THE HUH MINI-8100 AND HUH MINI-8100 'S' USER MANUAL

FROM

California Computer Systems
309 Laurelwood Road
Santa Clara, CA 95050
(408) 988-1620

HUH ELECTRONICS

THE MINI-8100 (S)

USER

MANUAL

The MINI-8100

Introduction

This User's Manual is divided into several parts. They are:

1. Introduction
2. Assembly Instructions
3. Installation/Hardware Considerations
4. Software Considerations
5. S-100 Compatibility
6. Theory of Operation
7. Appendicies:
   a. Parts List
   b. Drawings
   c. Schematic
   d. S-100 Bus Pinouts

If you purchased your MINI-8100 as a kit first read the assembly instructions and decide if you are capable of performing the assembly proceedure. If you have any doubts please return your kit and exchange it for an assembled unit.

If you are confident about your ability to assemble the kit, proceed to the Assembly Instructions.

If you purchased the MINI-8100 as an assembled unit, skip the Assembly Instructions and proceed directly to the Installation section.

In any case it's a good idea to read this entire manual first.

Please fill out the enclosed warranty return sheet and mail it back to us. You have no excuses - we provide a stamped self-addressed envelope for you. Your warranty return sheet is the only way that we will keep track of you as an 8100 user in case of updates etc.

One final bit of preface is in order. You are about to enter the world of the S-100 Bus. The S-100 Bus is the most versatile and widely supported in the microcomputer industry. But as with all things worthwhile it's going to take some work on your part to make something of it. Everyone's application is different and you can't expect each manufacturer to custom tailor his product to exactly fit your needs. For example, a peripheral board manufacturer may give you a basic software driver for his board, but you may need it to run somewhere else. Or your requirements or application may be slightly different than he had in mind.

The point of all this is that you are probably going to have to do some work to get various things to fly in the S-100 Bus environment. The work may be trivial or it may be extensive, but we just want you to be prepared.

Radio Shack stuff is "plug-it-in-and-go", but you pay the price of lack of versatility. With the S-100 Bus at your command, as Obi-Wan Kenobi said to Luke Skywalker, "You've just taken a step into a larger world!"

ASSEMBLY INSTRUCTIONS

Tools and supplies you will need.

To assemble the MINI-8100 you will need the following tools and supplies:

1. A soldering iron(see text)
2. Solder (see text)
3. Small pliers (needle nose)
4. Screwdriver
5. Lead Trimmer (diagonal cutters)
6. Lead Bender (optional - see text)

Do not under any circumstances use a soldering iron rated above 40 watts!! Damage to the circuit board and to the components will result. We have found that the Weller WP-25 with a small tip to be an excellent choice if you do not own a suitable iron. Don't even think about using that soldering gun!!!!

Your choice of solder is also extremely important. Be sure to use high quality ROSIN CORE solder. DO NOT under any circumstances use acid core solder. Use of acid core solder will not only void your warranty, but it will ruin your kit!! We have found that Ersin Multicore Solder 60/40 to be a good choice. Use a small gauge.

A lead bending tool is inexpensive (under three dollars) and will make the appearance of your kit much neater. They are available in your local electronics store and are usually called "Speedy Lead Benders". If you do decide to use a lead bender all the resistors in the MIN-8100 are on .4 inch spacing.

Good luck and remember to read each step thoroughly before attempting it, and please take your time. Good luck.

1. Install the IC sockets. There are two types of IC sockets in your MINI-8100 kit, 14 pin and 16 pin. Here's how to install an IC socket:

Take a look at figure #1 in the drawings section of the appendix. Note the IC socket. While holding an IC socket look at the picture and note the pin one designation of the socket. When installing an IC socket make sure that pin one of the socket is lined up with the dot silk-screened onto the PC board. The dot signifies pin one. All pin ones on the MINI-8100 face the same way.

Insert the socket from the component side of the board (the side with the printing on it) until it's plastic body is flush to the board. Make sure all the leads are in all the holes and that none are bent under. While holding the socket in place, invert the board and bend two leads on opposite corners outward at a 45 degree angle to hold the socket in place. Set the board component side down on your work table and then solder the two other leads on opposite corners to permanently fix the socket in place. If for some reason the socket is not flush to the board, now is the time to reposition it. Do this by reheating one of the soldered pins while applying gentle pressure from the component side of the board. Repeat for the other lead. Then rebend the other leads (bent earlier) to their normal position and solder all the remaining leads.

There are other methods of soldering in IC sockets and if you know of one that you like better, feel free to use it, as long as it works satisfactorily!!

Install the 16 pin sockets first. 16 pin sockets go in IC locations 4 through 8 and 10 through 13. Be sure to line pin one up with the dot. Also be careful not to install a socket in the locations marked RP1 and RP2 or SPARE.

Next install the 14 pin IC sockets. 14 pin sockets go in IC locations 1,2,3 and 9. Again be careful not to install a socket in the locations marked RP1, RP2 or SPARE and be sure to orient pin one correctly.

2. Next install the resistor networks RP1 and RP2. These are both 180 ohm networks and may be marked '411 [illegible] 002-181' or '761-3-R180' or 16-8-2-R180 depending on what manufacturer we got them from. Install them just as you would an IC socket.

They go in the locations marked RP1 and RP2. Be sure and orient pin one next to the dot.

3. Install the resistors. To install a resistor first bend it's leads to the proper spacing (.4 inches). Then insert the resistor leads through the proper mounting holes in the circuit board. Grasp the resistor leads on the solder side of th[illegible]ard and pull the resistor until it is flush to the board. Bend the resistor leads outward slightly to better hold it in place. Solder both leads and trim off the excess lead as close to the board as possible.

You may wish to insert all the resistors and then solder them all at once, or you may do them one at a time.

The resistors are installed according to the following table:

R#	Value	Color Code
R1	390 ohms	orange/white/brown
R2	390 ohms	orange/white/brown
R3	1K ohms	brown/black/red
R4	270 ohms	red/violet/brown
R5	180 ohms	brown/gray/brown
R6	10K ohms	brown/black/orange
R7	4.7Kohms	yellow/violet/red
R8	11K ohms	brown/brown/orange
R9,10,11	1K ohms	brown/black/red

4. Next install the capacitors. There are 3 styles of capacitors used in the MINI-8100. They are silver mica, ceramic disc and tantalum electrolytics and they are all shown in figure #1.

Silver mica capacitors are dark brown and have a shiny glazed ceramic body. Some people say they look like pinto beans with leads.

Ceramic discs are orangish to brownish in color and are shaped like small thin discs.

Tantalum electrolytics can be almost any color but they all have an epoxy body that looks sort of like a raindrop. These devices are polarity sensitive (which means you have to install them the right way) and are marked with either a plus sign or a colored dot to designate the positive lead.

To install a capacitor insert the leads through the proper mounting holes and pulling on the leads from the solder side, pull the capacitor so that it's body is close to the board. Turn the board over and bend the leads outward slightly to better hold the capacitor in place. Then solder the leads and trim off the excess as close to the board as possible.

First we will install the silver mica capacitors. There are three of these capacitors in the MINI-8100.

The first is C7 and it is a 100 pfd. It may be marked '100 but it will more than likely be marked 'CM05FD101J03' with the important numbers being the '101' which actually means 100 pfd.

The second is C9 and it's a 1 pfd and it may be marked '1 PF' but will also more than likely be marked 'CM05CD010D03' with the important numbers being '010'.

