1. Introduction

Module A-107 is a completely new **voltage controlled filter** that has available **36 filter types**: different versions of low pass, high pass, band pass, notch, all pass and filters with new response curves that have no name up to now.

Of course the standard VCF controls are available: **manual and voltage control** of **filter frequency** and **resonance.** For the filters of the first group (1...18) **self-oscillation** is possible, the filters of the second group (19...36) do not feature self-oscillation. On top of it a final **VCA** is available - even with manual and voltage control. All external control inputs are available twice: one with attenuator and one without.

The 36 filters are organized in **two groups of 18 filters** each. The filters can be arranged in 64 different **filter chains**. Each chain consists of **32 steps**. The sequence of a filter chain is passed through while the manual control is operated or the external control voltage changes from 0...+5V. **64 filter chains** can be programmed by the user and stored in the non-volatile memory of the module.

The **transition** between filters can be **soft (morphing)** or **hard (switching)**. The morphing time (manual and voltage controlled) defines the transition time between succeeding filters from a few milliseconds (switching) up to about 10 seconds.

Additionally a **"clocked" mode** is available. This means that the steps of the currently selected filter chain are selected one after another. Each **positive transition of the Clock** signal calls up the next filter of the chain. A positive trigger at the **Step Reset** input resets to the filter of the chain that corresponds to the momentary step CV. This allows e.g. to switch between the filters of the currently selected filter chain in sync with a sequencer.

The filter design is **100% analog** (CEM filter chip). Only the morphing control and memory managing is carried out by a microcontroller.

Remark: Because of technical reasons the transition between the two filter groups cannot be carried out soft as capacitors have to be switched. Soft transition (i.e. morphing) is possible only between the filters of each group (i..e. within the filters 1...18 or 19...36). Switching between filters causes a "click" if the filters are from different groups.

