bC16
MINIATURE PATCH SYNTHESIZER

Operation Manual v1.20

English

Chimera Synthesis

www.Chimera-Synthesis.com

CONTENTS...

BEFORE YOU START…

Thank you for purchasing (borrowing/stealing) a **bC16** miniature patch synthesizer, made by Chimera Synthesis. Please read this manual carefully and perhaps most of your questions will be answered (!).

FIRMWARE VERSION

Three versions of the firmware exist for the **bC16**, to check which version you have:

First Version (simple MIDI interface)

- No special markings or LED sequences.

Second Version (simple MIDI interface)

- Upon switch on the battery LED (green) will flash twice before remaining on.

Enhanced Version (enhanced MIDI interface)

- Upon switch on the battery LED (green) will flash three times before remaining on.

This manual assumes your **bC16** is the enhanced version. Any version can be upgraded at the Chimera Synthesis factory quickly to the enhanced version.

First version firmware anomalies

For various reasons the first version of the bC16 MIDI interface exhibits some anomalies:

- NOTE ON, VELOCITY=0 is not recognized as NOTE OFF (leading to hanging notes with certain keyboards/controllers).
- RUNNING STATUS not understood/ignored (RUNNING STATUS is not commonly used).
- PITCHBEND is set to +/- one octave, sensitivity cannot be altered.

Second version firmware changes

- This is a bug fix for the first version and corrects the NOTE ON, VELOCITY=0 problem only.

Enhanced version firmware changes

- NOTE ON, VELOCITY=0 is understood as being equivalent to NOTE OFF (greater compatibility with keyboards/controllers)
- RUNNING STATUS is understood and maybe used (improvements in control speed with XWIND controller and other high-bandwidth devices).
- PITCHBEND sensitivity can be adjusted via MIDI (RPN 0,0) – programmed in +/- cents, default pitchbend sensitivity is +/- 2 halftones.
- CC/NRPN override control of all knobs (except VCA/VCF) – use CC for simple adjustments, NRPN's for fine control over parameters.
- ARPEGGIATOR with choice of patterns, clock rates and clock sources – rising, falling, rise/fall, ordered modes, 20-6000BPM internal clock or MIDI clock with control from BPM/2 (half note) to BPMx24 (sixty-fourth note triplets).

POWERING UP…

Your **bC16** can be powered via the internal batteries (6xAAA cells) or via the MIDI jack socket. Please follow this procedure to avoid potentially damaging your **bC16.**

Using internal batteries

1. Loosen the three hex screws on the back of the battery compartment cover (use the supplied allen key/wrench.
   You do not need to undo these more than a half-turn or so.
2. Rotate the battery compartment cover clockwise. The cover will now be free. *This cover is made from powder coated steel and is quite heavy, watch your toes.*
3. Insert or change the six AAA cells (not supplied) – *use good quality batteries, cheap alkalines are liable to leak if left for long periods of time (damage caused by leaking batteries is not covered by the warranty).*
4. Replace battery compartment cover and tighten the three hex screws.
5. Move slide switch on the back of the **bC16** to the ON position (towards the right when looking at the back). The power LED (green) should now light. If it doesn't, check your connections, check your batteries then check your connections again.

Using external DC power

External DC can be supplied to the **bC16** via two of the pins on the MIDI socket (5 pin 180 degree DIN type).

The external power feed through the MIDI socket is coupled via a diode (prevents reverse polarity damage to the bC16) directly to the internal unregulated power bus – this power bus is not switched by the ON/OFF switch.

Please make sure any external DC supplied to the **bC16** via the MIDI socket is clean and between 9v and 12v and your source is capable of supplying at least 0.2A.

