0.1 microfarad ceramic disc capacitors. Because of various lead spacings found on the board, several different techniques will be used to install the capacitors. The ceramic disc capacitors can be installed either way in the board. The ceramic disc capacitors have no part numbers: their location is indicated simply by an oval on the board with lines leading to the holes where the leads should be inserted.

The first set of 0.1 microfarad ceramic disc capacitors will be installed in holes where the spacing matches the lead spacing of the capacitor. They should be simply inserted in the board and soldered.

Check	Location
( )	2C

Check	Location
( )	8B
( )	6D
( )	6E
( )	4J
( )	8L
( )	8N
( )	4V

The next capacitor to be installed also has normal spacing, but its location is not silk-screened on the board. This capacitor is installed at location 7V on the board, just to the left of the number "7" on the right side of the board. The capacitor is installed between the hole at the end of the long finger and the hole to the right and below it that goes through the foil extending to the edge of the board:

Check	Location
( )	7V

The next two capacitors will be installed in locations where there is insufficient clearance between integrated circuit sockets for the capacitor. The capacitors should be installed with the right lead very close to the board. Bend the left lead so that it goes between the sockets and into the proper hole. The lead should not be pushed against the printed circuit board lest it short against a trace on the board.

Check	Location
( )	4A
( )	7A

The next four capacitors will be installed with very wide lead spacing in the lower right side of the board. To eliminate the possibility of these capacitor leads shorting against the traces they run over, you will cover the leads with heat-shrinkable tubing before installing the capacitors. For each of the capacitors listed below, first bend the leads from the capacitor straight out from (tangent to) the bottom of the disc. Then fit the leads to the holes at the location where the capacitor is to be installed, and note the length of heat-shrinkable tubing to be used. Since the tubing shrinks in length as well as diameter, cut the length about 15% longer than required. Insert the tubing on both leads of the capacitor, then shrink it by applying heat from a soldering iron or match. (If you use a match, be sure not to scorch the tubing by holding it directly in the flame.)

Once the tubing has been installed, bend the leads at right angles, insert the leads in the holes, and solder normally.

Check	Location

( )	5Q
( )	5S
( )	2N
( )	2S

Now you will insert the last ceramic disc capacitor. This capacitor's location was incorrectly screened on the board, and you must install it at location 4H in the two holes where the screen indicates a 22 microfarad tantalum capacitor is to be installed. Since the ceramic capacitors may be installed either way, you can ignore the plus lead indication.

Check	Location
( )	4H

3.6. Voltage Regulator Installation

In the following steps you will install the two small TO5 regulators and the large TO3 regulator.

3.6.1. TO5 Regulators

To install a TO5 regulator, locate the regulator to be installed and a plastic spacer. Install the spacer on the regulator so that the dimples in the spacer point away from the body of the regulator. Insert the regulator in the proper hole, push it against the board, and bend its leads out to hold it in position. Then turn the board over, solder it in place, and clip the leads close to the board. The two TO5 regulators are DIFFERENT: be sure to install each in its proper location. Both regulators are installed in the lower left corner of the board.

Check	Part	Location
( )	78M12	2A (actually between 1 and 2)
( )	79M05	1A (actually below 1)

3.6.2. TO3 Regulator

Next, you will install the large TO3 regulator. This regulator will be identified by the marking "323K". Locate the regulator, the "U" shaped heat sink, and the two 6-32 bolts, nuts, and lockwashers. you will notice that the heat sink will only fit one

way on the board so that the regulator mounting pins will be exposed: install it this way. If you have thermal grease, apply it to the bottom of the heat sink and regulator. Now assemble the regulator to the board as follows: First, place the heat sink on the board in the proper position. Then place the regulator on top of it, so that the regulator pins extend through the two holes in the board. Align the holes in the regulator and heat sink to that they line up with the holes in the board, then insert the bolts from the bottom (solder side) of the board through the heat sink and regulator. Place a lockwasher over the end of the bolt, and tighten the nut. The nuts should be tightened firmly, but not so tight as to warp the board. Then turn over the board and solder the regulator leads to the pads through which they extend. After soldering, clip the leads close to the board (holding them so they do not fly).

3.7. Transistor Installation

In the next two steps you will insert the A5T3391 transistors at location 6E. The leads on the transistors are formed so that the transistors will be properly aligned when inserted in the triangular group of holes at this location. Insert the transistor in the group of holes, and position it so it stands about 1/8 inch above the board (don't mash it down against the board). Bend the leads out on the solder side to hold it in place. Then double check correct insertion by verifying that the flat side of the transistor points to the left of the board (when the board is held component side up with the edge connector pointing toward you). Then turn the board over again and solder the leads and clip them close to the board (holding them so they do not fly).

