

Tuning Modes Arciorgano

The Arciorgano is a 4-oktave ($c2-c6$) organ with one 7' register of open wood pipes.

It was built as a project of Johannes Keller and the research department of Musik Akademie Basel by Bernhard Fleig (Basel 2016) and follows the description of Vicentinos 16th century enharmonic organ. It has 36 keys per octave. 7 keys of the lowest octave are missing.

The open pipe $a4$ (as used in mode 2) has 492 Hz. The organ is tuned one full tone above 440 Hz.

The keyboard layout is the following:



Foto Caspar Johannes Walter, Juli 2016

The lower keyboard has 19 keys per octave: splitted black keys and two tastini between e/f and b/c . The upper keyboard has the same layout, but without the tastini.

When all pipes are fully open, the organ is tuned in mode 2 (in Vicentinos book called *l'altro modo*).

By putting small tuning inlays into the pipes several other tuning modes can be used.

Brief description of the tuning modes:

Mode 1	$\frac{1}{4}$ Komma mitteltönig $\frac{1}{4}$ comma meantone tuning. 30 fifths from $a\ b\ \flat\ \flat$ to $b\sharp$ Can be also seen as 19-tone $\frac{1}{4}$ comma meantone tuning on the lower Keyboard with 18 fifths from $g\ \flat$ to $b\sharp$. On the upper keyboard the pitches of the lower keyboard are shifted up by a diesis (128/125; 41¢). This mode allows to represent the full enharmonic circle of keys of the 16 th century. Vicentinos main tuning mode
Mode 2	adaptiv rein On the lower keyboard: 19-tone $\frac{1}{4}$ comma meantone tuning with 18 fifths from $g\ \flat$ to $b\sharp$. On the upper keyboard the pitches of the lower keyboard are shifted up by a quarter comma (5¢). This mode allows to have all fifths, thirds and triads in just intonation. Vicentinos <i>l'altro modo</i>
Mode 3	Walter pseudorein a modified limit-5 Just Intonation system. All major thirds are diminished by a Schisma. Good balance of fifths (perfect), thirds (2¢ too small), natural sevenths (3¢ too large).
Mode 4	Partch a 36-tone subset of Harry Partch's 43 tone limit-11 Just Intonation tuning system (with Partch's original reference of $1/1 = 392$ Hz)

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Mode 5

EDO-34

EDO-34 is a non-meantone experimental tuning providing fairly good fifths and thirds and introducing a very large syntonic comma-like interval.

Mode 6

1/3 Komma adaptiv rein

On the lower keyboard: 19-tone 1/3 comma meantone tuning with 18 fifths from $g\flat$ to $b\sharp$. On the upper keyboard the pitches of the lower keyboard are shifted up by a third comma (7ϕ). This mode allows to have all fifths, thirds and triads in just intonation.

Mode 7

Salinas 24+12

The 24 pitches of Francisco Salinas' *instrumentum perfectum* extended by 12 further tones. A perfect Just Intonation limit-5 tuning.

All modes can be played on

https://www.casparjohanneswalter.de/research/arciorcano_player
presets of all 7 modes are available.

Detailed keyboard layout of the 7 tuning modes:

Mode 1, 2 and 6 are meantone tunings. Mode 3 and 7 are limit-5 Just Intonation tunings, mode 4 a limit 11 Just Intonation tuning and mode 5 an equally tempered tuning.

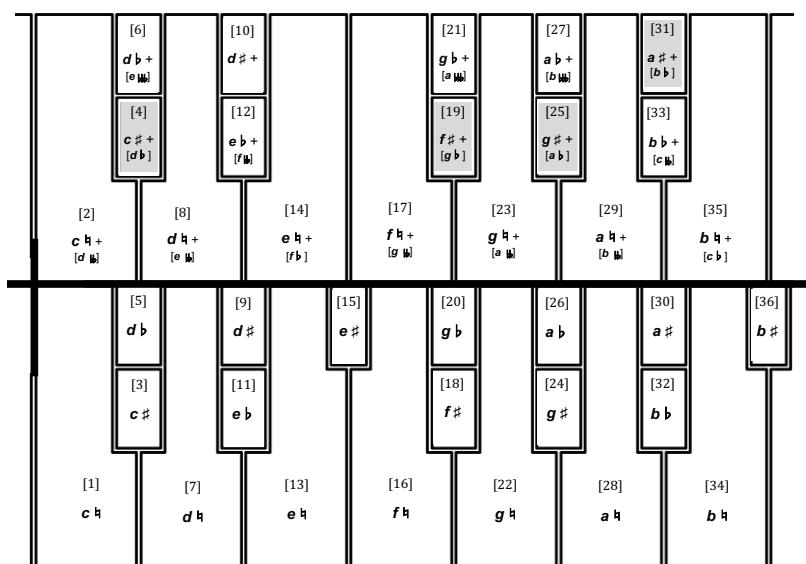
Keyboard Layout mode 1 „31 tone meantone“

On the lower keyboard:

19-tone quarter comma meantone tuning. All fifths are reduced by a quarter comma. The thirds are perfect ($5/4$).