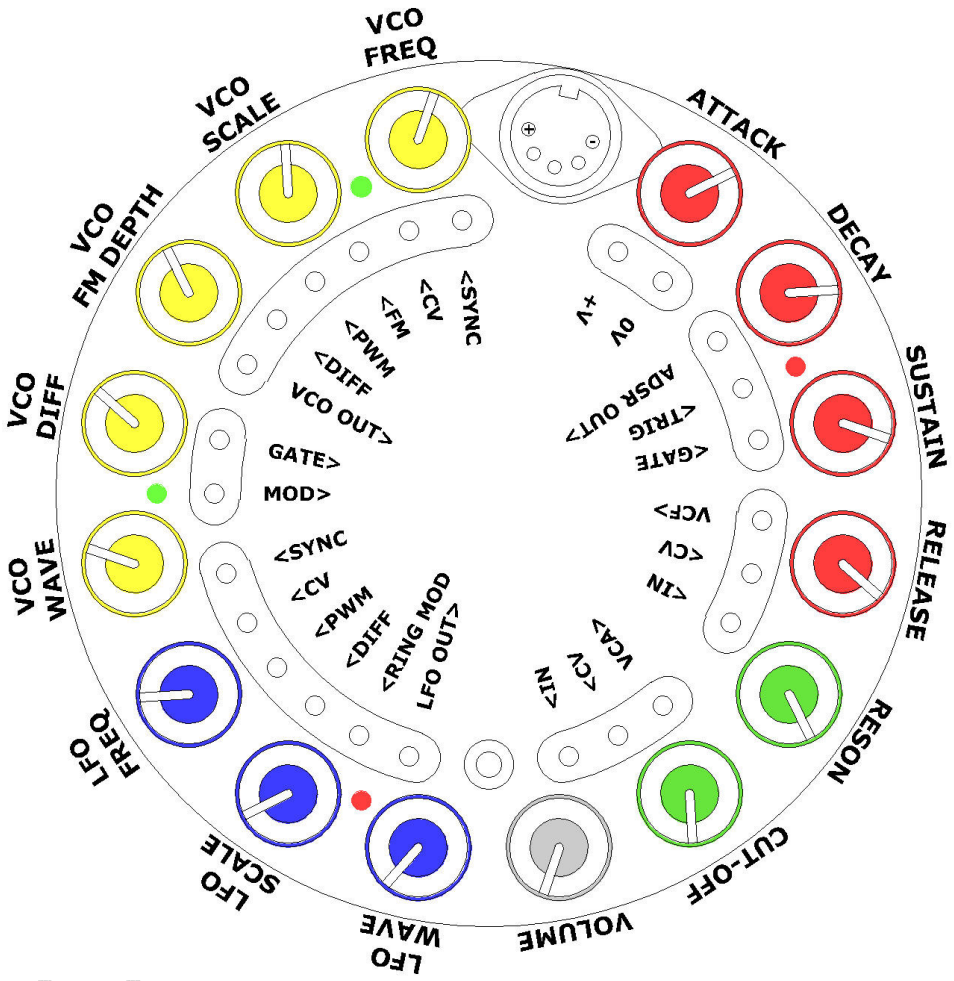
DIN socket pins	*Description*	*Notes*
1	**0v external DC input**	**Connect to 0v from PSU**
2	-	Not connected
3	**+9v to 12v external DC input**	**Connect to +V from PSU**
4	MIDI (+ve)	MIDI data (+ve)
5	MIDI (-ve)	MIDI data (-ve)
Ground shield	-	Not connected

POWERING DOWN

Move the slide switch on the rear of the **bC16** to the off position (towards the left when looking at the). Remember to remove the batteries if you don't intend to use your **bC16** for long periods.

As the power switch on the bC16 is not used when powering the unit from an external DC source; to power down disconnect or switch off the external supply.

LAYOUT…



LED function	Location	Colour
Power/Battery status	Between VCO SCALE and VCO FREQ	Green = OK
MIDI data received	Between VCO WAVE and VCO DIFF	Green = packet received
LFO output condition	Between LFO SCALE and LFO WAVE	Red (brightest at peak V)
EG output condition	Between DECAY and SUSTAIN	Red (brightest at peak V)

GETTING A SIGNAL OUT…

The most conventional way of getting a signal out of the **bC16** is to use the output amplifier (connected internally to the output of the VCA).

Headphone Output
3.5mm (1/8”) stereo jack socket (between VOLUME and LFO WAVE knobs).
Left and Right channels are wired together.
Shield/sleeve of the jack is 0v. You may connect a pair of headphones, powered speaker, soundcard etc... to this jack socket.

Signal Output
You may also take the signal directly out of the following 2mm sockets:
VCO OUT>
LFO OUT>
VCA>
VCF>

We suggest that in a conventional patch (VCO>VCF>VCA) using our cable #PL1500 between VCA> and 0V will result in the highest quality output.

Volume Control
Volume/Gain of the output is made using the **GREY** knob#9. Turn clockwise to increase the volume/gain. This control approximates logarithmic response.

Technical
The output amplifier is based on an LM386 and is powered from the unregulated + input (after the reverse polarity protection diode), both the input and output of this amplifier are AC coupled - so expect a click/thump if you power-up whilst monitoring this output. The LM386 is capable of driving an 8ohm load to around 325mW (10% THD).

