EXP-22

Rev-1

USER MANUAL

IMSAI is a division of Parastream Technologies, Inc.

Printed in the USA.

The Standard of Excellence in Vintage Microcomputers

IMSAI

Contents

Preface

From the president of Parastream Technologies, I would like to humbly thank you for your purchase of this classic IMSAI cabinet 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 graciously loaned us the EXP-22 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.

He and I worked together on the layout improvements over the 1975 version. I am very proud of the results of our efforts. It is still true to the original production while being a little bit easier to build.

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 EXP-22 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

Functional Description

The IMSAI 8080 system EXP-22 backplane has 22 connector positions. One is reserved for the front panel board and the other 21 are inside the card cage and are available for the MPU and any combination of memory or I/O cards.

The card-to-card spacing on the backplane is ¾-inch except for the front position which is reserved for the front panel board or the parallel I/O board for the dedicated processor to accommodate mounting the card in the special front position in the cabinet.

The EXP-22 is $^{1}/_{16}$-inch printed circuit board with double-sided plated-through holes. Each of the connector pins is connected by traces on both sides of the board. Heavy power traces are provided to handle the very large currents involved in a fully loaded back plane. The two connectors supplied with the IMSAI system are high-quality gold-plated-contact connectors, for reliable contacts and long life.

Trace spacing is tightly controlled on the board to avoid any close spots where shorts from solder bridges might tend to occur. The traces on the backplane are plated for better appearance and more reliable solder connections. A solder mask is provided on both sides of the board.