Check	Part	Location
( )	Q1	6E
( )	Q2	6E

3.8. Jumper Installation

In the following steps you will install jumper wires on the board. The jumpers route signals that due to the high density of the board could not be carried by traces on the board itself. Each jumper is identified by a letter. The holes into which the jumper is to installed are identified by the same letter. The installation checklist below will give explicit routing details for each jumper. The jumper wires are precut and identified by the letter code for the jumper to be installed. To install each

jumper, insert the stripped end of the wire in one hole, route the wire as instructed, and insert the other stripped end in the other corresponding hole. Then turn the board over and solder the wires in place and clip the excess stripped length close to the board. All jumpers are to be installed on the component side of the board.

Check	Jumper	Routing
( )	E	From "E" hole at 8H, down, to left of 22 microfarad capacitor at 7H, down and to left of four sockets at 6H to 3H, to left below socket at 2F, continuing left to "E" hole at 1B.
( )	F	From "F" hole at 8D down and to the left of the 04 socket at 7D, into the "F" hole at 6C.
( )	G	From "G" hole at 9K, left, below 74 socket at 9E, down to left of 1.5 microfarad capacitor at 8E, into "G" hole at 7D.
( )	H	From "H" hole at 8N, left paralleling "G" jumper just installed. At 8F, turn down and go between two holes within oval labeled XTL, then left of the two 22000 Ohm (red-red-orange) resistors and into hole "H".
( )	J	From "J" hole at 8Q, go left, then parallel the "H" jumper just installed. Continue to the left and down after the end of the "H" jumper, to the right of the disc capacitor at 6D, into the "J" hole at 4C.
( )	K	From "K" hole at 9N, go left and parallel "J" and "H" jumpers. At end of "H" jumper, continue parallel to the "J" jumper until the K" hole at 5D.

Double check the jumpers to make sure they are properly installed, that no bare wire appears on the component side of the board, and that they are routed as described above. Three wires (the "H", "J", and "K" jumpers) should pass between the two holes within the oval at 8F labeled XTL.

3.9. Crystal Installation

Now install the crystal in the two holes within the oval marked XTL. The three jumper wires passing between the holes will serve

to space the crystal above the board. Push the crystal down until the three jumpers beneath it lie flat against the board, then bend the crystal leads out on the other side of the board to hold it in place. Turn the board over, solder the crystal leads in place, and clip close to the board.

( ) Crystal installed

3.10. Option Jumper Installation

The following two steps select options for the M9900 CPU. In the first, a jumper is installed in one of two positions based upon the option desired. In the second, a jumper is installed or omitted depending upon the option desired.

3.10.1. RESET Jumper

The RESET jumper controls the action of the M9900 CPU when the RESET switch is pressed on the front panel. The RESET jumper is installed to the left of the 74 IC socket at location 8E. A wire is installed from the center large pad to the top pad if the CPU is to trap to location 0 (Reset vector) on a RESET, and from the center pad to the bottom pad (large pad immediately below it) if the CPU is to trap to location OFFFC (load vector). All Marinchip software requires that this jumper be installed for the Load vector option (center to bottom hole), but for special applications the other option may be selected. A piece of cut component lead may be used for this jumper. After installing the jumper, note below how it was installed: if from top to middle, write RESET, if from middle to bottom, write LOAD in the space provided. Then check the step as completed.

( ) RESET Reset jumpered to _____

3.10.2. MWRITE Jumper

The jumper from hole "M" at location 5G to hole "M" at location 1G (very close to the edge connector) should be installed if the CPU is to generate the S-100 signal MWRITE. In general, if the CPU is to be installed in a mainframe without a front panel, this jumper should be installed. If installing the CPU in a mainframe with a front panel (Altair / IMSAI), the jumper should be omitted. Installing this jumper in a system where it should not be used will do no harm. On the following check-off line, write in "IN"

if you install the MWRITE jumper and "OUT" if you do not. Then check the line.

( ) M MWRITE Jumper _____

3.11. Post-assembly Inspection

At this point all components that will be soldered to the printed circuit board have been installed. Inspect the board carefully looking for:

- Unsoldered connections.
- Traces bridged by solder blobs.
- "Cold" solder joints. These joints will appear dull and/or granular. Properly made joints will be smooth and shiny.

