

GENERAL MIDI SYSTEM LEVEL 1 DEVELOPER GUIDELINES

For Manufacturers and Composers
Second Revision, July 1998

Published by:
MIDI Manufacturers Association
Los Angeles CA

Prepared by Paul D. Lehrman, associate director for development
Center for Recording Arts, Technology & Industry, University of Massachusetts Lowell.

Additional text and editing by Howard Massey, MMA technical editor and
senior consultant, On The Right Wavelength

Copyright ©1996, 1998 MIDI Manufacturers Association

All rights reserved. No part of this document may be reproduced or transmitted in any form or
by any means, electronic or mechanical, including information storage and retrieval systems,
without permission in writing from the MIDI Manufacturers Association.

Second Printing 1998

MMA
POB 3173
La Habra CA 90632

CONTENTS

| | |
|--|----|
| Introduction..... | 1 |
| How to Use This Document | 1 |
| Acknowledgments | 2 |
| Changes to Specification in Second Revision | 2 |
| Additional Protocol Implementation Recommendations..... | 3 |
| Clarifications | 3 |
| Response to “GM System On” Message | 4 |
| Response to “Reset All Controllers” Message | 5 |
| RPN/NRPN Null Function Value..... | 6 |
| Use of Data Entry Controllers | 7 |
| GM Polyphony Requirements | 8 |
| GM Voice Allocation - Overflow and Channel Priority..... | 9 |
| Volume, Expression & Master Volume Response..... | 9 |
| Response to Pan | 11 |
| Use of Bank Select Messages..... | 11 |
| Response to Program Changes | 12 |
| Aftersound..... | 12 |
| Built-In Effects & Response to Effects Controllers..... | 13 |
| Additional Notes About Controllers..... | 14 |
| Additional Instrument Sounds (Extensions to GM) | 15 |
| Additional Drum Sounds & Kits (Extensions to GM) | 15 |
| Response to Note-off on Channel 10 (Percussion) | 16 |
| Mutually-Exclusive Percussion..... | 16 |
| File Formats and Editing Capability..... | 18 |
| MIDI Player Control: Starting in the middle | 18 |
| File Data: Prep bars | 19 |
| File Data: Pickup bars | 19 |
| File Data: SMF Marker Event..... | 20 |
| File Data: Other Meta-Events | 20 |
| File Data : Channel Assignments..... | 21 |
| File Data: Multiple Devices (non-GM hardware) | 21 |

Appendix A: 23
 Voice editing..... 23
Appendix B: 24
 Fat Labs Instrument Testing Specifications..... 24
 General..... 24
 Individual Timbres 24
 Percussion 25

Introduction

This document was commissioned by the MIDI Manufacturers Association in 1995 to help developers of General MIDI System Level 1 (GM Level 1) products determine how to make their products compatible with as many other GM products as possible. Based on a survey of existing products, this document provides insights into areas of compatibility which are not clearly defined by the text of the formal GM Level 1 Specification (MMA0007/RP003), and adds additional recommendations to that specification based on market realities. This document should be used by manufacturers of GM compatible musical instruments (typically called “synthesizers”) as well as by composers (authors of MIDI files) and developers of applications software to achieve more predictable playback of MIDI files.

Rather than attempt to redefine General MIDI “after-the-fact” (at this writing there are already over 1 million sound generating devices on the market which are designed for GM playback), this document identifies common practices and makes specific recommendations, yet still allows for freedom of creativity by individual manufacturers and developers.

The MMA GM Survey on which this document is based was commissioned to determine the current state-of-the-art in GM and to provide the information from which the MMA Technical Board could prepare recommendations. The work of collecting, compiling, and analyzing the survey data and making initial recommendations was done by Professor Paul Lehrman, a noted MIDI composer and author of numerous books and magazine articles on MIDI. Final editing and additional input was provided by Howard Massey, an industry MIDI consultant and author/educator. All recommendations were reviewed and evaluated by the MMA Technical Standards Board, to produce the final document you see here.

The survey results were published as part of the first printing of this document, but removed from the second (and on-line) publication(s).

How to Use This Document

This document begins with a summary of clarifications to the General MIDI System Level 1 specification. The summary clarifications are intended to be used as a companion and supplement to the actual specification. In many cases, the clarifications are additional information which the MMA Technical Board has determined should have been included in the published specification, but were omitted due to some oversight. In other cases this information is a clarification of ambiguous wording in the specification, and it is hoped that the new detail provided in this supplement will avoid further deterioration of GM compatibility.

The remainder of the document is an analysis of each issue of potential incompatibility (as determined by research into existing products). The issues are divided into two groups: “GM Synthesizer” issues and “GM Music File” issues. Within the GM Synthesizer group are any issues about the design of a GM compatible synthesizer that may be unclear, for both the manufacturer and the potential application or data developer. In the interest of making this a “quick reference guide,” the analysis of each issue is preceded by a summary of the

final recommendations, with separate recommendations for manufacturers of these products as well as for application or data developers where appropriate.

Appendix A lists common controls for voice editing, while Appendix B describes the procedure used by Fat Labs, a well known producer of music for computer games, to evaluate GM hardware for compatibility with music composed on Roland's Sound Canvas.

While the Sound Canvas is not an officially recognized reference for GM by the MMA, it is the predominant reference platform used by composers working in the field of interactive multimedia and PC games, as reported by the Interactive Audio Special Interest Group (IASIG). The appearance of the Fat Labs test procedure is not an endorsement of the test (nor the Sound Canvas) and is provided herein merely as additional information which developers may wish to use as a reference for determining an acceptable process for evaluating GM compatibility.

Acknowledgments

We would like to thank all of the MMA members who helped put the survey together; all who helped get others to respond; and all of those who responded. Special thanks to Tom Rettig, Yoshi Sawada, Mike D'Amore and Mike Kent. Extra special thanks to Barbara Blezard, administrative coordinator of the Recording Industry Environmental Task Force, based at the University of Massachusetts Lowell, who designed the database and entered the survey response data.

