

**IMSAI**

**CP-A**

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CP-A

FUNCTIONAL DESCRIPTION

The CP-A board is the operator's panel for the IMSAI 8080 System. It includes operator switches, indicator lights and all logic necessary to operate the IMSAI 8080 System.

The panel is completely self-contained and plugs into the back plane's 100 pin edge connector. With this design it is not necessary to mount the CP-A at the front of the cabinet. Instead, the board can be plugged (via an extender card) into any available slot in the back plane.\*

A full set of 16 address switches and 6 control function switches accept operator control and input. LED indicators are provided for the 16 bit address bus, the 8 bit data bus, the 8 bit status byte (control indicators for INTERRUPTS, ENABLED, RUN, WAIT and 8 bits of programmed output).

The CP-A board contains the logic necessary to drive the 8 programmed output indicators and the logic needed to read an 8-bit input byte from the high-order address switches. The DATA BUS indicators are run from the bi-directional portion of the data bus (via a flat cable to the MPU board) and show data either being read or written by the 8080 processor.

The indicators on the panel are wide-angle-view light emitting diodes mounted behind a contrast-enhancing acrylic panel assembly. All indicators and switches are explicitly marked. The photographically produced labels are very clear, protected by clear acrylic, and can never wear off. Bit positions are numbered, and binary bit values are labeled for both hexadecimal

\*The switches are included on the front panel whether it is mounted in the front of the panel or not.

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and octal formats. Special labels may be easily inserted to identify special functions for the programmed output port. Switches on the panel are high-quality paddle switches, and are color-coded for easy and error free use.

For situations in which it is not desired to locate the operator's panel at the cabinet front (such as use of the IMSAI 8080 as a dedicated controller), the CP-A front panel may be inserted (via extender card) into any back plane slot. In this arrangement, programs may be easily tested and debugged without time-consuming mounting and un-mounting of the front panel. For these applications, the front slot of the machine can be reserved for the parallel I/O board with its LED indicators showing through the front panel mask.

## THEORY OF OPERATIONS

The CP-A front panel assembly provides machine status indicators, user controlled switches, and control functions to the IMSAI 8080 operator. The CP-A board communicates with the MPU-A microprocessor and other boards through the 8080 back plane and, additionally, connects (via 16 conductor flat cable) to the bi-directional data bus of the 8080 microprocessor.

The CP-A panel uses 44 Light Emitting Diodes as front panel indicators. Many of these indicators directly correspond to signal levels on the IMSAI 8080 back plane, and are driven directly from the bus with no intervening logic. Indicators in this group are the 16 Address Bus LED's, the 8 STATUS byte LED's, the INTERRUPT ENABLED LED, the WAIT LED, and the HOLD LED.

The 8080 microprocessor chips bi-directional data bus levels (provided by a 16-conductor cable) are displayed on the DATA bus indicators via the 74LS04 (low power schottky hex inverter) sections. Also driven from the bi-directional bus is the 8212 8 bit latch used to drive the PROGRAMMED OUTPUT indicators. The RUN indicator is driven directly from the run/stop flip-flop (74107) on the CP-A Board.

The 16 ADDRESS-PROGRAMMED INPUT and ADDRESS-DATA switches allow the operator to place desired value (program, data, addresses) on the 8080's bi-directional bus.

As shown on the schematic, these switches connect 7405 (open collector) inverters to the bus in a wired-AND configuration.

Pullup resistors on the MPU Board ensure that the bus levels are all high unless any inverter on any one of the bus lines goes low. Thus, if an inverter goes low, (this condition will be discussed shortly) the address switch can be used to put either a high or low value on that line.

The function switches provide the operator with direct control of the microprocessor. The RUN/STOP switch controls the X-READY line via the RUN/STOP flip-flop.

If the switch is set to RUN, on the next falling edge of the Phase II clock, the RUN and X-READY lines are set high. If the switch is set to STOP, the high STOP value and the Phase II clock are NANDed (U16) and this value NANDed with the DATA OUT 5 bit (fetch/status) and the PROCESSOR SYNC line.

Thus, when the processor is fetching a new instruction, the RUN/STOP flip-flop will be reset, the processor X-READY line goes low, and the processor stops.

Several CP-A function switches operate by providing the 8080 with an instruction, executing the instruction, and then stopping the processor on the next cycle. The open collector 7405's and support gating put these instructions on the 8080's bi-directional bus. The EXAMINE function uses a jump instruction (hex C3) followed by two bytes of the address selected on the front panel switches.

This operation causes the processor to jump to the selected address and, then, the processor is stopped during the next cycle. When stopped, the processor was reading the selected byte from memory as if it were going to execute it. Therefore, the processor stops with the desired address displayed on the address bus and the contents of that address is displayed on the data bus.

If the RUN switch is operated at this time, the processor will continue to pull the selected byte from memory and execute it.

The EXAMINE NEXT and DEPOSIT NEXT switches use similar schemes and the NO-OP (hex 00 or octal 000) instruction to increment the address.

Much of the remaining logic of the CP-A is used to sequence these commands to provide the desired functions. The RUN/STOP flip-flop line, the SINGLE STEP line, the EXAMINE line, and the EXAMINE NEXT line are all input to an OR-gate controlling the X-READY line. (The X-READY line must be high for the processor to run. Its

function is identical to the P-READY line used by the memory and I/O boards. The X-READY line is reserved for use of the front panel to avoid conflicts of two gates driving the same backplane line). During each of these functions, the processor is permitted to execute an instruction, and then is stopped in the next cycle in a manner similar to the RUN/STOP flip-flop cycle described earlier.

For the SINGLE STEP function, a one-shot, triggered by the SINGLE-STEP switch, is used to produce a pulse and the trailing edge of that pulse is used to set a flip-flop which controls the SINGLE STEP line. This permits the processor to execute the present instruction. The SINGLE STEP flip-flop is reset by the occurrence of the sync pulse on the following instruction, thus causing the SINGLE STEP level to be removed and the processor to stop on the following cycle.

The EXAMINE-NEXT flip-flop is similarly controlled by the leading edge of a pulse from a one-shot driven by either the DEPOSIT NEXT or EXAMINE NEXT switch. The output of the flip-flop is used both to put the NO-OP (hex 00 or octal 000) onto the bi-directional data bus, and also to provide the READY signal so that the processor will execute the instruction. It is reset by the sync pulse on the following cycle, thus stopping the processor again.

The EXAMINE function involves a 4-step sequence produced by two flip-flops arranged as a counter. The pulse produced by the EXAMINE switch's one-shot starts the counter and on the first count, the jump instruction is inserted on the data bus. On successive counts of the two bit counter, the lower and upper address byte are inserted on the data bus in turn, and on the 4th count (that is, when the counter is back to 0), the processor is again stopped by the removal of the READY line. Thus, the EXAMINE logic provides the processor with the jump instruction and the two address bytes that the processor expects after a jump instruction and

stops the processor during the fetch of the designated memory byte.

Similarly, the DEPOSIT switch, when operated, produces a pulse from the DEPOSIT one-shot which is buffered to the MEMORY WRITE line on the backplane. The leading edge of this pulse also starts a second one-shot with a much longer period which puts the data from the data switches on to the data bus for the duration of the longer pulse. The DEPOSIT one-shots are triggered either by the operation of the DEPOSIT switch or by the trailing edge of the DEPOSIT NEXT one-shot so that the DEPOSIT function will operate at the end of the EXAMINE NEXT cycle.

The 7427 gate in U15.5 is used to insure that during the time the front panel is inserting any information on the bi-directional data bus, the MPU-A board's bi-directional data bus driver is not also trying to drive the bus at the same time.

The inputs to this gate are the DATA-ON line, the EXAMINE NEXT line and the EXAMINE line. These are the three functions during which the front panel is transferring data or instructions to the bus.

The inputs to the 7405 open-collector inverter bus drivers are the lines NO-OP, C3, HAD, and LAD. These levels are ANDed with the PDBIN signal so that the information appears on the bus during the time the processor is expecting to see it there.

