MP-09 Processor Board

Addendum Sheet

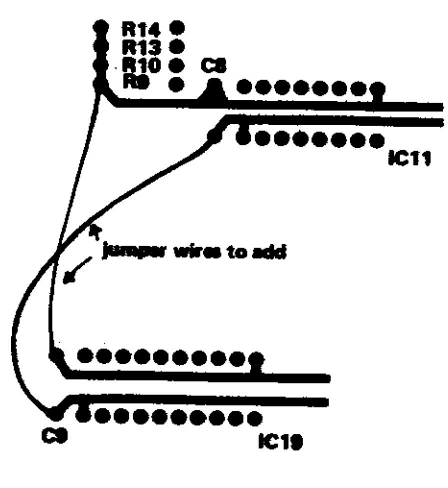
READ CAREFULLY BEFORE ASSEMBLY OR USE

The enclosed instruction set outlines both the assembly of the MP-09 processor board and the modifications necessary to make a SWTPC MP-68 6800 computer system 6809 compatible. If the 6809 board was received as a fully assembled board the first part of the assembly instructions may be skipped, but the modification instructions for the MP-M, MP-8M, MP-B, MP-B2, DMAF1 and other boards should be followed. Board programming instructions should also be followed.

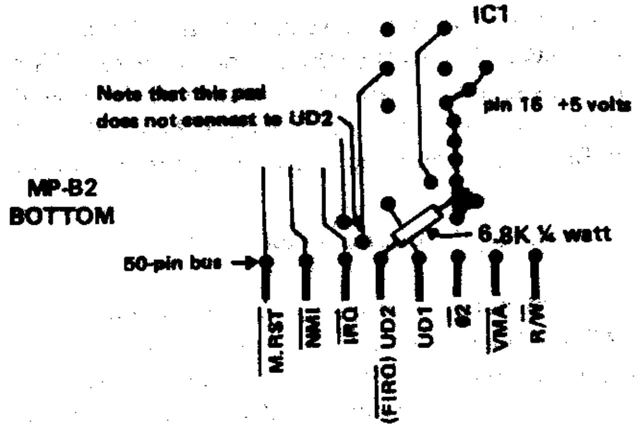
Assembly Instructions Additions

( ) After assembling the MP-09 board a resistor needs to be added for proper reset switch operation. Turn the MP-09 board so that you are looking at the BOTTOM side of the board and so that the edge connectors are nearest you. Locate the four pads to which the RST/NMI connector is attached. Attach a 1K ohm ¼ watt resistor between the left-most pad (the only one with no circuit board traces connected to it on the BOTTOM side of the board) and the +5 volt supply bus. The +5 bus can be found on pin 14 of IC6.

( ) Two additional wires need to be added to the board for proper +5 volt and ground returns. Connect a short jumper of light gauge wire from IC19 pin 10 to IC11 pin 8. These connections should be made on the BOTTOM side of the board at the ground side of capacitors C8 and C9. Connect another short jumper from the +5 side of C9 (the side with the PC trace that goes to IC19 pin 20) to the common junction of resistors R9, R10, R13 and R14. This junction connects to a PC trace that goes to IC11 pin 16.



( ) When using the MP-09 processor board with a MP-B or MP-B2 motherboard a 6.8K ohm ¼ watt resistor should be connected from the $\overline{FIRQ}$ (labeled as UD2 on the motherboard) bus line to +5 volts. The resistor should be attached on the bottom side of the board as shown:



( ) Although it is not required for proper S-BUG monitor operation, it is suggested that the IRQ jumper on the MP-S serial interface in I/O port #1 be installed. S-BUG will not work with the older MP-C serial control interface. The IRQ jumper is required for proper operation of the 6809 editor and other software forthcoming for the 6809.

( ) Most of the components on the MP-09 processor board have been chosen for operation at a 2 MHz clock speed. However, unless the board was supplied with a 8.0 MHz crystal for Y1, proper operation is not guaranteed beyond 1 MHz. The components on the original SWTPC 6800 mainframe and new /09 mainframe have also been selected for a maximum 1 MHz clock speed. Exceeding this will cause unpredictable results.

( ) If you locate the RESET button external to the 6809 mainframe and have trouble with the system randomly resetting, it may be necessary to run the two wires going to the RESET button in a shielded cable. The shield itself should be grounded.

Assembly Instructions MP-09 Microprocessor Board

Introduction

The MP-09 processor board is intended for use in Southwest Technical Products Corp. or similar computer systems using the SS-50 bus system. It consists of the MC6809 processor, ROM monitor, memory mangement system and buffering circuits. The board requires a 7 to 9 Volt unregulated DC voltage at approximately 1.0 Amp. The MP-09 may be used to replace 6800 processor boards in most any SWTPC 6800 computer system.

The new MP-09 board may be used in place of 6800 processor boards originally provided with the SWTPC 6800 Computer System and has the following features:

HARDWARE FEATURES
* SWTPC SS-50 bus compatible
* Paged memory addressing capability
* Extended addressing capability (up to 384 K bytes)
* Sockets provision for up to 8K of Intel 2716 pinout EPROM, PROM, ROM or RAM.
* Tight address decoding

ARCHITECTURAL FEATURES
* Two 8-bit accumulators can be concatenated to form one 16-bit accumulator
* Two 16-bit index registers
* Two 16-bit indexable stack pointers
* Direct page register allows direct addressing throughout memory space

INSTRUCTION SET
* Extended range branches
* 16-bit arithmetic
* Push/pull any register or set of registers to/from either stack
* 8 x 8 unsigned multiply
* Transfer/exchange any two registers of equal size
* Enchanced pointer register manipulation

ADDRESSING MODES
* All MC6800 modes, plus PC relative, extended indirect, indexed indirect, and PC relative indirect.
* Direct addressing available for all memory access instructions
* Index mode options include accumulator or up to 16-bit constant offset, and auto-increment/decrement (by 1 or 2) with any of the four pointer registers

When the SWTPC 6800 Computer System is being assembled work on only one board at a time. Each of the system's boards and their associated parts must not be intermixed to avoid confusion during assembly. The MOS integrated circuits supplied with this kit are susceptible to static electricity damage and for this reason have been packed with their foil leads impressed onto a special conductive foam or possibly wrapped in a conductive foil. In either case, do not remove the protective material until specifically told to do so later in the instructions.

PC Board Assembly

NOTE: Since all of the holes of the PC board have been plated thru, it is only necessary to solder the components from the bottom side of the board. The plating provides the electrical connection from the "BOTTOM" to the "TOP" foil of each hole. Unless otherwise noted it is important that none of the connections be soldered until all of the components of each group have been installed on the board. This makes it much easier to interchange components if a mistake is made during assembly. Be sure to use a low wattage iron (not a gun) with a small tip. Do not use acid core solder or any type of paste flux. We will not guarantee or repair any kit on which either product has been used. Use only the solder supplied with the kit or a 60/40 alloy resin core equivalent. Remember all of the connections are soldered on the bottom side of the board only. The plated-thru holes provide the electrical connection to the top foil.

( ) Before installing any parts on the circuit board, check both sides of the board over carefully for incomplete etching and foil "bridges" or "breaks". It is unlikely that you will find any; but, should there be one especially on the "TOP" side of the board, it will be very hard to locate and correct after all of the components have been installed on the board.

( ) Attach all of the resistors to the board. As with all other components unless noted, use the parts list and component layout drawing to locate each part and install from the "TOP" side of the board bending the leads along the "BOTTOM" side of the board and trimming so that 1/16" to 1/8" of wire remains. Solder. You should have a 1M Ω resistor left over.

( ) Install all of the capacitors on the board. Be sure to orient the electrolytic capacitors correctly. The polarity is indicated on the component layout drawing. Solder.

( ) Attach and solder crystal Y1 to the circuit board. Leave about 1/8" between the top of the board and the base of the crystal so that none of the printed circuit traces short out against the body of the crystal.

( ) Attach crystal Y2 to the circuit board. It should be oriented so its length lies flat across the circuit board as shown in the outline on the component layout drawing. If the crystal has long thin wire leads, they may be bent down 90 degrees at the base of the crystal so they fit into the two holes provided for the crystal on the circuit board. If the crystal has short heavy wire leads, solder onto and at a 90 degree angle the crystal's leads some heavy bus wire. The bus wire with the crystal attached may then be inserted into the board. In either case the crystal must be attached so its metal case could never inadvertantly come into contact with either the foil on the circuit board or either one of its own two leads. Solder. If desired, the crystal may be firmly secured by strapping the body of the crystal to the circuit board using a piece of light gauge wire. The wire need not be insulated. Pads are provided for attaching the wire adjacent the sides and just beneath the body of the crystal.

( ) Starting from one end of the circuit board install each of the five, 10-pin Molex female edge connectors along the lower edge of the board. These connectors must be inserted from the "TOP" side of the board and **must** be pressed down firmly against the board. Make sure the body of the connector seats firmly against the circuit board and that each pin extends completely into the holes on the circuit board. Not being careful here will cause the board to either wobble and/or be crooked when plugged onto the mother board. It is suggested that you solder only the two end pins of each of the five connectors until all have been installed; at which time, if everything looks straight and rigid, you should solder the, as yet, unsoldered pins.

( ) Insert the small nylon indexing plug into the edge connector pin indicated by the small triangular arrow on the "BOTTOM" side of the circuit board. This prevents the board from being accidentally plugged onto the mother board incorrectly.

( ) Install integrated circuits IC5 thru IC7, IC9 thru IC13, IC15 thru IC21 and IC23. As each one is installed, make sure it is down firmly against the board and solder only two of the leads to hold the IC in place while the other IC's are being inserted. Be very careful to install each in its correct position. **Do not** bend the leads on the back side of the board. Doing so makes it very difficult to remove the integrated circuits should replacement ever be necessary. The semicircle notch or dot on the end of the package is used for orientation purposes and must match with the outlines shown on the component layout drawing for each of the IC's. After inserting all of the integrated circuits go back and solder each of the as yet unsoldered pins.

( ) Cut off the **center** pin on integrated circuit IC22.