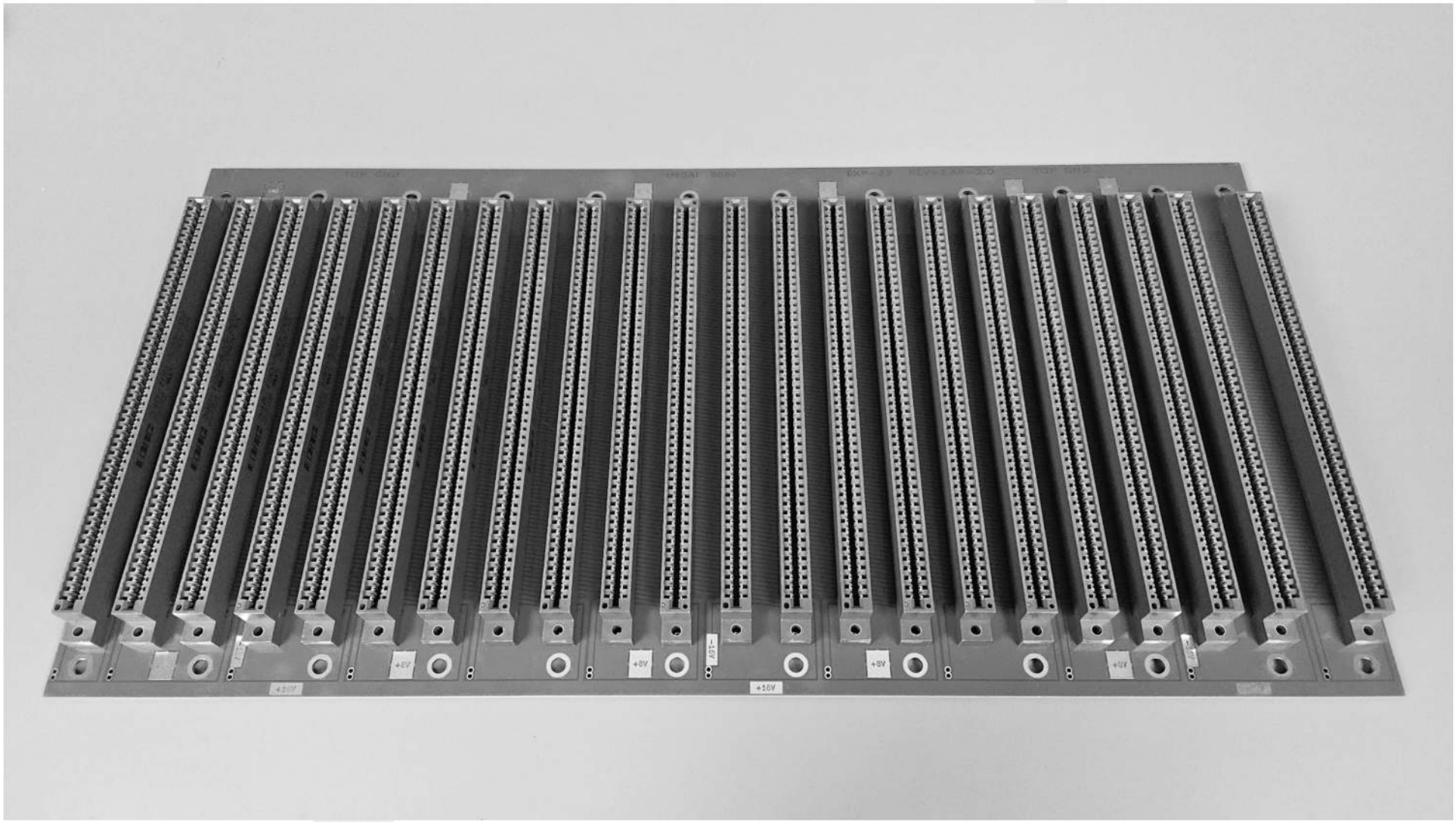

Figure 1. EXP-22, Fully Assembled

Parts List

Item	Part #	Qty	Description
Card Guide	20-00010005	2	IMSAI Card Guide
Nut	21-10120101	24	#6-32 Hex, Large
Washer	21-23125802	48	Shoulder Washer, #6, Fibre
Standoff	21-35123004	24	Female/Female, Hex Threaded, #6-32, ¼", Aluminum
Screw	21-74125012	24	Binding Head, Slotted, #6-32, ¾", Nylon
Connector	24-20010050	2	Card Edge, 0.125" pitch, 100 Pin, Gold
Wire	25-00214000	12" (305mm)	Stranded, 14 AWG, Black, Alpha 891441 BK
Wire	25-00214090	36" (915mm)	Stranded, 14 AWG, White, Alpha 891441 WH
Wire	25-00218030	30" (760mm)	Stranded, 18 AWG, Orange, Alpha 891819 OR
Wire	25-00218040	30" (760mm)	Stranded, 18 AWG, Yellow, Alpha 891819 YL
PC Board	92-20000310	1	Printed Circuit Board, IMSAI EXP-22 Rev-1
Manual	98-15000510	1	IMSAI EXP-22 User Manual

Assembly Instructions

Before you begin, clear your workspace, and try to minimize distractions for the next couple of hours.

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

Tools

In addition to the usual electronics soldering and rework tools, you will need the following:

- $^{11}/_{32}$ inch and $^{7}/_{16}$ inch hex nut drivers.
- $^{1}/_{4}$-inch (6.5 mm) slotted screwdriver.
- Needle nose plier.
- Flush-cutting wire cutters.
- Small hand wire stripper with 14 AWG and 18 AWG wire capacity. Large hand-held strippers are not recommended for this job.
- Temperature controlled soldering station.
- Solder wire of your choice.
    - 37/63 (leaded) solder wire is usually easiest to work with but may not be available in your area. Most solder wire used for rework should be fine.
    - Rosin or no-clean fluxes are recommended, water-clean and others are not recommended. Rosin flux should be cleaned off the board when the assembly is complete using Isopropyl alcohol (IPA) at 90% or better concentration.
- Solder sucker and/or wick to aid in correcting soldering mistakes.

General Assembly Tips

The backplane appears to be the simplest of all the boards to assemble. The solder mask minimizes the chances of shorting adjacent traces. However, it is imperative that extra care be taken during assembly to avoid excess solder shorting adjacent pins. Because shorts on the backplane are extremely hard to locate and correct when it is between the board and the connector, it is worth the builder's time to give special attention to making certain that no such shorts occur. Use only as much solder as required for a good joint. If too much solder is used, either the pool of solder can short to an adjacent pin on the top side or the solder can leak through and form a ball on the backside which can also short to an adjacent pin.

