Forethought Products

BETSI

S-100 Interface/Motherboard

Assembly/Operating Manual

TABLE OF CONTENTS

ASSEMBLY INSTRUCTIONS FOR THE BETSI BOARD

Introduction

Welcome to the growing group of people who are using microcomputer systems in business, control, research, and educational applications. If you are new to electronic kit assembly, let us quote the best advice that we know: "If all else fails, read the instructions." We know it is it exciting to be assembling a computer system of your own, but a few minutes spent to carefully read and study the assembly suggestions can save you much frustration while you're assembling the kit. Don't try to make the assembly more complicated than it is. If each component is properly soldered to each etched pad on the board, the unit will function perfectly. Just take your time on each solder joint and everything will go smoothly.

If you need help or clarification on how to perform some part of the assembly, don't forget your friends or acquaintances who have put together kits before. Your local computer store or computer club usually has someone with experience who is happy to help, too. If all else fails, drop us a note or give us a call at (503) 485-8575. There's usually somone here to answer questions Monday thru Friday 10-5 (West Coast Time). In addition this number rings at a residence on weekends so that you can usually catch us on Saturday and Sunday too.

Tools

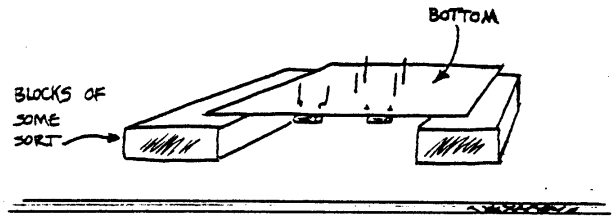
There are a few tools that are necessities for electronic assembly. They are: small screwdriver, diagonal cutting pliers (diagonal wire cutters), and wire stripper (inexpensive adjustable type). You'll need a soldering iron rated 25-42 watts. Irons with elements larger than 42 watts get too hot for heat-sensitive integrated circuits (ICs). A 25 watt unit is recommended as it is difficult to do damage to components with this heat range. You may find it difficult to thoroughly heat larger pads with this wattage, though. The 42 watt types work fine, but should not be left on an IC pin for longer than 4 or 5 seconds at a time. A 1/8" round or flattened tip is usually used. Be sure to get the "long-life" or "iron-clad" type, copper types dissolve while you solder; they're not worth using. When you buy solder, be sure it's "rosin core"; acid core is useless (and damaging) in electrical use. It's usually best to get the smallest (finest) size of solder available. With small solder, you'll have better control over the amount of solder that is applied to each joint. If you run across "multi-core" solder, buy it, it's great.

When you get carried away and end up with too much solder on a joint, a roll of "Solder-up" de-soldering wick will come in handy. You'll also need a slightly damp sponge to keep your soldering tip clean. A magnifying glass (up to 3X) is often

helpful to see what's really happening between those little copper lines.

Work Area

A brightly lit area or good desk lamp is essential. You may also want to find several books, wooden blocks, etc. to support the circuit board during soldering. Placing these under each end of the board will help the components from being bent and give you a steady work surface when the board is turned over for soldering.



Clothing

You may have heard of MOS or CMOS ICs that are damaged by static charges that can build up on you or your equipment. Betsi uses only TTL ICs which are <u>not</u> sensitive to static charges. Now's your chance; put on that Hawaiian shirt made out of 12 different synthetic fibers!

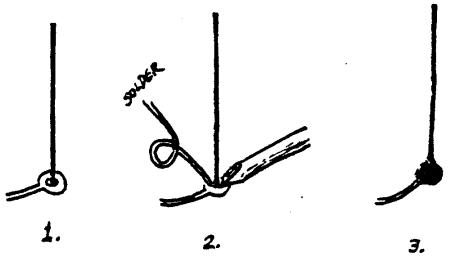
Soldering Technique

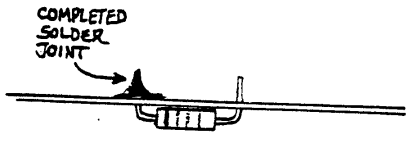
The key to good solder joints is thorough heating of the two metal surfaces which are being soldered together. The most important part of the process is a clean, tinned soldering tip. If the tip is not cleaned, it will get a small film of corrosion over it. This outer covering does not conduct heat. A dirty tip which is pressed against the surface to be soldered will not properly heat one or both of the surfaces.

To properly clean a soldering tip, wipe it against a slightly damp sponge and immediately apply a small amount of solder directly to the tip. Applying this coating of solder to the tip (called "tinning" the tip) slows the process of oxidation (or corrosion) and helps to conduct heat to the solder joint.

The oxidation occurs while the iron is waiting to be used, so CLEAN AND TIN THE TIP JUST BEFORE USE, NOT WHEN IT IS BEING REPLACED IN ITS STAND.

To heat a solder joint, press the tip simultaneously against both surfaces to be joined. Then feed enough solder onto the joint to completely cover the copper pad and form a mound around the wire or IC pin. Remove the solder and keep the iron tip on the joint for another second. This bubbles out any rosin left in the joint.





If the surface of the solder turns dull when it cools (1 to 3 seconds after removing the soldering iron), the joint was not properly heated. Apply the soldering tip to the joint and re-heat it for several seconds. A small bit of fresh solder can be added since the rosin core helps the solder flow over the joint. If you get too big a "blob" on the joint, place a piece of "Solder-up" over the joint and hold the hot iron tip on the braid until the solder is soaked up. You may have to move to fresh braid to remove all the solder on the joint.

While you are soldering you must also watch for "solder bridges" where a piece of solder has stuck to a nearby circuit trace and formed a bridge to another trace. This usually happens when too much solder is applied to a joint and overflows to a nearby trace or pad. It can also happen when a tinned iron is accidentally touched to the board between two or more traces. A small piece of solder can be left behind which shorts the traces together. It should be noted that soldering normally leaves a shiny transparent film of rosin behind on the board. This film is not conductive, and doesn't have the silver color of solder. If in doubt, use a sharp-pointed object to scrape between the traces; rosin will scrape away, solder won't.

Remember to keep the tip clean and tinned. Give the tip an extra coat of solder before you unplug the iron and it will be easier to tin the next time you use it.

ASSEMBLING BETSI

The top side of the Kimsi board can be identified by the "BETSI" and "FORETHOUGHT PRODUCTS" lettering. The bottom side is covered with a green "solder mask" material which helps prevent solder bridges. All parts are inserted from the top of the board and soldered to the bottom side of the board. Refer to the parts placement diagram for the location of each part in the steps below.

IC Sockets. While installing the IC sockets on the Betsi board, you may want to orient them to indicate the 'pin 1' direction that the IC will follow. Some IC sockets have a marking (such as a notch or a molded shape) near one corner or end of the socket. Orienting this mark in the same direcion that the IC's pin 1 should point will aid in orienting the IC when it is inserted later. The orientation of the socket does not actually affect the operation of the unit in any way.