Lastly is C10 and its a 39 pfd and it may be marked '39 PF' but will more than likely be marked 'CM05ED390J03' with the important numbers the '390'.

Next install the disc ceramic capacitors. In the MINI-8100 they are all .1 mfd and may be marked '.1' or '104'. Install these capacitors in locations C1-4,C8, and C11-13.

Lastly install the 10 mfd tantalum electrolytic capacitors. There are two of these. One is C5 and the other is C6. Be sure to observe the polarity when installing these capacitors. The plus sign silk-screened onto the board should match the plus sign or dot on the capacitor. THIS IS VERY IMPORTANT!!!

5. Next install the crystal Y1. To install the crystal, position it over the mounting area in the upper left-hand corner of the board and note how it's leads must be bent so that they go through their holes properly. Bend the leads accordingly using a needle-nose pliers. Insert the crystal's leads through the holes and pull them until the crystal is flush with the board. Invert the board and solder the leads. Trim off the excess. Now using a spare piece of component lead, bend it into a U-shaped form so that it will mount snug around the crystal when both ends are placed through the holes on opposite sides of the crystal. Solder this lead in place to hold the crystal securely.

6. Next install the regulator VR1. It is either marked '7805' or LM340T-5. First position the regulator over the mounting area at the upper left of the board, just below the crystal. Line up the hole in the mounting tab with the hole in the board. Then note how the leads must be bent so that they go in their holes. Bend the leads accordingly. Now take the heatsink and position it over the mounting hole and then place the regulator over the heat-sink so that all the holes are lined up and the leads are through the proper holes. Using a 6-32x1/2 screw and nut fasten the whole thing tightly. Insert the screw from the solder side of the board, the nut should be on the top of everything. Then solder the three regulator leads and trim off any excess.

7. Install the four pin terminal block in it's position next to the regulator. Insert it from the component side of the board so that it lines up correctly. Making sure the terminal block is flush to the board, invert the board and solder it in place. Note that your terminal block may or may not include mounting ears.
IF THIS IS AN 8100S, YOU DON'T HAVE A TERMINAL BLOCK.

8. Install the S-100 connector. Insert the connector from the component side and gently seat it flush to the board. Make sure that no pins are bent under. Invert the board and solder one pin on each end of the connector. Turn the board over again and make sure the connector is flush to the board and that it is aligned correctly. Then solder the remaining pins. Check carefully for solder shorts.

If you have more connectors of your own, now might be a good time to install them. IF THIS IS AN 8100S, YOU DON'T HAVE A MOTHERBOARD

9. Lastly install the foyr rubber feet. These go in the four corners of the board over the four holes also in the corners. Peel off the paper backing from the feet and press the foot securely and squarely in each corner. IF THIS IS AN 8100S, YOU DON'T HAVE ANY RUBBER FEET.

10. All that is left to do is to plug in the IC's in their sockets. When plugging in the IC's make sure that you line up the pin one designation (see figure #1) with the dot on the PC board. This is extremely important. Also make sure that no pins are bent under the IC. These are very hard to see, but you can sight along the edge of the board to see under the IC. None of the IC's in the MIN-8100 are static sensitive.

The IC's are installed according to the following table:

IC#	Designation
IC1	74LS00
IC2	74LS20
IC3	74LS08
IC4	74368 or 8098
IC5	74367 or 8097
IC6	74367 or 8097
IC7 and IC8	9602
IC9	74LS74
IC10-IC13	74367 or 8097

NOTE: Due to parts shortages any IC may or may not be an 'LS' part. For example, the 74LS74 may be a 7474 in your kit or the 74367 may be a 74LS367. All the parts will work interchangeably in the MINI-8100.

THIS COMPLETES ASSEMBLY OF YOUR MINI-8100!!!!

SYSTEM INSTALLATION/HARDWARE CONSIDERATIONS

In this section we will tell you how to plug the system together and explain the various system considerations as they relate to hardware. By a system we mean a TRS-80 and a MINI-8100 together.

First you will need to obtain a power supply. The power supply must supply 8-10 volts of UNREGULATED DC voltage for the MINI-8100's circuitry to function. The S-100 Bus requires the same 8-10 volts and also +16 volts and -16 volts.

The current requirements of the MINI-8100 are under 500 ma (1/2 an amp). The S-100 Bus current requirements will depend solely on the S-100 boards you wish to use. Check the manufacturers specs to find out how large a power supply you will need. The average supply ought to be +8 volts @ 8 amps, +16 volts @ 2 amps and -16 volts at 2 amps. This should be enough for almost any complement of S-100 boards you might choose.

A commercial power supply meeting the above requirements is available from ALPHA POWER, 20536 Plummer St., Chatsworth, CA 91311, (213) 998-9873. This supply comes assembled and tested and we have verified that it is of high quality and works well. As of April 79 it sold for $62.50 qty. one. Order model #2D-S100.

If you have a MINI-8100S your mainframe should supply the necessary power.

To connect the power supply merely attach wires from the outputs of the supply to the appropriate power inputs on the terminal block. The voltages are silk-screened onto the PC board next to the terminal. Be sure to use fairly large wire for the +8 and ground lines. Make sure there are no shorts.

Once the power supply has been connected, you will need to connect the TRS-80 to the MINI-8100. To do this first set up your TRS-80 system but leave space for the MINI-8100 or mainframe to the left of the keyboard unit.

Take the ribbon cable and note that it has a colored stripe running down one side. This designates pin one of the cable. Also note that the cable comes out of the connectors on the end in either one direction or the other, but that it is not ambiguous.

Plug the ribbon cable onto the 'expansion connector' of the TRS-80 so that the cable stripe is towards the right rear of the keyboard and the cable exits it's connector facing downwards.

Now plug the other end of the cable onto the MINI-8100 (J1) so that the cable stripe lines up with the 'cable stripe' designation on the PC board and so that the cable exits it's connector facing upwards or towards the components.

Make sure that both ends of the cable are firmly seated and double check the orientation. All that remains is to power up the system and see if it flies. We recommend that you power up the MINI-8100 first and then the TRS-80 or both together.

Your TRS-80 should say MEMORY SIZE? Type an ENTER and the system should be on the air. If the memory size prompt does not appear, turn the TRS-80 off, wait about 10 seconds and turn it on again. If this fails to make the system come up try the proceedure again a few times. If you still don't have any luck, turn everything off and check that all the cables are connected correctly, including the power supply.

Check to make sure that there are no IC's plugged in backwards and that there are no IC's installed with bent under pins. Bent pins are 95% of the reason boards don't work the first time. Also carefully inspect your work for unsoldered pins or solder shorts.

You shouldn't have had any problems if you purchased a factory assembled unit, but sometimes something gets worked loose or otherwise meesed up in shipment. If you can't get the MINI-8100 to fly, you have three options. They are:

1. Troubleshoot and repair the unit youself. If you are an experienced hardware type and have the necessary test equipment, read the Theory of Operation section and have at it.
2. Return the unit to your local computer store for service. They will usually charge you for service but they may be able to service the unit quicker than the factory.
3. Return the unit to the factory for service. Kits are warrantied for parts only! (But we won't charge you to find the defective part) Assembled units are warrantied for parts and labor. See the warranty sheet for the specifics about where and how to return the unit and the specfic terms and conditions of the warranty.

Don't be scared. The MINI-8100 has been designed and carefully engineered to be as trouble-free as possible and will probably work the first time.