And thanks go to MMA Technical Board members Bob Lee (Gulbransen) and Rick Cohen (Kurzweil) for their efforts to edit and correct the recommendations and explanations herein.

Changes to Specification in Second Revision

The second revision documents a change in the MMA recommendation for correct response to the Reset All Controllers (CC #121) message. Expression was added to the list of controls which should be reset. The descriptions and/or placement in the document of some items to be reset or not reset were also rewritten for more clarity.

An additional paragraph was added to clarify the proper use of the Bank Select message in those files which are intended to support both General MIDI and extensions such as Roland's GS or Yamaha's XG devices.

General MIDI System — Level 1 Specification

Additional Protocol Implementation Recommendations

- Data Entry Controllers (CC#6, CC#38)
- RNP/NRPN Null Function (C/A JMSC-0011)
- Mutually Exclusive use of Hi-hat and Triangle in Percussion Channel
- Response to Note-Off for Long Whistle and Long Guiro in Percussion Channel
- Response to All Sounds Off Message (cc120)

Clarifications

- Defined response to Turn GM System On Message
- Defined response to Reset All Controllers Message (*revised*)
- Defined Channel Priority scheme for Voice Allocation
- Defined Volume and Expression Controller response curves
- Defined Response to Pan Controller Messages
- Defined Response for Non-GM Controllers (Bank Select, Effects, etc.)
- Defined Response for Aftertouch (MIDI 1.0 Detailed Specification Recommendation)

(See text for specific details about each of these recommendations.)

GM Synthesizer Issues

Response to “GM System On” Message

- The time required for complete response to the Turn GM System On message should be as short as possible (the current hardware average is 100ms).
- The response to this message should include the following actions on all Channels:
 1. All actions defined for the Reset All Controllers message (see next section) plus:
 - Set Volume (#7) to 100
 - Set Expression (#11) to 127
 - Set Pan (#10) to 64
 2. Devices which also respond to Effects Controllers (#91-#95) should reset to default values (power-up state). Effects are not required for GM but effects controllers may still be used by composers (see that section)
 3. Any other actions needed to restore the device to GM-compatible settings, such as reset Bank Select and Program Change to “0”.
- GM devices which support other modes of operation should “wake up” (power on) in GM mode, and not go out of GM Mode when receiving non-GM compatible messages (such as Bank Select).

File Player Recommendations: Devices designed only to play GM music files, or when in a mode which is designed only to play GM music files, should transmit the GM Mode On message upon power-up. Developers of software applications designed to play GM music files exclusively should ensure that the Turn GM System On message is transmitted when the application is launched, such as from a dialog prompting the user to connect and turn on the receiving device.

Composer Recommendations: Composers should not include the GM System On message in the body of GM music files. However, if necessary, the message can be included in “prep” bars (see page 21), as long as a delay of 100 - 200 ms before the onset of music is also provided.

Details:

Description of Issue:

After receiving a “GM System On” message, some devices need a period of time to reset themselves before they can start producing sound. How prevalent is this practice, what length pauses are required, and what can composers and authors do to avoid problems? In addition, some devices will go in or out of GM mode under certain conditions. What are these conditions, and are any of them acceptable?

Findings:

5 of the hardware respondents said that their devices don’t need any amount of time after receiving a Turn GM System On message before they can play sound. 2 were vague about the length of the pause needed, and of the others the range was from 10 ms all the way to “1-2 seconds”, with 100 ms being the median value.

GM Synthesizer Issues

The most common time for a module to go into GM mode is when the unit powers up, which is as it should be. 11 devices go into GM mode the first time they're turned on, and 9 of those go into GM mode every time they're turned on. In addition, 7 of these can be put into GM mode from the front panel. 3 devices never go out of GM mode. 7 devices go out of GM mode when they receive specific Bank Select commands, but surprisingly, only 5 do so when they receive a Turn GM System Off message. One device goes out of GM mode when it receives a "GS Reset" (SysEx) command. 6 can go out of GM mode from the front panel.

Response to "Reset All Controllers" Message

- The MMA recommends that reception of the Reset All Controllers (CC #121) message cause the following response in GM devices:
 - Set Modulation (#1) to 0.
 - Set Expression (#11) to 127.
 - Set Pedals (#64-67) to 0.
 - Set Registered and Non-registered parameter LSB and MSB to null value (127).
 - Set Pitch Bender to center (64/0).
 - Reset Channel pressure to 0.
 - Reset polyphonic pressure to 0 (for all notes on that Channel).
 - All other controllers should be set to 0, otherwise the behavior should be documented.

The Association of Music Electronics Industry (AMEI, formerly the Japan MIDI Standard Committee) has proposed that the following parameters specifically be left unchanged upon receipt of a Reset All Controllers message. The MMA has not yet officially adopted this recommendation but it is unlikely that following this recommendation would cause serious incompatibilities. The MMA is expected to respond on this issue for both GM and non-GM devices shortly.

Do not Reset:

- Program change
 - Bank Select (#0 and #32)
 - Volume (#7)
 - Pan (#10)
 - Effects Controllers #91-95 (not a GM control)
 - Sound controllers #70-79 (not a GM Control)
 - Other Channel mode messages (#120, #122-#127)
- Manufacturers should create a section in their documentation for response to the Reset All Controllers message, especially for controllers used by the device on a global basis, if any.

GM Synthesizer Issues

- If a device will respond differently to the Reset All Controllers message in General MIDI mode or in its native mode, this behavior should also be documented.

Details:

Description of Issue:

With the advent of many new controllers in MIDI, including Bank Select, the state of a controller after reset has become significant to compatibility issues as well as in performance situations. Exactly how should controllers in GM devices be reset following the reception of a Reset All Controllers (CC #121) or Turn GM System On SysEx message? This specific issue was not addressed in the MMA GM Survey, so this information has been obtained through an MMA proposal.

