AFTER TOUCH™

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CX5M MUSIC COMPUTER SYSTEM

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AFTERTOUCH

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From The Editor

MANY NEW THINGS for this third issue of AFTERTOUCH! First of all, we have our first contributions from readers. From Manny Fernandez, we have a Rhodes-like voice he programmed for keyboardist/percussionist Victor Feldman. You will find Manny's voice, called VICSRHODES, on page 5.

We also have our first article from a reader: Beginning on page 8, you will find a detailed discussion of ways in which DX7 voices can be "translated" for use with the internal tone generator of the CX5M music computer. The article, by Ken Leivers, comes complete with a set of conversion tables for the different parameter value ranges of the two programming systems.

Back on page 18, you will find our first collection of hot tips, "Final Touch." Another reader, Jim Mancuso, has supplied us with a great method for preprogramming tempos on the RX11. In addition, Gary Leuenberger and David Bristow tell us how to use the QX1 to program RX11 drum patterns.

Also, due to popular demand, we are providing you with a set of blank DX7 voice charts, which you are free to copy and use to document your DX7 voices. These charts, on pages 6 and 7, follow the AFTERTOUCH format first used and explained by Gary Leuenberger in the first issue. Using these charts, you will be able to *see* the shape of the algorithm as part of your voice data. Happy programming!

As you can see, your input is already having a strong effect on the contents of AFTERTOUCH. Let's keep the flow of information going. If you want to belong to or start a Users Group in your area, please send us a letter: Include your address and (if you wish) your telephone number. We'll print it, and others in your area will be able to contact you to set up meetings, information swap meets, or other gatherings.

Keep the questions coming, too. Your input will help us to give you the kind of information you need. We look forward to hearing from you!

—TD

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John Chowning

Part 2 Of An Exclusive Interview With The Father Of Digital FM Synthesis. By Tom Darter.

AS DIRECTOR OF the Center for Computer Research and Musical Acoustics at Stanford University [CCRMA], John Chowning has long been an articulate and enthusiastic spokesman for music produced by electronic means. While still a graduate student in composition at Stanford in 1964, he became interested in electronic music. Since the school had no analog synthesis equipment but did have a large computer, he jumped directly into digital synthesis.

In the '70s, the results of his research in the field of FM digital synthesis were licensed to Yamaha, and the rest is history. As you will discover from this exclusive, two-part interview, Dr. Chowning's keen insights are important for any student of FM.

In part 1 [published in last month's issue of AFTERTOUCH], Chowning explained his early work with FM, and described the convoluted pathway that connected his original theory of digital FM to its current pinnacle of commercial success. In this month's installment [part 2], Dr. Chowning discusses his recent work with the DX7, and outlines ways in which the DX instruments can be used as teaching tools in the fields of acoustics and psychoacoustics.

* * * *

TD: *When did you first work with the DX7?*

JC: You mean the first time I actually sat down and worked with it for more than a few random hours?

TD: *Yes.*

JC: In January of 1985, at IRCAM in Paris. I had seen prototypes in Japan, but that was more listening, talking about what was being done, and giving suggestions, rather than sitting down and working with it myself. And in fact they were at that time far away from what the DX7 has become.

TD: *So for all this time since the DX7 has come out, your work has continued to be on the large mainframe computer at Stanford?*

JC: That's right. This year marks the first chance I've really had to sit down and get to know the DX7 rather intimately. I'm writing a piece for two virtuoso pianists, each playing a KX88 controlling a TX816, with computer control between voices. Ever since the GS1, which is much less flexible than the later instruments, I felt that the technology at least coupled basic musical gestures in effective musical ways—velocity did something now beyond just making it louder; it affected the bandwidth, the spectrum. I felt that the instruments were ready for at least a few pieces to be done with them. Now with the TX816, I think there are a lot of pieces that could be done with MIDI control keyboards. It is a different but complementary medium to that which we use here at Stanford. I plan to finish the piece soon.

"This year marks the first chance I've really had to sit down and get to know the DX7 rather intimately."

TD: *Is your SLAPCONGAS patch [presented in the October '85 issue of AFTERTOUCH] the very first DX7 sound you ever came up with?*

JC: Yes.

TD: *Were you aiming specifically at a drum patch when you began work on the sound?*

JC: Yes. That was rather purposeful and successful. I was interested in that because of David Wessel. He is a kind of musician/scientist/mathematician at IRCAM, and he is also a drummer. In fact, he was my student when he was doing his graduate work here at Stanford. We were talking about flams in the context of synthesis, and I thought it would be possible to do that with the DX7, because you have independent sections in many of the algorithms.

So I tried to make flams, I think, and then got into the idea of doing a conga, which sometimes uses flams for fortissimo sounds. I did it in about a day and a half—I'm still not nearly as skilled as some of those who've been working with the DX7 for years, but I guess my theoretical understanding was quite a bit of help. So I sat down and put together a drum which is conga-like. On all drums, pianissimo sounds are very different than a whacked fortissimo, and I wanted to build those differences into the sound. That was a lot of fun. I really enjoyed it. So that was my first sound on the DX7, completed in February of 1985.

TD: *Have you been doing a lot of programming recently for your piece, working on the TX816?*

JC: Yes. One of the central ideas for the piece was that I would try to get the very best piano sounds I could, because for one brief instant in the piece, the pianists will be playing sounds that are more or less within their own domain. But I took it as a challenge, because the best way to learn a system is to start by trying to simulate something. So, after the FM conga sound, I started working on piano tones. Then David Bristow came over from England, and we started working on it together. That was a very

Continued on page 20

TR1	14	0	0	53	OFF	0
WAVE	SPEED	DELAY	PMD	AMD	SYNC	PMS

LFO

R1	R2	R3	R4
99	99	99	99
L1	L2	L3	L4
50	50	50	50

PITCH ENVELOPE

C2
KEY TRANSPOSE

ON
OSC SYNC

FUNCTIONS

POLY	2	0	NA	OFF	0
POLY/MONO	RANGE	STEP	MODE	GLISSANDO	TIME
	PITCH BEND		PORTAMENTO		

(CONTROLLER)	RANGE	PITCH	AMPLITUDE	EG BIAS
MOD WHEEL	NA	NA	OFF	OFF
FOOT CONTROL	NA	NA	OFF	OFF
BREATH CONTROL	NA	NA	OFF	OFF
AFTERTOUCH	NA	NA	OFF	OFF

FREQUENCY	DETUNE	AMS		
20.72	0	0		
ENVELOPE DATA				
R1 64	R2 23	R3 27	R4 36	RS 0
L1 99	L2 85	L3 0	L4 0	
KEYBOARD SCALING				
CURVE		BREAKPOINT		DEPTH
L	-L	B2	L	19
R	+L		R	17
OP#	OUTPUT LEVEL	VELOCITY		
3	67	3		

FREQUENCY	DETUNE	AMS		
229.1Hz	-4	0		
ENVELOPE DATA				
R1 85	R2 85	R3 17	R4 48	RS 0
L1 95	L2 0	L3 0	L4 0	
KEYBOARD SCALING				
CURVE		BREAKPOINT		DEPTH
L	+E	G2	L	51
R	-E		R	52
OP#	OUTPUT LEVEL	VELOCITY		
5	93	3		

FREQUENCY	DETUNE	AMS		
1.00	-5	1		
ENVELOPE DATA				
R1 86	R2 25	R3 18	R4 36	RS 1
L1 96	L2 89	L3 0	L4 0	
KEYBOARD SCALING				
CURVE		BREAKPOINT		DEPTH
L	+E	G2	50	L
R	-E		40	R
OP#	OUTPUT LEVEL	VELOCITY		
6	93	2		

4

FREQUENCY	DETUNE	AMS		
14.00	+4	0		
ENVELOPE DATA				
R1 94	R2 41	R3 30	R4 48	RS 6
L1 99	L2 72	L3 0	L4 0	
KEYBOARD SCALING				
CURVE		BREAKPOINT		DEPTH
L	-E	C3	L	44
R	-L		R	0
OP#	OUTPUT LEVEL	VELOCITY		
2	61	4		

FREQUENCY	DETUNE	AMS		
1.778Hz	-4	0		
ENVELOPE DATA				
R1 89	R2 20	R3 20	R4 52	RS 4
L1 99	L2 90	L3 0	L4 0	
KEYBOARD SCALING				
CURVE		BREAKPOINT		DEPTH
L	+L	C3	L	0
R	-E		R	17
OP#	OUTPUT LEVEL	VELOCITY		
4	99	2		

FREQUENCY	DETUNE	AMS		
1.00	+5	1		
ENVELOPE DATA				
R1 89	R2 20	R3 20	R4 52	RS 4
L1 99	L2 90	L3 0	L4 0	
KEYBOARD SCALING				
CURVE		BREAKPOINT		DEPTH
L	+L	A2	L	54
R	-E		R	60
OP#	OUTPUT LEVEL	VELOCITY		
1	98	6		

ALGORITHM #11

VICS-RHODES. A DX7 Voice By Manny Fernandez.