Insert 14-pin sockets for IC2-11. Insert 16-pin sockets for IC1, 12, and 13. Insert a 20-pin socket for IC14, and insert 24-pin sockets for P1-P4. To hold the sockets in place for soldering, place a flat piece of wood (or thick cardboard) on top of the sockets and tape the wood to the circuit board (so the sockets are sandwiched between the wood and the Betsi board). Alternately, masking tape can be placed over each socket to hold it in place. Be sure each socket is held tightly against the board; then flip the board over and solder each pin to its pad on the bottom of the board.

R1-R3. Using the Betsi Parts List, identify resistors R1-R3 and insert them in their proper locations on the board. Then solder and clip the leads.

C1-C6. Mount these capacitors as close to the board as possible. Insert discs C1-C5, solder and clip the leads. Insert the dipped mica capacitor C6, solder and clip the leads.

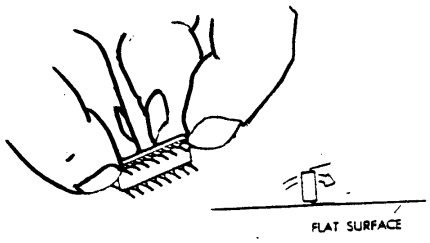
C7. This polarized capacitor MUST be inserted with the end marked '+' connected to the circuit board pad marked '+'. Insert C7, solder, and clip the leads.

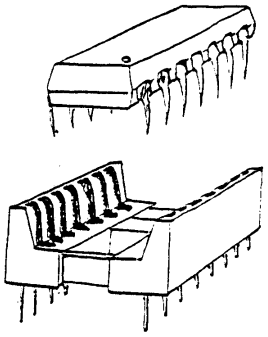
Voltage Regulator. VR1 is mounted with its metal tab in contact with the circuit board. The leads should be bent to fit into the three holes near the large pad which VR1 is mounted on. Mount the VR with a 6/32 screw from the top side and a nut on the bottom side of the board. After tightening the nut, solder the three leads and clip any excess.

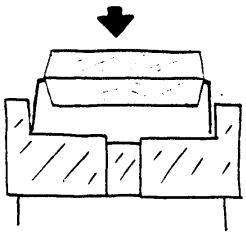
IC Insertion. ICs are usually stamped with two numbers as well as the manufacturer's initials or symbol. The first number (often on the upper part of the chip) is a three or four digit date code. The second number is the type code which identifies the function that the chip performs. It is usually six or

seven digits long, often ends with an 'A' or 'N', and may have a prefix which can be ignored.

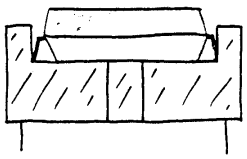
Each IC is inserted by referring its type number to the Parts Placement Diagram (ie. IC1 is a 74123 type IC). Each IC has a mark to identify its 'pin 1' end (see illustration in the Parts List). Pin 1 of each IC MUST point in the direction shown in the Parts Placement Diagram. Since IC's are shipped with their pins bent slightly outward, each IC should be placed against a flat surface and 'rolled' slightly to bring the pins to a 90° angle with the IC body as shown below.







IC being inserted into socket



IC inserted into socket

After inserting all the ICs into their sockets, recheck that each one is in its proper socket and is oriented in the right direction. Also check that no pins are outside the socket or bent underneath the IC. Pins bent underneath are very hard to spot, so look closely for this.

Pet Connector. The connector which connects Betsi to PET is inserted into the two rows of holes nearest the bottom edge of the board. This unit is not the most cooperative one to install as there are always a few pins that don't quite line up with the holes. It's best to align and insert one row of pins at a time. Fit the front row of pins in place and use a pencil, needle nose pliers, etc., to nudge the mis-aligned pins into their holes. After the front row of pins is inserted, roll the connector slightly and repeat the procedure for the back row while keeping the front row in place. Make sure the connector body is pressed down tightly against the circuit board and solder the pins in place. No additional mechanical support is needed for the connector body. The square pins of the connector are very strong and have no trouble supporting the connector when Betsi is being attached to the PET.

100-Pin Connectors. 100-pin connectors may be installed and used in any of the four available motherboard locations. However,if only one connector is going to be installed in the board it is recommended that the position nearest the PET connector be used. This will keep the S-100 board in a close, compact position to the PET.

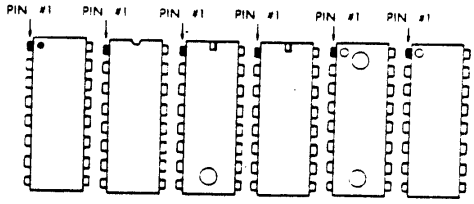
Insert the connector in place and MAKE SURE IT IS FIRMLY SEATED against the board. A connector that is soldered in place crooked is all but impossible to fix. Turn the board over and solder each pin to the board. After soldering, check carefully for solder bridges.

Mounting Holes. Betsi may be mounted in a user supplied enclosure using the mounting holes in the circuit board near the ends of the S-100 connectors.

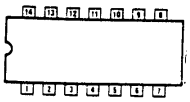
To support the board without an enclosure, use the eight 1" screws included. On each screw, fit one thick and one thin fibre washer, insert thru the Betsi board, and secure with a nut on the bottom side of the board. To tighten the screws, hold the nut stationary and tighten using a screw driver (rotating the nut or overtightening the screw can cause damage to the board's solder mask).

Betsi Parts List

C1-C5	.1 uf disc capacitor
C6	22 pf silver mica capacitor
C7	22 mf/15V electrolitic capacitor
IC1	74123
IC2	74LS02
IC3-IC4	74LS00
IC5	74LS02
IC6	74LS04
IC7	74LS20
IC8-IC10	74LS30
IC11	74LS10
IC12-IC13	74LS157
IC14	81LS95 or 81LS97



