

Multi I/O Board

Setup and Users Manual

September 2007



Preliminary Edition

Briel Computers
5392 Cornell Blvd
North Ridgeville, OH 44039

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Version 1.0

Published by Briel Computers
5392 Cornell Blvd
North Ridgeville, OH 44039
USA

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Forward

Expanding the replica 1 and apple 1

The Multi I/O board for the replica 1 and the apple 1 has been a work in progress for over a year. The idea was to give the replica 1 expansion I/O ports and features at a low cost. I built this board after wanting to make the replica 1 talk. I found and tested the speakjet chip and found that it was a simple solution for a good voice chip. The interface to the speakjet requires a true serial port, so I quickly designed a simple serial port for the replica 1 with the speakjet chip.

Shortly after I made a breadboard design and tested it out I realized I didn't want to stop with just a simple serial port card that speaks. I decided to add my single chip EEPROM programmer circuit using the 28C64 EEPROM. Now there were two features on the card. But I still felt the card was missing something to allow users to have I/O fun. I decided the board needed a couple 8 bit I/O ports. It needed Ports that can be used to read switches, or light up LED's, or whatever the user wanted to create. So, I decided to add a 6522 VIA (Versatile Interface Adapter) chip that gives the user two 8-bit bidirectional ports and 4 handshaking signals.

The last feature was a small breadboard area that gives the user the ability to add hardware to their board and run their own experiments.

Since the speakjet is a little expensive I decided to make that chip an option to help keep the price down. I'm sure not everybody will want to make their replica 1, or apple 1 talk. I hope you enjoy the multi I/O board and use it to run lots of experiments of your own.

Vince Briel

Setup and Users Manual

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Chapter 1: Assembling the HIT

The Multi I/O Board kit is a pretty simple circuit board to assemble. First let's do an inventory of all the parts:

Part Description	Qty
14 pin socket	1
24 pin socket	1
28 pin socket	1
28 pin ZIF socket	1
40 pin socket	1
1.8432MHz crystal	1
mono speaker connector	1
db9 serial connector	1
2X10 pin female header	1
Single jumper	1
Jumper shunt	1
.1uF capacitor	7
22pF capacitor	1
1uF electrolytic capacitor	5
blank Multi I/O PCB	1
74LS00	1
74154	1
28C64	1
6522 VIA	1
6551 ACIA	1
speackjet (optional)	1

Start with the 7 .1uF capacitors labeled C1-C7 (see note below). Place them through the holes all the way in either direction, and bend the extra leads away from one another. Trim the extra lead from the bottom of the board. Once you have all 7 installed, flip the board and solder them down.

NOTE: Capacitor C6 needs to be installed from either the backside or leave long length on the lead's so the ZIF socket will fit. The original design was for a standard socket for the EEPROM but the ZIF socket was added as an improved feature. The socket is slightly larger than a standard socket and blocks the C6 capacitor holes.

Next, install the sockets. Insert the 40 pin socket and verify that the notch at the top of the socket is facing the breadboard area. All of the chips will face this direction. Flip the board over and set it on your workbench. Solder down two pins at opposite ends from one another. Flip the board back over and make sure the socket is seated correctly. If not, heat the pin you just soldered down and press the socket all the way into the board. Finish soldering the socket and repeat for the other sockets. Note that the ZIF socket goes where the 28C64 EEPROM is labeled.

Next install the 22pF capacitor C8 the same as you installed the .1uF capacitors.

Next install the jumper post for JP1. It may be easier if you place the speakjet jumper shunt on when doing this, or use tape to hold down the jumper when you flip the board over. You may want to straighten up the jumper so it is straight when finished.

The next item to install is the I/O port female connector. There is no incorrect orientation for this part.

Next install the mono speaker jack and solder it down.

Carefully install the DB9 serial port connector and solder down the pins including the ground connectors.

