

# MIDI Implementation

V1.0 – 14.08.2026

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## Introduction

This document describes the MIDI implementation of the Manatee synthesizer, based on **Firmware version 1.09**. It covers every supported MIDI message and its precise format

Manatee is compatible with MIDI Version 1.0 and MPE (MIDI Polyphonic Expression).

The physical transport comprises three DIN-5 connectors: MIDI In, MIDI Thru, and MIDI Out, handling voice messages, real-time messages, and System Exclusive messages.

Firmware update SysEx scheme is intentionally out of scope and reserved for internal use.

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# 1 Standard channel voice messages

The following messages are supported on all 16 MIDI channels.

Running status is also supported (reusing of the last status for repeating messages).

| Message               | Status byte      | Data bytes     |
|-----------------------|------------------|----------------|
| Note Off              | 0x8n             | note, velocity |
| Note On               | 0x9n             | note, velocity |
| Polyphonic Aftertouch | 0xA <sub>n</sub> | note, pressure |
| Control Change        | 0xB <sub>n</sub> | CC#, value     |
| Program Change        | 0xC <sub>n</sub> | program        |
| Channel Pressure      | 0xD <sub>n</sub> | pressure       |
| Pitch Bend            | 0xE <sub>n</sub> | LSB, MSB       |

- **Per-part channel matching**  
Each of the 4 parts has its own SYSTEM\_PART\_MIDI\_CHANNEL setting (OFF, 1–16, or OMNI). A message on channel n is accepted by a part if it's configured to listen on this precise channel or the part is set to OMNI.
- **Note/velocity range split**  
SYSTEM\_PART\_MIDI\_NOTE\_LOW/HIGH and SYSTEM\_PART\_MIDI\_VELO\_LOW/HIGH are available for each part. Note On events outside a part's configured note or velocity window are dropped, enabling keyboard/velocity splits across parts on the same channel.
- **Note priority**  
SYSTEM\_MIDI\_NOTE\_PRIORITY (LAST, FIRST, LOWEST, HIGHEST) governs which note wins in mono/legato modes and which note is retained when the note list empties.
- **Local Control**  
CC 122 toggles SYSTEM\_MIDI\_LOCAL\_CONTROL (value 0 = off, 127 = on); other values are ignored.
- **Omni / Mono / Poly modes**  
CCs (CC 124/125/126/127) are implemented as specified by MIDI 1.0 and act on a part's channel assignment or play mode.
- **MPE support**  
a Multi can be flagged MULTI\_MPE. In that mode, MPE Lower / Upper zones are defined by both SYSTEM\_MPE\_LOWER\_MEMBERS / SYSTEM\_MPE\_UPPER\_MEMBERS member channel counts, with master channels fixed at MIDI channel 1 (lower zone) and channel 16 (upper zone) per the MPE specification. Per-note pitch bend range for each zone is settable via RPN, and CC 74 together with channel / poly aftertouch are treated as MPE per-note expression and routed to EXPRESSOR\_CC74 / EXPRESSOR\_AFTER with configurable depth (SYSTEM\_MPE\_CC74\_AMOUNT, SYSTEM\_MPE\_AFTER\_AMOUNT). Additional MPE expressiveness can be programmed within the presets using the Manatee expressors and modulation matrix.

## 2 Clock & transport

### 2.1- Real-time messages

Real-time status bytes (0xF8–0xFF) are handled inline, independent of running status.

| Message               | Byte |
|-----------------------|------|
| Timing Clock (24 PPQ) | 0xF8 |
| Start                 | 0xFA |
| Continue              | 0xFB |
| Stop                  | 0xFC |
| Active Sensing        | 0xFE |
| System Reset          | 0xFF |

- **Clock source**  
SYSTEM\_CLOCK\_SOURCE selects AUTO, INTERNAL, MIDI, or EXTERNAL (analog clock in). In MIDI/AUTO mode, incoming 0xF8 ticks are used to derive tempo.
- **Clock / Transport RX and TX gating**  
SYSTEM\_MIDI\_CLOCK\_RX/TX, SYSTEM\_MIDI\_TRANSPORT\_RX/TX. When TX is enabled the unit generates its own 0xF8 stream plus Start/Continue/Stop as transport state changes internally.
- **Active Sensing**  
RX side arms a 3s watchdog, if no MIDI message arrives within that window while sensing was active, the unit stops all voices. TX side, when SYSTEM\_MIDI\_SENSING\_TX is enabled, emits 0xFE every 300 ms.
- **Arpeggiator**  
The Arpeggiator can optionally echo its generated notes out over MIDI enabling it with SYSTEM\_MIDI\_ARP\_TX.

### 2.2- System Common messages

Two System Common messages round out clock/transport handling.

| Message               | Byte | Data bytes  |
|-----------------------|------|-------------|
| Song Position Pointer | 0xF2 | LSB, MSB    |
| Song Select           | 0xF3 | song number |

- **Song Position Pointer**  
converts the incoming 14-bit MIDI-beat count to the internal tick base (SPP x 6 = 6 internal ticks per MIDI beat).
- **Song Select**  
Selects and loads a Multi slot, slot = song % (STORE\_FACTORY\_MULTI\_SLOTS + STORE\_MULTI\_SLOTS). It walks factory Multis first, then user Multis.  
Gated by SYSTEM\_MIDI\_PGMC\_RX (the same enable flag as Program Change).

### 3 Bank Select & Program Change

Manatee uses a combination of Bank Select / Program Change messages to select the Preset used on a particular part. Whole Multis are selected using the specific Song Select message.

| Message           | Status/CC | Data bytes |
|-------------------|-----------|------------|
| Bank Select (MSB) | CC 0      | value      |
| Bank Select (LSB) | CC 32     | value      |
| Program Change    | 0xCn      | program    |

#### Bank Select MSB (CC 0)

Selects a bank across factory banks followed by user banks, wrapping.

bank = value % (STORE\_FACTORY\_PRESET\_BANKS + STORE\_PRESET\_BANKS).

#### Bank Select LSB (CC 32)

Is not implemented, sending it has no effect.

#### Program Change

The preset is loaded into the addressed part immediately.

preset = program % STORE\_PRESET\_SLOTS\_PER\_BANK.