The input port from the high order address switches is implemented simply by decoding the address FF and ANDing it with the DBIN signal so that switch values appear on the data bus during the time that the processor is expecting information from the port FF.

The same address decode signal is ANDed with the STATUS OUT line to enable the 8212 8 bit latch which drives the PROGRAMMED OUTPUT indicators. The information on the bi-directional data bus is then latched onto the output port at the time of the processor write strobe.

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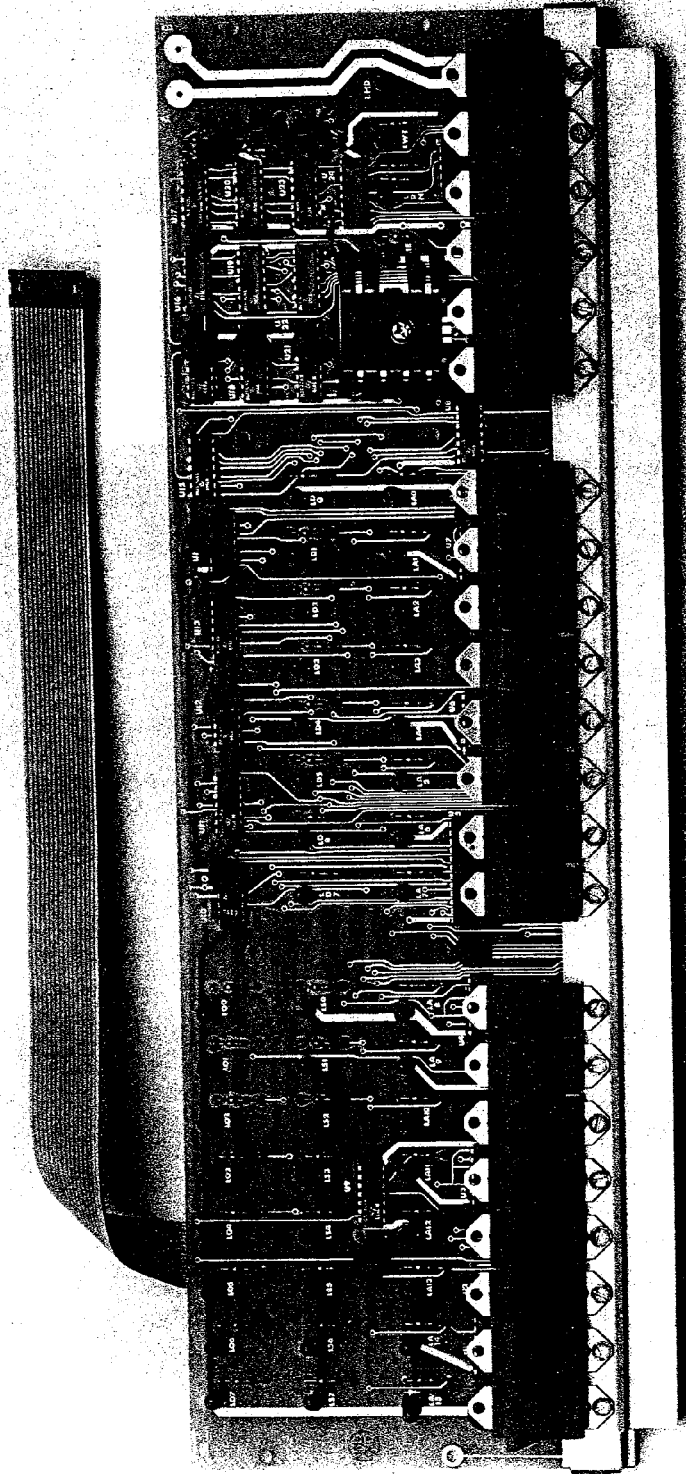
The STATUS WORD DISABLE line (SSWDSB, Pin 53 backplane) is gated to insure that no conflicts are created between the bi-directional bus drivers on the MPU and CP-A boards. This signal is controlled by the same gating that places the high order address switch values on the data bus for a front panel (address hex FF) read.

The STATUS WORD DISABLE line, Pin 53 in the backplane, is also run by the signal which puts the high order address switches onto the data bus for the port FF read instruction so that the bi-directional data bus is not being driven by the bi-directional drivers on the MPU board at the same time that the front panel is inserting the switch information on the data bus.

The RESET switch directly grounds the RESET line on the backplane which is detected by the MPU board and processed to form a RESET pulse which re-appears on the backplane as a Power On Clear.

When the RESET switch is thrown to EXTERNAL CLEAR, the switch directly grounds the EXTERNAL SWITCH line on the backplane. There is a diode between the RESET line and the EXTERNAL CLEAR line so that during a reset operation an EXTERNAL CLEAR is also generated.





CP-A REV. 4



CP-A, Rev. 4  
Parts List

BOARD: CP-A

| <u>ITEM</u> | <u>IMSAI<br/>PART #</u> | <u>QUANTITY</u> | <u>DESCRIPTION/IDENTIFYING MARKS</u>                                     |
|-------------|-------------------------|-----------------|--|
| Solder      | 15-0000001              | 10'             |  |
| Heat Sink   | 16-0100002              | 1               | Thermalloy/6106B-14  |
| Screw       | 20-2203001              | 22              | 4x $\frac{1}{4}$ " Slotted Hex Head, Self-Tapping,<br>Type A Sheet Metal |
| Screw       | 20-3203001              | 2               | #6x $\frac{1}{4}$ " Self-Tapping Sheet Metal                             |
| Screw       | 20-3302001              | 1               | 6-32x5/16" Phillips Pan Head Machine                                     |
| Screw       | 20-3916002              | 8               | 6-32x1 $\frac{1}{4}$ " Button Head Allen Machine, Black                  |
| Nut         | 21-3120001              | 1               | 6-32 Hex   |
| Lockwasher  | 21-3350001              | 1               | #6 Internal Star Lockwasher  |
| Spacer      | 21-3600001              | 8               | #6x $\frac{1}{4}$ " White Nylon  |
| Spacer      | 21-3600002              | 8               | 7/16" White Nylon  |
| Switch      | 26-1500001              | 8               | Blue Paddle Switch, on/none/on   |
| Switch      | 26-1500002              | 8               | Red Paddle Switch, on/none/on  |
| Switch      | 26-1500003              | 2               | Red Paddle Switch, momentary   |
| Switch      | 26-1500004              | 3               | Blue Paddle Switch, momentary  |
| Switch      | 26-1600001              | 1               | Red Rocker Switch, on/none/on  |
| Resistor    | 30-3220362              | 44              | 220 Ohm, $\frac{1}{4}$ Watt/red, red, brown                              |
| Resistor    | 30-4100362              | 9               | 1K Ohm, $\frac{1}{4}$ Watt/brown, black, red                             |
| Resistor    | 30-5470362              | 6               | 47K Ohm, $\frac{1}{4}$ Watt/yellow, violet, black                        |
| Resistor    | 30-6270362              | 1               | 270K Ohm, $\frac{1}{4}$ Watt/red, violet, yellow                         |
| Capacitor   | 32-2000110              | 2               | .001uF Disk Ceramic  |
| Capacitor   | 32-2001010              | 1               | .01uF Disk Ceramic   |
| Capacitor   | 32-2010010              | 17              | .1uF Disk Ceramic  |

