

# Tutorial

revision 1.0 – by Peter Mcilwain

**Introduction**

*Nodal* is a generative software application for composing music. It uses a novel method for the notation and playing of MIDI based music. This method is based around the concept of a user-defined graph. The graph consists of nodes (musical events) and edges (connections between events). You interactively define the graph, which is then traversed by any number of players who play the musical events as they encounter them on the graph. The time taken to travel from one node to another is based on the length of the edges that connect the nodes. *Nodal* is free software available for Mac OS X based computers.

**Working with Nodal**

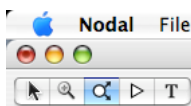
*Nodal* does not make any sound by itself – it only generates MIDI data. You will need a MIDI synthesiser to hear the output that *Nodal* is making. *Nodal* is compatible with any MIDI synthesiser. For simple demonstrations we recommend SimpleSynth. *Nodal* will also work with Apple's GarageBand software.

**1. Setting Up**

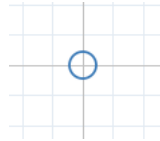
In order to make a sound you must have a software synthesiser open that you can connect to via Core MIDI.

- 1.1. Open both *Nodal* and your MIDI synthesiser application.
- 1.2. In your MIDI synthesiser application, set the MIDI input to "Nodal Output" (*Nodal* by default sends out MIDI using this port).

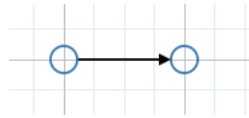
**2. Making a simple network**



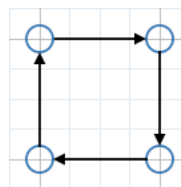
- 1.1. Click on the *Node & Arc* tool as shown above.



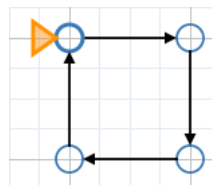
- 1.2. Click on the grid to make a node.



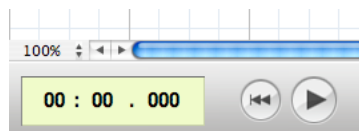
- 1.3. Click, hold and drag to make an arc connecting to another node.



- 1.4. Add two more nodes to make a closed circuit.



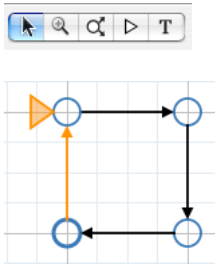
- 1.5. Click on the *Voice Group* tool then add a starting triangle by clicking in the middle of the node as shown.



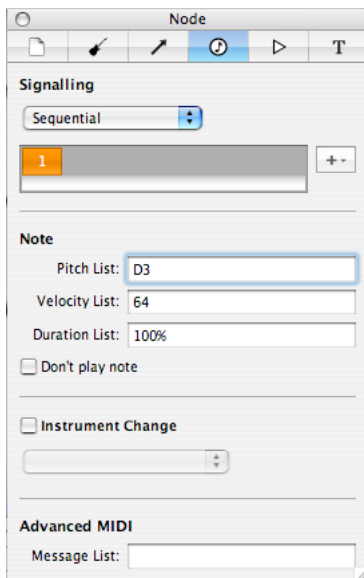
- 1.6. Press play

You should hear middle C (C3 in MIDI) being played continuously. As each pitch is played, a node will flash.

## 2. Editing Pitch Information

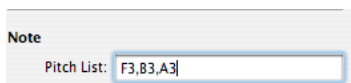


- 2.1. Keep the program playing and click on the *Selection* tool. Then select one of the nodes.



- 2.2. In the *Node Inspector* window change the pitch to D3 then press return (on the QWERTY keyboard).

You should now be hearing 3 nodes sounding the pitch C3 and a single node sounding D3.



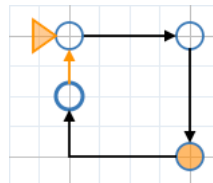
- 2.3. Select another node and change the pitch to a list – F3,B3,A3

You will now hear a more complex sequence of pitches: two nodes sounding C3, one sounding D3 and one that cycles through the pitches F3, B3, and A3.

