YAMAHA

Advanced Microtuning Data

DX7 II·FD/D

DIGITAL PROGRAMMABLE ALGORITHM SYNTHESIZER

SUPPLEMENTAL BOOKLET

Welcome

This is the fifth in a series of booklets devoted to the application of the microtuning capability found on the DX7 II. Presented here is the data for seven ethnic, historical, and contemporary microtunings you can implement and explore using your DX7 II. This data is accompanied by short descriptions of the origin and nature of each scale.

For continuing information concerning the DX7 II FD/D, consult AfterTouch, the official publication of the Yamaha Users Group. Many advanced functions will be discussed in its pages in the coming months. There will also be information regarding the availability of other materials concerning more advanced applications. To receive a free copy of AfterTouch every month, send your request to AfterTouch, P.O. Box 7938, Northridge, CA 91327-7938. On your letter or postcard, be sure to indicate that you are the owner of a DX7 II FD/D.

Contents

1 Introduction

Introduction

The microtunings contained in this booklet are derived from the Equal Temperament preset. Each one consists of more than twelve notes per octave. As such, they require more than twelve keys per octave to play. Each octave of sound, or "pitch octave," requires more than one octave on the keyboard. This means that the keyboard must be "remapped" to accommodate the extra notes found in each octave. The following data specifies a new pattern of keys on the keyboard for each microtuning. You will find that the keys no longer correspond to the notes you might expect.

In each of the scales, some keys on the keyboard are not used. This is due to the fact that the number of notes in each pitch octave does not correspond exactly to the number of keys in two, three, or four octaves on the keyboard. Any keys not listed in the tuning data are irrelevant and need no tuning value assignment. In all but one case, the integrity of the keyboard octave has been maintained. That is, if a scale begins on a C key, the next pitch octave will also begin on a C key. The tuning data is given for one pitch octave. The tuning unit values for each of the relevant keys is listed.

2 New Microtuning Data

17 Tone Arabic

The Arabic world was quick to adopt the Pythagorean scale as the tonal basis for its music. The original Arabic scale was derived from a succession of fourteen pure fifths (later expanded to seventeen). As in Greece and Europe, the tones so derived were transposed into the scope of one octave to form the scale.

With seventeen tones per octave, the scale must extend over two keyboard octaves. The tuning data below lists only those keys on the keyboard which are used to play the scale. Since this scale was usually played on a lute-like instrument, a plucked string patch would be most appropriate.

Key Name	Coarse Tune	Fine Tune	Tuning Units	Interval Size TU	Interval Size Cents
>>> C 1 <<<	C 1	+0	(2986)		
				77	90.23
>>> C#1 <<<	C#1	-9	(3063)		
				77	90.23
>>> D 1 <<<	D 1	-17	(3140)		
				20	23.44
>>> D#1 <<<	D 1	+3	(3160)		
				77	90.23
>>> E 1 <<<	D#1	-5	(3237)		
				77	90.23
>>> F 1 <<<	E 1	-14	(3314)		
				20	23.44
>>> G 1 <<<	E 1	+6	(3334)		
				77	90.23
>>> A 1 <<<	F 1	-2	(3411)		
				77	90.23
>>> B 1 <<<	F#1	-10	(3488)		
				77	90.23
>>> C 2 <<<	G 1	-19	(3565)		
				20	23.44
>>> C#2 <<<	G 1	+1	(3585)		
				77	90.23
>>> D 2 <<<	G#1	-7	(3662)		
				77	90.23
>>> E 2 <<<	A 1	-15	(3739)		
				20	23.44
>>> F 2 <<<	A 1	+5	(3759)		
				77	90.23
>>> G 2 <<<	A#1	-4	(3836)		
				77	90.23
>>> A 2 <<<	B 1	-12	(3913)		
				77	90.23
>>> B 2 <<<	C 2	-20	(3990)		
				20	23.44
>>> C 3 <<<	C 2	+0	(4010)		

Indian 22 Sruti

The scale used in India to perform ragas consists of 22 pure intervals known as sruti. This scale includes most of the intervals in the Just chromatic scale such as 16/15, 9/8, 6/5, 5/4, 4/3, 45/32, 3/2, 8/5, 5/3, and 15/8.

With 22 tones per octave, two keyboard octaves are needed to play the entire scale. As the table of tuning data reveals, all keys except A# are used. Any linear timbre will work well with this scale of just intervals. A sitar sound would be particularly appropriate.