The board should be checked with an ohmmeter carefully both before and after assembly to ensure that it will operate properly. While the chance that incomplete etching during manufacture left two traces shorted is extremely slight, the ohmmeter check before assembly is worthwhile simply because it would be so difficult to correct such a problem after a card edge connector is soldered in place over it.

To test the board, either a simple ohmmeter, a battery connected to a buzzer, or a low-voltage light bulb and test leads are all that is required Each pair of adjacent traces should be checked with the continuity tester to be sure that there is no connection between them. Should any adjacent traces be found to be electrically connected during this pre-assembly check, careful inspection of the board should reveal the short. Any incompletely etched

copper or other metallic path between the two traces should be removed with a sharp knife, such as an X-Acto knife.

After each connector is soldered in, the continuity check should be made again to make certain that during assembly no shorts were created. If any are discovered, steps should be taken to remove them before further assembly. In most cases, this short will have been caused by too much solder having been applied and may be removed simply by removing the excess solder. If an Extender board is available, a simple tester may be made from it by temporarily connecting all the pins on the front side, except pin 1, together, connecting all the pins on the back side, except pin 100, together and then connecting the continuity tester between the two sides of the Extender board. If this extender board is inserted in the card edge connector as it is soldered, the continuity tester will indicate immediately any short between any two adjacent traces.

Card Edge Connector Insertion

The 100 pin card edge connectors are symmetrical so that they may be inserted either way. The connector stands off the board slightly supported by raised feet at each end. Each connector should be checked during assembly to make sure that it is seated properly and that the board near the center of the connector is neither pushed further toward the connector nor lifted away before the connector is soldered in place to prevent the board from bowing.

The board is not completely symmetrical, and the connectors must be inserted from the top side. The top side is the side on which the +8 volt foil is broken every 2 connectors to allow the 2 traces for + and −16 volts to extend from the 16 volt bus at the end of the board into the connector pins. The back side of the board has both the very heavy ground bus and the 1 inch wide 8 volt foil area continuous for the full length of the board. The +16 volt trace is the 0.2-inch trace on the edge of the board alongside the +8 volt bus on the front side, that is, the side where the +8 is broken to allow for the pairs of +16 volt traces to extend into the pins. The −16 volt bus is the 0.2-inch-wide trace along the edge of the board on the back side underneath the +16 volt bus. NOTE: Before mounting any connectors, locate the front of the board. The connector for the front panel (CP-A board) needs to be mounted in the first position at the front of the board. Notice that the spacing between the first and second positions at the front of the backplane is wider than the spacing between any two of the other connector positions.

Before soldering in the first connector, you should decide on how you would like to arrange the card slots in the cabinet.

The suggested procedure for inserting and soldering a connector is to insert the connector in place, seat the two ends firmly against the feet and solder the two pins on each end.

Next, the position of the center of the board next to the connector should be checked and either pushed further toward the connector or pulled away so that the gap between the connector and the board is uniform all the way across. Then the two pins in the center of the connector should be soldered.

One final check should be made to make sure that the gap is uniform all the way across the connector and the remaining pins in the connector should be soldered.

Care should be taken to check each connector after solder to make sure that every pin was soldered because it is easy to miss a pin and not see it during a quick inspection.

Mounting in the Cabinet

Now that the EXP-22 assembly is complete, it's time to install it in the cabinet.