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| <u>ITEM</u>    | <u>IMSAI<br/>PART #</u> | <u>QUANTITY</u> | <u>DESCRIPTION/IDENTIFYING MARKS</u>                             |
|----------------|-------------------------|-----------------|--|
| Capacitor      | 32-2233070              | 2               | 33uF Tantalum  |
| Diode          | 35-1000006              | 1               | Signal Diode/1N914   |
| LED            | 35-3000001              | 44              | Light Emitting Diode/red   |
| 8T97           | 36-0089701              | 1               | Hex Tri-State Buffer/N8T97B                                      |
| 7400           | 36-0740001              | 2               | Quad 2 Input NAND/SN7400N  |
| 7402           | 36-0740201              | 2               | Quad 2 Input NOR/SN7402N   |
| 7404           | 36-0740401              | 1               | Hex Inverter/SN7404N   |
| 74LS04         | 36-0740402              | 2               | Hex Inverter (Low Power Schottky)/SN74LS04N                      |
| 7405           | 36-0740501              | 5               | Hex Inverter Open Collector/SN7405N                              |
| 7410           | 36-0741001              | 1               | Triple 3 Input NAND/SN7410N                                      |
| 74LS10         | 36-0741002              | 1               | Triple 3 Input NAND (LPS)/SN74LS10N                              |
| 7427           | 36-0742701              | 1               | Triple 3 Input NOR/SN7427N                                       |
| 7430           | 36-0743001              | 1               | 8 Input NAND/SN7430N   |
| 74LS30         | 36-0743002              | 1               | 8 Input NAND (LPS)/SN74LS30N                                     |
| 7805           | 36-0780501              | 1               | 5V Positive Volt Regulator/MC7805CP                              |
| 8212           | 36-0821201              | 1               | I/O Port/P8212/S1002   |
| 74107          | 36-7410701              | 3               | Dual J-K Flip Flop With Clear/SN74107N                           |
| 74123          | 36-7412301              | 3               | Dual Monostable Multivibrator, Retriggerable with Clear/SN74123N |
| Cable Assembly | 91-0400001              | 1               | Cable K Assembly   |
| PC Board       | 92-0000002              | 1               | CP-A, Rev. 4   |
| Plastic Panel  | 93-3010006              | 1               | Clear Plastic Panel  |
| Plastic Panel  | 93-3010007              | 1               | Red Plastic Panel  |
| Bracket        | 93-3010011              | 1               | Switch Bracket   |
| Photo Mask     | 93-3010015              | 1               |  |
| Paper Backing  | 93-3010016              | 1               |  |

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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.

LED INSTALLATION

- 3) For a professional appearing finished CP-A Board two items in the assembly are important: first, the mounting of the LED indicator lamps, and second, the mounting of the paddle switches. Care is necessary in the mounting of both of these items to insure evenly spaced, straight line rows of components. If they are assembled carefully, the panel will have a professional appearance second to none. If these two items are assembled haphazardly, the panel will function; however, it will have a distinctly less than workmanlike appearance.

For maximum ease in uniform assembling, the LED indicator lamps should be installed on the board first, before any other components have been installed. They should not be pushed fully against the board, but, rather, should be set up approximately 1/8 inch to place them closer behind the acrylic panel mask; this provides for a greater viewing angle during panel operation. A small easy-to-make jig is extremely useful in accurate positioning of the LED indicators. This mounting aid consists of 1/8 inch thick material. A piece of 1/8 inch plastic, aluminum or masonite, or two pieces of 1/16 inch material such as vector board or old printed circuit board make ideal jigs.

A 3/4 square inch piece of the 1/8 inch material, or two of the 1/16 inch material should be cut and a narrow slot, such as would be produced by a hacksaw or coping saw blade, cut into one side a little bit past the center. As each light-emitting diode is installed in the board, leads can be inserted through the short slot cut into this piece and then through the board and the LED should be pushed up hard against the 1/8 inch piece so that its base sits flat and it will be held accurately 1/8 inch away from the surface of the front panel board. The lead should be soldered from the back while someone is holding the LED against the mounting aid from the front. The mounting aid can then be slipped out from under the LED.

Take care that every LED is mounted in the correct direction with the cathode down towards the 100 pin edge connector at

the bottom of the board. The cathode can be recognized by its proximity to the flat side on the base of the light emitting diode.

- 4) Insert and solder each of the forty-four red LED's at locations:

LO0 through LO7

LA0 through LA15

LD0 through LD7

LS0 through LS7

LIE, LHO, LRN, LWT

#### RESISTOR INSTALLATION

- 5) Insert and solder each of the forty-four 220 ohm  $\frac{1}{4}$  watt resistors (red/red/brown) R16 through R59. See Assembly Diagram for location.
- 6) Insert and solder each of the six 47K ohm  $\frac{1}{4}$  watt resistors (yellow/violet/orange) R3, R4, R5, R8, R9, and R12. See Assembly Diagram for location.
- 7) Insert and solder one 270K ohm  $\frac{1}{4}$  watt resistors (red/violet/yellow) R1. See Assembly Diagram for location.
- 8) Insert and solder each of the nine 1K ohm  $\frac{1}{4}$  watt resistors (brown/black/red) R2, R6, R7, R10, R11, R13 through R15, and R60. See Assembly Diagram for location.

#### IC INSTALLATION

- 9) Insert and solder each of the two 7400 IC's at locations U14 and U25.
- 10) Insert and solder each of the two 7402 IC's at locations U13 and U16.
- 11) Insert and solder the one 7404 IC at location U10.
- 12) Insert and solder each of the two 74LS04 IC's at locations U8 and U15.
- 13) Insert and solder each of the five 7405 IC's at locations U1, U3, U4, U6, and U7.
- 14) Insert and solder the one 7410 IC at location U12.
- 15) Insert and solder the one 74LS10 IC at location U11.
- 16) Insert and solder the one 7427 IC at location U15.5.

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- 17) Insert and solder the one 7430 IC at location U21.
- 18) Insert and solder one 74LS30 IC at location U9.
- 19) Insert and solder each of the three 74107 IC's at locations U18, U19, and U22.
- 20) Insert and solder each of the three 74123 IC's at locations U17, U20, and U23.
- 21) Insert and solder the one 8T97 IC at location U24.
- 22) Insert and solder the one 8212 IC at location U5.

DISCRETE COMPONENT INSTALLATION

NOTE: Lead allowance on all capacitors must be long enough to allow them to be flattened (or laid down) flush on the board or chip to facilitate front panel mounting.

- 23) Insert and solder each of the seventeen .1uf capacitors at locations C1, C2, C5, C6, C7, and C11 through C22.  
  
C2, C3, C5, C6, and C7 should be laid down.
- 24) Insert and solder each of the two .001 uf capacitors at locations C3 and C8.
- 25) Insert and solder the one .01 uf capacitor at location C4.
- 26) Insert and solder the two 33 mf 25 volt tantalum capacitors at locations C9 and C10. NOTE: Observe polarity as marked on board.
- 27) Insert and solder the 1N914 diode at position CR1.

REGULATOR AND HEAT SINK

- 28) Before installing heat sink bend all the heat sink fins horizontally (outward) to facilitate front panel mounting. The middle fin located on the right hand side of the board (when mounted) should be broken off or bent inward in order to allow space for the INTERRUPT/ENABLE LED (LIE) to be seen through the front panel.

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- 29) To install the regulator and heat sink first bend the 7805 regulator leads at 90 degree angles to a length which allows their insertion into the hole pattern of the CP-A board. Then place heat sink as shown in Assembly Diagram and insert regulator as described above. Use a #6 screw on the component side of the board and lockwasher and nut on the solder side of the board. Tighten the screw carefully to insure proper alignment of the heat sink to prevent shorting to adjacent traces.

CP-A TO MPU-A INSTALLATION

- 30) Using the 16 conductor ribbon cable with 16 pin 3M dual inline connector, insert one end into the hole pattern U2 from the back side of the CP-A board so that it can be soldered from the front (component side) of the CP-A board. The cable should be mounted so that it extends upward from the top of the chassis when the board is mounted.

SWITCH INSTALLATION

NOTE: There are three types of switches included for installation on the front panel (disregarding color). They include:

- A. One 2 position red rocker switch. This is the AC power switch.
- B. 5 momentary 3 position with spring return to center paddle switches - identified by the lack of a Nipple (raised portion) on the front of the switch mounting tab.
- C. 16 2 position no spring return paddle switches.

NOTE: Temporarily plug a 100 pin edge connector on the CP-A Board while switches are being soldered to help insure proper spacing between the PC Board and switch bracket.