Outgoing Program Change is likewise gated by SYSTEM\_MIDI\_PGMC\_TX, sent whenever the user changes a preset from the front panel.

#### Song Select (see §2)

Selects the Multi, it is the multitimbral equivalent to Program Change: it swaps all the 4 parts + their preset/mix assignment.

## 4 Control Change / CC support

CC handling has two independent, non-exclusive layers, both gated on RX by SYSTEM\_MIDI\_CC\_RX and on TX by SYSTEM\_MIDI\_CC\_TX.

### 4.1 MIDI-standard CCs

Handled directly regardless of parameter mapping:

| CC# | Name                  | Effect                                                                                             |
|-----|-----------------------|----------------------------------------------------------------------------------------------------|
| 0   | Bank Select (MSB)     | Sets part's active program bank                                                                    |
| 1   | Modulation Wheel      | Routed to EXPRESSOR_MODWHEEL                                                                       |
| 2   | Breath Controller     | Routed to EXPRESSOR_BREATHCTRL                                                                     |
| 4   | Foot Controller       | Routed to EXPRESSOR_FOOTCTRL                                                                       |
| 11  | Expression            | Routed to EXPRESSOR_EXPRESSION                                                                     |
| 64  | Sustain Pedal         | >64 = pedal down (holds notes)<br>+ routed to EXPRESSOR_SUSTAIN                                    |
| 74  | Timbre / Brightness   | Routed to EXPRESSOR_CC74<br>used also as the MPE per-note timbre dimension<br>when MULTI_MPE is on |
| 120 | All Sounds Off        | Immediately silences the part's voices<br>+ clears reverb tails                                    |
| 121 | Reset All Controllers | Resets expressors to default                                                                       |
| 122 | Local Control         | 0=off, 127=on                                                                                      |
| 123 | All Notes Off         | Note-off for all held notes on the part                                                            |
| 124 | Omni Mode Off         | Sets the part's channel to part index + 1                                                          |
| 125 | Omni Mode On          | Sets the part's channel to OMNI                                                                    |
| 126 | Mono Mode             | Forces PRESET_PLAY_MODE = MONO                                                                     |
| 127 | Poly Mode             | Forces PRESET_PLAY_MODE = POLY                                                                     |

### 4.2 Parameter-mapped CCs

A second table maps roughly 90 of the 128 CC onto synthesis parameters.

Receiving one of these CCs scales the 0-127 value into that parameter's native range and applies it live. See the full CC to Parameter table in **section 6**. The same table doubles as the NRPN reference, since NRPN is the superset.

Sending is symmetric: front-panel / edit changes to any parameter that has a CC assignment are sent back out when SYSTEM\_MIDI\_CC\_TX is enabled.

## 5 NRPN and RPN support

NRPN (Non-Registered Parameter Numbers) is implemented per MIDI 1.0 conventions using CC 98/99 (LSB/MSB) to select the parameter and CC 6/38 (Data Entry MSB/LSB) to set its value, tracked independently per MIDI channel.

- **CC 99 / 98 => NRPN MSB/LSB**  
loads a 14-bit parameter number for NRPN access
- 
- **CC 101 / 100 => RPN MSB/LSB**  
loads the same 14-bit register for RPN access
- 
- **CC 6 / 38 => Data Entry MSB/LSB**  
loads a high resolution 14-bit value.  
Receiving the MSB is enough to affect the parameter although receiving the LSB adds the wanted additional resolution and re-applies the value to whichever NRPN/RPN is currently selected.

## 5.1 The NRPN number is the parameter ID

Unlike a conventional synth with a separate NRPN lookup table, Manatee's NRPN number is the internal parameter ID directly:

- **0x0000: PRESET\_ID\_BASE**  
per-preset, per-part sound parameters
- **0x0400: MULTI\_ID\_BASE**  
multi-level parameters: reverb, MPE flag, name...
- **0x0800: MULTI\_PART\_ID\_BASE**  
per-part mix parameters: level, pan, sends, preset slot...
- **0x1000: SYSTEM\_ID\_BASE**  
global device settings
- **0x2000: SYSTEM\_PART\_ID\_BASE**  
per-part device/MIDI settings: channel, note range...

The reception of NRPN messages is gated by SYSTEM\_MIDI\_NRPN\_RX. Any parameter in any of the five ranges above can be addressed by NRPN, including ones with no CC equivalent. Values are scaled from 0..0x3FFF linearly onto the parameter's native [min, max] range.

**Section 6** below enumerates the Preset, Multi, and Multi-Part ranges (the performance-relevant parameters). For global / system parameters, compute the NRPN number with:  
number = SYSTEM\_ID\_BASE + index (or SYSTEM\_PART\_ID\_BASE + index for per-part settings).  
Outgoing NRPN (SYSTEM\_MIDI\_NRPN\_TX) packs the param as NRPN MSB/LSB followed by the scaled value as Data Entry MSB/LSB, all on the addressed channel.

## 5.2 Implemented RPNs

| RPN    | Name                            | Behavior                                                                                                                                                              |
|--------|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0x0000 | Pitch Bend Sensitivity          | Sets the channel's bend range in semitones, MSB only.<br>In MPE mode, writing this on a zone's master channel instead sets SYSTEM_MPE_LOWER / UPPER_MASTER_BENDRANGE. |
| 0x0006 | MPE Configuration Message (MCM) | Standard MIDI MPE zone-configuration RPN.                                                                                                                             |

All other RPNs (Fine Tuning, Tuning Bank/Program Select, etc.) are not implemented.

## 6 Full CC / NRPN parameter table

To compute an NRPN number:

NRPN number = PRESET\_ID\_BASE (0x0000) / MULTI\_ID\_BASE (0x0400) /  
MULTI\_PART\_ID\_BASE (0x0800) + the row's index in that section.

A dash in the CC column means the parameter is only accessible through NRPN or Sysex.