Key Name	Coarse Tune	Fine Tune	Tuning Units	Interval Size TU	Interval Size Cents
>>> C 1 <<<	C 1	+0	(2986)		
				77	90.23
>>> C#1 <<<	C#1	-9	(3063)		
				18	21.09
>>> D 1 <<<	C#1	+9	(3081)		
				61	71.48
>>> D#1 <<<	D 1	-15	(3142)		
				18	21.09
>>> E 1 <<<	D 1	+3	(3160)		
				77	90.23
>>> F 1 <<<	D#1	-5	(3237)		
				18	21.09
>>> F#1 <<<	D#1	+13	(3255)		
				61	71.48
>>> G 1 <<<	E 1	-12	(3316)		
				18	21.09
>>> G#1 <<<	E 1	+6	(3334)		
				77	90.23
>>> A 1 <<<	F 1	-2	(3411)		
				18	21.09
>>> B 1 <<<	F 1	+16	(3429)		
				61	71.48
>>> C 2 <<<	F#1	-8	(3490)		

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Note Name	Coarse Tune	Fine Tune	Tuning Units	Interval Size	
				TU	Cents
>>> C 2 <<<	F#1	-8	3490		
				18	21.09
>>> C#2 <<<	F#1	+10	3508		
				77	90.23
>>> D 2 <<<	G 1	+1	3585		
				77	90.23
>>> D#2 <<<	G#1	-7	3662		
				18	21.09
>>> E 2 <<<	G#1	+11	3680		
				61	71.48
>>> F 2 <<<	A 1	-13	3741		
				18	21.09
>>> F#2 <<<	A 1	+5	3759		
				77	90.23
>>> G 2 <<<	A#1	-4	3836		
				18	21.09
>>> G#2 <<<	A#1	+14	3854		
				61	71.48
>>> A 2 <<<	B 1	-10	3915		
				18	21.09
>>> B 2 <<<	B 1	+8	3933		
				77	90.23
>>> C 3 <<<	C 2	+0	4010		

19 Tone Equal Temperament

Several music theorists have proposed divisions of the octave into more than twelve equal intervals. One of these proposals divides the octave into nineteen equal steps. The advantages of this scheme over twelve tone equal temperament include greater purity of minor thirds, major thirds, minor sixths, and major sixths. In addition, the intervals with ratios near the 7-limit are no more than 21.4 cents out of tune (as compared with 33.1 cents in twelve tone equal temperament). The disadvantages of this temperament include the intonation of perfect fifths, which are 5.3 cents narrower than those found in twelve tone equal temperament (and 7.3 cents narrower than pure fifths).

With nineteen tones per octave, the keys listed in the table below are used to play the scale. Notice that the pattern within both keyboard octaves is repeated except for the absence of A# in the upper octave.

Key Name	Coarse Tune	Fine Tune	Tuning Units	Interval Size TU	Interval Size Cents
>>> C 1 <<<	C 1	+0	(2986)		
				54	63.28
>>> D 1 <<<	C#1	-32	(3040)		
				54	63.28
>>> E 1 <<<	C#1	+22	(3094)		
				54	63.28
>>> F 1 <<<	D 1	-9	(3148)		
				54	63.28
>>> F#1 <<<	D#1	-40	(3202)		
				53	62.11
>>> G 1 <<<	D#1	+13	(3255)		
				54	63.28
>>> G#1 <<<	E 1	-19	(3309)		
				54	63.28
>>> A 1 <<<	E 1	+35	(3363)		
				54	63.28
>>> A#1 <<<	F 1	+4	(3417)		
				54	63.28
>>> B 1 <<<	F#1	-27	(3471)		
				54	63.28
>>> C 2 <<<	F#1	+27	(3525)		

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Key Name	Coarse Tune	Fine Tune	Tuning Units	Interval Size TU	Cents
>>> C 2 <<<	F#1	+27	(3525)		
				54	63.28
>>> D 2 <<<	G 1	-5	(3579)		
				54	63.28
>>> E 2 <<<	G#1	-36	(3633)		
				54	63.28
>>> F 2 <<<	G#1	+18	(3687)		
				54	63.28
>>> F#2 <<<	A 1	-13	(3741)		
				53	62.11
>>> G 2 <<<	A 1	+40	(3794)		
				54	63.28
>>> G#2 <<<	A#1	+8	(3848)		
				54	63.28
>>> A 2 <<<	B 1	-23	(3902)		
				54	63.28
>>> B 2 <<<	B 1	+31	(3956)		
				54	63.28
>>> C 3 <<<	C 2	+0	(4010)		

31 Tone Equal Temperament

This scale is another proposed alternative to the twelve tone equal tempered scale. It shares many of the advantages and disadvantages of the 19 tone equal tempered scale. In addition, it includes ratios very near the 11-limit.

