

SECRETS OF THE YAMAHA FB-01

Discover how the power of System Exclusive codes can reveal the hidden potential of this low-cost FM sound module.

by Jim Johnson



For MIDI musicians on shoe-string budgets, the Yamaha FB-01 is one of the most popular synthesizers around. While its 4-operator architecture doesn't produce the sound quality of its 6-op brothers, its multi-timbral capabilities make it terrific for anyone who wants to make lots of music for a little money. But, you get what you pay for, and a budget synth like this couldn't possibly have the versatility and features of a more expensive instrument. Or could it?

As a matter of fact, once you master the secrets of the FB-01's System Exclusive codes, you can make it (and its cousin, the IBM Music Feature, which includes an FB-01 sound generation chip, a MIDI interface, and other features on an IBM card) change voice, configuration, and system parameters, play microtonal scales, and introduce you to serious MIDI programming.

The FB-01's hidden features are thoroughly documented on pages 45 through 57 of its manual, but an unhappy combination of poor translation, inconsistent numbering systems, and just plain errors make this material just about incompre-

hensible to anyone lacking an advanced engineering degree or, at least, experience with MIDI. Having tons of the latter, I dug some sense out of the manual and would like to pass along a few simple FB-01 Sys Ex applications. If you've never worked with System Exclusives, check out "Fun with System Exclusives" in the March 1987 **EM**.

MESSAGE TYPES

The FB-01 has four types of System Exclusive messages.

- **Data dumps**, which contain entire configurations, voices, or voice banks, are only of interest if you're writing an FB-01-specific editor/librarian.

- **Request messages** tell the FB-01 to start a data dump. If you have a generic librarian program or Sys Ex storage device, you'll want to explore these messages, but they're straightforward enough that we don't need to discuss them here.

- **Microtonal tuning messages**, which Yamaha calls "fractional tuning" messages, are potentially the most exciting aspect of the FB-01 for some musicians, but are so bizarrely implemented as to be virtually

useless in most situations.

- **Parameter changes**, which allow you to program the FB-01's front panel settings remotely, are the most immediately useful to a musician. They let you manipulate single parameters from a sequencer or any controller that sends System Exclusive messages.

DEBUGGING THE DOCUMENTATION

The FB-01's Sys Ex documentation says the instrument uses three numbering schemes: binary (base 2), hexadecimal (base 16), and decimal (the familiar base 10). These all express the same thing but for different situations. Binary is useful for showing the status of each bit in the number; hexadecimal (hex) numbers are used when a byte's top four bits represent one quantity, the lower four another.

Since sequencers and controllers that send Sys Ex require you to enter numbers in either hex or decimal (but not both), you'll need to convert the numbers in the manual to one of these notation systems. After a few years' experience, it's not too tough to do this in your head, but in the meantime, use a programmer's calculator, like Casio's FX-590 or FX-450, with conversion functions. (Conversion tables offer too much chance for error, and your eyes won't be happy with all the squinting.) All the examples here use decimal notation.

The next paragraphs in the manual contain a glaring error that could plunge the uninitiated into hours of head-scratching. The MIDI Channel this document refers to is *not* the MIDI Channel we all know and love: it's the MIDI Channel minus one. The same goes for the system channel and the instrument number. (The system channel, by the way, is a method Yamaha and certain other companies use to differentiate among Sys Ex messages. Each Sys Ex message can be assigned to one of a number of FB-01s by imbedding a number from one to sixteen

in the message. Any instrument set to this system channel number will respond to the message.) The explanation for this odd numbering is that Yamaha lists the range of MIDI Channels as "0 to 15" for reasons that would only make sense to assembly language programmers. I won't go into details, but if you don't allow for this offset, the FB-01 won't recognize any of your messages. (For consistency, I use the true MIDI Channel and instrument numbers here.)

A confusing oversimplification found throughout the documentation is the equation: "x + y = data," where potentially large numbers are broken down into two bytes to fit into MIDI's 7-bit data format. If you're computer-literate, you probably realize that this doesn't represent simple addition, but a *binary concatenation*, where x and y are the upper and lower portions of the number. For those who are unfamiliar with computer jargon and don't want a fairly boring lecture on how large numbers are "nibblized," the corrected equations follow. On pages 48 and 49, the equation should read: "x*16 + y = data," and at the top of page 51, the equation should read "x*128 + y = data." Surprisingly, the equation at the bottom of page 51 is correct as it stands. Of course, since you'll be starting with the data value and working back to x and y, you'll need to do a little algebra to solve these equations; just remember that the maximum values for x and y are 15 for the first corrected equation and 127 for the second equation, and you'll be okay.