Notes:

Basic sound of piano is produced by Ops #6 and #4. Op #4 is set to fixed frequency of 1.778 to create a slow chorusing effect.

Op #5 is set to fixed frequency of 229.1 to create the "thump" of the hammer.

Ops #1, #2, and #3 are used to create the sound of the tine sound of the Rhodes. The "stuff" comes from Op #3: Although the 14:1 ratio of Ops #1 and #2 creates a good approximation of the tine, the overall harmonic structure is much more complex and includes some non-harmonic (clangorous) components. Thus, Op #3 is set to a ratio of 20.72 (start at 14.00, and move up using the Frequency Fine parameter).

Try setting Ops #2 and #3 EG Level 4 to 95 and Rate 4 to 80, to create a harpsichord-like effect in the tine sound.

Blank Voicing Charts In The AFTERTOUCH Format.

The chart on this page can be used to record voices programmed using the following algorithms: 1-11, 14-19, and 28. Connect the relevant operator boxes, add the feedback loop in the proper place, and fill in the blanks. Ignore the operator boxes that are not needed for the algorithm you are using.

WAVE	SPEED	DELAY	PMD	AMD	SYNC	PMS

LFO

R1	R2	R3	R4
L1	L2	L3	L4

PITCH ENVELOPE

KEY TRANSPOSE

OSC SYNC

FUNCTIONS

POLY/MONO	RANGE	STEP	MODE	GLISSANDO	TIME
	PITCH BEND		PORTAMENTO		

(CONTROLLER)	RANGE	PITCH	AMPLITUDE	EG BIAS
MOD WHEEL				
FOOT CONTROL				
BREATH CONTROL				
AFTERTOUCH				

FREQUENCY | DETUNE | AMS
ENVELOPE DATA
R1 | R2 | R3 | R4 | RS
L1 | L2 | L3 | L4
KEYBOARD SCALING
CURVE | BREAKPOINT | DEPTH
OP# | OUTPUT LEVEL | VELOCITY

FREQUENCY | DETUNE | AMS
ENVELOPE DATA
R1 | R2 | R3 | R4 | RS
L1 | L2 | L3 | L4
KEYBOARD SCALING
CURVE | BREAKPOINT | DEPTH
OP# | OUTPUT LEVEL | VELOCITY

FREQUENCY | DETUNE | AMS
ENVELOPE DATA
R1 | R2 | R3 | R4 | RS
L1 | L2 | L3 | L4
KEYBOARD SCALING
CURVE | BREAKPOINT | DEPTH
OP# | OUTPUT LEVEL | VELOCITY

FREQUENCY | DETUNE | AMS
ENVELOPE DATA
R1 | R2 | R3 | R4 | RS
L1 | L2 | L3 | L4
KEYBOARD SCALING
CURVE | BREAKPOINT | DEPTH
OP# | OUTPUT LEVEL | VELOCITY

FREQUENCY | DETUNE | AMS
ENVELOPE DATA
R1 | R2 | R3 | R4 | RS
L1 | L2 | L3 | L4
KEYBOARD SCALING
CURVE | BREAKPOINT | DEPTH
OP# | OUTPUT LEVEL | VELOCITY

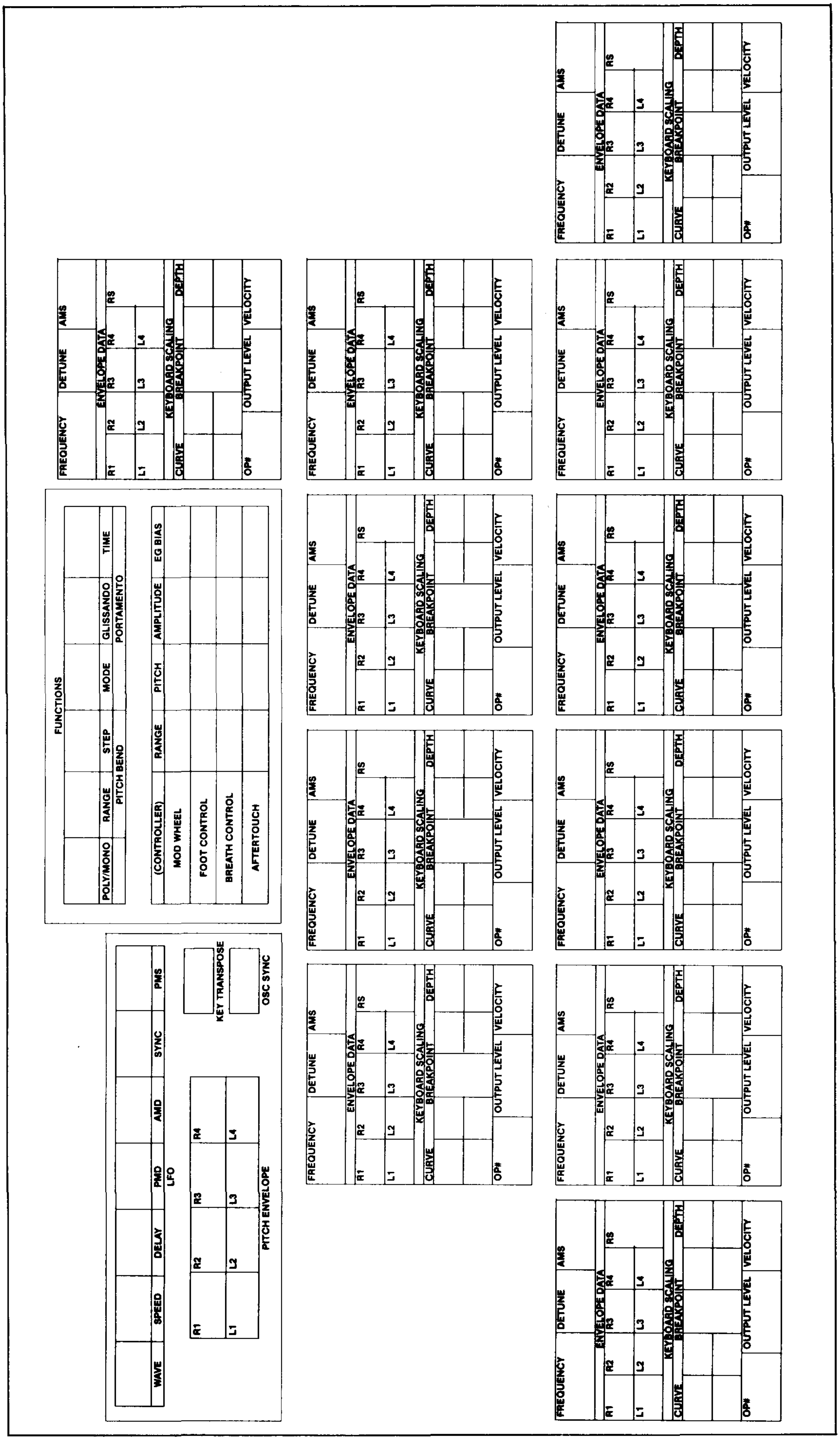
FREQUENCY | DETUNE | AMS
ENVELOPE DATA
R1 | R2 | R3 | R4 | RS
L1 | L2 | L3 | L4
KEYBOARD SCALING
CURVE | BREAKPOINT | DEPTH
OP# | OUTPUT LEVEL | VELOCITY