( ) Install integrated circuit IC22 on the circuit board. This component must be oriented so its metal face is facing the circuit board with the small metal heatsink sandwiched between the two. The heatsink and IC are secured to the circuit board with a 4-40 x 3/8" screw, lockwasher and nut. The leads of the integrated circuit must be bent down into each of their respective holes and trimmed, and the heatsink must be oriented as shown in the component layout drawing. Solder.

( ) Attach the seven integrated circuit sockets to the board in the IC1 thru IC4, IC8, IC14 and IC24 positions only. The 40-pin socket goes in the IC14 position while the 24-pin sockets are used for IC1 thru IC4 and IC24. A 16-pin socket goes in the IC8 position. Turn each socket so the corner having the indexing tab is adjacent the pin indicated by the "dot" within the integrated circuit outline on the component layout drawing. Solder.

( ) Attach DIP switch S1 to the circuit board. The switch must be mounted so the switches are ON when flipped toward the top edge of the circuit board. Solder.

( ) Insert the eight 3-pin programming strips into the positions indicated on the component layout drawing. The strips must be installed from the top side of the board with the short pined side of the blocks soldered into the board. Solder. Programming blocks will be plugged onto these strips as outlined later in this instruction set.

( ) Orient and insert the 4-pin right angle male connector along the top edge of the board as shown in the component layout drawing. Some units may be shipped with a 5-pin connector instead of the required 4-pin. If so, remove the center pin by pulling it out with a pair of pliers. Solder.

( ) Working from the "TOP" side of the circuit board, fill in all of the feed-thru's with molten solder. The feed-thru's are those unused holes on the board whose internal plating connects the "TOP" and "BOTTOM" circuit connections. Filling these feed-thru's with molten solder guarantees the integrity of the connections and increases the current handling capability.

NOTE: MOS integrated circuits are susceptable to damage by static electricity. Although some degree of protection is provided internally within the integrated circuits, their cost demands the utmost in care. Before opening and/or installing any MOS integrated circuits you should ground your body and all metallic tools coming into contact with the leads, thru a 1M Ω ¼ watt resistor (supplied with the kit). The ground must be an "earth" ground such as a water pipe, and not the circuit board ground. As for the connection to your body, attach a clip lead to your watch or metal ID bracelet. Make absolutely sure you have the 1 Meg Ω resistor connected between you and the "earth" ground, otherwise you will be creating a dangerous shock hazard. Avoid touching the leads of the integrated circuits any more than necessary when installing them, even if you are grounded. Static electricity should be an important consideration in cold, dry environments, it is less of a problem when it is warm and humid.

( ) Install **MOS** integrated circuits IC4, IC14 and IC24 following the precautions given in the preceding section. As each is installed, make sure it is down firmly into the socket. Be very careful to install each in its correct position. The "dot" on the end of the package is used for orientation purposes and **must** match with that shown on the component layout drawing for each of the IC's. IC4 is the 24-pin IC supplied with the kit that will function as the system's monitor. Do not get it confused with the other 24-pin IC, the 14411.

( ) Now that most of the components have been installed on the board, double check to make sure all have been installed correctly in their proper location.

( ) Check very carefully to make sure that all connections have been soldered. It is very easy to miss some connections when soldering which can really cause some hard to find problems later during check out. Also, look for solder "bridges" and "cold" solder joints which are another common problem.

This completes the assembly phase for the MP-09 board. The System Checkout instructions are used after having assembled the MP-09 Microprocessor/System Board, MP-B2 Mother Board, MP-S Serial Interface, and the MP-P2 Power Supply.

Since the MP-09 Circuit Board now contains MOS devices it is susceptable to damage from severe static electrical sources. One should avoid handling the board any more than necessary and when you must, avoid touching or allowing anything to come into contact with any of the conductors on the board.

Reset Cable Assembly

The MP-09 processor board requires that a separate cable be run from the top edge of the processor card to the RESET button on the front panel of the chassis. This cable attaches to the RESET button in place of the cable connected from the MP-B or MP-B2 mother board. Construct the cable as follows:

( ) Twist together two 15" pieces of heavy gauge insulated wire for their entire length.

( ) Attach the two large spaded lug connectors to each wire on one end of the cable.

( ) Attach the two small connector pins to each wire on the other end of the cable. After these pins have been attached, slide each into the two position nylon connector shell. Polarity is not important. This completes the Reset Cable assembly.

How It Works

The entire Computer System is built around IC14, the 6809 Microprocessor Unit (MPU). Most of the components within the system are used to provide the clocks, buffering and decoding necessary to interface to this integrated circuit.

Integrated circuit IC4 is a 2048 x 8 bit read only memory (ROM). Whenever the computer system is first powered up or when the front panel RESET switch is depressed the computer jumps to this operating system firmware (programming stored in ROM) which gives the user terminal control.

IC24 is the crystal controlled clock/baud rate generator. It produces the baud rate clock frequencies required by the control and serial interfaces. IC23 provides the buffering for each of the used outputs on baud rate generator IC24.

Integrated circuit IC18 is responsible for generating the power-up RESET which loads the mini-operating system stored in the ROM. IC9 generates a NMI (non-maskable interrupt).

Integrated circuits IC12 and IC13 are used as non-inverting address line buffers for each of the sixteen address lines. Integrated circuit IC19 is an inverting bi-directional transceiver buffer for the system's eight bi-directional data lines. The gates feeding the enable lines of the transceiver IC's guarantee the appropriate receive or transmit data bus buffers are enabled at the proper time.

Address translation for address lines A12 thru A15 is handled by write only memory IC11.

+5 VDC power for the board is supplied by voltage regulator IC22.

Configuring the MP-09 Processor Board to replace a 6800 processor board

The MP-09 processor board has one four-position DIP switch and eight two-position programming strips that must be configured before the board is plugged into the computer system.

The four switches on DIP switch S1 are described as follows from left to right:

LOW BAUD:	Leaving the switch ON generates low interface baud rates of 110, 150, or 9600, 300, 600 or 4800, and 1200 baud. Flipping the switch OFF generates interface high baud rates of 440, 600, or 38400, 1200, 2400 or 19200 and 4800 baud. These higher baud rate clocks are carried respectively on the same baud rate lines. **This switch should normally be ON which is the LOW BAUD mode.**
EØØØ-E7FF ROM/RAM SELECT (IC1)	Flipping this switch ON activates the IC1 ROM/RAM socket on the processor board. The socket is intended for dedicated controller applications. Since the physical address of the component conflicts with that of the interface addresses **the switch must be flipped OFF.** The component plugged into the socket may be any 5V 2716 compatible EPROM, PROM, ROM or RAM.
E8ØØ-EFFF ROM/RAM SELECT (IC2)	Flipping this switch ON activates the IC2 ROM/RAM socket on the processor board. The socket is intended for dedicated controller applications. Since the physical address of the component may conflict with that of the interface addresses **the switch should be flipped OFF.** The component plugged into the socket may be any 5V 2716 compatible EPROM, PROM, ROM or RAM.
FØØØ-F7FF ROM/RAM SELECT (IC3)	Flipping this switch ON activates the IC3 ROM/RAM socket on the processor board. The socket is intended for dedicated controller applications. Since the physical address of the component conflict with that of the DMA controller address assignment **the switch must be flipped OFF.** The component plugged into the socket may be any 5V 2716 compatible EPROM, PROM, ROM or RAM.

There are eight two-position programming strips on the MP-09 board. The specified function for each programming strip is selected by plugging the shorting block between the center pin of the strip and the pin adjacent the noted function. The functions for most of the programming strip pins are noted on the TOP side of the board adjacent the appropriate pins.

150b/9600b	This option causes the MP-09 to generate either a 150 or 9600 baud clock on the 50-pin bus line marked 150b (S3) when the LOW BAUD switch is ON on switch S1. When the LOW BAUD switch is OFF these become 600 and 38,400 baud clocks respectively.
4800b/600b	This option causes the MP-09 to generate either a 4800 or 600 baud clock on the 50-pin bus line marked 600b (S1) when the LOW BAUD switch is ON on switch S1. When the LOW BAUD switch is OFF these become 19,200 and 2400 baud clocks respectively.
110b/BR	The option selects either the baud rate or bus request function on the MP-09 board. For now it is suggested that you set this option for the 110b function. This will cause the MP-09 board to generate a 110 baud clock when the LOW BAUD switch is ON on switch S1. When the LOW BAUD switch is OFF this becomes a 440 baud clock. With the jumper in the BR position the 110b line will become the Bus Request line.
2S/3S	The **3S** option provides the ability to float the drivers driving the baud rate lines when the MP-09 board is halted. It is an option reserved for future use and should not be selected. **Install the jumper in the 2S position.**

BA/BA &BS	This option gives the MP-09 board the ability to float the address and data bus when both BA and BS are high or just when BA is high. **Install the jumper in the BA & BS position.**
RAM/ROM for IC3	This option gives the ability to use either a 2716 pinout RAM or ROM for IC3. The position of the jumper is not important.
RAM/ROM for IC2	This option gives the ability to use either a 2716 pinout RAM or ROM for IC2. The position of the jumper is not important.
RAM/ROM for IC1	This option gives the ability to use either a 2716 pinout RAM or ROM for IC1. The position of the jumper is not important.

Parts List — MP-09 Processor Board

Integrated Circuits

——	*IC1	2516 pin compatible ROM or RAM
——	*IC2	" " " " " "
——	*IC3	" " " " " "
——	*IC4	" " " " " "
——	*IC5	74LS30 8 input NAND gate
——	*IC6	74LS02 quad NOR gate
——	*IC7	74LS138 1 of 8 decoder
——	*IC8†	74LS189 RAM memory
——	*IC9	555 timer
——	*IC10	74LS157 data selector
——	*IC11	74LS189 RAM memory
——	*IC12	74LS244 octal buffer
——	*IC13	74LS244 octal buffer
——	*IC14	6809 processor
——	*IC15	74LS74 dual flip flop
——	*IC16	74LS21 dual AND gate
——	*IC17	74LS86 exclusive OR gate
——	*IC18	555 timer
——	*IC19	74LS640 octal inverting transceiver
——	*IC20	74LS241 octal buffer
——	*IC21	74LS00 quad NAND gate
——	*IC22	7805 voltage regulator
——	*IC23	74LS240 octal inverting buffer
——	*IC24†	14411 baud rate generator

† Either IC8 or IC24 may be installed. Both may not be used simultaneously. Use the one supplied with your board.

