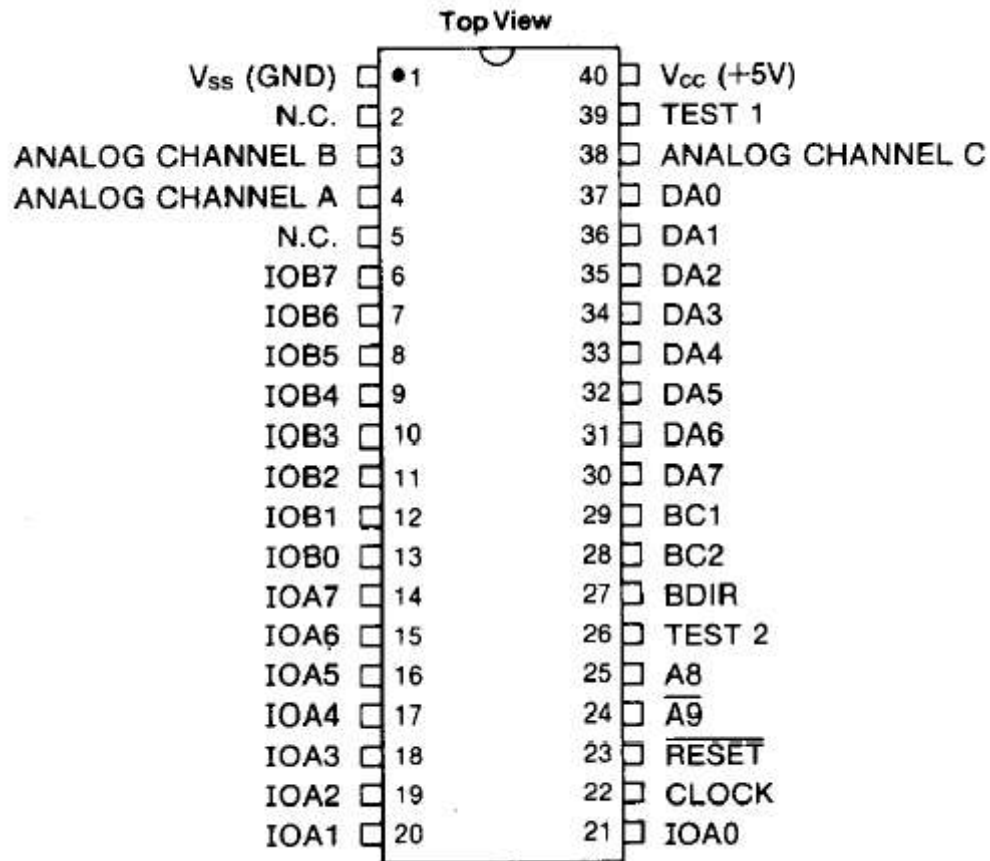


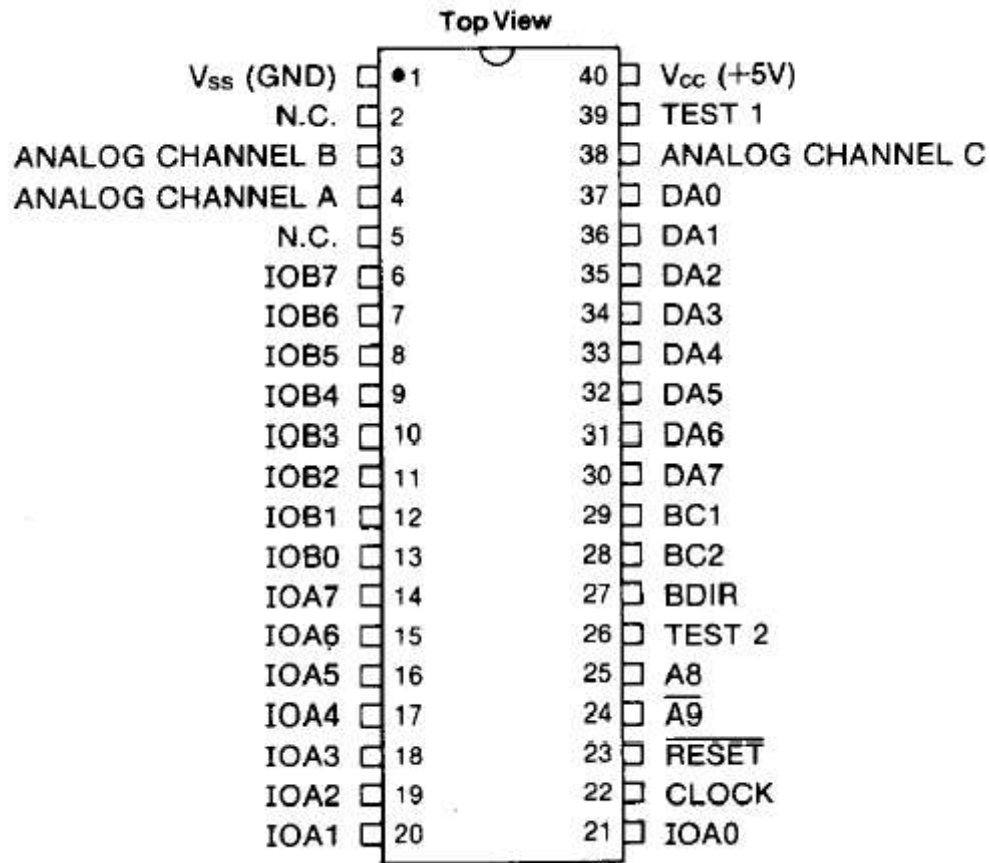
# ZX Spectrum 128K: AY-3-8910/8912 sound synthesizer IC

## Overview

The AY-3-8910/8912 is a sound generator IC containing three tone generators and a white noise generator. In addition to its sound producing capabilities, the AY-3-8910 has two 8-bit I/O ports and the AY-3-8912 has one.