CONTROL VOLTAGES…

In order to maximize battery life and minimize unnecessary level conversions the **bC16** does not use the 1v/octave or 1.2v/octave voltage standard found in many mains powered modular synthesizers.

The **bC16** uses the **0.586 volts per octave** standard.

Control voltages are in the range 0v to 5v (8.5 octaves).

Over Voltage Conditions
Control voltage inputs are designed to withstand over voltage conditions of +/- 15v. The unit may not function correctly during these over voltage conditions however no damage will occur.

Control voltage outputs are somewhat less tolerant of over voltage as they are connected to output amplifiers via small resistors. Be careful not to expose these

Static Precautions
The **bC16** has been designed to withstand +/- 8kv (human body model) static discharges without damage, however some lock-ups may occur under certain conditions. Switch of the **bC16**, wait 10 seconds and switch back on if you experience this.

Technical
Internally the **bC16** uses a low-noise 2.5v precision voltage reference to scale control voltage inputs (with the exception of the VCA and VCF).
CV inputs are divided by two (using a resistive divider), buffered and then converted from analog using the 2.5v reference.
The conversion process results in a CV value in the DSP of 0 to 1023 (10 bits), 120 bits are used per octave resulting in a sensitivity of:

120/1023 x 2.5v = 0.293v per octave AFTER the resistive divider, so at the 2mm socket we get 0.293v x 2 = **0.586v** per octave

PATCHING…

The **bC16** uses standard 2mm mini-banana sockets to connect most signals into, across and out of the unit. Here are some dos and don'ts (mainly).

DO…
…buy our low-cost packets of 2mm stackable banana leads, available in various colors and lengths and supplied in robust little plastic boxes. See www.Chimera-Synthesis.com for these great items.

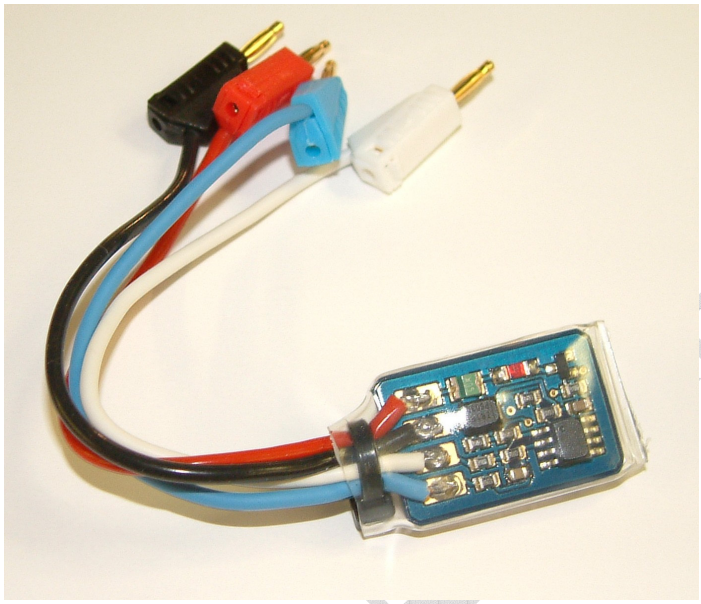
DON'T…
…stack more than two stackable leads on any mini-banana port – the risk is that you knock into the 'tower' and bend the bottom mini-banana or potentially fracture the socket on the PCB inside the unit.

…poke bare wires down the mini-banana ports. You risk damaging the **bC16** if the end of the wire goes astray inside the unit.

…connect unknown signals to the **bC16** mini-banana ports, you risk causing irreversible damage to the unit.

CONTROL SIGNAL INVERTER…

There are times when you might wish to change the control voltage behavior of a **bC16** function (such as inverting the CV input of the VCF), in order to do this each **bC16** is supplied with an **inverter**. The **inverter** looks like this:



The **inverter** is powered directly from the **bC16**'s external +5v power buss which is available on two of the 2mm patch sockets found on the **bC16** and is connected like so:

	inverter function	
RED **inverter** wire	+5v power	connect to +v on the **bC16**
BLACK **inverter** wire	0v power	connect to 0v on the **bC16**
BLUE **inverter** wire	signal input	connect to output on **bC16** to be inverted (i.e. ADSR OUT)
WHITE **inverter** wire	inverted signal output	connect to input on **bC16** (i.e. VCF CV)

The **inverter** has first order low-pass filter built-in and although the inverter is DC coupled and designed for control voltages we have tested it with the AC coupled outputs on the **bC16** (such as VCO OUT).