The next part to install is the 5 electrolytic capacitors. These are polarized so you must insert them correctly. The edge of the capacitor has a negative (-) arrow pointing towards one of the pins. This means that the other pin is positive. It is just a little longer than the negative pin and it goes where the + hole is for the capacitor. Bend the leads away from one another, flip the board over and solder down the capacitor. Trim the extra lead from the bottom of the board and repeat with the remaining 4 capacitors.

The last part to install is the crystal. It is not polarized so you can install it either way. Be sure to trim the extra lead from the back of the board.

Next step is to carefully install the chips. Pin 1 is to the left of the notch on the chip edge. Use caution when installing the chips because the machined sockets will not accept the pin if it isn't lined up just right.

After the last chip is installed check over your board for errors.

Chapter 2: Installing the Multi I/O Board

The Multi I/O Board is very easy to install and only requires a few steps. First of all, if you have a CFFA1 board you can not have an EEPROM in the ZIF socket at the same time as the CFFA1. You must remove the 28C64 from the ZIF socket or remove the CFFA1 if you intend on programming the 28C64 right away.

NOTE: Before you install your Multi I/O Board, read through the instructions carefully. Failure to follow instructions could result in damage to your replica 1, apple 1 clone or the multi I/O board.

Make sure you are working on a cleared table or bench with the replica 1 slot expander or R144 slot adapter within easy access. Observe the edge of the Multi I/O Board with the slot pins and look for the numbers on either end. Match the 22 on the multi-board to the replica 1 slot expander board, r144 adapter or apple 1 clone and insert the card until it stops.

To verify that the board is installed correctly, the Multi I/O Board chips face away from the replica 1 with the r144 adapter or they face the 40 pin header on the slot expander board.

If you have your own speakjet chip and it is installed, you can choose if you want to enable or disable it with the jumper. Plug in a set of standard powered pc speakers and turn them on with the volume not too loud. When you apply power to the replica 1, the speakjet should say "READY" if the volume is loud enough and the jumper is on. Pressing reset will reset the speakjet too and once again it will say "READY".

Chapter 3: Using the serial port

The serial port on the Multi I/O board is controlled via a 6551 ACIA UART chip. This means that the port can run at speeds up to 19,200 BAUD. With your computer and replica 1 powered off, attach a standard serial cable M/F DB9 between your PC and the replica 1 Multi I/O board. You can attach a serial to USB cable if you do not have a serial port on your computer. Remove the speakjet jumper if you are using a speakjet chip so that you do not get garbage output on the speakers. You are now ready to power up the replica 1 and use the serial port.

There is a version of the Woz monitor that has been modified for the Multi I/O board and is included for use. Keep in mind that the apple 1 programs use the TV and keyboard for I/O so once you load a program and run it, you must switch back to the TV and keyboard.

Set up HyperTerminal the same as you did with the replica 1 but this time, you don't need the line delays and you need to set the speed to 19200, N, 8, 1.

Load the serialwozC300 program and type 7F00R. To get the Woz monitor going, press ESC on your PC keyboard and the Woz monitor is now running. Make sure caps lock is on and examine some memory locations, change memory, etc to make sure it is working. Now try dumping one of your favorite replica 1 programs through the monitor and run it. Remember that once you run the program, the I/O switches back over to the replica 1 video and keyboard.

For direct programming of the serial port, here is some helpful address information:

To start the serial port, set the BAUD rate by programming address C303 with the value for the speed you want. For example, if you want the BAUD rate to be 9600, make C303:1E. If you want it at 19,200, then make C303:1F.

Now, set C302 so there is no parity. To do this, program C302 with the value 0B by typing in C302:0B.

To send a byte in a program, send the data to C300, then check C301 and loop until C301 has a value of hex 10.

To receive a character is just as easy. First check the status register C301. If it is hex 08 there is an incoming character. The character is stored in location C300.

This is just a small bit of information on how the ACIA is used to read and write data. Refer to the 6551 ACIA manual for further programming information.

