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Special XG Effects Issue

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Spotlight On: XG Effects

Professional audio engineers have long known the value of high-quality effects such as reverb, delay, chorusing, flanging, and the like, but it is only in recent years that effects have become an integral part of MIDI instruments. This is one reason why General MIDI—developed in the early 90s—has no provision for onboard effects, and no standardized way of controlling them. One of the most powerful aspects to the XG format is that it addresses this deficiency in GM by providing defined means for accessing, controlling and customizing multiple onboard effects. In this X-tended article, we'll take a close look at the many ways that XG effects can be used to add that professional touch to your MIDI files.

How Many Effects Are Too Many?

Audio engineers will tell you that you can never have too many effects on hand. Sometimes a single sound will be need to be processed by multiple effects, while other times multiple sounds will need be routed into one effect. The key here is *flexibility*, and the XG format provides plenty of that!

Base-level XG instruments such as the Yamaha DB50XG daughterboard or MU50 tone generator must provide at least three discrete onboard effects: Reverb, Chorus, and a third kind of effect known as "Variation." The Variation effects types include most of the Reverb and Chorus presets, and many more. This isn't just the department of redundancy department, either—XG purposely duplicates those effects types so that you can use two different types of Reverb or Chorus simultaneously. In addition, Variation effects can be used in an "Insertion" configuration, which we'll talk more about shortly.

Higher-level XG instruments such as the Yamaha MU80 include all three of these effects and add to them additional effects processors such as Distortion and a master graphic equalizer. But whether your XG instrument has three or five effects processors, you really have access to an almost unlimited number of effects, since each processor is capable of producing several different effects types. For example, the Reverb processor can produce numerous reverberant halls, rooms, stages, or plates. The Chorus processor can produce not only chorusing, but also flanging or phasing (these kinds of effects, by the way, can

have great impact on FX sounds as well as on musical sounds). The Variation processor can generate most of the above, and can also produce delays, echoes, rotary speaker, tremolo, EQ, distortion, and other effects. And, not only does XG allow you to customize any of these effects, it even enables you to have each of the effects processors call up different effects types "on the fly," as the MIDI file is playing back. It's like having dozens of effects devices at your fingertips—a situation any recording engineer would appreciate!

Effects Assignment and Routing

In order to apply effects to a sound, you need to first select which effects type you want for each of the three XG effects. This is accomplished by inserting system exclusive messages in your setup measure, as shown in figure 1 (in a pinch, they can also be sent during music data playback but, due to the fact that these kinds of MIDI messages can cause momentary glitches, only during significant gaps in the music).

Name	Sysex	Default
Reverb Type	F0h 43h 1nh 4Ch 02h 01h 00h DD dd F7h	Hall 1
Chorus Type	F0h 43h 1nh 4Ch 02h 01h 20h DD dd F7h	Chorus 1
Variation Type	F0h 43h 1nh 4Ch 02h 01h 40h DD dd F7h	Delay LCR

Note: n = device number; DD = data (MSB); dd = data (LSB).

Figure 1

A complete listing of the XG effects types is provided in the XG Specifications and in your instrument's owners manual. Base-level XG instruments provide 8 Reverb and Chorus effects types, along with 35 Variation effects types. If you select from among these "essential" effects types, your MIDI file will be guaranteed effects compatibility with all XG instruments.

You also need to define a pathway through which the "dry" signal gets into the effects processor, and then another pathway through which the effected ("wet") signal leaves the processor and is added to the overall mix. In recording terminology, the former is called an effects (or "auxiliary") send (since the signal is sent to the effects processor), and the latter is called an effects (or "auxiliary") return (since the signal returns from the effects processor to the main mix). Mixing consoles will traditionally provide two or more effects sends on every channel. In this way, the signal from any number of channels can be combined ("submixed") and routed to an outboard effects processor.

XG instruments utilize a similar kind of routing scheme, only here all routing is done internally (and digitally, so there is no signal degradation). The first step is to

assign different XG voices to each of the "parts" (each part is a discrete timbre, responding on a user-defined MIDI channel; normally, part one receives on MIDI channel 1, part two on MIDI channel 2, etc.). The second step is to route signal as required to the Reverb, Chorus, and/or Variation processors using XG's onboard effects sends (however, in order to use a send/return configuration for Variation effects, a parameter called "Variation Connection" has to be changed from its default of "Insertion" to a new value of "System"—more on this shortly). To access these effects sends, use standard MIDI control change messages, as shown in figure 2.