This microtuning's pitch octave extends over three keyboard octaves. The relevant keys are listed in the table of tuning data below.

Key Name	Coarse Tune	Fine Tune	Tuning Units	Interval Size TU	Interval Size Cents
>>> C 1 <<<	C 1	+0	(2986)		
				33	38.67
>>> D 1 <<<	C 1	+33	(3019)		
				33	38.67
>>> E 1 <<<	C#1	-20	(3052)		
				33	38.67
>>> F 1 <<<	C#1	+13	(3085)		
				33	38.67
>>> F#1 <<<	D 1	-39	(3118)		
				33	38.67
>>> G 1 <<<	D 1	-6	(3151)		
				33	38.67
>>> G#1 <<<	D 1	+27	(3184)		
				33	38.67
>>> A 1 <<<	D#1	-25	(3217)		
				33	38.67
>>> A#1 <<<	D#1	+8	(3250)		
				33	38.67
>>> B 1 <<<	D#1	+41	(3283)		
				33	38.67
>>> C 2 <<<	E 1	-12	(3316)		

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Note Name	Coarse Tune	Fine Tune	Tuning Units	Interval Size TU	Interval Size Cents
>>> C 2 <<<	E 1	-12	(3316)		
				33	38.67
>>> D 2 <<<	E 1	+21	(3349)		
				33	38.67
>>> D#2 <<<	F 1	-31	(3382)		
				33	38.67
>>> E 2 <<<	F 1	+2	(3415)		
				33	38.67
>>> F 2 <<<	F 1	+35	(3448)		
				33	38.67
>>> F#2 <<<	F#1	-17	(3481)		
				34	39.84
>>> G 2 <<<	F#1	+17	(3515)		
				33	38.67
>>> G#2 <<<	G 1	-36	(3548)		
				33	38.67
>>> A 2 <<<	G 1	-3	(3581)		
				33	38.67
>>> A#2 <<<	G 1	+30	(3614)		
				33	38.67
>>> B 2 <<<	G#1	-22	(3647)		
				33	38.67
>>> C 3 <<<	G#1	+11	(3680)		
				33	38.67
>>> D 3 <<<	A 1	-41	(3713)		
				33	38.67
>>> E 3 <<<	A 1	-8	(3746)		
				33	38.67
>>> F 3 <<<	A 1	+25	(3779)		
				33	38.67
>>> F#3 <<<	A#1	-28	(3812)		
				33	38.67
>>> G 3 <<<	A#1	+5	(3845)		
				33	38.67
>>> G#3 <<<	A#1	+38	(3878)		
				33	38.67
>>> A 3 <<<	B 1	-14	(3911)		
				33	38.67
>>> A#3 <<<	B 1	+19	(3944)		
				33	38.67
>>> B 3 <<<	C 2	-33	(3977)		
				33	38.67
>>> C 4 <<<	C 2	+0	(4010)		

5th Octave Harmonic

As you may recall from the third and fourth booklets in the microtuning series, the ratios found in the linear harmonic spectrum can be used to construct different scales. The third booklet, "The Acoustics of Microtuning," includes a twelve tone scale that is built using some of the intervals found in the fifth octave of this spectrum. The scale presented here is constructed using all of the ratios from the fifth octave.

With 16 notes per pitch octave, two keyboard octaves are used to play the scale. The only black key used in the keyboard mapping is F♯. Sounds with a linear harmonic spectrum would be most appropriate for this microtuning.