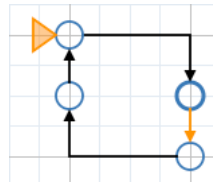
Note that each node has a list for MIDI velocity which can be formatted in the same way as pitch.

## 3. Editing Rhythm

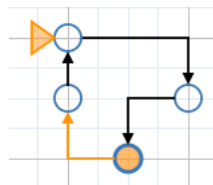
The circuit, or network, that you have just made consists of 4 nodes arranged in a square. The square represents a cycle of 4 beats so we could say that the music is currently 4/4 time.



step 1.



step 2.



step 3.

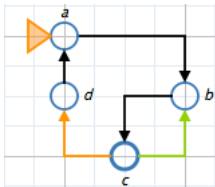
- 3.1. Using the *Selection* tool, change the position of the nodes in the 4 beat square as shown above.

You have now produced four rhythms that occur in 4/4 time. You can however, place the nodes anywhere on the grid. Try out different placements

of nodes and you will hear a huge range of different rhythmic patterns.

Before continuing with the tutorial edit the network to the pattern shown in *step 3* of 3.1.

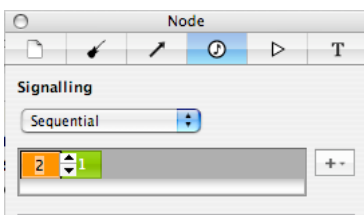
#### 4. Changing Output Arcs



4.1. Add another arc by clicking on the *Node & Arc* tool then click, hold and drag from the middle of node c to the middle of node b.

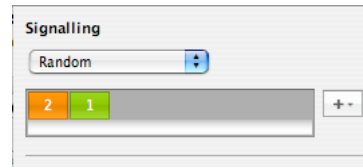
This produces a more complex series of node firings:  
*a, b, c, d, a, b, c, b, c, d ... etc*

Node c has two output arcs (or connections), which can be seen by clicking on the node with the *Selection* tool. They are designated by colour, orange and green. Each time node c fires the output arcs are selected in sequence, orange, green, orange, green, ... etc.



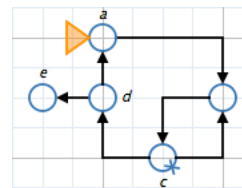
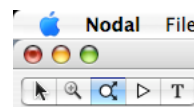
4.2. Click on the *Selection* tool and select node c. Then in the *Node Inspector* double click on the orange square and click on the up arrow to change to number to 2.

This will produce:  
*a, b, c, d, a, b, c, d, a, b, c, b, c, d ... etc.*



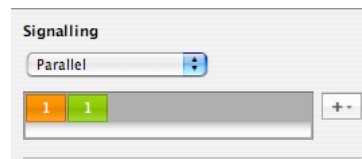
4.3. In the *Node Inspector* change the signalling to random as shown.

You will now hear a constantly changing pattern because the output from node c is selected randomly.

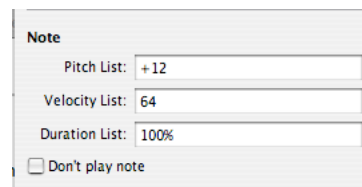


4.4. Click on the *Node & Arc* tool make a new node as shown above.

Notice that as soon as node e fires the sequence stops. This is because there are no outputs from e to connect it to other nodes.



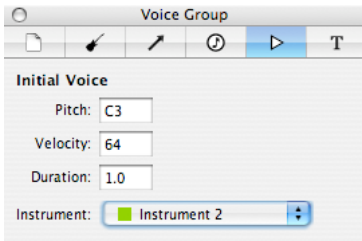
4.5. Select node d and in the *Node Inspector* change the Signalling method to Parallel as shown.



4.6. Select node e and change the pitch to +12.



You should now be hearing a polyphonic texture with two parts playing at once. In Nodal these parts are called voices. One voice starts at node *a* and the other at node *b*.



5.7. With the *Selection* tool click on the starting triangle for node *b*. Then in the *Voice Group* inspector window select instrument 2 as shown.

5.8. Stop, rewind and start the program again.

You should now hear the two starting voices with two different instrument sounds.