Control #	Name	Default Value
5Bh	Reverb Send Level	28h
5Dh	Chorus Send Level	00h
5Eh	Variation Send Level	*

** set to "Off" since default is "Variation Connection = INS"*

Figure 2

Thus, if you wanted the voice receiving on MIDI channel 1 to route signal to the Reverb effect, for example, you would send the following MIDI message:

B0h 5Bh dd

where dd = data value, ranging from 00h (no signal routed) to 7Fh (maximum signal routed). Similarly, if you wanted the voice receiving on MIDI channel 6 to route signal to the Chorus effect, you would send the following MIDI message:

B5h 5Dh dd

Again, dd = data value, with lower values causing less signal to be routed to the effect and higher values causing more signal to be routed. Bear in mind that, since these are controller change messages, they can be continuously varied in real time even as the MIDI file is playing back with no audible glitches or interruptions. In this way, XG allows you to automate your effects send levels in the same way that you can automate voice level using MIDI controllers #7 (volume) and #11 (expression). Incidentally, the XG format even allows realtime control over volume and effects send levels (as well as pan position and filter and envelope settings) of individual voices within rhythm kits. This is done with special MIDI control change messages called NRPNs (short for "Non-Registered Parameter Numbers"). *(Editor's note: We'll be doing a feature article on NRPNs in an upcoming issue of XG Xtra)*

Effects return levels are handled a little bit differently in that there is an expectation that, in general, you will only need to set them once per song and then "forget" them (though you can continuously vary the amount of effected signal entering your mix by altering the effects send levels in

real time via MIDI control change messages). For this reason, the effects return levels are set with system exclusive messages, which, as described previously, should normally only be sent during your setup measure (or, in a pinch, during significant musical pauses). These messages are shown in figure 3.

Name	Sysex	Default
Reverb Return Level	F0h 43h 1nh 4Ch 02h 01h 0Ch dd F7h	40h*
Chorus Return Level	F0h 43h 1nh 4Ch 02h 01h 2Ch dd F7h	40h*
Variation Return Level	F0h 43h 1nh 4Ch 02h 01h 56h dd F7h	40h*

*Note: n = device number; dd = data. * 00h = -∞dB; 40h = 0 dB; 7Fh = +6 dB*

Figure 3

As mentioned previously, the Variation effect doesn't always use this send/return configuration. In fact, the XG initialization default sets the "Variation Connection" parameter to "Insertion" mode, where, instead of using a send and return, the Variation effect is applied at unity gain (that is, with no level attenuation or boost) to one single user-specified part. The advantage to using the Variation effect in an Insertion configuration is that you don't have to worry about send or return levels; they are automatically set to optimum. This is useful when applying an effect such as 2-band or 3-band EQ, where you'll simply want maximum signal-to-noise ratio without any need to alter the amount of effect being added. The disadvantage to using the Insertion configuration is that the Variation effect can only be applied to one part. If you want to be able to apply the Variation effect to multiple parts (or if you simply want control over the Variation send and return levels), set the Variation Connection parameter to "System" mode, using the system exclusive message shown in figure 4.

Normally, all three XG effects remain independent of one another, in what is known as "parallel" routing. However, there are three important XG parameters that enable you to use the effects in varying degrees of "serial" routing, where the

Name	Sysex
Variation Connection = System	F0h 43h 1nh 4Ch 02h 01h 5Ah 01h F7h
Variation Connection = Insertion*	F0h 43h 1nh 4Ch 02h 01h 5Ah 00h F7h

** default* *Note: n = device number*

Figure 4

output from the Chorus effect is patched directly to the input of the Variation effect, or the output from the Variation effect is patched directly to the input of the Reverb and/or Chorus effects. To change from the default setting of parallel routing, use the system exclusive messages shown in figure 5, inserting data values greater than 0 (the higher the data value, the more signal is routed):