RPN/NRPN Null Function Value

- The RPN/NRPN Null Function (MIDI 1.0 Approved Protocol JM5C-0011) is not listed as a requirement in the GM Level 1 specification, but according to the MIDI protocol should be recognized by any MIDI device which also recognizes RPNs. Therefore this function is recommended for all GM Devices (and should be implemented in response to the Reset All Controllers message ... see page 6).

Composer Recommendations: See the MIDI Specification for instructions on when to use this message. Due to the apparent lack of implementation in current products, composers should not use this message if ignoring it will cause unacceptable playback.

Details:

Description of Issue:

RPNs (and NRPNs) are designed so that when a parameter is selected and then followed by a corresponding Data Entry (CC # 6/38) or Data Increment/Decrement (CC # 96/97) value, all subsequent data values will continue to address that parameter until another RPN or NRPN is selected. The “Null function” value (7F for both the MSB and LSB) is used to lock in the value of the RPN or NRPN so that subsequent Data Entry and Data Increment/Decrement commands are ignored. Some manufacturers, however, implement the Null function, or variations thereof, in response to other events or commands.

Findings:

Our survey determined that there is a confusion among manufactures as to what exactly it means to “null” a Registered or Non-Registered Parameter. Apparently some thought the question applied to resetting values to their default settings (or zero). Respondents also indicated that the following commands/events affect the current RPN values, but did not always indicate which way. (Note: some devices respond to more than one of these, and some don’t respond to any of them):

GM Synthesizer Issues

| <u>Commands/Events that Affect RPN/NRPN Values (survey)</u> | <u>Respondents</u> |
|---|--------------------|
| Power Off/On | 3 |
| GM Mode On or other mode change (CC#s 124-127) | 3 |
| Program Change | 2 |
| Reset All Controllers (CC#121) | 2 |
| RPN Null Function | 2 |
| Bank Select | 1 |

The MMA does not yet have a recommendation on the appropriateness of response to these messages, other than Reset All Controllers (recommended).

Use of Data Entry Controllers

- Data Entry MSB (CC# 6) and LSB (CC #38) are required to be implemented by all GM devices for the adjustment of RPNs defined in the specification

Composer Recommendations: Composers adjusting RPNs should utilize the Data Entry MSB (CC# 6) and, if necessary, the Data Entry LSB (CC #38), not the Data Increment/Decrement (CC #96/97) for this purpose.

Details:

Description of issue:

According to the GM Level 1 Specification, a device must respond to RPNs 00-02. However, it is not specified how to *adjust* these parameters —by using Data Entry (CC #6 and CC #38), Increment/Decrement (CC #96/97), or by other means.

Findings:

9 of the 13 respondents indicated that their hardware devices support the Data Entry MSB (CC #6) for the adjustment of RPNs 00-02 (Pitch Bend Range, Fine Tuning, and Coarse Tuning, respectively). Only one respondent indicated that the Data Entry LSB (CC #38) was supported, and only one indicated support for the Reset RPN (7F/7F). Because the GM Level 1 Specification mandates response to RPNs for pitch bend sensitivity and tuning, support for the Data Entry MSB (CC# 6) and LSB (CC #38) is an oversight in the specification.

GM Synthesizer Issues

GM Polyphony Requirements

- GM devices should have as many voices (24 or more) as possible available at all times.
- GM Devices should diligently avoid “stacking” of voices (oscillators), so that composers can be sure that 24 note polyphony is available for all instrument sounds.
- Composers may want to limit their compositions to 16 simultaneous notes for compatibility with currently popular products which “stack” oscillators in contrast to the above recommendations.

Details:

Description of Issue:

The GM Level 1 Recommended Practice specifies a minimum of either 24 “voices” for melodic and percussion sounds, or 16 for melody and 8 for percussion. Most people assume that this means that under all circumstances, a GM synthesizer that receives 24 MIDI note-on commands will produce 24 distinct sounds. However, a number of manufacturers, in an effort to improve sound quality without radically increasing the size of the sound engine, use two or more oscillators to create some programs. For example, Honky-tonk piano (program #4) is often created by layering two standard piano sounds and detuning them—a practice which results in total polyphony being reduced in half (from 24 to 12, for example). To compensate, manufacturers can raise the number of voices available, so that the chances of polyphonic overload are reduced. But even in those cases, unless the manufacturer provides at least 48 voices and no program uses more than two voices, polyphony of 24 cannot be guaranteed.

As far as composers are concerned, the question is, under current practice, how many voices are available in a General MIDI module to cover all possible scores? A secondary issue is whether it is desirable to separate percussion and non-percussion voices.

14 out of the 16 products described share polyphony between percussion and melody voices. Of the 2 others, one is a software-based synth engine (wavetables are loaded into a computer's RAM and played back, under MIDI control, directly through the CPU and a DAC), and one's answers were ambiguous. Of the 14 products that share polyphony, 10 provide 32 voices. Of the remainder, one provides 64 voices, but since it uses at least 2 voices on every program, the practical polyphony is reduced to 32.

The use of multiple voices to create GM programs is widespread. Only one respondent said that no programs used multiple voices — the others ranged from 15 to 55 (not including the “64-voice” system mentioned above), with the median value being around 30. The majority of systems have no programs that use 3 or more voices, and of those that do, the median value is 5.

GM Synthesizer Issues

GM Voice Allocation - Overflow and Channel Priority

- Allocation priority should always be given to the most recent voice(s) played. Second priority should be given to the loudest voice(s) currently being played. In addition, manufacturers should implement other musically-oriented solutions, such as stealing individual oscillators from multiple-oscillator programs, and reassigning oscillators which can no longer contribute substantially to the perception of a note.
- Notes on certain MIDI Channels should have priority over others. That is, Channel 10 receives highest priority, followed by Channel 1, then Channel 2, etc., with Channel 16 receiving lowest priority.