### 6.1 Preset parameters — base 0x0000

| NRPN   | Parameter              | CC        | Type         |
|--------|------------------------|-----------|--------------|
| 0x0000 | Category               | -         | CATEGORY     |
| 0x0001 | Name char 0            | -         | CHAR         |
| 0x0002 | Name char 1            | -         | CHAR         |
| 0x0003 | Name char 2            | -         | CHAR         |
| 0x0004 | Name char 3            | -         | CHAR         |
| 0x0005 | Name char 4            | -         | CHAR         |
| 0x0006 | Name char 5            | -         | CHAR         |
| 0x0007 | Name char 6            | -         | CHAR         |
| 0x0008 | Name char 7            | -         | CHAR         |
| 0x0009 | Play Mode              | -         | PLAYMODE     |
| 0x000A | Play Volume            | -         | UNIPOLAR_8B  |
| 0x000B | Unison Detune          | 30 (0x1E) | UNIPOLAR_8B  |
| 0x000C | Unison Width           | 31 (0x1F) | UNIPOLAR_8B  |
| 0x000D | Glide Time             | 5 (0x05)  | UNIPOLAR_5B1 |
| 0x000E | Vibrato Rise           | -         | UNIPOLAR_5B1 |
| 0x000F | Vibrato Rate           | 76 (0x4C) | UNIPOLAR_5B1 |
| 0x0010 | Vibrato Depth          | 77 (0x4D) | MODWHEELER   |
| 0x0011 | Tremolo Rise           | -         | UNIPOLAR_5B1 |
| 0x0012 | Tremolo Rate           | 78 (0x4E) | UNIPOLAR_5B1 |
| 0x0013 | Tremolo Depth          | 79 (0x4F) | MODWHEELER   |
| 0x0014 | Arp Mode               | -         | ARP_MODE     |
| 0x0015 | Arp Octaves            | -         | UNIPOLAR_3B  |
| 0x0016 | Arp Pattern            | -         | ARP_PATTERN  |
| 0x0017 | Arp Grid               | -         | ARP_GRID     |
| 0x0018 | Arp Gate               | -         | ARP_GRID     |
| 0x0019 | Arp Mask               | -         | ARP_MASK     |
| 0x001A | Oscillator Coarse      | 27 (0x1B) | SEMITONE     |
| 0x001B | Oscillator Fine        | 28 (0x1C) | CENTS        |
| 0x001C | Oscillator Balance     | 29 (0x1D) | BIPOLAR_7B   |
| 0x001D | Generator Wavelet      | 70 (0x46) | WAVELET      |
| 0x001E | Generator Spectrum     | 16 (0x10) | SPECTRUM     |
| 0x001F | Generator Rotation     | 17 (0x11) | BIPOLAR_8B   |
| 0x0020 | Generator Inversion    | 18 (0x12) | UNIPOLAR_8B  |
| 0x0021 | Generator Formant      | 19 (0x13) | BIPOLAR_8B   |
| 0x0022 | Generator Level        | 80 (0x50) | UNIPOLAR_8B  |
| 0x0023 | Sub Carrier            | 20 (0x14) | CARRIER      |
| 0x0024 | Sub Content            | 21 (0x15) | UNIPOLAR_8B  |
| 0x0025 | Sub Content (LFO2 mod) | 22 (0x16) | UNIPOLAR_8B  |

| <b>NRPN</b> | <b>Parameter</b>      | <b>CC</b> | <b>Type</b>     |
|-------------|-----------------------|-----------|-----------------|
| 0x0026      | Sub FM Rate           | 23 (0x17) | FM_RATE         |
| 0x0027      | Sub FM to EnvF Amount | 24 (0x18) | UNIPOLAR_8B     |
| 0x0028      | Sub Coarse            | 25 (0x19) | SEMITONE        |
| 0x0029      | Sub Level             | 81 (0x51) | UNIPOLAR_8B     |
| 0x002A      | Noise Enable          | 60 (0x3C) | SWITCH          |
| 0x002B      | Noise Rate            | 61 (0x3D) | UNIPOLAR_8B     |
| 0x002C      | Noise Color           | 62 (0x3E) | BIPOLAR_7B      |
| 0x002D      | Noise Level           | 83 (0x53) | UNIPOLAR_8B     |
| 0x002E      | Ring-Mod Enable       | 59 (0x3B) | SWITCH          |
| 0x002F      | Ring-Mod Level        | 82 (0x52) | UNIPOLAR_8B     |
| 0x0030      | LF01 Rate             | 44 (0x2C) | UNIPOLAR_8B     |
| 0x0031      | LF01 Phase            | -         | LFO_PHASE       |
| 0x0032      | LF01 Amount           | 45 (0x2D) | BIPOLAR_8B      |
| 0x0033      | LF01 Rise             | -         | TIME_6B         |
| 0x0034      | LF01 Fall             | -         | TIME_6B         |
| 0x0035      | LF01 Duration         | -         | CLOCK_RATE      |
| 0x0036      | LF01 Resync           | -         | CLOCK_RATE      |
| 0x0037      | LF01 Clocked          | -         | SWITCH          |
| 0x0038      | LF01 Shape A          | 46 (0x2E) | LFO_SHAPE       |
| 0x0039      | LF01 Shape B          | 47 (0x2F) | LFO_SHAPE       |
| 0x003A      | LF01 Shape C          | 48 (0x30) | LFO_SHAPE       |
| 0x003B      | LF01 Expressor        | -         | EXPRESSOR       |
| 0x003C      | LF01 Target           | -         | LFO_PARA_TARGET |
| 0x003D      | LF02 Rate             | 49 (0x31) | UNIPOLAR_8B     |
| 0x003E      | LF02 Phase            | -         | LFO_PHASE       |
| 0x003F      | LF02 Amount           | 50 (0x32) | BIPOLAR_8B      |
| 0x0040      | LF02 Rise             | -         | TIME_6B         |
| 0x0041      | LF02 Fall             | -         | TIME_6B         |
| 0x0042      | LF02 Duration         | -         | CLOCK_RATE      |
| 0x0043      | LF02 Resync           | -         | CLOCK_RATE      |
| 0x0044      | LF02 Clocked          | -         | SWITCH          |
| 0x0045      | LF02 Shape A          | 51 (0x33) | LFO_SHAPE       |
| 0x0046      | LF02 Shape B          | 52 (0x34) | LFO_SHAPE       |
| 0x0047      | LF02 Shape C          | 53 (0x35) | LFO_SHAPE       |
| 0x0048      | LF02 Expressor        | -         | EXPRESSOR       |
| 0x0049      | LF02 Target           | -         | LFO_PARA_TARGET |
| 0x004A      | LFOF Rate             | 54 (0x36) | UNIPOLAR_8B     |
| 0x004B      | LFOF Phase            | -         | LFO_PHASE       |
| 0x004C      | LFOF Amount           | 55 (0x37) | BIPOLAR_8B      |
| 0x004D      | LFOF Rise             | -         | TIME_6B         |
| 0x004E      | LFOF Fall             | -         | TIME_6B         |
| 0x004F      | LFOF Duration         | -         | CLOCK_RATE      |
| 0x0050      | LFOF Resync           | -         | CLOCK_RATE      |
| 0x0051      | LFOF Clocked          | -         | SWITCH          |
| 0x0052      | LFOF Shape A          | 56 (0x38) | LFO_SHAPE       |
| 0x0053      | LFOF Shape B          | 57 (0x39) | LFO_SHAPE       |
| 0x0054      | LFOF Shape C          | 58 (0x3A) | LFO_SHAPE       |