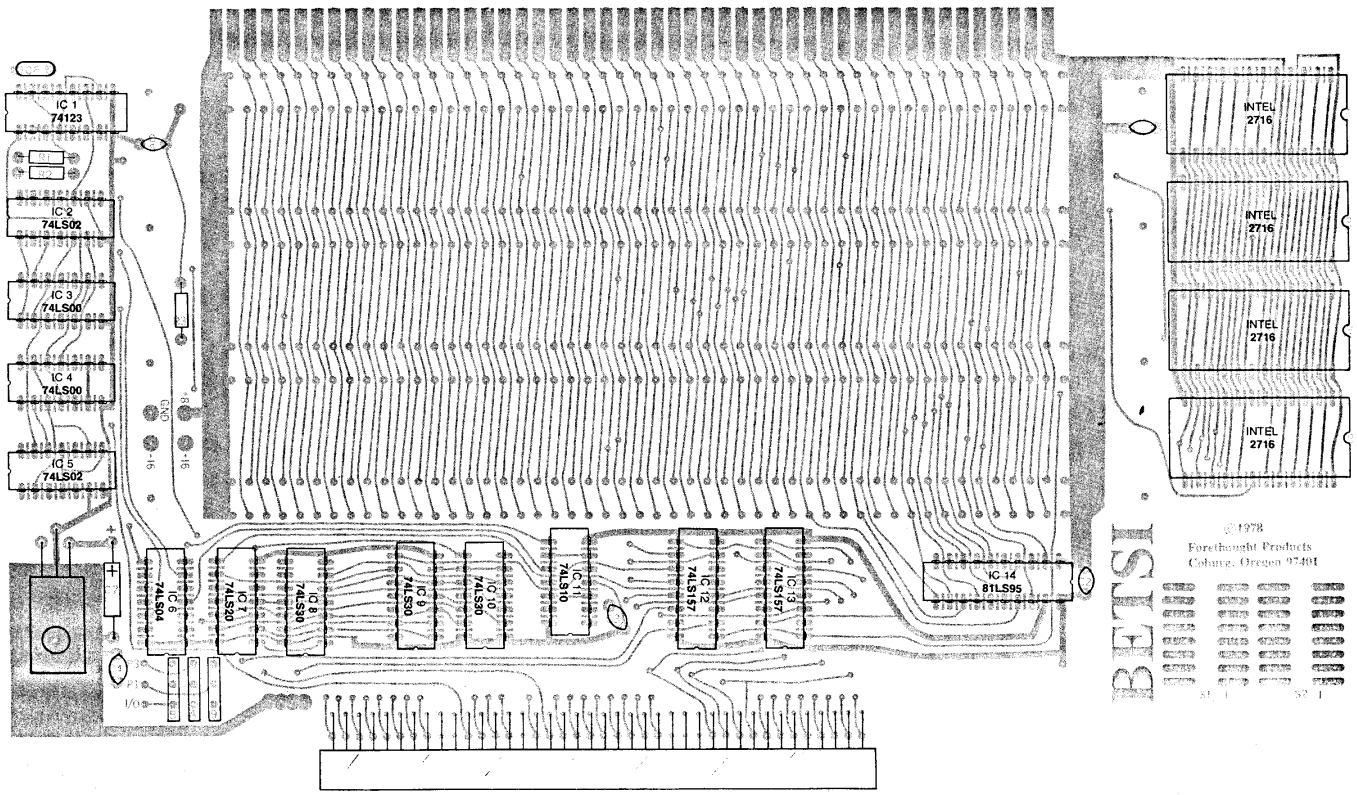
IC TOP VIEW showing various notches and markings which designate the pin 1 end of the IC.



IC TOP VIEW showing pin numbering of IC

P1-P4	(for future use) Intel type 2716 EPROM
R1-R2	6.8K ohm resistor (blue, gray, red, gold)
R3	1K ohm resistor (brown, black, red, gold) or 2.2K ohm resistor (red, red, red, gold)
S1-S2	Spare IC area for optional circuit prototyping
VR1	LM340T-5 or 7805 voltage regulator

Betsi Parts Placement Diagram



BETSI OPERATING INSTRUCTIONS

Power for the Betsi board

Power for the Betsi interface circuitry as well as the S-100 boards used in the system can be supplied by any S-100 type power supply. It should provide Betsi with the following unregulated voltages: +8-10V, +16-20V, -16-20V. The Betsi board requires only the +8 voltage for operation, as do many static memory boards. The +16 and -16 voltages may not be needed for some applications; check the voltage requirements of the S-100 boards that you plan to use in your system.

The amount of current (amps) will increase as S-100 boards are added to the system; the following should give you an idea of what to expect.

	+8	+16	-16
Betsi witnout any S-100 boards	120ma	-	-
Betsi with 8K static RAM board	1.5A	-	-
Betsi with 32K EXPANDO-RAM	520ma	100ma	35ma
Betsi with 4 typical S-100 boards	5A	500ma	200ma

Power supply lines are connected to Betsi thru the four pads marked GND (ground), +8, +16, and -16. Routing of these lines is not critical. They may be connected from the top or the bottom side of the board. Use heaver wire (14-16 gauge) for +8 and GND if the supply is any distance from the Betsi board.

Power-up

Before connecting the Betsi to PET, it is a good idea to make some preliminary tests. First, without connecting the Betsi to PET, apply power to Betsi alone. Should there be any smoke or red hot parts, you'll know right away where the problem is (usually a part that was installed backwards). Forgoing any excitement of that magnitude, check the voltage coming out of the voltage regulator (VR) if you have a voltmeter available. Touch the negative probe to the VR's mounting screw and the positive probe to the VR's pin which is nearest to the edge of the board. The reading should be approximately 5 volts. Problems with the VR can be due to unsoldered VR leads (VR cold), shorted power traces on the board (VR hot), or a defective VR (voltage low, VR cold).

Second, remove power from the Betsi board, and make sure the PET is turned off. Connect Betsi to the PET pushing it firmly onto the expansion connector on the right side of PET's case. Without applying power to Betsi, turn the PET on and wait for it to display its power-up message. If the message does not appear, there is a problem with the Betsi board. A solder bridge or other problem has shorted together an address or data line on the board. Turn the PET off, remove Betsi, and inspect it carefully for a short circuit between an IC or S-100 connector pins.

If the Betsi passes the two tests above, connect the Betsi to PET and apply power to Betsi. Turn PET on and make sure that the power-up message is displayed. If not, check for an IC that has been inserted backwards (pin 1 pointing the wrong direction).

In most applications the Betsi board should be connected to the PET and powered-up before the PET is turned on. The units may actually be turned on or off in any order as long as they remain attached to each other. However, both units should be turned off when Betsi is being connected or disconnected from PET. In addition, S-100 cards must NEVER be inserted or removed from Betsi unless the power to Betsi is OFF.

Connecting S-100 cards

All S-100 boards plug into Betsi with their component side toward the PET computer. It is best to insert one by grasping the lower corners of the board and pressing it into place (pressure on the top of the board can be disastrous if you slip).

NEVER add or remove an S-100 board from Betsi with Betsi turned on. Damage can result to the board being inserted or removed. If a board doesn't seem to work, turn off the power and try reinserting it into the slot. Boards can function improperly if they are not fully "seated" into the S-100 connector.

PET Operation with Betsi

Betsi has been engineered so as not to disrupt the operation of PET in any way. The Betsi should be connected to PET and powered-up before PET is turned on. PET will then start-up noting in its "BYTES FREE" message any extra memory that is connected to Betsi. In addition to extra memory being usable with PET's BASIC, S-100 memory and I/O boards on Betsi can also be accessed using the PEEK, POKE, SYS, and USR commands.

