ATARI 2600 FREQUENCY AND TUNING CHART

Version 1.1
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Florianopolis, Brazil

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This document is five pages long (with the charts on the last two pages, which are not numbered for printing purposes).

Comments, corrections and suggestions are welcomed!

Based on the three setups developed by Paul Slocum on "Atari 2600 Music And Sound Programming Guide", available at www.qotile.com, and here used with his permission.

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/////// **Features**

- Paul Slocum's tuning Setups all in one single printable page;
- Setups are identified by colors, making the chart easy to read;
- Data values for both TIA registers and Slocum's Sequencer Kit;
- NTSC and PAL are in separated charts.

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/////// **Introduction**

When working on music for the Atari 2600, planning and studying ahead the tuning issues of the TIA is always a good place to start. Its non-tempered scales are one of the characteristics that bind the sound of the 2600 in a unique aesthetic. Nevertheless, these same non-tempered scales are also one of the reasons why writing for this console can be a bit difficult. So, one must learn to deal effectively with TIA's off-key notes (something like "if you can't win them, join them"). For that, many Atari 2600 enthusiasts and scholars have done many efforts.
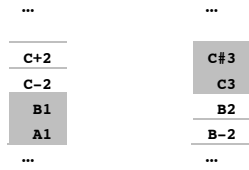
Paul Slocum is one of those. He is the creator of the Synthcart (available at the AtariAge store) and of the Sequencer Kit (available for free at this website), both for the Atari 2600. In 2003, he published the version 1.02 of his "Atari 2600 Music and Sound Programming Guide". In that document he developed three Setups (here always in capital letter to avoid confusion) to deal with the console's tuning issues. What he actually did was to organize the distortions and frequencies in groups that would stay as mush as possible inside a certain tuning or key reference. Most of those Setups were actually directions to use with his Sequencer Kit, as well as with Synthcart. Of course, they can be used anywhere. It's more about driving the TIA than anything else.

My "Atari 2600 Frequency And Tuning Chart" came to be because I would always find myself looking up and down my printed version of Slocum's guide, flipping through the pages and Setups when trying to find a path of notes that could be desirable. I always felt that one day I should figure out a way to put all that information in one single page.

One day I finally did it. I poured the three Setups on MS Excel, linked all then to one shared scale and granted an id color to each of them (plus one id color to notes common to two Setups).

With the chart ready I could, with one single glimpse, found out that there's no distortion able to play D#5, if that was a possible pitch I was aiming for, for example. Or, let's say, I need the bass to go C2, D2 and E2 in ascending fashion for a brief fill. Looking at the chart I can easily see that the bass cannot play D2, but the saw distortion can. I can then achieve my desired effect doing bass C2, saw D2, bass E2. Also, if I want to have an idea of how the Setups are related to the octaves (or how the distortions are related to the Setups) I can easily check that out by observing the colors of the notes. And of course, if I just want to stay within a particular Setup, I just go about my business looking at the colors too.

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  ////////////////////////////////////////////////////////////////////////////
  ////////////////////////////////////////////////////////////////////////////
  /////// A few considerations
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It's a pretty straightforward and user-friendly chart, so reading and understanding it
won't be hard. I you have any doubt about the information (like how the Setups were
created) found in this chart I suggest you go check on Paul Slocum's document. Still,
there are a few details I would like to cover here.

/// 1. The Setups are identified by id colors as follows:

SETUP #1
SETUP #2
SETUP #3
SETUP #2 & #3

So notes in red belong to Setup number 1, in blue to Setup number 2 and so on. It's
really important to pay attention to the fact that some notes are common to more than
one setup. So, when looking at the chart for Setup 1, you must look for **red** notes.
When using the chart for Setup 2, you have to look for **blue** and **orange** notes. When
picking notes from Setup 3, you should look for **green** and **orange** notes.

/// 2. Reading the Distortion/Channel Header goes like this:

	6 [001] Bass	7 [010] Pitfall			4 [000] Square
#	cents	bass code	pitfall code	#	cents	driver code
B8				1	-9	[%00000001]
E8				2	-11	[%00000010]

First there's the TIA code for the distortion (AUDCx register), followed by the binary
distortion code (binaries are always in brackets in this document) for Slocum's music
driver (Sequencer Kit) and the distortion's name or description. The next row there's
the TIA value for frequency (AUDFx register), followed by the cents offset (related to
Concert A440Hz), followed by the frequency code for Slocum's music driver.

Here's an example: for the oscillator 1 to play a Square wave pitched E8, we would
need AUDC1=4, AUDF1=2 and AUDV>0 (so we actually have some volume to hear it). In Paul
Slocum's music driver we would add [%00000010] in its pattern system (without the
brackets).

Please, do note that since Bass and Pitfall have exactly the same frequencies, they
share the header together.