On the upper keyboard:

A transposition by a *Diesis* (128/125; ca. 41ϕ) indicated by a plus sign (+). This + has the same indication than the dot in Vicentinos notation. The grey marked keys double keys of the lower keyboard. The transposition by a Diesis also can be seen as continuation of the circle of meantone fifths seen in the lower keyboard. This designation is given in square brackets.



This causes a chain of 31 tones connected equally by meantone fifths. The “wolfe” between $b\sharp$ and $a\flat$ is very close to a perfect fifth (-0,7 ϕ). This enables the 31 tone meantone tuning to be a full enharmonic, endless transposable meantone tuning.

Tuning Modes Arciorgano

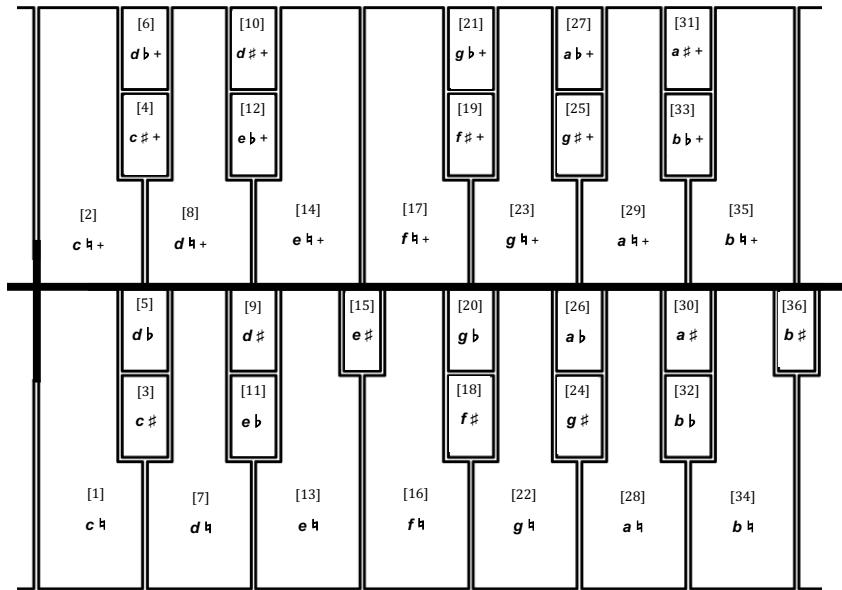
Keyboard Layout mode 2 „1/4 Komma adaptiv rein“

On the lower keyboard:

Quarter comma 19-tone meantone tuning, with the typical reduced fifths.

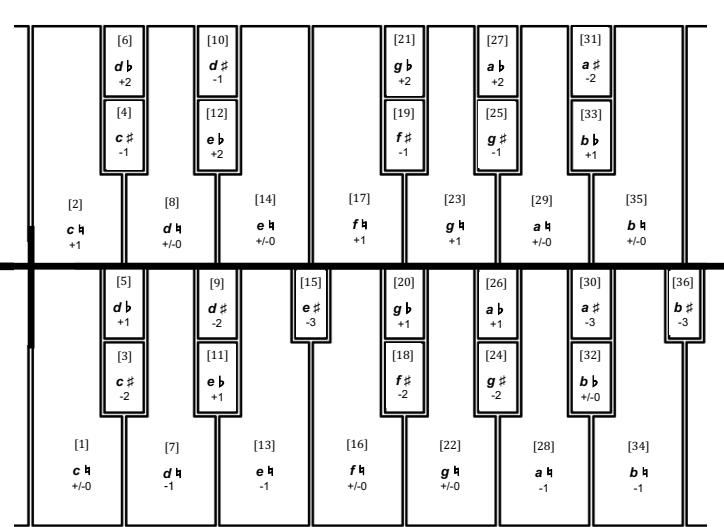
On the upper keyboard a compensation of the meantone comma to provide perfect fifths (indicated by the + sign). All available triads (major and minor) can be played in perfect just intonation, always in a certain fingering pattern. In chord progressions all those perfect triads are connected by meantone fifths.

Perfect (major) thirds within one keyboard. Perfect fifths and perfect minor thirds with the base on the lower keyboard and the higher note on the upper keyboard. Mode 2 provides all diatonic, chromatic and enharmonic chord progressions in the area from *g flat* to *b sharp* with each chord sounding in perfect intonation.



Tone Lattice and Keyboard Layout mode 3 „Walter pseudorein“

Level of thirds						
+2	+1	+/-0	-1	-2	-3	
e b	g h	... b h	... d #			
a b	c h	e h	g #			
d b	f h	a h	c #			
g b	b b	d h	f #	a #		
e b	g h	b h	d #			
a b	c h	e h	g #	b #		
d b	f h	a h	c #	e #		
g b	b b	d	f #	a #		
[c b]	[e b = d #] ...					