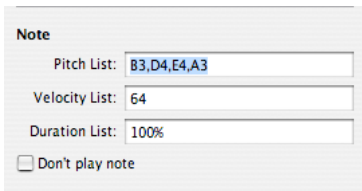
As the program plays you will notice that the notes that are made by node *e* have a long sustain in comparison to other notes. To explain this it is necessary to understand how the duration parameter works.

Note duration is, by default, set to 100%. This is a relative value that relates to the output arc length. For example, the duration of notes made by node *a*, are 100% of the distance/time between *a* and *b*. Beats are represented with the darker lines in the background grid, so we can see that the distance between nodes *a* and *b* is one and a half beats.

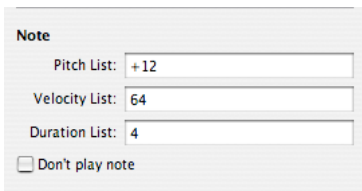
The duration for notes made by node *e* however, is set to 4. This designates 4 beats and is a fixed value – changing output arc length does not change the duration time.

You may have noticed that the arcs can only snap to vertical or horizontal orientation. This limitation automatically quantises distance/time to units of beats.

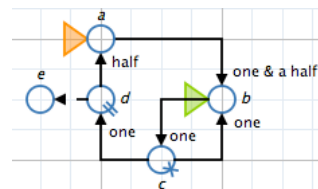
## 6. Changing Duration



6.1. Select node *d* and change the pitch list in the inspector window to: B3,D4,E4,A3.

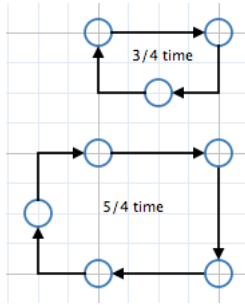


6.2. Select node *e* and change the duration to 4.

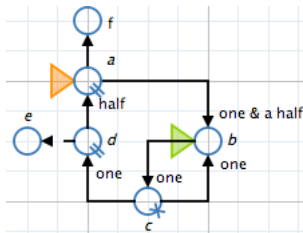


The smaller grid units represent subdivisions of the principal grid. Therefore in this tutorial, a beat can be sub-divided into 4 grid units. To work out the duration of an arc count the total number of grid units. For example the distance from node *a* to node *b* is 4 grid units across and 2 down. This gives a total of 6 units or 1 and a half beats.

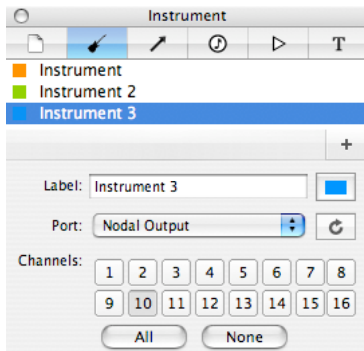
It may not first be apparent however it is possible to create networks for all time signatures – 3/4 and 5/4 time signatures are shown below.



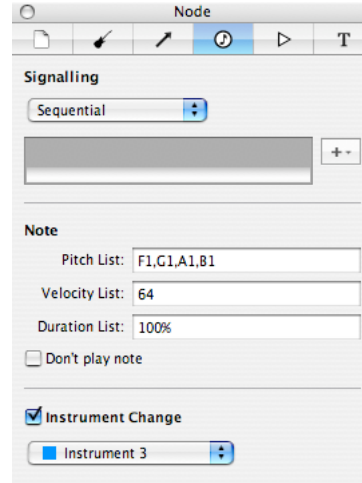
## 7. Instrument Triggering



7.1. Create a new node connected to node *a* as shown. Set the signalling for node *a* to parallel.



7.2. Create a new instrument (click on the + button in the *Instrument* inspector). Set the MIDI channel for this instrument to 10. Note that it is possible designate more than one MIDI channel to an instrument, so in this case make sure that only 10 is selected.



7.3. Select node *f* and, in the *Node* inspector, set the pitch list to F1,G1,A1,B1. Then select the *Instrument Change* option and select Instrument 3 from the menu, as shown above.

