

Resonator Neuronium

RNS-N6 First Realisation

Operating Manual



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Foreword

Dear customers, first of all I want to thank you very much for your decision to purchase the unique Resonator Neuronium.

I leave it up to you whether you will consider it a sound production tool, a performance machine, a musical instrument, synthesizer, FX unit or an objective piece of art.

I hope that it will bring lots of joy and inner satisfaction to you. I myself am repeatedly fascinated by the strange but organic sounds which emanate from this kaleidoscope of a sound producer.

Initial reactions are mostly those of loud laughter because these sounds partly remind one of animal vowels or ape screaming.

Recently an editor of a magazine, who was born in Mozambique, was here for an interview. He heard the first tones from the resonator, and without hesitating a second he mentioned it sounded exactly like animal noises from Africa, and that such a direct organic animalistic sound he had never experienced from an electronic synthesizer before.

When I made the very first tunes in 2001 whilst programming at home, sitting at the open balcony window, even birds came by and sang in response because they obviously thought this would be a friend (or competition) ☺

How can a unit be improved when it is able to make people laugh? Well, it can also scare you...but hey, here we have a great pallet of human emotions.

I hope that you can use these emotions as sonic pictures within your electronic sound compositions as much as a painter draws the expressions with his inner eye using different brushes. Why not use a very complex brush from time to time?

I'm very honoured by the fact that there is a little worldwide community which shares my personal thoughts, researches and musical ideas.

In the beginning I wasn't sure if one can or even should sell such an experimental sound production tool.

The initial thought was more a rebellious one: I wanted to develop something that is derived from my very own individual ideas and wishes and that does not fit to a form of marketed music synthesis. I found it was time to create a new sound synthesis.

And because in my private life I am much more interdisciplinary than "only" being a designer of electronic musical instruments, the outcome was something that contains a lot of other areas of knowledge. Beyond the pure electronic and musical thoughts there are ideas from biology, chemistry, cybernetics, system dynamics, communication and lately philosophy all implemented in the Resonator Neuronium.

Therefore I had the desire in the beginning not only to establish this project commercially but rather to understand myself as an artist who is introducing his work to the world.

By selling the Resonator Neuronium to people it becomes possible to bring this sound production concept to a public that is becoming more and more bored by a never ending flood of plug-ins and plagiarists.

By the vast number and exchangeability of many software synths the value of a sound producer has dropped in the view of many people. A plug-in, a synth, a crack, I just can get anything cheap or for free...and what's the value of it?

Most people don't even have at least the tiniest imagination about how much work and know-how is required to build these tools.

This has damaged us all, musicians and manufacturers, because playing an instrument without feeling

a value for it or having a minimum respect for it feels bad and is not creative in the end. For the manufacturers, it has damaged business which I have painfully experienced through the last years as well.

It may be that in 5 years, soft synths become sonically indistinguishable from real analog (right now in the age of G5 and P4 3.6GHz, they are still fairly far away from being the same), but I think the actual problem is the value that we see in music and the ways to get there. Soft synths are not bad in themselves, and certainly I know some very good ones, but the hype surrounding this new technology and the piracy mentality and therefore the junking and crapping of sound synthesis tools hasn't helped the music – it is also often only seen as cheap stuff. I hope and feel at the same time that a counter movement to this cultural "clearance sale" is manifesting. It is a dictum of contemporary spirit how people make music and why they have to do it.

I can imagine that the contradiction of software and hardware harmonises now to an ideal supplement (say symbiosis) because both realms together have real advantages nobody has to forego.

Many people have written me over the past years to praise my instruments and even to give thanks to me that they exist.

For this I want to thank you very much at this point! Interestingly enough, these or similar sounding sentences mostly came up: "thank you for your great instruments, you just rock... keep up the good work, guys, and please don't give up."

Obviously there is a consciousness as to what quality means, and that quality isn't only natural. I just want to add that I don't have supernatural capabilities nor that the Jomox company makes instruments of supernatural quality.

I do my work thoroughly and I have a clear concept – analog sound production first, then the digital control around it – and I build hardware through material efforts, production, control and quality control. Obviously this is quite a lot nowadays.

Some suppliers told me that the result of my huge technical efforts is not state-of-the-art any more...if so, be happy to own a device of an extincting species☺

I hope that you will have lots of joy with it though. We should do what we like with what helps our creativity and is fun for us. The universe handles the details...

I always put the sound and the usability to the top of the list. And that means also offering a tactile fun that you should have with hardware in general. I don't want to sell devices that aren't fun for me to use, and because of this they have been successful up until now.

So I have implemented some new things in the Resonator Neuronium: The net programming and selection of neurons, for instance, are made simply by touching the touch-sensitive pot knobs – you just have to touch them for selection and you have them already in your hand (by the way, made from gold plated brass) to adjust the value. Net connections can be seen immediately through a sophisticated matrix of 3-color LEDs which show the polarity of signals in red or green.

I have even tried to limit the menu and operating levels to a human level. Certainly some functions are not 100% perfectly implemented though. There will surely be some updates in future which can be downloaded by midi into the device's flash in the serial version now.

But I hope I could give some of you a surprise gift. In the past half year I worked very intensely on hardware and software changes. Probably I wouldn't have done this if I had not sold this unit to people. As the designer and user of one's own units you know very well how to handle bugs and incomplete parts.

Regarding the sound I am very anxious to know your reactions. Many people have acknowledged to me that the sound is very organic which I have experienced a lot as well.

Maybe the concept is kind of a catalyzer for a new sound aesthetics which finds a place in experimental or commercial music compositions, film scores or performances. If so, I would be very happy about it.

Although this is an operating manual, this project has been running through my life for a couple of years now so that it appears to me as if I were writing a book. For this reason I want to thank a few people that have helped and supported me a lot through my endeavours:

First off, my lovely wife Heidi who never stopped believing in me and who always supported me in my personal development. Even if it meant a deprivation of shared time for her.

Then there's Peggy Sylopp and Giovanni Longo who did the first performances with the Resonator Neuronium with me. In December 2002 we had the first performance with Resonator Neuronium and computer visuals during the exhibition in the Glaslager of the Berlinische Galerie. I enjoyed that very much!

Thanks to my suppliers BEK, Leiterplatten Nord, Schweitzer Systemtechnik and many more.

And, of course, I thank you, the first 16 brave owners of this unit to take the risk. Thank you for having waited patiently for such a long time until the first serial units were finally finished. Without the pre-financing, this project would have never taken place. For this you deserve honest admiration.

I think I have said enough about reasons and backgrounds and therefore I want you just to put your hands on and explore this micro universe with its about $2^{6^{256}}$ (an unimaginable number) possible states yourself...