The **inverter** is protected against damage from reverse polarity by an automatically resetting 0.05A poly-fuse (the green bit on the PCB), do-not connect it to any voltage higher than 6v – damage WILL occur.

Power consumption is ~5.4mA at full LED brightness (i.e. signal input=0v).

The **inverter** 'signal input' impedance is 100,000 ohms and the 'signal output' impedance is 470 ohms.

The **inverter** has a small red LED (the red bit on the PCB) used to indicate the voltage level of the output, this LED is not connected directly across the output but via an output tracking variable current source (LED current is proportional to the inverted output voltage).

The transfer function of the **inverter** is: **Vout = (Vin x -1) + 5**

i.e. if you put 0v in, you get 5v out. If you put 4v in you get 1v out. Etc…

…work in progress (10 FEB 2009)

LFO – LOW FREQUENCY OSCILLATOR…

…work in progress (10 FEB 2009)

VCF – VOLTAGE CONTROLLED FILTER…

A 4th order (24dB/octave) voltage controlled filter, adapted for the **bC16** to work from lower system voltages. Similar to the classic Moog™ filter and built using discrete matched transistor pairs.

Control knobs determine the cut-off frequency and the amount of resonance (self-oscillation) that the filter exhibits. External CV input controls the cut-off / centering.

Socket	Name	Direction	Notes
#11	VCF OUT	Output	
#12	CV IN	Input	0-5v cutoff frequency rises
#13	VCF IN	Input	

NB: All measurements w.r.t. 0V

RESONANCE (GREEN control knob)
Fully CCW, minimum resonance
Fully CW, maximum resonance

CUT-OFF (GREEN control knob)
Fully CCW, lowest frequency cut-off (maximum high frequencies are passed)
Fully CW, highest frequency cut-off (minimum high frequencies are passed)

Note
The VCF cut-off operates the opposite way to most conventional synthesizers, if you wish to use the VCF in this 'conventional' way please use the inverter device supplied.

EG – ENVELOPE GENERATOR…

…work in progress (10 FEB 2009)

VCA – VOLTAGE CONTROLLED AMPLIFIER…

…work in progress (10 FEB 2009)

ARPEGGIATOR...

The **bC16** now has an in-built arpeggiator with several modes of operation and choice of arpeggiator clocks/speeds. The internal operation of the arpeggiator is complex and you should take time to experiment with the **bC16**'s arpeggiator as it may function differently to other synthesizer arpeggiators. The arpeggiator only functions when a MIDI keyboard/ sequencer is connected to the **bC16** and the MIDI channel is set correctly.

The arpeggiator can be set to play notes in a rising arpeggio (lowest notes first), a falling arpeggio (highest notes first), a combination of repeating sequence of rising and falling notes or to play the notes in the order that they were struck in.
The arpeggiator MODE is controlled by knob#2 (VCO SCALE):

Arpeggiator modes table:

knob#2*	CC#21	NRPN 0,17	Arpeggiator MODE
0-12%	0-15	0-127	Arpeggio OFF**
13-25%	16-31	128-255	Rising arpeggio
26-36%	32-47	256-383	Falling arpeggio
37-49%	48-63	384-511	Rising/Falling arpeggio (starts with rising)
50-100%	64-127	512-1023	Ordered arpeggio (plays in order notes struck)

*knob values are approximate
**resets arpeggiator back to internal clock mode if MIDI CLOCK is disconnected.

The speed of the arpeggio is controlled by either the internal arpeggio clock generator (from 20 BPM to 6,000 BPM) or by an external MIDI CLOCK. When using an external MIDI CLOCK the arpeggiator can be variably scaled to speeds between {MIDI CLOCK BPM divided by two} and {MIDI CLOCK BPM multiplied by twenty-four}.
The arpeggiator SPEED is controlled by knob#1 (VCO FREQ):

Arpeggiator MIDI CLOCK speeds table:

knob#1*	CC#20	NRPN 0,16	MIDI CLOCK (0xF8)	
0-6%	0-7	0-63	BPM /2	Half note
6-18%	8-23	64-191	BPM	Quarter note
18-31%	24-39	192-319	BPM x2	Eighth note
31-44%	40-55	320-447	BPM x3	Eighth note triplets
44-56%	56-71	448-575	BPM x4	Sixteenth note
56-69%	72-87	576-703	BPM x6	Sixteenth note triplets
69-81%	88-103	704-831	BPM x8	Thirty-second note
81-93%	104-119	832-959	BPM x12	Thirty-second note triplets
93-100%	120-127	960-1023	BPM x24	Sixty-fourth note triplets