System Map

The PET computer has specific reserved areas of its memory for expansion. A chart showing these areas is found in Commodore's "An Introduction To Your New PET," page 24. The areas not yet in use are hex address 1000-7FFF (for RAM expansion) and 9000-BFFF (for ROM expansion). Any S-100 boards used with Betsi must fall within these address areas to be recognized (the address expansion area from 1000-1FFF is already used on 8K PETs). In addition there are specific areas which can be set aside for use by the on-board PROM sockets and calls to S-100 I/O 'ports'. These options are discussed in the following sections.

Choosing S-100 RAM boards

A Random Access Memory (RAM) card used with Betsi must meet two requirements. First (with the exception of the SD Sales EXPANDO-RAM) it must be a 'static' type memory rather than 'dynamic' types. Dynamic RAM boards with "invisible refresh" or other advertising claims are designed specifically for 8080 CPU systems and will not function correctly with PET or Betsi. The only exception to this rule is the SD Sales EXPANDO-RAM dynamic memory board which is usable with Betsi due to the on-board refresh controller provided especially for this board. Second, all RAM boards must have an access time of 500 ns or less. At least 90% of the S-100 RAM boards currently available fall into both these categories (static RAM 500 ns or faster). Any of them should work well with Betsi.

Using S-100 RAM boards

When adding RAM to the PET, keep in mind that all memory must be contiguous. That is, each new memory block must be set to the address immediately above the memory that already exists. Upon power-on, the PET computer searches its RAM area starting at 1000 and going upward. It writes and reads to each cell until it finds one that fails (ie. does not read back the same data written). This point is considered the top of the usable memory area. If the added RAM boards are not positioned to form a continuous block of memory the PET monitor will locate the empty area between them and ignore any memory above that point.

Each S-100 RAM card is supplied with switches or jumpers on the card which allow you to set its address or location within the

system. Since the PET's RAM ends at hex address 1FFF (0FFF in 4K systems) the first RAM board added to the system should be at address 2000 (1000 for a 4K PET). Memory blocks may be added up to PET's 32K limit. Remember that since the 32K limit includes PET's internal memory, an 8K PET can use a maximum of 24K external (S-100) RAM. Any memory cells above address 7FFF will be ignored by the PET's BASIC.

Using On-board PROMs

The Betsi board contains on-board sockets (P1-P4) which can hold up to four Intel 2716 type Programmable Read Only Memory (PROM) chips without the need for an additional S-100 board. These sockets can be used either for specialized PET firmware that may be available in the future, or user installed custom software.

To use PROM sockets P1-P4, it must first be determined at what address the PROM should reside (this information will normally be furnished with the PROM). The PROM should then be placed in the proper socket, and if necessary changes made to Betsi's jumper area (near VR1) to locate it at the proper address. The following table describes the effects of the two jumpers on the PROM locations.

Jumper	P1	P2	P3	P4
P1 to '9'	9000-97FF	9800-9FFF		
P3 to 'A'			A000-A7FF	A800-AFFF
P1 to 'A'	A000-A7FF	A800-AFFF		
P3 to 'B'			B000-B7FF	B800-BFFF

Jumper P1 affects P1 and P2 only.
Jumper P3 affects P3 and P4 only.

Jumpers may be made in any combination of the above (such as P1 to '9' and P3 to 'B'), but P1 and P3 should not both be jumpered to the same address area. The Betsi board is supplied with P1 and P3 pre-jumpered to '9' and 'A' respectively. If changes are made to either of these jumpers, the existing jumpers (traces) from P1, P3 and I/O should be cut to avoid addressing conflicts. If PROMs are not used with your Betsi, it is not necessary to cut or change jumpers P1 or P3. They will not affect the system in any way until PROMs are actually plugged into sockets P1-P4.

Using S-100 PROM boards

PROMs containing software/firmware for PET can also be used with Betsi by mounting them on any of the commonly available S-100 PROM boards. These PROMs must fall into either the area normally used for RAM expansion (1000-7FFF) or ROM expansion (9000-BFFF). In addition, their location should not conflict with other S-100 boards, any on-board PROMs (P1-P4) which are in-

stalled in the system, or Betsi's I/O area. PROMs used with PET must have an access time of 450 ns or faster.

Using S-100 I/O boards

Many S-100 Input/Output (I/O) boards may be used with Betsi to connect to the 'outside world'. These boards are usually compatible with Betsi unless they exceed the 450 ns access requirement, or use the PRDY line to attempt stopping the processor (PET's hardware will not 'stop' or 'wait' for any S-100 board). S-100 I/O boards do not respond to normal memory addresses like system RAM or PROM, but communicate thru a one byte 'port' number. Any one of the 256 possible port numbers (00-FF hex, 0-256 decimal) are normally called with the 8080's IN or OUT instructions. Since the PET's 6502 CPU does not have the IN or OUT instructions, a special memory address area has been set aside to communicate with these ports.

When S-100 I/O boards are used with Betsi, the port number for each board is selected (via the switches or jumpers on the S-100 board) in the normal manner (this may be any number which is easy to use or remember). Note that there may be both an input port and an output port with the same number. Input port #5 or output port #5 will respond depending on whether a PEEK (input) command or a POKE (output) command is used to call the port.

The special address area that has been set aside to handle I/O ports is pre-jumpered to address BF00 (48896 decimal). An I/O port is read/written to by adding the port number to this location and using PEEK or POKE. For example, you would read data from port #0 using PEEK (48896) or write a 1 into port #5 using POKE 48901,1. You could also use PEEK (48896 + X) where X equals the port number.

If the pre-jumpered I/O area conflicts with another memory use (such as a PROM that resides at BF00-BFFF), it may be jumpered to a new area as shown below.

Jumper	Hex area used	Decimal address for I/O calls
I/O to '9'	9F00-9FFF	40704 + port number
I/O to 'A'	AF00-AFFF	44800 + port number
I/O to 'B'	BF00-BFFF	48896 + port number

If the I/O jumper is changed, remember to cut the existing jumper trace which is etched onto the board. If the existing trace is cut and no jumper is installed, there will be no I/O area in the system.

Using S-100 Video Display boards

Should an additional video board be needed in your system, most S-100 video display boards for the S-100 bus are accessed thru both memory address locatons and I/O ports. They are treated and used in the same manner as additional system RAM or I/O

ports would normally be. Remember that most of these boards are random access displays. Software routines are necessary to make these boards act as a regular CRT. NOTE: the Cromemco TV Dazzler video board attempts to stop the CPU during processing and is not compatible with PET/Betsi.

Using PROM Programmers

There are several different types of PROM programmer boards which plug into the S-100 bus. In addition, there are several programmer modules which can be used with S-100 systems. These do not plug into the bus, but are out-board (self contained) units which connect by cable to user provided I/O ports.

In the first category, boards which plug directly into the bus, there are some which program via memory addressing. These boards (such as Cromemco's BYTESAVER) require that the CPU stops (or waits) during a write instruction for programming to take place. Since the 6502 processor will not "wait" during a write cycle, these boards will not function properly in a PET/Betsi system. Other boards (such as the PROM SETTER from Szerlip Enterprises) are addressed as I/O ports and should work well with Betsi.