Chapter 9: Fun with the Speakjet

Now that you know how to use the serial port, you actually know how to use the Speakjet. If you have purchased a speakjet and have it installed, you will want to enable the speakjet with the jumper. JP1.

Programming the speakjet is not very difficult but requires knowing how to use phonemes to have the chip form sounds to produce words. Refer to the speakjet manual for a better explanation of phonemes and how to use them. You will need to study how to produce words and change speeds and add pauses to get the words to sound just right. There is a small library of words that will help get you started.

Besides speech, the speakjet has the ability to produce a few simple sounds. While there are only a few built in sounds, bending pitch, or changing speed of the sound can help manipulate to create a whole library of sounds.

To verify that your speakjet is functioning, make sure you have a powered speaker that has volume control attached to the Multi I/O board and turn it on. If your replica 1 (or apple 1 clone) is not turned on, you can do so now. Make sure you attach a jumper on JP1 to enable the speakjet chip. You should then hear the speakjet say "READY". Every time you RESET the replica 1, the speakjet will now say "READY". You are now ready to program the speakjet.

You use the serial port on the multi I/O board but you don't need to have it attached to a PC and it is probably better if you just disconnect any cable that might be attached while using the speakjet.

To send sounds to the speakjet you can write assembly programs or BASIC to program the speakjet. The speakjet communicates with the 6551 ACIA UART at 9600 BAUD and 8 bit with NO parity. The first thing you should do in your program is set up the ACIA with these settings.

One thing you will notice when you are using the speakjet is that it does not hold up the system. You can send the data and be processing other functions while the speakjet is still sounding out words.

The following program is a small sample in BASIC to get your speakjet to talk. It says a sentence and then does a few sound samples.

```
32 REM -15616 = C300 ACIA
33 REM -15615 = C301 ADDRESS TO CHECK IF SERIAL PORT CLEAR
34 REM -15614 = C302 SET PARITY
35 REM -15613 = C303 BAUD RATE SETTING 1E=9600 1F=19200
40 POKE -15613,30: REM 30=1E FOR 9600 BAUD 8 BIT
50 POKE -15614,11: REM SET FOR NO PARITY
60 DIM A(50)
61 REM SET SPEED
62 R=-15616:B=-15615:POKE A,21
63 X= PEEK (B): IF X#16 THEN 63
64 REM NOW SET SPEED, DEFAULT IS 114
65 POKE R,110
66 X= PEEK (B): IF X#16 THEN 66
```

```
70 A(1)=183
71 A(2)=7
72 A(3)=159
73 A(4)=146
74 A(5)=164
75 A(6)=2
76 A(7)=189:A(8)=8:A(9)=132:A(10)=8:A(11)=146
77 A(12)=6: REM 90MS PAUSE
78 A(13)=147:A(14)=8:A(15)=128
79 A(16)=6: REM PAUSE BEFORE PLAY
80 A(17)=199:A(18)=7:A(19)=145:A(20)=131:A(21)=154
90 A(22)=6: REM PAUSE BEFORE A
92 A(23)=154:A(24)=128:A(25)=6
94 REM GAME
95 A(26)=8:A(27)=178:A(28)=154:A(29)=140
96 A(30)=211:A(31)=212
97 A(32)=2
98 A(33)=148
99 A(34)=8
100 A(35)=131
101 A(36)=198
102 A(37)=8
103 A(38)=145
104 A(39)=194: REM K
105 A(40)=8
106 A(41)=136
107 A(42)=2: REM PAUSE BEFORE 'ONE
108 A(43)=147
109 A(44)=14:A(45)=135
110 A(46)=8:A(47)=141
111 A(48)=0
112 I=1
120 S=A(I): IF S=0 THEN 9999
130 POKE R,S
140 X= PEEK (-15615): IF X#16 THEN 140
150 I=I+1: GOTO 120
9999 END
```

If you have everything set up correctly, this program should produce a sentence and a small sound clip. This should get you going to create your own phrases. Feel free to discuss your own ideas on the Briel Computers web forum site.