With warm regards,

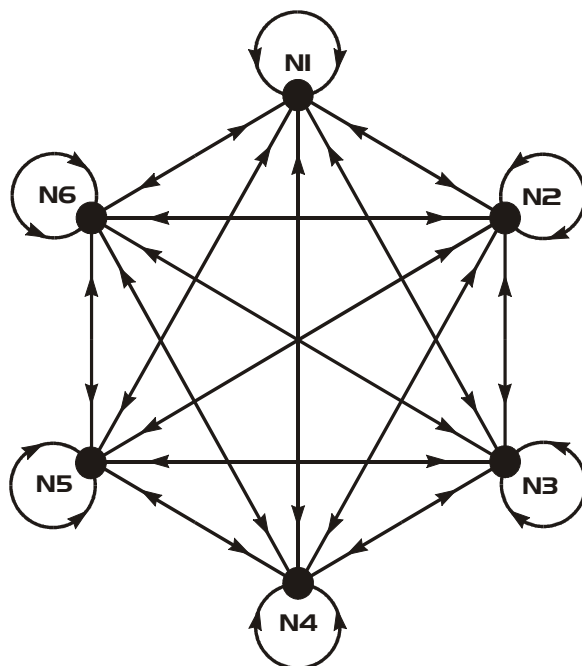
Jürgen Michaelis
MJ - Yogi

1. The Net

1.1 Main Structure

The Resonator Neuronium contains an analog neural net which has 2 main analog layers and a digital layer with sequencers.

The first layer represents the networking of neurons by addition, which means summation as in a mixer, and the second represents the linking by frequency modulation. All possible paths are physically existent and can be activated by programming. In the Resonator Neuronium there are 6 neurons which result in a number of 36 possible links in one layer between the neurons.



Pic.1

Each of the shown linking paths is existent for every direction to and from each neuron and for every layer, via summation and FM. This is shown by the arrows which point in both directions.

The self-networking of each neuron, or better its feedback, is shown as loop arrows. These can be positive as well as negative. Thus the arrows point here in both directions too, although only one inner physical path is existent for its own feedback.

Also FM has its own loop, which means that a neuron-filter indeed can modulate itself through FM.

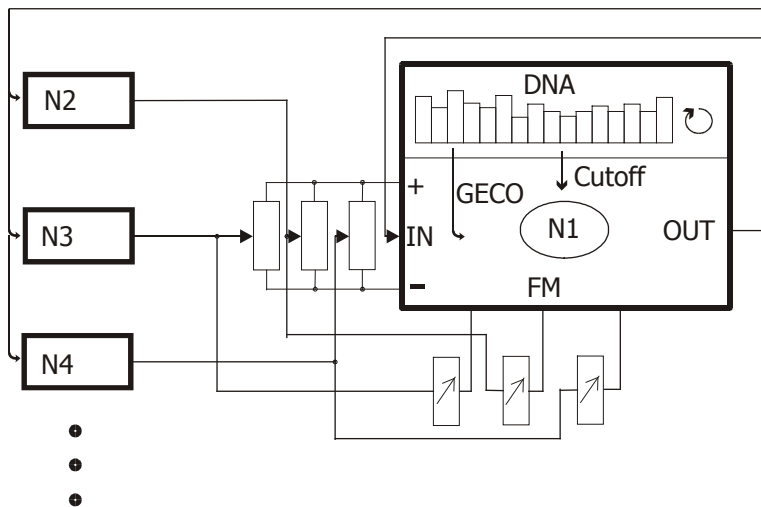
The network looks the same from every point of view, hence it is symmetrical regarding each single neuron and its network links.

⇒ In the R.N. the resulting sounds are NOT generated from different building blocks like VCO, VCF, VCA, Envelope, LFO, etc. as on classical synths but by network vibrations, feedbacks and complex interactions between EQUAL elements. In this case it's implemented by differential cascade filters (moog ladder) ⇐ (as described at www.jayemsonic.de).

These elements, say neurons, are modular in hardware and can theoretically be exchanged later on by different (and different sounding) neuron-filters. Swapping them is easy and can be performed by the user just by opening the bottom plate and exchanging the plug-in (real plug-ins☺) modules.

1.2 Net node structure

If you take a single neuron and its links apart, you'll get the following picture:



Pic.2

Additive layer: The output signals come from all neuron outputs and are mixed by the input potentiometers to the neuron input, like an audio mixer, with the only difference that it can be continuously both positive or negative. If you keep with the audio mixer example, it is as if you switch the phase button automatically on the mixer when you cross zero (center of the knob).

FM layer: Additionally, the output signals from the other neurons are also mixed together by other potentiometers in order to modulate the cutoff frequency of the neuron filter. On FM it is only mixed without a change in sign.

Digital layer: Attached to the neuron filter there is the GECO which feeds an analog but digitally generated signal (oscillator or wave) dependent on the activated stimulus function to the neuron itself and thus to the greater network, if links are programmed. The GECO contains a step sequencer which can control the basic cutoff of the neuron filter. Please note that each neuron contains its own independent sequencer and GECO.

1.3 External Inputs

You have the ability to feed external signals into neurons 1 and 4. Both channels are linked if only one plug is inserted into one channel. The input gain can be controlled by the input gain knob. By this you can trigger, filter and excite the network with external audio signals and obtain interesting effects and sounds.

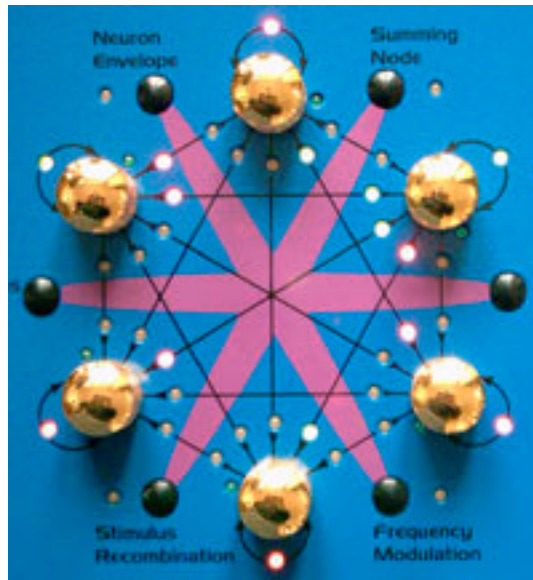
Furthermore, there is a D-sub connector placed at the rear carrying all analog inputs and outputs and some supply voltages. Potentially one could craft a custom-made breakout box to integrate the R.N. for example into a modular system or a studio cabling, or cascade several Resonators to form a larger network.