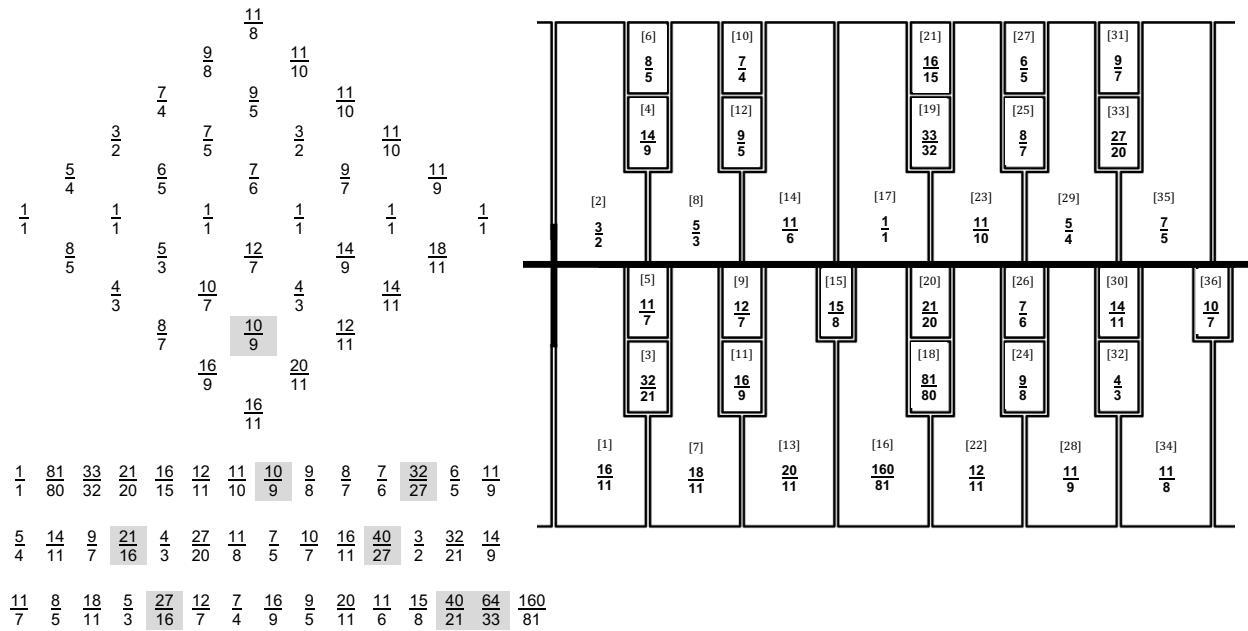


All fifths (y-axis) are perfect (3/2). The thirds (x-axis) are – relatively to the perfect third 5/4 – diminished by one *Schisma* (1,95 ¢). This causes a chain of 24 tones connected by perfect fifths. Additionally, the augmented sixth represented by the step +2 fifths +2 thirds

(in the Pythagorean idea the double diminished octave) approaches fairly well the perfect natural seventh 7/4. This mode combines the secondary qualities of the intervals in Pythagorean Tuning as well balanced representatives of a limit-7 Just Intonation tuning concept with the practical advantage of a typical limit-5 Just Intonation tuning concept keyboard layout.