| <b>NRPN</b> | <b>Parameter</b>           | <b>CC</b>  | <b>Type</b>     |
|-------------|----------------------------|------------|-----------------|
| 0x0055      | LFOF Expressor             | -          | EXPRESSOR       |
| 0x0056      | LFOF Target                | -          | LFO_TARGET      |
| 0x0057      | Envelope S Attack          | 73 (0x49)  | TIME            |
| 0x0058      | Envelope S Sustain         | 104 (0x68) | UNIPOLAR_8B     |
| 0x0059      | Envelope S Release         | 72 (0x48)  | TIME            |
| 0x005A      | EnvF Decay                 | 105 (0x69) | TIME            |
| 0x005B      | EnvF Velocity (aftertouch) | -          | UNIPOLAR_6B1    |
| 0x005C      | EnvF Amount                | 106 (0x6A) | BIPOLAR_8B      |
| 0x005D      | EnvF Attack Velocity       | -          | UNIPOLAR_8B     |
| 0x005E      | EnvF Decay Velocity        | -          | UNIPOLAR_8B     |
| 0x005F      | EnvF Mode                  | -          | ENV_MODE        |
| 0x0060      | EnvF Reset                 | -          | SWITCH3         |
| 0x0061      | EnvF Cycle                 | 107 (0x6B) | SWITCH3         |
| 0x0062      | EnvF Expressor             | -          | EXPRESSOR       |
| 0x0063      | EnvF Target                | -          | LFO_TARGET      |
| 0x0064      | EnvA Decay                 | 108 (0x6C) | TIME            |
| 0x0065      | EnvA Velocity (aftertouch) | -          | UNIPOLAR_6B1    |
| 0x0066      | EnvA Amount                | 109 (0x6D) | BIPOLAR_8B      |
| 0x0067      | EnvA Attack Velocity       | -          | UNIPOLAR_8B     |
| 0x0068      | EnvA Decay Velocity        | -          | UNIPOLAR_8B     |
| 0x0069      | EnvA Mode                  | -          | ENV_MODE        |
| 0x006A      | EnvA Reset                 | -          | SWITCH3         |
| 0x006B      | EnvA Cycle                 | 110 (0x6E) | SWITCH3         |
| 0x006C      | EnvA Expressor             | -          | EXPRESSOR       |
| 0x006D      | EnvA Target                | -          | LFO_TARGET      |
| 0x006E      | Filter Model               | 85 (0x55)  | FILTER_MODEL    |
| 0x006F      | Filter Cutoff              | 74 (0x4A)  | UNIPOLAR_8B     |
| 0x0070      | Filter Resonance           | 71 (0x47)  | UNIPOLAR_8B     |
| 0x0071      | Filter EnvF Amount         | 75 (0x4B)  | UNIPOLAR_8B     |
| 0x0072      | Filter LFOF Amount         | 86 (0x56)  | UNIPOLAR_8B     |
| 0x0073      | Filter Reserved            | -          | FREE            |
| 0x0074      | Filter Track               | -          | FILTER_TRACKING |
| 0x0075      | Resonator Model            | 87 (0x57)  | RC_MODEL        |
| 0x0076      | Resonator Cutoff           | 88 (0x58)  | UNIPOLAR_8B     |
| 0x0077      | Resonator Track            | -          | RC_TRACKING     |
| 0x0078      | Drive Model                | 89 (0x59)  | DRIVE_MODEL     |
| 0x0079      | Drive Gain                 | 90 (0x5A)  | UNIPOLAR_8B     |
| 0x007A      | Drive Mix                  | 91 (0x5B)  | BIPOLAR_7B      |
| 0x007B      | Delay Model                | 63 (0x3F)  | DELAY_MODEL     |
| 0x007C      | Delay Time                 | 92 (0x5C)  | UNIPOLAR_8B     |
| 0x007D      | Delay Feedback             | 93 (0x5D)  | UNIPOLAR_8B     |
| 0x007E      | Delay Vibe                 | -          | VIBE            |
| 0x007F      | Delay Polarity             | -          | POLARITY        |
| 0x0080      | Delay Color                | 95 (0x5F)  | BIPOLAR_7B      |
| 0x0081      | Delay Mono                 | -          | SWITCH3         |
| 0x0082      | Delay Level                | 94 (0x5E)  | UNIPOLAR_8B     |
| 0x0083      | Delay Duration             | -          | CLOCK_RATE      |