Assuming your TRS-80 responds normally with the MINI-8100 attached you are ready to try an S-100 board out. A static memory board is a good first try.

To plug an S-100 board into the MINI-8100, first make sure that all power is off!!! Then plug the board in so that it's components face away from the components of the MINI-8100. There is also an arrow on the PC board and the words "S-100 BOARD COMPONENTS TO FACE". Just follow the sign.

See the chapter on S-100 Compatibility to determine what boards you can use and what boards you can't.

If you decide to mount the MINI-8100 in a box a small fan should be provided to cool the S-100 boards.

If you have a MINI-8100S installation will be much like the above, except that you don't have to connect a power supply to the MINI-8100S. The cables will connect similarly. Just be sure that you have the MINI-8100S properly installed in your mainframe before applying power. ALSO MAKE SURE THAT ANY CPU BOARD YOU MIGHT HAVE IN YOUR MAINFRAME IS REMOVED BEFORE ATTEMPTING TO USE THE MINI-8100!! Damage to the CPU board and the MINI-8100S may result. The TRS-80 is now the CPU for that mainframe.

A few final word about the hardware map of the system is in order. A 16K Level 2 TRs-80 uses all the RAM space from 0000 hex to 7FFF hex. Any attempt to address any S-100 board in the same space will cause a conflict that will more than likely cause the system to crash.

The TRS-80 also uses I/O port FF for the cassette interface and changing the display modes. Avoid this port number as well.

If you wish to use the MINI-8100 in conjunction with the TRS-80 expansion interface, plug the MINI-8100 cable onto the 'Screen Printer Port' of the expansion interface instead of to the keyboard. Hook the expansion interface to the TRS-80 in the normal way.

Always make sure that the power is off before plugging in and unplugging any S-100 boards to the MINI-8100.

SOFTWARE CONSIDERATIONS

In this section we will attempt to describe some of the software considerations concerning putting the TRS-80 on the S-100 Bus and hopefully point you in the right direction concerning solutions to the problems. This is not intended to be a course in programming. We will also not attempt to give specific solutions because everybody's problem is different. If you are a complete novice we suggest that you seek help. There are many ways to find help. One way is through your local computer store. They may have staff ready to help you or they may know of several consultants in your area. Another possibilty is a local computer club or TRS-80 user's group. Help is generally available from a fellow computerist.

If you have an extensive business application or some other involved application, don't expect to get too much help for free. Software may turn out to be the biggest system expense.

One of the biggest problems with S-100 software is that most S-100 systems have RAM at 0 and up so that most software is designed to run there. Microsoft Basic is a good example. It was designed to run from 0, except Radio Shack put it in ROM at 0.

Some companies supplying software will relocate it so that the TRS-80 can run it, some will not, or want outrageous fees for doing so. Most of this software is 'systems' software, like BASICs and Disk Operating Systems, Assemblers Etc. In other words, large programs any normal person wouldn't want to write themselves.

There is hope! Since the TRS-80 is one of the larger selling computers, many major software houses are making TRS-80 versions of their software available.

Anyway, the other kind of software is the small 'driver' program. Usually this is a small machine language routine that talks to a particular peripheral board. These programs are not very long usually and are easily relocated or rewritten. Usually the manufacturer will provide the 'source' code. This can be assembled by any TRS-80 assembler (even the one by Radio Shack!) to run anywhere.

Some of the drivers can be simulated in BASIC by using the PEEK, POKE, IN and OUT commands, especially where speed is not important. Consult the Level 2 Basic Manual for details on how to use these commands. Also take a look at the USR function and the SYSTEM command.

The best way to learn about this stuff is to play with it. Ask your local computer store about good books or classes. Even some Radio Shack stores have been offering classes in Machine Language Programming. A computer club may be useful too. There is nothing like working out the problem with someone who has been down the road before. Subscribing to a TRS-80 newspaper may also be useful.

The most common software problem will be that of interfacing exsisting programs not designed to run on the TRS-80 to talk to the TRS-80 keyboard and video display routines. These routines already exsist in the ROMs in your TRS-80 so we'll tell you a bit about how to use them.

The Video Display routine is the main 'output' routine of the TRS-80. It is called an output routine because it is how the computer generally outputs information to you - on the screen. Other programs may also need to output information to you, so the easiest thing to do is to have it 'call' the video display routine already present in the ROM.

The character to be displayed should be in the A register (accumulator) when the routine is called. This is called 'passing' the character. If the program you are patching (patching means to replace the program's output routine with the TRS-80's) passes the character in a different register you will need to move it to the A register first, and you may have to preserve the contents of the A register prior to moving the character there and then restore it at the end (PUSH AF, POP AF).

The routine below is assembled to run at address 7000 hex but it is only an example and should be reassembled to run at the actual desired address. If the program you are patching does not have enough room to put the routine in place, simply put a jump instruction there and locate the actual routine somewhere in high memory or somewhere out of the way.

Video Display Routine

Address	Code	Mnemonic		
7000	D5	PUSH	DE	
7001	FD E5	PUSH	IY	
7003	CD 33 00	CALL	0033H	;Display Routine
7006	FD E1	POP	IY	
7008	D1	POP	DE	
7009	C9	RET		

The Keyboard Scan routine is the TRS-80's main input routine. It is called an input routine because it is generally how the computer gets data inputted to it - through your typing on the keyboard. Other programs may also need to have data inputted to them so the easiest thing to do is to call the keyboard scan routine already present in the ROM.

The keyboard scan routine looks at every key and if none is pressed it will return a 0 value in the A register. If a key has been pressed it will return the ASCII value in the A register instead. The OR A instruction in the routine below checks to see if the A register is 0 or not. If it is, there is no character so we loop back to scan the keyboard again and continue to do so until a key is pressed. As mentioned before, the character is then in the A register. If your program requires the character to be passed in a different register, you will have to do the appropriate move instruction. (contents of A may need to be preserved as above).

If the routine you are patching does not have enough room for the following routine, then put a jump instruction there and locate the actual routine in high memory or somewhere out of the way. The following routine is assembled to run at 7000 hex, but it is only an example and should be reassembled to run at the desired address.

Keyboard Scan Routine

```
Address    Code        Mnemonic

7000       D5                   PUSH   DE
7001       FD E5                PUSH   IY
7003       CD 2B 00    LOOP     CALL   002BH  ;KBD scan routine
7006       B7                   OR     A      ;A=0 if KBD clear
7007       CA 03 70             JZ     LOOP   ;Loop if no char.
700A       FD E1                POP    IY
700C       D1                   POP    DE
700D       C9                   RET
```

Note that an absolute jump was used for reasons of clarity, but you can save a byte by using a relative jump instead. (JRZ)

S-100 Bus Compatibility

In this section we will attempt to explain the limitations involved in interfacing S-100 Bus boards to the TRS-80. We will also include a partial list of boards that are known not to work or known to work. We depend on you, the user, to let us know of your successes and failures with the various S-100 boards available.

Basically there are two restrictions: Any board which requires DMA (direct memory access) will not work and any board that requests a wait state longer than one millisecond will also not work. The reason for both of these is that the dynamic memory refresh cycle will be interrupted for too long and the memory data will be lost.

So the two questions to ask of your prospective board supplier are: "Does this board use DMA?" and "Does this board request a wait state longer than one millisecond?" If the answer to any of these questions is "Yes." then the board will not work in the MINI-8100/TRS-80 system.