Stop, rewind and play the program, you will now hear a tom-tom percussion part that is triggered by node *a*. This is caused by the use of the *Instrument Change* option that was set for node *f*. Instrument change limits all instruments that are connected to the outputs of the node that is being set to the instrument that is set.

**Appendix 1 – General MIDI Program Numbers**

1 Acoustic Grand Piano	42 Viola	91 Pad 3 (polysynth)
2 Bright Acoustic Piano	43 Cello	92 Pad 4 (choir)
3 Electric Grand Piano	44 Contrabass	93 Pad 5 (bowed)
4 Honky-tonk Piano	45 Tremolo Strings	94 Pad 6 (metallic)
5 Electric Piano 1	46 Pizzicato Strings	95 Pad 7 (halo)
6 Electric Piano 2	47 Orchestral Harp	96 Pad 8 (sweep)
7 Harpsichord	48 Timpani	97 FX 1 (rain)
8 Clavi	49 String Ensemble 1	98 FX 2 (Soundtrack)
9 Celesta: +12	50 String Ensemble 2	99 FX 3 (crystal)
10 Glockenspiel: +24	51 Synth Strings 1	100 FX 4 (atmosphere)
11 Music Box	52 Synth Strings 2	101 FX 5 (brightness)
12 Vibraphone	53 Choir Aahs	102 FX 6 (goblins)
13 Marimba	54 Voice Oohs	103 FX 7 (echoes)
14 Xylophone: +12	55 Synth Voice	104 FX 8 (sci-fi)
15 Tubular Bells	56 Orchestra Hit	105 Sitar
16 Dulcimer	57 Trumpet: -2	106 Banjo
17 Drawbar Organ	58 Trombone	107 Shamisen
18 Percussive Organ	59 Tuba	108 Koto
19 Rock Organ	60 Muted Trumpet	109 Kalimba
20 Church Organ	61 French Horn: -7	110 Bag pipe
21 Reed Organ	62 Brass Section	111 Fiddle
22 Accordion	63 SynthBrass 1	112 Shanai
23 Harmonica	64 SynthBrass 2	113 Tinkle Bell
24 Tango Accordion	65 Soprano Sax: -2	114 Agogo
25 Acoustic Guitar (nylon): -12	66 Alto Sax: -9	115 Steel Drums
26 Acoustic Guitar (steel): -12	67 Tenor Sax: -14	116 Woodblock
27 Electric Guitar (jazz): -12	68 Baritone Sax: -21	117 Taiko Drum
28 Electric Guitar (clean): -12	69 Oboe	118 Melodic Tom
29 Electric Guitar (muted): -12	70 English Horn: -7	119 Synth Drum
30 Overdriven Guitar: - 12	71 Bassoon	120 Reverse Cymbal
31 Distortion Guitar: - 12	72 Clarinet: -2	121 Guitar Fret Noise
32 Guitar Harmonics: - 12	73 Piccolo: +12	122 Breath Noise
33 Acoustic Bass	74 Flute	123 Seashore
34 Electric Bass (finger)	75 Recorder	124 Bird Tweet
35 Electric Bass (pick)	76 Pan Flute	125 Telephone Ring
36 Fretless Bass	77 Blown Bottle	126 Helicopter
37 Slap Bass 1	78 Shakuhachi	127 Applause
38 Slap Bass 2	79 Whistle	128 Gunshot
39 Synth Bass 1	80 Ocarina	
40 Synth Bass 2	81 Lead 1 (square)	
41 Violin	82 Lead 2 (sawtooth)	
	83 Lead 3 (calliope)	
	84 Lead 4 (chiff)	
	85 Lead 5 (charang)	
	86 Lead 6 (voice)	
	87 Lead 7 (fifths)	
	88 Lead 8 (bass + lead)	
	89 Pad 1 (new age)	
	90 Pad 2 (warm)	