The pin out of the D-sub connector can be found in the appendix.

1.4 Additive nodes

The network connections are implemented by digitally controlled analog potentiometers and are storable.

In the R.N. you can store different net structures for each preset that are shown by a number of LEDs in the link arrows.



Pic.3

These LEDs are two-colored and show the sign of the input signal in the additive network layer.

LED off = no interaction

LED green = negative input signal

LED red = positive input signal

This point is of enormous importance for understanding the resonant neuron synthesis. Each network signal can be fed into the neuron input by the pots, negatively or positively. In the center position of the potentiometer, the interaction is actually zero or switched off because positive and negative signs are just balanced.

The actual intensity isn't shown by the LEDs, this is later described in 3.1 summing node (additive nodes).

1.5 FM nodes

For FM paths there are no signs. Here we only have displayed:

LED off = no FM

LED orange = FM active

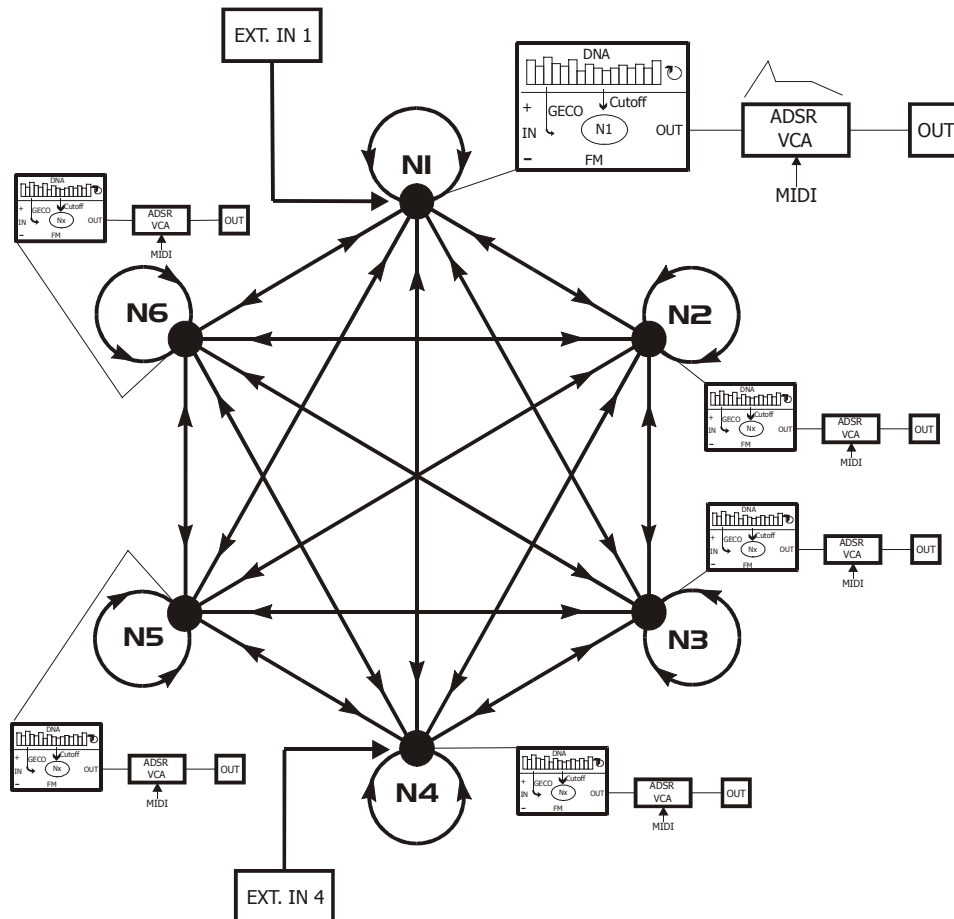
The actual intensity isn't shown by the LEDs, this is later described in 3.3 Frequency Modulation.

1.6 Digital Stimuli (GECO)

Even without excitement the analog net still performs, dependent on programming, simple oscillations to any chaotic complex rhythmic vibrations.

But it can also be excited from outside by a signal or a tone, the so-called stimulus.

To every neuron belongs a small microcontroller which performs different tasks: It programmes all the digital potentiometers, sets the rest of the analog parameters as the cutoff for the neuron filter, and generates the stimulus and the so-called "DNA sequences".



Pic.4

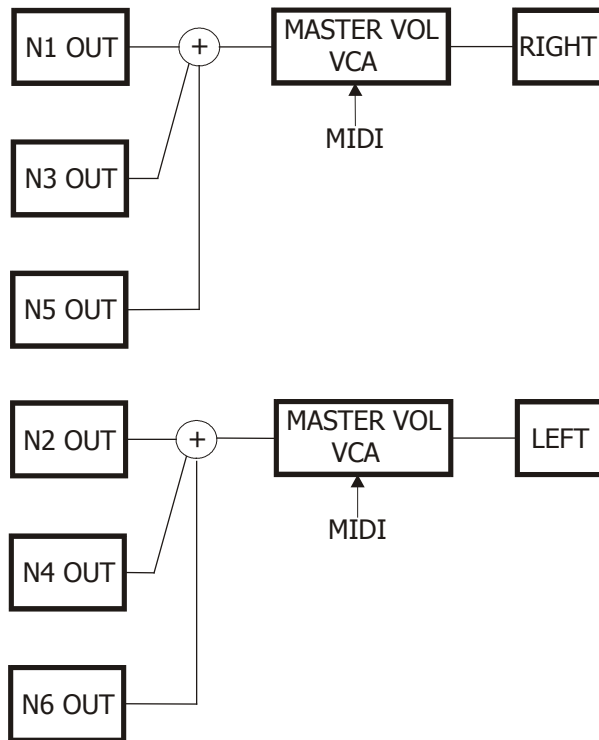
Hence, on each neuron there is a little independent sequencer with a tone generator. These tones can be played over midi. The sequencer can control the cutoff of its individual neuron filter and can control the different wave models of the so-called GECO (Generative Evolutionary Controlled Oscillator). These sequences are programmable by the user.

Steps, number of steps, values and models are all integrated into the micro sequencer and are interpreted as a so-called DNA code. Moreover, each neuron processor is linked to the other processors in order to exchange data and "mate" (recombine the DNA codes) with each other or mutate by a random function. So, new sound constellations can always evolve from a start preset. More about this in chapter 2.

The GECO and command descriptions are given in 3.4 Stimulus Recombination 3.5 Stimulus Edit.