The second category, out-board programming units, do not present any problems for the PET/Betsi system since they are used in conjunction with typical parallel I/O ports and do not connect directly to the S-100 bus.

Problems with S-100 Bus Boards

Here are a few tips for using S-100 bus boards.

If the PET does not recognize a new RAM board, double check the address selection jumpers or switch settings on the S-100 board; this is an easy place to make a mistake.

Each board you add to your system draws additional power from your power supply. Be sure you have enough power available or erratic operation may result. Most S-100 boards must have a minimum input voltage of approximately 7 volts; boards with battery backup circuitry need 7.5 or 8 volts.

Watch out for those heat sinks. They can and do run quite warm (hot). Try to avoid skin contact with them while you're poking around. This tip won't fix your system, but at least your system won't fix you.

When using PEEK, POKE and SYS, remember that hexidecimal locations must be converted to their decimal equivalents for these instructions.

ADDITIONAL HARDWARE INFORMATION

INTERRUPTS. The S-100 bus interrupt line (pin 73 is connected directly to $\overline{IRQ}$ on PET. S-100 boards may interrupt PET via this line as they would an 8080.

RESET. PET may be reset from the S-100 bus by pulling the Power-On Clear (POC) line, pin 99, or Processor Reset (PRESET) line, pin 75, low. In addition, both of these lines will go low briefly when the PET is turned on. They may be used to reset external units which should be cleared during power-up.

USING BETSI IN AN S-100 MAINFRAME. In addition to its use as a stand alone motherboard, Betsi can also be used as an interface between PET and an existing S-100 mainframe. To use Betsi for this purpose a cable is installed between Betsi's edge connector pads (where the pins of the PET connector are usually installed), and the PET connector. Note that the entire top row of pins on the PET connector are connected in common (to GND) on the bottom side of the Betsi board. Forty separate lines are not needed for these pins; two or three lines will carry the GND signal adequately. Each of the 40 pins on the bottom row of the PET connector should be connected (via a cable) to its corresponding pad on the edge of the Betsi board. The length of cable used should be kept to a minimum. Lengths greater than 12" will probably prove unsuitable in some applications.

Before using Betsi in another S-100 mainframe, be certain to remove any external power supply leads from Betsi (power will be provided by the S-100 bus in the mainframe). Betsi/PET will act as the CPU board for the bus. Any other CPU board in the mainframe must be removed. Consideration should also be given to the drivers on Betsi which may not function reliable with more than ten S-100 boards on the bus.

S-100 COMPATIBILITY. In using an S-100 bus compatible system, several things should be remembered. First, the S-100 bus was designed around the 8080 CPU. Bus lines which reflect a signal unique to the 8080 processor (such as pin 29 which indicates the status of the internal interrupt enable flag) are difficult to simulate since there is no similar 6502/6800 signal. The lack of these signals rarely causes a problem. They are generally used only with boards which work specifically with the 8080 CPU.

Second, the S-100 bus is not yet a standard. Few manufacturers use all the defined pins on the bus and many differ in their use of each pin. With the many similar, unnecessary, and redundant pin functions on the S-100 bus, it is becoming more of a mess and less of a standard. If you have trouble using an S-100 board that is new to your system, take a minute to check the board's schematic. See which signals are used by the board and compare these pin numbers with the Betsi "S-100 Bus Definition". If the Betsi use (noted in parenthesis) of any pin differs from

the standard S-100 bus usage, modification of the S-100 board may be necessary. Forethought Products will supply modification information and make application notes available on S-100 boards which are found to be not plug-compatible with Kimsi. If you suspect a board to be incompatible with Kimsi, send us the schematic and operating information for the board and it will receive our immediate attention.

The best "weapon" against bugs is to stick with boards that are known to be Betsi compatible and to make such information available to all Betsi users. If you have an S-100 bus board that you're happy with, drop us a note so that it can be added to the list. If you've found a problem with a board, send us a schematic and tell us about the problem. If your letter requires a reply, please include a return envelope.

S-100 / Betsi Bus Definition

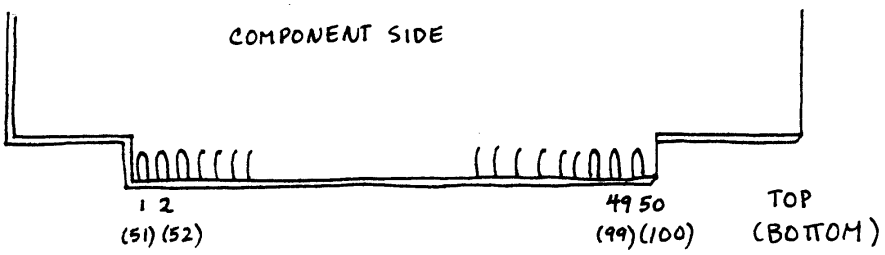
The following definition is given for the standard S-100 bus. Differences or comments about the Betsi/S-100 bus are shown in parentheses. All signals are TTL. Address and data lines are TRUE logic (1 = high) . "P" prefix indicates a processor command or control signal; "S" prefix indicates a processor status signal.

PIN	SYMBOL	USE
1	+8V	+8 volts - Unregulated input to 5V regulators
2	+16V	+16 volts - Source of positive unregulated voltage.
3	XRDY	External Ready (not used).
4	VI0	Vectored Interrupt Line 0 (not used).
5	VI1	
6	VI2	
7	VI3	
8	VI4	
9	VI5	
10	VI6	
11	VI7	
12-17	UNUSED	
18	$\overline{\text{STATUS DSBL}}$	Tri-states the 8 status lines (not used).
19	$\overline{\text{CC DSBL}}$	Tri-states the 6 command/control lines (not used).
20	UNPROT	Unprotects currently addressed memory board (tied low).
21	SS	Single step control (not used).
22	$\overline{\text{ADDR DSBL}}$	Tri-states the address lines (not used).
23	$\overline{\text{DO DSBL}}$	Tri-states the data lines (not used).
24	Ø2	Phase 2 clock.
25	Ø1	Phase 1 clock.
26	PHLDA	Hold Acknowledge (not used).
27	PWAIT	Acknowledges that processor is waiting (tied low).
28	PINTE	Indicates interrupt enabled (not used).