/// 3. Since the 2600 tuning can sometimes create two pitches that soar over one
single note, I used the plus and minus signs (before the octave number) to determine
higher or lower pitches of a same note. This differs a bit from Paul's guide because
here all three setups are shown together and a differentiation had to be done. For
example, let's take a look a small section of the Saw channel.

25	+61	[%11011001]	D#+2
26	-5	[%11011010]	D#-2
27	+34	[%11011011]	D2
29	+15	[%11011101]	C#2
30	+56	[%11011110]	C+2
31	+3	[%11011111]	C-2

There are two D#2 and C#2. The lower D#2 (with -5 cents) will be described as D#-2 and
the higher D#2 (with +61 cents) will be D#+2. The same goes to C#2. This kind of
situation will be always flag the boundaries of two Setups. As we can notice here,
D#+2 belongs to **Setup 1** and D#+2 belongs to **Setup 2 and 3**.

/// 4. Some octave ranges are highlighted with a gray background tone for rapid visualization.

…		…
C+2		C#3
C−2		C3
B1		B2
A1		B−2
…		…

/// 5. The two notes from the Low Bass belongs to Setup 2 and are down on the far left of the chart. Since there are only two notes I placed them together with the Bass and Pitfall column, but it should be emphasized that it really represents a distinct distortion.

10	−11	[%xxx01010]	
12	0	[%xxx01100]	
	14 [xxx] Low Bass		**< SETUP #2**

The Low Bass code for Slocum's music driver is here described as [xxx] (three yet to be described binaries) for there's the need to assign it in the driver's Sound Type Array section. Read the driver's manual for more information.

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/////// **Printing Tips**

Since the goal was to squeeze the whole chart in one single A4 page, some considerations had to be taken. To generate the printable PDF, the top and bottom margin were set to zero and the whole document was scaled to 97% of its normal size. Some printers will not be able to work properly with such document setup, probably leaving some parts of the chart out. If that happens, I suggest printing the chart on A3 paper and then trimming the exceeding borders, leaving at least a 0.5cm (0.20 inches) margin. Reducing the size of the document might result in a printed chart with a tiny font size that it's just too small for reading.

For a solid and sturdy chart, I recommend using coated paper (300gr or higher) and then applying a diaphanous laminate/adhesive plastic surface on it.

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/////// **Version History**

version 1.1 (February 3, 2011):

– major correction on the chart: purple "Setup #1 & #3" removed. There are no notes that are actually shared by Setup #1 and Setup #3. This error came from an early prototype that had a misspelled file name. So please, be aware that version 1.0 is non-functional;

– PAL chart available;

– the document now includes three new topics: Features, Printing Tips and Version History.

version 1.0 (January 31, 2011):

– first version, NTSC only.

6 [001] Bass | 7 [010] Pitfall **4 [000] Square** **12 [101] Lead** **1 [110] Saw**