Composer Recommendations: It is advised that MIDI file authors insure that voice overflow situations (where more than 24 notes need to be played simultaneously) are avoided. A MIDI file checker application can help identify these situations.

Details:

Description of issue:

Roland and Yamaha recommend specific Channel assignments for specific instrumentation, supposedly to provide better compatibility during a voice-overflow situation. If allocation schemes can contribute to compatibility problems, is there a recommendation for how notes (and Channels) should be prioritized?

Findings:

The respondents were split evenly between last-note and highest-volume priority. Three used various combinations of priorities. The issue of Channel priority was not addressed in the survey; however, many manufacturers including Roland and Yamaha follow the scheme described above, and this is also the scheme recommended by the IASIG for the upcoming Downloadable Sounds specification for synthesizers.

Volume, Expression & Master Volume Response

- Volume (CC#7) and Expression (CC #11) should be implemented as follows:

For situations in which only CC# 7 is used (CC#11 is assumed "127"):

$$L(\text{dB}) = 40 \log (V/127) \text{ where } V = \text{CC\#7 value}$$

For example: **CC#7 amplitude**

| | |
|-----|-----------|
| 127 | 0dB |
| 96 | - 4.8dB |
| 64 | -11.9dB |
| 32 | -23.9dB |
| 16 | -36.0dB |
| 0 | $-\infty$ |

This follows the standard "A" and "K" potentiometer tapers.

GM Synthesizer Issues

For situations in which both controllers are used:

$$L(\text{dB}) = 40 \log (V/127^2) \text{ where } V = (\text{volume} \times \text{expression})$$

The following table denotes the interaction of volume and expression in determining amplitude:

| CC#7 | CC#11 | total amplitude | CC#7 | CC#11 | total amplitude |
|------|-------|-----------------|------|-------|-----------------|
| 127 | 127 | 0dB | 127 | 96 | -4.8 dB |
| 96 | 127 | -4.8dB | 127 | 64 | -11.9dB |
| 64 | 127 | -11.9dB | 127 | 32 | -23.9dB |
| 32 | 127 | -23.9dB | 127 | 0 | $-\infty$ |
| 16 | 127 | -36.0dB | 64 | 64 | -23.9dB |
| 0 | 127 | $-\infty$ | 32 | 96 | -28.8dB |

- The Master Volume SysEx message is not specified in GM Level 1 (and the MMA is in the process of clarifying its application), so its implementation is optional at best.

Composer/Application Recommendations: Volume should be used to set the overall volume of the Channel prior to music data playback as well as for mixdown fader-style movements, while Expression should be used during music data playback to attenuate the programmed MIDI volume, thus creating diminuendos and crescendos. This enables a listener, after the fact, to adjust the relative mix of instruments (using MIDI volume) without destroying the dynamic expression of that instrument.

Details:

Description of Issue:

Use of volume (CC#7) and expression (CC#11) are required by GM Level 1, but there is a degree of confusion regarding their exact effect on sound levels, either singly or in combination. In addition, the Master Volume Universal System Exclusive command is not mentioned in GM Level 1, but is finding favor among some manufacturers.

Findings:

Not surprisingly, all hardware respondents said their devices responded to Continuous Controller #7. There was general agreement about how these two controllers interacted as well: In 9 cases, their values were combined (multiplied) to get the actual level. The recommended volume response curves for CC#7 (volume) and CC#11 (expression) used herein were provided to the General MIDI Working Group of the IASIG/MMA by Yamaha Corporation. Roland uses the same response curve, and other Japanese manufacturers who are members of the AMEI have agreed to do the same.

Of the 20 software respondents, all used CC#7 and 11 use CC#11. The largest number of software respondents (6) said they used CC#7 to set initial level and CC#11 for dynamic expression during music playback. In 2 other cases, CC#11 was set to a preset level and kept there.

Master Volume is supported by 6 hardware respondents, and 2 others have plans to include it in the future. Only 3 of the software respondents use it.

Response to Pan

- Immediate response to a Pan command (applying it to currently-sounding notes) should be supported.

Composer Recommendations: Until the above recommendation is universally implemented, composers of GM music files should be aware that sustained notes may not be panned on all devices.

Details:

Description of issue:

Correct response to the Pan (CC #10) command is not defined in the GM specification document. Some devices respond by immediately shifting the apparent position of all currently sounding notes (on the Channel), while others will not move a current sound (choosing to Pan only those notes received after the Pan command).

Findings:

Software makers seem to be more optimistic that sustained notes will be affected by Pan commands than the current state of hardware would indicate. 12 of the 20 software respondents expect Pan commands to be acted upon immediately, while only 5 of the 14 hardware respondents said that sustained notes will be affected by a Pan command (although two more said they were planning to implement sustained-note Pan on their next models). Though one could imagine cases where not-panning would be nice, one should assume (by default) a timely response to a Pan message.

Use of Bank Select Messages

- Bank Select (CC #0/32) should be *completely ignored* in GM Mode.

Composer Recommendations: Composers of GM music files should not assume that any voices other than the GM Sound Set are available and should therefore not use Bank Select messages. Variations on GM voices can be accomplished by altering the playing style or by using controllers to introduce variations into the music

Details:

Description of issue:

GM Level 1 defines only a single Sound Set of 128 instruments and does not mandate the use of the Bank Select controller (CC #0/32). Yet many GM instruments provide additional sounds, accessed by Bank Select commands (sometimes followed by Program Changes), and some GM devices automatically go out of GM mode when Bank Select messages are received.

Findings:

GM Synthesizer Issues

12 of the 14 hardware respondents recognize the Bank Select MSB (CC #0). Of those, 4 also recognize the Bank Select LSB (CC #32). In 3 cases, they are followed by a Program Change command in order to call up a “variation” on the sound — this is the GS approach. In 7 cases they choose non-GM banks, and in at least one case they specifically take the device out of GM mode. These commands are much less frequently used on percussion Channels: only 2 of the devices recognize Bank Select on Channel 10, and then to select a non-drum bank for the Channel.