29	A5	Address line 5
30	A4	
31	A3	
32	A15	
33	A12	
34	A9	
35	DO1	Data Out line 1
36	DO0	
37	A10	
38	DO4	
39	DO5	
40	DO6	
41	DI2	Data In line 2
42	DI3	
43	DI7	
44	SMI	Indicates a processor fetch cycle (not used).
45	SOUT	Indicates that address bus contains address of an output device, data bus is stable when $\overline{\text{PWR}}$.
46	SINP	Indicates address bus contains address of input device, data should be placed on bus when PDBIN.
47	SMEMR	Current cycle will be a memory read.
48	SHLTA	Acknowledges a HALT instruction (not used).
49	$\overline{\text{CLOCK}}$	2 MHz clock signal (not used).
50	GND	Ground
51	+8V	
52	-16V	Source of negative unregulated voltage.
53	$\overline{\text{SSW DSB}}$	Sense switch disable (not used).
54	$\overline{\text{EXT CLR}}$	External clear (pulled up by 1K ohm resister to +5V).
55-66	NOT USED	
66	$\overline{\text{RFSH}}$	Refresh signal to dynamic RAM boards (usable only with S.D. Sales Expandoram board)
67	$\overline{\text{PHANTOM}}$	Disables some RAM boards during power-up (not used).

68	MWRITE	Data on the Data Out bus is to be written into the currently addressed memory location.
69	$\overline{PS}$	Used to indicate the status of protected memory boards (not used).
70	PROT	Protects currently addressed memory board (tied low).
71	RUN	STOP/RUN signal from front panel (not used).
72	PRDY	Pull low to freeze processor at current address (not used).
73	$\overline{PINT}$	Interrupt Request - Request is not honored if the processor is in a HOLD state or if the interrupt disable flag is set (connected to PET's $\overline{INT}$ line).
74	$\overline{PHOLD}$	Processor HOLD request (not used).
75	$\overline{PRESET}$	Processor Reset - Program counter is cleared and instruction register is set to 0 (resets PET).
76	PSYNC	Indicates the beginning of each machine cycle.
77	$\overline{PWR}$	Processor Write - Data on the Data Out bus is stable when $\overline{PWR}$.
78	PDBIN	Processor Data Bus In - Data should be placed on the Data In bus when PDBIN.
79	A0	Address line 0
80	A1	
81	A2	
82	A6	
83	A7	
84	A8	
85	A13	
86	A14	
87	A11	
88	DO2	Data Out line 2
89	DO3	
90	DO7	
91	DI4	Data In line 4
92	DI5	
93	DI6	
94	DI1	
95	DI0	
96	SINTA	Interrupt Acknowledge (not used).

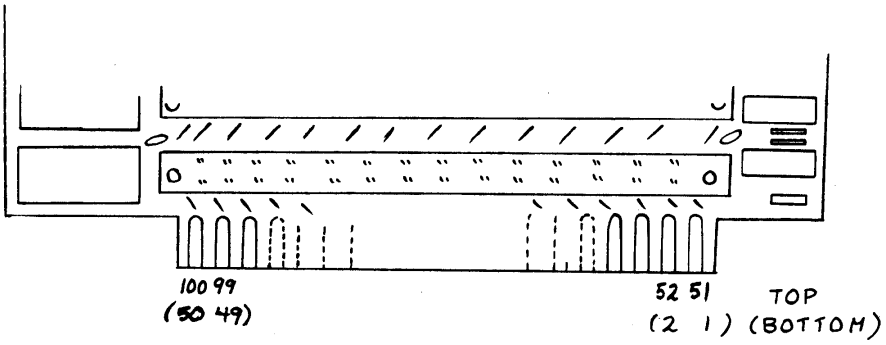
97	SWO	Current machine cycle will be a write memory or output function (same as $\overline{R/W}$ from 6502).
98	SSTACK	Indicates that the address bus holds the pushdown stack address from the Stack Pointer (not used).
99	$\overline{POC}$	Power-On Clear (Resets the PET).
100	GND	Ground



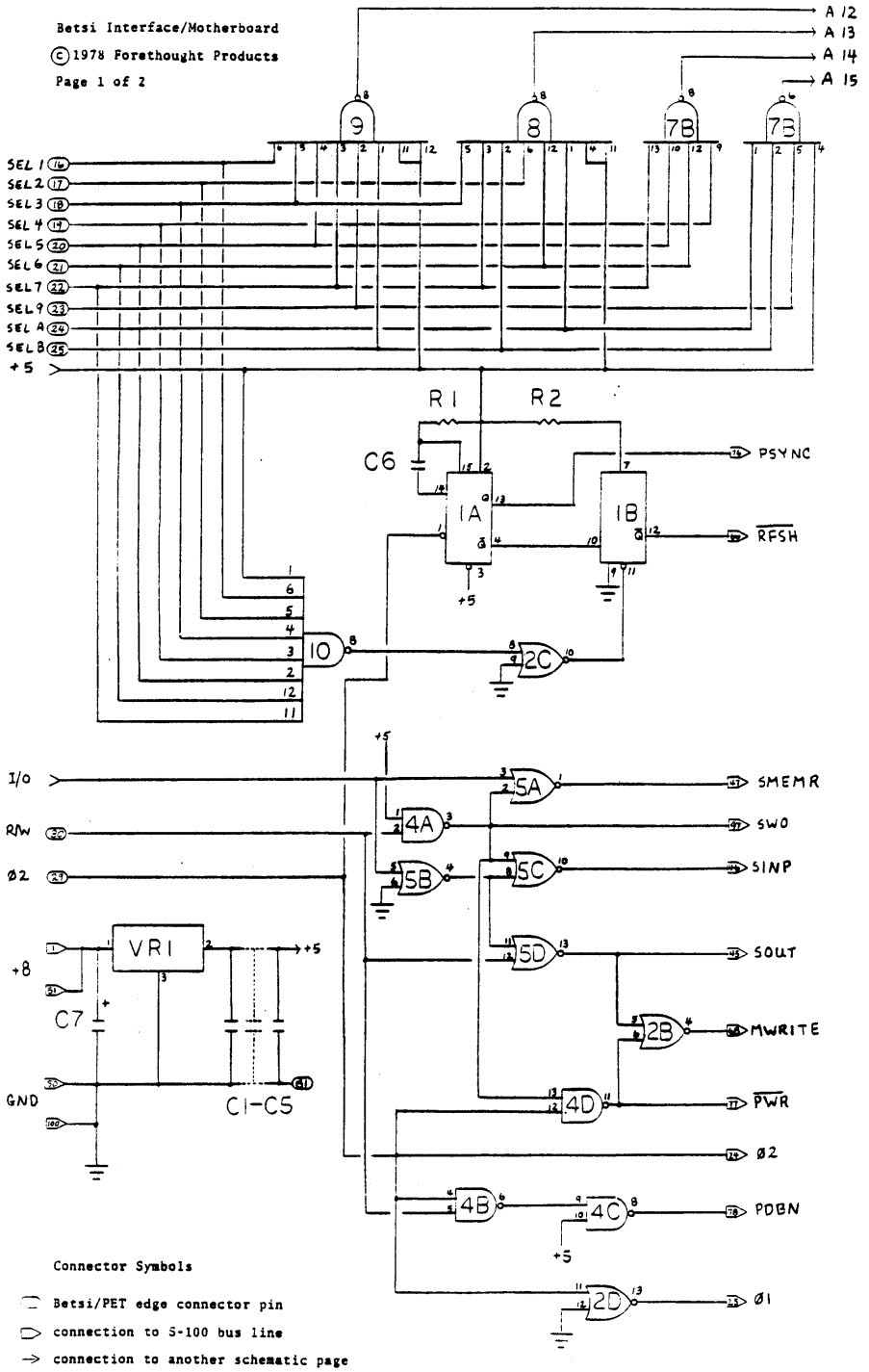
PIN LOCATIONS

1-50 ON TOP
51-100 BOTTOM

BUSTAP. The BUSTAP provides a convenient way to attach to the sytem bus for experimenting, trouble-shooting, and expanding the system. The pin identification diagram is shown below.