Note	#	cents	bass code	pitfall code	#	cents	driver code	#	cents	driver code	#	cents	driver code	Note
B8					1	−9	[%00000001]							B8
E8					2	−11	[%00000010]	0	−11	[%10100000]				E8
B7					3	−10	[%00000011]							B7
G7					4	+4	[%00000100]							G7
E7					5	−11	[%00000101]	1	−11	[%10100001]				E7
C7											0	+2	[%11000000]	C7
B6					7	−9	[%00000111]							B6
A6					8	−13	[%00001000]	2	−14	[%10100010]				A6
G6					9	+4	[%00001001]							G6
F6					10	+39	[%00001010]							F6
E6					11	−11	[%00001011]	3	−11	[%10100011]				E6
D6					12	+49	[%00001100]							D6
C6					14	+2	[%00001110]	4	+2	[%10100100]	1	+2	[%11000001]	C6
B5	0	+45	[%00100000]	[%01000000]	15	−10	[%00001111]							B5
A#5					16	−15	[%00010000]							A#5
A5					17	−14	[%00010001]	5	−14	[%10100101]				A5
G#5					18	−7	[%00010010]							G#5
G5					19	+4	[%00010011]							G5
F#5					20	+20	[%00010100]							F#5
F5					21	+39	[%00010101]				2	0	[%11000010]	F5
E+5					22	+62	[%00010110]							E+5
E−5					23	−12	[%00010111]	7	−12	[%10100111]				E−5
D+5					25	+49	[%00011001]							D+5
D−5					26	−16	[%00011010]	8	−16	[%10101000]				D−5
C+5					28	+60	[%00011100]							C+5
C−5					29	+2	[%00011101]	9	+2	[%10101001]	3	+2	[%11000011]	C−5
B+4	1	+45	[%00100001]	[%01000001]	30	+45	[%00011110]							B+4
B−4					31	−9	[%00011111]							B−4
A#4								10	+39	[%10101010]				A#4
A4								11	−13	[%10101011]				A4
G#4											4	+16	[%11000100]	G#4
G4								12	+48	[%10101100]				G4
F#4								13	+20	[%10101101]				F#4
F4								14	0	[%10101110]	5	0	[%11000101]	F4
E+4	2	+43	[%00100010]	[%01000010]										E+4
E−4								15	−11	[%10101111]				E−4
D4								17	−16	[%10110001]				D4
C#4								18	−9	[%10110010]				C#4
C4								19	+3	[%10110011]	7	+3	[%11000111]	C4
B3	3	+45	[%00100011]	[%01000011]										B3
A#+3								21	+37	[%10110101]				A#+3
A#−3											8	−2	[%11001000]	A#−3
A+3								22	+60	[%10110110]				A+3
A−3								23	−14	[%10110111]				A−3
G#3								24	+15	[%10111000]	9	+15	[%11001001]	G#3
G+3	4	+58	[%00100100]	[%01000100]				25	+47	[%10111001]				G+3
G−3								26	−17	[%10111010]				G−3
F#3											10	+50	[%11001010]	F#3
F#−3								27	+19	[%10111011]				F#−3
F+3								28	+59	[%10111100]				F+3
F−3								29	+1	[%10111101]	11	+1	[%11001011]	F−3
E+3	5	+43	[%00100101]	[%01000101]				30	+43	[%10111110]				E+3
E−3								31	−11	[%10111111]				E−3
D#3											12	+61	[%11001100]	D#3
C#3											14	+13	[%11001110]	C#3
C3											15	+3	[%11001111]	C3
B2	7	+42	[%00100111]	[%01000111]										B2
B−2											16	−3	[%11010000]	B−2
A#2											17	0	[%11010001]	A#2
A+2	8	+42	[%00101000]	[%01001000]										A+2
A−2											18	+5	[%11010010]	A−2
G#2											19	+16	[%11010011]	G#2
G2	9	+59	[%00101001]	[%01001001]										G2
F#+2											21	+51	[%11010101]	F#+2
F#−2	10	−6	[%00101010]	[%01001010]										F#−2
F2											23	0	[%11010111]	F2
E2	11	+43	[%00101011]	[%01001011]										E2
D#+2											25	+61	[%11011001]	D#+2
D#−2	12	+4	[%00101100]	[%01001100]							26	−5	[%11011010]	D#−2
D2											27	+34	[%11011011]	D2
C#2											29	+15	[%11011101]	C#2
C+2	14	+56	[%00101110]	[%01001110]							30	+56	[%11011110]	C+2
C−2											31	+3	[%11011111]	C−2
B1	15	+46	[%00101111]	[%01001111]										B1
A1	17	+39	[%00110001]	[%01010001]										A1
G1	19	+59	[%00110011]	[%01010011]										G1
F#1	21	−4	[%00110101]	[%01010101]										F#1
F1	22	+16	[%00110110]	[%01010110]										F1
E1	23	+44	[%00110111]	[%01010111]										E1
D#1	25	+4	[%00111001]	[%01011001]										D#1
D1	26	+41	[%00111010]	[%01011010]										D1
C#1	28	+19	[%00111100]	[%01011100]										C#1
C+1	29	+58	[%00111101]	[%01011101]										C+1
C−1	30	0	[%00111110]	[%01011110]										C−1
B+0	31	+44	[%00111111]	[%01011111]										B+0

14 [xxx] Low Bass — < SETUP #2

Note	#	cents	driver code
B−0	10	−11	[%xxx01010]
G#0	12	0	[%xxx01100]

ATARI 2600 FREQUENCY AND
TUNING CHART (NTSC)

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Based on the 3 setups developed by Paul Slocum on
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SETUP #1
SETUP #2
SETUP #3
SETUP #2 & #3