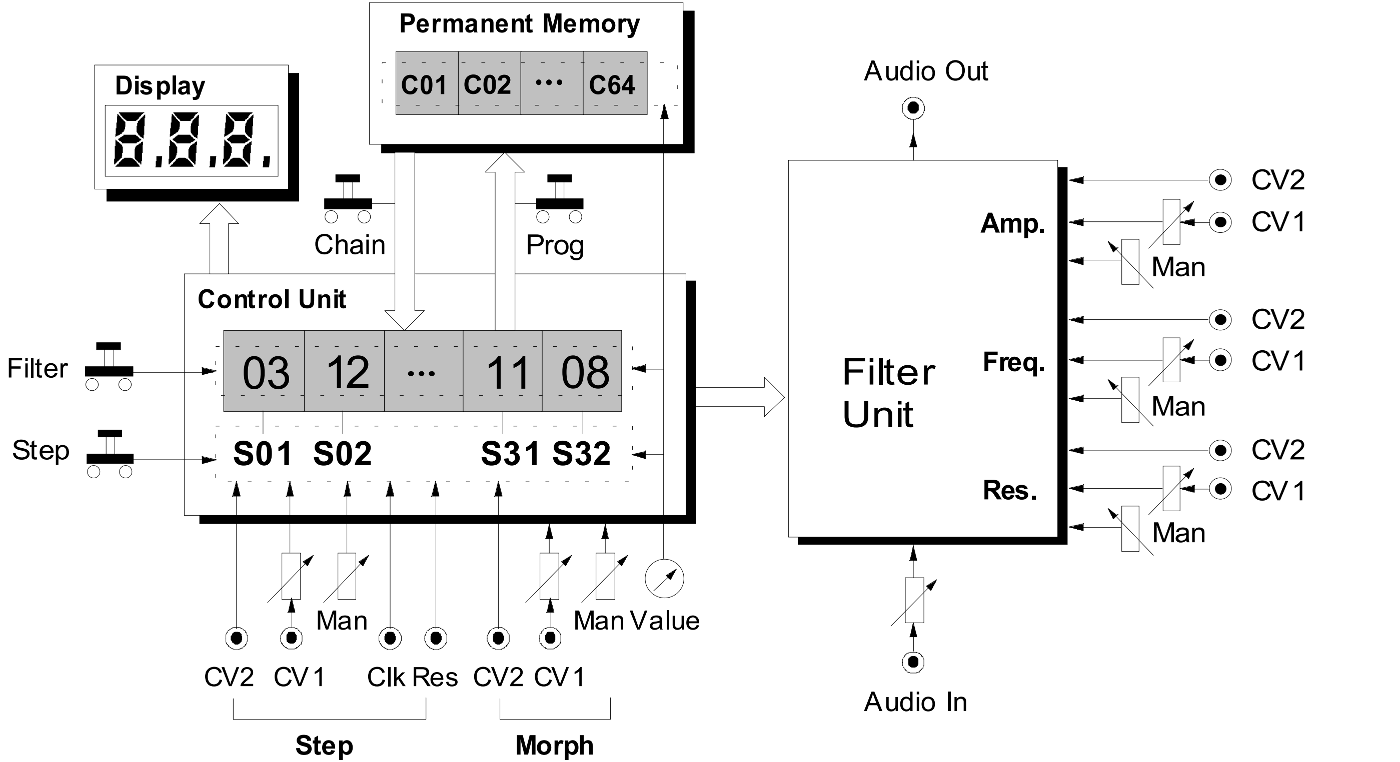


Fig.1: A-107 Overall view

2. Basic principles

Module A-107 consists of the 100% analog **filter unit** with the parameters filter frequency, resonance/emphasis and amplification, and the digital **control unit** with **display,** corresponding controls (buttons, rotary encoder) and **non-volatile memory.**

The control unit manages the **memory** that contains the 64 **filter chains** with 32 steps each. The control unit is responsible for all parameters that refer to switching and morphing of filters within the selected chain, the control of the analog filter unit to obtain the desired filter and the memory management.

The buttons "Step" and "Filter" determine if the display shows the Step number (S) within the currenty selected filter chain (i.e. the so-called working buffer) or the filter type (F).

The buttons "Chain" and "Prog" are used to transfer a filter chain between the non-volatile memory (64 memories) and the working buffer.

The values for Step, Filter and Chain are set by the endless rotary encoder labelled “Value”.

Provided that a clock signal is applied to the Step Clock input the **clocked mode** is activated. In this mode each positive transition of the clock signal triggers the advance to the next step of the filter chain in the working buffer. If step 32 is reached the next clock switches back to step 1 of the chain.

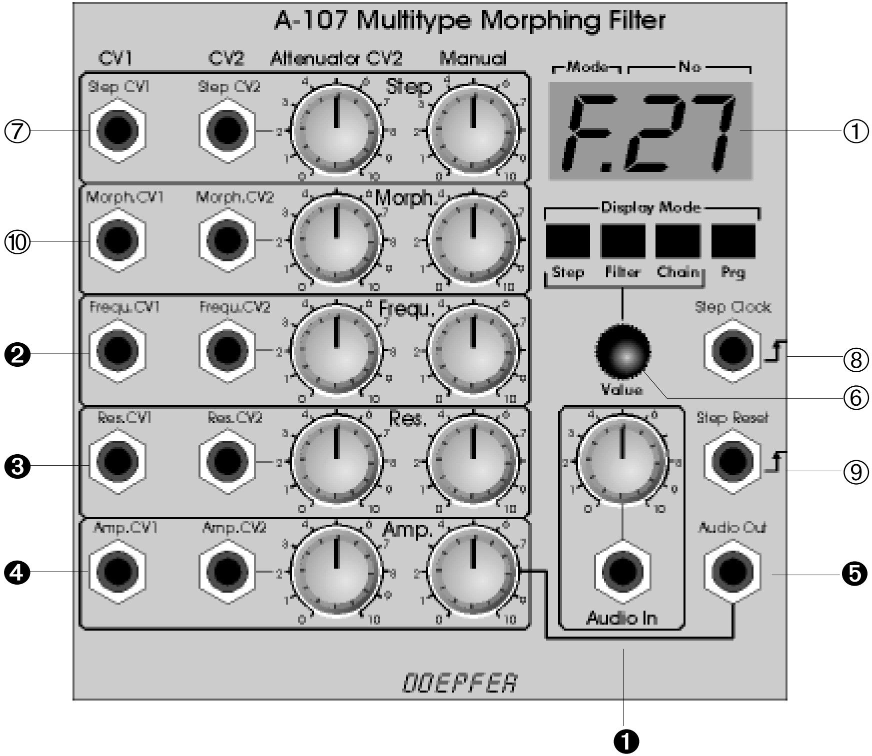
Addressing the filters of the chain in the working buffer can also be controlled by the **manual step** control and/or an external **control voltage** at one of the Step CV inputs. According to the manual setting and the external voltage(s) the corresponding filter within the chain is addressed.