**Appendix 2 – Decimal to Hexadecimal Conversion table**

Decimal Hex	43 0x2B	87 0x57
0 0x00	44 0x2C	88 0x58
1 0x01	45 0x2D	89 0x59
2 0x02	46 0x2E	90 0x5A
3 0x03	47 0x2F	91 0x5B
4 0x04	48 0x30	92 0x5C
5 0x05	49 0x31	93 0x5D
6 0x06	50 0x32	94 0x5E
7 0x07	51 0x33	95 0x5F
8 0x08	52 0x34	96 0x60
9 0x09	53 0x35	97 0x61
10 0x0A	54 0x36	98 0x62
11 0x0B	55 0x37	99 0x63
12 0x0C	56 0x38	100 0x64
13 0x0D	57 0x39	101 0x65
14 0x0E	58 0x3A	102 0x66
15 0x0F	59 0x3B	103 0x67
16 0x10	60 0x3C	104 0x68
17 0x11	61 0x3D	105 0x69
18 0x12	62 0x3E	106 0x6A
19 0x13	63 0x3F	107 0x6B
20 0x14	64 0x40	108 0x6C
21 0x15	65 0x41	109 0x6D
22 0x16	66 0x42	110 0x6E
23 0x17	67 0x43	111 0x6F
24 0x18	68 0x44	112 0x70
25 0x19	69 0x45	113 0x71
26 0x1A	70 0x46	114 0x72
27 0x1B	71 0x47	115 0x73
28 0x1C	72 0x48	116 0x74
29 0x1D	73 0x49	117 0x75
30 0x1E	74 0x4A	118 0x76
31 0x1F	75 0x4B	119 0x77
32 0x20	76 0x4C	120 0x78
33 0x21	77 0x4D	121 0x79
34 0x22	78 0x4E	122 0x7A
35 0x23	79 0x4F	123 0x7B
36 0x24	80 0x50	124 0x7C
37 0x25	81 0x51	125 0x7D
38 0x26	82 0x52	126 0x7E
39 0x27	83 0x53	127 0x7F
40 0x28	84 0x54	
41 0x29	85 0x55	
42 0x2A	86 0x56	

### Appendix 3 – Continuous Controller Messages

Control Number (2nd Byte Value)			Control Function	3rd Byte Value	
Decimal	Binary	Hex		Value	Used As
0	00000000	0x00	Bank Select	0-127	MSB
1	00000001	0x01	Modulation Wheel or Lever	0-127	MSB
2	00000010	0x02	Breath Controller	0-127	MSB
3	00000011	0x03	Undefined	0-127	MSB
4	00000100	0x04	Foot Controller	0-127	MSB
5	00000101	0x05	Portamento Time	0-127	MSB
6	00000110	0x06	Data Entry MSB	0-127	MSB
7	00000111	0x07	Channel Volume (formerly Main Volume)	0-127	MSB
8	00001000	0x08	Balance	0-127	MSB
9	00001001	0x09	Undefined	0-127	MSB
10	00001010	0x0A	Pan	0-127	MSB
11	00001011	0x0B	Expression Controller	0-127	MSB
12	00001100	0x0C	Effect Control 1	0-127	MSB
13	00001101	0x0D	Effect Control 2	0-127	MSB
14	00001110	0x0E	Undefined	0-127	MSB
15	00001111	0x0F	Undefined	0-127	MSB
16	00010000	0x10	General Purpose Controller 1	0-127	MSB
17	00010001	0x11	General Purpose Controller 2	0-127	MSB
18	00010010	0x12	General Purpose Controller 3	0-127	MSB
19	00010011	0x13	General Purpose Controller 4	0-127	MSB
20	00010100	0x14	Undefined	0-127	MSB
21	00010101	0x15	Undefined	0-127	MSB
22	00010110	0x16	Undefined	0-127	MSB
23	00010111	0x17	Undefined	0-127	MSB
24	00011000	0x18	Undefined	0-127	MSB
25	00011001	0x19	Undefined	0-127	MSB
26	00011010	0x1A	Undefined	0-127	MSB
27	00011011	0x1B	Undefined	0-127	MSB
28	00011100	0x1C	Undefined	0-127	MSB
29	00011101	0x1D	Undefined	0-127	MSB
30	00011110	0x1E	Undefined	0-127	MSB
31	00011111	0x1F	Undefined	0-127	MSB
32	00100000	0x20	LSB for Control 0 (Bank Select)	0-127	LSB
33	00100001	0x21	LSB for Control 1 (Modulation Wheel or Lever)	0-127	LSB
34	00100010	0x22	LSB for Control 2 (Breath Controller)	0-127	LSB
35	00100011	0x23	LSB for Control 3 (Undefined)	0-127	LSB
36	00100100	0x24	LSB for Control 4 (Foot Controller)	0-127	LSB
37	00100101	0x25	LSB for Control 5 (Portamento Time)	0-127	LSB
38	00100110	0x26	LSB for Control 6 (Data Entry)	0-127	LSB
39	00100111	0x27	LSB for Control 7 (Channel Volume, formerly Main Volume)	0-127	LSB
40	00101000	0x28	LSB for Control 8 (Balance)	0-127	LSB
41	00101001	0x29	LSB for Control 9 (Undefined)	0-127	LSB
42	00101010	0x2A	LSB for Control 10 (Pan)	0-127	LSB
43	00101011	0x2B	LSB for Control 11 (Expression Controller)	0-127	LSB
44	00101100	0x2C	LSB for Control 12 (Effect control 1)	0-127	LSB
45	00101101	0x2D	LSB for Control 13 (Effect control 2)	0-127	LSB
46	00101110	0x2E	LSB for Control 14 (Undefined)	0-127	LSB

