# MPU-A

## Rev-4

## USER MANUAL

IMSAI is a division of Parastream Technologies, Inc.



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IMSAI

# Preface

From the president of Parastream Technologies, I would like to humbly thank you for your purchase of this MPU-A kit. Without your continued interest in the IMSAI product line, this product would never have been made. The last IMSAI products were shipped in 1979 from IMSAI Manufacturing Corporation in San Leandro, California, and around 2008 from the IMSAI division of Fischer-Freitas Corporation in Orangevale, California. The IMSAI division of Parastream Technologies has been shipping IMSAI products since 2024.

This project would not have been possible without RetroTechReboot, AKA ShadowTronBlog, who cloned the MPU-A printed circuit board from his unbuilt IMSAI 8080 kit. He has given me countless hours of advice, stories about his career and technical input. He has become a good friend.

Check out his video of the NOS IMSAI 8080 at

https://www.youtube.com/watch?v=BxJFUx2r5ps&t=2393s

or scan the QR code to the right.

I hope you enjoy building and using the MPU-A as much as we did designing and producing the kit.

Sincerely,

Robert E. Weatherford
CEO / President
IMSAI Division
Parastream Technologies, Inc.
https://www.parastream.com

# About This Manual

This manual is in three distinct parts. This first part is the introduction, errata, and clarifications to the second part, which is the original San Leandro copy of the MPU-A User Manual. The third part contains any additional drawings or other engineering notes that were not covered in the second part.

# Errata

In the THEORY OF OPERATIONS section, it is stated that "One K pullup resistors to +5 volts are connected…" Those resistors are 4.7 kΩ.

# Clarifications

Early MPU-A kits shipped with an overtone mode 18.00MHz crystal that required a tank circuit to operate properly. By 1977, the crystal was changed to a series resonant type that was in a smaller case and did not require the tank circuit. Although the schematic and most of the User Manual has had references to these components updated and deleted as appropriate, the photograph still shows the tank circuit components.

# MPU-A

## FUNCTIONAL DESCRIPTION

The MPU-A board is the processor board for the IMSAI 8080 Microcomputer System. It is designed using the 8080 microprocessor chip. The bus arrangement and board connector has been chosen to be 100% compatible with the MITS Altair M8800 Microcomputer system so that all boards are 100% interchangeable between the Altair system and the IMSAI 8080 system.

Every effort has been made to keep the design simple and straight-forward to maximize reliability and ease of maintenance. MSI and LSI are used where appropriate, and discrete components are held to a minimum for greater circuit reliability and ease of assembly.

The 8224 clock driver chip and an 18 Megahertz crystal are used to generate the 2-phase, 2 Mehagertz non-overlapping clock for the 8080A. An 8212 is used as a latch for the status signals and two 8216 tri-state bi-directional bus drivers are used to interface the 8080A with the IMSAI 8080 input and output data buses. All other address, status, and control lines are driven by tri-state bus drivers.

Unregulated +16, -16, +8 volts, and ground must be supplied to the bus. On-board regulation is used to arrive at the power supply levels needed to run the chips. Integrated circuit power regulators with overload protection are used. The board is supplied with ample bypass filtering using both disc ceramic and tantalum capacitors.

The board connector is a 100 pin edge connector on .125 inch centers 50 pins on each side. Dimensions are 5 inches by 10 inches, using 2 sided glass reinforced epoxy laminate, with plated feed-through holes to eliminate the need for any circuit jumpers. The contact fingers are gold-plated over nickel for reliable contact and long life. All other circuitry is tin-lead plated for better appearance and more reliable solder connections.

Power-on reset is included on this board along with pull up resistors for all inputs required so that with the front panel removed from the INSAI 8080 machine, the power-on reset will start the program at position 0 out of a ROM. All other necessary conditions are met so that the system will run without the front panel attached, for use in dedicated controller applications where no operator-processor interaction is desired.