For both the clocked and CV addressed mode the transition time between succeeding filters can be controlled manually by the **Morphing control** and/or an external **control voltage** at one of the Morphing CV inputs.

Attention: CV addressing "overruns" the filter selected in the clocked mode.

All parameters can be controlled resp. modulated by different voltages at the same time: **filter step**, **morphing time, filter frequency**, **resonance** and **amplification**.

3. Overview


A-107 Multitype Morphing Filter
CV1
CV2
Attenuator CV2
Manual
Mode
No
Step CV1
Step CV2
Step
F.27
Morph.CV1
Morph.CV2
Morph.
Display Mode
Step
Filter
Chain
Prg
Frequ.CV1
Frequ.CV2
Frequ.
Step Clock
Value
Res.CV1
Res.CV2
Res.
Step Reset
Amp.CV1
Amp.CV2
Amp.
Audio Out
Audio In
DOEPFER
⑦
⑩
❷
❸
❹
①
⑧
⑥
⑨
❺
❶

Programming Unit Controls:

① **Display**: 3 digit LED display

② **Step**: button, calls up display mode "Step"

③ **Filter**: button, calls up display mode "Filter"

④ **Chain**: button, calls up display mode "Chain"

⑤ **Prog**: button, calls up display mode "Prog"

⑥ **Value**: rotary encoder to set the value for Step, Filter and Chain

⑦ **Step**: two CV inputs with/without attenuator, and manual control for Step setting

⑧ **Step Clock**: digital signal input for clock/gate-triggered advance to next step

⑨ **Step Reset**: digital signal input to set the step to a position within the chain defined by the momentary step CV

⑩ **Morph**: two CV inputs with/without attenuator, and manual control for morphing time

Filter Unit Controls:

❶ **Audio In**: audio input of the filter

❷ **Freq.**: two CV inputs with/without attenuator, and manual control for filter frequency

❸ **Res.**: two CV inputs with/without attenuator, and manual control for filter resonance/emphasis

❹ **Amp.**: two CV inputs with/without attenuator, and manual control for filter amplification

❺ **Audio Out**: audio output of the filter

4. Programming Unit Controls

① Display

This is a 3-digit LED display with three decimal points. These display modes are available:

S01 current **Step** within the filter chain (= working buffer), range 01 - 32

F01 **Filter type** of the currently selected step within the chain (= working buffer), range 01 - 36

C01 number of the **Chain** that is called up from the memory, range 01 - 64

P01 number of the chain that is used to store (**P**rogram) the working buffer into the memory, range 01 - 64 (the character "S" is alread used for Step -> P = Program)

The **left and middle decimal point** of the display indicate **morphing**. The points are flashing alternately while the morphing is in progress. The blinking frequency is an approximate measure for the morphing time. As soon as the new filter type is reached both points turn off.

The **right decimal point** is a **warning indicator** for the functions CHAIN and PRG and is blinking as soon the button ④ or ⑤ is operated (see below).

② Step

Operating this button calls up the display mode that shows the **current step** of the chain in the working buffer.

There are different was to select another step within the chain:

- Operate the **Value control** ⑥
- Operate the **manual Step control** (see ⑦)
- Altering one of the the **Step CVs** (see ⑦)
- Feeding a **Clock signal** to socket ⑧.

The first two items relate to manually controlled steps. The two last items correspond to voltage resp. clock controlled step addressing and are suitable for automatic filter addressing and morphing (e.g. controlled by a LFO, ADSR, random CV, Theremin, ribbon, foot controller. MIDI-to-CV or a sequencer).

