My "HomeBrew" I/O card

My "homebrew" I/O card began life as a "Solid State Music" I/O-PROM-UNIVERSAL card. It had a couple of "open" areas and was designed so that you could add a little circuitry if you needed to.

Originally intended to have a single AY-5-1013 UART added to it, I instead put on two 8251 uarts with associated baudrate clock generator and RS-232 interfaces (made with op-amps).

Fortunately the original card was designed to be flexible, and even chips which had been "designated" were on general purpose pads - as you can see from the photos, I modified the circuitry quite extensively...

The following pages contain the original documentation for the Solid State Music card. The last handwritten page contains a few notes on my changes, which appears to be the only documentation that I have remaining.
This card was designed to provide an I/O interface for the Altair 8800 computer. Additional pads have been provided to facilitate the addition of EPROMs, a UART, RAMs or other circuits as required. The basic kit provides the necessary parts for the implementation of two I/O ports. Other kit options are being prepared for supplementary functions such as TTY interface, video monitor interface, etc.

Figure 1 shows the layout of the committed areas for the I/O and the uncommitted areas for other circuitry.

1.0 I/O Card Connections (refer to figures 2, 4 & 5)

1.1 Jumpers. If this card is used for I/O functions a few connections have to be made on the board with jumpers first.

(a) Connect "SM" (U5, pin 12) to the 1K ohm pull-up resistor (5 pads-1.25" to the right of the letters "SM" and up 0.625" on the front side of the board.)
(b) Connect "SO" (edge conn. pin 45) to "SOUT" (U6 pin 5).
(c) Connect "SI" (edge conn. pin 46) to "SINP" (U6, pin 9).
(d) Connect "OUT STEB" (5 pads) to pin 13(DS2) of all of the 8212 IC's that will be used as output ports.
(e) Connect "INP STEB" (5 pads) to pin 13(DS2) of all of the 8212 IC's that will be used as input ports.

1.2 Port (address) Selection. The Altair Computer can drive up to 256 input or output ports by decoding eight of the sixteen output address lines from the Intel 8080 CPU chip. The 8-line address decoder (SN74142) on the Universal Card can enable up to eight consecutive port devices in the range of "0" to "255".

As shown on figure 4, U3 drives up to eight ports in a group range selected by jumpers (or Dip Switch) at U7. If you want to select ports numbered 0 thru 7, then the code for U7 is "00000" and no jumpers are needed for U7 (pins 12 thru 16 connected over to pins 5 to 1). Note: U7, pin 16 is the most significant bit and U7, pin 12 is the least significant bit of the group address for the ports.
SOLID STATE MUSIC
Assembly Instructions

1.2 Cont’d

<table>
<thead>
<tr>
<th>U7 selects the group address, pins</th>
<th>U3 selects the port address within a group</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 15 14 13 12</td>
<td>C B A</td>
</tr>
</tbody>
</table>

Binary value:
- MSB: 128
- LSB: 64 32 16 8

4 2 1

To connect the addressing circuit to the port, place a jumper from 1 (DS1) of the 8212 IC to pins 1 thru 7 or pin 9 depending on what address you want that port to be.

JUMPERS, U7

<table>
<thead>
<tr>
<th>1.3 To select PORT RANGE</th>
<th>pins</th>
<th>pins</th>
<th>pins</th>
<th>pins</th>
<th>pins</th>
<th>pins</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 thru 7</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>8 thru 15</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>16 thru 23</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>24 thru 31</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>32 thru 39</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>248 thru 255</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
</tbody>
</table>

1.4 To select PORT NUMBER within a selected range:

Make port drive connections to the following pins of U3 (74L42)

1st port - pin 9
2nd port - pin 7
3rd port - pin 6
4th port - pin 5
5th port - pin 4
6th port - pin 3
7th port - pin 2
8th port - pin 1

1.5 PARALLEL INPUT PORT (MITS Rev. 1)

The 8212 (U8) is used as an input port at address 001 in this configuration. The keyboard or inputting device should provide a positive pulse for a DAV (data available) strobe to place data into the 8212. If your DAV is negative, invert it with a 7404. The added DM8097 device is used as a one-bit input port at address 000 as a status flag.
1.6 PARALLEL INPUT PORT (Processor Tech. Corp compatible)
The same as MITS Rev. 1 circuit except at #, add an inverter (7404) between U8 pin 23 and the DM8097 pin 14. Also, move # connection to pin 93 (instead of 95) which will give a "DI6" bit.

1.7 PARALLEL INPUT PORT (IMSAI 8080 compatible)
Same as MITS Rev. 1 circuit except add an inverter (7404) between pin 23 of U8 and pin 14 of the DM8097. Then change # connection to pin 93. Then connect pin 1 of U8 to pin 6 of U3 and pin 4 of U4 to pin 5 of U3.

1.8 Types of Ports. For additional information on some port configurations that can be constructed with the 8212 IC get a copy of the "8212 Eight-Bit Input/Output Port." Microcomputer Peripherals—Schottky Bipolar pamphlet from Intel Corp., 3065 Bowers Ave, Santa Clara Ca.

2.0 1K/2K PROM CARD CONNECTIONS (refer to figures 3 & 4)

2.1 Jumpers. If this card is used for PROM functions, a few connections have to be made on the board with jumpers first.

(a) Connect "SM" (U5, pin 12) to pin 47 (edge conn. pin near "SI").
(b) Connect the data outputs of the 1702A type PROM to the appropriate data input lines (edge conn. pins) of the Altair bus.
(c) Connect the address lines (edge conn. pins) A0 to A7 to the appropriate address pins on the 1702A.