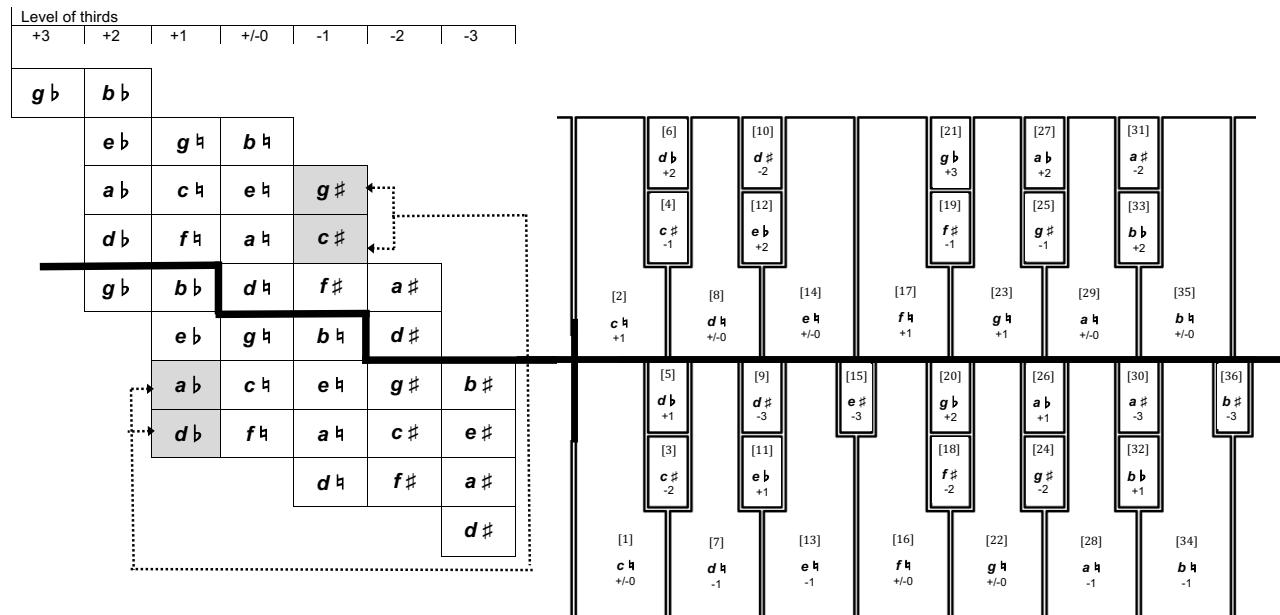
Tuning Modes Arciorgano

Pitches and Keyboard Layout mode 4 „Partch“



36-tone subset of the 43 Partch tones. The grey marked pitches (always written as ratios) are missing in the subset, as seen in the tonality diamond above and the full 43 tone scale below. The 1/1 reference is 392 Hz, according to the system of Partch.

Tone Lattice and Keyboard Layout mode 5 „EDO 34“



All fifths (y-axis) have 705,88 ¢. The thirds (x-axis) have 388,24 ¢. It consists of two complete cycles of fifths (17 each), one for level of thirds with even numbers, one for level of thords with odd numbers. It is infinitely transposable. In contrary to the meantone systems it has a representation for the syntonic comma. (grey fields: duplication of pitches)

Tuning Modes Arciorgano

Keyboard Layout mode 6 „1/3 Komma adaptiv rein“

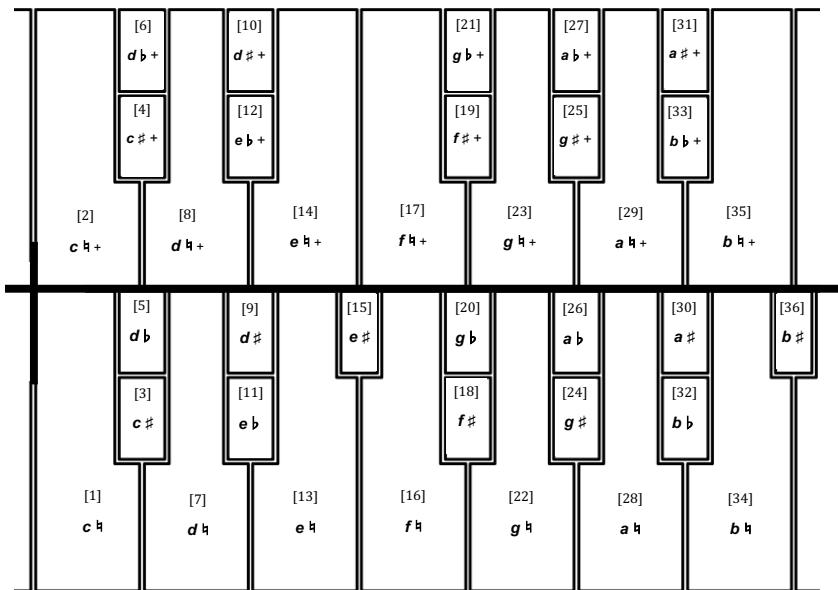
On the lower keyboard:

19-tone third comma meantone tuning, with the typical reduced fifths.

On the upper keyboard a compensation of the meantone comma to provide perfect fifths (indicated by the + sign).

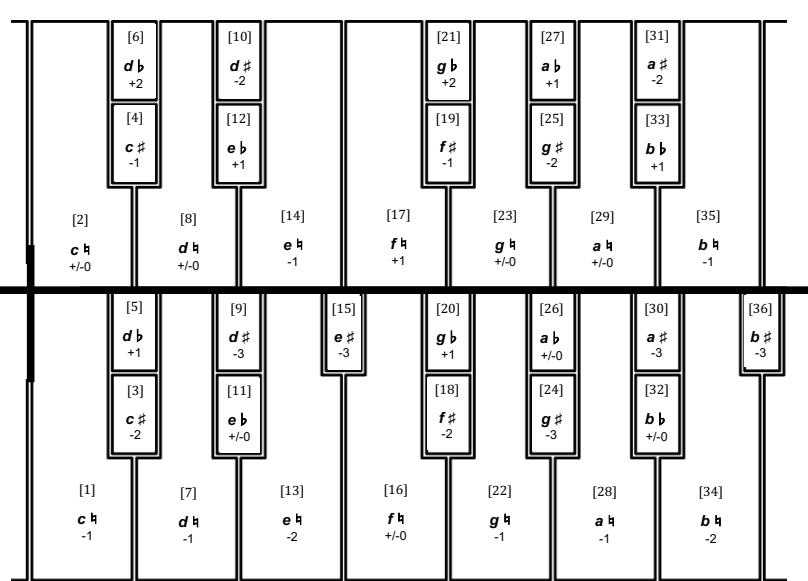
All available triads (major and minor) can be played in perfect just intonation, always in a certain fingering pattern. In chord progressions all those perfect triads are connected by meantone fifths.