③ Filter

Operating this button calls up the display mode that shows the **filter type** of the currently selected step of the chain in the display.

To select another filter type the **Value** control ⑥ has to be operated. A detailed **list of all filter types** with frequency response curves is available in chapter 7.

☞ The filters are organized in **two filter groups** with 18 filters each. To obtain a **continuous morphing** (soft transition) for all filters within a chain only filters from the same group have to be used. If two succeeding filters are from different groups a short "click" will be heard as capacitors have to be switched between the filter groups. Of course this characteristic can be used intentionally for special effects.

How to program a filter chain:

❒ Make sure that no external control signals are fed into the inputs Step CV ⑦, Step Clock ⑧ and Step Reset ⑨. These signals would disturb the programming procedure as they change the current step within the chain !

❒ Operate the Step button ② and select the desired step (e.g. S01) within the current filter chain (working buffer) by using the value control ⑥.

❒ Operate the Filter button ③ and select the desired filter type (e.g. F13) for the current step by using the value control ⑥.

❒ Select the next step (e.g. S02) by operating the Step button ② and assign the filter type for this step as described above

❒ Continue until all steps are programmed. It is not necessary to program all 32 steps of a chain. If you e.g. want only 5 different filters you may only program the steps 1...5. But you have to pay attention that only these programmed steps are addressed later e.g. by the external CV (use the attenuated CV input !)

☞ If you want to keep the chain in the working buffer before you modify the settings you have to store the working buffer into one of the 64 non-volatile memories (see item ⑤ PROG).

☞ The working buffer is erased during power off. If you want to keep the working buffer you have to store it into one of the 64 non-volatile memories (see item ⑤ PROG). After power on chain #1 is called up from the non-volatile memory.

④ Chain

Operating this button **calls up a chain** from the memory, i.e. the chain is copied from the non-volatile memory into the working buffer. To avoid wrongly operation one has to keep the button pressed for about one second before the function is executed.
The display shows the number of the last chain in use (e.g. C23) and the **right decimal flashes slowly** as a **warning** that the chain in the working buffer will be overwritten if the process is continued.
If the chain button was operated wrongly one simply has to operate the Step button ② or the Filter button ③ to reach the corresponding display mode.
How to **copy** a chain from the memory into the working buffer:

❐ Select the **number of the desired chain** by means of the **Value control** ⑥.

❐ Operate the **Chain button again** and hold it pressed for about **2 seconds**.

GET During this time the right decimal points flashes fast and the display shows GET.

☞ If you release the chain button while the display shows "GET" the copy procedure is interrupted and the right decimal point flashes slowly again.

After about 2 seconds the chain is copied from the non-volatile memory into the working buffer.

⑤ Prog

Operating this button **stores a chain** into the memory, i.e. the chain is copied from the working buffer non-volatile memory. To avoid wrongly operation one has to keep the button pressed for about one second before the function is executed.
The display shows the number of the last chain in use (e.g. P19) and the **right decimal flashes slowly** as a **warning** that the chain in the memory will be overwritten if the process is continued.
If the chain button was operated wrongly one simply has to operate the Step button ② or the Filter button ③ to reach the corresponding display mode.
How to **store** a chain into the non-volatile memory:

❐ Select the **number of the desired chain** by means of the **Value control** ⑥.

❐ Operate the **Chain button again** and hold it pressed for about **2 seconds**.

PRG During this time the right decimal points flashes fast and the display shows GET.

☞ If you release the button while the display shows "PRG" the store procedure is interrupted and the right decimal point flashes slowly again.

After about 2 seconds the chain is stored into the selected chain of the non-volatile memory and the display shows the latest step.

This operation concept makes it possible to copy chains within the non-volatile memory.

To copy e.g. chain 17 to chain 53 one has to copy chain 17 by means of the CHAIN function into the work buffer. Then the working buffer is stored into chain 53 by means of the function PROG.

⑥ Value

This **endless rotary encoder** is used to select steps, filter types and chains as described in the sections above.