Resistors

——	R1	10K	ohm ¼ watt resistor
——	R2	10K	" " " "
——	R3	470	" " " "
——	R4	10K	" " " "
——	R5	10K	" " " "
——	R6	10K	" " " "
——	R7	1K	" " " "
——	R8	1M	" " " "
——	R9	1K	" " " "
——	R10	1K	" " " "
——	R11	10K	ohm ¼ watt resistor
——	R12	10K	" " " "
——	R13	1K	" " " "
——	R14	1K	" " " "
——	R15	1M	" " " "
——	R16	1M	" " " "
——	R17	1M	" " " "
——	R18	10K	" " " "
——	R19	10K	" " " "
——	R20	1K	" " " "

Capacitors

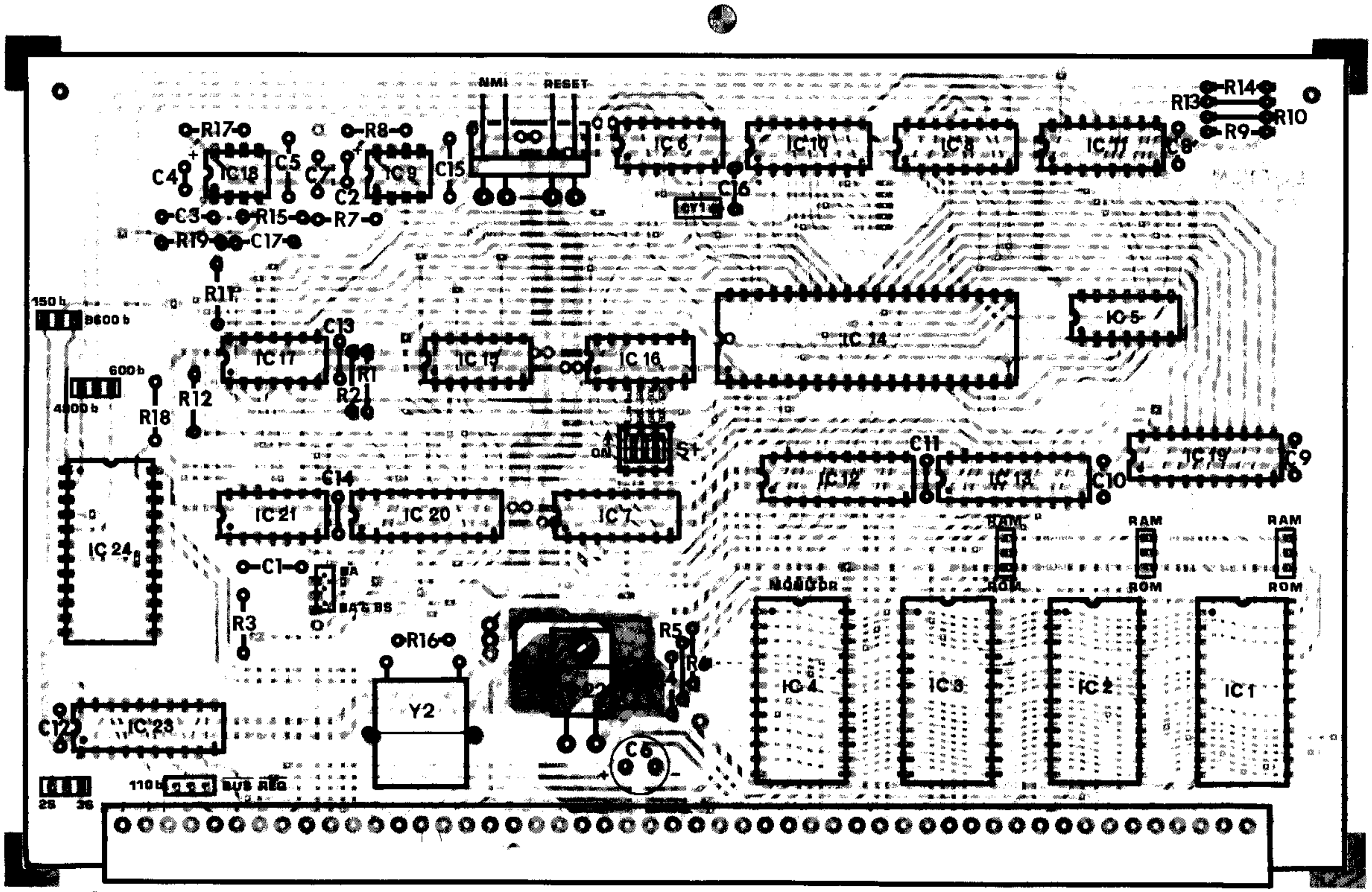
——	C1	100 pfd capacitor
——	*C2	0.47 mfd tantalum capacitor
——	C3	0.1 mfd film capacitor
——	*C4	0.47 mfd tantalum capacitor
——	C5	0.01 mfd capacitor
——	*C6	220 mfd @ 10 VDC electrolytic capacitor
——	C7	0.1 mfd capacitor
——	C8	0.1 " "
——	C9	0.1 mfd capacitor
——	C10	0.1 " "
——	C11	0.1 " "
——	C12	0.1 " "
——	C13	0.1 " "
——	C14	0.1 " "
——	C15	0.01 " "
——	C16	20 pfd capacitor
——	C17	220 pfd capacitor

Miscellaneous

——	Y1	4.0 or 8.0 MHz crystal
——	Y2	1.8432 MHz crystal
——	*S1	4-position DIP switch

*All components flagged with a * must be oriented as shown in the component layout drawing.

† A 4.0 MHz crystal is used for 1 MHz system operation and a 8.0 MHz crystal is used for 2 MHz operation.



MP-09 PROCESSOR BOARD

Dynamic Address Translator (DAT)

The MP-09 processor board contains an on board Dynamic Address Translator (DAT) that changes (or translates) the addresses output on the upper four address lines by the 6809 processor before these addresses are output onto the system bus. This scheme effectively breaks the system's 64K address space into sixteen 4K segments starting from location ØØØØ. Each memory location within these 4K segments has associated with it a physical and logical address. The physical address is the physical or electrical location of the address within the system's 64K address space. It is the address output onto the 50-pin bus. For example, an 8K memory board jumper programmed for the lower 8K of memory physically resides from ØØØØ - 1FFF (Ø - 8K) and thus has this physical address. The interfaces of an unmodified MP-B or MP-B2 mother board have a physical address starting at 8ØØØ (32K).

The logical address is the unmodified address that must be output by the processor to access these translated physical addresses. The earlier MP-A and MP-A2 boards did not have an address translator and their physical and logical addresses were the same. With the address translator on the MP-09 board a physical address in memory may have from Ø to 16 logical addresses depending upon the configuration of the address translator. To better understand this, refer to the figure 1. As you can see from figure 1, the address translator can be envisioned as a translation table between logical and physical addresses in 4K segments. When you are writing machine language programs for your MP-09 processor all instruction addresses will be to logical addresses. You must know the state of the address translator to determine physical addresses.

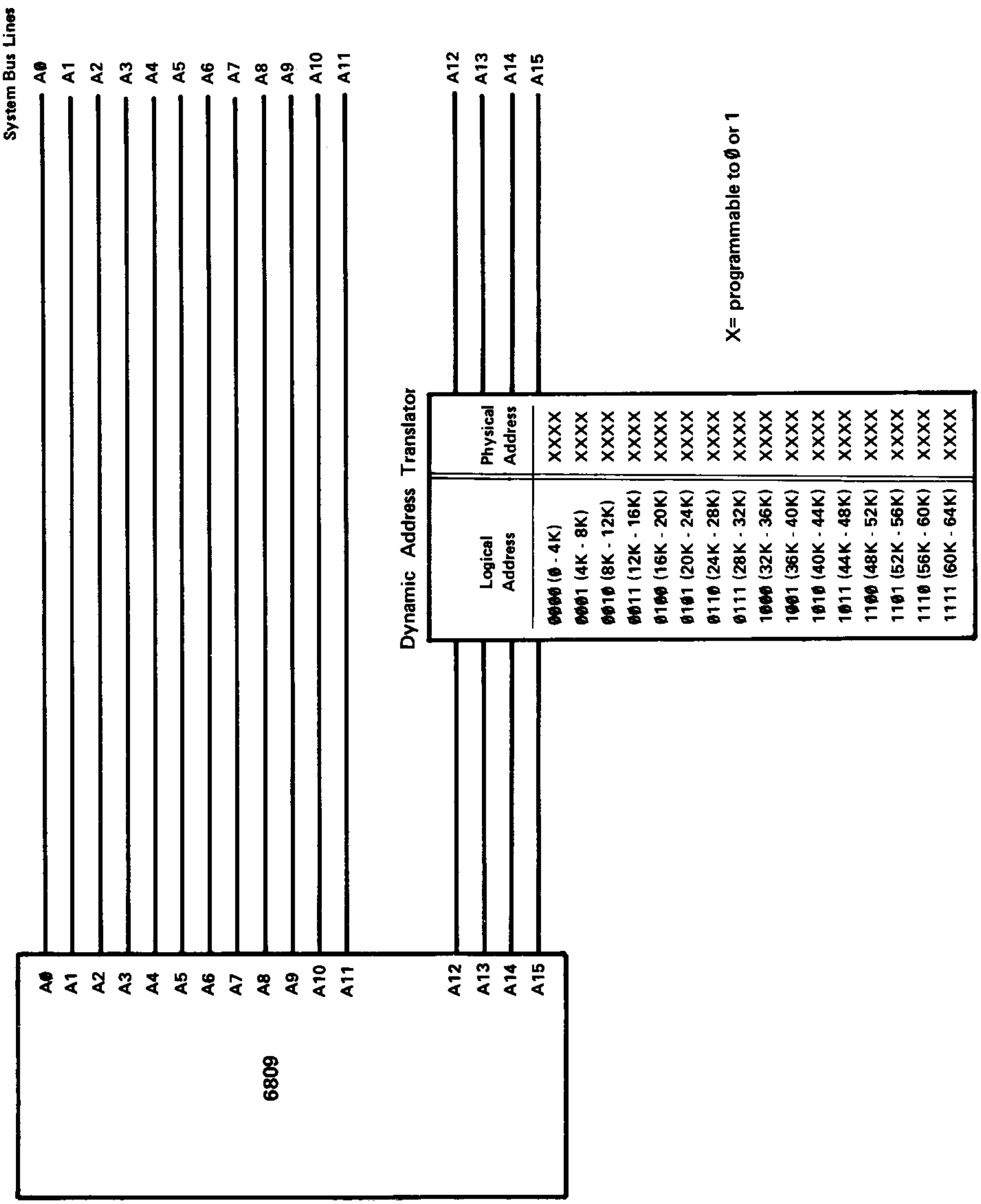
Electrically the address translator is a 4-bit wide, 16-position high speed random access memory. It is physically and logically addressed in the upper 16 bytes of memory (FFFØ - FFFF) as write only memory. It is loaded by writing the complement of the desired upper four bits of the physical address using the lower 4 bits of the data byte to the memory location corresponding to the selected logical address. The 4K logical address segments start sequentially from FFFØ. As an example, we can create an unmodified modifier where physical and logical address are the same by writing the following to memory:

memory location	logical address	data	physical address
FFFØ	ØØØØ - ØFFF	ØF	ØØØØ - ØFFF
FFF1	1ØØØ - 1FFF	ØE	1ØØØ - 1FFF
FFF2	2ØØØ - 2FFF	ØD	2ØØØ - 2FFF
FFF3	3ØØØ - 3FFF	ØC	3ØØØ - 3FFF
FFF4	4ØØØ - 4FFF	ØB	4ØØØ - 4FFF
FFF5	5ØØØ - 5FFF	ØA	5ØØØ - 5FFF
FFF6	6ØØØ - 6FFF	Ø9	6ØØØ - 6FFF
FFF7	7ØØØ - 7FFF	Ø8	7ØØØ - 7FFF
FFF8	8ØØØ - 8FFF	Ø7	8ØØØ - 8FFF
FFF9	9ØØØ - 9FFF	Ø6	9ØØØ - 9FFF
FFFA	AØØØ - AFFF	Ø5	AØØØ - AFFF
FFFB	BØØØ - BFFF	Ø4	BØØØ - BFFF
FFFC	CØØØ - CFFF	Ø3	CØØØ - CFFF
FFFD	DØØØ - DFFF	Ø2	DØØØ - DFFF
FFFE	EØØØ - EFFF	Ø1	EØØØ - EFFF
FFFF	FØØØ - FFFF	ØØ	FØØØ - FFFF

We can move a physical address segment of 1ØØØ - 1FFF (4K - 8K) to logical address of ØØØØ ØFFF (ØK - 4K) by writing a ØE to address location FFFØ. Take note however that the same physical address segment is also at a logical address of 1ØØØ - 1FFF (4K - 8K) as well since we have not changed that part of the address translator.

Although all of this circuitry may seem complicated and unnecessary, it is an integral part of a system designed for multitasking and multiuser environments. It is a feature rarely found in inexpensive computers but seemed fitting for a system with the computing power of the Motorola 6809 microprocessor. It is not necessary that the user understand how to operate the address translator but is advisable that the user know that it exists and to understand the meaning of logical and physical addresses.

FIGURE 1


System Bus Lines
AØ A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11
A12 A13 A14 A15
X= programmable to Ø or 1
Dynamic Address Translator
Logical Address
Physical Address
ØØØØ (Ø - 4K) XXXX
ØØØ1 (4K - 8K) XXXX
ØØ1Ø (8K - 12K) XXXX
ØØ11 (12K - 16K) XXXX
Ø1ØØ (16K - 20K) XXXX
Ø1Ø1 (20K - 24K) XXXX
Ø11Ø (24K - 28K) XXXX
Ø111 (28K - 32K) XXXX
1ØØØ (32K - 36K) XXXX
1ØØ1 (36K - 40K) XXXX
1Ø1Ø (40K - 44K) XXXX
1Ø11 (44K - 48K) XXXX
11ØØ (48K - 52K) XXXX
11Ø1 (52K - 56K) XXXX
111Ø (56K - 60K) XXXX
1111 (60K - 64K) XXXX
A12 A13 A14 A15
AØ A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11
A12 A13 A14 A15
6809

Memory Map for the MP-09

In order to expand the RAM memory capacity from the SWTPC 6800 computer system's 40L limit to 56K for the MP-09 processor, it will be necessary to modify the MP-B or MP-B2 mother board and (where applicable) the DMAF-1 disk controller board so they are decoded above 56K in the system's physical memory map. Take note that by doing this the system becomes incompatible with the original MP-A and MP-A2 6800 processor boards using the MIKBUG , SWTBUG and DISBUG monitors. **This modification is required regardless of the amount of memory installed in the system.**

The mother board modification relocates the I/O addresses from the original 8ØØØ - 8FFF (32K - 36K) assignment to EØØØ -EFFF (56K - 60K). The DMAF-1 modification moves the board from the 9ØØØ -93FF (36K - 37K) assignment to FØØØ - F3FF (60K - 61K). Since the ROM sockets on the MP-09 processor board are also physically decoded from EØØØ - FFFF (56K - 64K), only the upper 2K ROM socket (IC4) may be used. IC4 is reserved for the system monitor and is addressed from F8ØØ - FFFF (62K - 64K).

This configuration leaves 56K of address space available for user RAM memory. A minimum system configuration when using either the MF-68 or DMAF-1 disk systems would be 8K of memory just to boot the system. Loading and running Basic or other utilities would of course require more memory. A minimum system configuration without a disk would be 4K of RAM memory. The actual physical location of the memory within the system is not important since the monitor locates and logically readdresses all RAM memory plugged into the system. The user must make sure, however, that there are no memory boards within the system residing in the same physical address. With a minimum 4K system, the 4K of memory will be mapped so that it is logically addressed from DØØØ - DFFF. With 8K of RAM memory, the memory will be sequentially mapped so it is logically addressed from CØØØ - DFFF. Any additional memory will reside from DEØØ - DFFF. The DOS, if resident, will reside from CØØØ - DBFF. The monitor loads the system stack pointer with DFFF, and sets the direct page register to zero.

PC Board Modifications for the MP-09

If you have received the MP-09 board as part of an assembled computer system from Southwest Technical Products Corp., all of the computer system boards probably have been modified for compatibility with the MP-09. If you are using the MP-09 processor board to replace the MP-A or MP-A2 processor boards in an existing system or kit, it will be necessary to patch several of the comptuer system boards for compatibility with the MP-09.

MP-B2 Mother Board Modification for I/O decoding at EØØØ -EFFF

The MP-B2 mother board presently decodes all I/O interfaces from 8ØØØ - 8FFF (32K - 36K). To change the MP-B2 (not MP-B) board so the interfaces are decoded from EØØØ - EFFF, unplug the system and remove the mother board from the chassis.

1) Cut the PC trace on the bottom side of the board that goes to pin 15 of IC6. Cut the trace right next to IC6.
2) Attach and solder an insulated jumper between IC5 pin 12 (a pad is provided) and IC6 pin 9. Run this jumper on the bottom side of the board.
3) Remove the wire going to the $\overline{\text{MRST}}$ pin on the MP-B2.
4) Cut the wire (with the spade connector) loose from the 12-pin Molex connector pin 9 right at the Molex connector.
5) Cut loose the two wires from the UD1 and UD2 lines on the mother board and also the other end of these wires from the 12-pin Molex connector. This completes the MP-B2 modification. When you reinstall the board be sure to reconnect the connector going to the MP-P power supply.

MP-B Mother Board Modification for I/O decoding at E000 - EFFF

If your computer system has a MP-B (not MP-B2) mother board, power down the system, unplug the connector going to the power supply board and remove the board. Make the following modifications.

1) Cut the foil conductor connecting pin 10 to pin 12 of IC4, the 7400 NAND gate, on the "BOTTOM" side of the mother board.
2) Attach and solder an insulated jumper between pin 11 of IC4 (7400 NAND gate) to pin 6 of IC6 (74LS138 decoder) on the "BOTTOM" side of the board.
3) Attach and solder a separate insulated jumper between pin 12 of IC4 (7400 NAND gate) and address line A12 on the "BOTTOM" side of the board.
4) Cut the PC trace connecting to IC6 pin 11 on the "BOTTOM" side of the board. Cut the trace right at IC6.
5) Attach and solder an insualted jumper between IC5 pin 6 and IC6 pin 7 on the "BOTTOM" side of the board.
6) Tape the three jumper wires to the "BOTTOM" side of the board so they do not break off or get pinched.
7) Remove the wire going to the $\overline{\text{M.RST}}$ pin on the MP-B.
8) Cut the wire (with the spade connector) loose from the 12-pin Molex connector pin 9 right at the Molex connector.
9) Cut loose the two wires from the UD1 and UD2 lines on the mother board and also the other end of these wires from the 12-pin Molex connector.
10) Re-install the mother board and reconnect the connector going to the MP-P power supply board.