Finally, on page 49, the section in Table 3 labeled "Parameter Change by MIDI Channel" should be labeled "Parameter Change by System Channel."

CHANGING PARAMETERS WITH SYS EX

Three groups of FB-01 parameters can be changed with individual types of Sys Ex messages: voice parameters, configuration parameters, and system parameters. Parameters in the first two groups can also be changed either by MIDI Channel (if you are using only one FB-01 or if you have more than one on the same channel and want to make the same changes to both) or by system channel and instrument number (if you have more than one FB-01 or you stack two on the same channel but change their settings independently).

On pages 47, 48, and 52, the manual lists the information needed to change a configuration parameter, albeit some-

what haphazardly. Here's the same information in a more useful format:

Configuration Parameter Change by MIDI Channel

Value	Meaning
240	Start of Sys Ex
67	Yamaha ID
MIDI Channel +15	Substatus & Channel
21	Parameter Group
pp	Parameter Number (see below)
dd	Data Value
247	End of Sys Ex (EOX)

Configuration Parameter Change by System Channel and Instrument

Value	Meaning
240	Start of Sys Ex
67	Yamaha ID
117	Substatus
System channel -1	
Instrument # +23	
pp	Parameter Number (see below)
dd	Data Value
247	End of Sys Ex (EOX)

Configuration Parameters

#	Name	Range
0	Number of notes	0 - 8
1	MIDI Channel -1	0 - 15
2	Key limit (high)	0 - 127
3	Key limit (low)	0 - 127
4	Voice bank -1	0 - 6
5	Voice number -1	0 - 47
6	Detune	0 - 127
7	Octave +2	0 - 4
8	Output level	0 - 127
9	Pan	0, 64, 127 0 = Left
10	LFO enable	0 - 1
11	Portamento time	0 - 127
12	Pitch bend range	0 - 12
13	Mono/Poly	0 - 1 0 = Poly
14	PMD controller	0 - 4 0 = Off
		1 = Aftersustain
		2 = Wheel
		3 = Breath
		4 = Pedal
15	Unused	
16	LFO speed	0 - 127
17	AMD	0 - 127
18	PMD	0 - 127
19	LFO waveform	0 - 3
20	LFO load enable	0 - 1
21	LFO sync	0 - 1
22	AMS	0 - 3
23	PMS	0 - 7

You'll quickly understand how to condense and format the other tables in the back of the FB-01 manual.

There are plenty of ways you can use this information. Suppose you're using a configuration that stacks two sounds—a mellow lead and a nasty scrunch—on MIDI Channel 15, creating a 4-voice, polyphonic, composite sound. The scrunch is normally mixed much lower than the lead, but you'd like to bring it out more at one point. Assume the scrunch is instrument 2, the FB-01's system channel is 4, its initial volume is 50, and you'd like to change its volume to 100. Here is the string of bytes you send to make the change:

240 67 117 3 25 8 100 247

Since we only want to change *one* of two voices stacked on a single channel, the message we use is a "change by system channel and instrument" type. The MIDI Channel and the original volume setting are irrelevant in this case.

Spend a little time mulling over the tables I've presented and the originals in the FB-01 manual. You'll quickly understand how to condense and format the other tables in the back of the FB-01 manual like I did the first one. Here are a few more fully extracted Sys Ex messages and the page numbers where they're described, to serve as reference points.

Select voice bank 0 for the voice on MIDI Channel 5 (pages 48 & 52):

240 67 20 21 4 0 247

Select voice 48 for the voice on MIDI Channel 5 (pages 48 & 52):

240 67 20 21 5 47 247

Set Feedback to 7 and Algorithm to 1 for instrument 1, system channel 1 (pages 49 & 53):

240 67 117 0 24 76 3 8 247

Select configuration number X on system channel S (page 49):

240 67 117 (S-1) 16 34 (X-1) 247

FB-01 FRACTIONAL TUNING

About the time the FB-01 was released, synthesists began showing interest in microtonal tunings, sparked primarily by Wendy Carlos' *Beauty in the Beast* album. So Yamaha gave the FB-01 and most of its subsequent instruments the ability to play "between the notes." (If you're not familiar with alternate tunings, check out the four articles on the subject in the November 1986 *EM*, "Two Commodore 64 Alternate Tuning Programs" [October 1987], "Just Intonation on the New Yamaha Synths" [July 1988], and various "Letters" columns, especially Wendy Carlos's letter [February 1988]).