Minor thirds within one keyboard. Perfect fifths and perfect major thirds with the base on the lower keyboard and the higher note on the upper keyboard. The 19 tones of the lower keyboard provide can be closed to a complete circle by a “wolfe” between *b sharp* and *g flat* slightly smaller than a perfect fifth (-8,1 ¢). This enables the mode 6 to be a full cromatic, (but not enharmonic) endless transposable meantone tuning.



Tone Lattice and Keyboard Layout mode 7 „Salinas 24+12“

Level of Thirds					
+2	+1	+/-0	-1	-2	-3
d ♭ 27 25	519,55 22 20	905,87 27 16	92,18 135 128		
g ♬ 36 25	1017,60 9 5	203,91 2 8	590,22 45 32	976,54 225 128	
e ♭ 5 5	315,64	701,96	1088,27	274,58	
a ♭ 5 5	813,69	0,00	386,31	772,63	1158,94
d ♭ 16 15	111,73	498,04	884,36	70,67	456,99
g ♬ 44 45	609,78	996,09	182,40	568,72	955,03
e ♭ 32 27	294,13	689,45	1066,76	253,08	
a ♭ 128 81	792,18	1178,49	364,81	751,12	



All fifths (3/2; y-axis) and thirds (5/4; x-axis) are perfect. The ratio of each tone is given as well as the distance from *c 1/1* in cents. The 24 Tones of the Salinas' complete scale are in the blank fields, the grey fields give 12 additional tones, following Salinas' own idea to transpose and/or mirror his scale.

Tuning Modes Arciorgano

Arciorgano, pitches of all tuning modes in cents relative to c (mode 2)

key	Mode 2 ad.1/4komma reference	Mode 1 31meantone	Mode 3 WalterPseudorein	Mode 4 Partch	Mode 5 EDO34	Mode 6 ad.1/3komma	Mode 7 Salinas
$c \natural$	0,00	-35,68	-25,41	-54,95	-46,60	-12,55	-32,26
$c\#+$	5,38	5,38	-1,95	-1,68	-11,31	-5,38	-10,75
$c\#$	76,05	40,37	41,35	25,59	23,99	50,95	59,92
$c\#\#$	81,43	81,43	64,81	61,29	59,28	58,12	81,43
$d \flat$	117,11	81,43	88,28	78,86	59,28	113,52	100,98
$d \flat +$	122,48	122,48	111,74	110,06	94,58	120,69	122,49
$d \flat \natural$	193,16	157,47	155,04	148,96	129,87	177,02	171,65
$d\sharp+$	198,53	198,53	178,50	180,73	165,16	184,19	193,16
$d\sharp$	269,21	233,52	245,26	229,50	200,46	240,53	242,33
$d\#\sharp$	274,58	274,58	268,72	265,20	235,75	247,69	263,83
$e \flat$	310,26	274,58	292,19	292,46	271,05	303,09	283,38
$e \flat +$	315,64	315,64	315,65	313,97	306,34	310,26	304,89
$e \flat \natural$	386,31	350,63	358,95	331,37	341,64	366,59	354,06
$e\sharp+$	391,69	391,69	382,41	345,73	376,93	373,76	375,56
$e\sharp$	462,36	426,68	425,71	384,64	412,22	430,10	446,24
$f \flat$	503,42	467,74	472,63	474,86	447,52	492,66	487,29
$f\sharp+$	508,80	508,80	496,10	496,37	482,81	499,83	508,80
$f\sharp$	579,47	543,79	539,40	517,88	518,11	556,17	557,97
$f\#\sharp$	584,85	584,85	562,86	549,64	553,40	563,34	579,47
$g \flat$	620,53	584,85	586,32	580,84	588,69	618,73	599,03
$g \flat +$	625,91	625,91	609,78	608,10	623,99	625,90	620,53
$g \flat \natural$	696,58	660,90	676,55	647,01	659,28	682,24	669,70
$g\sharp+$	701,96	701,95	700,01	661,37	694,58	689,41	691,21
$g\sharp$	772,63	736,95	743,31	700,28	729,87	745,74	740,37
$g\#\sharp$	778,00	778,00	766,77	727,54	765,16	752,91	761,88
$a \flat$	813,69	778,00	790,23	763,24	765,16	808,31	781,43
$a \flat +$	819,06	819,06	813,69	812,01	800,46	815,47	802,94
$a \flat \natural$	889,74	854,05	856,99	843,78	835,75	871,81	873,61
$a\sharp+$	895,11	895,11	880,46	882,68	871,05	878,98	895,12
$a\sharp$	965,78	930,10	923,76	913,88	906,34	935,31	944,28
$a\#\sharp$	971,16	971,16	947,22	931,45	941,64	942,48	965,79
$b \flat$	1006,84	971,16	970,68	994,41	976,93	997,88	985,34
$b \flat +$	1012,22	1012,22	994,14	1015,92	1012,22	1005,05	1006,85
$b \flat \natural$	1082,89	1047,21	1060,90	1047,69	1047,52	1061,38	1056,01
$b\sharp+$	1088,27	1088,27	1084,37	1078,88	1082,81	1068,55	1077,52
$b\sharp$	1158,94	1123,26	1127,67	1113,86	1118,11	1124,88	1148,19
$c \flat$	1200,00	1164,32	1174,59	1145,05	1153,40	1187,45	1167,74