Things are different on the software side: 12 of the software recipients do not use Bank Select at all. Of the others, 3 use CC#0, and 3 more also use CC#32.

Note: CC#0 and CC#32 were defined in 1990 as the Bank Select message and should not be used for any other purpose, separately or together. Transmission of only CC#0 or CC#32 is not a complete Bank Select message and should be discouraged.

Response to Program Changes

- Program Changes received during a sustained note should not cut off the note.

Composers/Application Recommendations: Despite the fact that most GM hardware will not cut off notes upon receipt of a Program Change message, the safest course of action is still to send these messages during silent portions of the music.

Details:

Some developers expressed concern that devices receiving a Program Change in the middle of a sustained note could cause the note to be cut off? This turned out to not be a problem— only 2 of the 14 hardware respondents report that a Program Change sent during a sustained note will cut off the note.

Aftertouch

- Channel Pressure (Aftertouch) response is a requirement of General MIDI, and should be used to add vibrato (or tremolo, if more appropriate) to voices. Manufacturers should assume that developers will use the *full* range of Aftertouch values, so high values of Aftertouch should not create unnatural amounts of vibrato.
- Other uses of Aftertouch such as volume or timbral change should be avoided.

Composer Recommendations: Composers of GM music files should not hesitate to use Aftertouch to add vibrato to voices; however, since there are no standards as to how much vibrato is to be applied with a given Aftertouch value, it is probably wise to err on the conservative side, lest listeners experience seasickness after a few bars. Some manufacturers also have chosen to implement Aftertouch as tremolo where appropriate to the instrument, so this should be considered by composers.

GM Synthesizer Issues

Details:

Description of Issue:

Response to Channel Pressure (Aftertouch) is a GM requirement, but no specifics are given as to how a device should respond.

Findings:

All but one manufacturer recognizes Aftertouch, and the majority of them use it to control either pitch-based vibrato depth or a more complex set of vibrato parameters. Five manufacturers said their Aftertouch response was programmable, and it is probably safe to assume that the default versions of their GM programs map Aftertouch to some form of vibrato.

Built-In Effects & Response to Effects Controllers

- Although not mandated by GM, manufacturers should feel free to provide onboard effects. The minimum suggested number of effects is two — Reverb and Chorus — though more may be provided, at the manufacturer's discretion.
- Controllers 91 and 93 should be used to set Reverb and Chorus send levels in order to maintain compatibility with current defacto standards (GS and XG, among others).
- Default effects send levels (those used on power-up or upon receipt of a GM Mode On message) should be moderate (value = 64 or less).
- Unassigned Controllers should not be used (to switch effects or for any other purpose).

Composer Recommendations: If including effects controllers can enhance the playback of a file, while at the same time the lack of effects will not harm it, then composers should feel free to use them. Because it cannot be assumed that effects send or return levels will default to any predictable value when a GM device is turned on or switched to GM mode, composers should place initial values — for safety purposes in the lower end of the range — for Controllers 91 and 93 on all Channels in “prep bars” at the beginning of music files.

Details:

Description of Issue:

Reverb, chorus, delay, flanging, EQ, etc. are to be found in just about every GM device on the market, since they can improve the sound significantly at relatively modest cost. GM Level 1, however, includes not a single mention of effects, and so manufacturers are on their own as to what effects to include, and how to make them accessible to the user.

Findings:

GM Synthesizer Issues

A majority of music industry respondees reported their products have effects. 8 of the respondents reported their devices could produce two effects simultaneously, and 3 said theirs could handle three or more. The GS (and base-level XG) usage of two effects — reverb and chorus — are most common in the GM community.

Virtually all of these devices set their reverb and chorus send levels via CC#91 and CC#93, respectively. Software respondents are a bit more conservative; only 7 use these controllers in their files. Though other effects are available in some of the hardware, none of them were addressed by the software respondents.

Only one hardware respondent reported that the effects on their devices are not adjustable. 3 said they were adjustable on a global or per-program basis, while 9 said they were adjustable on a per-Channel basis. Several hardware respondents use unassigned controllers or NRPN's to select effects programs or variations, while others use SysEx messages.

The default settings of the effects varied widely among the hardware respondents, and effects are not required for GM, so no obvious recommendation (other than to follow the Sound Canvas and XG guidelines) is evident from this survey.

Additional Notes About Controllers

- Factory presets should generally be set up with all controllers (except Volume [CC #7] and Expression [CC #11]) set to 0 or 64 (center), as the case may be.
- The All Sound Off (CC#120) Channel Mode message is recommended for all MIDI devices, though not listed as a requirement in the GM System Level 1 specification.
- Non-standardized adjustments should be made with NRPNs or SysEx, as defined by the MIDI Specification.

Composer Recommendations: Composers of GM music files should assume that the only controllers available to them are those listed in GM Level 1 — with the addition of Data Entry (CC#6 and, if necessary, CC #38) for adjusting RPNs. Use of non-standard controllers for special purposes should be restricted to systems (applications) where the MIDI data is not intended for playback on other systems.

Details:

Appendix A presents a detailed listing of the controllers used in surveyed GM hardware devices. What is clear from this data is that virtually all such devices support all the controllers and Channel Mode messages required by GM Level 1. Most also implement those described in Roland's GS and Yamaha's base-level XG command sets (including Bank Select [CC #0/32], Data Entry [CC #6/38], Sostenuuto [CC #66], Soft Pedal [CC #67], Reverb Send Level [CC #91], and Chorus Send Level [CC #93]).

GM Synthesizer Issues

Among software respondents, 2 replied that they include RPNs in their files, and one replied that they use “unassigned” (non-defined) controllers for internal functions. Appendix B presents a summary of common NRPN messages for “voice editing”.