Of course this will not cover each specific board, but will suffice the majority. You should have no problems with static memory boards, EPROM boards, or I/O boards. Things to be careful about are floppy disc controllers, PROM programmers and graphics boards.

Ultimately the final test is to plug it in and see if it works. We do not recommend the use of dynamic memory boards.

Some I/O boards (usually serial interfaces) expect to see a 2 Mhz clock signal on pin 24 (Ø2) of the S-100 Bus. This was safe in the early days because the Altairs and IMSAIs all ran at 2 Mhz. But the TRS-80 runs at 1.76 Mhz so pin 24 (Ø2) is also at 1.76 Mhz.

The serial boards depend upon this 2 Mhz signal to generate their baud rates and will not run at the proper rate at 1.76 Mhz. This is why pin 49 (Clock) has been specified as a 2 Mhz signal by the S-100 Bus standards committee. This leaves the CPU free to run at any frequency.

So if you have one of the boards that expects to see 2 Mhz on pin 24 you must cut the trace on that board that connects to pin 24 and connect it to pin 49 instead. This will insure that the board works properly.

If you have any doubts (a lot of boards look at Ø2 but don't care what frequency it's at) consult the manufacturer of the board in question or your local dealer.

Below is a list of the boards that have been reported to work in the MINI-8100. If the reference is by itself it means that HUH Electronics' technicians have used the board successfully. If the reference is followed by an asterisk it means that a customer or more have reported that the board works. If the reference is followed by a number sign (#) it means that we have examined the technical data on the board and can see no problems, but we have not actually checked the board out in the flesh.

Following this list is another list of the boards known not to work.

There is no implication that these lists guarantee any compatibility, or that they are definitive, but are merely provided for your information. We have made every effort to see that they are accurate.

Boards Known to Work

Memory

All static RAM boards are known to work so far - we recommend either GODBOUT or Morrow's/Thinker Toys RAM boards as excellently designed and reliable.

EPROM Boards

Microdesign MR-8, MR-16.
Cromemco Bytesaver READ ONLY!!
Ithaca Audio *
Thinker Toys Switchboard
Godbout ROM boards *#
IBEX *

I/O Boards

Processor Technology 3P+S
Thinker Toys Switchboard
IMSAI SIO-2 *
Cromemco TUART *
Cromemco D+7AI/O
DC Hayes Modem #
Mullen Relay Board *
IMSAI PIO *#

Graphics Boards

Vector Graphics HIRES Graphics Board
Objective Design Graphics Set *#

Disc Controllers

North Star Single Density
Thinker Toys Discus 1
Micromation Doubler *
Ithaca Audio *

Miscellaneous Boards

Computalker CT-1
Speechlabs *#
Tarbell Cassette Interface *
Processor Technology CUTS #
Percom Cassette Interface *
Boostrap Microsounder *
ALF Quad Chromatic Pitch Generator

Please help us add to this list by reporting to us. All registered owners will be sent updates.

A list of the S-100 signals that are emulated by the 8100 series is contained in the appendix of your manual. Please consult this list if you have any questions.

Boards Known Not to Work

Cromemco Dazzler
Cromemco Bytesaver will not program PROMs.
IMSAI VIO *
IMSAI Front Panel
TDL Z16 (some work some don't)
Digital Systems Disc Controller
Software Technology Music System

Some S-100 Boards monitor S-100 Bus line #26, PHLDA so that they don't glitch during a DMA. Since PHLDA is a DMA related signal and since the 8100 series does not implement DMA this line was left floating (not connected to anything). This can cause some problems with boards that monitor this line.

The fix is to simply connect this line to ground at some convenient point. Then the board will never think that there's a DMA going on because there won't be.

This section will describe how the circuitry of the MINI-8100 works. To better understand the system (meaning the TRS-80 and the MINI-8100) it will be helpful to also examine the "TRS-80 Microcomputer Technical Reference Handbook" (Radio Shack Catalog #26-2103) which is available from your local Radio Shack Store or the place at which you purchased your computer. Also helpful will be the Z-80 Technical Manual which is published by Zilog and Mostek, makers of the Z-80.

These books will give you the necessary background to understand the operation of the MINI-8100.

You will need to refer to the schematics located in the appendix section of this manual. We will generally work from left to right across each schematic page as we follow the signal flow.

First is the address bus buffers. The "TA" lines mean that they are address lines coming from the TRS-80. These lines feed only the buffers IC's 10 ,11, 12 and 13. These are tri-state buffers but their enable lines are tied permanently low keeping them enabled always. The only unusual part about this section is the 180 ohm pull-down resistors on the TA lines. This is necessary as a "deglitching" network because the TA lines are very noisy. In a normal system environment this noise could probably be tolerated because the noise settles out after a while (it's ringing noise), but the dynamic RAMs require perfectly stable addresses for the refresh etc. and the noise really screws them up. The signals are nice and clean coming out of the buffers and these lines feed the S-100 Bus address lines as well as the rest of the system.

The data bus in the TRS-80 is bidirectional (BØ - B7) but the S-100 bus has two different data busses - the DO bus and the DI bus. The DI bus means "data input" and refers to data being input to the processor from an S-100 device. The DO bus means "data output" and refers to data being output from the processor.

The DI bus is connected directly to the TRS-80 bidirectional data bus. Data being output from an S-100 card will be presented to the buffers inside the TRS-80 at the appropriate time. We saw no real need to duplicate the buffers in the TRS-80 so we didn't. This also negated any need to gate the data bus with any "external select" signal which would have had to be generated and require more circuitry.

The DO bus needs bus drivers however and IC's 5 and 6 are used to do this. They are tri-stated by the PDBIN (processor data bus in) signal so that they do not drive the bus during an input cycle.

Next we have some of the miscellaneous control and status signals needed on the S-100 bus. Looking at the schematic (page 1) we will examine these lines from the top down. But first a bit of explanation of the $\overline{WR}$, $\overline{RD}$, $\overline{IN}$, and $\overline{OUT}$ lines from the TRS-80 is in order.

The $\overline{WR}$ line is gated in the TRS-80 with the Z-80 MREQ line so that the $\overline{WR}$ line is only active for memory writes. Similarly thr $\overline{RD}$ line is also gated with MREQ to signify memory reads.

The $\overline{IN}$ line is gated with $\overline{IORQ}$ to signify an I/O read and the $\overline{OUT}$ line is also gated with $\overline{IORQ}$ to signify an I/O write.

The MWRITE signal on the S-100 bus signifies a memory write cycle so the $\overline{WR}$ line serves almost directly for this purpose but it needs to be inverted. IC 4 is an inverting bus driver so this performs the inversion as well as buffering the signal to the S-100 bus.

SMEMR is an S-100 bus status signal signifying a memory read cycle and the $\overline{RD}$ line when inverted by IC 4 nicely becomes SMEMR.

Similarly $\overline{IN}$ and $\overline{OUT}$ when inverted and buffered become SINP and SOUT respectively.

$\overline{INTAK}$ is the interrupt acknowledge signal and when inverted becomes SINTA. This is also inverted and buffered by IC 4 .

The tri-state enable of IC 4 is tied permanently so it is always on.

$\overline{SWO}$ and $\overline{PWR}$ are both active low S-100 bus signals signifying a write cycle, be it memory or I/O so it is generated by anding the $\overline{WR}$ and $\overline{OUT}$ signals in a section of IC 3. This is then buffered by two sections of IC13 and becomes $\overline{SWO}$ and $\overline{PWR}$.

