

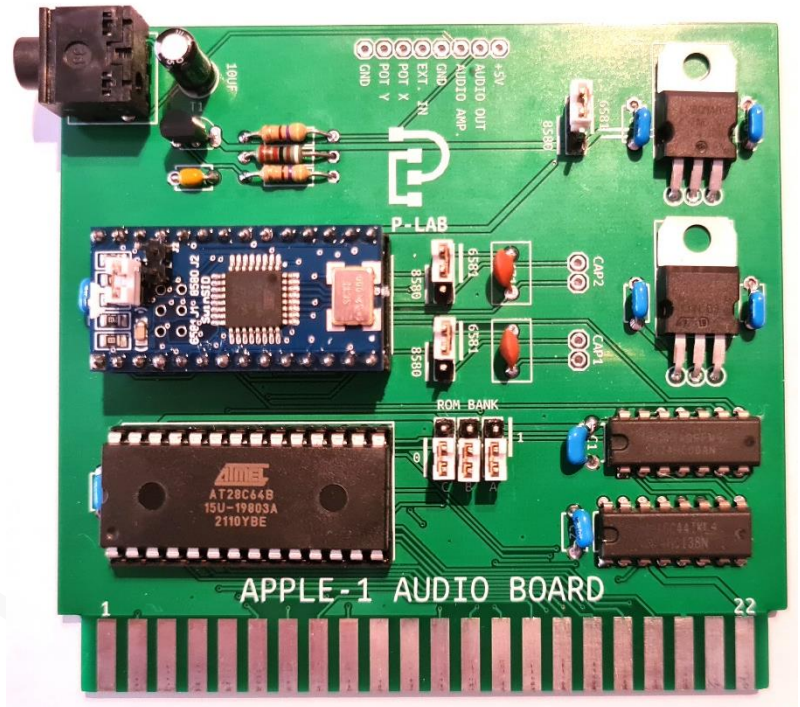
APPLE-1 AUDIO BOARD

v1.0

The *Apple-1 Audio Board* is an electronic board, designed for Apple-1 computer, that allows you to produce sounds and sound effects with maximum ease and freedom.

This document contains:

1. Package contents
2. Warning about the risk of damage due to electrostatic discharges
3. Product description and features
4. Set up and installation
5. Operations and memory mapping
6. INTEGER BASIC example program
7. The Piano demo program
8. Limits of the demo program
9. Final notes



Picture above is for illustration purpose only. Actual product may vary due to product enhancement or component availability.

1. PACKAGE CONTENTS

- *Apple-1 Audio Board* complete with SwinSID.

2. DAMAGES FROM ELECTROSTATIC DISCHARGES

Apple-1 Audio Board is sensitive to static electricity, just like your Apple computer, and may be damaged by it. Before any operation on your devices, you must discharge the static electricity accumulated by your body and prevent it from building up again. We do not accept any responsibility for damage, even serious or fatal, caused to people / things / intellectual property during the installation or use of this device.

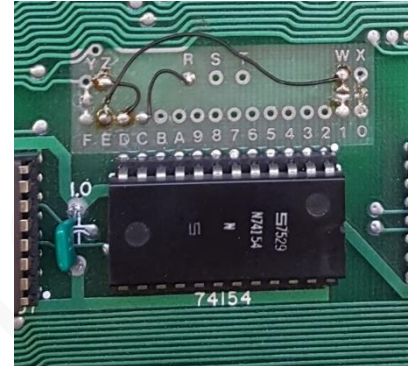
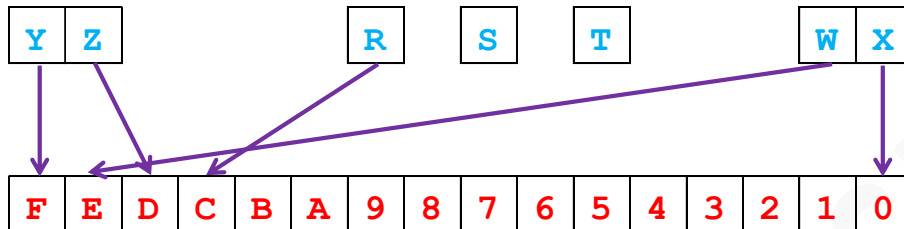
3. PRODUCT DESCRIPTION AND FEATURES

Apple-1 Audio Board is an electronic board that allows you to play simple melodies or produce sounds with your Apple-1 computer (Original or Replica). It is based on the famous MOS 6581 sound chip and is compatible with the later model 8580 and its modern clones (SwinSID).