☞ If an external Step CV or Step clock signal is applied the effects of the external signals and the value control will interfer. To select a value with the **Value** control no step CV or step clock should be applied.

⑦ Step

This group of controls serves to **address a step** within the currently selected filter chain. It contains a **manual Step** control and two **Step CV inputs** (one with attenuator, one without attenuator).

A variable control voltage applied to a Step CV input leads to a step selection and consequently filter selection accordingly to the applied control voltage. The setting of the **Morphing** section defines if the transition time between succeeding steps. resp. filters.

A control voltage of 0V at Step CV input 2 corresponds to step 01, +5V to step 32.

The effects of the manual step control and the external step CV inputs are added up. The manual control can be used to adjust an **offset** (e.g. step 16). The external control voltage (e.g. from a LFO) could modulate the step value around the offset (e.g. 11...21 = 16-5 .... 16+5). For bipolar control voltages (e.g. from an LFO) an offset is required to take advantage of the full voltage range. For positive control voltages (e.g. from an ADSR, sequencer or MIDI-to-CV) the offset control may be set to zero.

⑧ Step Clock

The positive transition (low to high) of a **Clock signal** at this input advances to the **next step of the current chain.**

If step 32 is reached the next clock switches back to step 1 of the chain.

☞ If an external Step CV and Step clock signal is applied the effects of both signals will interfer. Whenever the step control voltages changes the step corresponding to this voltage is addressed immediately !

Therefore we recommend to apply no varying control voltages to the Step CV inputs in the clocked mode unless the interfering effects are intentional.

⑨ Step Reset

The positive transition (low to high) at this input **resets to the step** of the chain that corresponds to the **momentary step CV** (manual + external). The manual step control has to be turned to zero if a reset to step 1 is desired. A slowly varying external control voltage at the step CV inputs can be used to reset to different steps.

The step reset input is also helpful to synchronize "filter sequences" by applying a sequener generated reset signal to this input (e.g. .

⑩ Morph

This group of controls serves to define the **morphing time** between succeeding filters. It contains a **manual Morphing** control and two **Morphing CV inputs** (one with attenuator, one without attenuator).

Applying a **slowly variable control voltage** at one of the Morphing CV leads to modulations of the morphing time.
A control voltage of 0V at Morphing CV input 2 corresponds to a few milliseconds (~ switching), +5V to about 10 seconds morphing time.

The effects of the manual morphing control and the external morphing CV inputs are added up. The manual control can be used to adjust an **morphing offset**. The external control voltage (e.g. from a LFO or sequencer) could modulate the morphing time the offset. For bipolar control voltages (e.g. from an LFO) an offset is required to take advantage of the full voltage range. For positive control voltages (e.g. from an ADSR, sequencer or MIDI-to-CV) the offset control may be set to zero.

5. Filter Unit Controls

❶ Audio In • Level Control

The socket is the **audio input** of the filter were the audio signal has to be fed in. The attenuator controls the **input level** of the signal to be filtered. If the filter's output signal is distorted, turn this control down, unless the distortion is wanted as a special effect. Distortion appears approx. above middle position of the control (~5) for normal A-100 signals (e.g. VCO A-110).

❷ Frequency

This group of controls serves to define the **filter frequency**. It contains a **manual frequency** control and two **frequency CV inputs** (one with attenuator, one without attenuator).

The **filter frequency** is manually adjusted with the manual frequency control. To modulate the cut-off frequency by an **external voltage** (e.g. from a LFO or ADSR) the control voltage has to be patched into one of the two **frequency control inputs**. One input is equipped with an attenuator to control the frequency modulation amount of the corresponding input.

The **effect of filter frequency** depends upon the **filter type** that is selected with the programming unit. In case of a lowpass or high pass it is the cut-off frequency, for a bandpass or notch it is the middle frequency. More details can be found in the manuals of other A-100 filters (e.g. A-121, A-123, A-124, A-108, A-105/122).

❸ Resonance

This group of controls serves to define the **filter resonance/emphasis**. It contains a **manual resonance** control and two **resonance CV inputs** (one with attenuator, one without attenuator).