- ☐ Begin by turning the cabinet on its side with the power supply bay above the backplane bay.
- ☐ Locate the twenty-four backplane mounting holes in the cabinet base plate. They are in two rows running from the front to the back, spaced a little over 7 inches (180 mm) apart. Refer to FIGURE 2 for a pictorial of how the backplane mounting system is arranged.
- ☐ In each of the mounting holes, insert a ¾-inch nylon screw and thread on a ¼-inch aluminum standoff. Leave the standoffs where they can move a little, as they will be tightened later.
- ☐ Turn the cabinet over on its feet. Insert a shoulder washer onto each of the twenty-four screws. The flat side of the washer must be in contact with the standoff and the shoulder oriented upwards.
- ☐ Carefully fit the backplane board onto the mounting screws and shoulder washers. You may need to wiggle the board around a bit to get all the shoulder washers to seat.
- ☐ Insert the remaining twenty-four shoulder washers shoulder-down over the screws onto the board.
- ☐ For each of the twenty-four screws, lift the cabinet up enough to get a finger onto the screw head. Thread one of the twenty-four hex nuts onto the screw and hand-tighten.
- ☐ Turn the cabinet back on its side again. For each of the twenty-four screws, use the flat-bladed screwdriver to drive each screw into the standoff between the backplane and the base plate. Do not overtighten; these are nylon screws and are very easy to strip out. Press the backplane board into the base plate while tightening the nylon screw from the other side. If it doesn't want to catch, try pressing on the screw with a finger.
- ☐ Turn the cabinet over on its feet. Using the $^{11}/_{32}$-inch hex nut drivers, tighten all twenty-four hex nuts. Do not overtighten as it is easy to strip out the nylon screw threads.

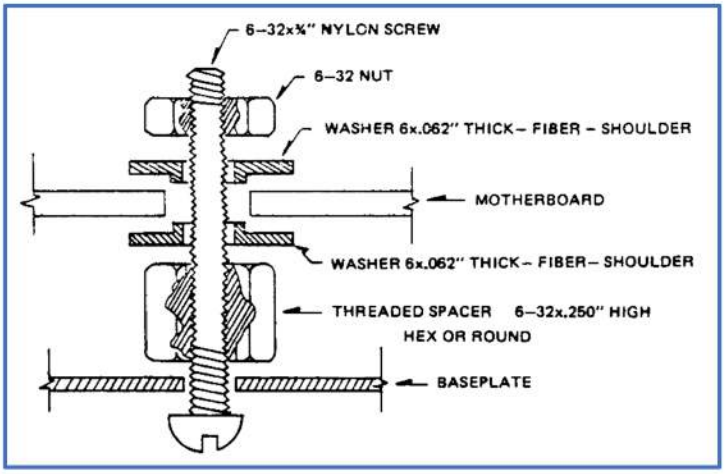

Figure 2. Backplane Mounting Detail

Wiring to the Power Supply

If you have not mounted the power supply in the cabinet, mount it now or at least place it in the power supply bay where it will ultimately be mounted. The procedure is to solder a wire to an EXP-22 pad and cut the wire to the proper length to the power supply and finally solder all the wires to their corresponding power supply pads. Refer to FIGURE 3.

When running the power supply wires across the backplane, be sure not to run over any open card edge connector positions in case you decide to install connectors there later.

- ☐ Locate the length of white #14 hookup wire. Strip approximately ¼ inch (6 mm) from one end. Tin the stripped end with solder. Apply a generous amount of solder to the backmost +8V square pad. Holding the wire with needle nose plier, reflow the wire onto the pad. Locate a +8V power supply pad and cut the wire to length. Do not solder the cut end of the wire to the power supply yet; that is done at the end of this section.
- ☐ Repeat the above procedure with the next two +8V pads. This should use up most of the white wire supplied. Refer to FIGURE 3.
- ☐ Locate the length of black #14 hookup wire. Strip approximately ¼ inch (6 mm) from one end. Tin the stripped end with solder. Apply a generous amount of solder to the backmost GND square pad. Holding the wire with needle nose plier, reflow the wire onto the pad. Locate a GROUND power supply pad and cut the wire to length.
- ☐ Repeat the above procedure with the next two GND pads. This should use up most of the black wire supplied. Refer to FIGURE 3.
- ☐ Locate the length of yellow #18 hookup wire. Strip approximately ¼ inch (6 mm) from one end. Tin the stripped end with solder. Apply a generous amount of solder to the center −16V rectangular pad. Holding the wire with needle nose plier, reflow the wire onto the pad. Locate a −16V power supply pad and cut the wire to length.
- ☐ Repeat the above procedure with the front −16V pad. This should use up most of the yellow wire supplied. Refer to FIGURE 3.
- ☐ Locate the length of orange #18 hookup wire. Strip approximately ¼ inch (6 mm) from one end. Tin the stripped end with solder. Apply a generous amount of solder to the center +16V rectangular pad. Holding the wire with needle nose plier, reflow the wire onto the pad with the wire heading toward the back of the cabinet. Route the wire across the backplane. Refer to FIGURE 3. Locate a +16V power supply pad and cut the wire to length.
- ☐ Repeat the above procedure with the front +16V pad. This should use up most of the orange wire supplied.