Serial routing is useful when you want to process an already effected sound. For example, flanging a signal that includes reverb causes the reverb itself to be flanged. The sonic result is quite different than if you simply flange a dry signal and also separately add reverb to that same dry signal. To demonstrate, initialize your XG instrument (by sending it an XG System On message) and then assign the "Xplosion" SFX voice (Bank Select MSB [cc #0] = 40h, Bank Select LSB [cc #32] = 00h, program #115) to a part. Play a note—you'll hear the sound with some reverb, due to the default Reverb send and return levels. Now, using the sysex messages outlined above, reduce the Reverb send level to 0 and raise the Chorus send level to 64h (100 decimal). Play another note in order to listen to the explosion with the Chorus 1 (default) effects type instead. Next, raise the Reverb send level to 64h (100 decimal) and play a note in order to hear the explosion effected by both Reverb and Chorus—but in parallel (the default routing), with dry signal being routed to both processors. To hear the aural contrast with serial effects routing, transmit the "Send Chorus to Reverb" sysex message shown above with a data value of 7Fh (127 decimal, which is maximum). The explosion with serial Reverb and Chorus routing is arguably richer and more drastic than with parallel routing, and you'll be able hear the difference even more clearly if you choose a more severe Chorus effects type, such as Chorus 3 or Flanger 2.

Name	Sysex	Default
Send Chorus To Reverb	F0h 43h 1nh 4Ch 02h 01h 2Eh dd F7h	00h*
Send Variation To Reverb	F0h 43h 1nh 4Ch 02h 01h 58h dd F7h	00h*
Send Variation To Chorus	F0h 43h 1nh 4Ch 02h 01h 59h dd F7h	00h*

Note: n = device number; dd = data. ** = -∞ dB; sets Parallel routing.*

Figure 5

Using XG Effects to Create Ambience

One important feature of XG effects is that they all provide stereo outputs in order to provide realistic ambience. Their returns are normally panned to the center (this provides the maximum left-right spread), but you can optionally choose to offset the pan point so as to shift the spread. The system exclusive messages used to do so

are shown in figure 6 below.

In conjunction with the standard MIDI Pan control change message (cc #10), this can have important applications in gaming or in virtual reality presentations, where you wish to create dynamic movement within a virtual ambient space. For example, try initializing your XG instrument (by sending it an XG System On message) and then assign a melody voice or SFX voice to a part. A good choice for this example would be the "FootStep" sound, found in the SFX voices bank (Bank Select MSB [cc #0] = 40h, Bank Select LSB [cc #32] = 00h,), program #101. Under the initialization defaults, all parts will be routing signal to the Reverb effect (using the default Hall 1 effect type) with a send level of 40 (decimal). The Reverb return defaults to 64 (decimal), so you'll hear some reverb on the footsteps as you play notes (in fact, due to these defaults, you'll always hear a small amount of some reverb applied to all parts after initializing an XG instrument). Now, as you continue playing notes, use a hardware or software controller to send cc #10 messages on the MIDI channel being used by the "FootStep" part—you'll hear the footsteps pan from their default center position to the left (as cc #10 values less than 64 are transmitted) or to the right (as cc #10 values greater than 64 are transmitted).

Name	Sysex	Default
Reverb Pan Position	F0h 43h 1nh 4Ch 02h 01h 0Dh dd F7h	40h*
Chorus Pan Position	F0h 43h 1nh 4Ch 02h 01h 2Dh dd F7h	40h*
Variation Pan Position	F0h 43h 1nh 4Ch 02h 01h 57h dd F7h	40h*

*Note: n = device number; dd = data. * 00h = Left; 40h = Center; 7Fh = Right*

Figure 6

This helps create the illusion of movement, but XG allows you to go much further in shaping your virtual space. For example, try using the system exclusive message shown above to shift the pan position of the reverb return so that it is no longer center (that is, hard left / hard right). If you now continuously apply Pan (cc #10) messages to the "FootStep" part while playing notes, you'll hear our imaginary wanderer traveling through a space that is acoustically unreal, with the reverb staying to one side even when the source signal moves. Because the XG effects are all mono-in, stereo out, continuously altering the pan position of the voice does not also cause the position of the reverb to continuously change. Thanks to the provision of multiple effects, however (and thanks also to the redundancy built into the Variation effects types), XG does allow you to construct pseudo-stereo-in, stereo-out effects. To do so, simply select a Reverb effects type (try one of the Room types) and the same exact effects type for the Variation effect. Set the

Variation Connection to System (giving you send/return control) and pan the Reverb effect half-left and the Variation effect (which is identical) half-right. This moderate panning (values of around 20h and 60h) yields more realistic results than hard left-right panning. Now when you apply cc #10 messages to the "FootStep" part, the reverb position will appear to change along with the pan position of the voice itself, adding to the overall realism. Try selecting different Reverb effect types (and the identical type for the Variation effect) and observe how some (notably those with shorter reverberant times, such as the Room and Stage presets) impart more ambient information than others.