47	00101111	0x2F	LSB for Control 15 (Undefined)	0-127	LSB
48	00110000	0x30	LSB for Control 16 (General Purpose Controller 1)	0-127	LSB
49	00110001	0x31	LSB for Control 17 (General Purpose Controller 2)	0-127	LSB
50	00110010	0x32	LSB for Control 18 (General Purpose Controller 3)	0-127	LSB
51	00110011	0x33	LSB for Control 19 (General Purpose Controller 4)	0-127	LSB
52	00110100	0x34	LSB for Control 20 (Undefined)	0-127	LSB
53	00110101	0x35	LSB for Control 21 (Undefined)	0-127	LSB
54	00110110	0x36	LSB for Control 22 (Undefined)	0-127	LSB
55	00110111	0x37	LSB for Control 23 (Undefined)	0-127	LSB
56	00111000	0x38	LSB for Control 24 (Undefined)	0-127	LSB
57	00111001	0x39	LSB for Control 25 (Undefined)	0-127	LSB
58	00111010	0x3A	LSB for Control 26 (Undefined)	0-127	LSB
59	00111011	0x3B	LSB for Control 27 (Undefined)	0-127	LSB
60	00111100	0x3C	LSB for Control 28 (Undefined)	0-127	LSB
61	00111101	0x3D	LSB for Control 29 (Undefined)	0-127	LSB
62	00111110	0x3E	LSB for Control 30 (Undefined)	0-127	LSB
63	00111111	0x3F	LSB for Control 31 (Undefined)	0-127	LSB
64	01000000	0x40	Damper Pedal on/off (Sustain)	<63 off, >64 on	---
65	01000001	0x41	Portamento On/Off	<63 off, >64 on	---
66	01000010	0x42	Sostenuto On/Off	<63 off, >64 on	---
67	01000011	0x43	Soft Pedal On/Off	<63 off, >64 on	---
68	01000100	0x44	Legato Footswitch	<63 Normal, >64 Legato	---
69	01000101	0x45	Hold 2	<63 off, >64 on	---
70	01000110	0x46	Sound Controller 1 (default: Sound Variation)	0-127	LSB
71	01000111	0x47	Sound Controller 2 (default: Timbre/Harmonic Intens.)	0-127	LSB
72	01001000	0x48	Sound Controller 3 (default: Release Time)	0-127	LSB
73	01001001	0x49	Sound Controller 4 (default: Attack Time)	0-127	LSB
74	01001010	0x4A	Sound Controller 5 (default: Brightness)	0-127	LSB
75	01001011	0x4B	Sound Controller 6 (default: Decay Time - see MMA RP-021)	0-127	LSB
76	01001100	0x4C	Sound Controller 7 (default: Vibrato Rate - see MMA RP-021)	0-127	LSB
77	01001101	0x4D	Sound Controller 8 (default: Vibrato Depth - see MMA RP-021)	0-127	LSB
78	01001110	0x4E	Sound Controller 9 (default: Vibrato Delay - see MMA RP-021)	0-127	LSB
79	01001111	0x4F	Sound Controller 10 (default undefined - see MMA RP-021)	0-127	LSB
80	01010000	0x50	General Purpose Controller 5	0-127	LSB
81	01010001	0x51	General Purpose Controller 6	0-127	LSB
82	01010010	0x52	General Purpose Controller 7	0-127	LSB
83	01010011	0x53	General Purpose Controller 8	0-127	LSB
84	01010100	0x54	Portamento Control	0-127	LSB
85	01010101	0x55	Undefined	---	---