- ☐ Raise the power supply onto its mounting screws to gain better access to the wiring pads from underneath the board.
- ☐ Strip approximately ⅛ inch (3 mm) from each of the ten wires from the EXP-22 to the power supply. Run each wire through the pad hole from the bottom of the board and solder from the top side. The black wires go to the GROUND pads, white wires to the +8V pads, orange wires to the +16V pads, and yellow wires to the −16V pads.
- ☐ Reseat the power supply and tighten the mounting nuts.

Figure 3. EXP-22 Wiring Overview

User Guide

With the proper care taken during assembly, the backplane should be the most reliable board in the system. The only attention the user will typically put on the backplane is when more card slot positions are to be added.

IMSAI 8080 Bus Signal List

+8V	1		51	+8V	
+16V	2		52	−16V	
XRDY	3		53	$\overline{\text{SSW DSB}}$	
$\overline{\text{VI 0}}$	4		54	$\overline{\text{EXT CLR}}$	
$\overline{\text{VI 1}}$	5		55	CGND	
$\overline{\text{VI 2}}$	6		56		
$\overline{\text{VI 3}}$	7		57		
$\overline{\text{VI 4}}$	8		58		
$\overline{\text{VI 5}}$	9		59		
$\overline{\text{VI 6}}$	10		60		
$\overline{\text{VI 7}}$	11		61		
	12		62		
	13		63		
	14		64		
	15		65		
	16		66		
	17		67		
$\overline{\text{STATUS DSBL}}$	18		68	MWRITE	
$\overline{\text{CCDSBL}}$	19		69	$\overline{\text{PS}}$	
UNPROT	20		70	PROT	
SS	21		71	RUN	
$\overline{\text{ADDR DSBL}}$	22		72	PRDY	
$\overline{\text{DO DSBL}}$	23		73	$\overline{\text{PINT}}$	
ϕ2	24		74	$\overline{\text{PHOLD}}$	
ϕ1	25		75	$\overline{\text{PRESET}}$	
PHLDA	26		76	PSYNC	
PWAIT	27		77	$\overline{\text{PWR}}$	
PINTE	28		78	PDBIN	
A 5	29		79	A 0	
A 4	30		80	A 1	
A3	31		81	A 2	
A 15	32		82	A 6	
A 12	33		83	A 7	
A 9	34		84	A 8	
DO 1	35		85	A 13	
DO 0	36		86	A 14	
A 10	37		87	A 11	
DO 4	38		88	DO 2	
DO 5	39		89	DO 3	
DO 6	40		90	DO 7	
DI 2	41		91	DI 4	
DI 3	42		92	DI 5	
DI 7	43		93	DI 6	
SMI	44		94	DI 1	
SOUT	45		95	DI 0	
SINP	46		96	SINTA	
SMEMR	47		97	$\overline{\text{SWO}}$	
SHLTA	48		98	SSTACK	
$\overline{\text{CLOCK}}$	49		99	$\overline{\text{POC}}$	
GND	50		100	GND	

IMSAI 8080 System Bus Structure

The IMSAI 8080 System bus structure consists of 100 lines. These are arranged 50 on each side of the plug-in boards, with pins 1 through 50 on the component side and pins 51 through 100 on the back side. As the board is viewed right-side up (components up, 100 pin connector towards you) pin #1 is on the left end on the top and pin 51 is on the back side directly opposite pin #1.

Conventions:

SYMBOLS: "P" prefix indicates a processor command or control signal

"S" prefix indicates a processor status signal

LOADING: All inputs to a card should be loaded with a maximum of 1 TTL low power load

LEVELS: All bus signals except the power supply are TTL. All Data and Address lines are positive TRUE (ground = 0 bit)

DO: Data out from the perspective of the processor. Data written by the processor (to memory or output ports) appears on this bus.