Also, at this time check again that all the tantalum capacitors have been installed with the plus (+) lead in the proper hole, and that the bands on all the diodes installed at locations 6L to 6N face away from the edge connector.

If you have access to an ohmmeter, measure the resistance between the following sets of edge connector pins:

( )	1 and 50	_____	(50 is behind 1 on back)
( )	1 and 2	_____	
( )	1 and 51	_____	(51 is behind 2 on back)
( )	2 and 50	_____	
( )	50 and 51	_____	
( )	2 and 51	_____	

If any of these pairs measures zero ohms, there is a short circuit between the power traces caused by a solder bridge (all boards are tested for power shorts before shipment, so the fault must have been created during assembly). DO NOT APPLY POWER TO A BOARD WITH A POWER SHORT: IT WILL DESTROY YOUR COMPUTER! The board must be repaired before testing may continue.

4. Testing

Now that the basic assembly is done, you will test the various subsystems of the M9900 CPU, and perform the final steps of assembly.

4.1. Preliminary Testing

In the following steps you will make several tests that verify the functioning of the power supply of the M9900 CPU and test for errors that might cause damage to other boards in the computer or to the TMS9900 processor chip. These tests require an ohmmeter or a DC coupled oscilloscope. Since much expensive equipment may be saved by an error detected during these tests, it is suggested that you borrow a meter or scope and make these tests rather than skipping them.

( ) Remove all removable boards from your computer.

( ) Insert the M9900 CPU, preferably on an extender board. Attach the ground lead of your meter or scope to the end of the bolt on the right side of the large voltage regulator.

( ) In the next step you will turn on the computer. If any of the tantalum capacitors have been installed backwards, they will explode. To protect yourself, keep your face away from the front and the area above the board. If any of the capacitors do explode, a large volume of smelly black smoke will be generated. Before you turn on power, be ready to turn power off immediately and to open the windows in case this happens.

( ) Turn on the computer. Assuming everything looks O.K., measure the voltage on all 100 of the edge connector pins. (The traces on the extender board are an easy place to do this). Be careful not to short any of the pins together while making this test. Except for pins 1 and 2 on the front and pins 51 and 52 on the back, all voltages should measure between 0 and 5.2 volts. If any voltages are measured outside this range, the board should be carefully examined to locate the fault which is causing this problem. This test protects the other boards in your system from faults in the M9900 CPU.

( ) Attach a sharp point to the probe of your meter or scope and measure the voltage at the following pins of the 64

pin socket for the TMS9900. Pin 1 is at the upper left when viewed from the component side.

Pin	Voltage	
1	_____	(Should be -5)
27	_____	(Should be +12)

Now measure the voltage at all the other pins of the 64 pin socket. All voltages should be between 0 and 5.2 volts. If any voltage (other than at pins 1 and 27) is out of range, the fault causing the problem must be corrected before the TMS9900 is installed, lest it be destroyed.

( ) Turn off the computer.

( ) Remove the M9000 CPU board.

4.2. TTL IC Installation

Now you will install all of the TTL integrated circuits in their sockets. Pin 1 on each integrated circuit may be indicated by a notch in the end of the package, a deep circle on the top of the package, a little circle near pin 1, or other ingenious scheme devised to make construction more straightforward. The end of the IC with the pin 1 marking will be installed in the end of the socket with the filled-in corner that signifies pin 1. As a cross-check, when the board is held component side up with the edge connector toward you, pin 1 of all the vertically mounted ICs will point away from you, and pin 1 of the horizontally mounted ICs will point to your left.

Most ICs are shipped with the pins bent out for use in automatic insertion machines. It is very difficult to insert these ICs in sockets unless the pins are straightened first. Grasp the IC package with your fingers and press the leads against a flat surface such as a table top and gently bend all the leads on both sides of the IC until they form a right angle with the IC package. Then you should be able to insert the IC in the socket with no trouble. Generally, the best way to insert an IC is to set it on the top of the socket with all pins in the holes. Any pins that don't line up with the holes should be pushed into position with tweezers or other tool. Then the IC may be gently "walked" into the socket with a rocking motion of your thumb. After installing each IC, check that no pins have been bent under or protrude outside the socket. If pins have been bent, remove the IC by prying it out from both ends alternately with a small screwdriver,

straighten the bent pin(s) with sharp nose pliers, and try again.