Chassis Reset Switch Rewiring

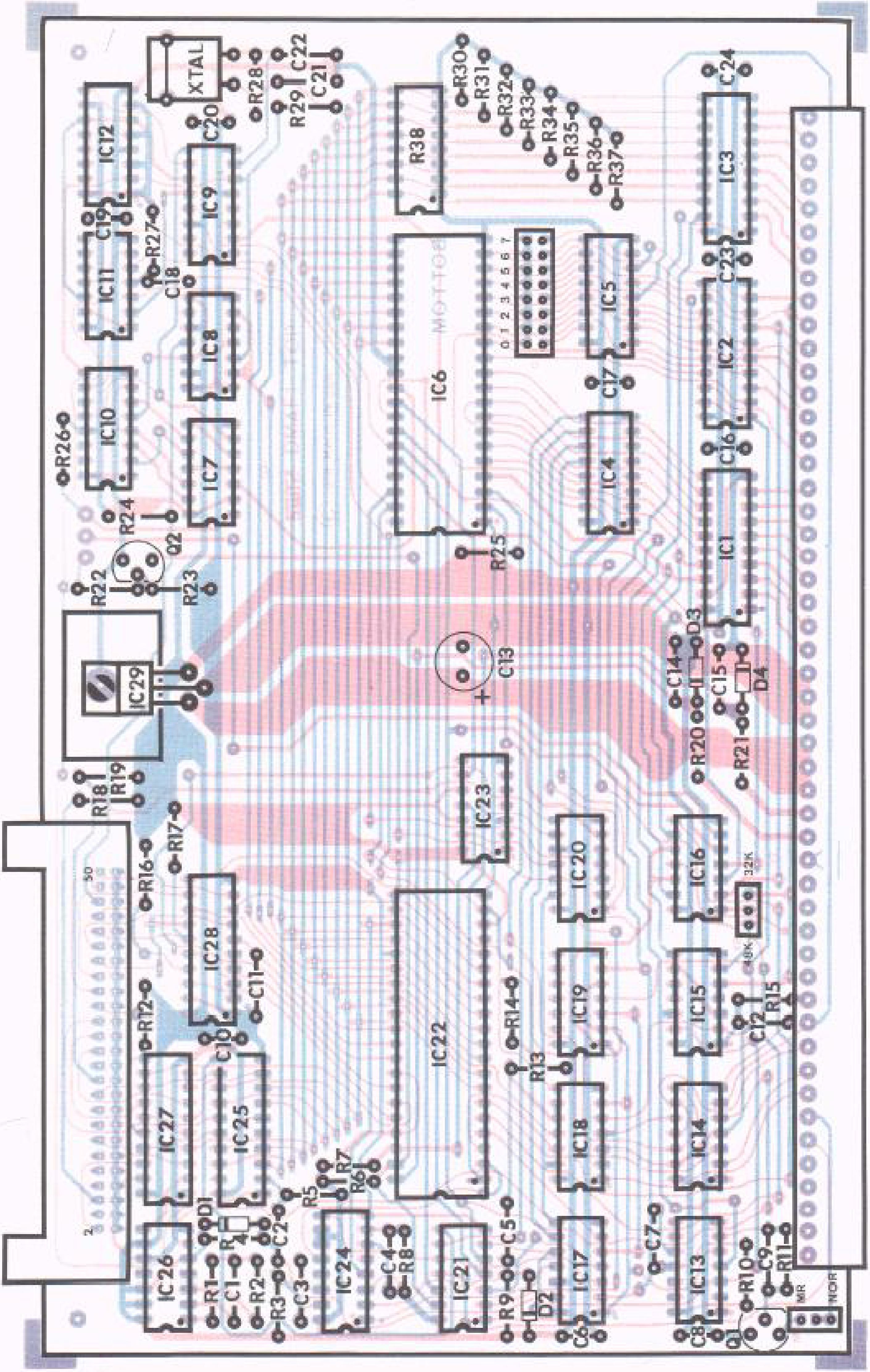
The MP-09 processor card does not use the M.RST (manual reset) line carried on the 50-pin bus as do its MP-A and MP-A2 predecessors. This line has instead been renamed the Memory Ready (M.RDY) line. The MP-09 processor board has been designed so the front panel RESET button connects directly to the processor card. Depressing the RESET button as well as powering the system up generates a RESET sequence.

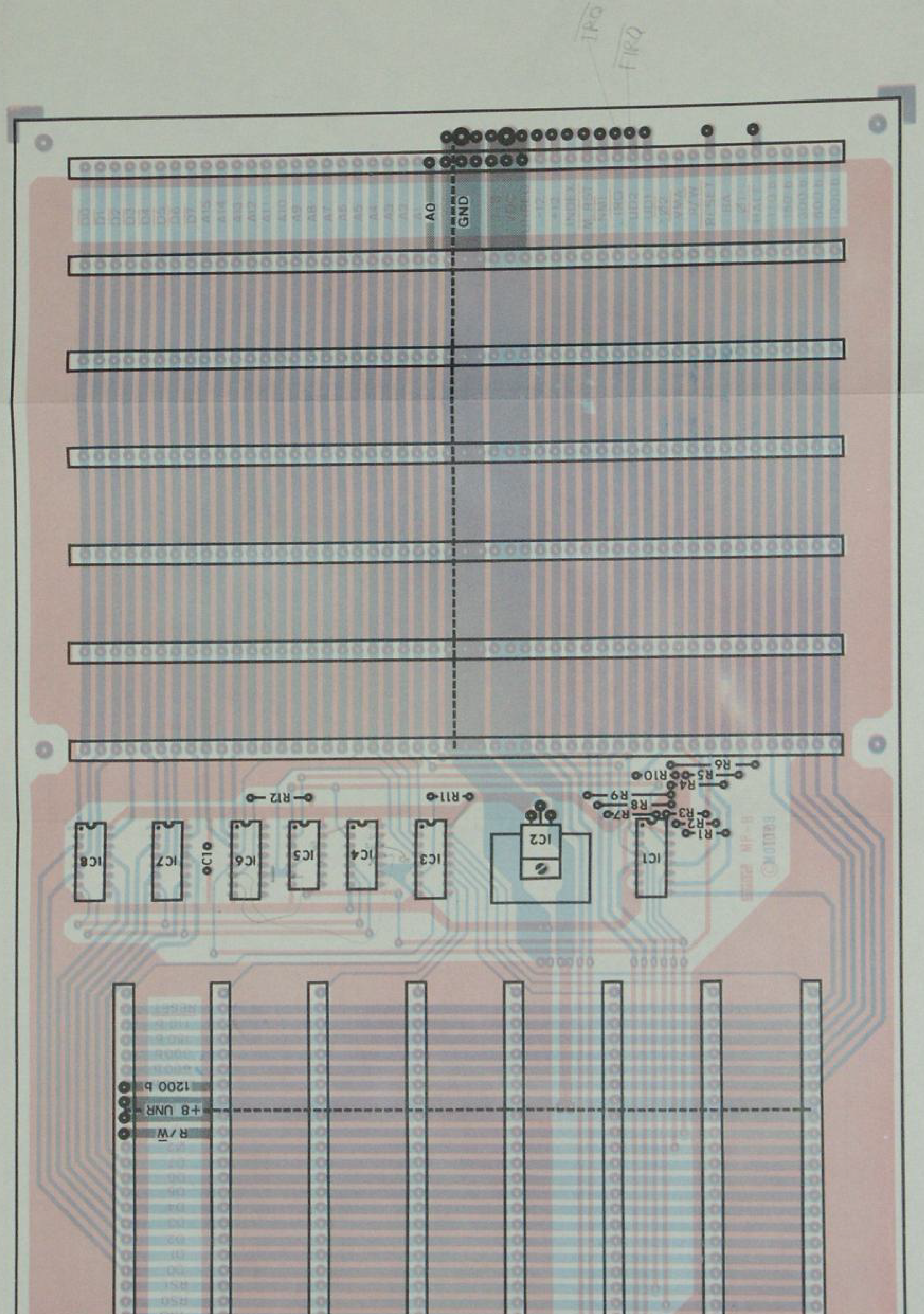
Attach the terminals of the RESET switch wire harness built earlier to the two RESET switch terminals. Polarity is not important. The other end of the wire harness will plug into the RESET connector terminal along the top edge of the MP-09 board after it is installed in the system.

DMAF1 Controller Board Modification for decoding at F000 - F3FF

The DMAF1 floppy disk controller board must be modified as follows to allow for address decoding at F000 - F3FF.

1) Cut the foil trace on the BOTTOM side of the board between IC15 pin 4 and 5.
2) Cut the foil trace on the TOP side of the board going to IC16 pin 2. Cut the trace right at IC16. Now from the BOTTOM side of the board attach and solder an insulated jumper wire to the trace that you just cut loose. A pad is provided just below IC16. Attach and solder the other end of the jumper wire to IC15 pin 4.
3) Attach and solder another insulated jumper from IC16 pin 2 to IC16 pin 7 on the BOTTOM side of the board.
4) Disregard the DMAF1 instructions for **Configuring the DMAF1 Disk for the SWTPC 6800 Computer System** and do as follows:
5) Plug one shorting block between the center pin and NOR terminal on the NOR/MR header.


XTAL
IC1
IC2
IC3
IC4
IC5
IC6
IC7
IC8
IC9
IC10
IC11
IC12
IC13
IC14
IC15
IC16
IC17
IC18
IC19
IC20
IC21
IC22
IC23
IC24
IC25
IC26
IC27
IC28
IC29
R38
C13
Q1
Q2
D1
D2
D3
D4
32K
48K
MR
NOR


A0
GND
IC1
IC2
IC3
IC4
IC5
IC6
IC7
IC8
C1
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
1200 b
+8 UNR
R/W

6) Plug another shorting block between the center pin and 48K terminal on the 32K/48K header.

7) Plug the remaining shorting block between the 4 and the pin immediately below it on the Ø1234567 header.

Memory Board Modifications

The Dynamic Address Translator on the MP-09 processor board is capable of logically relocating physical address space in its 64K byte memory capacity. This address translation is limited, however, to 4K byte segments. On power up the monitor checks selected memory locations in each of these 4K segments over the entire 64K address space. It then logically maps the available memory as described in an earlier section of this documentation. This feature essentially lets you physically address your memory boards anywhere from the ØØØØ - DFFF (0K - 56K) RAM address area with no need for contiguous memory. No two boards however may ever be jumper programmed to occupy the same physical address space. It is suggested however that you adhere to the following guidelines when configuring your memory boards:

1) Physically address your memory boards in order of decreasing size. Example, 32K boards in low physical memory followed by 16K boards, followed by 8K boards, followed by 4K boards.

2) Address the lowest order board to start at memory location ØØØØ.

3) Make the memory contiguous so there are no "holes" between the bottom and top of RAM memory.

4) Never install a 2K MP-M memory board in the system. Make sure all MP-M boards are fully expanded to 4K of memory.

Since the RAM address area is larger now, it is possible to have RAM memory above 8ØØØ (32K). Most of the SWTPC memory boards were not designed for operation above 8ØØØ (32K) but may be modified as follows. Instructions are given for the 4K MP-M, 8K MP-M, 16K MP-16 and 32K MP-32. These are the only memory boards supplied by SWTPC at the time of this writing.