DI: Data in from the perspective of the processor. Data read by the processor (from memory or input ports) appears on this bus.

Bus Definition

Pin	Symbol	Name	Function
1	+8V	+8 volts	Unregulated input to +5V regulators
2	+16V	+16 volts	Positive unregulated voltage
3	XRDY	External Ready	Used by Front Panel: Pulling this line low will cause the processor to enter a WAIT state. XRDY and the normal Ready Line (PRDY) must both be TRUE (high) for the processor to run.
4	$\overline{\text{VI 0}}$	Vectored Interrupt Line #0	
5	$\overline{\text{VI 1}}$	Vectored Interrupt Line #1	
6	$\overline{\text{VI 2}}$	Vectored Interrupt Line #2	
7	$\overline{\text{VI 3}}$	Vectored Interrupt Line #3	
8	$\overline{\text{VI 4}}$	Vectored Interrupt Line #4	
9	$\overline{\text{VI 5}}$	Vectored Interrupt Line #5	
10	$\overline{\text{VI 6}}$	Vectored Interrupt Line #6	
11	$\overline{\text{VI 7}}$	Vectored Interrupt Line #7	

Pin	Symbol	Name	Function
12 to 17	UNUSED		
18	$\overline{\text{STATUS DSBL}}$	STATUS DISABLE	Allows the buffers for the eight status lines to be tri-stated
19	$\overline{\text{CCDSBL}}$	COMMAND CONTROL DISABLE	Allows the buffers for the six output command/control lines to be tri-stated
20	UNPROT	UNPROTECT	Reserved for input to the memory protect flip-flop on a given memory board
21	SS	SINGLE STEP	Used by Front Panel to disable input buffer while panel drives bidirectional data bus
22	$\overline{\text{ADDR DSBL}}$	ADDRESS DISABLE	Allows the buffers for the sixteen address lines to be tri-stated
23	$\overline{\text{DO DSBL}}$	DATA OUT DISABLE	Allows the bidirectional data bus drivers for the eight data lines to be tri-stated for both input and output data buses
24	$\phi 2$	Phase 2 Clock	
25	$\phi 1$	Phase 1 Clock	
26	PHLDA	Hold Acknowledge	Processor control output signal which appears in response to the HOLD signal; indicates that the data and address bus will go to the high impedance state on the 8080. Note: $\overline{\text{ADDR DSBL}}$ and $\overline{\text{DO DSBL}}$ must be driven to tri-state the system bus
27	PWAIT	WAIT	Processor control output signal which acknowledges that the processor is in a WAIT state
28	PINTE	INTERRUPT ENABLE	Processor control output signal indicating interrupts are enabled: may be set or reset by EI and DI instruction and inhibits interrupts from being accepted by the CPU if it is reset
29	A 5	Address Line #5	
30	A 4	Address Line #4	
31	A 3	Address Line #3	
32	A 15	Address Line #15	
33	A 12	Address Line #12	
34	A 9	Address Line #9	
35	DO 1	Data Out Line #1	
36	DO 0	Data Out Line #0	
37	A 10	Address Line #10	
38	DO 4	Data Out Line #4	
39	DO 5	Data Out Line #5	
40	DO 6	Data Out Line #6	
41	DI 2	Data In Line #2	
42	DI 3	Data In Line #3	
43	DI 7	Data In Line #7	