| <b>NRPN</b> | <b>Parameter</b>       | <b>CC</b>  | <b>Type</b>  |
|-------------|------------------------|------------|--------------|
| 0x0084      | Delay Resync           | -          | CLOCK_RATE   |
| 0x0085      | Delay Clocked          | -          | SWITCH       |
| 0x0086      | EQ1 Model              | 111 (0x6F) | EQ_MODEL     |
| 0x0087      | EQ1 Center             | 112 (0x70) | UNIPOLAR_8B  |
| 0x0088      | EQ1 Gain               | 113 (0x71) | UNIPOLAR_8B  |
| 0x0089      | EQ2 Model              | 114 (0x72) | EQ_MODEL     |
| 0x008A      | EQ2 Center             | 115 (0x73) | UNIPOLAR_8B  |
| 0x008B      | EQ2 Gain               | 116 (0x74) | UNIPOLAR_8B  |
| 0x008C      | Mod Matrix 1 Source    | -          | MACRO_SOURCE |
| 0x008D      | Mod Matrix 1 Amount    | 117 (0x75) | BIPOLAR_8B   |
| 0x008E      | Mod Matrix 1 Expressor | -          | EXPRESSOR    |
| 0x008F      | Mod Matrix 1 Target    | -          | MACRO_TARGET |
| 0x0090      | Mod Matrix 2 Source    | -          | MACRO_SOURCE |
| 0x0091      | Mod Matrix 2 Amount    | 118 (0x76) | BIPOLAR_8B   |
| 0x0092      | Mod Matrix 2 Expressor | -          | EXPRESSOR    |
| 0x0093      | Mod Matrix 2 Target    | -          | MACRO_TARGET |
| 0x0094      | Mod Matrix 3 Source    | -          | MACRO_SOURCE |
| 0x0095      | Mod Matrix 3 Amount    | 119 (0x77) | BIPOLAR_8B   |
| 0x0096      | Mod Matrix 3 Expressor | -          | EXPRESSOR    |
| 0x0097      | Mod Matrix 3 Target    | -          | MACRO_TARGET |
| 0x0098      | Spectrum Snapshot A    | -          | FREE         |
| 0x0099      | Spectrum Snapshot B    | -          | FREE         |
| 0x009A      | Spectrum Snapshot C    | -          | FREE         |
| 0x009B      | Spectrum Snapshot D    | -          | FREE         |
| 0x009C      | LF01 One-Shot          | -          | SWITCH       |
| 0x009D      | LF02 One-Shot          | -          | SWITCH       |
| 0x009E      | LF0f One-Shot          | -          | SWITCH       |
| 0x009F      | Revision               | -          | FREE         |

## 6.2 Multi parameters — base 0x0400

| <b>NRPN</b> | <b>Parameter</b> | <b>CC</b> | <b>Type</b>  |
|-------------|------------------|-----------|--------------|
| 0x0400      | Name char 0      | -         | CHAR         |
| 0x0401      | Name char 1      | -         | CHAR         |
| 0x0402      | Name char 2      | -         | CHAR         |
| 0x0403      | Name char 3      | -         | CHAR         |
| 0x0404      | Name char 4      | -         | CHAR         |
| 0x0405      | Name char 5      | -         | CHAR         |
| 0x0406      | Name char 6      | -         | CHAR         |
| 0x0407      | Name char 7      | -         | CHAR         |
| 0x0408      | MPE Enable       | -         | SWITCH       |
| 0x0409      | Reverb Model     | -         | REVERB_MODEL |
| 0x040A      | Reverb Diffusion | -         | UNIPOLAR_8B  |
| 0x040B      | Reverb Feedback  | -         | UNIPOLAR_8B  |
| 0x040C      | Reverb Vibe      | -         | VIBE         |
| 0x040D      | Reverb Color     | -         | UNIPOLAR_6B1 |
| 0x040E      | Reverb Size      | -         | UNIPOLAR_8B  |

| <b>NRPN</b> | <b>Parameter</b> | <b>CC</b> | <b>Type</b> |
|-------------|------------------|-----------|-------------|
| 0x040F      | Reverb Mono      | -         | SWITCH3     |
| 0x0410      | Reverb Level     | -         | UNIPOLAR_8B |
| 0x0411      | Reserved 1       | -         | FREE        |
| 0x0412      | Reserved 2       | -         | FREE        |
| 0x0413      | Reserved 3       | -         | FREE        |
| 0x0414      | Reserved 4       | -         | FREE        |
| 0x0415      | Reserved 5       | -         | FREE        |
| 0x0416      | Reserved 6       | -         | FREE        |
| 0x0417      | Revision         | -         | FREE        |

### 6.3 Multi-Part parameters (4 per Multi) — base 0x0800

| <b>NRPN</b> | <b>Parameter</b> | <b>CC</b> | <b>Type</b>  |
|-------------|------------------|-----------|--------------|
| 0x0800      | Preset Index     | -         | PRESET_INDEX |
| 0x0801      | Preset Bank      | -         | PRESET_BANK  |
| 0x0802      | Coarse Tune      | -         | SEMITONE     |
| 0x0803      | Fine Tune        | -         | CENTS        |
| 0x0804      | Level            | 7 (0x07)  | UNIPOLAR_8B  |
| 0x0805      | Pan              | 10 (0x0A) | BIPOLAR_7B   |
| 0x0806      | Unused           | -         | FREE         |
| 0x0807      | Reverb Send      | 12 (0x0C) | UNIPOLAR_8B  |
| 0x0808      | Aux Send         | 13 (0x0D) | UNIPOLAR_8B  |
| 0x0809      | Main Send        | 14 (0x0E) | UNIPOLAR_8B  |
| 0x080A      | Origin Index     | -         | PRESET_INDEX |
| 0x080B      | Origin Bank      | -         | PRESET_BANK  |

### 6.4 System parameters — base 0x1000

| <b>NRPN</b> | <b>Parameter</b>       | <b>CC</b> | <b>Type</b>  |
|-------------|------------------------|-----------|--------------|
| 0x1000      | Master Level           | -         | UNIPOLAR_7B  |
| 0x1001      | Active Multi Slot      | -         | MULTI        |
| 0x1002      | Global Tuning          | -         | TUNING       |
| 0x1003      | Pitch Bend Range Up    | -         | UNIPOLAR_7B1 |
| 0x1004      | Pitch Bend Range Down  | -         | UNIPOLAR_7B1 |
| 0x1005      | Clock Source           | -         | CLOCK_SOURCE |
| 0x1006      | Clock PPQ              | -         | CLOCK_PPQ    |
| 0x1007      | Clock BPM              | -         | TEMPO        |
| 0x1008      | MPE Lower Zone Members | -         | UNIPOLAR_4B  |
| 0x1009      | MPE Upper Zone Members | -         | UNIPOLAR_4B  |
| 0x100A      | SysEx Device ID        | -         | DEVID        |
| 0x100B      | SysEx RX Enable        | -         | SWITCH       |
| 0x100C      | SysEx TX Enable        | -         | SWITCH       |
| 0x100D      | MIDI Local Control     | -         | SWITCH       |
| 0x100E      | MIDI Note Priority     | -         | PRIORITY     |
| 0x100F      | MIDI CC RX Enable      | -         | SWITCH       |
| 0x1010      | MIDI CC TX Enable      | -         | SWITCH       |
| 0x1011      | MIDI NRPN RX Enable    | -         | SWITCH       |