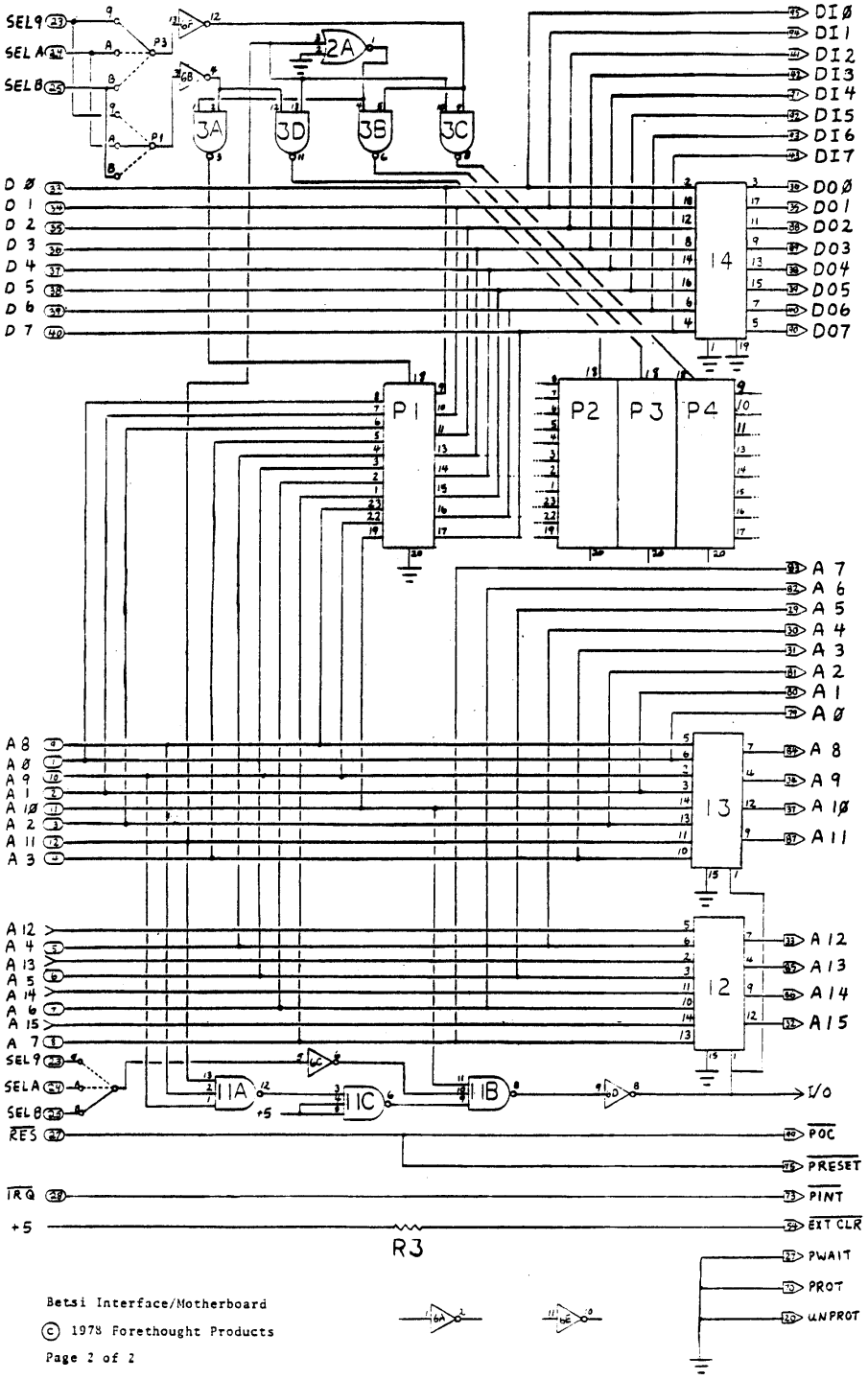


Betsi Interface/Motherboard



Connector Symbols

- Betsi/PET edge connector pin
- connection to S-100 bus line
- connection to another schematic page



Betsi Interface/Motherboard

WARRANTY

Kits. All parts and materials are warranteed for a period of 90 days. A replacement part will be sent when the defective part is returned to the factory along with a note of suspected malfunction and the serial number of the unit.

Factory Assembled Units are warranteed for 120 days following purchase. Defective units which are sent to the factory post-paid will be repaired and returned at no charge.

This warranty is void for parts that, in the opinion of Forethought Products, have been damaged thru misuse by the purchaser and is limited to repair or replacement of the Forethought Products unit which is defective.

If you have a unit or part which you suspect is defective, call or write us giving a complete description of the problem before you return anything to the factory. We can often find a solution to the problem which will save both of us time and energy as well as postage charges.

Call (503) 485-8575 or write to:

Forethought Products
87070 Dukhobar Road
Eugene, Oregon 97402

Betsi Application Note #B1

Using the SD Sales EXPANDORAM board with Betsi or Kimsi

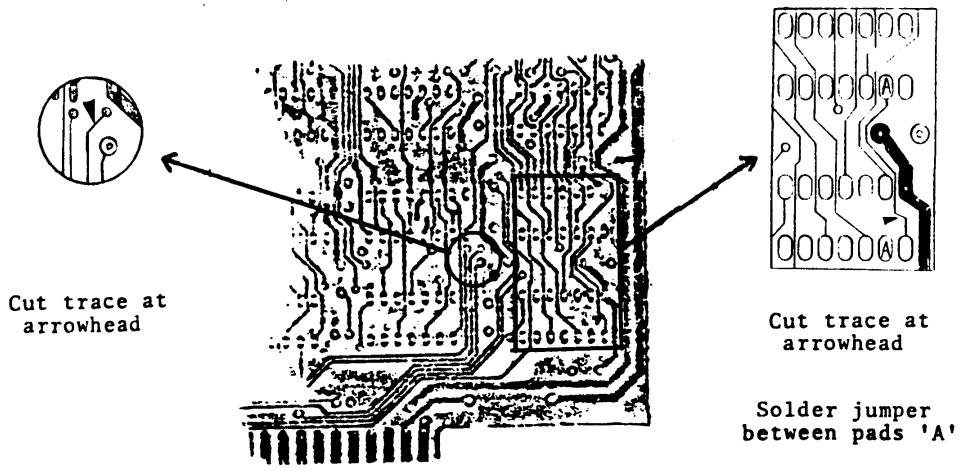
The Betsi board contains refresh control circuitry which allows the SD Sales Dynamic RAM board (EXPANDORAM) to be used with PET/Betsi. Before using this board, the following modifications should be made. Your Expandoram board will be marked "Rev A" or "Rev B" on the front of the board. Follow the modifications for either Rev. A Kit, Rev. A Assembled, or Rev. B board. DO ONLY ONE of these procedures, whichever applies to your board. You can then refer to the general SET-UP information (for all versions) at the end of this App. Note.