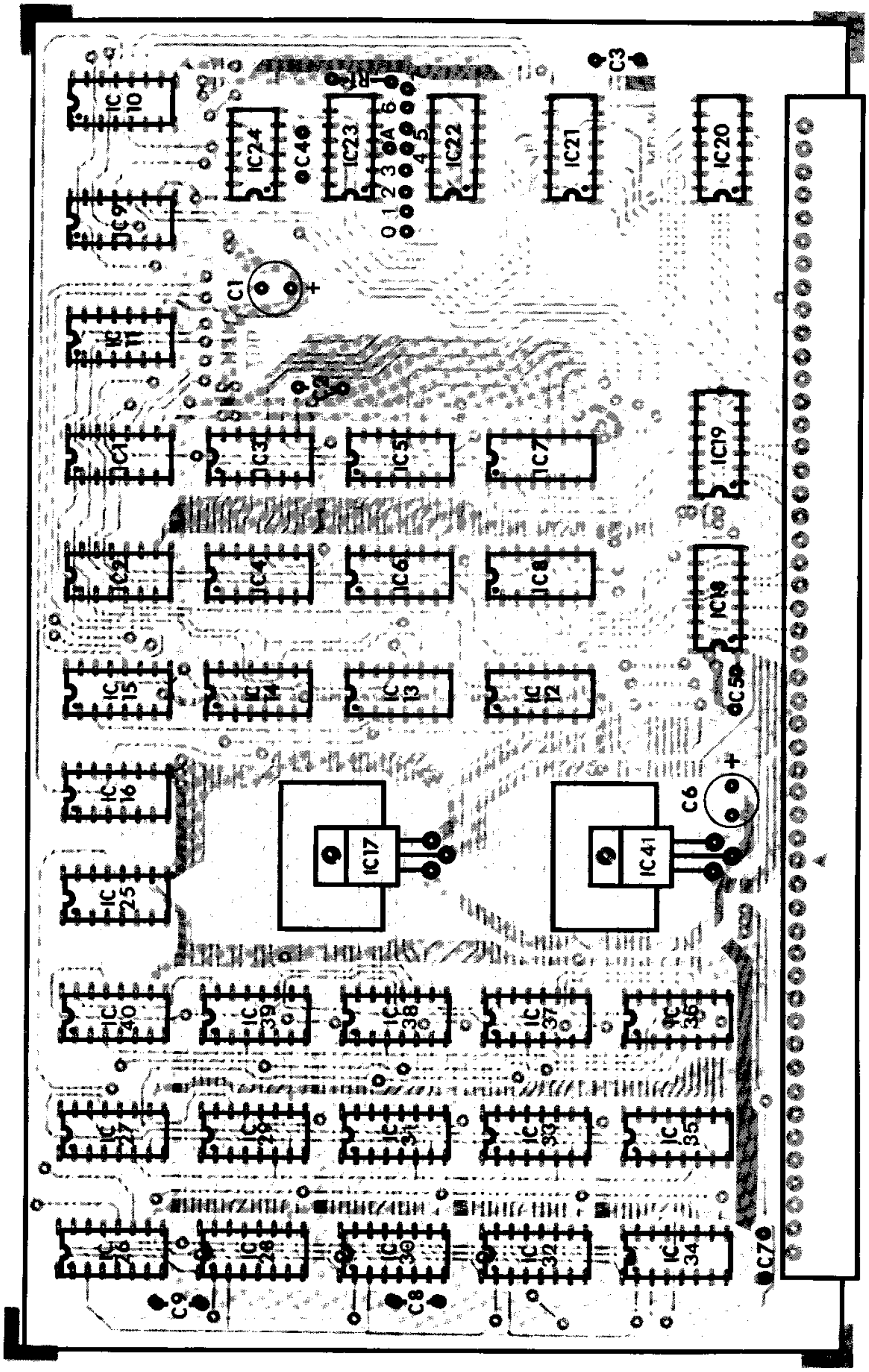
Modifying the 4K MP-M Memory Board for Operation above 32K

To modify the MP-M memory board for operation above 32K break the conductor foil between pin 6 of integrated circuit IC22 and pin 1 of IC24 as well as the conductor foil between pin 4 of IC22 and connector pin A15. Break the conductors near IC22 using a small screwdriver or knife to scribe a small line across the trace deep enough to break the conductive path. Using a piece of light gauge hookup wire connect pin 6 of IC22 to connector pin A15. Using a separate piece of hookup wire connect pin 4 of IC22 to pin 2 of IC24. Check your modifications and wiring for accuracy. This completes the modification. Use the table below to determine the proper position for the address select programming jumper which must be installed on the memory board.

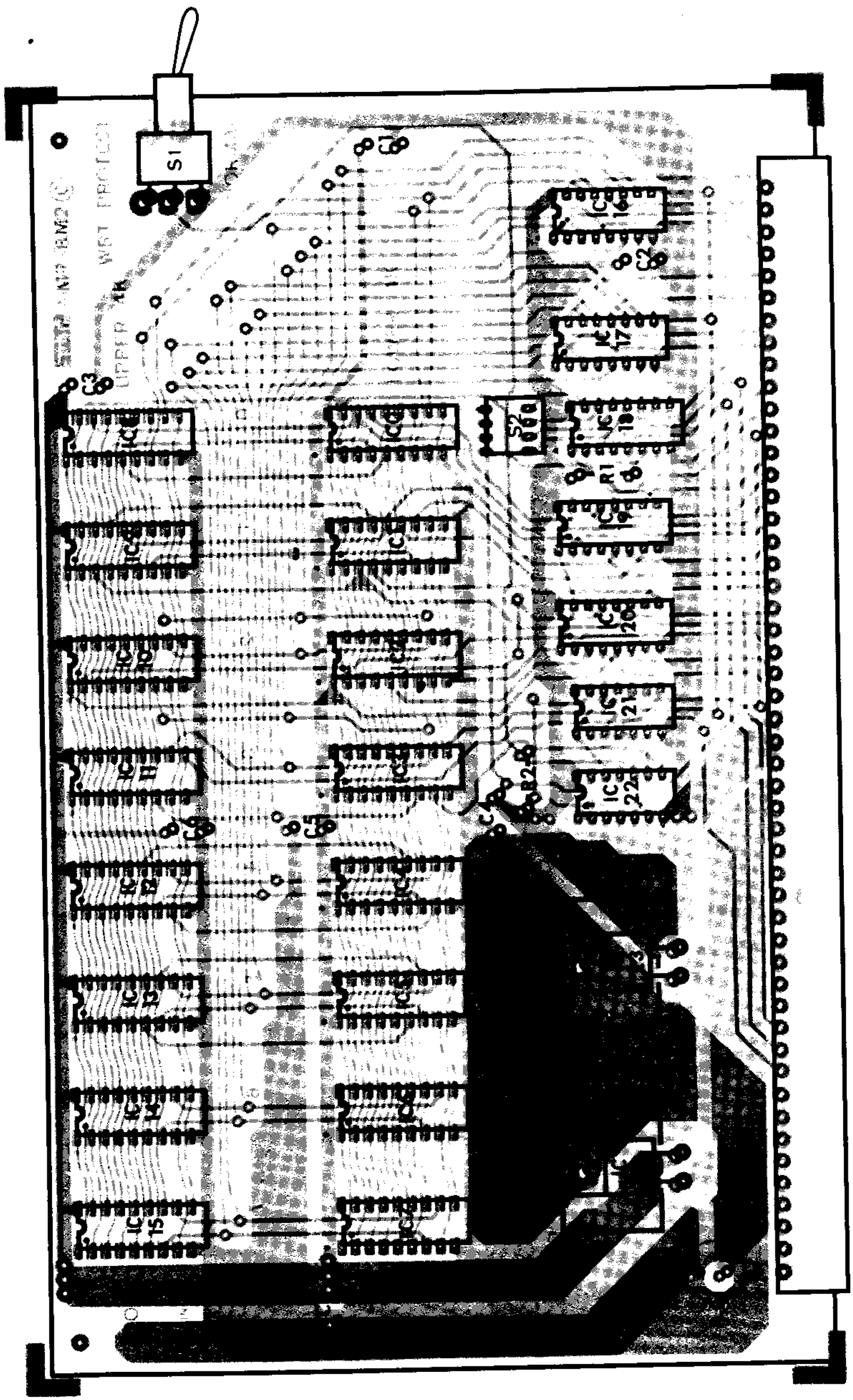
TABLE 1

MP-M Memory Address Assignment Table (Hex) above 32K

Board #	Memory Quandrant (K of memory)	Starting Address	Ending Address
	1	8000	83FF
	2	8400	87FF
0	3	8800	8BFF
	4	8C00	8FFF
	1	9000	93FF
	2	9400	97FF
1	3	9800	9BFF
	4	9C00	9FFF
	1	A000	A3FF
	2	A400	A7FF
2	3	A800	ABFF
	4	AC00	AFFF
	1	B000	B3FF
	2	B400	B7FF
3	3	B800	BBFF
	4	BC00	BFFF
	1	C000	C3FF
	2	C400	C7FF
4	3	C800	CBFF
	4	CC00	CFFF
	1	D000	D3FF
	2	D400	D7FF
5	3	D800	DBFF
	4	DC00	DFFF
	1	E000	E3FF
	2	E400	E7FF
6	3	E800	EBFF
	4	EC00	EFFF
	1	F000	F3FF
	2	F400	F7FF
7	3	F800	FBFF
	4	FC00	FFFF



IC10
IC9
IC11
IC1
IC2
IC15
IC16
IC25
IC40
IC27
IC26
IC24
IC3
IC4
IC14
IC39
IC28
IC23
IC5
IC6
IC13
IC38
IC31
IC30
IC22
IC7
IC8
IC12
IC37
IC33
IC32
IC21
IC19
IC18
IC36
IC35
IC34
IC20
IC17
IC41
C1
C2
C3
C4
C5
C6
C7
C8
C9
R1
0 1 2 3 A 4 5 6



MP–M/MP–MX Memory IC Assignment Map

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Quadrant 1 (1K)	IC15	IC13	IC11	IC9	IC7	IC5	IC3	IC1
Quadrant 2 (2K)	IC16	IC14	IC12	IC10	IC8	IC6	IC4	IC2
Quadrant 3 (3K)	IC40	IC38	IC36	IC34	IC32	IC30	IC28	IC26
Quadrant 4 (4K)	IC25	IC39	IC37	IC35	IC33	IC31	IC29	IC27

00 hex = 0000 0000 binary
01 hex = 0000 0001 binary
02 hex = 0000 0010 binary
04 hex = 0000 0100 binary
08 hex = 0000 1000 binary
10 hex = 0001 0000 binary
20 hex = 0010 0000 binary
40 hex = 0100 0000 binary
80 hex = 1000 0000 binary

Modifying the 8K MP-8M Memory Board for Operation above 32K

To modify the MP-8M memory board for operation above 32K first flip all of the address select slide switches on the memory board to their OFF position. For operation from 40K to 48K (8ØØØ to 9FFF) solder a piece of light gauge hookup wire from pin 1 of IC22 to pin 11 of IC18. For operation from 48K to 56K (CØØØ to DFFF) solder a piece of light gauge hookup wire from pin 1 of IC22 to pin 9 of IC 18. For operation from 56K to 64K (EØØØ - FFFF) solder a piece of light gauge hookup wire from pin 1 of IC22 to pin 7 of IC18. Only one of the three above mentioned jumpers may be installed at a time. Check your wiring for accuracy. This completes the modification. Table II gives the new memory assignments of each of the memory integrated circuits.