## THEORY OF OPERATION

The IMSAI MPU-A board is structured around the 8080A microprocessor chip, and much of the MPU-A board is wired to support the 8080A device. The MPU-A board provides interfacing between the 8080A chip and the data and address busses, clock and synchronization signals, and the voltage regulation necessary for the 8080A and other chips. The internal functioning of the 8080A is thoroughly described in the Intel 8080 Microcomputer System User's Manual. Reference should be made to this manual for information concerning the operation and use of the 8080A.

The address lines from the 8080A drive the address bus on the back plane through 8T97 tri-state buffer drivers. These drivers may be disabled through the ADDRESS DISABLE line on pin 22 of the back plane. The 8216 bi-directional bus drivers connect the 8080's bi-directional DATA IN and DATA OUT busses. The direction of data transmission is determined by the DIRECTION ENABLE line. The DIRECTION ENABLE line is in turn controlled by the front panel and the processor status signals DATA BUS IN and HALT ACKNOWLEDGE. The 8216 can be disabled by the DATA OUT DISABLE line on pin 23 of the back plane.

The 8080A's bi-directional data bus is also connected to the data bus socket and the 8212 status byte latch. The data bus socket is used to connect the front panel to the bi-directional bus, while the 8212 latch transfers the status byte to the back plane via 8T97 drivers. These drivers are disabled by the STATUS DISABLE line on pin 18 of the back plane. The 8212 is latched up by the STATUS STROBE signal of the 8224 clock chip to store the status information for each instruction cycle.

One K pullup resistors to +5 volts are connected to all the bi-directional bus lines to ensure that during the time the bus is not driven, the 8080A reads all 1's.

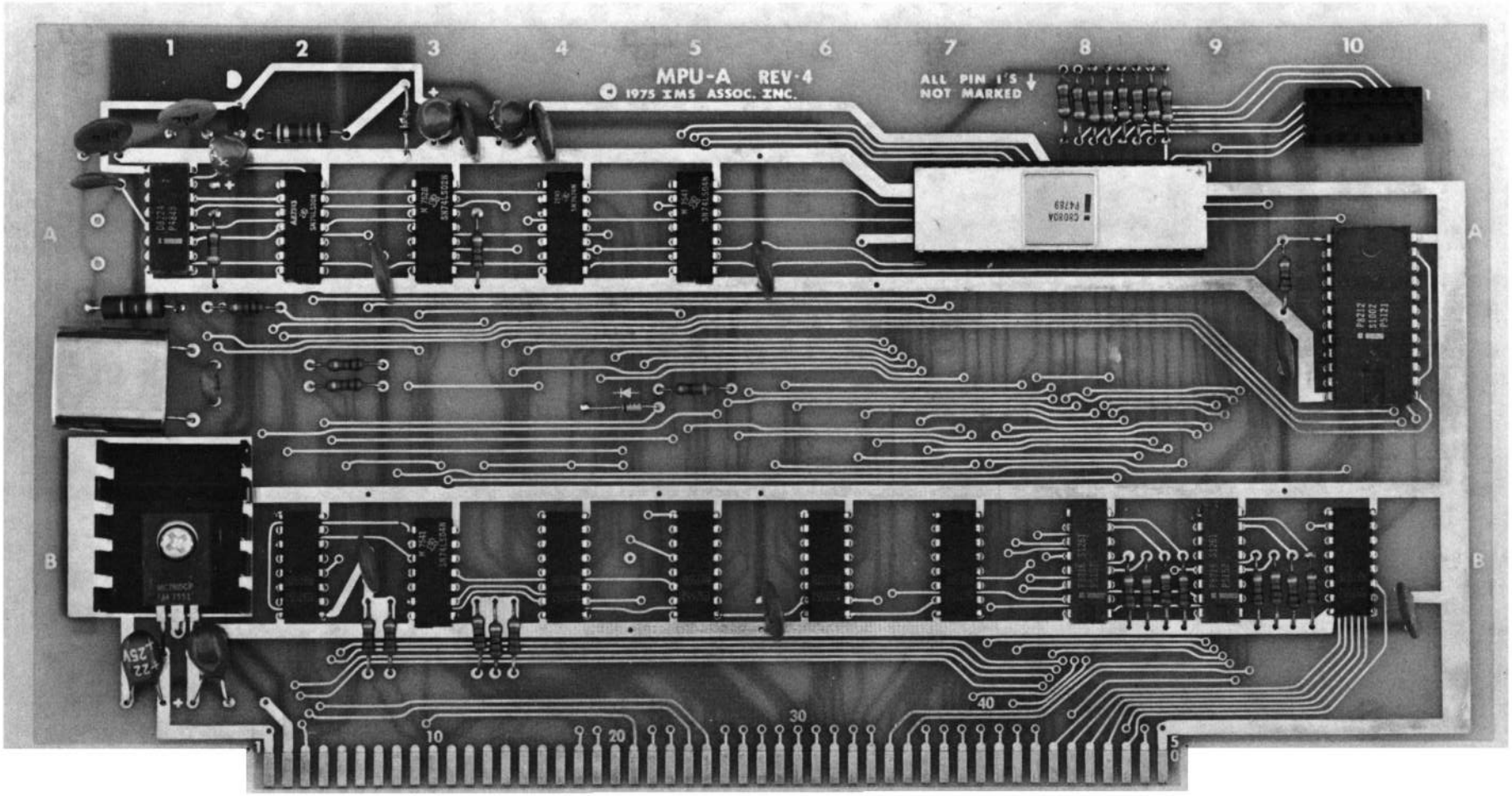
The 8224 clock chip and crystal oscillator provide the two-phase non-overlapping 2 megacycle system clock for the 8080A. These clocks are also driven onto the back plane through 8T97 tri-state buffered drivers.