- 31) The last step is the assembly of the switches and the switch mounting bracket. Note that the front panel includes switches whether mounted in the front of the cabinet or not. The POWER/ON/OFF Rocker Switch mounts at the extreme right switch position. The Paddle Switches are provided in both two-position and center-off spring return types. The two-position switches are used for the ADDRESS-DATA and ADDRESS PROGRAMMED INPUT location while the center off-spring return are used for the Control Functions.

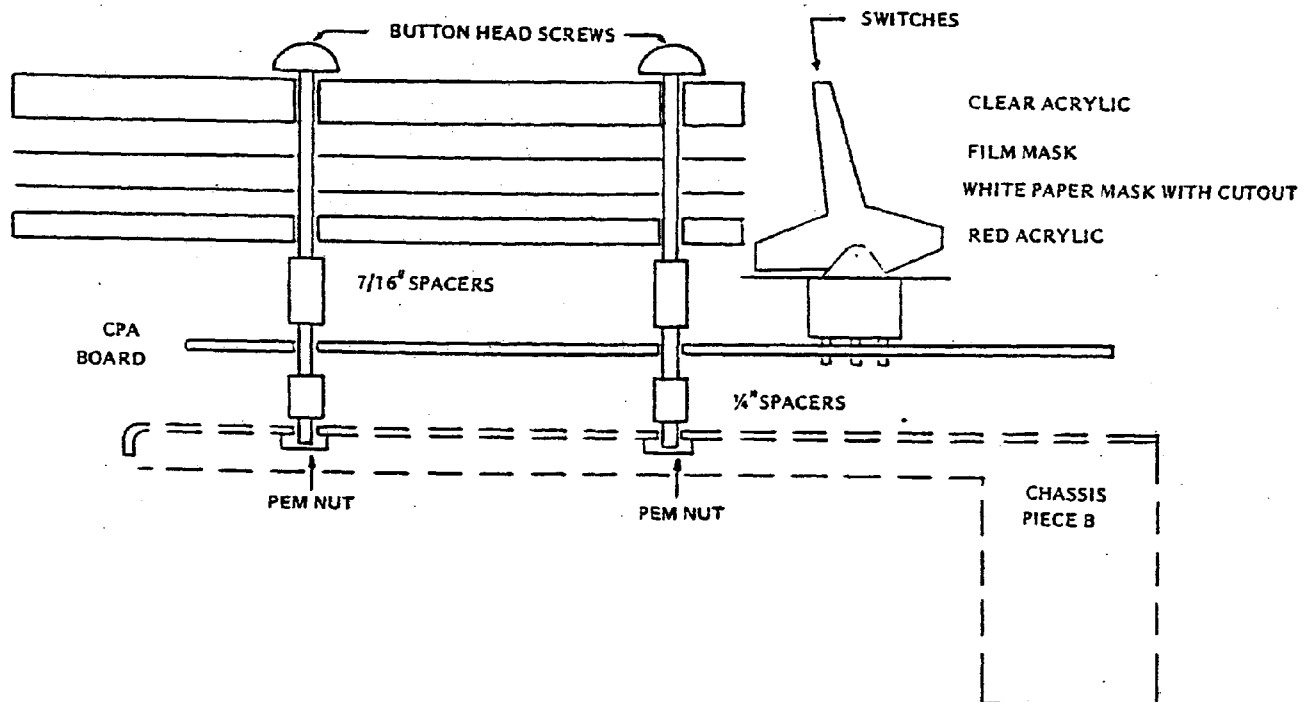


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- 32) When the entire row has been spaced accurately, the board should be turned over and a center switch should be soldered in place taking care that the board is not bowed towards or away from the switches. When the board is positioned correctly, there will be a small space approximately  $3/64$  inch or slightly under  $1/16$  inch between the bottom of the switch and the front of the front panel board. The two end switches should be similarly checked to make sure that the spacing to the board is correct and soldered in place, and then one switch each at the  $1/4$  positions checked as to spacing from the board and soldered into place. Then the remainder of the switches can be soldered. Examine visually for solder splash or bent/unsoldered pins.

PANEL ASSEMBLY

Refer to the diagram to see how the clear front acrylic piece, the photograph mask, the die cut paper backup and the red acrylic panel are assembled in sequence with the  $6/32 \times 1\frac{1}{2}$  inch button head screws.



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Both the Photographic mask and the paper backup sheet should be trimmed to size after assembly. Marks are provided on both, and they should be cut out carefully using a straight edge and a very sharp knife against a wooden cutting board. Scissors may be used if a guide line is first drawn on the sheets. The 8 holes for the assembly screws should be cut out on the mask and the paper sheet as indicated in the diagram. Then the protective paper may be removed from the two acrylic sheets and the sandwich assembled carefully. Avoid getting dust caught in between any of the pieces. A soft lint-free rag very slightly moistened can be an aid in cleaning any dust off plastic or film surfaces.

When the acrylic pieces, film and paper have been assembled, eight 7/16 inch spacers may be slipped over the screws and then the whole assembly inserted through the mounting holes on the CP-A board. Take care that there is no interference from any component standing too high and that the acrylic panels sit down completely on the 7/16 inch spacers against the board.

Eight 1/4 inch spacers can then be slipped over the screws behind the CP-A board and eight #6 nuts and lockwashers can be put on to hold the sandwich together.

The panel board should now be ready to plug in and use. If the board is going to be assembled in the front location of a cabinet, to serve as a permanent front panel, the eight nuts should be removed at this time. Install the cap screws in the PEM nuts in the front panel sheet metal.

## USER GUIDE

The CP-A board contains no user option jumpers or any other special connections that must be made to use the board. If the panel is mounted in the IMSAI 8080 cabinet then the power on/off switch should be connected using a separate wire to the power supply section as described in the Power Supply documentation. If the panel board is not going to be mounted in the cabinet, then the power switch should not be connected. In this case, the power switch on the inside or on the back of the cabinet would be used for controlling power to the IMSAI 8080.

Panel installation requires a backplane slot. The panel may be plugged directly into the front slot of the mother board (with the mounting screws from the acrylic face plate assembly extending through the metal panel immediately behind and secured with lock washers and nuts) or plugged on an extender card into any location in the back plane.\* The 16 pin DIP plug on the end of the flat cable must also be inserted into the corresponding socket in the upper right hand corner of the MPU-A board.

Only one front panel should be plugged into the bus at any time to avoid conflicts between multiple driving sources on the same signal lines for some of the control lines between the front panel and the system bus. The front panel is now ready to operate.

The 16 ADDRESS-DATA and ADDRESS-PROGRAMMER INPUT switches are 2 position paddle switches and represent a 0 in the down position and a 1 in the up position. The switches are provided in two colors, and can be arranged either in color groups of four to assist programming in hexadecimal or color groups of 3, 3 and 2, to aid in octal programming.

The low order byte of address switches, serve to enter into memory either data or program instructions. These switches are labeled ADDRESS-DATA 0 through 7. Each byte of data or program that is to be entered from the front panel is set into these switches after the appropriate address has been selected and entered. The switch

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\*Switches should be included whether the front panel is mounted in the front of the cabinet or not.

positions are not indicated on the indicator lights until the information is deposited in memory. At that time the information from these switches appears on the data bus. The high order byte of address switches is labeled ADDRESS-PROGRAMMED INPUT and these switches can be read by the program as input port position hex FF or octal 377. The additional labels 0 through 7 are provided above these switches to assist in interpreting the switch positions when being used as an input port. The position of these switches does not appear in the indicators until the input instruction from position FF is executed, during which execution time the switch positions appear on the data bus as it is being read into the 8080 processor.

The six control switches are grouped at the right end of the panel. They are center-off two-position spring-return switches with the exception of the POWER ON/OFF switch, which is a rocker type to eliminate accidental powerdowns. The function switches are provided in alternating colors for easy identification and to reduce operator error.

The RUN/STOP switch controls program execution. When the switch is pushed to the RUN position, a control signal is sent to the processor board and enables it to start or continue executing program instruction beginning in the location indicated at that time in the address bus lights. When the address switch is depressed to the STOP position, this enable signal is removed from the processor board at the beginning of the next instruction cycle so that the processor will stop executing during the fetch cycle for that following instruction.