## Pinouts





DA0-DA7 are multiplexed data and address lines, as used in the range of GI processors that this IC was originally part of. The BC1 and BDIR pins are used to control the IC as follows:

Function	BDIR	BC1
Inactive	0	0
Read	0	1
Write	1	0
Latch address	1	1

In addition to using BC1 and BDIR, A8 should be taken high to enable the chip. IOA0-IOA7 are the input/output pins (the AY-3-8910 has an additional

set marked IOB0-IOB7). The IC does not contain an internal oscillator - the clock input to the CLK pin should fall between 1MHz-2MHz, so a typical Z80 system's clock would need to be divided.

## Registers

The AY-3-8910/8912 contains 16 internal registers as follows:

Register	Function	Range
0	Channel A fine pitch	8-bit (0-255)
1	Channel A course pitch	4-bit (0-15)
2	Channel B fine pitch	8-bit (0-255)
3	Channel B course pitch	4-bit (0-15)
4	Channel C fine pitch	8-bit (0-255)
5	Channel C course pitch	4-bit (0-15)
6	Noise pitch	5-bit (0-31)
7	Mixer	8-bit (see below)
8	Channel A volume	4-bit (0-15, see below)
9	Channel B volume	4-bit (0-15, see below)
10	Channel C volume	4-bit (0-15, see below)
11	Envelope fine duration	8-bit (0-255)
12	Envelope course duration	8-bit (0-255)
13	Envelope shape	4-bit (0-15)
14	I/O port A	8-bit (0-255)

15	I/O port B	8-bit (0-255)
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## Notes

- The AY-3-8912 does not contain register 15.
- The volume registers (8, 9 and 10) contain a 4-bit setting but if bit 5 is set then that channel uses the envelope defined by register 13 and ignores its volume setting.
- The mixer (register 7) is made up of the following bits (low=enabled):

Bit: 7	6	5	4	3	2	1	0
I/O	I/O	Noise	Noise	Noise	Tone	Tone	Tone
B	A	C	B	A	C	B	A

The AY-3-8912 ignores bit 7 of this register.

## Envelopes

The AY-3-8910/8912 contains the following preset envelopes or waveforms (set using control register 13). Note that these affect volume only and not the pitch:

0	\_____	single decay then off
1	/	single attack then hold
4	/ _____	single attack then off
8	\\ \\ \\ \\ \\ \\ \\ \\ \\	repeated decay
9	\_____	single decay then off
10	\\ \\ \\ \\ \\ \\ \\ \\	repeated decay-attack
11	\\	single decay then hold
12	/ \\ \\ \\ \\ \\ \\ \\ \\	repeated attack



- Sinclair ZX Spectrum 128/+2/+3
- Amstrad CPC 464/664/6128
- Mattel Intellivision
- BBC Micro
- Atari ST
- Sega Master System

#### Port Specifics

The control (register select) and data output ports are as follows (in decimal):

#### Machine Port Addresses

So, to produce a simple sound from BASIC ...

```

10 LET ayctrl=65533
20 LET aydata = 49149
30 OUT ayctrl,7 : REM select the mixer register
40 OUT aydata,62 : REM enable channel A only
50 OUT ayctrl,1 : REM channel A course pitch
60 OUT aydata,50 : REM set it
70 OUT ayctrl,8 : REM channel A volume
80 OUT aydata,15 : REM set it to maximum

```

... or from assembler ...

```

ayctrl EQU    65533
aydata  EQU    49149

start   ld     d,7           ; select the mixer register
        ld     e,62          ; enable channel A only
        call  outer         ; send it to PSG
        ld     d,1           ; channel A course pitch
        ld     e,50          ; pitch value

```

```

        call    outer          ; send it to PSG
        ld      d,8            ; channel A volume
        ld      e,15           ; maximum
        call    outer          ; send it to PSG
        ret

outer   ld      bc,ayctrl      ; select control port
        out     (c),d          ; send specified value
        ld      bc,aydata      ; select data port
        out     (c),e          ; send specified value
        ret

```

For an easy way to generate the required course and fine pitch values, try the following program:

```

10 INPUT "Note value ",n
20 INPUT "Octave ",o
30 LET f=INT(n/2^o)
40 LET c=INT(f/256)
50 PRINT "Fine = ";f;" Course = ";c

```

The pitch values required by this program are as follows:

Note	Value	Note	Value
C	3421	F#	2419
C#	3228	G	2283
D	3047	G#	2155
D#	2876	A	2034
E	2715	A#	1920
F	2562	B	1892

## References

Micro Interfacing Circuits - Book 2, by R. A. Penfold, ISBN 0-85934-106-2, Spectrum 128 manual, (c) 1986 Sinclair Research Ltd, Sinclair User magazine, 1986 (issue unknown).

This text was entered by Alastair Booker on 4th April 1995. Please feel free to contact me regarding anything contained in this document. I have produced a generic AY-3-8912 interface circuit for Z80-based systems and will make this available to anyone who requires it.



*Frissitve: 8/13/2010*