FREQUENCY | DETUNE | AMS
ENVELOPE DATA
R1 | R2 | R3 | R4 | RS
L1 | L2 | L3 | L4
KEYBOARD SCALING
CURVE | BREAKPOINT | DEPTH
OP# | OUTPUT LEVEL | VELOCITY

FREQUENCY | DETUNE | AMS
ENVELOPE DATA
R1 | R2 | R3 | R4 | RS
L1 | L2 | L3 | L4
KEYBOARD SCALING
CURVE | BREAKPOINT | DEPTH
OP# | OUTPUT LEVEL | VELOCITY

FREQUENCY | DETUNE | AMS
ENVELOPE DATA
R1 | R2 | R3 | R4 | RS
L1 | L2 | L3 | L4
KEYBOARD SCALING
CURVE | BREAKPOINT | DEPTH
OP# | OUTPUT LEVEL | VELOCITY

FREQUENCY | DETUNE | AMS
ENVELOPE DATA
R1 | R2 | R3 | R4 | RS
L1 | L2 | L3 | L4
KEYBOARD SCALING
CURVE | BREAKPOINT | DEPTH
OP# | OUTPUT LEVEL | VELOCITY



The chart on this page can be used to record voices programmed using the following algorithms: 5-13 and 20-32. Connect the relevant operator boxes, add the feedback loop in the proper place, and fill in the blanks. Ignore the operator boxes that are not needed for the algorithm you are using.

CX5M

Conversion Factors And Hints For Programming DX7 Voices Into The CX5M. By Ken Leivers.

THERE ARE NOW A number of different FM digital operator/algorithm configurations available, from the 6-operator system of the DX7 and related instruments to the various 4-operator systems such as those found in the DX9, the DX21, and the CX5M's internal FM digital tone generator unit.

Although many voices are available for all of these systems, the large majority of the available voices have been designed for the DX7-based six-operator systems. To take advantage of this large library of voices, I have developed a way to convert DX7 voices for use with the CX5M's internal synthesizer. Obviously, there are some compromises involved, since the CX5M system has only four operators. Beyond that, the number values for almost all of the other parameters are different. To overcome that problem, you will find a number of conversion tables below. These will help you to "translate" parameter values from one system to the other.

The conversion values were derived largely by ear; a number of types of graph paper were also used to plot the various ranges and values. Although one might be able to be a little more exact using electronic measuring equipment, the conversion values in the charts below have proven to be quite accurate. Using the techniques and charts below, CX5M owners can now have access to the large library of voices developed originally for the DX7.

Algorithm—Since the DX7 has 6 operators and the CX5M only 4, choose the 4 DX7 operators that provide the major part of the DX7 sound that you want to program on the CX5M. Then pick the CX5M algorithm to use in your programming that has the same configuration as (or is most similar to) the DX7 algorithm minus the DX7's two extra operators. Since the DX7 and the CX5M operators are numbered differently in their algorithms, make sure that you program each operator according to its corresponding position in the algorithm rather than to its operator number.

Feedback—Values for feedback are the same for both the DX7 and the CX5M.

LFO. Speed—for sawtooth, sine, square and triangular waves:

DX7		CX5M
1	=	115
2	=	140
3	=	145
4	=	151
5	=	156
6	=	161
7	=	166
8	=	168
9	=	171
10	=	173
12	=	177
14	=	181
15	=	182
17	=	185
20	=	189
23	=	193
25	=	195
30	=	198
35	=	203
40	=	205
50	=	211
60	=	216
70	=	227
80	=	235
90	=	243
99	=	255

AMD (amplitude modulation depth)

DX7		CX5M
10	=	2
20	=	4
30	=	6
40	=	8
50	=	10
60	=	12
70	=	14
80	=	16
90	=	18
99	=	20

PMD (pitch modulation depth)

DX7		CX5M
1	=	1
2	=	5
3	=	10
4	=	15
5	=	20
7	=	30
10	=	40
15	=	50
20	=	60
25	=	70
30	=	80
35	=	90
40	=	100
45	=	110
50	=	120
55	=	127

AMS
(amplitude modulation sensitivity)

DX7		CX5M
1	=	1
2	=	2
3	=	3

PMS
(pitch modulation sensitivity)

DX7		CX5M
1	=	3
2 & 3	=	4
4	=	5
5 & 6	=	6
7	=	7

Wf (waveform)

DX7	CX5M
Saw up (or Saw down)	= 0
Square	= 1
Sine or Triangle	= 2
Sample & Hold	= 3

Note: The LFO speeds for Sample and Hold waveform on the CX5M are about half as fast as those of the other waveforms on the CX5M. To figure the correct LFO speed on the CX5M for the Sample and Hold, subtract an additional 120 from the CX5M LFO speed given above. *Example*: If DX7 LFO speed = 10 and thus the CX5M LFO speed = 173, then for Sample and Hold (only) on the CX5M, the correct value would be 53 (or, 173 – 120 = 53).

F (frequency of operator)—Values for frequency are the same for both the DX7 and the CX5M. If an inharmonic frequency (fine tune) is used in a DX7 operator, find its exact match in the table in the CX5M's FM Voicing Program manual or else use just the fundamental frequency value. *Example:* If a DX7 operator has a frequency value of 5.12, then use just the value of 5 in the corresponding CX5M operator.

Envelope generator—Depending on the DX7's EG rate and level values for each operator, use the relevant formula given below in determining the correct EG to use for each CX5M operator. (Conversion tables follow)

On the DX7, if Rate 2 = 99, Level 1 = Level 2, and Level 3 = 0, then:

DX7	CX5M
Rate 1 =	Attack
Rate 3 =	1st-Decay
	Sustain = 0 (always)
	2nd-Decay = 0 (always)
Rate 4 =	Release

On the DX7, if Level 1 = Level 2 and Level 3 does not equal zero, then:

DX7	CX5M
Rate 1 =	Attack
Rate 3 =	1st-Decay
Level 3 =	Sustain
	2nd-Decay = 0 (always)
Rate 4 =	Release

On the DX7, if Level 1 is greater than Level 2 and Level 3 does not equal zero, then:

DX7	CX5M
Rate 1 =	Attack
Rate 2 + Rate 3 ÷ 2 =	1st Decay
Level 3 =	Sustain
	2nd-Decay = 0 (always)
Rate 4 =	Release

On the DX7, if Rate 2 is less than 99, Level 1 = Level 2, and Level 3 = 0, then:

DX7	CX5M
Rate 1 =	Attack
Rate 2 =	1st-Decay
	Sustain = 15 (always)
Rate 3 =	2nd-Decay
Rate 4 =	Release

On the DX7, if Level 1 is greater than Level 2 and Level 3 = 0, then:

DX7	CX5M
Rate 1 =	Attack
Rate 2 =	1st-Decay
Level 2 =	Sustain
Rate 3 =	2nd-Decay
Rate 4 =	Release

On the DX7, if Level 1 is less than Level 2, then:

DX7	CX5M
Rate 1 + Rate 2 ÷ 2 =	Attack
Rate 3 =	1st-Decay
Level 3 =	Sustain
	2nd-Decay = 0 (always)
Rate 4 =	Release

Continued on page 10

Using these conversion tables, many DX7 voices can be simplified and "translated" for use with the CX5M's internal FM tone generator.