The CLOCK line on the back plane is driven from the TTL Phase II clock line through a delay so that the phase relation of the clock signal to the Phase II and Phase I back plane signals, is nearly identical to that produced by the MITS Altair 8800 system. Six sections of a 7404 are used for this delay to provide greater simplicity and higher reliability than a one-shot. The 8224 chip also provides the power-on reset function through use of a 4.7K resistor and 33 uf capacitor connected to the reset input of the 8224. The power-on reset is applied to the 8080A and is applied to the POWER ON CLEAR line, pin 99 on the back plane.

The two BACK PLANE READY signals are ANDed and connected to the 8224 for synchronization with the Phase II clock before being connected to the 8080A chip. The INTERRUPT line is connected directly to the 8080A, while the HOLD REQUEST line is synchronized with the Phase II clock and then connected to the 8080A.

The six processor status signals (SYNC WRITE, STROBE DATA BIT IN, INTERRUPT ENABLED, HOLD ACKNOWLEDGED, and WAIT ACKNOWLEDGE) are all driven onto the back plane through 8T97 tri-state buffered drivers. These drivers may be disabled by the CONTROL DISABLE line, pin 19 on the back plane.

The +5 volts is regulated from the +8 volts by a 7805 integrated circuit regulator, while the -5 volts is regulated by a 5 volt zener and a 470 ohm resistor from the 16 volt bus. The +12 volts is regulated by a 12 volt Zener and connected to the +16 volt line by two 82 ohm ½ watt resistors in parallel. All voltages are filtered with 33 microfarad tantalum and disc ceramic capacitors.