Chapter 5: Programming the EEPROM

The EEPROM programmer is from the 1 chip EEPROM circuit idea release a few years ago. It allows the use of a 28C64 EEPROM just like the one used in the replica 1 to be directly accessed. You can read or write directly to the chip simply by addressing the memory location it occupies.

CAUTION: If you have a CFFA1 you must remove it to program with the EEPROM because the EEPROM uses some of the same memory locations as the CFFA1.

With a 28C64 chip installed in the ZIF (Zero Insertion Force) socket to program the chip simply program where you want to at address range \$A000-BFFF. You can even dump programs from your PC directly into the EEPROM by dumping with Hyper Terminal.

You can use the 28C64 to store data or copy over your replica 1 ROM and modify it to do whatever you want.

CAUTION: Never remove or insert an EEPROM into the ZIF socket while power is on. Doing so will damage your replica 1, EEPROM and the Multi I/O board.

Remember that since the EEPROM programmer treats the EEPROM like memory, it is easy to write over any data on the EEPROM. It is suggested that you remove the EEPROM when not using it to avoid accidental programming.

Chapter 6: Interfacing with the 6522 VIA

The 6522 VIA (Versatile Interface Adapter) is an interface chip with 16 bidirectional I/O signals. These signals are divided up into 2 ports labeled port A and port B. We will discuss port A to keep things simple but you can program port B exactly the same way.

When you read or write to/from these ports you access one port at a time. Since the ports are bi-directional, you can have some pins on port A set as input and others set as output. This gives the user total flexibility to have as much input or output pins as needed for a project.

Keeping the addressing simple here is a brief description of some of the address registers in the Multi I/O board.

Address	Function	Description
C200	Data for port B	this address is where you read or write data to/from port B
C201	Data for port A	this address is where you read or write data to/from port A
C202	DDRB	Data direction for the 8 pins of port B. 0 is input & 1 is output
C203	DDRA	Data direction for the 8 pins of port A. 0 is input & 1 is output

There are other registers and more advanced functions to the 6522 but we will only cover basic I/O signals.

Let's start with the Data Direction Register. Since we are dealing with port A, we need to program address C203 with a value that sets the I/O pins for port A as input or output. Keeping things easy, we will start with all the pins as output. To do this, simply make all 8 bits of C203 have the binary value of 11111111, or FF.

C203: FF

You can at anytime in software change the ports to input simply by changing the DDR to 0. If you want all pins on port A as input that would be 00000000 or simply 00.

C203:00

But what if you want half as input and half as output? You want to set PA0-PA3 as input and PA4-PA7 as output? Well, that would be 11110000 or F0. PA7 is the high bit, and PA0 is the low bit just like a standard binary 8 bit value. It makes things easy to keep track of.

C203:F0

Since 1111 in binary is F and 0000 is 0 that makes for a value of F0

Now that you have the Data Direction Register set, simply read or write to/from C201 for port A. If you are using port A as 8 input bits, just read C201 and the value determines what pins are high or low. If you are using port A as an output, just set the bits you want high or low with a hex value equal to the port output.

Appendix A: Multi I/O Board Memory Map

Multi I/O Board Memory Diagram	
A000-BFFF	EEPROM
6522 VIA	
C200	Data port B
C201	Data port A
C202	DDRB
C203	DDRC
C204	T1 Low order Latch/Counter
C205	T1 High order Counter
C206	T1 Low order Latch
C207	T1 High order Latch
C208	T2 Low order Latch/Counter
C209	T2 High order Counter
C20A	Shift Register
C20B	Auxiliary Control Register
C20C	Peripheral Control Register
C20D	Interrupt Flag Register
C20E	Interrupt Flag Enable
C20F	I/O Register A
6551 ACIA	
C300	Data Register
C301	Status Register
C302	Command Register
C303	Control Register

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