Now actually insert the ICs in their sockets:

Check	Location	IC type
( )	3A	74LS74
( )	4A	74LS74
( )	6A	74LS74
( )	8A	74LS74
( )	1C	74LS00
( )	3C	74LS08
( )	5C	74LS32
( )	7C	74LS10
( )	1D	74LS373
( )	3D	74LS148
( )	4D	74LS279
( )	5D	74LS04
( )	7D	74LS04
( )	2F	74LS241
( )	5F	74LS241
( )	7F	74LS362
( )	8E	74LS74
( )	8G	74LS11
( )	3H	74LS241
( )	5H	74LS241
( )	3J	74LS241
( )	5J	74LS241
( )	8L	7425
( )	8M	74LS20
( )	9M	74LS00
( )	9P	74LS08
( )	8P	74LS04
( )	7M	74LS138
( )	7P	74LS11
( )	5P	74LS241
( )	5Q	74LS241
( )	5T	74LS373
( )	2M	74LS373
( )	2P	74LS241
( )	2R	74LS373
( )	2T	74LS241

After completing these steps, only the large socket for the TMS9900 and the 16 pin socket in the lower right corner of the board will be unfilled.

4.3. Intermediate Tests

If you have access to a DC to 10 MHz or better oscilloscope, you should now test that the clock generator is working properly. Install the board on an extender board, insert in the computer, attach the scope ground to the end of the bolt at the right end of the large regulator, and turn on the computer.

Using a sharp point on the oscilloscope probe, examine the following pins on the 64 pin socket for the TMS9900. On each pin, you should see a squarewave with a period of 500 nanoseconds, a peak-to-peak voltage of 12 volts, and a duty cycle of 3/16. If the clock signals are not correct, repair the clock circuitry before inserting the TMS9900.

( ) Pin 8
( ) Pin 9
( ) Pin 25
( ) Pin 28

At this time, you should repeat the test of all 64 pins on the TMS9900 socket. Only pins 1, 8, 9, 25, 27, and 28 should read outside the range of 0 to 5.2 volts. Any fault causing an improper voltage on any other pin should be corrected before inserting the TMS9900.

Turn off the computer and remove the M9900 CPU board.

4.4. Installing the TMS9900

It can be put off no longer. Now you are going to have to put the TMS9900 IC into its socket. The TMS9900 is an MOS circuit, and can be damaged by extreme static discharges. The TMS9900 employs on-chip protection networks, so normal handling should cause no problems. The normal precautions of avoiding synthetic clothing, touching the ground plane on the board and the conductive foam containing the IC before handling the IC, and avoiding touching the IC pins when possible are wise. A much greater hazard than static damage is that of bending a pin or breaking the IC in two while trying to install it in its socket. Don't let fear of handling the IC because of static hazard lead you to damage it by not installing it carefully.

Now that you're scared to death of the prospect of attempting the next steps, let a word of encouragement be given. The author knows of no case in which any of the aforementioned dire events have ever happened.

The following steps will lead you through the installation of the TMS9900.

( ) Touch the conductive foam holding the TMS9900 and grasping the IC by both ends (not touching the pins), remove the IC from the foam, and set the IC on the 64 pin socket.

( ) The IC pins will normally be spread out so that they are too wide to go in the socket. If this occurs, pick up the IC by the ends, and grasping it firmly by the ends, bend the pins straight against a table top. Alternate bending the pins on each side of the IC until when the IC is placed on the top of the socket, most of the pins line up with the holes. Don't worry about a few recalcitrant pins at this point.

( ) Now make sure that the TMS9900 is aligned with the socket (no pins overhanging the end), and that pin 1 points away from the edge connector. If it isn't, correct it.

( ) Now apply a very light pressure to the center of the TMS9900, and with a pair of sharp tweezers or other tool, guide any misaligned leads into the socket holes. The light pressure on the IC will keep these leads in place.

( ) Now, without letting up pressure, shift your hands so that both thumbs are pressing on the IC on opposite sides of the center. Firm pressure, exerted with a smooth, slow, buildup in pressure, will cause the IC to snap into the socket. Frequently, one entire side will snap in first. Unless this causes pins on the other side of the IC to pop out, this is no cause for concern. Simply shift your pressure to the other side of the IC until it snaps in also.

( ) Once the IC is inserted, check it one more time to be absolutely sure that the pin 1 indication is at the upper left corner of the IC when the board is held component side up with the edge connector toward you.

4.5. Final Tests

Insert the M9900 CPU into your computer. Plug in all the other boards. If proper ROM chips are installed in the PROM or System Monitor board, the computer configuration agrees with the PROM you are using, the M9900 CPU is working properly, and your terminal is properly connected, when you turn on the power and push RESET, you

should be greeted with the message:

```
Marinchip 9900 Monitor
```

If this happens, congratulations! If not, proceed to the next chapter of this manual.