MPU-A REV-4
© 1975 IMS ASSOC. INC.
ALL PIN 1'S
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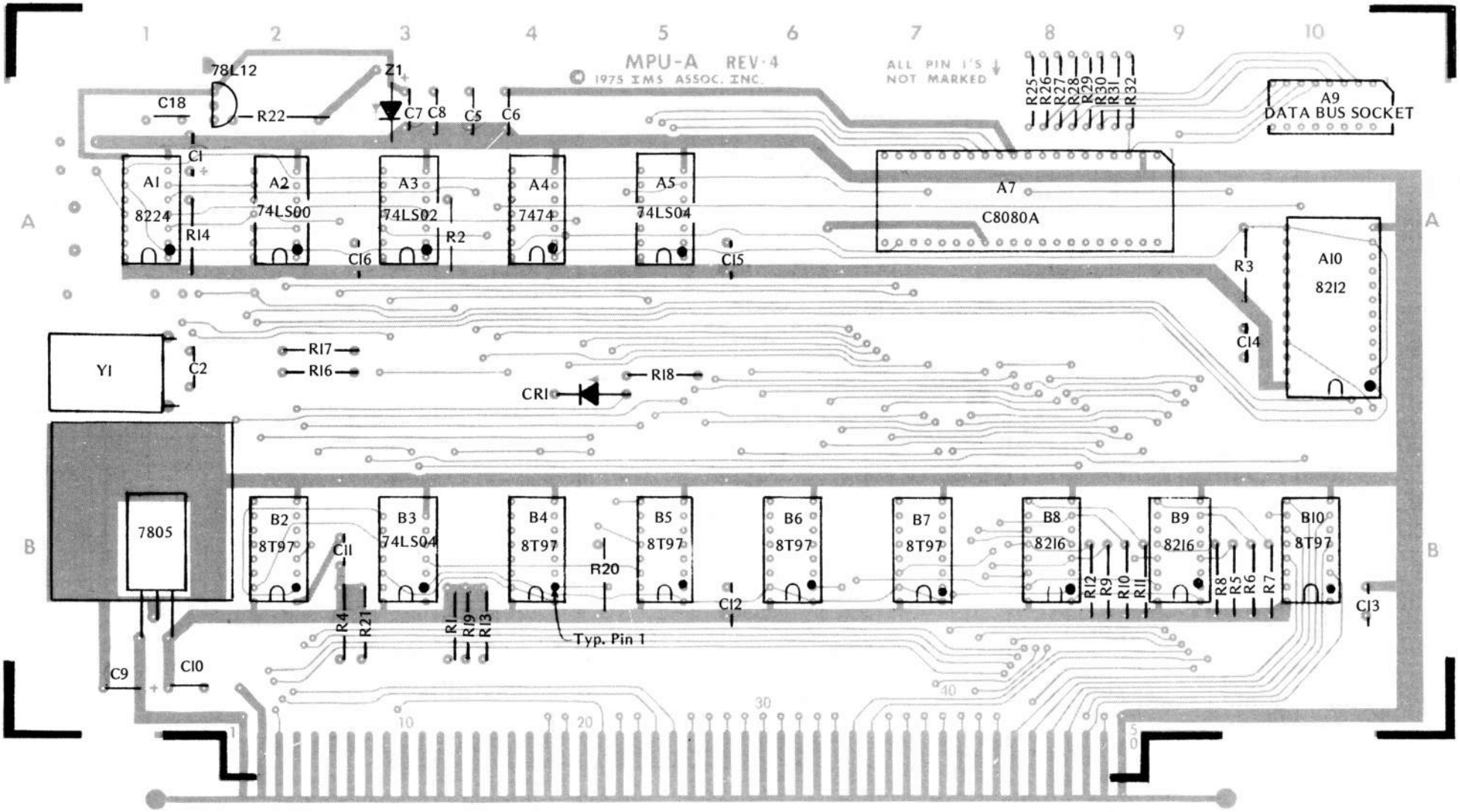
**MPU-A REV 4**