Taking things a "step" further (pardon the pun), you can simulate front-rear spatiality by inversely varying the overall sound level (using Expression, cc #11) and the effects send level (cc #91 in the case of the Reverb effect, or cc #94 in the case of the Variation effect) so that, as the level of the part is decreased, the effects send level is increased. If you have assignable software faders or a hardware MIDI controller box (such as the JL Cooper FaderMaster or FaderMaster Pro, available from JL Cooper Electronics, 12500 Beatrice St., Los Angeles, CA 90066; telephone 310-306-4131, fax 310-822-2252)), you can easily accomplish this by grouping two faders, one assigned to cc #11 and the other assigned to cc #91 or cc #94, with the output of one of the two inverted. Now, as you play notes while moving the master fader, the footsteps appear to come forward to the foreground (when level is maximum and effects send level is minimum) or go back into the distance (when level is decreased and send level is increased). Combine this with the pseudo-stereo-in effects setup described in the preceding paragraph and, as shown in figure 7 on the following page, you can build a virtual XG humanoid that goes wandering through the four corners of an imaginary room!

Synchronize this with computer-generated animation, and you've got a stunning spatial illusion—all created using the power of XG and standard MIDI messages.

Customizing XG Effects

Although your XG instrument provides dozens of factory-programmed effects types, you're not limited to just using these presets. The XG format specifies that every effects type provide up to sixteen user-programmable parameters, so that, in every situation, you can customize the effect to precisely complement the music or sound effect you're creating. A complete listing of these programmable parameters is provided in your XG instrument's owners manual, and is also included in the XG Specifications. To alter XG effects parameters, use the system exclusive messages shown in figure 8 (on the second page following).

(continued on 2nd page following)

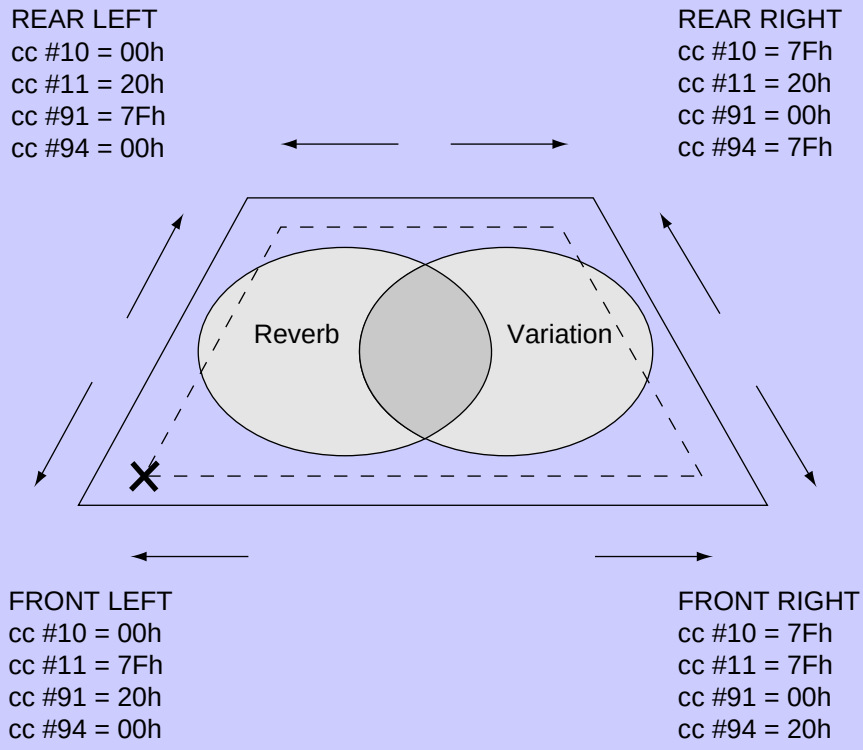
REAR LEFT
cc #10 = 00h
cc #11 = 20h
cc #91 = 7Fh
cc #94 = 00h
REAR RIGHT
cc #10 = 7Fh
cc #11 = 20h
cc #91 = 00h
cc #94 = 7Fh
Reverb
Variation
FRONT LEFT
cc #10 = 00h
cc #11 = 7Fh
cc #91 = 20h
cc #94 = 00h
FRONT RIGHT
cc #10 = 7Fh
cc #11 = 7Fh
cc #91 = 00h
cc #94 = 20h