1.7 VCA Envelope

Last but not least, the generated signal of each neuron gets picked up by a VCA envelope with ADSR to gate or release the sound by an external midi note. The envelopes are true analog, too, so the signal doesn't leave the analog realm at all. All values are individually adjustable for each neuron and are storable. The net signal is always present and active, the VCA envelopes just pick it up. There is also a function to generally switch on or off all VCA envelopes.



Pic.5

Between output mixer and stereo jacks, a master VCA is placed in order to control the main volume by Midi CC 7. After power-on, this VCA is always full levelled.

2.1 DNA Structure

```
      GECO   Cutoff Control
||||||| Mother DNA
||||||| Father DNA
```

The DNA is ordered in different sections. The functions of the areas are described in the following sections. The DNA is always made in 2 parallel strings: mother and father who mostly (but not always) are mirrored to each other.

If a neuron mates with another neuron it exchanges the whole DNA set with the other which results in a domination of the single father's or mother's "genes" each with a 50% likelihood. All phenotypical (the look of the individual) characteristic features are exchanged then to create a new "individual", meaning a new sequencer and sound combination.

2.11 GECO Wave Buffer

```
||||||| Mother DNA
||||||| Father DNA
```

Every GECO contains the whole set of mother and father DNA. Each of the two 16 byte sequences controls the sequence or sound of the selected wave model. With physical modelling it is the exciting pattern, with PCM waves it's the single samples and with loop wave sequences it's the single microloop steps of the sequencer that are represented by the DNA bytes.

This implies that the information of the GECO buffer is differently interpreted depending on the wave model. The values stay the same regardless which model is selected and are transferred completely during a mating.

The division into mother and father DNA becomes important by the mating of two neurons. Here the strings of mother and father DNA get recombined with the strings of the other and hence produce totally new combinations that can work in 2 recombination modes. Those recombination modes are fairly closely oriented to organic processes in nature. In tiny dimensions similar processes occur when an egg cell is fertilized with a sperm cell.

On mating, there is a 50% likelihood of every DNA step to get set by a father or mother DNA byte of the partner. In one recombination mode the father or mother DNA sets get summed and averaged, in the other they are just replaced - as it exactly does in nature on selection of chromosomes and father or mother genes.

Both DNA sets can be manually edited (see -> 3.4 Stimulus Edit)

2.12 Cutoff Buffer

```
||||||| Mother DNA
||||||| Father DNA
```

The cutoff sequence is made up of 16 steps which are again made up of 8 mother and father numbers. The sequence plays back mother and father DNA on an interleave scheme. They can only be edited together (see -> 3.5 Stimulus Edit) since it is one concatenated sequence. On mating, a part of the sequence shares the "genetic code" of the next generation.

2.13 Control Buffer

1	2	3	4	5	6	7	8	
								Mother DNA
								Father DNA

In the control area, the control of all sequences is coded. Mother and father DNA have identical codes here. The single bytes contain information about the number of played steps and step direction. This information is coded in specific bits of the control group.

1 Last step cutoff sequence

This determines the number of played steps of the cutoff sequence. Maximum is 16. If a smaller value is edited here, for instance 8th step sequences or any other value, uneven measures can be obtained. This is very interesting when other neurons have different last steps. Then you get polyrhythmic interferences which can be very interesting in musical terms.

2 Reverse cutoff sequence (value>8)

3 (Play mode cutoff sequence) not implemented

5 Volume GECO Wave

Volume of GECO wave, resolution: 16 steps

6 Model select GECO Wave

The wave models described above can be selected here. 8 different wave models can be chosen.

7 Last step GECO wave sequence

This determines the number of played steps of the GECO wave sequence. Maximum is 16. If a smaller value is edited here, for instance 8th step sequences or any other value, uneven measures like 14/16 can be created. This is very interesting when other neurons have different last steps. Then you get polyrhythmic interferences which can be very interesting in musical terms.

8 Reverse GECO wave sequence; DNA interpreter

This plays the GECO wave reversed. Additionally there is another flag in this byte: The DNA interpreter. If it is activated, the DNA area of the GECO is interpreted as information as to which wave model is to be played back. Hence you can establish very complex sequences of different wave models within a sequence.

2.2 Wave Models

2.21 Physical modelling mode

The first wave model is a primitive physical modelling.

The DNA string is the exciter and also the wave buffer for this wave model. On a trigger the pattern gets read from the father string of the DNA chain and is then transferred to the mother area.

In this ring buffer (mom area) the signal runs around and around like in a small echo loop (feedback pipe) made from tiny 16 samples and interferes with the old samples. This produces a string-like or percussion-like releasing tone that sounds - depending on the exciting pattern (father DNA) - more or less metallic and has a longer or shorter decay.

So if you want to change the exciting pattern and therefore the sound you have to edit the father area.

You can also edit the mother area, but then only the wave pipe gets excited on one sample which sounds as if you were bowing a string. The value gets immediately overwritten by the feedback pipe again.

The pitch of the tone, like the other wave models, can be played over a hooked up midi keyboard.

2.22 PCM Father wave

The father DNA gets read out like a tiny looped sample of 16 samples. Each DNA byte of the GECO area represents a sample of this loop.

2.23 PCM Mother wave

The mother DNA gets read out like a tiny looped sample of 16 samples. Each DNA byte of the GECO area represents a sample of this loop.

2.24 Noise

Mother and father DNA are additionally superimposed by a random function to create a noise signal which has a rest correlation to the tone pitch.

2.25 PCM Father- and Mother interleave

Father and mother DNA are read out as a tiny 16 samples loop and played back intermittently. On every second loop run it is played forward or reversed.

2.26 Rectangular loop wave

Every DNA byte gets processed bit by bit to a micro loop. The instruction is very primitive: If the bit is set, play a rectangular loop, if not, play nothing. This results in nested loops derived from the binary structure that are perceived as a tone which has overtone patterns due to the bit structure.

By sequencing these micro loop DNA bytes interesting metallic to acid-like sounding sequences are created.

In the sequencer the mother DNA is played first, then the father DNA.

2.27 Triangular loop wave

With this, the same happens as described with rectangular loops, the only difference is that instead of a rectangle a triangle is created. The instruction is very primitive as well:

If a bit is set, play an ascending slope, if not, play a descending one.

2.28 Sawtooth loop wave

With this, the same happens as described with rectangular loops, the only difference is that instead of a rectangle a sawtooth is created. If the bit is set, play an ascending slope, if not, let it fall to a certain level.

2.3 DNA Sequences

2.31 GECO Wave Sequences

The different wave models can be played in sequences. In order to do this, steps can be set and the steps can be edited in value.

If a step is set, the value information of this position is read and given to the GECO. If nothing is set, nothing is played.