2.2 Speed Considerations. The Altair Computer uses a 2 MHz clock to time all its functions which gives a single cycle period of 500 nsec. If the PROM you are using has an output data access time of greater than 500 nsec, then a slow-down circuit has to be built on the unused part of this card or the computer will not be able to read the PROM. (See appendix 1 for a slow-down circuit.)

2.3 PROM Addressing. The addressing of PROM is similar to Port Selection as described in this pamphlet.

<table>
<thead>
<tr>
<th>Binary value</th>
<th>MSB</th>
<th>32</th>
<th>768</th>
<th>2048</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

 U7 selects the starting page (256 bytes) address, pins

<table>
<thead>
<tr>
<th>16</th>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

 U3 selects up to 8 pages (PROMs).

<table>
<thead>
<tr>
<th>1024</th>
<th>256</th>
</tr>
</thead>
</table>
2.3 Cont'd

Connect the outputs of U3 (pins 1 thru 7 and 9) to the chip select (CS) pin of the PROM. Note: U3 pin 9 is the enable for the first page, U3 pin 7 is the second page enable, etc.

3.0 Parts List

<table>
<thead>
<tr>
<th>preferred part</th>
<th>alternate</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1..............SN7485</td>
<td></td>
</tr>
<tr>
<td>U2..............SN74L804</td>
<td>SN74L04,</td>
</tr>
<tr>
<td>U3..............SN74L42</td>
<td>SN74L42, 74LS42</td>
</tr>
<tr>
<td>U4..............SN7486</td>
<td></td>
</tr>
<tr>
<td>U5..............SN74L00</td>
<td>74LS00</td>
</tr>
<tr>
<td>U6..............SN74L00</td>
<td>74LS00</td>
</tr>
<tr>
<td>U7..............Dip Switch (8)</td>
<td>Jumper</td>
</tr>
<tr>
<td>U8..............Intel 8212</td>
<td>74S412</td>
</tr>
<tr>
<td>U10.............Intel 8212</td>
<td>74S412</td>
</tr>
</tbody>
</table>

FIGURE 1 - GENERAL CARD LAYOUT
FIGURE 2 - I/O CARD LAYOUT

1K/2K PROM CARD LAYOUT - FIG 3
SOLID STATE MUSIC
Assembly Instruction

8-LINE ADDRESS DECODER—FIG 4
The 8212 IC is an eight-bit Latch with a special mode control circuit and tri-state outputs. With pin 2 (MD) of the 8212 connected to ground the IC will act as an input device with data loaded into the latch on trailing edge of a positive pulse to pin 11 (STB).

Input Port

Using the above input port circuit and connecting pin 23 (INT) to pin 73 of the computer bus, a port with interrupt is created. When the CPU is interrupted it will execute the eight-bit mach. instruction on the bus after it has finished its present instruction. If you do not have a special interrupt system, the interrupt will place an RST-7 instruction into the CPU.

Input Port with Interrupt

The output port function is selected by connecting pin 2 (MD) to a logic "one." The 8212 will be loaded with data from the bus when it is addressed by the computer thru pins 13 and 1.

Output Port
NOTE:
PIN 24 ON BUS IS B;
PIN 12 ON BUS IS GROUND

SERIAL DATA IN FROM INTERFACE
CLOCK (16X Baud Rate)
SERIAL DATA OUT TO INTERFACE

UART WIRING COMPATIBLE
WITH ALTAIR SOFTWARE FOR
REV.0 & REV.1 SERIAL I/O
(W/0 MODIF)

SOLID STATE MUSIC 10-2
©1977
SELECTABLE BAUD RATE CLOCK FOR UART

TTY INTERFACE HEADER
20 mA CURRENT LOOP
ICs REQUIRED:

1  74L03
1  74L74

<table>
<thead>
<tr>
<th>PROM SPEED</th>
<th>RA</th>
<th>RB</th>
<th>NUMBER OF WAIT CYCLES ADDED</th>
</tr>
</thead>
<tbody>
<tr>
<td>.5 us</td>
<td>GND</td>
<td>GND</td>
<td>NO WAIT CYCLES (Circuit not required)</td>
</tr>
<tr>
<td></td>
<td>RC</td>
<td>GND</td>
<td></td>
</tr>
<tr>
<td>1 us</td>
<td>GND</td>
<td>RC</td>
<td>ONE WAIT CYCLE - 0.5 us added per byte</td>
</tr>
<tr>
<td>1.5 us</td>
<td>RC</td>
<td>RC</td>
<td>TWO WAIT CYCLES - 1.0 us added per byte</td>
</tr>
</tbody>
</table>

The IO-2 concept and tape master were created by Malcolm Wright. Important contributions were made by Lynn Cochran - The UART circuits and TTY interfaces, for example.
Serial Port Dip Switch Settings

**Low speed**
- 150 - 600 BPS Low strap
- 300 - 1200 BPS High strap

**High speed**
- 300 - 1200 BPS Low strap
- 600 - 2400 BPS High strap

Serial Port 2 is 1/8 Times Speed of Serial Port #1

Connector Identification:

**Port 1**
- Serial Port 1
- Serial Status 1
- Parallel Out
- Serial Data 2
- Serial Status 2
- Parallel In

9.6 w/4
OC =

Counter CLK:
→ pin 8 of
OSCL

0.3 C