4. SET UP AND INSTALLATION

4.1 INITIAL CHECKS

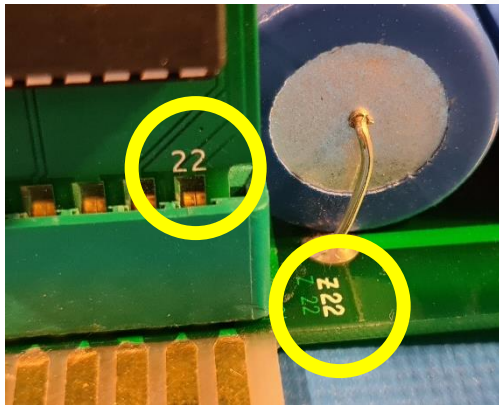
Apple-1 must be set up with the configuration “WITH ACI”, with the following connections in the CHIP SELECT area:



The diagram and the picture show the necessary connections. These wirings are quite standards among all the all Apple-1 computers, both Originals and Replicas. There is no need to wire other dedicated/custom connections.

4.2 INSTALLATION, EXTERNAL CONNECTIONS, JUMPERS CONFIGURATION

4.2.1 INSTALLATION



The card must be inserted as shown in the picture:

The number "22" on the card and the number "22" on the motherboard must be on the same side.

The number "22" on the card must therefore face the outer side of the Apple-1 motherboard.

Using the card in combination with other UNBUFFERED expansion boards and/or devices such as passive BUS EXTENDER could lead to malfunctions: do not use this kind of devices.

WARNING: Switching on the computer with the card oriented incorrectly **INSTANTLY DAMAGES** the computer and the card itself.

4.2.2 EXTERNAL CONNECTIONS

The card has a **3.5mm Stereo Jack connector** for connecting to an amplified speaker or to the AUDIO-IN channel of the TV/monitor you use for your Apple-1. The connection cable is not supplied.

The audio output is not powerful enough to drive a speaker but can drive headphones.

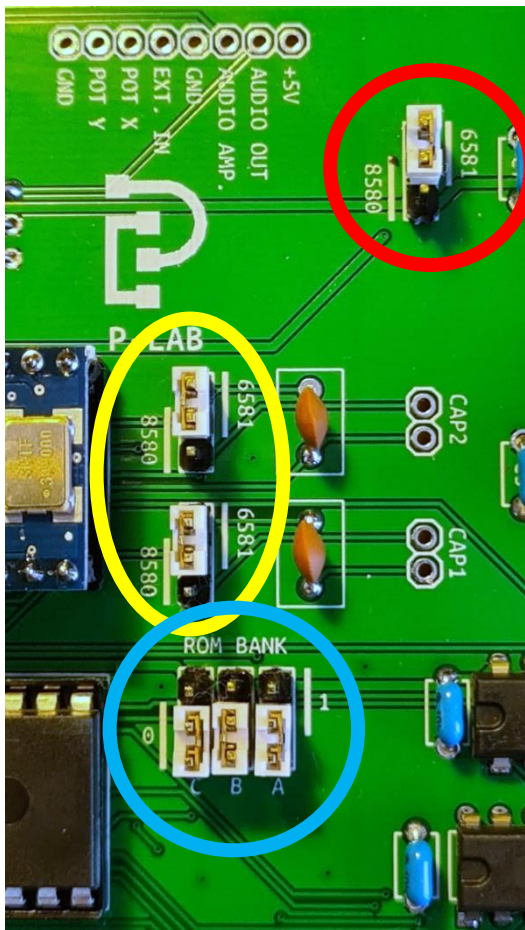
There is also a contact strip on the top side with a description of the signals on each pin. The functions EXT. IN, POT X and POT Y are not supported by the supplied SwinSID.

Therefore, if you plan to use these functions you will need your own authentic 6581/8580.

4.2.3 JUMPERS CONFIGURATION

The jumpers on the board have three functions:

- Select the type of Audio Chip installed, the default is 6581 / SwinSID configured as 6581,
- Select the filter capacitors of the appropriate value according to the installed Audio Chip,
- Select the desired EEPROM bank.



- RED jumper to select the correct model of your Audio Chip. **WARNING: incorrect selection (e.g. jumper in position 6581 but an 8580 is mounted on the board) will instantly and irreversibly damage the Audio Chip present.**

- YELLOW jumpers will select the pair of filter capacitors. In position “6581” the installed 470 pF capacitors will be used. In position “8580” the capacitors at CAP1 and CAP2 will be used. The choice of the value of these capacitors and their installation is left to the end user.

BLUE jumpers are related to the selection of the desired EEPROM bank. They determine which 2 kB physical portion of the EEPROM will be mapped to the Apple-1.

Please refer to the next section and Appendix-1 for a detailed explanation.

Jumpers settings and connections to external devices must always be made with the computer switched off.