Additional Instrument Sounds (Extensions to GM)

- Additions (or variations) to the GM Sound Set should not be accessible while the device is in GM mode.
- In order to maintain some degree of standardization among GM devices, organization of and access to variation sounds may be most appropriate if done in the manner of GS and/or XG specifications.

Composer Recommendations: Composers of GM music files should assume there are no other sounds available besides the GM Sound Set, unless they are writing for specific platforms.

Details:

Exactly half of the devices surveyed contain from anywhere from 32 to 500+ additional sounds besides the GM sound set. There was no apparent consensus on how these sounds are laid out: only two manufacturers (besides Roland) mentioned GS’s “variations” scheme, and the rest use their own structure. Yamaha has since introduced a largely compatible structure with their XG format, but there are sufficient variations between XG and GS (and GM) to require an additional document describing this issue.

Additional Drum Sounds & Kits (Extensions to GM)

- Extra drum sounds (additions or variations to the GM Percussion Map) should not be accessible while the device is in GM mode.
- In order to maintain some degree of standardization among GM devices, organization of and access to variation sounds may be most appropriate if done in the manner of GS and/or XG specifications.

Composer Recommendations: Composers of GM music files should not use variation kits (via program changes, etc.) or extended drum notes unless absolutely sure that they will not result in unacceptable degradation of the performance on dissimilar instruments. For example, the gentle Roland brush snare sound will be replaced with a strong snare hit on most GM devices, which would generally be unacceptable to the composer.

Details:

The GS approach to drum kits is very popular: 7 devices provide extra sets in conformity with the GS guidelines, and subsets or approximations of the GS sets are found in 8 more. Only 2 devices reported that they had no additional drum sounds besides the standard GM set. But how the additional sets are accessed is not as clear

GM Synthesizer Issues

cut. 6 use Program Change commands (as per GS), 2 use Bank Select by itself (a practice specifically prohibited by the MIDI Specification), and 2 use a combination of the two. Almost all devices use notes outside of the GM Percussion Map range to access additional sounds, but it is unclear if there is any consensus therein.

Response to Note-off on Channel 10 (Percussion)

- Only those two GM percussion sounds whose duration is most naturally under player control — long whistle and long Guiro — should respond to note-offs on Channel 10. *Note: The MIDI Specification requires that all Note-On commands have a corresponding Note-Off command, and it is assumed that all MIDI transmitters will comply with this requirement)*

Composer Recommendations: There is little harm (musically speaking) sending a note-off message to a drum (one-shot) that will be ignored, but composers of GM music files should also assume that these messages may not work on all GM devices and author accordingly.

Details:

Description of Issue:

In musical context, percussion sounds are typically of defined length, in comparison to other instruments which have a variable sustain segment under composer control. Are any of the percussion sounds in a GM device cut off upon receipt of a Note-off command? This is of particular importance if composing percussion tracks with drum pads which have a short, fixed-length, note duration.

Findings:

Only 3 of the 14 respondents said that any of their GM percussion sounds respond to note-off commands. (Somewhat more said this applies to non-GM percussion sounds.) The sounds in question, when they were specified, included whistle, long Guiro, and open cymbals, with no apparent consistency.

Mutually-Exclusive Percussion

- Two mutually-exclusive groups for drum sounds are recommended: open/pedal/closed hi-hat and open/mute triangle. Additional groups of mutually-exclusive drum sounds may be included as long as those groupings make sense musically.

Composer Recommendations: Composers of GM music files can assume that the two above-named mutually-exclusive groups are supported by GM devices but should not assume the presence of other groups.

Details:

GM Synthesizer Issues

Description of Issue:

In order to support realism expectations, manufacturers set up certain groups of sounds in the percussion set to be mutually exclusive, so that playing a sound in the group cuts off any other previously-played sound in the group (as would naturally happen).

Findings:

12 of the 14 respondents use one or more mutually-exclusive groups for their GM percussion sounds. GS, for example, mandates several mutually exclusive groups: high/low whistle, long/short Guiro, “open/mute” cuica, open/mute triangle, and open/pedal/closed hi-hat. (Another pair, open/mute surdo, uses sounds not included in the GM Percussion Map.) Besides Roland, one other manufacturer includes all of the GS groups. 2 others include 3 of the GS groups, and 2 more include 2 of the GS groups (specifically hi-hat and triangle). 5 more have mutually-exclusive groups but did not specify what they were, and one allows users to define their own groups.

MMA GM Music File Issues

File Formats and Editing Capability

- SMFs should be considered editable, and if composers want their files *not* to be editable by users, they should use proprietary formats.
- Files which may be edited should avoid Program Changes within the body of the music, which could be lost in editing, resulting in playback with incorrect sounds. Likewise, authors should avoid controllers or notes hanging over bar lines, which could result in unexpected articulation and stuck notes after editing.

The issue: What provisions need to be made so that GM files can be edited by users? If a GM music file is user-editable, how can you enable chunks of files to be moved around while making sure that Program Changes and controller messages are preserved in their correct places? Can editing be prevented?

Findings: Exactly half of the software respondents said their files were not editable by users. Of these, 4 distribute files in a proprietary (i.e., non-translatable) format, and 5 are read-only files, either on a CD-ROM, hidden in a CD-ROM or Windows Resource, or in an unspecified form. One respondent puts a copyright notice meta-event into their files.

Of the files that are editable, all are provided in SMF format. Only one respondent stated their files are in Type 1 format, and one stated their files are in Type 0 format; the rest did not specify a type.

Only one respondent said that documentation is included with their software explaining the issues for editing and providing instructions on how to deal with them. One respondent said “it should be up to the sequencer software”.

MIDI Player Control: Starting in the middle

- MIDI “player” or driver software should determine whether or not a GM music file can be started in the middle.
- Players should be capable of chasing controllers and program changes, either by scanning the file backwards from the starting point (“walking” the file) or by using special setup files. If using the former method, the scanning code must be fast and have a high level of priority in order to avoid long delays.