TABLE II
MP-8M Memory Address Assignment Table (Hex) above 32K

Board Select	Half of Memory	Starting Address	Ending Address
IC18 pin 11	lower	8000	8FFF
	upper	9000	9FFF
IC18 pin 10	lower	A000	AFFF
	upper	B000	BFFF
IC18 pin 9	lower	C000	CFFF
	upper	D000	DFFF
IC18 pin 7	lower	E000	EFFF
	upper	F000	FFFF

MP-8M Memory IC Assignment Table

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Lower 4K	IC7	IC6	IC5	IC4	IC3	IC2	IC1	IC0
Upper 4K	IC15	IC14	IC13	IC12	IC11	IC10	IC9	IC8

Hex to Binary Conversion

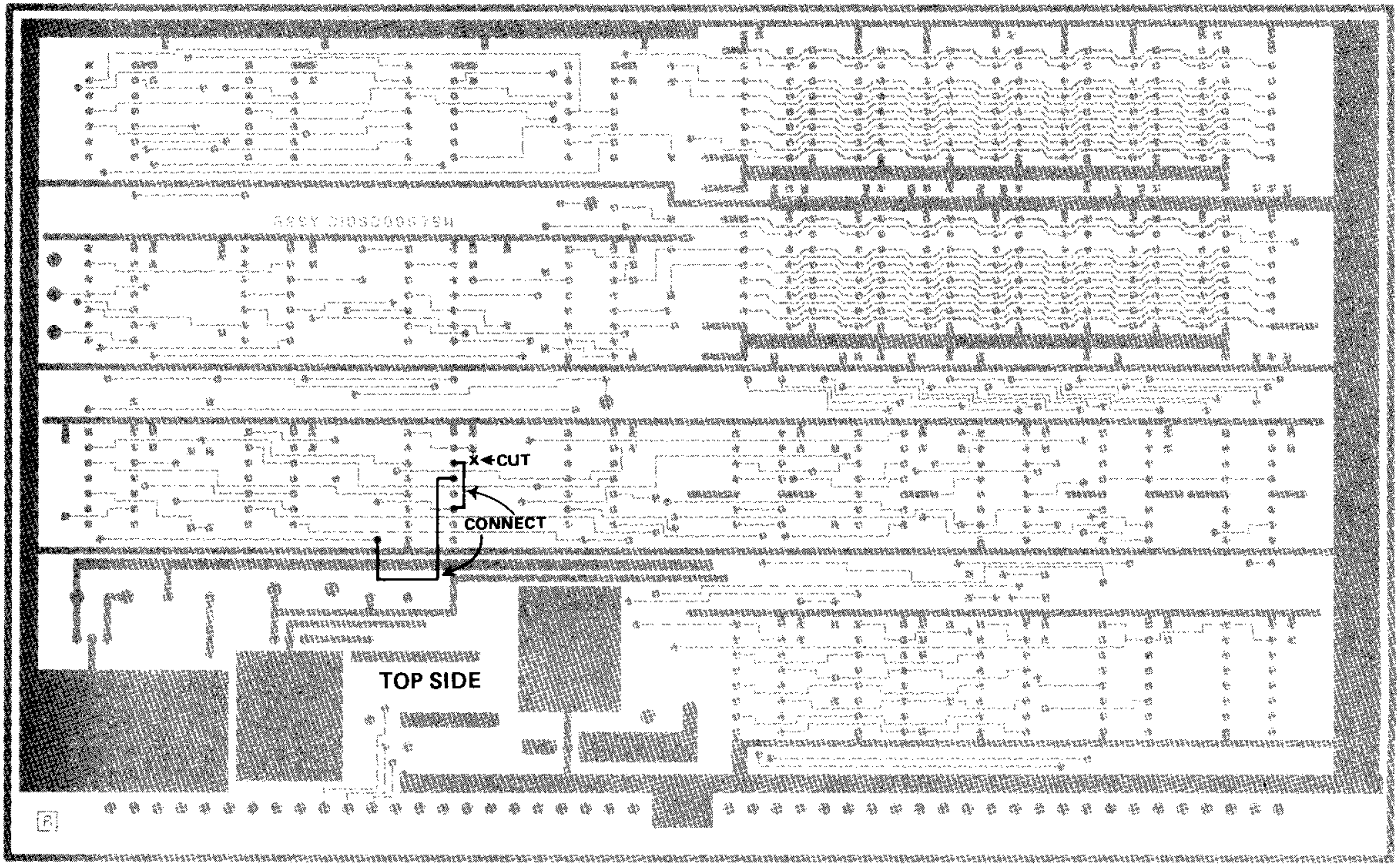
00 hex = 0000 0000 binary
01 hex = 0000 0001 binary
02 hex = 0000 0010 binary
04 hex = 0000 0100 binary
08 hex = 0000 1000 binary
10 hex = 0001 0000 binary
20 hex = 0010 0000 binary
40 hex = 0100 0000 binary
80 hex = 1000 0000 binary

Modifying the Motorola SM53508 16K/32K Dynamic Memory Board for operation above 32K

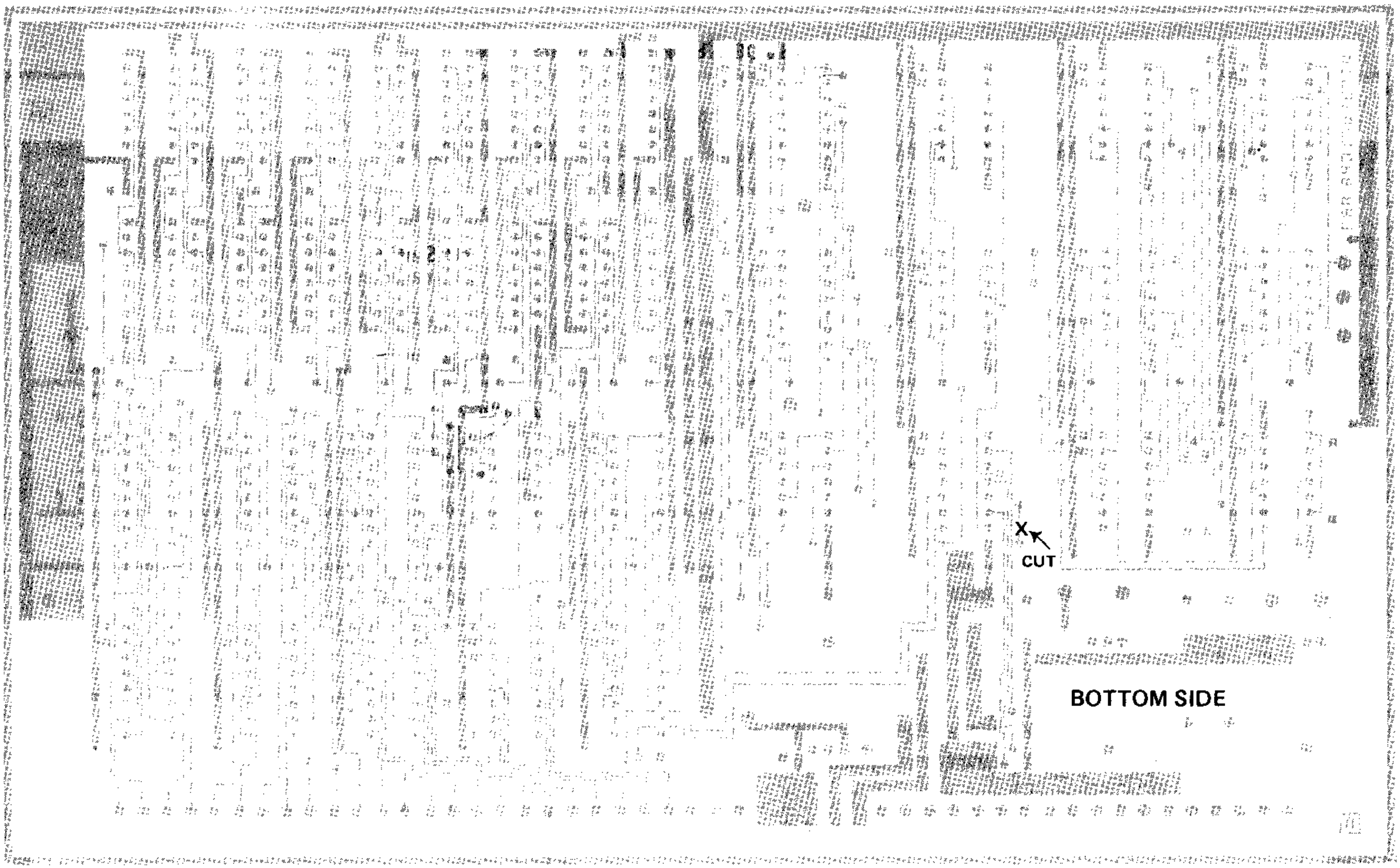
To modify the Motorola SM53508 board for operation above 32K, do the following using the attached drawing for references:

1) Cut the foil trace connecting U11 pin 14 to ground on the component side of the board.
2) Cut the foil trace connecting U11 pin 11 to U9 pin 4 on the bottom side of the board. Cut the trace right at U9 pin 4.
3) Attach and solder a light gauge insulated wire on the component side of the board between U11 pin 11 and U11 pin 14.
4) Attach and solder a light gauge insulated wire on the component side of the board between U11 pin 13 and U9 pin 4.
5) The E1 jumper should be installed and the E2 jumper removed.
6) Check your modifications for accuracy.