86	01010110	0x56	Undefined	---	---
87	01010111	0x57	Undefined	---	---
88	01011000	0x58	Undefined	---	---
89	01011001	0x59	Undefined	---	---
90	01011010	0x5A	Undefined	---	---
91	01011011	0x5B	Effects 1 Depth (default: Reverb Send Level - see MMA RP-023) (formerly External Effects Depth)	0-127	LSB
92	01011100	0x5C	Effects 2 Depth (formerly Tremolo Depth)	0-127	LSB
93	01011101	0x5D	Effects 3 Depth (default: Chorus Send Level - see MMA RP-023) (formerly Chorus Depth)	0-127	LSB
94	01011110	0x5E	Effects 4 Depth (formerly Celeste [Detune] Depth)	0-127	LSB
95	01011111	0x5F	Effects 5 Depth (formerly Phaser Depth)	0-127	LSB
96	01100000	0x60	Data Increment (Data Entry +1) (see MMA RP-018)	N/A	---
97	01100001	0x61	Data Decrement (Data Entry -1) (see MMA RP-018)	N/A	---
98	01100010	0x62	Non-Registered Parameter Number (NRPN) - LSB	0-127	LSB
99	01100011	0x63	Non-Registered Parameter Number (NRPN) - MSB	0-127	MSB
100	01100100	0x64	Registered Parameter Number (RPN) - LSB*	0-127	LSB
101	01100101	0x65	Registered Parameter Number (RPN) - MSB*	0-127	MSB
102	01100110	0x66	Undefined	---	---
103	01100111	0x67	Undefined	---	---
104	01101000	0x68	Undefined	---	---
105	01101001	0x69	Undefined	---	---
106	01101010	0x6A	Undefined	---	---
107	01101011	0x6B	Undefined	---	---
108	01101100	0x6C	Undefined	---	---
109	01101101	0x6D	Undefined	---	---
110	01101110	0x6E	Undefined	---	---
111	01101111	0x6F	Undefined	---	---
112	01110000	0x70	Undefined	---	---
113	01110001	0x71	Undefined	---	---
114	01110010	0x72	Undefined	---	---
115	01110011	0x73	Undefined	---	---
116	01110100	0x74	Undefined	---	---
117	01110101	0x75	Undefined	---	---
118	01110110	0x76	Undefined	---	---
119	01110111	0x77	Undefined	---	---
<b>Note:</b>	Controller numbers 120-127 are reserved for Channel Mode Messages, which rather than controlling sound parameters, affect the channel's operating mode.				
120	01111000	0x78	[Channel Mode Message] All Sound Off	0	---
121	01111001	0x79	[Channel Mode Message] Reset All Controllers (See MMA RP-015)	0	---
122	01111010	0x7A	[Channel Mode Message] Local Control On/Off	0 off, 127 on	---
123	01111011	0x7B	[Channel Mode Message] All Notes Off	0	---
124	01111100	0x7C	[Channel Mode Message] Omni Mode Off (+ all notes off)	0	---
125	01111101	0x7D	[Channel Mode Message] Omni Mode On (+ all notes off)	0	---
126	01111110	0x7E	[Channel Mode Message] Poly Mode On/Off (+ all notes off)	**	---
127	01111111	0x7F	[Channel Mode Message] Poly Mode On (+ mono off +all notes off)	0	---

\*\* Note: This equals the number of channels, or zero if the number of channels equals the number of voices in the receiver.