Key Name	Coarse Tune	Fine Tune	Tuning Units	Interval Size TU	Interval Size Cents
>>> C 1 <<<	C 1	+0	(2986)		
				90	105.47
>>> D 1 <<<	C#1	+4	(3076)		
				84	98.44
>>> E 1 <<<	D 1	+3	(3160)		
				80	93.75
>>> F 1 <<<	D#1	-2	(3240)		
				76	89.06
>>> F#1 <<<	E 1	-12	(3316)		
				72	84.38
>>> G 1 <<<	F 1	-25	(3388)		
				68	79.69
>>> A 1 <<<	F#1	-42	(3456)		
				66	77.34
>>> B 1 <<<	F#1	+24	(3522)		
				63	73.83
>>> C 2 <<<	G 1	+1	(3585)		
				60	70.31
>>> D 2 <<<	G#1	-24	(3645)		
				58	67.97
>>> E 2 <<<	G#1	+34	(3703)		
				56	65.63
>>> F 2 <<<	A 1	+5	(3759)		
				54	63.28
>>> F#2 <<<	A#1	-27	(3813)		
				52	60.94
>>> G 2 <<<	A#1	+25	(3865)		
				50	58.59
>>> A 2 <<<	B 1	-10	(3915)		
				48	56.25
>>> B 2 <<<	B 1	+38	(3963)		
				47	55.08
>>> C 3 <<<	C 2	+0	(4010)		

6th Octave Harmonic

This microtuning is similar to the fifth octave harmonic scale presented above. The only difference between them is that this scale is derived from the sixth octave of the linear harmonic spectrum.

With 32 notes per pitch octave, three keyboard octaves are used to play the scale. Like the fifth octave harmonic scale, this microtuning has an even number of notes per octave. This means that the pattern of keys used in each keyboard octave can be identical. The relevant keys are listed below with the tuning data. Again, a sound with a linear harmonic spectrum would be most suitable for this microtuning.

Key Name	Coarse Tune	Fine Tune	Tuning Units	Interval Size TU	Interval Size Cents
>>> C 1 <<<	C 1	+0	(2986)		
				45	52.73
>>> C#1 <<<	C#1	-41	(3031)		
				45	52.73
>>> D 1 <<<	C#1	+4	(3076)		
				42	49.22
>>> D#1 <<<	D 1	-39	(3118)		
				42	49.22
>>> E 1 <<<	D 1	+3	(3160)		
				40	46.88
>>> F 1 <<<	D#1	-42	(3200)		
				40	46.88
>>> G 1 <<<	D#1	-2	(3240)		
				38	44.53
>>> G#1 <<<	D#1	+36	(3278)		
				38	44.53
>>> A 1 <<<	E 1	-12	(3316)		
				36	42.19
>>> A#1 <<<	E 1	+24	(3352)		
				36	42.19
>>> B 1 <<<	F 1	-25	(3388)		
				34	39.84
>>> C 2 <<<	F 1	+9	(3422)		

– continued –

Note Name	Coarse Tune	Fine Tune	Tuning Units	Interval Size TU	Cents
>>> C 2 <<<	F 1	+9	3422		
				34	39.84
>>> C#2 <<<	F#1	-42	3456		
				34	39.84
>>> D 2 <<<	F#1	-8	3490		
				32	37.50
>>> D#2 <<<	F#1	+24	3522		
				32	37.50
>>> E 2 <<<	G 1	-30	3554		
				31	36.33
>>> F 2 <<<	G 1	+1	3585		
				30	35.16
>>> G 2 <<<	G 1	+31	3615		
				30	35.16
>>> A 2 <<<	G#1	-24	3645		
				30	35.16
>>> A#2 <<<	G#1	+6	3675		
				28	32.81
>>> B 2 <<<	G#1	+34	3703		
				28	32.81
>>> C 3 <<<	A 1	-23	3731		
				28	32.81
>>> C#3 <<<	A 1	+5	3759		
				27	31.64
>>> D 3 <<<	A 1	+32	3786		
				27	31.64
>>> D#3 <<<	A#1	-27	3813		
				26	30.47
>>> E 3 <<<	A#1	-1	3839		
				26	30.47
>>> F 3 <<<	A#1	+25	3865		
				25	29.30
>>> G 3 <<<	B 1	-35	3890		
				25	29.30
>>> G#3 <<<	B 1	-10	3915		
				24	28.13
>>> A 3 <<<	B 1	+14	3939		
				24	28.13
>>> A#3 <<<	B 1	+38	3963		
				24	28.13
>>> B 3 <<<	C 2	-23	3987		
				23	26.95
>>> C 4 <<<	C 2	+0	4010		

Partch

Harry Partch is widely considered to be the father of modern microtonality. He developed a 43 tone scale based on the principles of Just intonation and built an entire orchestra of acoustic instruments on which music written in this scale could be played. These included many different mallet instruments, organs, and adapted string instruments. Unfortunately, many of them did not have an appropriate timbre for this tuning. Just tunings such as Partch's require linear harmonic spectra.