With physical modelling, a step triggers the exciting of a wave pipe (similar to picking a string) so that rhythmic percussive cowbell to string-like sequences can be created.

The values of the GECO buffer (mother and father) are only responsible for the excitement and creation of a single tone and do NOT change the sequence pattern.

The same rules from 2.22 to 2.25 PCM wave generated tones or noise apply here.

For tonal GECO waves, as in 2.26 to 2.28 (microloop waves), the tone is either played for the endurance of a step or otherwise not.

Here a stored value resembles the currently replayed micro loop sequence in every byte of the GECO buffer. So some complex melodious sounding sequences are created that actually only change the overtone and octave settings but not the pitch of tones. Every step of the 16 GECO buffer bytes creates its own bit pattern that is read out by the sequencer as a micro loop. Intermittently the mother sequence and then the father sequence is played back.

Generally this means that the information of the GECO buffer is differently interpreted by the chosen wave model. The values itself stay untouched though and are transferred in whole through mating.

The step information is stored in the control buffer and can be changed by the step edit (see 3.5 Stimulus Edit). As a default 4 quarter steps are set.

2.32 Cutoff Sequences

The cutoff sequences control the filter cutoff for every step of the sequencer. If a step is set, the value information of this location is read and given out to the filter. If it is not set, the formerly played value is not changed.

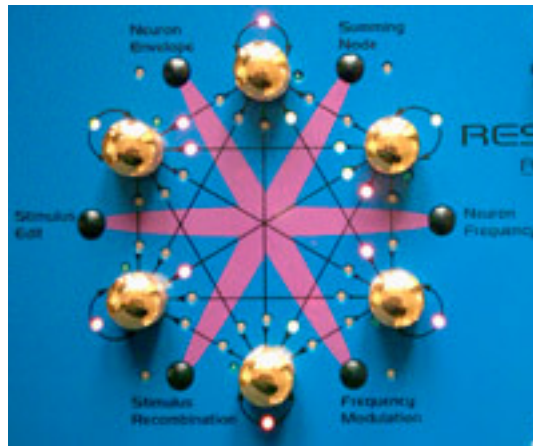
Thus you can simplify existing, complicated 16 step sequences or let them unfold again without changing the step values.

You can hear the filter sequence best if a filter is in negative self-resonance. With complex interactive filter modes, through neuron programming, the filter's own sequence and those of the other neurons influence the action of the whole network.

The step information for cutoff is stored in the control buffer of DNA and can be changed by step edit (see 3.5 Stimulus Edit). As default values all 16 steps are set.

3. Direct commands

Direct commands can be selected by the black buttons placed around the hexagon. Together with the golden potentiometer knobs, located on the hexagon's points, they form the main user interface to program the network links and the stimuli.



Pic.6

3.1 Summing Node (Additive nodes)

If you press the button "Summing Node" the display shows:

```
| Edit Neuron Net Input |  
|TxNeuXXX ->RxNeurXXX |
```

As long as none of the blue LEDs close to the pots are lit up, the command has not yet completed. You still have to select the source TxNeur and then the destination RxNeur. The Transmitter Tx sends its signal to the receiver Rx which sums up the signal at its input.

a) Select Transmitter

This is made by touching one of the 6 golden knobs. Immediately its blue LED lights up and the LCD displays a number at TxNeu that corresponds to the selected net node:

```
|TxNeu001 ->RxNeur001 | Example
```

b) Select Receiver

Now you have to select the receiver by touching another knob. The blue LED of the second knob starts flashing to indicate that the receiver is now selected. The LCD displays the number of the receiving neuron:

```
|TxNeu001 ->RxNeur003 | Example
```

Now you can change the value by scrolling the knob of the receiver. As you do this, the corresponding LED at the arrow in the link matrix lights up. It displays red when the value is positive and green when the value is negative. In the center position the LED fades and indicates therefore that the

interaction on this net node is switched off.
The LCD displays the value:

```
|TxNeu001 ->RxNeur003-054| Example  
Value range -127..127
```

As long as a transmitter is selected, you can simply switch to another receiver by touching another knob which causes its LED to flash. The only difference is that now the other net node gets summed up by the same procedure as before.

If you want to choose another transmitter, you have to fetch the command again by pressing the key "Summing Node" once more. Now the whole procedure starts again. You can build up as many net connections as you desire. The LEDs in the matrix display show the established connections.

By pressing the button "exit" you can quit the function.

A special situation is the self-connection: if by step a) above, you have selected a transmitter, and the same number of the transmitter is also shown as the number of the receiver; and if you don't choose another receiver and turn the transmitter knob; then the blue transmitter LED starts flashing itself and the red/green LED of the self-feedback loop of this net node lights up. This produces the self-feedback of a single neuron.

You can also step back on a neuron itself, as if you had chosen and processed different receiver neurons. This targets also the neuron itself.

TIP: Now listen how the self-feedback works: if you turn left, the value becomes negative and the filter starts oscillating – this resembles the resonance of common synthesizer filters. If you turn right, the value becomes positive and the filter starts to make a low frequency bass tone which increases to a toggling stable vibration. If you insert an external signal to this neuron, it sounds bulkier and more distorted until the toggle vibration sets in. The frequency of this tone depends of course on the cutoff (see the next command).

3.2 Neuron Frequency (Cutoff)

If you press the key "Neuron Frequency" the display shows:

```
| Edit Node Cutoff |  
|XXX XXX XXX XXX XXX XXX|  
Value range 000..127
```

Now you can adjust the cutoff frequency for each neuron individually. The values of the 6 neurons are displayed in the LCD.

By scrolling the corresponding knob in the hexagon the cutoff gets edited.

By pressing the button "exit" you can quit the function.

The cutoff is the basic value of each neuron. The filter cutoff of the neuron is actually influenced by the internal sequencer and by FM as well. Internally the values get summed up.

TIP: By tweaking the cutoff you can greatly enhance an already existing programmed net. It's partly only little changes which lead to totally different sounds and tones in a complex net. It's up to experimentation because all neurons influence each other on a programmed net. For live performance this is an indispensable function. Sometimes a programmed net is so complex and sensitive against chaotic turbulences that it has several "stable" states or modes. It can sound very different depending on the input signal. Even the start condition is important. For instance, from which preset you select the regarding net and switch it to.

3.3 Frequency Modulation

If you press the button "Frequency Modulation" the display shows:

```
| Edit Neuron Net FM |  
|TxNeuXXX ->RxNeurXXX |
```

As long as none of the blue LEDs close to the pots light up, the command has not yet completed. You still have to select the source TxNeur and then the destination RxNeur.