| NRPN   | Parameter                        | CC | Type           |
|--------|----------------------------------|----|----------------|
| 0x1012 | MIDI NRPN TX Enable              | -  | SWITCH         |
| 0x1013 | MIDI Program Change RX Enable    | -  | SWITCH         |
| 0x1014 | MIDI Program Change TX Enable    | -  | SWITCH         |
| 0x1015 | MIDI Clock RX Enable             | -  | SWITCH         |
| 0x1016 | MIDI Clock TX Enable             | -  | SWITCH         |
| 0x1017 | MIDI Transport RX Enable         | -  | SWITCH         |
| 0x1018 | MIDI Transport TX Enable         | -  | SWITCH         |
| 0x1019 | MIDI Active Sensing RX Enable    | -  | SWITCH         |
| 0x101A | MIDI Active Sensing TX Enable    | -  | SWITCH         |
| 0x101B | MIDI Arpeggiator Note TX Enable  | -  | SWITCH         |
| 0x101C | LCD Contrast                     | -  | UNIPOLAR_8B    |
| 0x101D | LCD Backlight Level              | -  | LCD_BACKLEVEL  |
| 0x101E | LED Brightness                   | -  | LED_BRIGHTNESS |
| 0x101F | Parameter Pots Mode              | -  | POT_MODE       |
| 0x1020 | Macro Pots Mode                  | -  | POT_MODE       |
| 0x1021 | Back-to-Home Behavior            | -  | SWITCH         |
| 0x1022 | Clock External Quantize          | -  | SWITCH3        |
| 0x1023 | Clock MIDI Quantize              | -  | SWITCH3        |
| 0x1024 | MPE Lower Zone Master Bend Range | -  | UNIPOLAR_7B    |
| 0x1025 | MPE Upper Zone Master Bend Range | -  | UNIPOLAR_7B    |
| 0x1026 | MPE Aftertouch Amount            | -  | UNIPOLAR_8B    |
| 0x1027 | MPE CC74 Amount                  | -  | UNIPOLAR_8B    |
| 0x1028 | Stay On Page                     | -  | SWITCH         |
| 0x1029 | Pitch Pot Mode                   | -  | PITCH_MODE     |
| 0x102A | Main Output Boost                | -  | BOOST          |
| 0x102B | Aux Output Boost                 | -  | BOOST          |
| 0x102C | Reserved 3                       | -  | FREE           |
| 0x102D | Reserved 4                       | -  | FREE           |
| 0x102E | Reserved 5                       | -  | FREE           |
| 0x102F | Reserved 6                       | -  | FREE           |

## 6.5 System-Part (4 in total) parameters — base 0x2000

All 8 System-Part parameters. These repeat per part, but the receiving part is selected by which MIDI channel the message arrives on, not by the NRPN number itself:

| NRPN   | Parameter                | CC | Type         |
|--------|--------------------------|----|--------------|
| 0x2000 | MIDI Channel             | -  | MIDI_CHANNEL |
| 0x2001 | MIDI Note Range Low      | -  | UNIPOLAR_7B  |
| 0x2002 | MIDI Note Range High     | -  | UNIPOLAR_7B  |
| 0x2003 | MIDI Velocity Range Low  | -  | UNIPOLAR_7B  |
| 0x2004 | MIDI Velocity Range High | -  | UNIPOLAR_7B  |
| 0x2005 | MIDI Voice Booker        | -  | MIDI_BOOKER  |
| 0x2006 | MIDI Voice Stealer       | -  | MIDI_STEALER |
| 0x2007 | Output Routing           | -  | PART_ROUTING |

## 7 SysEx implementation

### 7.1 Framing

F0 00 21 2C 04 <deviceId> <service> <payload...> F7  
where 00 21 2C 04 is the Fred's Lab manufacturer ID.

- **DeviceID**  
matched against SYSTEM\_SYSEX\_DEVID (0-126), or 0x7F to address all devices.
- **RX and TX are gated** by SYSTEM\_SYSEX\_RX / SYSTEM\_SYSEX\_TX;  
a SysEx received while either is disabled is dropped.
- **Universal Non-Realtime Identity Request**  
F0 7E <deviceId> 06 01 F7

which replies with a standard **Identity Reply**

F0 7E <deviceId> 06 02 00 21 2C 04 00 00 00

<firmVerLSB> <firmVerMSB> <bootVerLSB> <bootVerMSB> F7

### 7.2 Services

| Service        | Value | Direction                      | Purpose                                                         |
|----------------|-------|--------------------------------|-----------------------------------------------------------------|
| Request Preset | 0x01  | RX (request) →<br>TX (reply)   | Ask the unit to dump a preset edit buffer                       |
| Request Multi  | 0x02  | RX → TX                        | Ask the unit to dump the active Multi                           |
| Request System | 0x03  | RX → TX                        | Ask the unit to dump global System settings                     |
| Request Param  | 0x04  | RX → TX                        | Ask for a single parameter's current value                      |
| Dump Preset    | 0x11  | RX (incoming)<br>TX (outgoing) | Full preset parameter block                                     |
| Dump Multi     | 0x12  | RX / TX                        | Full Multi block (Multi params + all 4 parts'<br>mixing params) |
| Dump System    | 0x13  | RX / TX                        | Full System settings block                                      |
| Dump Param     | 0x14  | RX / TX                        | Single parameter set/announce                                   |

Slot addressing (14-bit, LSB-first, used by Request/Dump Preset and Request/Dump Multi):

| Value         | Meaning                                                                        |
|---------------|--------------------------------------------------------------------------------|
| 0x3000-0x3003 | Part 1-4 edit buffer, the currently-playing patch for that part                |
| 0x30FF        | "Active" edit buffer = whichever part is currently selected on the front panel |
| Anything else | Reserved for addressing presets/multis directly in EEPROM storage              |

Only the four edit buffers (plus "active") can be requested or written over SysEx in the current firmware.