# IMS ASSOCIATES INC.

ASSEMBLY DIAGRAM

MPU-A REV 4 2/76



5/18/76

| ITEM | IMSAI PART # | QUANTITY | DESCRIPTION |
|---|---|---|---|
| Solder | 15-0000001 | 5' | |
| Heat Sink | 16-0100002 | 1 | Thermalloy Heat Sink, 6106B-14 |
| Screw | 20-3302001 | 1 | 6-32x5/16" Phillips Pan Head Machine |
| Nut | 21-3120001 | 1 | 6-32 Hex, CAD |
| Lockwasher | 21-3350001 | 1 | #6 Internal Star Lockwasher |
| Socket | 23-0800001 | 1 | 16 Pin, Solder Tail, IC Socket |
| Socket | 23-0800004 | 1 | 40 Pin, Solder Tail, IC Socket |
| Resistor | 30-3470462 | 1 | 470 Ohm, ½ Watt (yellow, violet, brown) |
| Resistor | 30-4100362 | 19 | 1K Ohm, ¼ Watt (brown, black, red) |
| Resistor | 30-4470362 | 10 | 4.7K Ohm, ¼ Watt (yellow, violet, red) |
| Capacitor | 32-0239010 | 1 | 39pF Disk Ceramic |
| Capacitor | 32-2010010 | 9 | .1uF Disk Ceramic |
| Capacitor | 32-2233070 | 5 | 33uF, 25V Tantalum |
| Diode | 35-1000005 | 1 | 1N751A Diode |
| Diode | 35-1000006 | 1 | 1N914 Silicon |
| Crystal | 35-5000003 | 1 | 18.00 MHz, Series Resonant, HC-18 Case, Cut AT, Fundamental Mode, .02% Tolerance |
| 8T97 | 36-0089701 | 6 | Hex Tri-State Driver |
| 74LS00 | 36-0740002 | 1 | Quad 2 Input NAND (Low Power Schottky) |
| 74LS02 | 36-0740202 | 1 | Quad 2 Input NOR (LPS) |
| 74LS04 | 36-0740402 | 2 | Hex Inverter (LPS) |
| 7474 | 36-0747401 | 1 | Dual D Flip Flop |
| 7805 | 36-0780501 | 1 | 5V Positive Voltage Regulator |

| ITEM | IMSAI PART # | QUANTITY | DESCRIPTION |
|---|---|---|---|
| 78L12 | 36-0781202 | 1 | 12V Regulator |
| 8080A | 36-0808001 | 1 | Microprocessor |
| 8212 | 36-0821201 | 1 | Input/Output Port |
| 8216 | 36-0821601 | 2 | Bi-Directional Bus Driver |
| 8224 | 36-0822401 | 1 | Clock Generator and Driver |
| Chapter | 81-0000031 | 1 | MPU-A (for separate orders only) |
| PC Board | 92-0000011 | 1 | MPU-A Rev. 4 |

## MPU-A ASSEMBLY INSTRUCTIONS

1) Unpack your board and check all parts against the parts lists enclosed in the package.

2) If gold contacts on the edge connector appear to be corroded, use pencil eraser to remove any oxidation. NOTE: Do not use Scotchbright or any abrasive material as it will remove the gold plating.

## RESISTOR INSTALLATION

3) Insert and solder nineteen 1K ohm 1/4 watt resistors (brown/black/red) R1 through R13, R15 through R17, R19, R20 and R21. See Assembly Diagram for location.

4) Insert and solder ten 4.7K ohm 1/4 watt resistors (yellow/violet/red) R14, R18, and R25 through R32. See Assembly Diagram for location.

5) Insert and solder one 470 ohm 1/2 watt resistor (yellow/violet/brown) R22. See Assembly Diagram for location.

## IC INSTALLATION

NOTE: All IC pin 1's point in the direction of the edge connector unless otherwise indicated on the board.

6) Insert and solder the one 74LS00 in location A2.

7) Insert and solder the one 74LS02 at location A3.

8) Insert and solder each of the two 74LS04's at location B3 and A5.

9) Insert and solder the one 7474 at location A4.

10) Insert and solder the one 8224 at location A1.

11) Insert and solder each of the six 8T97's at locations B2, B4, B5, B6, B7, and B10.

12) Insert and solder each of the two 8216's at locations B8 and B9.

13) Insert and solder the one 8212 at location A10.