PDBIN is almost the opposite of $\overline{PWR}$ except that it is an active high signal. So it it generated by nanding $\overline{RD}$ and $\overline{IN}$ and then is buffered and goes out to the S-100 bus. IC 13 performs the buffering. This signal, as described before, also controls the tri-state buffers on the DO bus.

PSYNC is an S-100 bus signal that signifies the begining of a machine cycle. Each cycle has to be either a memory or an I/O operation and $\overline{WR}$, $\overline{RD}$, $\overline{IN}$, and $\overline{OUT}$ cover all the cycles. One of these lines will go low near the begining of each machine cycle. This falling edge should signify the begining of a machine cycle so we nand them all in a section of IC 2. This produces a positive signal for every cycle but will stay high too long to satisfy the requirements of the PSYNC signal. This is remedied by applying this signal to the positive edge trigger input of a one-shot, IC7 , a 9602. The output of the one-shot then produces a signal with a constant time period. Since the input is edge triggered, the timing cycle will only start at the begining of each cycle. The time constant of the one-shot is set by R6 and C 7and their values have been selected to provide a pulse lasting about 450 nanoseconds. This pulse is buffered by a section of IC13 and then becomes the PSYNC signal. Note that C 7 is a silver mica type to provide good temperature stability.

$\overline{WAIT}$ is an input signal to the TRS-80. When this line goes low a wait state will be requested of the processor. The two "wait request" lines on the S-100 bus are PRDY and XRDY. You might ask why they are designated RDY (ready) rather than wait. Well these can be looked at either in the positive or negative sense. In the positive sense when these lines are high they indicate that the peripheral card is ready, therefore not needing a wait state. But when either of these lines are low the peripheral card is saying I'm not ready so please wait for me. In any case all you need to know is that a low requests a wait state. PRDY and XRDY are anded by a section of IC3 and applied to the $\overline{WAIT}$ line of the TRS-80.

PWAIT is an S-100 bus signal signifying that a wait cycle is in progress. It is derived from the anded RDY lines but is synchronized to Ø2 by a section of IC 9, a D-type flip-flop. It is then buffered by a section of IC 13and it becomes the PWAIT signal. We utilized the inverting output of the flip-flop to get the proper signal polarity.

Starting at the top of page 2 we encounter a signal named $\overline{RAS}$. $\overline{RAS}$ stands for row address strobe and is used for latching addresses into the dynamic RAMs.
Right now it's important for you to know that $\overline{RAS}$ falls coincident with the falling edge of the Z-80 clock at fairly regular intervals.

Now the TRS-80 bus has no clock signal on it, but the S-100 bus wants to see Ø1and Ø2 clock signals synced up to the rest of the signals, so it won't do to just to have an oscillator free run at the TRS-80 clock frequency.

The problem is: without any clock signals on the TRS-80 bus how do we get a clock on the S-100 bus? Well the answer is to regenerate the clock. If there were any signals that occured at regular intervals regenerating the clock would be a simple task. But of course there aren't. $\overline{RAS}$ is as close as we can come so we'll have to use it anyway. Here's what happens:

$\overline{RAS}$ as it comes out of the TRS-80 is pretty noisy so it needs to be deglitched. A portion of IC5 and R3, R4 and R5 form a schmitt trigger which cleans up $\overline{RAS}$ and also gives it plenty of drive.

This signal is then applied to negative edge trigger input of a section of IC7, a 9602 one-shot. The timing components R7 and and C9 provide a very short pulse at the output, approximately 65 nanoseconds.

The other half of IC8 is wired with feedback through a section of IC1, a nand gate, to form an oscillator. The free running frequency of the oscillator is set by the timing components R8 and C10to be approximately 3.52 Mhz--twice the TRS-80 clock frequency. It is not however a normal oscillator for this one can be restarted by applying a pulse to one input of the nand gate and the clear input to the one-shot simultaneously. The output of the first one-shot provides this pulse and as we know from before, this pulse is synced to the TRS-80 clock.

So now what happens is this: The oscillator free runs for a while until a trigger pulse comes along which starts the oscillator out in step with the TRS-80 clock. Since the two frequencies are not identical, the oscillator will start to drift out of sync with the TRS-80 clock. But it can't get too far because in a very short while (but not always the same - that's the rub) along will come another pulse and restart the whole thing again.

So now we have an oscillator running right along with the TRS-80, but not at the same frequency, nor is it symetrical. The frequency is twice that of the TRS-80, so we run the signal into a section of IC9 wired as a divide-by-two toggle. This performs the dual function of halving the frequency and at the same time squaring it up. There is only one small problem. The toggle can toggle first from an unknown state. For example Ø2 could be Ø1 and vice versa depending on how the circuit felt when you turned it on. This is solved by feeding back the Q output from the flip-flop to the Clear input of the first one-shot so that pulses only occur out of it at a specific state of IC9. This effectively halves the number of pulses occuring, but that's OK, there are plenty of them. But it does make sure the oscillator starts up in a known state.

The non-inverting output of IC 9 is buffered by a section of IC10 and becomes Ø2 on the S-100 bus. The inverting output is likewise buffered by a section of IC10 and becomes Ø1.

This creates a 1.76 Mhz clock, but the original Altair and it's followers ran at 2 Mhz, so many boards expect that frequency to be on the bus.

Usually the 2 Mhz signal is used to generate a baud rate on a serial I/O card. The S-100 bus does not specify a certain frequency for the processor clocks, but an auxiliary clock signal on pin 49 called $\overline{\text{CLOCK}}$ was specified at 2 Mhz.

So to keep those serial boards running at the right frequency we have provided a 2 Mhz crystal oscillator for the $\overline{\text{CLOCK}}$ signal. IC 1, R 1 and 2, C1 and the 2 Mhz crystal form a classic crystal oscillator. This is buffered by a section of IC 5 and applied to the bus.

The $\overline{\text{PINT}}$ (processor interrupt) line on the S-100 bus is tied directly to the $\overline{\text{IRQ}}$ line of the TRS-80 bus because these two signals are virtually identical.

The UNPROT line is tied high and the PROT line is tied low to insure that memory boards always come up unprotected.

$\overline{\text{SYSRES}}$ on the TRS-80 bus is low for a number of cycles on power-up and then goes high. This signal is tied directly to $\overline{\text{POC}}$ (power on clear) of the S-100 bus. This line also will go low when the RESET button on the TRS-80 is depressed, but it really does not cause a reset but rather an $\overline{\text{NMI}}$. Well, you can't have everything. This signal is inverted by a section of IC24 to provide an active high reset signal for the UART described later. This signal is called MR.

The rest of circuitry on page 2 of the schematic is the 5 volt regulator VR1. It is a 7805 type and is wired as any regulator should be. Also shown are the various power and ground connections to the system.

This completes the theory of operation section.