## 7.3 Payload packing & checksum

Parameter values (16-bit signed, always within  $\pm 0x1FFF$ ) are packed 7-bit-safe, 4 values per group of 5 bytes: each of 4 consecutive parameter values contributes its low 7 bits as its own byte, and their 4 high (8th) bits are collected into one trailing “tops” byte.

An 8-bit XOR checksum is accumulated over every packed byte (including the tops bytes) and appended just before F7. A checksum byte of 0x7F in a received dump disables the check (meant for testing only); otherwise a mismatch shows an on-screen CRC error with the computed/received values.

- **Send / Receive Preset**  
packs / unpacks all 160 Preset parameter values for one part.
- **Send / Receive Multi**  
packs the Multi-level block, then all 4 parts’ Multi-Part blocks back to back, XOR-combining all sub-block checksums into one trailing byte.
- **Send / Receive System**  
packs the global System parameter block.
- **Send / Receive Parameter**  
a lightweight single-parameter form:  
part, paramID (2x7bit), value (2x7bit)  
no packing, no checksum, used when NRPN are not supported and SysEx are preferred.
- **The Mega Pack**  
chains one Multi dump followed by all 4 Preset dumps as a sequence of separate SysEx messages. Used for a full “backup everything that’s currently loaded” export.

## 8 Parameter value types reference

Every parameter above declares one of the following value types, which fixes its raw numeric range and, for enumerated types, its list of named options in source order (index 0 first). This appendix is the decoder for the Type column in section 6.

| Type         | Range       | Values / Description                                                                                                                     |
|--------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------|
| FREE         | 0 to 255    | Free/raw numeric value (unused or internal bookkeeping field, e.g. name characters' padding, revision counters, spectrum snapshot slots) |
| CHAR         | 32 to 127   | ASCII character code (printable range) - used for preset/multi name characters                                                           |
| UNIPOLAR_8B  | 0 to 255    | Unipolar level/amount                                                                                                                    |
| BIPOLAR_8B   | -127 to 127 | Bipolar level/amount, centered at 0                                                                                                      |
| UNIPOLAR_7B  | 0 to 127    | Unipolar level/amount (7-bit range)                                                                                                      |
| UNIPOLAR_7B1 | 0 to 128    | Unipolar level/amount (7-bit range + 1, e.g. semitone bend range)                                                                        |
| BIPOLAR_7B   | -64 to 64   | Bipolar level/amount, centered at 0 (7-bit range)                                                                                        |
| UNIPOLAR_2B  | 0 to 3      | Small unipolar selector (4 steps)                                                                                                        |
| UNIPOLAR_3B  | 0 to 7      | Small unipolar selector (8 steps, e.g. arpeggiator octave span)                                                                          |
| UNIPOLAR_4B  | 0 to 15     | Small unipolar selector (16 steps, e.g. MPE zone member count)                                                                           |
| UNIPOLAR_5B1 | 0 to 32     | Unipolar time/amount (33 steps, e.g. glide time, vibrato/tremolo rise & rate)                                                            |
| UNIPOLAR_6B1 | 0 to 64     | Unipolar time/amount (65 steps, e.g. envelope velocity/aftertouch amount, reverb color)                                                  |
| MODWHEELER   | 0 to 255    | Special unipolar amount where 0 means "follow the mod wheel" (MODW) and 1-255 is a fixed depth                                           |
| SEMITONE     | -36 to 36   | Semitone offset, centered at 0 (3 octaves either way)                                                                                    |
| CENTS        | -50 to 50   | Fine-tune offset in cents, centered at 0                                                                                                 |
| TUNING       | 20 to 60    | Global reference pitch, raw value + 400 = Hz (420-460 Hz)                                                                                |
| DEVID        | 0 to 126    | SysEx device ID (0x00-0x7E; 0x7F is reserved for "broadcast/all devices" and excluded from this range)                                   |
| TEMPO        | 0 to 255    | Tempo, raw value + 30 = BPM (30-285 BPM)                                                                                                 |
| TIME         | 0 to 255    | Time value: 0 = --- (instant/off), 1-254 = scaled time, 255 = INF (infinite/hold)                                                        |
| TIME_6B      | 0 to 64     | Time value (6-bit): 0 = --- (instant/off), 1-63 = scaled time, 64 = INF (infinite/hold)                                                  |
| PRESET_INDEX | 0 to 63     | Preset slot index within a bank (64 slots)                                                                                               |
| PRESET_BANK  | 0 to 5      | Preset bank selector: I (init), A, B, C, D, E (E is hidden/reserved for Multi-origin bookkeeping)                                        |
| MULTI        | 0 to 15     | Multi slot index (16 slots)                                                                                                              |
| SWITCH       | 0 to 1      | Off, On (displayed as "--" / "ON")                                                                                                       |
| SWITCH3      | 0 to 1      | Off, On (displayed as "OFF" / "ON")                                                                                                      |
| POLARITY     | 0 to 1      | Positive, Negative                                                                                                                       |
| PLAYMODE     | 0 to 5      | Mono, Legato, Poly, Mono Unisono, Legato Unisono, Poly Unisono                                                                           |