The transmitter Tx sends its signal to the receiver Rx on which the signal modulates the filter frequency.

a) Select Transmitter

This is made by touching one of the 6 golden knobs. Immediately, its blue LED lights up and the LCD displays a number at TxNeu that corresponds to the selected net node:

```
|TxNeu001 ->RxNeur001 | Example
```

b) Select Receiver

Now you have to select the receiver Rx by touching another knob. The blue LED of the second knob starts flashing to indicate that the receiver is selected now. The LCD shows up the number of the receiving neuron:

```
|TxNeu001 ->RxNeur003 | Example
```

Now you can change the value by scrolling the knob of the receiver. As you do this, the corresponding LED at the arrow in the link matrix lights up. In contrast to the additive networking it only lights orange because there is no change in sign, only zero or the intensity. In the leftmost position the LED fades and indicates therefore that the interaction on this net node is switched off.

The display shows the value:

```
|TxNeu001 ->RxNeur003-054| Example
```

Value range 000..255

As long as a transmitter is selected, you can simply switch to another receiver by touching another knob which causes its LED to flash. The only difference is that now the other net node becomes frequency modulated by the same procedure as before.

If you want to choose another transmitter, you have to fetch the command again by pressing the button "Summing Node" once more. Now the whole procedure starts again. As with the additive layer, you can build up as many net connections as you desire. The orange LEDs in the matrix display the established connections.

By pressing the key "exit" you can quit the function.

A special situation is the self-connection: if by step a) above, you have selected a transmitter, and the same number of the transmitter is also shown as the number of the receiver; and if you don't choose another receiver and scroll the transmitter knob; the blue transmitter LED starts flashing itself and the orange LED of the self-feedback loop of this net node lights up. This produces the self-modulation of a single neuron.

You can also step back on the neuron itself, as if you had chosen and processed different receiver neurons. This targets also the neuron itself.

TIP: FM connections make most sense if already existing additive connections produce tones or vibrations. If, for instance, 2 neurons are self-oscillating due to negative feedback (see 3.1), you can make them modulate each other by means of the FM-linking. If you program the to and the from path, you achieve a cross modulation.

If you set a neuron into positive feedback, you get something like an LFO with which you can modulate other self-oscillating neurons. But with many different connections you can achieve much more complex and interesting set ups...

3.4 Stimulus Recombination

If you press the key "Stimulus Recombination" the display shows:

```
| Edit Net Stim Recombin|  
|TxNeuXXX ->RxNeurXXX  |
```

As long as none of the blue LEDs close to the pots light up, the command has not yet completed. You still have to select the source TxNeur and then the destination RxNeur.

The transmitter Tx sends its signal for recombination, or rather for mating, to the receiver Rx, which retransfers its genome (DNA string) to the transmitter on this order. This leads to a mating procedure of both the DNA of transmitter and receiver to allow the transmitter to become the new DNA.

a) select transmitter

This is made by touching one of the 6 golden knobs. Immediately its blue LED lights up and the LCD displays a number at TxNeu that corresponds to the selected net node:

```
|TxNeu001 ->RxNeur001   | Example
```

b) Select Receiver

Now you have to select the receiver Rx by touching another knob. The blue LED of the second knob starts flashing to indicate that the receiver is now selected. The LCD displays the number of the receiving neuron:

```
|TxNeu001 ->RxNeur003   | Example
```

Now you can change the value by scrolling the knob of the receiver. As you do this, the corresponding LED at the arrow in the link matrix lights up. In contrast to the additive networking it only lights orange because there is no change in sign, only zero or the intensity. In the leftmost position, the LED fades and indicates therefore that the interaction on this net node is switched off.

The display shows the value:

```
|TxNeu001 ->RxNeur003-054| Example  
Wertebereich -127..127
```

As long as a transmitter is selected, you can simply switch to another receiver by touching another knob which causes its LED to flash. The only difference is that now the other net node becomes frequency modulated by the same procedure as before.

If you want to choose another transmitter, you have to fetch the command again by pressing the button "Summing Node" once more. Now the whole procedure starts again. You can only make one net connection per neuron. The LEDs in the matrix show already existing connections.

The chosen net mating connections are established once every 16 steps (one measure) by the sequencer, as long as "Rcm" (Recombination) is set to "on" in the sequencer menu.

By pressing the key "exit" you can quit the function.

3.5 Stimulus Edit

If you press the button "Stimulus Edit" the display shows:

```
| select a node GCO SEQ|  
|GCO Mom Bar Val Sto Exit|
```

To continue, a net node has to be selected. This is made by touching one of the 6 knobs of the neurons.

Now a bar sequencer is shown in the display:

```
|                GCO SEQ|  
|GCO Mom Bar Val Sto Exit|
```

Each neuron has such a sequencer. You can switch them around just by touching one of the neuron knobs. The display is updated automatically.

For programming different layers, you can select sub menus through the 4 soft buttons which have the following functions:

GCO / CuS

GECO wave sequence / Cutoff + Control Sequence [Mom]

Here you can switch between wave sequences and cutoff sequences.

```
|          X          XXX SEQ|  
|GCO Mom Bar Val Sto Exit|
```

Values of the bars get adjusted by soft knob 1. The bar located at the cursor which is displayed as an "X" shows the value roughly quantized, while the same number is displayed right next to the sequencer row again as a 3-digit value.

The cursor can be moved by the up/down keys or by soft knob 2.

The various functions of the wave segments are dependent on the GECO settings and are described in chapter 2. The GECO.

The cutoff sequence additionally contains the control area for sequence control only if the Dad sequence is chosen. The second half of the bars refer here to:

```
| 1 2 3 4 5 6 7 8 XXXLaSC|
```

```
|CuS Dad Bar Val Sto Exit|
```

- 1 LaSC=Last step cutoff sequence
- 2 RevC=Reverse cutoff sequence
- 3 PMoC=Play mode cutoff sequence (not implemented)
- 4 NoAv=not implemented
- 5 VolG=Volume GECO wave
- 6 ModG=Model select GECO wave
- 7 LaSG= Last step GECO wave sequence
- 8 RevG= Reverse GECO wave sequence

Numbers are printed within the bars. On moving the cursor, a shortcut is displayed on the right which resembles the function in the control buffer. The exact description of this function is given in chapter 2.13 Control Buffer.

Mom / Dad

Mother / Father Sequence

Switches between the mom- and dad-sequence. Only through using a GECO wave sequence can different sequences be chosen here. If you are in the cutoff area, you can switch between the actual cutoff sequence and the control area (dad).

Bin / Bar

Binary / bar display

For micro loop waves it may be useful to see the bit patterns of the corresponding step. If this switch is set to BIN, you can see every edited byte as a bit pattern of 8 bits printed on the left in the step bars.