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Arciorgano, retuning of the pipes in all modes relative to the reference mode 2 (in cents)

key	Mode 2 ad.1/4komma reference	Mode 1 31meantone	Mode 3 WalterPseudorein	Mode 4 Partch	Mode 5 EDO34	Mode 6 ad.1/3komma	Mode 7 Salinas
c ♯	0,00	-35,68	-25,41	-54,95	-46,60	-12,55	-32,26
c♯+	5,38	0,00	-7,33	-7,05	-16,68	-10,76	-16,13
c #	76,05	-35,68	-34,69	-50,46	-52,06	-25,10	-16,13
c #+	81,43	0,00	-16,61	-20,14	-22,14	-23,30	0,00
d ♯	117,11	-35,68	-28,83	-38,25	-57,83	-3,59	-16,13
d ♯+	122,48	0,00	-10,75	-12,43	-27,91	-1,80	0,00
d ♭	193,16	-35,68	-38,12	-44,20	-63,29	-16,13	-21,50
d♯+	198,53	0,00	-20,03	-17,81	-33,37	-14,34	-5,37
d #	269,21	-35,68	-23,94	-39,71	-68,75	-28,68	-26,88
d #+	274,58	0,00	-5,86	-9,39	-38,83	-26,89	-10,75
e ♯	310,26	-35,68	-18,08	-17,81	-39,22	-7,17	-26,88
e ♯+	315,64	0,00	0,00	-1,68	-9,30	-5,38	-10,75
e ♭	386,31	-35,68	-27,36	-54,95	-44,68	-19,72	-32,26
e♯+	391,69	0,00	-9,28	-45,96	-14,76	-17,93	-16,13
e #	462,36	-35,68	-36,65	-77,72	-50,14	-32,26	-16,13
f ♯	503,42	-35,68	-30,79	-28,56	-55,90	-10,76	-16,13
f♯+	508,80	0,00	-12,70	-12,43	-25,99	-8,97	0,00
f #	579,47	-35,68	-40,07	-61,59	-61,36	-23,30	-21,50
f #+	584,85	0,00	-21,99	-35,20	-31,45	-21,51	-5,37
g ♯	620,53	-35,68	-34,21	-39,69	-31,84	-1,80	-21,50
g ♯+	625,91	0,00	-16,13	-17,81	-1,92	0,00	-5,37
g ♭	696,58	-35,68	-20,03	-49,57	-37,30	-14,34	-26,88
g♯+	701,96	0,00	-1,95	-40,58	-7,38	-12,55	-10,75
g #	772,63	-35,68	-29,32	-72,35	-42,76	-26,89	-32,26
g #+	778,00	0,00	-11,23	-50,46	-12,84	-25,10	-16,13
a ♯	813,69	-35,68	-23,46	-50,45	-48,52	-5,38	-32,26
a ♯+	819,06	0,00	-5,37	-7,05	-18,60	-3,59	-16,13
a ♭	889,74	-35,68	-32,74	-45,96	-53,98	-17,93	-16,13
a♯+	895,11	0,00	-14,66	-12,43	-24,06	-16,13	0,00
a #	965,78	-35,68	-42,02	-51,91	-59,44	-30,47	-21,50
a #+	971,16	0,00	-23,94	-39,71	-29,53	-28,68	-5,37
b ♯	1006,84	-35,68	-36,16	-12,43	-29,91	-8,97	-21,50
e ♯+	1012,22	0,00	-18,08	3,70	0,00	-7,17	-5,37
b ♭	1082,89	-35,68	-21,99	-35,20	-35,37	-21,51	-26,88
b♯+	1088,27	0,00	-3,90	-9,39	-5,46	-19,72	-10,75
b #	1158,94	-35,68	-31,27	-45,08	-40,84	-34,06	-10,75
c ♭	1200,00	-35,68	-25,41	-54,95	-46,60	-12,55	-32,26