| Type            | Range   | Values / Description                                                                                                                                                                                                                              |
|-----------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PRIORITY        | 0 to 3  | Last, First, Low(est), High(est)                                                                                                                                                                                                                  |
| SPECTRUM        | 0 to 17 | Part (user spectrum), Root, Even, Odd, 7th-Up, 4-Sure, Take-5, TX-Bells, B-Split, Ana-Mux, What's-47, Aaaah, Early-V, Late-V, Odd-Step, Ever-Rise, Expon-Rg, Full-Bar                                                                             |
| WAVELET         | 0 to 5  | None, Sine, Sawtooth, Square, Thick, Narrow                                                                                                                                                                                                       |
| CARRIER         | 0 to 4  | None, Sine, Sawtooth, Square, Triangle                                                                                                                                                                                                            |
| FM_RATE         | 0 to 6  | /4, /2, x1, x2, x3, x4, x5                                                                                                                                                                                                                        |
| FILTER_MODEL    | 0 to 8  | None, LP12, BP12, HP12, LP24, HP24, Notch, LP, HP                                                                                                                                                                                                 |
| FILTER_TRACKING | 0 to 10 | -200%, -150%, -100%, -50%, -25%, 0% (none), 25%, 50%, 100%, 150%, 200%                                                                                                                                                                            |
| RC_MODEL        | 0 to 2  | None, LP6, HP6                                                                                                                                                                                                                                    |
| RC_TRACKING     | 0 to 2  | None, Pitch, Filter                                                                                                                                                                                                                               |
| DRIVE_MODEL     | 0 to 4  | None, Tube, Fuzz, Bitcrush, Compressor                                                                                                                                                                                                            |
| DELAY_MODEL     | 0 to 3  | None, Echo, Ping-Pong, Comb                                                                                                                                                                                                                       |
| EQ_MODEL        | 0 to 10 | None, Low-Cut, Low-Shelf, Low-Boost, High-Cut, High-Shelf, High-Boost, Peak-Shelf, Peak-Boost, Notch, Compressor                                                                                                                                  |
| REVERB_MODEL    | 0 to 1  | None, Hall                                                                                                                                                                                                                                        |
| VIBE            | 0 to 1  | Dark, Bright                                                                                                                                                                                                                                      |
| ENV_MODE        | 0 to 5  | -D-R, AD-R, -DSR, ADSR, GATE, A--R                                                                                                                                                                                                                |
| LFO_SHAPE       | 0 to 18 | None, Flat, Sine, Triangle, Saw-Up, Saw-Down, Square, Pulse-25, Pulse-75, WM-Wave, NU-Wave, Jump, Bounce, Ridge-Up, Ridge-Down, Roof, Random, Slew-Straight, Slew-Step                                                                            |
| LFO_PHASE       | 0 to 10 | Free, Random, Velocity, 0°, 30°, 45°, 90°, 120°, 180°, 240°, 270°                                                                                                                                                                                 |
| LFO_TARGET      | 0 to 19 | None, Volume, Panning, Pitch, Balance, Gen Pitch, Gen Level, Sub Pitch, Sub Level, Sub Content, Sub Content (LFO2), Noise Level, Ring Level, Filter Cutoff, Filter Reso, Filter Cutoff×EnvF, Filter Cutoff×LFOf, RC Cutoff, Drive Gain, Drive Mix |
| LFO_PARA_TARGET | 0 to 17 | None, Volume, Pan, Pitch, Balance, Gen Rotation, Gen Inversion, Gen Formant, Noise Rate, Noise Color, Delay Time, Delay Feedback, Delay Color, Delay Level, EQ1 Center, EQ1 Gain, EQ2 Center, EQ2 Gain                                            |
| EXPRESSOR       | 0 to 18 | None, Random, Noise, LFO1, LFO2, Sustain, Pitch Bend, Mod Wheel, Breath Ctrl, Foot Ctrl, Expression, Pressure, EnvF, EnvA, LFOf, Velocity, Bend, Aftertouch, CC74                                                                                 |
| CLOCK_RATE      | 0 to 21 | None, 8 bars, 7 bars, 6 bars, 5 bars, 4 bars, 3 bars, 2 bars, 1.5 bars, 1 bar, 3/4, 1/2, 3/8, 1/3, 5/16, 1/4, 3/16, 1/6, 1/8, 1/12, 1/16, 1/24                                                                                                    |
| MACRO_SOURCE    | 0 to 16 | None, LFO1, LFO2, LFOf, EnvF, EnvA, Part, Note, Velocity, Slot, Random, Noise, One, Two-Thirds, Half, Third, Fourth                                                                                                                               |
| MACRO_TARGET    | 0 to 32 | None, Volume, Panning, Pitch, Balance, Gen Rotation, Gen Inversion, Gen Formant, Gen Pitch, Gen Level, Sub Content, Sub Content (LFO2), Sub Pitch, Sub Level, Noise Rate, Noise Color, Noise Level, Ring Level, Filter Cutoff, Filter             |

| Type           | Range   | Values / Description                                                                                                                                               |
|----------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                |         | Reso, Filter EnvF, Filter LFOf, RC Cutoff, Drive Gain, Drive Mix, Delay Time, Delay Feedback, Delay Color, Delay Level, EQ1 Center, EQ1 Gain, EQ2 Center, EQ2 Gain |
| ARP_MODE       | 0 to 2  | Off, On, Hold                                                                                                                                                      |
| ARP_PATTERN    | 0 to 6  | Order, Up, Down, Up/Down, Down/Up, Walk, Random                                                                                                                    |
| ARP_GRID       | 0 to 9  | 1/96, 1/64, 1/48, 1/32, 1/24, 1/16, 1/12, 1/8, 1/6, 1/3 (also reused for Arp Gate length)                                                                          |
| ARP_MASK       | 0 to 7  | All, M1, M2, M3, M4, M5, M6, M7                                                                                                                                    |
| CATEGORY       | 0 to 19 | Init, Pad, Bass, Lead, Keys, Pluck, Arp, Brass, Bell, Wind, String, Voice, Chiptune, Atmospheric, Drone, Drum, Percussion, Sweep, Noise, SFX                       |
| MIDI_CHANNEL   | 0 to 17 | Off, Channel 1-16, Omni                                                                                                                                            |
| PART_ROUTING   | 0 to 6  | Mixer, Main, Aux, Main Left, Main Right, Aux Left, Aux Right                                                                                                       |
| POT_MODE       | 0 to 2  | Jump, Offset, Grab                                                                                                                                                 |
| CLOCK_SOURCE   | 0 to 3  | Auto, Internal, MIDI, External                                                                                                                                     |
| CLOCK_PPQ      | 0 to 10 | 1, 2, 3, 4, 6, 8, 12, 16, 24, 32, 48 pulses per quarter note                                                                                                       |
| LCD_BACKLEVEL  | 0 to 3  | None (off), Low, High, Smart (auto-dim)                                                                                                                            |
| LED_BRIGHTNESS | 0 to 2  | Low, Medium, Standard                                                                                                                                              |
| PITCH_MODE     | 0 to 2  | Semitone, Fine, Sub-octave                                                                                                                                         |
| BOOST          | 0 to 2  | 0 dB, 6 dB, 12 dB (output gain before the DAC)                                                                                                                     |

Happy MIDI routing & Manatee patching!

**The Fred's Lab Team**