5. What to do if it doesn't work

If you do not receive the monitor sign-on message when you turn on the computer and push RESET, something is wrong. The following sections will describe the most common problems encountered in bringing up M9900 systems.

5.1. Improper System Configuration

The system monitor PROMs you are using must exactly match the configuration of the machine you are using. Check the configuration sheet you received with the PROMs against the following items in your computer.

- Amount of RAM configured and address jumpers on all RAM boards.
- Starting address of PROM board, and that PROMs are in proper sockets. The two monitor PROMs must be installed so that they occupy the address space between F800 and FFFF.
- Type of Serial I/O for which PROMs are configured, and device address strapping on serial I/O board.

If these checks fail to find anything wrong, the configuration is probably correct.

5.2. Improper Option Jumpers on M9900

If the option jumpers are improperly set on the M9900 CPU, the system will fail to work correctly. First of all, check the RESET/LOAD jumper to the left of the 74LS74 IC at location 8E. The jumper must be between the middle hole and the bottom hole for the Marinchip software to work. If it is in any other position, correct it and try again.

If the MWRITE jumper between the two holes labeled "M" is not installed, and you are not sure whether it should be or not, install it and see if the problem goes away. (Refer to the section on "Option Jumper Installation" for details on installation of this jumper.)

5.3. M9900 CPU Construction Errors

Check the M9900 CPU board very carefully for the following errors. Most errors found in kits fall into the following categories:

- Solder bridges between traces and pads.
- "Cold" solder joints.
- Unsoldered leads.
- Diodes installed backwards.
- Tantalum capacitors installed backwards.
- ICs installed backwards.
- Pins bent under or outside socket on ICs.

Repeat the checks for these errors listed in the previous chapter of this manual. Note that solder bridges beneath components on the component side of the board cannot be found by inspection.

5.4. Thumbnail Guide to M9900 Troubleshooting

The following brief paragraphs are a guide to the potential troubleshooter of an inoperative M9900 CPU. They are in no way a complete troubleshooting guide, but serve mainly to isolate the problem to the major board subsystem causing the difficulty. It is assumed that an oscilloscope is available for these tests. What follows is the basic procedure used by Marinchip Systems in checking out boards returned for service.

- Examine pin 7 of the TMS9900. If you see pulses, the microprocessor is executing instructions. If it is, the problem is likely in the address or data bus drive. If it is not, the problem is likely in the memory bus controller.

- If the processor is not executing instructions, examine pin 63. If pin 63 is always low, the processor is stuck accessing memory. If pin 62 is low and S-100 pins 3 and 72 are both high, the problem is in the memory bus controller circuitry.

- If the processor is executing instructions, watch pin 6 on the processor as you press the RESET button. It should stay low while the button is held down, and go high about 2 seconds after the button is released. Then examine pin 4 on the processor. It should

either stay low while the RESET button is held down or pulse low shortly after the RESET button is released. After processor pin 6 goes high, pin 4 should go high. If it does not, or pin 6 behaves abnormally, the problem lies in the RESET/LOAD generation logic.

. If these tests fail to reveal the problem, examine the address and data leads on the S-100 bus. If any looks abnormal, check the input and enable of the buffer that drives the lead.

Beyond these simple tips, troubleshooting must be based upon the schematic and the "Hardware Description" manual.

5.5. Marinchip Factory Repair Policy

If your kit does not work, and you cannot find the problem, you can ship it to Marinchip Systems postpaid for repair. When you send the kit, please include a complete description of what problems and symptoms you have encountered, and what corrective action you attempted to correct the problems. Also send a complete description of your configuration and INCLUDE THE SYSTEM MONITOR PROMS YOU ARE USING. Your kit will be repaired for a fixed service fee, currently $50. Defective parts will be replaced without charge if the kit is returned within 90 days of purchase. If the magnitude of repairs are excessive, or the kit has been damaged or in the judgement of Marinchip Systems was assembled in an unworkmanlike manner, or has been subjected to unreasonable abuse, Marinchip Systems may refuse to service the kit for the fixed price. In this case, we will notify the sender of our estimate for the repairs and give the sender the option of having us return the kit and the check for repairs, or procede with the repair work after being sent a check for the balance of the repair fee. Note that the fixed repair price must be included when the kit is returned for repair and that the fee is subject to change.