Pin	Symbol	Name	Function
44	SM1	M1	Status output signal that indicates that the processor is in the fetch cycle for the first byte of an instruction
45	SOUT	OUT	Status output signal which indicates that the address bus contains the address of an output device, and the data bus will contain the output data when $\overline{\text{PWR}}$ is active
46	SINP	INP	Status output signal which indicates that that the address bus contains the address of an input device, and the input data should be placed on the data bus when PDBIN is active
47	SMEMR	MEMR	Status output signal which indicates that the data bus will be used for memory read data
48	SHLTA	HLTA	Status output signal which acknowledges a HLT instruction
49	$\overline{\text{CLOCK}}$	CLOCK	2 MHz clock signal, unrelated to ϕ1 and ϕ2
50	GND	GROUND	
51	+8V	+8 volts	Unregulated input to +5V regulators
52	−16V	−16 volts	Negative unregulated voltage
53	$\overline{\text{SSW DSB}}$	SENSE SWITCH DISABLE	Disables the data input buffers so the input from the sense switches may be strobed onto the bidirectional data bus
54	$\overline{\text{EXT CLR}}$	EXTERNAL CLEAR	Clear signal for I/O devices (front panel switch closure to ground)
55	CGND	CHASSIS GROUND	
56 to 67	UNUSED		
68	MWRITE	MEMORY WRITE	From the Front Panel indicates that the current data on the Data Out Bus is to be written into the memory location currently on the address bus
69	$\overline{\text{PS}}$	PROTECT STATUS	Reserved to indicate the status of the memory protect flip-flop on the memory board currently addressed
70	PROT	PROTECT	Reserved for input to the memory protect flip-flop on the memory board currently addressed
71	RUN	RUN	Indicates that the RUN/STOP flip-flop is set to run on the front panel
72	PRDY	READY	Processor command/control input that controls the run state of the processor; if the line is pulled low the processor will enter a wait state until the line is released

Pin	Symbol	Name	Function
73	$\overline{\text{PINT}}$	INTERRUPT REQUEST	The processor recognizes an interrupt request on this line at the end of the current instruction or while halted. If the processor is in the HOLD state or the Interrupt Enable flip-flop is reset, it will not honor the request
74	$\overline{\text{PHOLD}}$	HOLD	Processor command input signal which requests the processor to enter the HOLD state; allows an external device to gain control of address and data buses as soon as the processor has completed its use of these buses for the current machine cycle
75	$\overline{\text{PRESET}}$	RESET	Processor command input; while activated the content of the program counter is cleared and the instruction register is set to 0
76	PSYNC	SYNC	Processor control output provides a signal to indicate the beginning of each machine cycle
77	$\overline{\text{PWR}}$	WRITE	Processor control output used for memory write or I/O output control; data on the data bus is stable while the $\overline{\text{PWR}}$ is active
78	PDBIN	DATA BUS IN	Processor control output signal indicates to external circuits that the data bus is in the input mode
79	A 0	Address Line #0	
80	A 1	Address Line #1	
81	A 2	Address Line #2	
82	A 6	Address Line #6	
83	A 7	Address Line #7	
84	A 8	Address Line #8	
85	A 13	Address Line #13	
86	A 14	Address Line #14	
87	A 11	Address Line #11	
88	DO 2	Data Out Line #2	
89	DO 3	Data Out Line #3	
90	DO 7	Data Out Line #7	
91	DI 4	Data In Line #4	
92	DI 5	Data In Line #5	
93	DI 6	Data In Line #6	
94	DI 1	Data In Line #1	
95	DI 0	Data In Line #0	
96	SINTA	INTA	Status output signal to acknowledge signal for INTERRUPT request
97	$\overline{\text{SWO}}$	WO	Status output signal indicates that the operation in the current machine cycle will be a WRITE memory or output function

Pin	Symbol	Name	Function
98	SSTACK	STACK	Status output signal indicates that the address bus holds the pushdown stack address from the Stack Pointer
99	$\overline{POC}$	Power-On Clear	
100	GND	GROUND	

Specifications

All specifications are at 77°F (25°C) unless otherwise noted.

Dimensions	16.82 × 8.54 × 0.775 in (427.1 × 216.9 × 19.7 mm)
Weight	2 slots installed: 13.4 oz (380 g) 11 slots installed: 1.5 lb (670 g) 22 slots installed: 2.2 lb (1.0 kg)
PC Board Dimensions	16.82 × 8.54 × 0.063 in (427.1 × 216.9 × 1.6 mm)
PC Board Construction	FR4, two-layer 1 oz copper with tin/lead plate (lead-free HASL for the RoHS version) and solder mask on both sides

Table of Figures

Document Revision History

Revision	Date	Initial	Description
DR-1	5/29/2025	REW	Initial release