EXPANDORAM Rev. A KITS (see over for Rev. B boards)

1. Remove IC19 and bend pins 8, 9, and 11 outward away from the body.
2. Solder a jumper between IC19 pins 8 and 9.
3. Reinsert IC19 in its socket.
4. Jumper E11 to E12 (Leave E10 open).

EXPANDORAM Rev. A. ASSEMBLED (assembled EXPANDORAMS purchased from Forethought Products have already been modified as in #1 and #2 below).

1. Cut the two traces on the back side of the EXPANDORAM board as shown below.
2. Solder a short jumper from IC24-9 to IC19-9 as shown.
3. Jumper E11 to E12 (Leave E10 open).



R1278

EXPANDORAM Rev. B, C, or E Modifications (Kit or Assembled)

1. Implement the following jumpers on the Expandoram board:

connected	open
E11 to E12	E10
E26 to E27	E25
E19 to E20	D21

2. Remove U19 from its socket, bend pin 11 outward, reinsert the IC.

OR

Remove the resistor (or bare wire) from location R10.

SET-UP (all versions)

Place the memory chips in the Expandoram board starting with bank 1. Additional chips should be placed in banks 2 and 3. Enable these banks by turning switches 2, 3 and 4 ON in address switch U2. Switches in U1 (Write Protect) should be set as follows; 1-4 ON, 5 OFF.

R1278

Forethought Products

87070 Dukhobar Rd. ☐ Eugene, OR 97402
(503) 485-8579

Comments on the Betsi / S-100 Compatibility List

Although the Betsi / S-100 Compatibility List is an important part of the Betsi documentation, please keep the following in mind when using it.

1) There is no reason to restrict your systems design to the boards listed here. The boards which are on this list are only the ones which have been catalogued to date; the number of S-100 board compatible with Betsi is actually many times greater than indicated here. For questions about boards which do not yet appear on the list, see the paragraph at the bottom of this page.

2) All boards which appear on this list are placed there at the earliest possible printing following their classification. The presence of any manufacturer's board does not indicate our recommendation or preference for the board; merely its compatibility with Betsi.

3) S-100 boards that are sold with software driver routines will usually be in 8080 machine code. Remember that this software will have to be re-written for use on a 6502 (PET) system.

S-100 boards are categorized as follows:

Boards KNOWN to be compatible - boards which have either been tested by us first hand or have been noted by other Betsi users as "working perfectly" in their Betsi systems.

Boards BELIEVED to be compatible - boards which we have heard favorable reports about but can't remember the source (usually phone calls) or boards which we have checked via schematic and found no probable incompatibilities (but for which we have not yet heard user reports on).

Boards NOT COMPATIBLE - boards which have been verified by their schematic to be incompatible in some way with a PMI/Betsi system.

WHAT YOU CAN DO - This list is only as good as Betsi users can make it. We maintain and update it on a regular basis, but its completeness depends on user input. If you have an S-100 board running on your Betsi that does not appear on the list, DROP US A CARD so that other Betsi users can consider it for their system. If you would like to see a board that does not appear on this list, drop us a line. We may have recently heard from someone regarding the board or can check the schematic for possible [illegible]

BETSI/S-100 BOARD COMPATIBILITY LIST JUNE 1979
("*" sign indicates a note applies)

S-100 boards KNOWN to be compatible with Betsi

Advanced Microcomputer Products - LOGOS I 8K RAM
Artec Electronics- 8 to 32K static RAM
Base 2- 8K RAM, 16K RAM
Cybercom (Solid State Music)- MB6A (8K static RAM)
DRC- 8K Static RAM
Dynabyte- 16K static RAM, 32K static RAM
Godbout Electronics- Economam II (8K RAM), Econ. IV (16K RAM)
Godbout Electronics- Economam VII (24K RAM)
IMSAI- RAM 4A-4 (4K static RAM)
Industrial Micro Systems (IMS)- 8K Static RAM
Ithaca Audio- 8K RAM, PROM board
Kent-Moore- VDM I and VDM II video boards, 4K and 8K RAM boards
Micro Applications- 4K Static RAM
Mullen- Relay/Opto-Isolator Control Board #22
Problem Solvers Systems- 8K RAM
Processor Technology- 8KRA (8K static RAM)
S.D. Sales- 4K RAM
S.D. Sales- Expandable EPROM (16K of 2708 or 32K of 2716)
S.D. Sales- Expandoram (8 to 32K dynamic RAM board) #1
Seals- 4K RAM and 8K RAM
Seattle Computer Products- 16K static RAM
Tarbell Electronics- Cassette Interface Board
Thinker Toys- Superram 16K static #19
Vandenberg Data Products- 16K Static RAM
Wameco- 8K Static RAM

S-100 boards BELIEVED to be compatible with Betsi

All static RAM boards on the market
Computalker Consultants- Computalker CT-1 Speech Synthesizer
Heuristics Inc.- Speechlab (speech recognition board)
IMSAI- PROM 1 (for reading 1702A PROMs)
Matrox- ALT-1400 (24 char X 80 line video board)
Matrox- ALT-256**Z (256 X 256 video graphics board)
Micro Works- DS-80 DIGISPEECH board
Sterity Enterprises-THE PROM SETTER (1702A/2704/2708 programmer)
Vector Graphics- Analog board, Precision Analog board
Wameco- RTC 1 (Real time clock)

S-100 boards NOT COMPATIBLE with Betsi

Most dynamic RAM boards #4
Cromemco- 8K bytesaver (will read but not program PROMs) #2
Cromemco- DT/AIO (D/A, A/D board) #3
Cromemco- TV Dazzler (color video board)
Solid State Music- MB-7 16K RAM
XYBEK- Prammer (PROM programmer) #2

NOTES-
#1 See Betsi Application Note #81
#2 Tries to stop CPU in write cycle during programming cycle
#3 Tries to stop CPU in write cycle while doing D/A conversion
#4 Tries to stop CPU in write cycle if necessary during refresh
#19 See application note #19
#21 See application note #21