This is the only microtuning in this booklet in which keyboard octaves are not maintained. The keyboard mapping presented here is the same one used by Partch on his modified organ keyboards. The scale begins on the D1 key and uses every chromatic key to play the 43 notes in the scale. The octave is played by the 44th key (A4). Partch labeled and color coded his keyboards to help performers negotiate the new keyboard mapping.

Key Name	Coarse Tune	Fine Tune	Tuning Units	Interval Size TU	Interval Size Cents
>>> D 1 <<<	D 1	+0	(3157)		
				18	21.09
>>> D#1 <<<	D 1	+18	(3175)		
				27	31.64
>>> E 1 <<<	D#1	-40	(3202)		
				27	31.64
>>> F 1 <<<	D#1	-13	(3229)		
				23	26.95
>>> F#1 <<<	D#1	+10	(3252)		
				34	39.84
>>> G 1 <<<	E 1	-42	(3286)		
				12	14.06
>>> G#1 <<<	E 1	-30	(3298)		
				15	17.58
>>> A 1 <<<	E 1	-15	(3313)		
				18	21.09
>>> A#1 <<<	E 1	+3	(3331)		
				23	26.95
>>> B 1 <<<	E 1	+26	(3354)		
				31	36.33
>>> C 2 <<<	F 1	-28	(3385)		
				23	26.95
>>> C#2 <<<	F 1	-5	(3408)		
				18	21.09
>>> D 2 <<<	F 1	+13	(3426)		

– continued –

Key Name	Coarse Tune	Fine Tune	Tuning Units	Interval Size TU	Interval Size Cents
>>> D 2 <<<	F 1	+13	(3426)		
				27	31.64
>>> D#2 <<<	F 1	+40	(3453)		
				34	39.84
>>> E 2 <<<	F#1	-11	(3487)		
				26	30.47
>>> F 2 <<<	F#1	+15	(3513)		
				15	17.58
>>> F#2 <<<	F#1	+30	(3528)		
				31	36.33
>>> G 2 <<<	G 1	-25	(3559)		
				23	26.95
>>> G#2 <<<	G 1	-2	(3582)		
				18	21.09
>>> A 2 <<<	G 1	+16	(3600)		
				27	31.64
>>> A#2 <<<	G#1	-42	(3627)		
				27	31.64
>>> B 2 <<<	G#1	-15	(3654)		
				30	35.16
>>> C 3 <<<	G#1	+15	(3684)		
				27	31.64
>>> C#3 <<<	G#1	+42	(3711)		
				27	31.64
>>> D 3 <<<	A 1	-16	(3738)		

– continued –

Note Name	Coarse Tune	Fine Tune	Tuning Units	Interval Size TU	Interval Size Cents
>>> D 3 <<<	A 1	-16	(3738)		
				18	21.09
>>> D#3 <<<	A 1	+2	(3756)		
				23	26.95
>>> E 3 <<<	A 1	+25	(3779)		
				31	36.33
>>> F 3 <<<	A#1	-30	(3810)		
				15	17.58
>>> F#3 <<<	A#1	-15	(3825)		
				26	30.47
>>> G 3 <<<	A#1	+11	(3851)		
				34	39.84
>>> G#3 <<<	B 1	-40	(3885)		
				27	31.64
>>> A 3 <<<	B 1	-13	(3912)		
				18	21.09
>>> A#3 <<<	B 1	+5	(3930)		
				23	26.95
>>> B 3 <<<	B 1	+28	(3953)		
				31	36.33
>>> C 4 <<<	C 2	-26	(3984)		
				23	26.95
>>> C#4 <<<	C 2	-3	(4007)		
				18	21.09
>>> D 4 <<<	C 2	+15	(4025)		

– continued –

Note Name	Coarse Tune	Fine Tune	Tuning Units	Interval Size TU	Interval Size Cents
>>> D 4 <<<	C 2	+15	(4025)		
				15	17.58
>>> D#4 <<<	C 2	+30	(4040)		
				12	14.06
>>> E 4 <<<	C 2	+42	(4052)		
				34	39.84
>>> F 4 <<<	C#2	-10	(4086)		
				23	26.95
>>> F#4 <<<	C#2	+13	(4109)		
				27	31.64
>>> G 4 <<<	C#2	+40	(4136)		
				27	31.64
>>> G#4 <<<	D 2	-18	(4163)		
				18	21.09
>>> A 4 <<<	D 2	+0	(4181)		

Notes