## DISCRETE COMPONENT INSTALLATION

14) Insert and solder the 16 pin IC socket at location A9.

15) Insert and solder the 40 pin IC socket at location A7. (Do not install the 8080 at this time.)

16) Insert and solder the one 1N914 diode (CR1) as shown in the Assembly Diagram. NOTE: Observe polarity as indicated on the board.

17) Insert and solder the one 5.1 volt diode 1N751 (Z1) as shown on the Assembly Diagram. NOTE: Observe polarity as indicated on the board.

18) Insert and solder the one 18 MHz crystal (Y1) as shown on the Assembly Diagram.

19) Insert and solder the one 39 pF disk capacitor (C2) as shown on the Assembly Diagram.

20) Insert and solder each of the nine .1 uF disk capacitors at locations C6, C8, C11 through C16, and C18.

21) Insert and solder each of the five 33 uF tantalum capacitors at locations C1, C5, C7, C9 and C10 as shown on the Assembly Diagram. NOTE: Observe polarity as marked on the board.

REGULATOR AND HEAT SINK INSTALLATION

22) Insert and solder the one 78L12, +12 volt regulator observing orientation as shown on the Assembly Diagram and on the board.

23) Bend the leads of the 7805 regulator at 90 degree angles approximately ¼" from the bottom edge of the regulator to facilitate insertion on top of the heat sink.

24) Insert the #6 screw through the regulator and heat sink and attach washer and nut from the back side of the board. NOTE: Be sure to hold the heat sink in proper vertical position while tightening the screw in order to prevent shorting to adjacent traces. Solder in the 7805 leads.

Before Installing the 8080 Chip

25) If possible before plugging in the 8080A chip, the board should be inserted in a chassis, the power turned on, and the voltage levels checked on the 40 pin socket. Pin 2

should be ground and pin 11 should be -5 volts. Pin 20 should be +5 volts and pin 28 should be +12 volts. If one of these three voltages is not correct, ascertain the cause and correct it before plugging in the 8080A chip. When these voltages measure correctly, the 8080A chip should be inserted carefully into the 40 pin socket (with the board removed and the power off!)

Finally, insert the 8080A microprocessor chip in the 40 pin IC socket at A7. Orient pin 1 as indicated on the board.

NOTE: The 16 pin IC socket located at A9 is where the front panel data bus cable plugs into the MPU-A board.

USER GUIDE

The IMSAI MPU-A board requires no jumpers or user options for its use. The board is ready to function after connection to the back plane and the bi-directional bus. The bi-directional bus lines are provided by a 16-conductor cable from the CPA board, connected via a 16-pin DIP plug in location A-10. Verify proper insertion of this plug (i.e., pin 1 to pin 1) before use of the board.

The clock crystal frequency is 18 megahertz, and the 8224 device derives from this 18 MHz signal the necessary 2 MHz two-phase non-overlapping system clock. These 2 MHz clocks are brought out onto the back plane for use by other system boards. The board must be used with an 8080A chip as the 8080 chip is not compatible with the 8224 clock generator. Information on the timing of the logic signals and the description of the 8080A instruction set can be found in the Intel 8080 Micro Computer Systems User's Manual.

# IMSAI ECO 24-0002

***Engineering Change Order for: MPU-A Rev-4***

## Summary

Component substitutions due to obsolescence.

## Details

The following components may have been discontinued and may be substituted according to the following table:

| Parastream / IMSAI Part # | Component | Designators | Parastream / IMSAI Part # | Substitution |
|---|---|---|---|---|
| **36-10007400 / 36-0747401** | 7474 2×D PET FF w/P&C PDIP | A4 | 36-10507400 / 36-0747402 | 74LS74 2×D PET FF w/P&C PDIP |

## Notes

This component substitution reduces the overall power consumption.

# Document Revision History

| Revision | Date | Initial | Description |
|---|---|---|---|
| **0** | 2024-08-29 | REW | Original. |