EG conversion tables—For use with EG formulas given earlier:

Attack rate			1st-Decay & 2nd-Decay Rate		
DX7		**CX5M**	**DX7**		**CX5M**
15	=	1	10	=	1
18	=	2	13	=	2
21	=	3	16	=	3
24	=	4	19	=	4
27	=	5	21	=	5
32	=	6	24	=	6
34	=	7	27	=	7
38	=	8	30	=	8
40	=	9	33	=	9
44	=	10	36	=	10
47	=	11	39	=	11
50	=	12	42	=	12
54	=	13	45	=	13
57	=	14	48	=	14
60	=	15	51	=	15
64	=	16	54	=	16
67	=	17	57	=	17
70	=	18	60	=	18
74	=	19	63	=	19
77	=	20	66	=	20
80	=	21	69	=	21
83	=	22	72	=	22
85	=	23	75	=	23
87	=	24	78	=	24
89	=	25	81	=	25
91	=	26	84	=	26
93	=	27	87	=	27
95	=	28	90	=	28
96	=	29	93	=	29
98	=	30	96	=	30
99	=	31	99	=	31

Sustain Level			Release Rate		
DX7		**CX5M**	**DX7**		**CX5M**
35	=	1	21	=	1
39	=	2	27	=	2
44	=	3	32	=	3
48	=	4	38	=	4
53	=	5	43	=	5
57	=	6	49	=	6
62	=	7	54	=	7
66	=	8	60	=	8
71	=	9	65	=	9
75	=	10	71	=	10
80	=	11	76	=	11
84	=	12	82	=	12
89	=	13	87	=	13
93	=	14	94	=	14
99	=	15	99	=	15

Output level of operator—Add 28 to the output level of each DX7 operator to get the output level for each CX5M operator. *Example:* If the DX7 operator #1 has an output (volume) level of 50, then the correct value for the operator with the same position (but not necessarily the same number) in the CX5M algorithm is 78.

Detune		
DX7		**CX5M**
+1	=	+1
+2	=	+2
+3 to +7	=	+3
-1	=	-1
-2	=	-2
-3 to -7	=	-3

Ks (key scaling)			Kd (key scaling down)		
DX7		**CX5M**	**DX7**		**CX5M**
Right & -LIN	=	0	1 & 2	=	1
Left & -LIN	=	1	3, 4, & 5	=	2
			6 & 7	=	3

Rk (rate key scaling depth)—CX5M keyboard scaling depths left and right are figured for a DX7 breakpoint of C3 (Middle C). For DX7 break points higher or lower than C 3, adjust CX5M keyboard scaling depth by ear.

LEFT (key scaling)			RIGHT (key scaling down)		
DX7		**CX5M**	**DX7**		**CX5M**
20	=	1	10	=	1
30	=	2	12	=	2
38	=	3	14	=	3
44	=	4	16	=	4
48	=	5	18	=	5
52	=	6	21	=	6
55	=	7	23	=	7
58	=	8	25	=	8
60	=	9	27	=	9
62	=	10	30	=	10
64	=	11	32	=	11
66	=	12	34	=	12
67	=	13	36	=	13
68	=	14	39	=	14
70	=	15	41	=	15

CX5M System

THE CX5M MUSIC COMPUTER System now has a number of new components, designed to answer the needs of users who have asked for more flexibility and more capability.

One of the most important new items is the SFG05 FM digital tone generator unit. This new tone generator plugs into the computer's slide slot, replacing the original tone generator, the SFG01. The SFG05 is fully MIDI compatible, meaning that (unlike the SFG01) it can be controlled from an external source via MIDI. With the SFG05, the CX5M Music Computer can function as an inexpensive, multi-timbral MIDI expander module.

If you are already a CX5M user, it is also possible to have your SFG01 tone generator unit upgraded to meet the specifications of the SFG05. Eddy Reynolds Keyboard Service has been authorized by Yamaha to update or exchange SFG01 units from existing CX5M customers, so that they can have the SFG05 functions without having to purchase the unit outright. This service will cost $55.00, including shipping and owner's manual. (For further information, write to: Eddy Reynolds Keyboard Service, 4247 Kraft Ave., Studio City, CA 91604; or call 818-508-7983).

The CX5M now also has disk drive storage capability. Two disk drives are now available, both of which use 3.5″ disks. The FD03 single-sided disk drive comes complete with controller, while the FD05 double-sided disk drive must be purchased in conjunction with the FD051 disk drive controller. All CX5M programs in the 300 series and the 500 series are fully compatible with these new disk drives.

For ease in programming and operator, the CX5M may also be equipped with the new MU01 Mouse. Many of the CX5M programs in the 300 and 500 series are fully compatible with Mouse operation.

New music programs include the YRM305 DX21 Voicing program (which can be used with the DX21, DX27, and DX100 FM digital synthesizers), and updated versions of earlier programs (which will function with the new disk drives and the Mouse).

In addition, there are now some Yamaha programs that go beyond the sphere of music. These are designed to make the CX5M more useful as a general-purpose work station. The new STC01 Teleword package (word processor/phone modem module) is an expansion device that plugs into the computer's slide slot.

New Products For The CX5M Music Computer System.

For more detailed product information, write to Yamaha International Corp., P.O. Box 6600, Buena Park, CA 90622.

Together with the TWE01 Teleword Enhancement program, the Teleword module opens up the world of word processing and modem communication to the CX5M user. There is also the new GAR01 Graphic Artists program, which gives the CX5M increased power to produce graphics and illustrations.

Many of these new products are pictured on this month's cover. Below you will find a list of all currently-available CX5M peripherals, programs, and accessories, complete with the current suggested retail price. As you can see, the power and flexibility of the CX5M Music Computer System is growing rapidly!

Computer & Peripherals

CX5M $469.00
MSX based music computer; internal FM tone generating system with 4 operators, 8 algorithms, 8-note polyphonic.

SFG05 $120.00
MIDI-compatible FM tone generator unit.

STC01 $345.00
Teleword Word Processor/Phone Modem module.

YK01 $100.00
44-note mini-keyboard for use with the CX5M.

YK10 $200.00
49-note standard-size keyboard for use with the CX5M.

FD03 $345.00
Single-sided 3.5″ disk drive with controller.

FD05 $345.00
Double-sided 3.5″ disk drive *without* controller. Must be used in conjunction with the FD051 disk drive controller.

FD051 $150.00
Disk drive controller for use with the FD05 disk drive.

MU01 $65.00
Mouse input/controller device.

PN101 $345.00
Dot impact printer for use with the CX5M.

CB01 $30.00
Printer cable.

PN101PF $30.00
Pin-feed adapter for the PN101.

PN101RB $10.00
Printer ribbon for the PN101.

RF02 $50.00
RF adapter for connecting the CX5M to a standard television set.

Continued on page 12

CX5M System

Continued

VC02 $10.00
Video cable for connecting the CX5M to a CRT monitor.

CA01 $25.00
Single cartridge adapter, to allow connection of a second cartridge via the CX5M's back port.

UDC01 $75.00
Blank data memory cartridge.

Programs & Cartridges

YRM101 $50.00
FM Music Composer program.

YRM102 $50.00
FM Voicing program, for use with the CX5M's internal FM tone generating system.

YRM103 $50.00
DX7 Voicing program.

YRM104 $50.00
FM Music Macro program.

YRM105 $50.00
DX9 Voicing program.

YRM301 $55.00
MIDI Recorder program.

YRM302 $55.00
RX Editor program.

YRM305 $55.00
DX21 Voicing program.

YRM501 $55.00
FM Music Composer II program.

YRM502 $55.00
FM Voicing II program.

YRM504 $55.00
FM Music Macro II program.

TWE01 $55.00
Teleword Enhancement program.

GAR01 $50.00
Graphic Artists program.

CMW31 $50.00
Keyboard Chord Master program.

CMW32 $50.00
Keyboard Chord Progression program.

CMW33 $50.00
Guitar Chord Master program.

FVD01 $20.00
FM Voice data cassette tape #1.

FVD02 $20.00
FM Voice data cassette tape #2.