APPENDICES

Qty.	Description	
1	IC, 74LS00	See note below
1	IC, 74LS08	
1	IC, 74LS20	
1	IC, 74LS74	
6	IC, 74367 or 8097	
1	IC, 74368 or 8098	
2	IC, 9602	
1	Regulator, 7805 or LM340T-5	
1	Crystal, 2 Mhz	
2	Resistor Networks, 180 ohm	
1	Resistor, 180 ohm	
1	Resistor, 270 ohm	
2	Resistor, 390 ohm	
4	Resistor, 1K ohm	
1	Resistor, 4.7K ohm	
1	Resistor, 10K ohm	
1	Resistor, 11K ohm	
1	Capacitor, 1 pfd, silver mica	
1	Capacitor, 39 pfd, silver mica	
1	Capacitor, 100 pfd, silver mica	
8	Capacitor, .1 mfd, ceramic disc	
2	Capacitor, 10 mfd, tantalum electrolytic	
1	Heatsink	
1	6-32 bolt and nut	
1	Four pin terminal block *	
1 or 4	S-100 Bus connectors * %	
1	12" or 36" 40 conductor cable assembly #	
4	Rubber mounting feet *	
1	MINI-8100(s) PC Board	
1	User's Manual	
1	Warranty Documentation	

* Not included with MINI-8100S
\# 12" Cable with MINI-8100, 36" Cable with MINI-8100S
% One S-100 connector with MINI-8100 Kit, four with MINI-8100 ASM

Note: Due to parts shortages, any 74 series IC may either be 'LS' series or not. For example, a 74LS00 may be either 74LS00 or 7400.

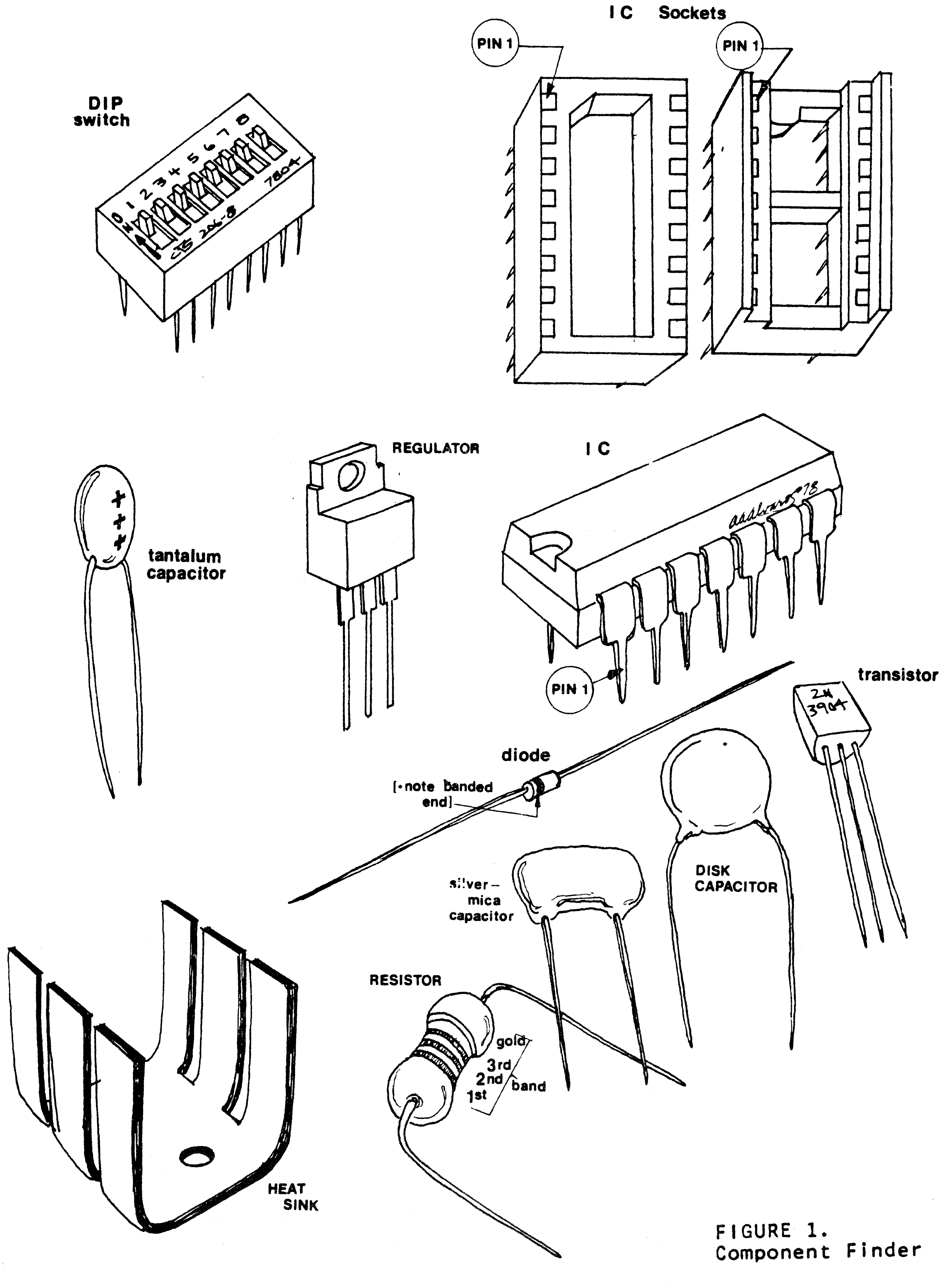
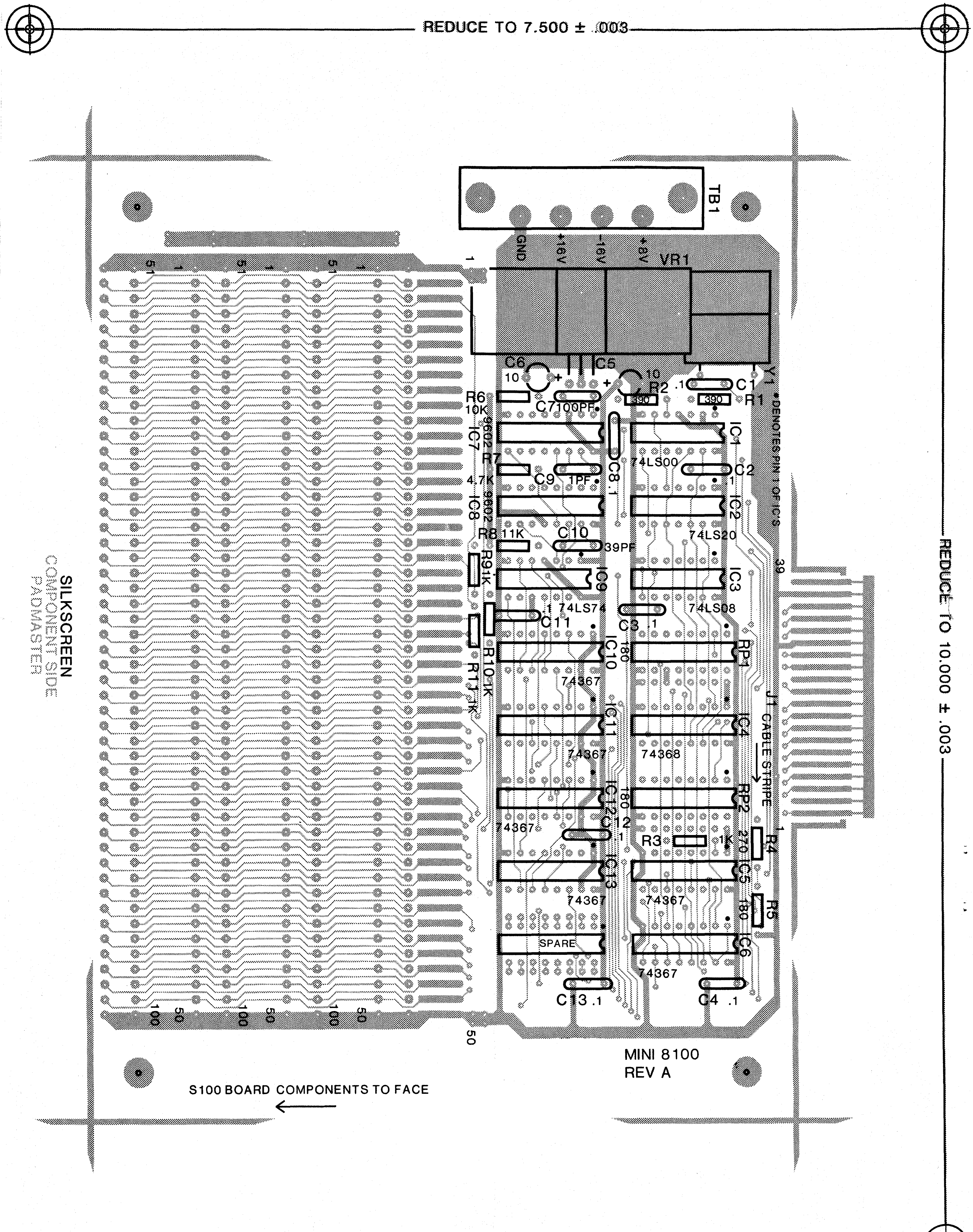
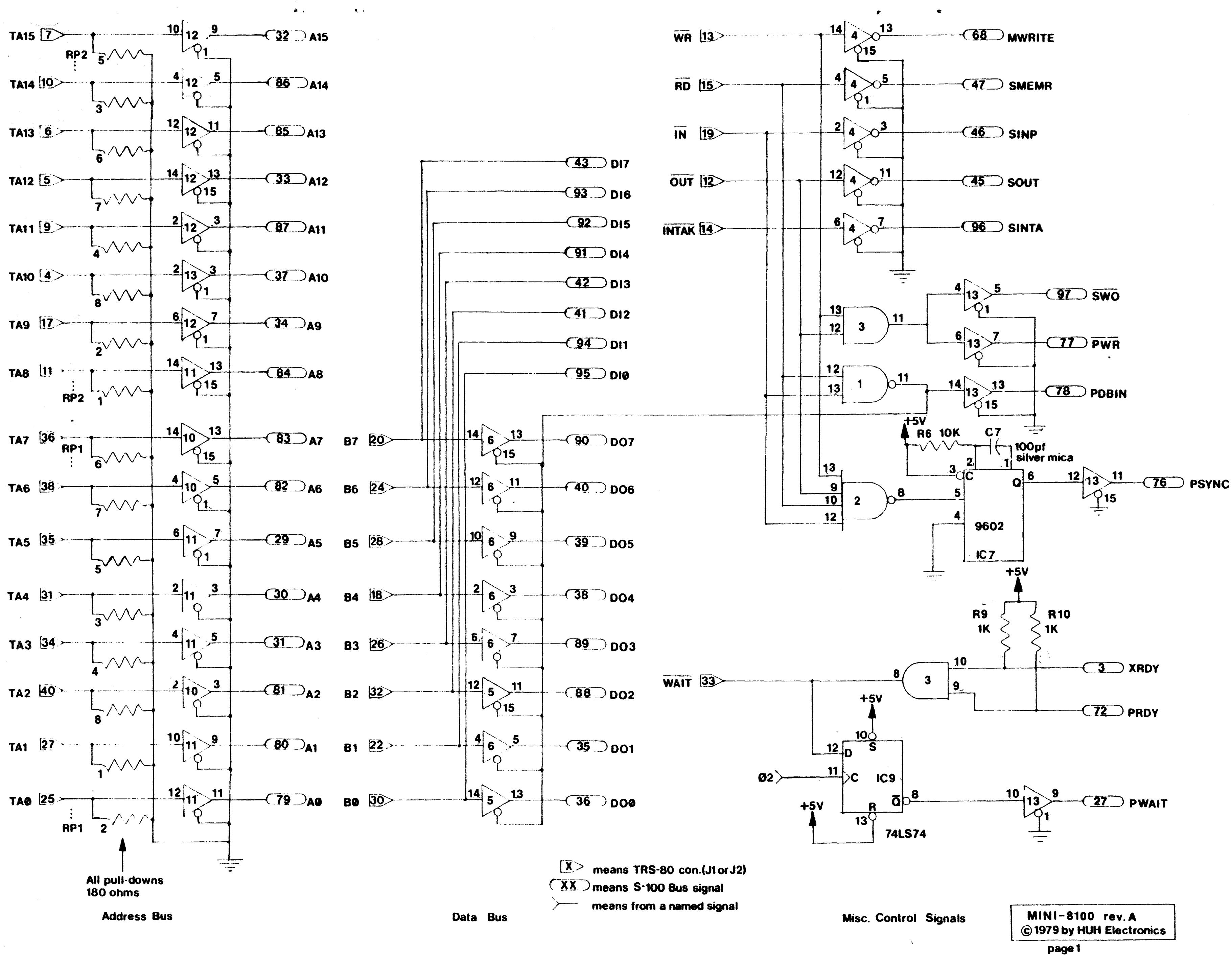