The issue: Since MIDI is a serial data stream, special care must be taken when starting a sequence in the middle, so that crucial commands that normally appear at the beginning of the sequence, such as Program Changes and controller settings, are not overlooked when the music starts to play.

Findings: 6 software application respondents had a simple answer to this: they don’t allow files to be started in the middle. Of those who do, 5 said before they play the file they scan (or “walk”) the file backwards from the designated starting point, and

MMA GM Music File Issues

transmit appropriate commands as they are found. 3 allow users to start the files at specific markers, and when they do, a special short setup file containing the necessary information is transmitted first.

File Data: Prep bars

- Prep bars should not be used where synchronization and exact starting time is an issue.
- Prep bars should be as short as possible (a few clock ticks should suffice in most situations)

The issue: It can be helpful for a GM sequence to be preceded with a preparatory (or “prep”) bar of some length so that the Turn GM System On message can be transmitted and initial values for controllers, Program Changes, pitchbend, Aftertouch, and other parameters can be set before the music starts to play. But prep bars can cause problems when there are timing issues to be considered, such as if MIDI file is used in sync with some visual. Should such a bar be used, and, if so, how long should it be?

Findings: There is a lot of variation found in how prep bars are used. Of those who use them, 6 use one complete 4/4 bar or more, while 4 try to minimize the amount of time necessary to start a file by making the prep bar very short, measured in a few clock “ticks” — for example, 9 ticks where 1 tick = 1/480 beat.

Obviously if music is to be synced with visuals or used for scene transitions — prep bars should not be used, or at least kept as short as possible. Composers should bear in mind that rarely will all 16 MIDI Channels be called upon to play on the downbeat of a sequence, so only the tracks playing at the beginning need to be initialized right away, and the time required to do that in most cases will be negligible. The initialization information for other tracks can be transmitted after the sequence starts, as long as it is sent before they need to play.

File Data: Pickup bars

- Pickup bars should be as brief as possible, set to the minimal time signature required (generally, 1/4 or 3/8 will suffice).
- A time signature meta-event should be inserted at the end of the pickup bar in order to set the correct time signature for the body of the music to follow.

The issue: Often a sequence will start out with a “pickup” — a group of notes shorter than a bar line that precede the first bar, such as the three eighth-notes at the beginning of “Seventy-Six Trombones.” Should this pickup be in a short bar by itself, or should it be the last part of a standard-length bar which has blank space at the beginning?

MMA GM Music File Issues

Findings: 5 software respondents said they use a full bar at the beginning of the sequence, and leave the beats before the pickup blank. 4 said they give the pickup bar its own time signature, equivalent to its length (in the above example, 3/8), and then change the time signature for subsequent bars. 4 said that it depended on the situation, and 3 on whether the start time or synchronization of the sequence was critical. One said they don't concern themselves with the barlines at all, and just "let the notes fall where they may".

File Data: SMF Marker Event

- Markers (an SMF Meta Event) may be used for any purpose, but a specific response to markers should not be assumed.

The issue: The correct use of Markers (Meta-Events under the Standard MIDI Files Recommended Practice) is unclear in the SMF document. How are they being used?

Findings: 3 software respondents said they use markers along with a short setup file (as described in the previous topic) for alternate starting points. 2 use them to synchronize sound effects, visuals, etc. (audio and other non-MIDI events are being considered for inclusion in a future version of SMF). 2 use them for internal purposes, and 2 will use them in their products' "next evolution." One respondent uses them to designate loop points, and another puts them on a separate track where they denote program changes (no details were given on this rather odd statement).

File Data: Other Meta-Events

- Copyright information (text) should be placed in the MIDI file using the Copyright Meta-Event.
- Song Titles should be placed on the MIDI file using the Sequence/Track Name event on the first track or in a Type 0 file.
- Meta-Events should not be used for proprietary purposes (except when used in closed systems such as video game consoles where the files can not be played on an incompatible device.)

The issue: How are other Meta-Events being used?

Findings: The largest number of respondents by far — 7 — are using the Copyright Notice Meta-Event. One other is putting a copyright notice within the track name list. 5 are using Meta-Events for unspecified or internal purposes. 4 are using Lyrics. 3 are using Track Names, and 3 are using "Titles," presumably Sequence/Track Name on the first track or in a Type 0 file. One is using Cue Points for alternate starting points.

File Data : Channel Assignments

- No specific assignment scheme (including the many GS, XG and variants) can be recommended as a sole scheme for all musical performances. However, new Meta-Events could be added to the Standard MIDI File Recommended Practice in future to identify parts regardless of Channel, allowing file players to intelligently map parts to playback Channels as needed to provide the best possible user interaction.

The issue: Besides the restriction that Channel 10 be reserved for key-based percussion, are there any other ways to designate Channels for specific instruments in a General MIDI sequence that make sense? That way, a user (or a hardware file player) can know how tracks are assigned (and which to mute or solo, for example)?

Findings: 11 respondents said they use no special designations for MIDI Channels in a sequence. Of the others, each had their own idea of how Channels should be used.

Since each file is designed for a different purpose, there is no assignment method which would serve all users. Instead, a recent proposal is that the file could be encoded with information which indicates which of the common musical “parts” appears on which Channels at which times. For example, the file could include an event which reports that following segment on Channel 2 contains the Bass Part, while the segment on Channel 3 is the Right-Hand Piano Part, Channel 4 is the Left-Hand Piano, etc. This can be changed throughout the piece as necessary, and the parts may be assigned to totally different Channels in another piece. This will enable devices (and users) to easily determine what parts to play/mute (etc.) in music-minus-one, music education, and other applications. However, this is not yet an MMA recommended practice.