CP60M

The CP60M Electro/Acoustic Piano And MIDI.

THE CP60M electro/acoustic piano is one of a new series of instruments equipped with MIDI. Since the sound of the instrument is generated acoustically and then amplified, it is of course impossible to control the CP60M from another MIDI keyboard—that is why the unit only has a MIDI OUT port.

However, it is precisely the fact that the CP60M is acoustic that gives it a unique place among MIDI instruments. Instead of approximating the action of an acoustic piano with weighted, wooden keys, the action of the CP60M *is* an acoustic piano action. For experienced piano players, the difference will be obvious: With the CP60M, you have the responsiveness and tactile feedback of an acoustic piano action, connected (via MIDI) to the tone-generating circuitry of a synthesizer.

The basic setup is simple: Just connect the MIDI OUT of the CP60M to the MIDI IN of the synthesizer you wish to control, and begin playing. To get the full feeling of the effect, turn the volume of the CP60M down, so that you are only listening to the sounds coming from the synthesizer. You should notice an immediate difference in the kind of responsiveness the keyboard gives you (as compared to a plastic or weighted-wooden action).

To take full advantage of the keyboard's nuance, choose patches in which velocity sensitivity plays a large part. After working with your synthesizer sounds for a while, you may find yourself adjusting some of the velocity sensitivity settings to maximize the response characteristics of the acoustic piano action.

Unlike the other pianos in the CP-MIDI series, the CP60M comes in one piece. The keyboard folds up into the body of the instrument, and the entire unit is on casters for easy transportation. If you are interested in playing your synthesizers the way you play acoustic piano, the CP60M could be just what you're looking for.

MIDI

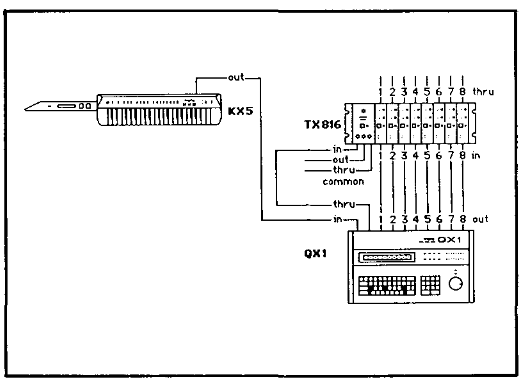
Understanding The Four Basic MIDI Modes. By Tom Darter.

AS INFORMATION travels down a MIDI cable, it may be sent to (or through) a number of instruments; but each instrument may respond to this information differently, depending on how it has been set to operate. In other words, MIDI instruments have a number of different modes of operation, and these modes determine how the instrument will react to MIDI information. Along with MIDI channels [explained in last month's MIDI article], the MIDI modes are the most important elements that contribute to MIDI's ability to perform musical sleight-of-hand.

Most basic MIDI information (such as a "note-on" or "note-off") comes complete with an informational "flag" that assigns it to one of the 16 MIDI channels. For instruments receiving this information, there are two possibilities—either the instrument will be assigned to recognize and respond to information on one specific MIDI channel, or it will be assigned to respond to *all* MIDI information, regardless of channel. This second condition is called "OMNI."

When an instrument is *not* set up in OMNI, it responds only to information on the MIDI channel to which it is assigned. In addition, it may respond to this channel information in different ways, depending on whether it is set up to act like a POLYphonic instrument or a MONOphonic instrument.

All in all, there are four MIDI Modes—four different ways that an instrument may respond to incoming MIDI information. These four



Here is a basic setup using MIDI Mode 3 with the TX816. Each module of the TX816 should be set (in Mode 3) so that its MIDI channel matches the MIDI channel of the QXI MIDI OUT terminal to which it is connected.

modes are specified by different combinations of the three MIDI mode messages outlined above: OMNI, POLY, and MONO. The combinations are pretty obvious, based on two simple conditions: An instrument can be in OMNI or not, and it may be either POLYphonic or MONOphonic. With these conditions in mind, the four MIDI modes are easy to understand. Here they are:

Mode 1: OMNI ON, POLY. An instrument in Mode 1 will respond to MIDI information sent over *any* of the 16 MIDI channels. This mode is sometimes called OMNI mode.

Mode 2: OMNI ON, MONO. This mode assigns MIDI information sent over any of the 16 MIDI channels to *one voice*. When set in this mode, an instrument will always play monophonically (one note at a time), no matter how much information is being sent over the various MIDI channels.

Mode 3: OMNI OFF, POLY. In this mode, an instrument will only respond to the MIDI information being sent on the channel to which it is assigned. Mode 3 is also known as POLY mode.

Mode 4: OMNI OFF, MONO. In this mode, an instrument will only respond to MIDI information being sent on the channel to which it is assigned, and it will respond to that information monophonically. Mode 4, also known as MONO mode, is most often used in multi-timbral instruments, where each voice can be assigned to a separate MIDI channel.

Since most synthesizers today are polyphonic, Mode 2 (OMNI ON, MONO) is the least common of the four. Mode 3 (OMNI OFF, POLY) is the most common, especially when a number of instruments are being used with a sequencer. The basic operation of the TX816 with the QX1, for example, will most often involve Mode 3.

In the early days of MIDI, many instruments were programmed so that they were in OMNI mode when turned on. This basic "default" setting is still quite common, though not as much as it was at the beginning of MIDI. The DX7, for instance, functions in POLY mode (MODE 3), and, when turned on, is initially assigned to MIDI channel 1.

As mentioned above, Mode 4 (ONMI OFF, MONO) is usually reserved for use with multi-timbral instruments such as the Oberheim Xpander. Each of the Xpander's six voices operate like a complete monophonic synthesizer. By assigning each voice to a different MIDI channel, it is possible create multi-timbral polyphony by controlling the Xpander with a multi-channel MIDI sequencer.

So, there is the story of the four MIDI Modes. They determine how any given MIDI instrument will respond to information sent on the 16 MIDI channels.

CX5M/RX

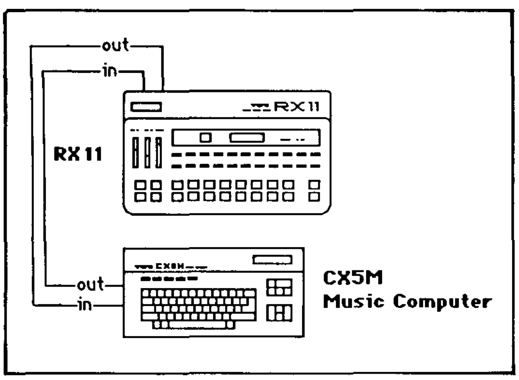
Use The CX5M As A Sophisticated PATTERN And SONG Programmer For The Percussion Sounds In The RX11 And RX15. By David Lourik.

THE RX11 IS A VERY sophisticated rhythm programming device; it can also be difficult to program. There are many variable functions, many more than can be easily displayed through the instrument's front panel.

The YRM302 RX Editor program for the CX5M gives you the full power and convenience of the CX5M Music Computer and its associated peripherals, all dedicated to the task of programming rhythm patterns and song chains for the drum and percussion sounds that reside in the RX11 and RX15.

In other words, the RX Editor program and the CX5M *replace* the RX11's internal PATTERN and SONG program functions. Although the basic approach to programming with the RX Editor is the same as that of the RX11's internal programmer, you will find that the CX5M/RX Editor package will give you more programming flexibility, in addition to providing you with all the operational advantages of the monitor display screens and the various CX5M peripheral devices.