*knob values are approximate

Arpeggiator internal clock speeds table:

knob#1*	CC#20	NRPN 0,16	INTERNAL ARP CLOCK (BPM)	
0-29%	0-37	0-300	20 to 300 BPM	+1 BPM steps
29-59%	38-75	300-600	300 to 900 BPM	+2 BPM steps
59-88%	76-112	600-900	900 to 2,100 BPM	+4 BPM steps
88-100%	113-127	900-1023	2,100 to 6,000 BPM	+32 BPM steps

*knob values are approximate

The arpeggiator will sequence between 2 and 8 notes, notes struck after the first 8 will be ignored. The presence of an external MIDI CLOCK will automatically switch the arpeggiator to MIDI CLOCK source.

MIDI INTERFACE…

Your **bC16** contains a powerful MIDI interface (MIDI IN only) that not only controls the VCO FREQuency and triggers the EG (envelope generator), but now allows remote control of 12 of the 15 knobs and can control/modify the arpeggiator.

Below is a set of tables that

1. Basic Information	**Values**	**Notes**
MIDI channels received	1-16	must match DIP selector on base
Note Numbers	0-127	0-11 treated as note 12
Program change	-	-
Bank select	-	-
Modes supported:	-	omni/Poly mode ignored
Note ON velocity	0-127	velocity=0 interprets as NOTE OFF velocity=1-127 ignored
Note OFF velocity	x	velocity ignored
Channel aftertouch	-	-
Poly(Key) aftertouch	-	-
Pitchbend	Yes	default pitchbend is +/- 2 halftones
Active sensing (0xFE)	Yes	-
System reset (0xFF)	-	-
Tune request	-	-
Universal SysEx	-	-
Manufacturer SysEx	-	-
RPN 00 (Pitch bend sensitivity)	0-2400	in +/- cents, eg 1200 = +/- 1 octave
RPN 01 (Channel fine tune)	-	-
RPN 02 (Channel course tune)	-	-
RPN 03 (Tuning program select)	-	-
RPN 04 (Tuning bank select)	-	-
RPN 05 (Modulation depth range)	-	-
2. MIDI timing & synchronization		
MIDI Clock (0xF8)	Yes	used for arpeggiator clock
Song position pointer	-	-
Song select	-	-
Start (0xFA)	Yes	sync/reset the arpeggiator clock
Continue (0xFB)	-	-
Stop (0xFC)	-	-
MIDI timecode	-	-
MIDI machine control	-	-
MIDI show control	-	-
3. Extensions compatibility		
GM extensions	-	-
DLS compatibility	-	-
Std MIDI files	-	-
XMF files	-	-
SP-MIDI compatible	-	-

x = don't care

Control Number Information		Values	Notes
0	Bank select (MSB)	-	-
1	Modulation wheel (MSB)	0-127	0-5v output on 2mm socket **MOD>**
2	Breath controller (MSB)	-	-
3	-	-	-
4	Foot controller (MSB)	-	-
5	Portamento time MSB)	0-127	0= minimum slide time 127= maximum slide time
6	Data Entry (MSB)	0-127	used by RPN/NRPN
7	Channel volume	-	-
8	Balance (MSB)	-	-
9	-	-	-
10	Pan (MSB)	-	-
11	Expression (MSB)	-	-
12	Effect control 1 (MSB)	-	-
13	Effect control 2 (MSB)	-	-
14-15	-	-	-
16	General controller 1 (MSB)	-	-
17	General controller 2 (MSB)	-	-
18	General controller 3 (MSB)	-	-
19	General controller 4 (MSB)	-	-
20	VCO FREQ ARP SPEED override MIDICLOCK DIVIDER override	0-127 0-127 0-127	FREQ knob if no NOTE ON issued 20-6000 BPM internal arp clock BPM/2 to BPM x24 if MIDICLOCK
21	VCO SCALE ARP MOD	0-127 0-127	SCALE knob of no NOTE ON issued selects ARP mode
22	VCO FM DEPTH	0-127	overrides VCO FM DEPTH knob
23	VCO WAVESHAPE	0-127	overrides VCO WAVESHAPE knob
24	VCO DIFF	0-127	overrides VCO DIFF knob
25	LFO FREQ	0-127	overrides LFO FREQ knob
26	LFO SCALE	0-127	overrides LFO SCALE knob
27	LFO WAVESHAPE	0-127	overrides LFO WAVESHAPE knob
28-31	-	-	-
32	Bank select (LSB)	-	-
33	Modulation wheel (LSB)	0-127	use in conjunction with CC#1
34	Breath controller (LSB)	-	-
35	-	-	-
36	Foot controller (LSB)	-	-
37	Portamento time (LSB)	-	-
38	Data entry (LSB)	0-127	used by RPN/NRPN
39	Channel volume (LSB)	-	-
40	Balance (LSB)	-	-
41	-	-	-
42	Pan (LSB)	-	-
43	Expression (LSB)	-	-
44	Effect control 1 (LSB)	-	-
45	Effect control 2 (LSB)	-	-
46-47	-	-	-
48	General controller 1 (LSB)	-	-
49	General controller 2 (LSB)	-	-
50	General controller 3 (LSB)	-	-
51	General controller 4 (LSB)	-	-
52-63	-	-	-