On moving the cursor this display vanishes to reveal the normal bar display.

Val / Stp

value / step input

```
| ___ _ _ X_ GCO 010 |  
|CuS Mom Bar Stp Sto Exit|
```

If step input is activated, you can select the steps to be played from a sequence of 16 steps.

You select the desired edit location with the cursor or soft knob II. Scrolling soft knob I to the right sets a step and scrolling it left clears a step.

In this edit mode you can also switch between GECO and cutoff sequence, and so immediately display the different steps for the different sequences.

If value input is activated, you can edit the value of a GECO step or cutoff step at the location of the cursor ("X").

3.6 VCA Envelope

If you press the button "Neuron Envelope" the display shows:

```
|ATT dec sus rel Sto Exit|  
| XXX XXX XXX XXX XXX XXX|
```


Value range 000..127

This command edits the VCA envelope for each neuron individually. The VCA envelope controls the loudness contour of the picked up neuron signal from the pressed key of a connected midi keyboard.

Attack

On initial selection of this command the switch ATT for attack is activated first. If you are currently in the other submenus (see below), press soft button 1 to return to the attack menu.

Scrolling the corresponding knobs in the hexagon edits the attack value of the individual envelope of one neuron.

You have also the possibility to edit all 6 neurons with the same value to obtain polyphonic, homogeneous envelopes by scrolling soft knob I. The numbers are then edited all at the same time. The individual numbers are overwritten though.

In case you wish to use individual envelopes, you should leave this function again by pressing exit shortly after editing so as to avoid overwriting the attack values unintentionally.

Attack changes the rise time of the VCA envelope which is triggered by a midi note.

Decay

Please press soft button 2 at the display. Now the following appears:

```
|att DEC sus rel Sto Exit|  
| XXX XXX XXX XXX XXX XXX|
```

Value range 000..127

You can change the decay of the individual envelope of the addressed knob in the hexagon by scrolling this knob. For general editing of all decay values follow the same procedure as in the attack section.

Decay changes the decay time of the VCA envelope after the completion of the attack phase when triggered by a midi note.

Sustain

Please press soft button 3 at the display. Now the following appears:

```
|att dec SUS rel Sto Exit|  
| XXX XXX XXX XXX XXX XXX|
```

Value range 000..127

You can change the sustain of the individual envelope of the addressed knob in the hexagon by scrolling this knob. For general editing of all sustain values follow the same procedure as in the attack section.

Sustain changes the sustained level of the VCA envelope as long as a midi note is held (the value where it stays after decay).

Release

Please press soft button 4 at the display. Now the following appears

```
|att dec sus REL Sto Exit|  
| XXX XXX XXX XXX XXX XXX|
```

Value range 000..127

You can change the release of the individual envelope of the addressed knob in the hexagon by scrolling this knob. For general editing of all release values follow the same procedure as in the attack section.

Release changes the release time of the VCA envelope after the midi note is off.

4. Menu Commands

You enter the main menu by pressing the button Menu\Presets. You can toggle between preset display and main menu by pressing this button several times.



Pic.7

```
|Init Neuron 001 Single|  
|Rx01 Tx01 Sto Exit| Preset display
```

```
|  
|Glb Seq Mid Edi Sto Exit| Main menu
```

In the main menu you can enter further sub menus by pressing one of the first 4 soft buttons. The functions below describe the different menu items in the order of the menu structure.

4.1 Glb [Global]

```
|  
|Pnc VCA Msc Tun Sto Exit| Global menu
```

4.1.1 Pnc [Panic All note off]

All notes get cleared and all VCA envelopes get closed.

4.1.2 VCA [VCA all open]

All VCA envelopes are opened so that all neurons can be heard at the same time.

4.1.3 Msc [Miscellaneous]

```
|LCD Clr Ini Ver Sto Exit|  
|XXX | Miscellanous[A1] menu
```

LCD [Contrast]

The LCD contrast can be changed by the left soft knob Edit I.

Clr [Global Parameter Init.]

All global parameters (Midi Ch, divider, clock settings, LCD contrast, sequ. switches, etc.) are initialised.

Ini [Initialise Machine]

The whole machine gets initialised. Attention, this erases everything including all programmed presets without any return! Before performing this function a security alert is shown which has to be confirmed with "yes", otherwise cancel with "exit".

Ver [Display OS Version]

Shows the version number of the OS (Operating System) which can be updated by means of a Sysex dump into the internal device's flash memory.

4.2 Seq (Sequencer)

```
|Seq Cut GCO Rcm      |  
|off off off off      | Sequencer menu
```

If the sequencer (seq) is set to on, the blue LED "Beatclock" starts flashing in quarters of the current tempo, and all 6 neuron sequencers are restarted. Depending on which sequencer function flags are set, the respective sequences are played back.

4.2.1 Seq [Main Seq on/off]

Switches the sequencer globally on or off. Also with turned off sequencer the pointer in each neuron gets updated.

4.2.2 Cut [Cutoff Seq on/off]

Switches the cutoff sequence on or off.

4.2.3 GCO [GECO Seq on/off]

Switches the GECO wave sequence on or off.

4.2.4 Rcm [Recombination Seq on/off]

Switches the recombination between neurons selected for recombination to on or off. On every 16th sequencer step (once a measure) the neuron partners selected on Stimulus Recombination mate and propagate a new generation in the target neuron.

4.3 Mid [Midi]

```
|  
|Cha Syn Ena Sys Sto Exit| Midi menu
```

4.3.1 Cha [Channel]

```
|RxC TxC          Sto Exit|  
| XXX XXX        | Midi channel menu
```

Here you can edit the midi receive channel (RxC) with soft knob 1 and the transmit channel (TxC) with soft knob 2. The values range from 1 to 16.

4.3.2 Syn [Synchronisation]

```
|Uni Syn Div BPM Sto Exit|  
|off off XXX XXX        | Synchronisation menu
```

Uni [Unisono]

Switches between unisono on or off. With unisono « on » all neurons are played simultaneously on a one note event with the same pitch.

Syn [Midi Clock Synchronisation]

Switches midi clock synchronisation on or off. In sync mode « on » the tempo clock is derived from the received midi clock. Please note that midi clock always operates independently of a midi channel. The reception of midi clock is indicated by the flashing of the blue beatclock LED in the rhythm of the clock divider (see Div). The sequencer is restarted automatically on reception of a midi start command.

Div [Clock divider]

The received midi clock, in the format 24ppq (pulses per quarter), gets divided by a pre-divider so that for instance only every 6th clock pulse lets the sequencer propagate one step. Adjust the number with soft knob Edit 1. Defaults: 3=32th, 6=16th, 12=8th, 24=4th notes for each sequencer step. Values between them generate X-triplet rhythms in relation to the master clock.