When the processor is enabled to RUN, the RUN light above the RUN/STOP switch will be lit. When the processor has been stopped, the WAIT light to the right of the RUN light will be lit. During normal operation, the RUN light will be on full and the WAIT light will be on partially, the exact amount depending on how many wait cycles are required by the memory and peripheral devices being run by the processor at the moment.

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The front panel must be holding the processor in the stopped condition for the SINGLE STEP switch, the DEPOSIT/DEPOSIT NEXT switch, or the EXAMINE/EXAMINE NEXT switch to operate.

The EXAMINE/EXAMINE NEXT switch provides the facility for observing what is stored in memory in any location or for setting the program counter to any desired location to initialize program execution there.

When examining the contents of a location in memory, the 16 address switches are used to enter the 16 bit address. This 16 bit address is normally said to be divided into two 8-bit sections labeled high order and low order. The high order address is on the left hand side of the panel, and the low order address is in the center. The low order byte contains bits 0 through 7 and the high order byte contains bits 8 through 15. When only a small amount of memory is being used the high order bits are normally 0 and the switches must be in down position, unless the address jumper selection on the memory board is wired otherwise.

When the EXAMINE switch is actuated, the processor jumps to the address location set in the 16 address switches and is stopped during the fetch cycle out of that memory location. At that time, the address bus indicators will show the address set in the 16 address switches and the data bus indicators will show the contents of that memory location. Any additional locations in memory may be observed by setting the 16 address switches to that desired address and actuating the EXAMINE switch again. When the EXAMINE NEXT switch is actuated, the address shown in the address bus indicators is incremented by 1 and the contents of that following memory location are displayed on the data bus lights. Thus, a program or data would normally be checked by setting the first address in the address switches and actuating the EXAMINE switch to see the first byte, and thereafter actuating the EXAMINE NEXT position to observe each succeeding byte of data or program.

The DEPOSIT/DEPOSIT NEXT switch is similar in its operation but provides for changing the data or program stored in the memory. When the switch is actuated to the DEPOSIT position, the values of the lower address byte switches, that is, bits 0 through 7 labeled Address-Data, are deposited into the address currently being indicated on the 16 address bus indicators. After the DEPOSIT switch is actuated, the data will appear on the data bus indicators. If the data was incorrect because the switches were set wrong, the switches can be changed, the DEPOSIT switch actuated again, and the new values will be deposited to memory in that same location.

When the DEPOSIT NEXT position is actuated, the address currently appearing in the 16 address bus indicators is first incremented by 1 and the data entered into the ADDRESS/DATA switches is deposited in that following location and will appear in the data bus. The DEPOSIT NEXT position functions exactly the same as depressing EXAMINE NEXT to increment the address bus by 1 and then actuating DEPOSIT to deposit the ADDRESS-DATA switch positions into that location.

When the processor is stopped, instructions may be executed one at a time through the use of the SINGLE STEP switch to the right of the RUN/STOP switch. If this switch is depressed or raised, the processor board is permitted to run one instruction, and it will stop when it is in the fetch cycle in the following instruction. Thus repeated operations of this switch permit the programmer to step through his program one instruction at a time and follow what the machine is doing, noticing on the data bus what the fetched instruction is, and on the address bus the location from which that instruction is being fetched. For instructions requiring multiple memory accesses, for instance those with an address following in the second or third byte, each operation of the SINGLE STEP switch advances through only one part of the instruction. Thus, each byte of the instruction being read in and each byte of data being read in or out may be observed on the panel.

CP-A  
User Guide  
Revision 1

The RESET/EXTERNAL CLEAR switch provides the system reset functions. When depressed to the EXTERNAL CLEAR position the CLEAR signal is given to all external input/output interface cards which are wired to be reset by this signal. When raised to the RESET position, the 8080 processor is reset. This sets the program counter to location 0 and then returns control to the processor. If the front panel is permitting the processor to run when the RESET switch is actuated, upon release of the RESET switch the processor continues execution starting at position 0. If the front panel was holding the processor in a stopped state, during the time the RESET switch was actuated, then the program counter will be set to 0. When the RESET switch is released, the processor will remain stopped and will be positioned at memory location 0.

The 8-BIT PROGRAMMED OUTPUT INDICATOR lights can be controlled by the program through the use of the output instruction to port location hex FF or octal 377. When 0 bits are output into this port, the indicator lights will be turned on and when 1 bits are output into this port, indicator lights will be turned off.

The STATUS BYTE INDICATOR LIGHTS display the condition of the status byte during the execution of that instruction. The 8 status bits included in the status byte are the Memory Read Bit, the Input Instruction Bit, the Instruction Fetch Bit M1, the Output Instruction Bit, the Halt/Acknowledge Bit, the Stack Operation Bit, the Write Output Complement Bit, and the Interrupt Acknowledge Bit. In normal front panel operation, whenever the machine is stopped and the EXAMINE, DEPOSIT, EXAMINE NEXT or DEPOSIT NEXT switches are being used, the MEMORY READ, the M1 INSTRUCTION FETCH, and the WRITE OUT COMPLEMENT STATUS lights should be on.

While single-stepping through a program, either these or other status lights will be on as appropriate to the instruction function being executed at that moment.

For a more complete description of the functions of the status bits, reference should be made to the Intel 8080 Micro Computer Systems User's Manual. The INTERRUPT ENABLED indicator is turned on whenever the interrupts are enabled into the 8080 processor by the INTERRUPT ENABLE INSTRUCTION. This light is turned off either by an interrupt occurring and the processor acknowledging it, or by the instruction to disable interrupts. The HOLD indicator light is lit whenever a special-purpose input/output card is holding the processor so as to gain direct access to the memory on the system bus.

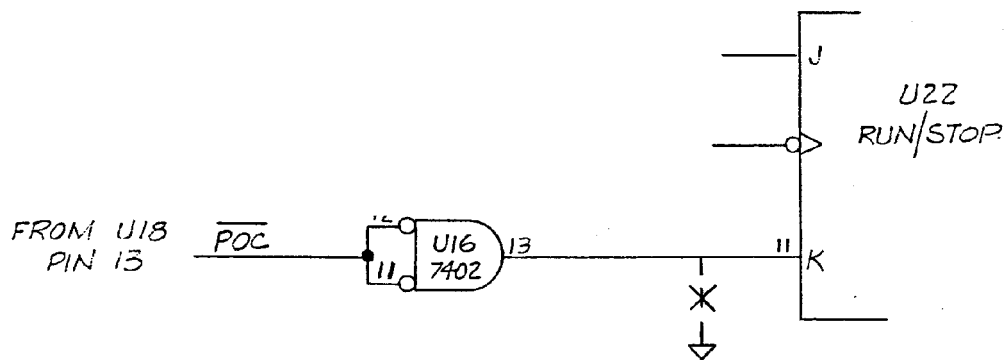


March 5, 1977

CPA REV 4 MODIFICATION

Modification to cause front panel to always come up in "stop" mode at power-up time.

- 1) Cut (comp. side) U-22 pin 11 free. (U-22 pin 11 was connected to U-22 pin 4 (ground) by a heavy trace under the chip.)
- 2) Connect (solder side) U-18 pin 13 to U-16 pins 11 and 12. Connect wire at the pads.
- 3) Connect (solder side) U-16 pin 13 to U-22 pin 11. Connect wire at the pads.



#### ERRATA FOR CPA REV-4 AND EARLIER

1. The following modification must be made to the CPA REV-4 or earlier REV'S if it is to be used with the RAM-16, RAM-32 or RAM-65 memory boards.  
This change makes the signal on backplane line 71 (RUN) agree with the bus definition. The change does not affect the CPA's compatability with other IMSAI products.
2. Refer to Fig 1 and make the following cut on the component side of the board:
  - (a) Cut the trace extending down from U24 pin 9.
3. Refer to Fig 2 and make the following cuts on the solder side of the board.
  - (a) Cut the trace from U24 pin 10 between this pin and feed through A.
  - (b) Cut the trace from feed through B near the spare IC location.
  - (c) Remove the entire pad of the feed through connected to edge connector pin 71.
4. Refer to Fig 2 and install the following jumpers on the solder side of the board.
  - (a) From U22 pin 5 to U24 pin 10.
  - (b) From edge connector pin 71 to U24 pin 9
  - (c) From feed through A to feed through B.
5. Correct the schematic as shown in Fig 3.