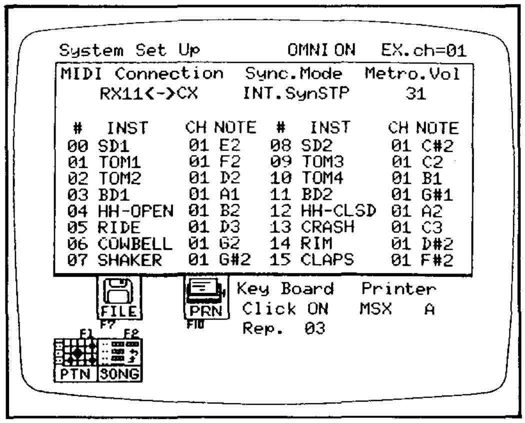
There are two basic operational setups, which are referred to in the RX Editor owner's manual as System 1 and System 2. System 1 uses just the RX unit and the CX5M, and is straightforward: Connect the MIDI OUT of the CX5M to the MIDI IN of the RX, and connect the MIDI OUT of the RX to the MIDI IN of the CX5M (see the accompanying diagram). System 2 allows you to input data using a MIDI keyboard such as the DX7: Connect the MIDI OUT of the DX7 (or other MIDI keyboard) to the MIDI IN of the CX5M, and connect the MIDI OUT of the CX5M to the MIDI IN of the RX unit (see the accompanying diagram).



Basic MIDI connections for using the RX Editor program.

The function keys F1, F2, F6 (SHIFT plus F1), and F7 (SHIFT plus F2) are used to select each of the four main display screens, as follows: F1 selects the Pattern Editor display, F2 selects the Song Editor display, F6 selects the System Set Up display, and F7 selects the Filer display. Other function keys select options such as Real Time Write mode (F4), Play mode (F5), and Print mode (F10). All of these options can also be selected by moving the cursor to the appropriate icon (on any of the screen displays) and then pressing the RETURN key.

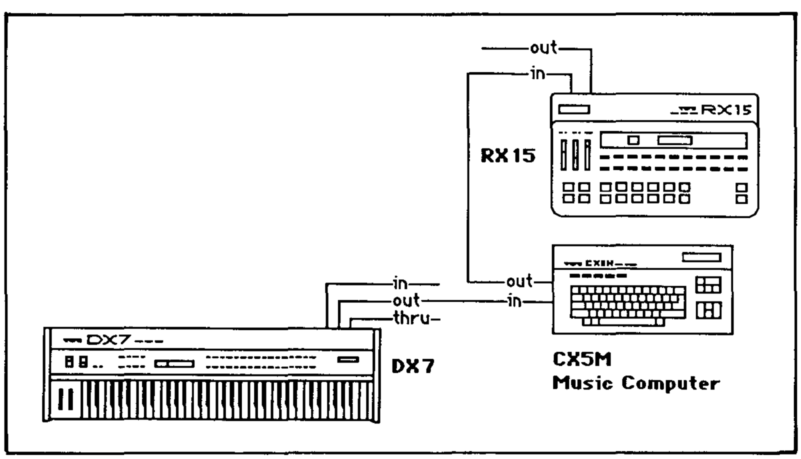
The real core of the RX Editor can be seen most easily by looking at the major screen displays. They can give you a quick idea of the options available, and can also show you the advantages of programming drum patterns and songs via the CX5M.



System Set Up screen display of the YRM302 RX Editor program.

The System Set Up display allows you to tell the computer which system configuration you are using (System 1 or System 2), and which RX unit you are using (RX11 or RX15). You also make a number of other basic operational choices using this screen, such as the MIDI transmission channels for each percussion instrument sound, the MIDI key number for each instrument sound, performance clock selection, metronome volume, and so on.

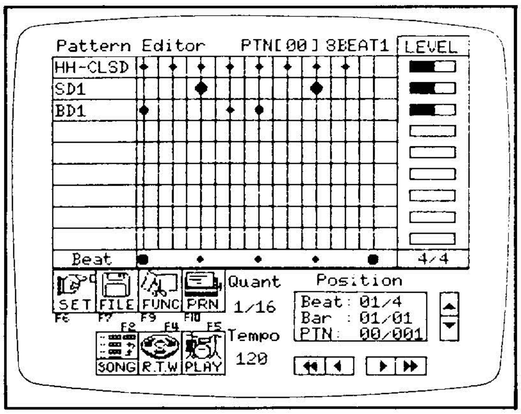
The Pattern Editor screen gives you access to the functions of Pattern Editor mode. This



Basic MIDI connections for using the RX Editor program with a MIDI keyboard as an input device.

mode allows for the sectional input of rhythm patterns. You begin by choosing a pattern number (00-99) and giving it a name. Then you determine the time signature and the number of bars in the pattern. There can be from 1 to 99 beats per bar (the top number in the time signature), and the beat duration (the bottom number in the time signature) can be 4, 6, 8, 12, 16, 24, or 32, giving you a range from quarter-notes to thirty-second-notes. Each pattern can be as short as one bar, or as long as 95 bars.

The Pattern Editor screen display also allows you to specify (and see) the output LEVEL and the position in the stereo image



(PAN—for the RX11 only). these settings can be memorized for each pattern.

Most obviously, the Pattern Editor display allows you to *see* your drum pattern in graphic form. Notes can be entered either directly onto the computer screen, or by pressing the RX11 instrument buttons or a MIDI keyboard (Real Time Write mode). Remember that input from a MIDI keyboard is possible with the System 2 configuration only.

Other Edit functions allow you to specify the MIDI velocity (and therefore the volume) of each note over a range from 1-8. The timing of each individual note can also be moved backward or forward in intervals of 1/96 (96th-notes).

The Song Editor screen display allows you to combine PATTERNS (created in Pattern Edit mode) into a single longer sequence, or SONG. However, the SONG Edit mode allows you to do much more than simply string groups of patterns together: The instrument LEVELS, the tone variation of the various sounds, and the tempo can be altered during the course of a song. You may also specify a number of different PATTERN repetition modes.

CX5M music computer.

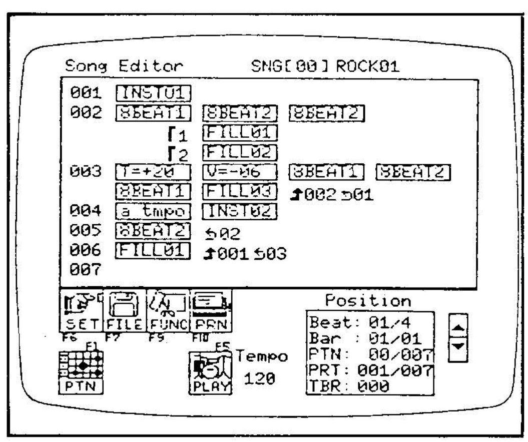
Pattern Editor screen display of the YRM302 RX Editor program.

Song Editor screen display of the YRM302 RX Editor program.

All of these operations can be performed in conjunction with the MU01 Mouse, which makes it easy to move around on each screen display, make choices, and enter data in various ways. The PN101 printer can be used to make hard copy versions of any of the screen displays (which allows you to keep a permanent printed record of your various PATTERNS and SONGS).

Finally, you have a number of storage options for the PATTERNS and SONGS you create using the RX Editor. You can use a cassette recorder to store data onto a cassette, or you can load your creations into a UDC01 data memory cartridge. Using the FD05 or FD03 floppy disk drive, you can store your material on 3.5″ floppy disks. And you can also load songs and patterns into your RX unit, for playback in those situations where the CX5M is not available.

As you can see, the YRM302 RX Editor program gives you a great deal of flexibility, visual feedback, and precise control over the nuances of rhythm PATTERN and SONG programming.



REV7

User Programmability And MIDI Control Of The REV7 Digital Reverb. By Tom Darter.

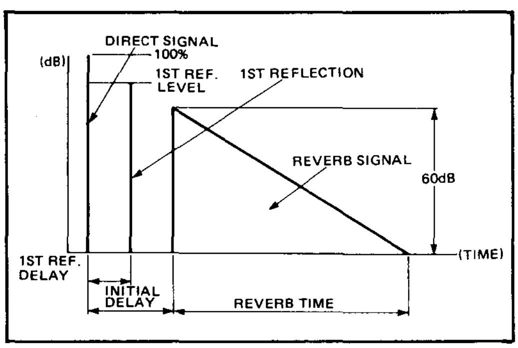
THE REV7 Professional Digital Reverberator is a programmable, MIDI-controllable signal-processing device with stereo output. It offers a wide variety of reverb, echo, delay, and ambient effects.