5. OPERATIONS AND MEMORY MAPPING

The board comes with a small demonstration program, with which you can use the keyboard of your Apple-1 as if it were a piano keyboard, albeit with some limitations.

Before describing how the program works in detail, it is worth briefly describing how the sound chip interfaces with the computer.

All the devices/peripherals connected to the 6502 microprocessors are "memory mapped".

This means that each device uses dedicated addresses to perform its Input/Output functions.

The SID is no exception, and its 29 registers have been mapped from address \$CC00 onwards.

The EEPROM that contains the example program also has its own addressing range, specifically from address \$C400 to address \$CBFF.

Since the board uses the address range \$C000-\$CFFF, the overall mapping can be summarized as follows:

C000-CFFF	C000-C3FF	1 kB	ACI
	C400-CBFF	2 kB	EEPROM
	CC00-CFFF	1 kB	SID

As can be seen, the 4 kB of the \$C000-\$CFFF range have been divided in three parts. The first block has been left unmapped, because already dedicated to the Cassette Interface (ACI) for compatibility reasons. The next 2 kB have been dedicated to the EEPROM. This space contains, for example, the sample program supplied and all the software you will decide to write and store on it.

Finally, a range of addresses has been dedicated to the actual sound chip.

Supported EEPROMS are 28c64 and 28c128. They have a capacity of 8 kB and 16 kB respectively.

The above-described mapping exposes 2 kB at a time, therefore we will obtain:

- 4 pages, 2 kB each, with 28c64 EEPROM
- 8 pages, 2 kb each, with 28c128 EEPROM

This allows multiple programs on the same storage medium, each up to 2 kB in length, to be selected using jumpers A, B and C (ROM BANK).

See Appendix-1 for a detailed explanation of how these jumpers work.

SID registers are mapped as follows:

SID REGISTER	HEX ADDR	DEC ADDR	INTEGER BASIC ADDR
0	CC00	52224	-13312
1	CC01	52225	-13311
2	CC02	52226	-13310

3	CC03	52227	-13309
4	CC04	52228	-13308
5	CC05	52229	-13307
6	CC06	52230	-13306
7	CC07	52231	-13305
8	CC08	52232	-13304
9	CC09	52233	-13303
10	CC0A	52234	-13302
11	CC0B	52235	-13301
12	CC0C	52236	-13300
13	CC0D	52237	-13299
14	CC0E	52238	-13298
15	CC0F	52239	-13297
16	CC10	52240	-13296
17	CC11	52241	-13295
18	CC12	52242	-13294
19	CC13	52243	-13293
20	CC14	52244	-13292
21	CC15	52245	-13291
22	CC16	52246	-13290
23	CC17	52247	-13289
24	CC18	52248	-13288
25	CC19	52249	-13287
26	CC1A	52250	-13286
27	CC1B	52251	-13285
28	CC1C	52252	-13284

The meaning and usage of the registers can be found in the official documentation and in the extensive literature available online.

Due to the address mapping explained above, SID's registers will start at the decimal address 52224.

The Apple-1 BASIC INTEGER handles numbers in the *16-bit Signed Integer* format, this means that it can only handle integer numbers between -32767 and 32767.

52224 is greater than 32767 (the largest acceptable number) therefore, it will "roll over" and become a negative number. To POKE a specific register just use the negative value.

For example:

POKE -13287,15 will raise the volume to the maximum.

Of course, there are no such things like "negative memory locations": it is just a matter of notation.

6. INTEGER BASIC EXAMPLE PROGRAM

The following program has been adapted to Integer BASIC from BASIC V2 to match the new SID initial address and the one-character variable's name.

```
10 S=-13312
15 L=S:H=S+1:W=S+4:A=S+5:I=S+6:J=S+24
20 POKE J,15
25 POKE A,16+9
30 POKE I,4*16+4
35 POKE H,29
40 POKE L,69
45 POKE W,17
50 FOR T=1 TO 1000:NEXT T
55 POKE W,0:POKE A,0:POKE H,0
60 END
```

The execution of the program above will produce a single tone for a few seconds. Please note that the initial address - used to calculate all the others - is expressed as a negative number and is the first address that has been mapped in memory, as shown in the table above.

7. THE PIANO DEMO PROGRAM

This program allows you to use part of the keyboard as a piano keyboard. It also allows you to choose the desired waveform (among the native ones), i.e. Square, Triangular, Sawtooth or Noise wave. It is also possible to choose one of the eight octaves available for each waveform and change them during play.