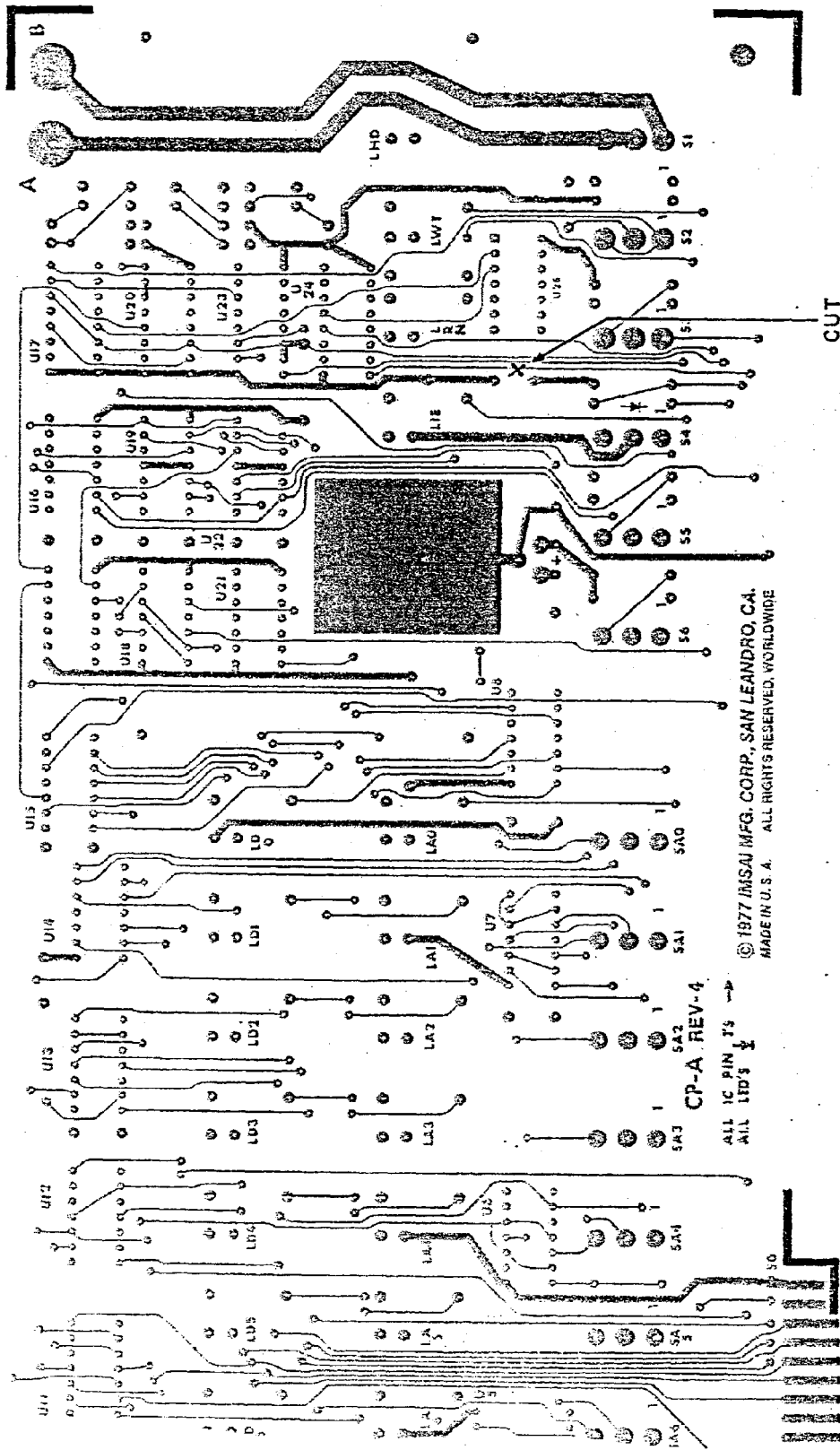


FIGURE 1  
 MODIFICATION TO CPA REV. 4 & EARLIER  
 FOR DYNAMIC RAM OPERATION  
 ECN - 77 - 0039

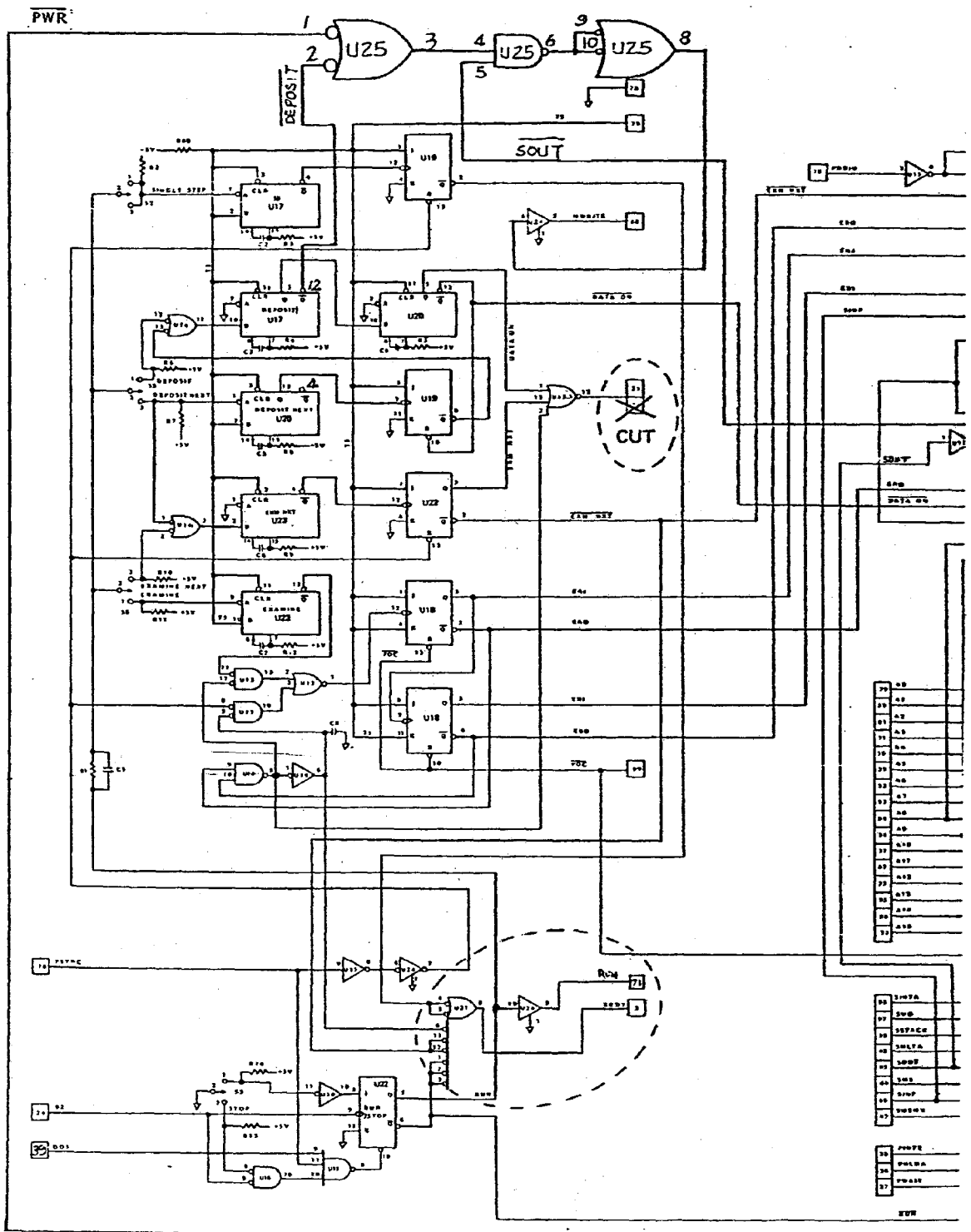


FIGURE 3  
 MODIFICATION TO CPA REV. 4 & EARLIER  
 ECN 77-0039

OPTIONAL MODIFICATION OF CP-A REVISION 4 OR EARLIER CP-A BOARDS  
TO CHANGE POWER SWITCH TO WRITE PROTECT/UNPROTECT SWITCH FOR USE  
WITH RAM 4A BOARDS.