Apparently Yamaha didn't have much time to implement microtonal tunings in the FB-01. Later instruments, such as the TX81Z and DX7II, allow you to apply a number of different tuning systems to note messages received from MIDI (or the instrument's keyboard, in the case of the DX7II). The FB-01, however, requires a special Sys Ex message for each note outside the normal equal-tempered scale. The advantage of this system is that the musician is not tied to a single scale at any instant; notes can be played at any point in the instrument's frequency range. The disadvantage is that the FB-01 requires a specialized "driver" program to put out the appropriate Sys Ex messages for microtoned notes.

The details of the FB-01's fractional tuning scheme are discussed on pages 50 and 51 of the manual. This is how it works: Yamaha has created a set of "pseudo-

events" (my term) that correspond to several standard MIDI messages (Note On/Off, Pitch Bend, etc.) and are enclosed in a special System Exclusive "shell" that starts with a 4-byte header and ends with the EOX byte (247). The shell can contain as many messages as you'd like. The individual events are like their standard counterparts except Note On and Note Off messages have an extra byte called the "key fraction." This specifies the amount of frequency offset—or "detuning," if you will—for that note, in cents (1/100th of a semitone). There is also a special "Note On/Off with duration" event that allows you to send a complete note, including its length, to the FB-01, which then counts the incoming MIDI clocks and turns the note off at the appropriate time. You can insert whatever delays you like between individual events in the same message. This means that a complete sequence could be sent to the instrument with a single Sys Ex message, as long as you don't try to send any standard MIDI messages along with the Sys Ex stuff.

DOING IT

So how do you use the FB-01's fractional tuning system? There are basically three possible approaches.

First, you could directly program the appropriate System Exclusive messages into your sequencer, but I only recommend this for masochists. To give you an idea of what I mean, **Fig. 1** shows a short sequence, in Dr. T's *KCS*, that plays two

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notes, a quarter tone apart, separated by a quarter note (as indicated by the 24 in the Time column), using two "Note On/Off with duration" events in a single Sys Ex message.

Second, you could write a computer program that would analyze incoming MIDI data, convert them to the appropriate FB-01 Sys Ex messages, then send that data to the computer's MIDI Out port. (Alas, to the best of my knowledge, there are no commercially available programs that will do this.) This approach is probably the most flexible, but it requires a dedicated computer and proficiency in real-time (i.e., high-speed assembly language) programming.

Third, you could write a program that would analyze sequencer files and replace the standard MIDI events with the appropriate Sys Ex messages. This approach requires you to record your pieces in equal-tempered intonation, so it's really only useful for tuning systems that are fairly similar to the equal-tempered scale, such as just intonation or mean-tone tuning, rather than more exotic systems like quarter-tone scales or Balinese tuning. Still, if you want to explore microtonal tunings with the FB-01 and have only average programming chops, this might be the best way to go.

Much as I'd like to write one, a program to accomplish either of these tasks would be much too complex to include with this article, so at this point, the ball is in your court. Armed with this article, the FB-01, a good programmer's calculator, and a sharp mind, there's not much you can't do with the instrument.

Jim Johnson is no longer the most eligible bachelor in Arizona, having gotten married in September. He still has pointy sideburns.

MSR-	ST	EVNT	TIME	CH	TYP	NOTE	VEL	DUR	Sequence #:	Name:
∅	1-	1	1	0	*	240			3	FB01Frac
∅	1-	1	2	0	*	67			Events left:	6117
∅	1-	1	3	0	*	117			Plays two notes 1/4 tone apart	
∅	1-	1	4	0	*	112			Backup	Copy Sequence
∅	1-	1	5	0	*	43			Transpose/Auto	Split PVG
∅	1-	1	6	0	*	60			Insert Adjust	Append
∅	1-	1	7	0	*	0			Cut	Merge
∅	1-	1	8	0	*	120			Copy	Delete Sequence
∅	1-	1	9	0	*	23			Paste	Ext Tun DSP SPX
∅	1-	1	10	0	*	0			Delete	
∅	1-	1	11	0	*	0			Erase	
∅	1-	25	11	24	*	43			Text Map	
∅	1-	25	12	0	*	60			Get Backup	
∅	1-	25	13	0	*	50			Print	Play
∅	1-	25	14	0	*	120			Change Repeats	Record
∅	1-	25	15	0	*	23			Step Time Append	Load/Save
∅	1-	25	16	0	*	0			Master Edit	Set Options
∅	1-	25	17	0	*	247			Find Calc	TRACK Mode SONG Mode
∅	1-	49	18	24	DE				Undo	Quit

FIG. 1: A three-note sequence created by programming System Exclusive messages into your sequencer. A tedious experience.