The program is launched with the command:

C 4 0 0 R followed by ENTER key



```
C400: 20
APPLE-1 SID PIANO
-----
BY CLAUDIO PARMIGIANI P-LAB
1..8: OCTAVE   *: THEREMIN
P: PULSE      W: SAWTOOTH
O: NOISE      T: TRIANGLE

MEMORY LOCATIONS:
282: WAVEFORM
288: ATTACK/DECAY
289: SUSTAIN/RELEA_SE
290/291: DURATION
294/295: PWM LO-HI
C406R : SOFT ENTRY

KEYBOARD:  S D   G H J
           Z X C V B N M ,
@
```

A screen summarizing the various possibilities offered by the program appears.

At the bottom of the screen, a piano keyboard is also sketched - the extension is one octave.

Musical notes will be played (one voice and one octave at a time) **after** choosing one of the 8 available octaves - using the number keys 1 to 8) and the desired waveform (P=Pulse / O=Noise / T=Triangle / W=Sawtooth).

Try, for example, typing **P 3** (Pulse, third octave) and then press the **Z X C** keys etc.

Due to the hardware management of the keyboard, the computer cannot detect for how long the keys are pressed. For this reason, the note duration has been predefined.

However, the shown memory locations allow you to modify parameters such as *Attack*, *Decay*, *Sustain*, *Release* (ADSR), note length, waveform envelope and related PWM parameters.

To change these parameters: press RESET and return to the WOZ Monitor. Change the desired locations and return to the music program from soft-entry point \$ C406:

C 4 0 6 R followed by ENTER key

The "Theremin" entry is currently under development: updates to the music program will follow. Note that this feature will only work with original 6581/8580 sound chips and not with modern replacements. To exit the program: Press the RESET button.

8. LIMITS OF THE DEMO PROGRAM

This board gives access to all the hardware offered by the supported sound chips, without any limitations. However, the demo music program uses only a small part of their great potential.

For instance: it uses only one of the three available voices.

The full exploitations of the possibilities of this card, especially when it comes to playing complex sound files or creating special effects, is left to you, faithful developers.

The plenty of space and free pages in EEPROM gives you the opportunity to develop new and original products on this computer which until now lacked any complex sound effects capability.

The software will have also to consider the lack of interrupt generators, such as video chips or CIAs, VIAs etc.

9. FINAL NOTES

SIMILAR PROJECTS

<https://sampopeltonen.github.io/Vicious/>

BIBLIOGRAPHY

6581 & SwinSID

http://archive.6502.org/datasheets/mos_6581_sid.pdf

<https://www.c64-wiki.com/wiki/SwinSID>

Apple-1 Operations manual & BASIC

<https://www.applefritter.com/files/a1man.pdf>

<https://www.applefritter.com/files/basicman.pdf>

CBM BASIC V2 Sound test program:

[ftp://ftp.zimmers.net/pub/cbm/c64/manuals/C64UsersManual\(IT\).pdf](ftp://ftp.zimmers.net/pub/cbm/c64/manuals/C64UsersManual(IT).pdf)

APPENDIX 1

The correspondence between Apple-1 mapped memory addresses and physical (absolute) addresses of the EEPROM can be summarized as follows:

JUMPER			Apple-1 Address		EEPROM physical Address		TOTAL SPACE	EEPROM TYPE	
C	B	A	FROM	TO	FROM	TO			
0	0	0	C400	C7FF	0400	07FF	2 kB	28C64	28C128
0	0	0	C800	CBFF	0000	03FF			
0	0	1	C400	C7FF	0C00	0FFF	2 kB		
0	0	1	C800	CBFF	0800	0BFF			
0	1	0	C400	C7FF	1400	17FF	2 kB		
0	1	0	C800	CBFF	1000	13FF			
0	1	1	C400	C7FF	1C00	1FFF	2 kB		
0	1	1	C800	CBFF	1800	1BFF			
1	0	0	C400	C7FF	2400	27FF	2 kB		
1	0	0	C800	CBFF	2000	23FF			
1	0	1	C400	C7FF	2C00	2FFF	2 kB		
1	0	1	C800	CBFF	2800	2BFF			
1	1	0	C400	C7FF	3400	37FF	2 kB		
1	1	0	C800	CBFF	3000	33FF			
1	1	1	C400	C7FF	3C00	3FFF	2 kB		
1	1	1	C800	CBFF	3800	3BFF			

Please note that, at physical (absolute) level, memory address of the EEPROM the "second" kB - highlighted in blue - is stored before the first kB - highlighted in green.

From the addressing point of view of Apple-1 this is irrelevant since the contiguity of the 2 kB (from \$C400 to \$CBFF) is ensured anyway.

Be aware of this detail if you want to use EEPROM to store your programs, especially if they exceed 1 kB in size.

We wish you will enjoy your *Apple-1 Audio Board!*

APPLE-1 AUDIO BOARD

INFO | ORDERS | SUPPORT: p-l4b@protonmail.com

[P-L4B @ PROTONMAIL.COM](mailto:p-l4b@protonmail.com)