The 30 preset programs in the REV7 can be divided into the following basic types: REV (reverb), E/R (Early Reflection), DELAY, ECHO, and MOD (Modulation Type, including Phase, Chorus, and Flange effects). Each of these presets can be edited by the user, and the resultant new effect can be stored in one of the 60 user-programmable memory locations. This gives a total of 90 different programs stored in the REV7's internal memory.

All user programs must be created by starting from one of the 30 presets. Each type of preset program has its own specific set of programmable parameters.

As with instruments like the DX7, "parameters" in the REV7 are the separate, individual elements that make up each effect. There are two types of parameters in the REV7—"invisible" parameters (non-programmable, fixed-value parameters) and programmable parameters (ones that you can modify). Because of this, you may find that you can set all of the programmable parameters of two different presets to the same value, and the resulting effects will still not be the same, due to differences in the non-programmable parameters.

Each preset type has up to 7 programmable parameters. As you might expect, these programmable parameters differ from one preset type to another. Here are the 7 programmable parameters for the REV Type presets:

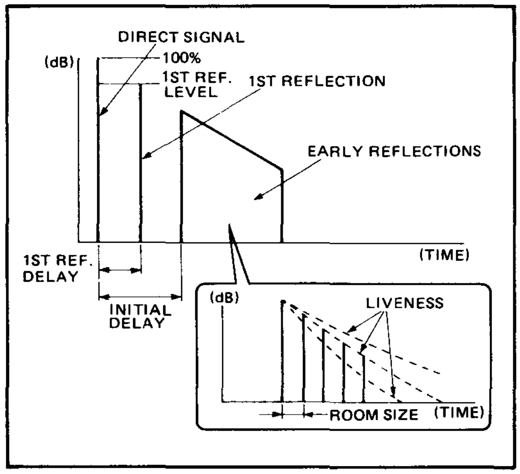


Basic parameters for reverberation effects.

1) Reverberation Time
2) Initial Delay
3) 1st Reflection Delay
4) 1st Reflection Level
5) Hi Reverb Time
6) Low Reverb Time
7) Diffusion

And here are the 7 programmable parameters for E/R Type presets:

1) Initial Delay
2) 1st Reflection Delay
3) 1st Reflection Level
4) Liveness
5) Room Size
6) Diffusion
7) Mode



Basic parameters for "early reflection" effects.

By the way, the "Mode" parameter in the E/R Type of preset is a special case, one that allows you to choose between 6 different operational modes: 1) Small Hall; 2) Large Hall; 3) Random; 4) Reverse; 5) Plate; and 6) Spring. The name of each mode indicates a typical environment or effect, but only the early reflections typical of that environment or effect are created in this type of preset.

Each one of the REV7's 30 presets is designed to create a specific kind of effect; in most cases, a number of "invisible" (non-programmable) parameters are involved in the creation of these specific effects. By keeping many of these values fixed, the effect will always retain its basic character, while the 7 programmable parameters will allow you to adjust the effect to suit your needs without altering the fundamental character of the effect. You could think of each one of the presets as being a dedicated, stand-alone signal processor with up to 7 front panel controls. The REV7 gives you 30 of these, each with its own set of controls.

To understand this more clearly, let's look at preset #1, "Large Hall," which is a REV Type of effect. For each one of the 7 programmable parameters, here are the settings that create "Large Hall," followed by the overall range of

REV7 digital reverberator.

each parameter:

1) Reverberation Time, 2.6 seconds; overall range, 0.3-10.0 seconds.

2) Initial Delay, 30.0 milliseconds; overall range, 0.1-100.0 milliseconds.

3) 1st Reflection Delay, 10.0 milliseconds; overall range, 0.1-100.0 milliseconds.

4) 1st Reflection Level, 0%; overall range, 0%-100%.

5) Hi Reverb Time, 0.3 times the mid-frequency reverb time; overall range, 0.1-1.0 times the mid-frequency reverb time.

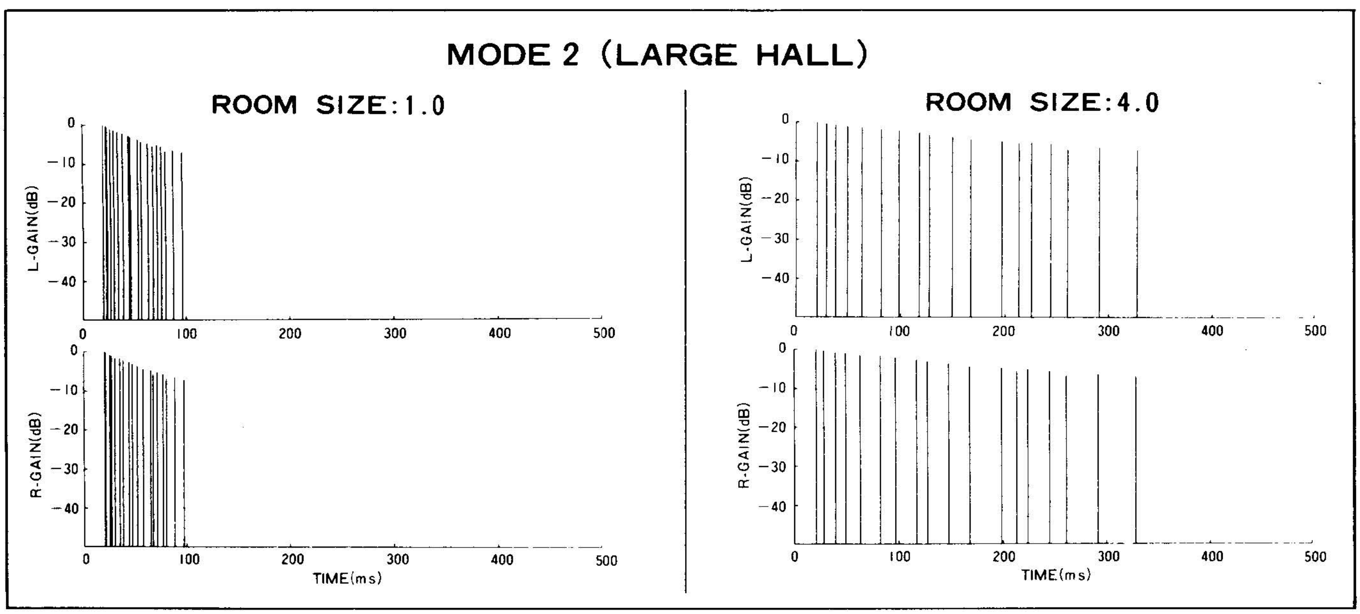
6) Low Reverb Time, 1.2 times the mid-frequency reverb time; overall range, 0.1-2.4 times the mid-frequency reverb time.

7) Diffusion, 5; overall range, 0-10.

As you can see, this preset offers you a great range of parameters settings. Using preset #1 as a starting point, you can define a number of different "large halls."

In addition to its programmable features, the REV7 also offers MIDI control of program selection. It can be set to respond to any one of the 16 MIDI channels (or to OMNI mode), and each one of the 90 internal programs can be programmed to respond to a specific MIDI Program Select number. Using this capability, you will be able to tie specific signal processing effects to specific voice programs in your synthesizer.

By getting to know the presets in the REV7, you can learn how to alter them to create your own kinds of ambient effects; through MIDI, these effects can then become an integral part of one or more of your synthesizer voices, giving you an entirely new level of sound programming.



This chart shows the exact number of type of early reflections created by the REV7 in Mode 2 (large Hall), for Room Sizes of 1.0 and 4.0.

Final Touch

Hot Tips On Preprogramming RX11 Song Tempos, And Programming RX Drum Patterns Via The QX1.

Pre-Programming Tempos With The RX11 Rhythm Programmer.

By Jim Mancuso.