File Data: Multiple Devices (non-GM hardware)

- Authors wishing to address multiple platforms should create different files for the different platforms.
- Files authored to Microsoft’s (now defunct) “Dual-Mode” format should be marked using Microsoft’s Mark-MIDI utility.
- Files authored for Roland GS or Yamaha XG should include the appropriate (GS or XG) reset events, but the GM System On message is still required for all GM devices. See Roland or Yamaha guidelines for the correct usage of these messages.
- MIDI file players should be capable of remapping music files based upon the identity and configuration of the target device (new Meta-Events may be added to the Standard MIDI File Recommended Practice for this purpose).

The issue: Composers writing for PC applications may need to write music that can be played on multiple (not just GM) formats. Should they combine all of the formats they want to address in one file.

MMA GM Music File Issues

Findings: Apparently there are many ways to address this issue. Three respondents produce different versions for the various platforms they want to address. Three depend on system software (i.e. Microsoft's "MIDI Mapper") to send data to different devices. Three respondents use proprietary Channel-mapping schemes and/or voice-allocation algorithms. One respondent uses a single format and depends on the software driver to mimic General MIDI on other formats. Yet another respondent claims that tracks for different platforms are assignable by a port event.

Microsoft's Multimedia PC (MPC) specification for Windows 3.0 and 3.1 called for the use of a "Mark-MIDI" flag to specify if the file included "Base" (Channels 13-16, with percussion on 16) or "Extended" (Channels 1-10, with percussion on 10) performance data (or both). The Windows 95 multimedia documentation, however, recommends that this flag be omitted from music files, since GM Level 1 (using all 16 Channels, with percussion on 10) is specified as being the minimum performance standard.

Microsoft's MIDI File Player (MCI Sequencer) has been written to recognize MPC formatted files and ignore the base data in favor of playing only the extended data on the GM device (eliminating the need to disable certain Channels to avoid doubling-up of instruments). This practice should be followed by all file players, and be extended to apply to GS and XG file formats as well.

APPENDIX A:

Voice editing

The important issue of GM voice and drum sound editing may become standardized in the future, at which time RPNs will likely be assigned for that purpose. Until that time, manufacturers are free to assign NRPNs (the “proprietary” equivalent of RPNs) for this purpose. The following NRPNs are common to both GS and XG, but will also likely have an unpredictable effect, or no effect, on GM products:

| MSB | LSB | Description |
|-----|-----|---|
| 01h | 08h | Vibrato rate |
| 01h | 09h | Vibrato depth |
| 01h | 0Ah | Vibrato delay |
| 01h | 20h | Filter cutoff frequency |
| 01h | 21h | Filter resonance |
| 01h | 63h | Envelope attack rate |
| 01h | 64h | Envelope decay rate |
| 01h | 66h | Envelope release rate |
| 18h | rr | Pitch coarse of specified drum sound |
| 1Ah | rr | Level of specified drum sound |
| 1Ch | rr | Panpot of specified drum sound |
| 1Dh | rr | Reverb send level of specified drum sound |
| 1Eh | rr | Chorus send level of specified drum sound |

Note: rr = drum sound note number

APPENDIX B:

Fat Labs Instrument Testing Specifications

The following outlines the testing requirements for Fat Labs Certification. Fat Labs certifies sound cards to be compatible with music written for GM instruments (specifically the Roland Sound Canvas). Their testing process is provided here as a reference for companies curious about what has already been done to validate GM compatibility, but is not an endorsement by the MMA of this particular process.

General

- a. The instrument system must comply with the Level 1 General MIDI spec.
- b. Polyphony lower than 24 simultaneous voices will be acceptable if listening to test files reveals that the formula used for dynamic voice allocation gives a suitable performance.
- c. The instrument system must default at power-up to General MIDI mode.
- d. The instrument system must default at power-up to a bend range equal to 2 half-steps.
- e. The instrument system must respond to controllers for Mod Wheel, Volume, Pan, Sustain Pedal, Pitch Bend Range, and All Notes Off. If it is claimed that the instrument system has reverb and chorus, it must respond to controllers for those effects as well.
- f. The instrument system must respond to Controller 7 while notes are sustained.
- g. For uses in advanced DOS games, the instrument system must have an MPU-401 interface in hardware, or must place minimal enough demands on the host system that we can be reasonably sure that all known software using General MIDI will work with the instrument system.

Individual Timbres

After the instrument system is set to a reference level and tuning standard, each timbre will be subjected to the following tests:

- a. Volume at Velocity 64, Different Octaves. For each octave (4 are tested: middle C, 2 octaves below, 2 octaves above, and one note that floats to 4 octaves above or below middle C, depending on the expected range of the instrument), a velocity offset of not more than ± 5 must produce a perceived volume that matches the Sound Canvas for most listeners.
- b. Volume at C3, Different Velocities. For each velocity (3 are tested: 17, 64, and 127), a velocity offset of not more than ± 5 must produce a perceived volume that matches the Sound Canvas for most listeners.
- c. Envelope. Time values for A, D, and R must be within 10% of the Sound Canvas's; for sustain, a velocity offset of not more than ± 5 must produce a perceived volume that matches the Sound Canvas for most listeners.

- d. Intonation. Intonation should be within ± 5 cents of the Sound Canvas. For timbres such as "Honky-Tonk Piano," that vary from the reference pitch, the instrument may be less detuned than the Sound Canvas.

Percussion

Each percussion instrument will be subjected to the following tests:

- a. Volume at C3, Different Velocities. For each velocity (3 are tested: 17, 64, and 127), a velocity offset of not more than ± 5 must produce a perceived volume that matches the Sound Canvas for most listeners.
- b. Envelope. Time values for A, D, and R must be within 10% of the Sound Canvas's; for sustain, a velocity offset of not more than ± 5 must produce a perceived volume that matches the Sound Canvas for most listeners.
- c. Panning. Percussion instruments must be panned to produce a perceived placement that, for most listeners, matches that of the Sound Canvas.