Figure 7

Again, because these are sysex messages, you'll want to include them only in your setup measure or during significant musical pauses. Bear in mind that you only need to use these messages where the default value for that particular parameter is not suitable for your needs. If, for example, you're using an effect that provides ten programmable parameters and you only want to tweak one of them (because the default values for the other nine parameters are suitable), you only need to send that one sysex message. You'll find assignable software faders or a hardware controller box useful in adjusting programmable effects parameters.

As figure 8 shows, all Reverb and Chorus parameters use only a single data byte, as do Variation parameters 11 - 16, but Variation parameters 1 - 10 use two data bytes (an MSB and an LSB). Bear in mind also that some effects parameters accept only a limited number of values, using "Data Value Assignment Tables" (published in your XG instrument's owners manual and in the XG Specifications) to translate the data value to an appropriate number. For example, a data value of 127 (7Fh) applied to an "LFO Frequency" parameter results in an LFO frequency of 39.7 Hz.

Name	Sysex
Reverb Parameter	F0h 43h 1nh 4Ch 02h 01h rr* DD F7h
Chorus Parameter	F0h 43h 1nh 4Ch 02h 01h cc** DD F7h
Variation Parameter	F0h 43h 1nh 4Ch 02h 01h vv*** DD dd F7h

Note: n = device number; DD = data (MSB); dd = data (LSB).
rr = Reverb parameter number
(02h - 0Bh = parameters 1 - 10; 10h - 15h = parameters 11 - 16).
cc = Chorus parameter number
(22h - 2Bh = parameters 1 - 10; 30h - 35h = parameters 11 - 16).
vv = Variation parameter number
(42h, 44h, 46h, 48h, 4Ah, 4Ch, 4Eh, 50h, 52h, 54h = parameters 1 - 10; 70h - 75h = parameters 11 - 16).

Figure 8

In addition, when using a Variation effect (other than EQ, compression, and Aural Exciter™ effects types) in Insertion mode, XG gives you the ability to alter a single factory-defined parameter in real time, using a standard MIDI control change message. For most Variation effects, this enables you to alter the wet/dry mix, essentially providing the same kind of realtime send/return control you'd have if the Variation effect were set to System mode.

As shown in figure 9, to accomplish this, first use a system exclusive message to specify the controller number you wish to use, and then use a second sysex message to specify the depth of the control:

A data value of 40h (corresponding to decimal 0) results in no control, with values greater than 40h resulting in increasing depth. Data values less than 40h result in decreasing depth, enabling inverse control. In other words, if you set the depth to 7Fh (maximum), sending a control change data value of 7Fh (maximum) results in a completely wet signal, while a control change data value of 00h (minimum) results in a completely dry signal. In contrast, setting the depth to 00h (minimum) causes precisely the opposite to occur, so that greater control change data values result in more dry signal and lesser control change data values result in more wet signal.

The Upshot

The XG format enables much the same kind of intensive high-level control over effects that a professional automated mixing console provides—only here, all the effects are built into the instrument and all the control is accomplished with standard MIDI messages. Just as a recording engineer can customize effects, build complex routings, and dynamically control instrument level and panning as well as effects send and return levels during a mix, so too can the XG developer. This raw power enables you to construct some pretty amazing music and sound effects tracks, which have the added bonus of requiring just a fraction of the storage capacity demanded by digital audio.

Name	Sysex	Default
AC1 Controller Number	F0h 43h 1nh 4Ch 08h 00h 59h dd F7h	10h*
AC1 Variation Control Depth	F0h 43h 1nh 4Ch 02h 01h 5Fh dd F7h	40h**

Note: n = device number; dd = data. ** = cc #16.* *** = 0 (decimal)*

Figure 9

XG publications available from Yamaha

- An Introduction to XG
- XG Specifications
- XG Guidebook
- XG Music Production Recommendations

All available online or in hard copy direct from Yamaha