When I first started using my RX11 live, the only problem I had was setting the tempos between songs. I didn't have a lot of time to fine tune the tempos, so I needed a system by which I could somehow preset the tempo so that all I had to do was select the SONG number, push START, and go. After much experimentation, here is what I came up with:

Let's say, for example, that I need to play a song at 125 bpm [beats-per-minute]. First of all, make sure that the machine is always set at 100 bpm using the coarse tune slider. You only have to do this once each time the unit is set up and turned on. All tempos are then preset (using 100 bpm as a starting point) using the TEMPO CHANGE function in the SONG EDIT mode.

Use the following procedure to preprogram a song to playback at 125 bpm:

1. Designate an unused pattern to read 1 bar of 1/32 time and leave it blank. I use pattern 99 so I always know where it is.

2. In the SONG EDIT mode, assign PART 1 to PTRN 99.

3. Enter TEMPO CHANGE mode. Advance using the +1/YES button until the display reads: "TEMPO UP +25." Exit the TEMPO CHANGE mode.

4. Advance to PART 2 in SONG EDIT mode and program the rest of the song as normal.

5. After the last pattern at the end of the song, enter TEMPO CHANGE mode and advance using the -1/NO button until the display reads: "TEMPO DOWN -25." Exit the TEMPO CHANGE mode.

This is what happens: The machine should always be "preset" to 100 bpm. When the START button is pressed for the song entered above, the machine is commanded to raise the tempo to 125 bpm. The entire song is played at 125. At the end of the song, the machine is commanded to return to 100 bpm and is therefore back to the "preset" value before the next song.

You may find it easier to program the song first and then program in the tempo change at the beginning by using the INSERT function. This saves you the time of having to reset the tempo every time you listen to your song while programming.

This method does not make it impossible to program tempo changes within the song; you just take them into account when programming the final Tempo Change back to the preset value of 100 bpm. For example, if the tempo of the song ends up at 60 bpm becvause of a ritard, then the final TEMPO CHANGE command should be "TEMPO UP +40," which returns the machine to 100 bpm prior to the next song.

* * * *

Building Up RX Drum Tracks With The QX1.

By Gary Leuenberger & David Bristow.

There are basically three ways to control the RX Series rhythmn controllers with the QX1:

1. Fill the RX internal memory with PATTERNS/SONGS and simply use MIDI CLOCK from QX1 terminal #8 to run the drum machine.

2. Fill the RX internal memory with PATTERNS/SONGS and record that data onto a track of the QX1. Do this by taking the QX1 OUT #8 into the RX; assign the RX to MIDI CLOCK; take the OUT of the RX into the IN of the QX1 and record the data.

3. Play the RX live from a DX or KX keyboard and RECORD that info into the QX1.

We find method 3 most effective. Here is a basic technique that works well for us, and gives us a nice way of building up drum tracks step by step. (Of course, when you play the RX instruments from an external keyboard via MIDI you also get the added benefit of *velocity* on the drums; the QX1 records and plays back this velocity information.) Here is our basic procedure:

1. To start with, connect the DX/KX MIDI OUT to the QX1 MIDI IN, and the QX1 MIDI THRU to the RX MIDI IN.

2. RECORD on TRACK 8. On this first pass, we lay down the foundation—basically KICK and SNARE, maybe a few HI HATs. For playback, diisconnect the RX from the QX1's MIDI THRU, and connect the QX1's MIDI OUT #8 to the RX MIDI IN. Then PLAY and determine if any QUANTIZE is needed to tighten up this "foundation" part.

3. Now to overdub. Since TRACK 8 is nice and tight, why screw it up with bad overdubbing? It is much safer to do overdubs on other tracks, and then mix them all together when you are sure. Unfortunately, you cannot hear what you've done and play the RX at the same time, as there is only one MIDI IN on the RX. What you must do (short of having two RX units) is to become familiar with which notes on the DX/KX keyboard correspond to which drum sounds. If you have time, create sounds on your TX modules that are close to the RX sounds, or at least have similar envelopes. Then as you overdub on a new track you can trigger the module and hear something in the correct ballpark while TRACK #8 is playing the basic track on the RX. With all of thiis in mind, try recording the notes for a cowbell on track #7.

QX1 digital sequence recorder.

4. To hear the results on the RX while still maintaining separate tracks, simply assign track 7 to Terminal #8 [Job Command 03] and both tracks will play the proper RX voices.

5. Continue to build tracks, assigning each to Terminal #8 for proper playback. Now each individual track can be independently edited and quantized until the final results are achieved.

6. When the part is to your liking, simply TRACK MIX all tracks down to track 8 and the drums are done!

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If you've got a hot tip on applications or use, send it along. If we use it, you'll receive full editorial credit, plus a check for $25.00.

Do you have a great new DX7 patch, a CX5M program, or a great pattern for the RX11? Send them in—we'll pay $25.00 for each one used.

By the way, we cannot assume liability for the safe return of unused ideas, patches, or manuscripts. We will only be able to return unused material to you if you enclose a self-addressed, stamped envelope with your material.

If you just have a question regarding the use of Yamaha professional products, send it along too, and we'll do our best to answer it in the pages of AFTERTOUCH. (We regret that we won't be able to answer questions through the mail, but we will use all of your questions to guide us in our choice of future topics.)

Finally, if you just want to get something off your chest, or if you'd like to establish direct contact with other X users, send something in to our letters column, "Touch Response." We'll do our best to print names and addresses of all those who are interested in starting up regional users groups.

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John Chowning

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rich interaction. I think we worked out some ways using the TX816 to create some very good piano sounds. It's not a question of trying to replicate exactly, but to produce a sound where the feeling for the player and the listener both is piano-like. And I think we succeeded.

TD: *Did you find yourself using the full resources of the 816?*

JC: Right. For example, the various modules were assigned to different parts of the keyboard. That is a nice way to get around the 16-voice polyphonic limit in the DX series, because as you know in typical piano music low tones sustain for a long time but they're also played less often. By assigning a small number of bass notes to the first module, a few more to the second, a few more to the third, etc., you build up a system where there are beating effects, which helps the pianolike-ness of the sound. You can create a sonic form in which most of the piano literature will work, at least, and some of it quite well. The bass tones don't go away prematurely.

TD: *Is it easier to get bass piano tones because there is only one string down there?*

JC: I don't think so. The inherent richness of the tones is so great that we don't hear it in such a subtle way. I think that is probably the biggest reason. It's easier to make the ear think it's hearing a low piano sound. Even though there is only one string, the complexity of vibration is probably greater than in the midrange.

TD: *Is that because of the wrapping and the size of the string?*

JC: Yes. It's pretty mysterious. Piano's a hard instrument. The sound is so well known, probably second only to the human voice.

TD: *What is your feeling about the potential use of the DX7 as a teaching tool, not only for FM theory, but for things like acoustics?*

JC: I think there is a great potential. Many basic acoustic phenomena can be demonstrated quite easily using the DX7. It could become an incredibly powerful tool for learning acoustics and psycho-acoustics at a very simple level.

Beating is one whole area. Using for instance algorithm #1, turn off all the operators except the two carriers. Listen to 1, now listen to 2, now detune 1 a little bit and hear beats; and if you increase the amount of detuning, it stops being amplitude modulation and becomes kind of a rough sound.

Residual frequencies is another area. Most people who work with synthesizers think that if they hear a pitch, then there has to be energy there. There's a nice experiment you can do with algorithm #32 where you generate harmonics 1, 3, 4, 5, 6, and 7; maybe with output levels that peak above the fundamental, so that 99 is at 6 or something. You listen to them all, and you hear a pitch at whatever key you're sounding. Now if you turn off operator 1 (which is supplying the 1st harmonic—the fundamental), then there is no more energy there, but if you sound the same key you still hear that pitch. There is no energy at the pitch at which one hears it. It has to do with the harmonics and the largest common denominator, I guess. That can be very nicely explained using algorithm #32.