FIGURE 1.
Component Finder



REDUCE TO 7.500 ± .003
REDUCE TO 10.000 ± .003
TB1
GND
+16V
−16V
+8V
VR1
V1
C1
C2
C3
C4
C5
C6
C7 100PF
C8 .1
C9 1PF
C10 39PF
C11
C12
C13 .1
R1 390
R2 390
R3 1K
R4 270
R5 180
R6 10K
R7 4.7K
R8 11K
R9 1K
R10 1K
R11 1K
IC1 74LS00
IC2 74LS20
IC3 74LS08
IC4 74368
IC5 74367
IC6 74367
IC7 9602
IC8 9602
IC9 74LS74
IC10 74367
IC11 74367
IC12 74367
IC13 74367
SPARE
RP1
RP2
•DENOTES PIN 1 OF IC'S
J1 CABLE STRIPE
MINI 8100
REV A
S100 BOARD COMPONENTS TO FACE
SILKSCREEN
COMPONENT SIDE
PADMASTER


TA15 7 TA14 10 TA13 6 TA12 5 TA11 9 TA10 4 TA9 17 TA8 11 TA7 36 TA6 38 TA5 35 TA4 31 TA3 34 TA2 40 TA1 27 TAØ 25
RP2 RP1
32 A15 86 A14 85 A13 33 A12 87 A11 37 A10 34 A9 84 A8 83 A7 82 A6 29 A5 30 A4 31 A3 81 A2 80 A1 79 AØ
All pull-downs
180 ohms
Address Bus
B7 20 B6 24 B5 28 B4 18 B3 26 B2 32 B1 22 BØ 30
43 DI7 93 DI6 92 DI5 91 DI4 42 DI3 41 DI2 94 DI1 95 DIØ
90 DO7 40 DO6 39 DO5 38 DO4 89 DO3 88 DO2 35 DO1 36 DOØ
Data Bus
WR 13 RD 15 IN 19 OUT 12 INTAK 14
68 MWRITE 47 SMEMR 46 SINP 45 SOUT 96 SINTA
97 SWO 77 PWR 78 PDBIN 76 PSYNC
+5V R6 10K C7 100pf silver mica
9602 IC7
R9 1K R10 1K
WAIT 33
3 XRDY 72 PRDY
Ø2 IC9 74LS74 27 PWAIT
X means TRS-80 con.(J1 or J2)
XX means S-100 Bus signal
means from a named signal
Misc. Control Signals
MINI-8100 rev. A
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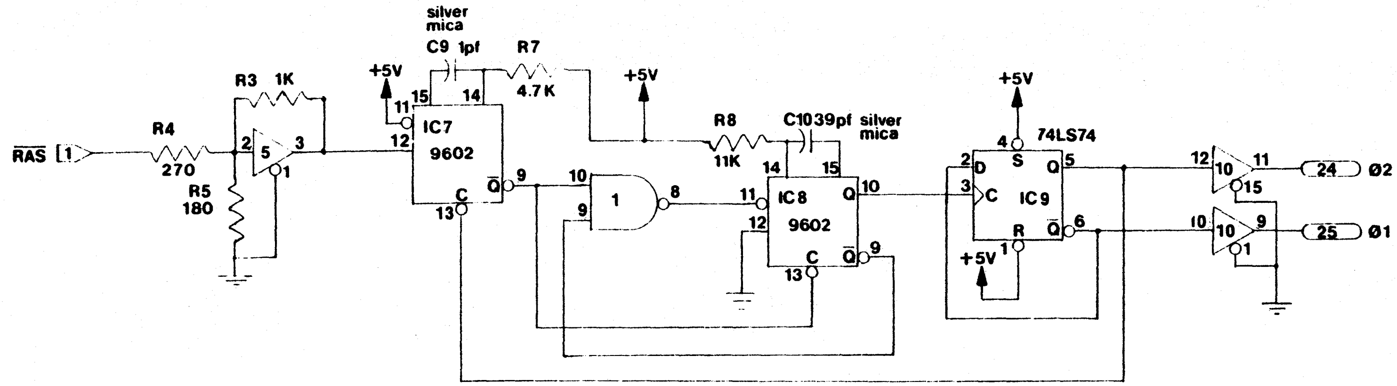
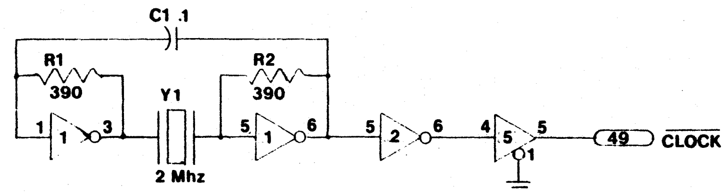
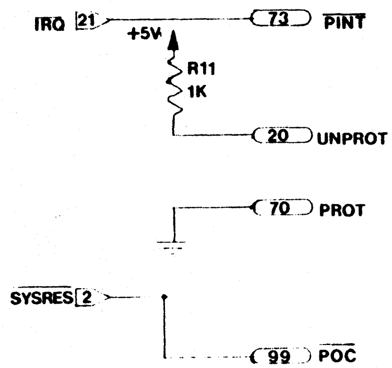
page 1



Clock Regenerator



2 Mhz Oscillator

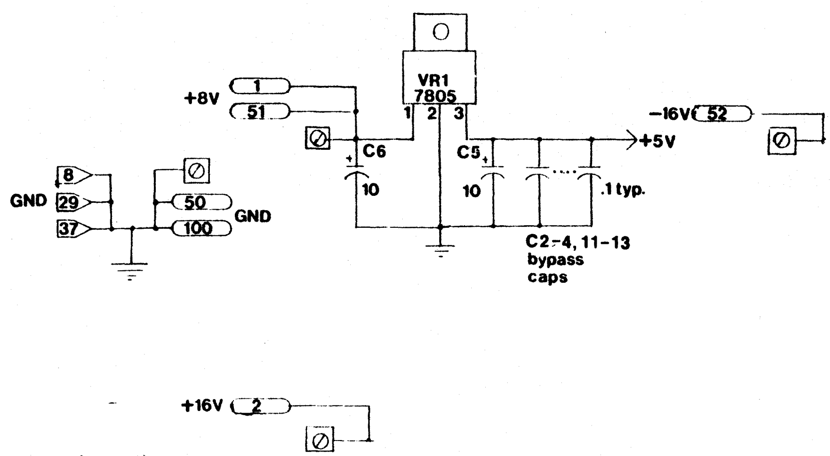


Misc. Signals

[X> means TRS-80 con.(J1 or J2)

(XX) means S-100 Bus signal

[Ø] means Terminal Block



Regulator

MINI-8100 rev. A

Below is a list of the S-100 Bus signals. Those marked with an asterisk '*' are <u>not</u> implemented by the 8100.

S-100 Pin #	Signal Name	Description
1	+8 volts	Unregulated supply
2	+16 volts	Unregulated supply
3	XRDY	Ready input to CPU
4 to 11	VIØ to VI7*	Vectored Interrupts
12 to 17	---	Not specified
18	STAT DSB*	Status Disable
19	C/C DSB*	Command Control Disable
20	UNPROT	Unprotect
21	SS*	Single Step (No longer used)
22	ADD DSB*	Address Disable
23	DO DSB*	Data Output Disable
24	ø 2	Phase Two Clock
25	ø 1	Phase One Clock
26	PHLDA*	Processor Hold Acknowledge
27	PWAIT	Proccessor Wait
28	PINTE*	Interrupts enabled
29	A5	Address Bit 5
30	A4	Address Bit 4
31	A3	Address Bit 3
32	A15	Address Bit 15
33	A12	Address Bit 12
34	A9	Address Bit 9
35	DO1	Data Output 1
36	DoØ	Data Output Ø
37	A10	Address Bit 10
38	DO4	Data Output 4
39	DO5	Data Output 5
40	DO6	Data Output 6
41	DI2	Data Input 2
42	DI3	Data Input 3
43	DI7	Data Input 7
44	SM1*	Status Bit M1 cycle
45	SOUT	Status Bit for Output Cycle
46	SINP	Status Bit for Input Cycle
47	SMEMR	Memory Request Cycle (read)
48	SHLTA*	Halt Acknowledge
49	CLOCK	2 Mhz Clock
50	GND	Ground
51	+8 volts	Unregulated supply
52	-16 volts	Unregulated supply
53	---	Not specified
54	EXT CLR*	External Clear
55 to 58	---	Not specified
59	SXTRQ *	Sixteen Request (for 16 bit CPU's)
60	---	Not specified
61	SXTN *	Sixteen Ack. (for 16 bit CPU's)
62 to 66	---	Not specified
67	PHANTOM*	Phantom
68	MWRITE	Memory Write

S-100 Pin #	Signal Name	Description
69 to 71	---	Not specified
72	PRDY	Ready input to CPU
73	PINT	Interrupt Input to CPU
74	PHOLD*	Hold input for DMA
75	PRESET*	Reset Input to Proccessor
76	PSYNC	Start of machine cycle
77	PWR	Processor Write cycle
78	PDBIN	Processor Data Bus In
79	AØ	Address Bit Ø
80	A1	Address Bit 1
81	A2	Address Bit 2
82	A6	Address Bit 6
83	A7	Address Bit 7
84	A8	Address Bit 8
85	A13	Address Bit 13
86	A14	Address Bit 14
87	A11	Address Bit 11
88	DO2	Data Output 2
89	DO3	Data Output 3
90	DO7	Data Output 7
91	DI4	Data Input 4
92	DI5	Data Input 5
93	DI6	Data Input 6
94	DI1	Data Input 1
95	DIØ	Data Input Ø
96	SINTA	Interrupt Acknowledge
97	SWO	Write Cycle Status
98	---	Not specified
99	POC	Power on clear
100	GND	Ground