REMOVE CP-A FROM CHASSIS

- A. Remove AC leads from pads A & B on CP-A, route to miniature toggle switch (e.g., C&K type 7101) mounted in  $\frac{1}{4}$ " hole (provided) in rear of chassis. Connect to center and bottom terminals of switch.
- B. Carefully suck solder away from terminals of Power switch on CP-A using a solder sucker or pieces of copper braid. Use enough heat to melt solder, but do not overheat board. Unscrew the Power switch from the bracket and heat all 3 terminals simultaneously. (Use 3 irons, or "timeshare" one--moving between the terminals.) When all 3 terminals are hot enough, the switch will easily lift out. DO NOT PULL. Pulling will damage the pads.
- C. Cut the following traces (refer to diagram):
  - Between center and upper AC Power switch terminal (front side),
  - ground lead going to HOLD light (back side),
  - trace to resistor on HOLD light (after feed through) (back-side),
  - trace to Mother board connector pin 20 (after feed through) (backside),
  - trace to Mother board connector pin 70 (after feed through) (front side).
- D. Re-install a 3-position momentary switch in old AC Power switch position.
- E. Install two 470 Ohm,  $\frac{1}{4}$  watt resistors between ground and the heavy traces from the switch (or to U24 pins 12 & 14).
- F. Install the following jumpers:
  - From +5 to resistor from old HOLD light (other end than LED)
  - From U22 pin 6 to switch center terminal
  - From pin 15 to pin 1 on U24
  - From the heavy trace (to the bottom AC Power switch terminal) to U24 pin 14
  - From the heavy trace (to the top AC power switch terminal) to U24 pin 12
  - From U24 pin 13 to the pad connected to pin 70

OPTIONAL MODIFICATION OF CP-A (Continued)

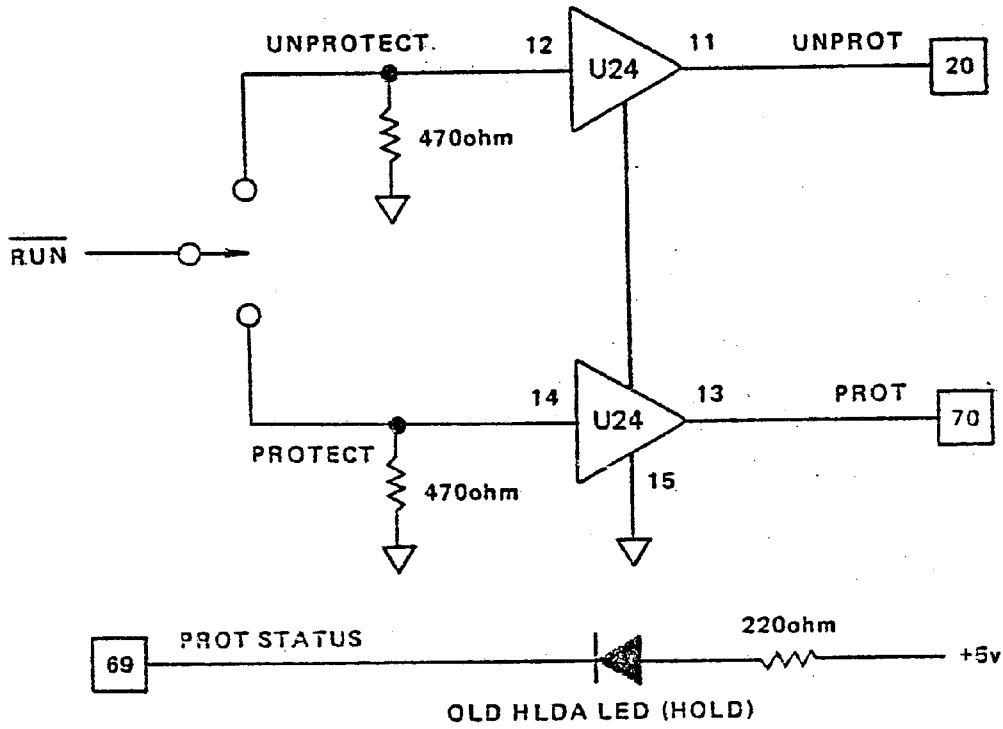
From U24 pin 11 to the pad connected to pin 20

From the bottom terminal of the HOLD light (cut from ground) to pin 69 (solder to the top 1/16" of finger only)

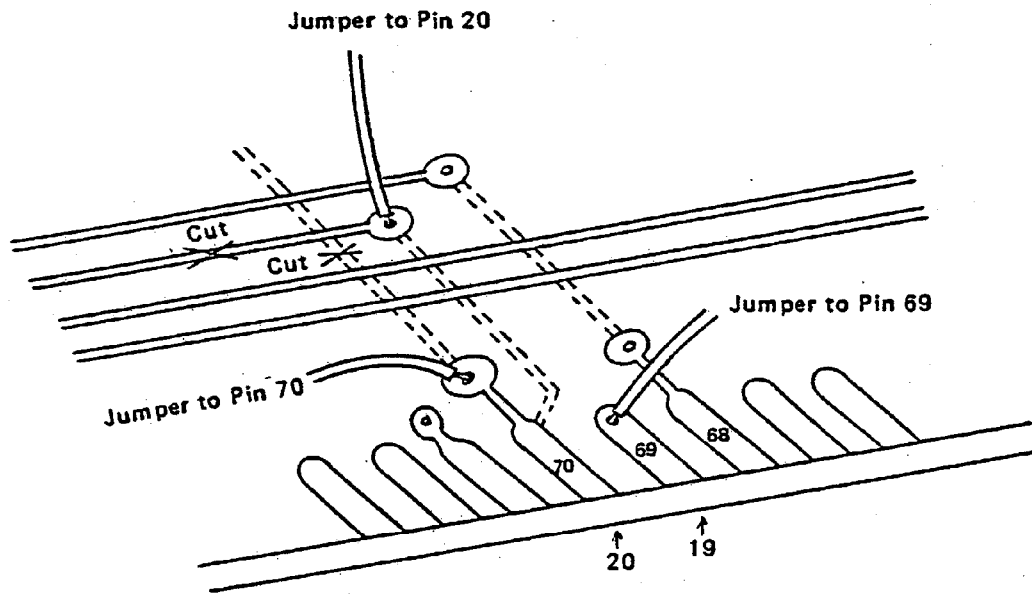
Insert labels to change HOLD (for light) to MEM. PROTECT and to change POWER ON/POWER OFF to PROTECT/UNPROTECT.

Re-assemble CP-A to chassis

The right-hand switch now serves to change the protect status of the currently addressed block of memory when the machine is not in a run mode. The LED which previously showed HOLD status now is lit when the currently addressed block of memory is protected.