Tuning Modes Arciorgano

Arciorgano, pitches of all tuning modes relatively to a4 = 440 Hz

key	Mode 2 ad.1/4komma reference	Mode 1 31meantone	Mode 3 WalterPseudorein	Mode 4 Partch	Mode 5 EDO34	Mode 6 ad.1/3komma	Mode 7 Salinas
c ♯	203,65	167,96	178,24	148,70	157,05	191,10	171,39
c ♭+	209,02	209,02	201,70	201,97	192,34	198,26	192,90
c #	279,69	244,01	245,00	229,23	227,63	254,60	263,57
c #+	285,07	285,07	268,46	264,93	262,93	261,77	285,07
d ♭	320,75	285,07	291,92	282,51	262,93	317,16	304,63
d ♭+	326,13	326,13	315,38	313,70	298,22	324,33	326,13
d ♯	396,80	361,12	358,69	352,61	333,52	380,67	375,30
d ♭+	402,18	402,18	382,15	384,37	368,81	387,84	396,81
d #	472,85	437,17	448,91	433,14	404,10	444,17	445,97
d #+	478,23	478,23	472,37	468,84	439,40	451,34	467,48
e ♭	513,91	478,23	495,83	496,11	474,69	506,74	487,03
e ♭+	519,29	519,29	519,29	517,61	509,99	513,91	508,54
e ♯	589,96	554,28	562,60	535,01	545,28	570,24	557,70
e ♭+	595,34	595,34	586,06	549,38	580,58	577,41	579,21
e ♭+	666,01	630,33	629,36	588,28	615,87	633,74	649,88
f ♭	707,07	671,39	676,28	678,51	651,16	696,31	690,94
f ♭+	712,44	712,44	699,74	700,02	686,46	703,48	712,45
f #	783,12	747,43	743,05	721,52	721,75	759,81	761,61
f #+	788,49	788,49	766,51	753,29	757,05	766,98	783,12
g ♭	824,18	788,49	789,97	784,48	792,34	822,38	802,67
g ♭+	829,55	829,55	813,43	811,75	827,63	829,55	824,18
g ♯	900,22	864,54	880,19	850,65	862,93	885,88	873,34
g ♭+	905,60	905,60	903,65	865,02	898,22	893,05	894,85
g #	976,27	940,59	946,96	903,93	933,52	949,39	944,02
g #+	981,65	981,65	970,42	931,19	968,81	956,55	965,52
a ♭	1017,33	981,65	993,88	966,89	968,81	1011,95	985,08
a ♭+	1022,71	1022,71	1017,34	1015,66	1004,10	1019,12	1006,58
a ♯	1093,38	1057,70	1060,64	1047,42	1039,40	1075,45	1077,25
a ♭+	1098,76	1098,76	1084,10	1086,33	1074,69	1082,62	1098,76
a #	1169,43	1133,75	1127,41	1117,52	1109,99	1138,96	1147,93
a #+	1174,81	1174,81	1150,87	1135,10	1145,28	1146,13	1169,43
b ♭	10,49	1174,81	1174,33	1198,06	1180,58	1,52	1188,99
e ♭+	15,87	15,87	1197,79	19,57	15,87	8,69	1210,49
b ♯	86,54	50,86	64,55	51,33	51,16	65,03	59,66
b ♭+	91,91	91,91	88,01	82,53	86,46	72,20	81,16
b #	162,59	126,90	131,32	117,50	121,75	128,53	151,84
c ♭	203,65	167,96	178,24	148,70	157,05	191,10	171,39

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Arciorgano, all pitches in cents relatively to equally tempered semitones in a4 = 440