Note	6 [001] Bass #	cents	bass code	pitfall code	4 [000] Square #	cents	driver code	12 [101] Lead #	cents	driver code	1 [110] Saw #	cents	driver code	Note
B8					1	−23	[%00000001]							B8
E8					2	−25	[%00000010]	0	−25	[%10100000]				E8
B7					3	−23	[%00000011]							B7
G7					4	−9	[%00000100]							G7
E7					5	−25	[%00000101]	1	−25	[%10100001]				E7
C7											0	−1	[%11000000]	C7
B6					7	−23	[%00000111]							B6
A6					8	−27	[%00001000]	2	−27	[%10100010]				A6
G6					9	−9	[%00001001]							G6
F6					10	+25	[%00001010]							F6
E6					11	−25	[%00001011]	3	−25	[%10100011]				E6
D6					12	+36	[%00001100]							D6
C6					14	−11	[%00001110]	4	−11	[%10100100]	1	−1	[%11000001]	C6
B5	0	+32	[%00100000]	[%01000000]	15	−23	[%00001111]							B5
A#5					16	−28	[%00010000]							A#5
A5					17	−27	[%00010001]	5	−27	[%10100101]				A5
G#5					18	−20	[%00010010]							G#5
G5					19	−9	[%00010011]							G5
F#5					20	+7	[%00010100]							F#5
F5					21	+26	[%00010101]				2	−1	[%11000010]	F5
E+5					22	+48	[%00010110]							E+5
E−5					23	−25	[%00010111]	7	−25	[%10100111]				E−5
D+5					25	+36	[%00011001]							D+5
D−5					26	−29	[%00011010]	8	−29	[%10101000]				D−5
C+5					28	+47	[%00011100]							C+5
C−5					29	−11	[%00011101]	9	−11	[%10101001]	3	−1	[%11000011]	C−5
B+4	1	+32	[%00100001]	[%01000001]	30	+32	[%00011110]							B+4
B−4					31	−23	[%00011111]							B−4
A#4								10	+23	[%10101010]				A#4
A4								11	−27	[%10101011]				A4
G#4											4	+3	[%11000100]	G#4
G4								12	+34	[%10101100]				G4
F#4								13	+6	[%10101101]				F#4
F4								14	−13	[%10101110]	5	−13	[%11000101]	F4
E+4	2	+30	[%00100010]	[%01000010]										E+4
E−4								15	−25	[%10101111]				E−4
D4								17	−29	[%10110001]				D4
C#4								18	−22	[%10110010]				C#4
C4								19	−11	[%10110011]	7	−11	[%11000111]	C4
B3	3	+32	[%00100011]	[%01000011]										B3
A#+3								21	+24	[%10110101]				A#+3
A#−3											8	−15	[%11001000]	A#−3
A+3								22	+47	[%10110110]				A+3
A−3								23	−27	[%10110111]				A−3
G#3								24	+2	[%10111000]	9	+2	[%11001001]	G#3
G+3	4	+45	[%00100100]	[%01000100]				25	+34	[%10111001]				G+3
G−3								26	−31	[%10111010]				G−3
F#3											10	+37	[%11001010]	F#3
F#−3								27	+6	[%10111011]				F#−3
F+3								28	+45	[%10111100]				F+3
F−3								29	−13	[%10111101]	11	−13	[%11001011]	F−3
E+3	5	+30	[%00100101]	[%01000101]				30	+30	[%10111110]				E+3
E−3								31	−25	[%10111111]				E−3
D#3											12	+48	[%11001100]	D#3
C#3											14	+1	[%11001110]	C#3
C3											15	−11	[%11001111]	C3
B2	7	+32	[%00100111]	[%01000111]										B2
B−2											16	−16	[%11010000]	B−2
A#2											17	−14	[%11010001]	A#2
A+2	8	+28	[%00101000]	[%01001000]										A+2
A−2											18	−8	[%11010010]	A−2
G#2											19	+3	[%11010011]	G#2
G2	9	+45	[%00101001]	[%01001001]										G2
F#+2											21	+36	[%11010101]	F#+2
F#−2	10	−19	[%00101010]	[%01001010]										F#−2
F2											23	−12	[%11010111]	F2
E2	11	+31	[%00101011]	[%01001011]										E2
D#+2											25	+48	[%11011001]	D#+2
D#−2	12	−9	[%00101100]	[%01001100]							26	−18	[%11011010]	D#−2
D2											27	+20	[%11011011]	D2
C#2											29	0	[%11011101]	C#2
C+2	14	+44	[%00101110]	[%01001110]							30	+44	[%11011110]	C+2
C−2											31	−11	[%11011111]	C−2
B1	15	+32	[%00101111]	[%01001111]										B1
A1	17	+27	[%00110001]	[%01010001]										A1
G1	19	+45	[%00110011]	[%01010011]										G1
F#1	21	−20	[%00110101]	[%01010101]										F#1
F1	22	+4	[%00110110]	[%01010110]										F1
E1	23	+28	[%00110111]	[%01010111]										E1
D#1	25	−9	[%00111001]	[%01011001]										D#1
D1	26	+27	[%00111010]	[%01011010]										D1
C#1	28	+5	[%00111100]	[%01011100]										C#1
C+1	29	+42	[%00111101]	[%01011101]										C+1
C−1	30	−11	[%00111110]	[%01011110]										C−1
B+0	31	+33	[%00111111]	[%01011111]										B+0
B−0	10	−22	[%xxx01010]											B−0
G#0	12	−13	[%xxx01100]											G#0

14 [xxx] Low Bass < SETUP #2

ATARI 2600 FREQUENCY AND
TUNING CHART (PAL)

| SETUP #1 |
| SETUP #2 |
| SETUP #3 |
| SETUP #2 & #3 |