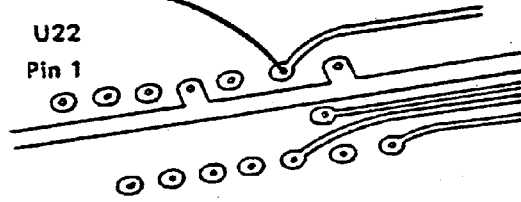
SOLDER SIDE  
( 51 → )





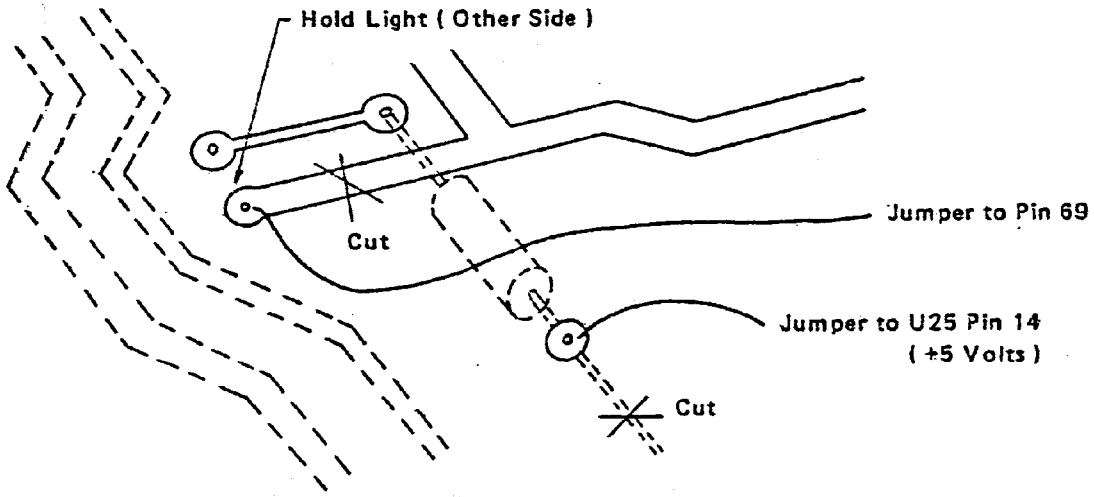
Jumper to U22 Pin 6

U22  
Pin 1

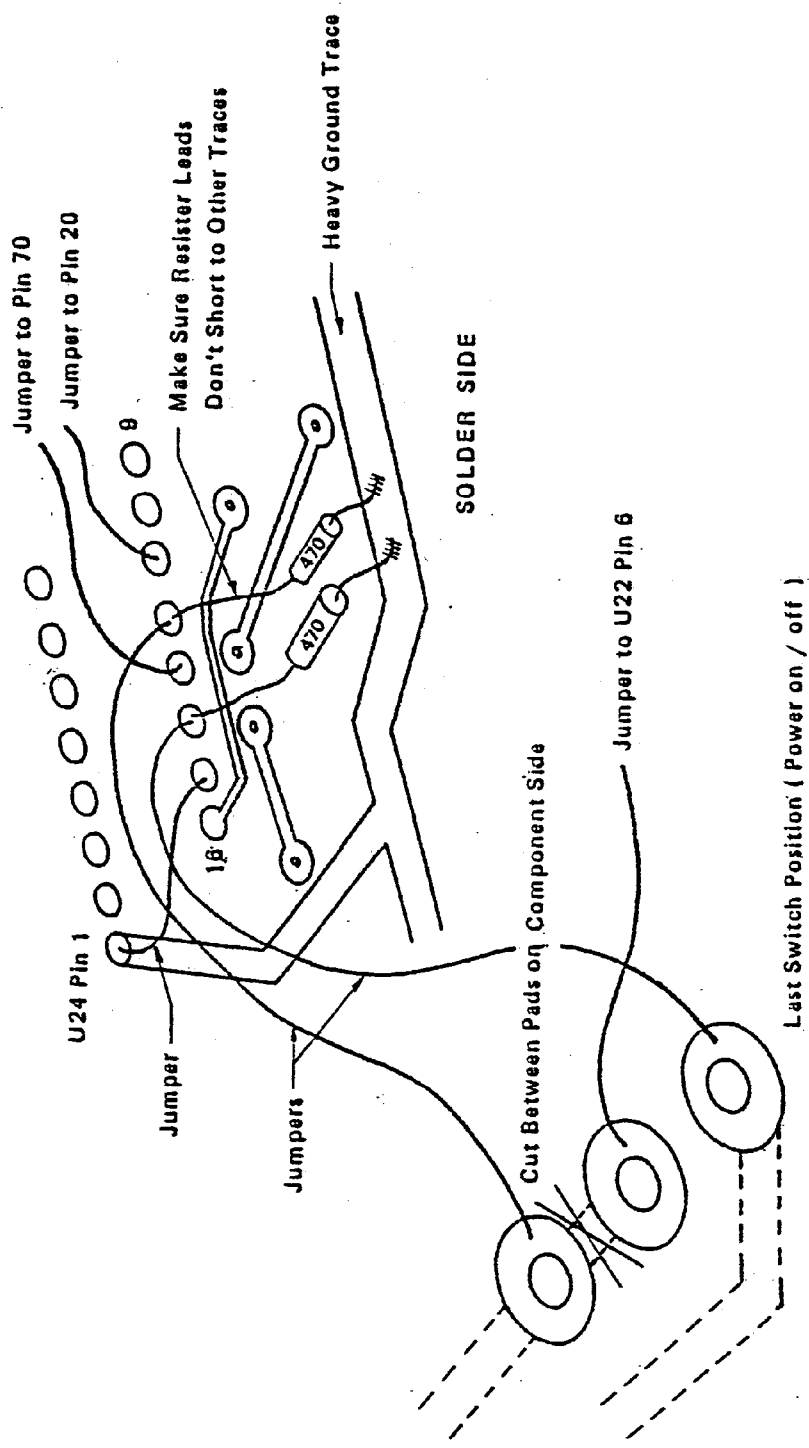


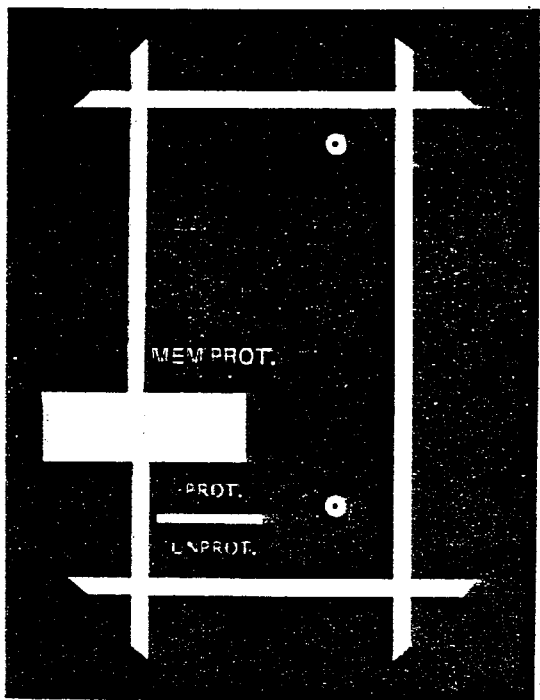
SOLDER SIDE

Hold Light ( Other Side )

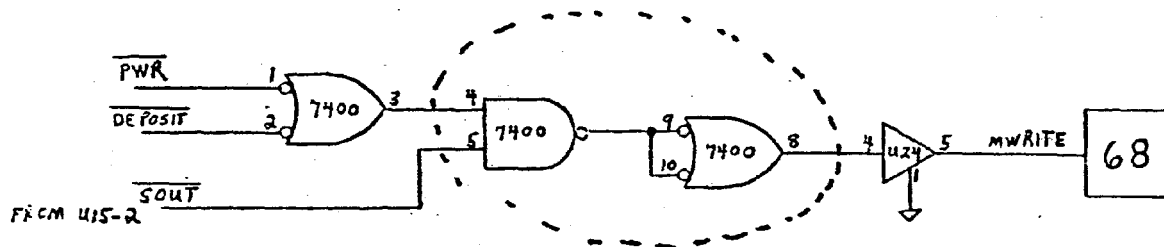


SOLDER SIDE





CP-A FRONT PANEL FOR REVISIONS 3 & 4  
FOR USE WITH NON-IMSAI MEMORY BOARDS



This modification should be made to your front panel board using two additional sections of the 7400 that is located directly above S-2 and S-3. This will keep your unit from writing into memory during an output.

February 3, 1976