key	Mode 2 ad.1/4komma reference	Mode 1 31meantone	Mode 3 WalterPseudor	Mode 4 Partch	Mode 5 EDO34	Mode 6 ad.1/3komma	Mode 7 Salinas
c ♭	d ♭ 3,6	d ♭ -32,0	d ♭ -21,8	c # 48,7	c # -43,0	d ♭ -8,9	d ♭ -28,6
c♯+	d ♭ 9,0	d ♭ 9,0	d ♭ 1,7	d ♭ 2,0	d ♭ -7,7	d ♭ -1,7	d ♭ -7,1
c♯	e b -20,3	d ♭ 44,0	d ♭ 45,0	d ♭ 29,2	d ♭ 27,6	e b -45,4	e b -36,4
c#+	e b -14,9	e b -14,9	e b -31,5	e b -35,1	e b -37,1	e b -38,2	e b -14,9
d ♭	e b 20,8	e b -14,9	e b -8,1	e b -17,5	e b -37,1	e b 17,2	e b 4,6
d ♭+	e b 26,1	e b 26,1	e b 15,4	e b 13,7	e b -1,8	e b 24,3	e b 26,1
d ♯	e ♭ -3,2	e ♭ -38,9	e ♭ -41,3	e ♭ -47,4	e ♭ 33,5	e ♭ -19,3	e ♭ -24,7
d ♯+	e ♭ 2,2	e ♭ 2,2	e ♭ -17,9	e ♭ -15,6	e ♭ -31,2	e ♭ -12,2	e ♭ -3,2
d ♯	f ♭ -27,1	e ♭ 37,2	e ♭ 48,9	e ♭ 33,1	e ♭ 4,1	e ♭ 44,2	e ♭ 46,0
d#+	f ♭ -21,8	f ♭ -21,8	f ♭ -27,6	f ♭ -31,2	e ♭ 39,4	f ♭ -48,7	f ♭ -32,5
e b	f ♭ 13,9	f ♭ -21,8	f ♭ -4,2	f ♭ -3,9	f ♭ -25,3	f ♭ 6,7	f ♭ -13,0
e b+	f ♭ 19,3	f ♭ 19,3	f ♭ 19,3	f ♭ 17,6	f ♭ 10,0	f ♭ 13,9	f ♭ 8,5
e ♭	f # -10,0	f # -45,7	f # -37,4	f ♭ 35,0	f ♭ 45,3	f # -29,8	f # -42,3
e ♭+	f # -4,7	f # -4,7	f # -13,9	f ♭ 49,4	f # -19,4	f # -22,6	f # -20,8
e #	g ♭ -34,0	f # 30,3	f # 29,4	f # -11,7	f # 15,9	f # 33,7	f # 49,9
f ♭	g ♭ 7,1	g ♭ -28,6	g ♭ -23,7	g ♭ -21,5	g ♭ -48,8	g ♭ -3,7	g ♭ -9,1
f ♭+	g ♭ 12,4	g ♭ 12,4	g ♭ -0,3	g ♭ 0,0	g ♭ -13,5	g ♭ 3,5	g ♭ 12,4
f #	a b -16,9	g ♭ 47,4	g ♭ 43,0	g ♭ 21,5	g ♭ 21,8	a b -40,2	a b -38,4
f#+	a b -11,5	a b -11,5	a b -33,5	a b -46,7	a b -43,0	a b -33,0	a b -16,9
g b	a b 24,2	a b -11,5	a b -10,0	a b -15,5	a b -7,7	a b 22,4	a b 2,7
g b+	a b 29,6	a b 29,6	a b 13,4	a b 11,7	a b 27,6	a b 29,5	a b 24,2
g ♭	a ♭ 0,2	a ♭ -35,5	a ♭ -19,8	a ♭ -49,3	a b -37,1	a ♭ -14,1	a ♭ -26,7
g ♭+	a ♭ 5,6	a ♭ 5,6	a ♭ 3,7	a ♭ -35,0	a ♭ -1,8	a ♭ -6,9	a ♭ -5,1
g #	b b -23,7	a ♭ 40,6	a ♭ 47,0	a ♭ 3,9	a ♭ 33,5	a ♭ 49,4	a ♭ 44,0
g#+	b b -18,4	b b -18,4	b b -29,6	a ♭ 31,2	b b -31,2	b b -43,4	b b -34,5
a b	b b 17,3	b b -18,4	b b -6,1	b b -33,1	b b -31,2	b b 12,0	b b -14,9
a b+	b b 22,7	b b 22,7	b b 17,3	b b 15,7	b b 4,1	b b 19,1	b b 6,6
a ♭	b ♭ -6,6	b ♭ -42,3	b ♭ -39,4	b b 47,4	b ♭ 39,4	b ♭ -24,5	b ♭ -22,7
a ♭+	b ♭ -1,2	b ♭ -1,2	b ♭ -15,9	b ♭ -13,7	b ♭ -25,3	b ♭ -17,4	b ♭ -1,2
a #	c ♭ -30,6	b ♭ 33,7	b ♭ 27,4	b ♭ 17,5	b ♭ 10,0	b ♭ 39,0	b ♭ 47,9
a#+	c ♭ -25,2	c ♭ -25,2	c ♭ -49,1	b ♭ 35,1	c ♭ 45,3	b ♭ 46,1	c ♭ -30,6
b b	c ♭ 10,5	c ♭ -25,2	c ♭ -25,7	c ♭ -1,9	c ♭ -19,4	c ♭ 1,5	c ♭ -11,0
e b+	c ♭ 15,9	c ♭ 15,9	c ♭ -2,2	c ♭ 19,6	c ♭ 15,9	c ♭ 8,7	c ♭ 10,5
b ♭	c # -13,5	c # -49,1	cis -35,4	c # -48,7	c ♭ -48,8	c # -35,0	c # -40,3
b#+	c # -8,1	c # -8,1	cis -12,0	c # -17,5	cis -13,5	c # -27,8	c # -18,8
b #	d ♭ -37,4	c # 26,9	cis 31,3	c # 17,5	cis 21,8	c # 28,5	d ♭ -48,2
c ♭	d ♭ 3,6	d ♭ -32,0	d ♭ -21,8	c # 48,7	cis -43,0	d ♭ -8,9	d ♭ -28,6