table continued on next page…

…from previous page

Control Number Information		Values	Notes
64	Sustain pedal	-	-
65	Portamento on/off	0-127	0-63= portamento OFF 64-127= portamento ON
66	Sostenuto	-	-
67	Soft pedal	-	-
68	Legato footswitch	-	-
69	Hold 2	-	-
70	Sound controller 1	-	-
71	Sound controller 2	-	-
72	EG release time	0-127	overrides EG RELEASE knob
73	EG attack time	0-127	overrides EG ATTACK knob
74	Sound controller 5	-	-
75	EG decay time	0-127	overrides EG DECAY knob
76	Sound controller 7	-	-
77	Sound controller 8	-	-
78	Sound controller 9	-	-
79	EG sustain level	0-127	overrides EG SUSTAIN knob
80	General controller 5	-	-
81	General controller 6	-	-
82	General controller 7	-	-
83	General controller 8	-	-
84	Portamento control	-	-
85-90	-	-	-
91	Effects depth 1	-	-
92	Effects depth 2	-	-
93	Effects depth 3	-	-
94	Effects depth 4	-	-
95	Effects depth 5	-	-
96	Data increment	x	increments the DATA ENTRY register
97	Data decrement	x	decrements the DATA ENTRY register
98	NRPN (LSB)	0-127	sets bottom 7 bits of NRPN number
99	NRPN (MSB)	0-127	sets top 7 bits of NRPN number
100	RPN (LSB)	0-127	sets bottom 7 bits of RPN number
101	RPN (MSB)	0-127	sets top 7 bits of RPN number
102-119	-	-	-
120	All sound off	x	kill all notes, centers pitchbend
121	Reset all controllers	x	centers pitchbend clears CC#20-27,72,73,75 and 79
122	Local control on/off	-	-
123	All notes off	x	kill all notes, centers pitchbend
124	Omni mode off	-	-
125	Omni mode on	-	-
126	Poly mode off	x	kill all notes, centers pitchbend
127	Poly mode on	x	kill all notes, centers pitchbend

x = don't care

NRPN MIDI COMMAND TABLE...

Address MSB ,LSB	NRPN function	Values	Notes
0,16	VCO FREQ ARP SPEED override MIDICLOCK DIVIDE override	0-1023 0-1023 0-1023	FREQ knob if no NOTE ON issued 20-6000 BPM internal arp clock BPM/2 to BPM x24 if MIDICLOCK
0,17	VCO SCALE ARP MOD	0-1023 0-1023	SCALE knob of no NOTE ON issued selects ARP mode
0,18	VCO FM DEPTH	0-1023	overrides VCO FM DEPTH knob
0,19	VCO WAVESHAPE	0-1023	overrides VCO WAVESHAPE knob
0,20	VCO DIFF	0-1023	overrides VCO DIFF knob
0,21	LFO FREQ	0-1023	overrides LFO FREQ knob
0,22	LFO SCALE	0-1023	overrides LFO SCALE knob
0,23	LFO WAVESHAPE	0-1023	overrides LFO WAVESHAPE knob
0,27	EG release time	0-1023	overrides EG RELEASE knob
0,28	EG sustain level	0-1023	overrides EG SUSTAIN knob
0,29	EG decay time	0-1023	overrides EG DECAY knob
0,30	EG attack time	0-1023	overrides EG ATTACK knob

Data entry values greater than 1023 will be normalized to 1023

PATCH SHEET…

… Work in progress (10 FEB 2009)