BPM [Beats per Minute]

The Edit II soft knob adjusts the BPM (beats per minute) of the sequencer tempo.

4.3.3 Ena [Enables]

PrC [Program Change]

Switches transmission and reception of program changes on or off.

Aft [After Touch]

Switches reception of aftertouch on or off.

Pit [Pitch]

Switches reception of pitch bend on or off.

CC [Continuous Controllers]

Switches transmission and reception of continuous controllers on or off.

4.4 Edi [Edit]

4.4.1 Nam [Name Edit]

```
|Xnit Neuron          |  
|< > << >>        | Name Edit Menü
```

Here you can edit the name of a preset. Press the arrow buttons to move the cursor right or left and change the letter by scrolling soft knob Edit I or II. The buttons with double arrows move the cursor by 4 digits.

4.4.2 Sti [Stimulus Edit]

4.4.3 Env [Envelope Edit]

4.4.4 Mor [More]

Ini [Editbuffer initialize]

This function initialises the edit buffer. All edits are made in the edit buffer and are not written immediately into the main memory. Only on storing with Store, will the edit buffer get written into a memory location (preset).

4.5 Sto [Store]

To store a preset, press Store. Now the following appears:

```
| Store - are you sure? |  
|           yes exit|  Store menu
```

If you choose "yes" the sound is stored in the actual preset.

But you can also select another preset by the up/down buttons which copies the sound into the other preset. The old preset name and the preset number of the target preset is displayed during this procedure. Storing into another preset overwrites the data of the old preset, so please take care. If you press yes, the sound gets stored and recalled from the new preset.

You can also quit the function with exit.

The possibility to store into other presets makes a copy function unnecessary by the way. The source preset stays untouched.

4.6 Exit

By pressing exit you can go one step higher in the menu levels or break critical functions like Store Preset.

4.7 Single/Multi

With this button you can switch between single mode and multi mode which is shown in the display as follows:

```
|Init Neuron  001  Multi|  
|Rx01 Tx01      Sto Exit|  Preset display
```

In single mode the R.N. only receives on one midi channel and the various neuron envelopes are triggered in the order of the last keys pressed on the keyboard. After 6 pressed keys all neurons are played and further played keys just « steal » the place of the last keys played (last note priority). In single mode you can play the R.N. actually like a polyphonic synthesizer.

In multi mode each neuron only receives on one channel which is firmly assigned in ascending order to channels 1-6.

5. Appendix

5.1 Midi Implementation

5.1.1 Received notes

Instrument	Single Mode	Multi Mode
	Key (Note Number)	Channel
Neuron 1 Envelope	C1(36)..C#5(85)	1
Neuron 2 Envelope	C1(36)..C#5(85)	2
Neuron 3 Envelope	C1(36)..C#5(85)	3
Neuron 4 Envelope	C1(36)..C#5(85)	4
Neuron 5 Envelope	C1(36)..C#5(85)	5
Neuron 6 Envelope	C1(36)..C#5(85)	6

On reception of a note, the running sequencer of the corresponding neuron is also restarted again. In single mode the neurons are triggered in order of the pressed keys. The blue LED of a neuron lights up when the corresponding midi note is pressed.

5.1.2 Received Continuous Controllers

CC 7 Master Volume

CC 14 Cutoff Neuron 1

CC 15 Cutoff Neuron 2

CC 16 Cutoff Neuron 3

CC 17 Cutoff Neuron 4

CC 18 Cutoff Neuron 5

CC 19 Cutoff Neuron 6

CC88 Switch Controller; several key functions can be remotely controlled :

Value	Function
00	menukey
01	singlemultikey
02	softbut1key
03	softbut2key
04	softbut3key
05	softbut4key
06	storekey
07	exitkey
08	stimuluskey
09	cutoffkey
10	progupkey
11	progdokey
12	stimrekombinatkey
13	fmkey
14	envelopekey
15	inputkey

On soft buttons 1..4 you can, by a sequence of some consecutive CC88 with corresponding values, make menu selections and edits, for instance sequencer functions on/off.

CC 100 Poti 1 ;Remote control of neuron pot 1, depending on currently selected menu function
 CC 101 Poti 2 ;Remote control of neuron pot 2, depending on currently selected menu function
 CC 102 Poti 3 ;Remote control of neuron pot 3, depending on currently selected menu function
 CC 103 Poti 4 ;Remote control of neuron pot 4, depending on currently selected menu function
 CC 104 Poti 5 ;Remote control of neuron pot 5, depending on currently selected menu function
 CC 105 Poti 6 ;Remote control of neuron pot 6, depending on currently selected menu function

CC 123 All notes off

Prog Change 00..100 selects presets 00..100.

5.1.3 System Exclusive Data

By system exclusive data only, hex dumps of the whole memory content are performed because sound control generally is only made by continuous controllers.
 A system exclusive command line reads as follows:

\$F0(SysEx Begin), \$31(JoMoX-Herstellercode), \$7F(Befehl Sys Ex Dump), \$64(Product Code R.N.),
 \$0X(RxChannel),XX(Data0),XX(Data1),..., \$F7(End of SysEx)

5.2 D-Sub Connector

1	2	3	4	5	6	7	8	9	10	11	12	13
IN 1	IN 2	IN 3	IN 4	IN 5	IN 6	GND	OUT 1	OUT 2	OUT 3	OUT 4	OUT 5	OUT 6
14	15	16	17	18	19	20	21	22	23	24	25	
+5V	+5V	GND	GND	GND	GND	GND	GND	GND	GND	-5V	-5V	

The inputs have a fixed input sensitivity which couples positively to the neurons and mixes with the rest of signals.

The outputs are pure neuron signals which are picked up before the VCA envelopes.

5.3 Technical Data

Instruments	Neuron 1-6
Sound production	analog on layer additive/FM, digital on stimuli/sequencer per neuron
User Memories	101
Pattern Memories	606 (per preset 6 neuron sequencer)
Tempo	38 BPM to 292 BPM in discreet single steps
Output level	about 0 dBu
Display	24 Character LCD Display
Buttons	16
Knobs	9x gold plated brass, 8 are touch sensitive
Main CPU	High Performance 8/16-Bit Risc Controller
Neuron CPU	6 High Performance 8/14 Bit Risc Controller
CPU clock	20 MHz
Power supply	external 10.5V AC/AC wall wart power supply
Housing	Iron angled casing blue coated
Measures	380mm x 235mm x 64mm
Weight	4.5 kg