The memory board is now functional from 32K thru 48K. After making the above modifications only 16K of memory on the board will be used—the board may not be used as a 32K board above address 8ØØØ. After modification, the board will not operate below 32K.



MP-16/MP-32 MEMORY BOARD


CUT
BOTTOM SIDE

SS-50 C Bus Description

In order to take full advantage of the additional features available in the 6809 processor, the following changes have been made in the bus assignments. All SWTPC peripherals for 6809 systems will use the SS-50C specifications listed below.

50-PIN BUS ASSIGNMENTS

SS-50 6800 BUS	SS-50C 6800 BUS	SS-50 6800 BUS	SS-50C 6800 BUS
D̅Ø̅	D̅Ø̅	GND	GND
D̅1̅	D̅1̅	GND	GND
D̅2̅	D̅2̅	7-8 VDC UNR	7-8 VDC UNR
D̅3̅	D̅3̅	7-8 VDC UNR	7-8 VDC UNR
D̅4̅	D̅4̅	7-8 VDC UNR	7-8 VDC UNR
D̅5̅	D̅5̅	−12	−16
D̅6̅	D̅6̅	+12	+16
D̅7̅	D̅7̅	INDEX	INDEX
A15	A15	M̅.̅R̅S̅T̅	M. RDY
A14	A14	N̅M̅I̅	B̅U̅S̅Y̅
A13	A13	I̅R̅Q̅	I̅R̅Q̅
A12	A12	UD2	F̅I̅R̅Q̅
A11	A11	UD1	Q
A10	A10	Ø2	E
A9	A9	VMA	VMA
A8	A8	R/W̅	R/W̅
A7	A7	R̅E̅S̅E̅T̅	R̅E̅S̅E̅T̅
A6	A6	BA	BA
A5	A5	Ø1	BS
A4	A4	H̅A̅L̅T̅	H̅A̅L̅T̅
A3	A3	100b	B̅U̅S̅ ̅R̅E̅Q̅ or 110b
A2	A2	150b	S3 or 9600b
A1	A1	300b	S2 or 300b
AØ	AØ	600b	S1 or 4800b
GND	GND	1200b	SØ or 1200b

30-PIN BUS ASSIGNMENTS

SS-30 6800 BUS	SS-30C 6809 BUS	SS-30 6800 BUS	SS-30C 6809 BUS
UD3	RS2	D4	D4
UD4	RS3	D5	D5
−12	−16	D6	D6
+12	+16	D7	D7
GND	GND	Ø2	E
GND	GND	R/W̅	R/W̅
INDEX	INDEX	+8 VDC	+8 VDC
N̅M̅I̅	F̅I̅R̅Q̅	+8 VDC	+8 VDC
I̅R̅Q̅	I̅R̅Q̅	1200b	1200b
RSØ	RSØ	600b	4800b
RS1	RS1	300b	300b
DØ	DØ	150b	9600b
D1	D1	110b	110b
D2	D2	R̅E̅S̅E̅T̅	R̅E̅S̅E̅T̅
D3	D3	I̅/̅O̅ ̅S̅E̅L̅	I̅/̅O̅ ̅S̅E̅L̅

$\overline{DØ}$ - $\overline{D7}$	The $\overline{DØ}$ - $\overline{D7}$ lines carry inverted data bits Ø thru 7 respectively forming 8-bit data words which are exchanged between the various boards within the system.
A15 - AØ	The A15 - AØ lines carry address bits 15 thru Ø respectively forming 16-bit addresses which are exchanged between the various boards within the system.
GND	The GND line is the system's common power supply and signal ground point.
7-8 VDC UNREG or +8 UNR	The 7 - 8 VDC UNREG is the line to which a +7 to 8 volt DC unregulated power supply should be attached. This voltage is then regulated down to +5 VDC by independent regulators on the various boards within the system.
−16, +16	The −16 and +16 are lines to which an isolated ground −16 and +16 power supply should be connected. The voltages are necessary for generating the currents required by 20mA. current loop and RS-232 equipment on the serial interfaces and by dynamic memory boards.
INDEX	The INDEX is an unused line and is provided so the pin on each of the male connectors may be cut with the corresponding female connector pins plugged, preventing the circuit boards from being plugged on incorrectly.
M.RDY	MEMORY READY is the wire—OR control line on the bus that allows the processor to work with peripheral devices slower than the clock speed of the system. It works by stretching the $\overline{E}$ phase of the clock for up to 10 microseconds.
$\overline{BUSY}$	The $\overline{BUSY}$ line is a wire—OR line on the bus that goes low to deny external access to memory or peripherals during a 6809 READ/MODIFY/WRITE cycle.
$\overline{IRQ}$	The $\overline{IRQ}$ is the wire—OR maskable single level interrupt request line feeding the processor board.
$\overline{FIRQ}$	The $\overline{FIRQ}$ is the wire—OR maskable single level fast interrupt request line feeding the processor board.
$\overline{Q}$	The $\overline{Q}$ line is a new clock output line that leads $\overline{E}$- (formerly $\overline{Ø2}$) by approximately 90° in phase. Its high to low transitions indicates that the address output on the address bus is valid.
$\overline{E}$	The $\overline{E}$ is the clock line formerly known as $\overline{Ø2}$. Data is valid out of the processor during a write on the falling edge of $\overline{E}$ and is clocked into the processor during a read on the rising edge of $\overline{E}$.
$\overline{VMA}$	The $\overline{VMA}$ line is a normally high line that goes low when a valid processor address is output onto the bus.
R/$\overline{W}$	The READ/$\overline{WRITE}$ line establishes the direction of data flow on the eight data lines, $\overline{DØ\text{-}D7}$. It is high for a read from memory or interface and is low for a write to memory or interface.
$\overline{RESET}$	The $\overline{RESET}$ line when low resets the registers internal to the processor and interfaces, and loads the ROM stored mini-operating system. This line is activated by a one-shot when the system is first powered up.

BA	The BUS AVAILABLE line goes high acknowledging a processor halt, bus grant or sync.
BS	The BUS STATUS line goes high acknowledging a halt, bus grant or interrupt. This line along with the BA line may be used to determine the status of the processor. BA and BS are valid on the falling edge of Q.

BA	BS	
Ø	Ø	normal
Ø	1	interrupt acknowledge
1	Ø	sync acknowledge
1	1	halt acknowlege or bus grant

$\overline{\text{HALT}}$	The wire–OR $\overline{\text{HALT}}$ line when brought low halts the processor and frees the system information bus for external control.
$\overline{\text{BUS}}$ $\overline{\text{REQ}}$	The wire–OR $\overline{\text{BUS}}$ $\overline{\text{REQUEST}}$ line when brought low tri-states the bus for short term DMA type data transfers. Unlike the halt sequence, BUS REQ is granted immediately.
S3 - SØ	The S3 thru SØ lines are extended address lines intended for a future paged memory system.

Functional Description — 30-Pin Bus Lines

RS2	The RS2 (Register Select 2) line is the buffered A2 address line.
RS3	The RS3 (Register Select 3) line is the buffered A3 address line.
−16, +16	(same as 50-pin bus)
GND	(same as 50-pin bus)
INDEX	The INDEX is an unused line and is provided so the pin on each of the male connectors may be cut with the corresponding female connector pins plugged preventing circuit boards from being inserted incorrectly.
$\overline{\text{FIRQ}}$	(same as 50-pin bus)
$\overline{\text{IRQ}}$	(same as 50-pin bus)
RSØ	The RSØ (Register Select Ø) line is the buffered AØ address line.
RS1	The RS1 (Register Select 1) line is the buffered A1 address line.
DØ - D7	The DØ - D7 Data lines are inverted and buffered 50-pin bus data lines $\overline{\text{DØ}}$ - $\overline{\text{D7}}$.
E	The E line is the inverted and buffered 50-pin bus $\overline{\text{E}}$ line.
R/$\overline{\text{W}}$	The R/$\overline{\text{W}}$ line is the buffered 50-pin bus R/$\overline{\text{W}}$ line.
+8 VDC	The +8 VDC line is electrically the same as the 50-pin bus 7-8 VDC UNR line.

1200b, 4800b, 300b, 9600b, 110b

These lines carry the 16X baud rate clocks for the serial interfaces used in the system. They carry baud rate clocks of 1200, 4800, 300, 9600 and 110 baud respectively. When the High Baud option on the processor board is selected, they may carry clocks for 4800, 19200, 1200, 38400, and 440 baud respectively.

Notes

All boards plugged onto the 50-pin bus should be designed for standard TTL voltage levels. All Input lines for data, address and control should present no more than one standard TTL load. All output lines for data, address and control should be capable of driving a minimum of ten standard TTL loads. Take note that control lines $\overline{\text{M.RST}}$, $\overline{\text{IRQ}}$, $\overline{\text{FIRQ}}$, M.RDY, $\overline{\text{HALT}}$, $\overline{\text{BUS}}$ $\overline{\text{REQ}}$ and $\overline{\text{BUSY}}$ are wire–OR lines and should be driven with open collector buffers or transistors capable of sinking at least 1.6 mA of current.

All boards plugged onto the 30-pin bus should be designed for standard TTL voltage levels. All input lines for data and baud rate should be a maximum of one standard MOS load. All remaining input lines should be a maximum of one standard TTL load. All data output lines should be capable of driving a minimum of ten standard MOS loads. Control lines $\overline{\text{FIRQ}}$ and $\overline{\text{IRQ}}$ are wire–OR lines and should be driven with open collector buffers or transistors capable of sinking at least 1.6 mA of current.

Both the 50- and 30-pin buses shall be constructed with Molex A2402 compatible connectors on the mother board and Molex A 2145-A compatible connectors on the plug-on boards. 50-pin boards should be (wherever possible) 5½″ high x 9″ wide. 30-pin boards should be (wherever possible) 3½″ high x 5¼″ wide.