The **filter resonance** is manually adjusted with the manual resonance control. To modulate the resonance by an **external voltage** the control voltage has to be patched into one of the two **resonance control inputs**. One input is equipped with an attenuator to control the resonance modulation amount of the corresponding input.

According to the selected filter type the resonance effect **emphasizes** the **frequencies** around the cut-off frequency (lowpass, highpass) or alters the bandwidth (bandpass, notch). For the **new filters** without names normally **one of the frequency peaks** shown in the response curves is **lifted up** (see chapter 7).

For the **filters 01 ... 18** (see chapter 7) the resonance can be adjusted right up to **self-oscillation**, in which case the filter will behave like a sine wave oscillator. The filters 19...36 do not support self-oscillation.

Even the effect of resonance and self-oscillation is treated more detailed in the manuals of other A-100 filters (e.g. A-121, A-123, A-124, A-108, A-105/122).

❹ Amp.

This group of controls serves to define the **filter amplitude or level**. It contains a **manual amplitude** control and two **amplitude CV inputs** (one with attenuator, one without attenuator). This control group is assigned to the final VCA (nothing but an exponential VCA that is connected to the filter output).

The **filter output level** is manually adjusted with the manual amplitude control. To modulate the amplitude by an **external voltage** (e.g. ADSR, LFO, sequencer) the control voltage has to be patched into one of the two **amplitude control inputs**. One input is equipped with an attenuator to control the resonance modulation amount of the corresponding input.

❺ Audio Out

Filter output ❺ sends out the filtered and level controlled audio signal.

6. User examples

☞ In the following we use the abbreviations LP (lowpass), BP (bandpass), HP (highpass), AP (allpass), NF (notch filter).

Before you continue with more complex applications of the A-107 we recommend to acquaint with the 38 filter types described in chapter 7. Take the time to hear all the filters and how they respond to filter frequency, resonance and distortion. Find out how morphing between 2 filters is influenced by the morphing time. Differences in loudness can be compensated with the amplitude control.

The easiest application is to **use only one single filter** from the pool of 38 filters. This makes quite sense as there are a lot of filters available that cannot be realized with other A-100 modules (e.g. the "fast food filter" no. 09, look at response curve to understand the name "fast food"). But the point of the A-107 are of course the filter chains and the morphing features. In the following we describe some suggestions:

Clocked mode

The advance to the next filter in the chain can be triggered by different events. Here some examples:

- Advance triggered by a **keyboard** by using the gate signal as step clock
- Advance triggered by manually operated control devices like **foot switches** (A-177), **Theremin** (gate output of the A-178), **light controller** (gate output of the A-179), **ribbon controller** (gate output of the A-198)
- **Random advance** with the Random Clock Generator A-117 or A-149-2 (or via CV with the A-118 random CV output or one of the outputs of A-149-1)
- **Periodical advance** with the rectangle output of a LFO, any clock signal or in sync with MIDI clock (clock out of the A-190 divided by the clock divider A-160 to obtain a smaller clock frequency)
- **Rhythmical advance** by means of **clock divider and sequencer** A-160/161, combined e.g. with the **logic module** A-166 and using the step reset input of the A-107,
- **more complex rhythmical filter sequences** by controlling the step clock by the trigger output of a **analog sequenzer (A-155** or **MAQ16/3**) or a **trigger sequenzer (Schaltwerk)**

Morphing

But the real fun arises with the morphing features of the A-107. Even here we recommend first to find out the sound behaviour between two different filters as it is a big difference to morph e.g. from 6dB LP => 24 dB LP, or LP => HP, or BP => NF, or HP => AP and so on. For this you may use the following system:

- ❐ Program a chain with two different filter types at step 01 and 02.
- ❐ Patch the rectangle output of a LFO to the step CV2 input of the A-107 and adjust the frequency of the LFO to about 1 Hz or less.
- ❐ Turn the manual step control, the attenuator of step CV2 and the manual morph control to zero.
- ❐ Select the display mode STEP.
- ❐ Look at the display and turn up the attenuator control of step CV2 slowly until the display shows alternately 01 and 02.
- ❐ Feed the audio input of the A-107 with the desired audio signal. The sawtooth output of a VCO is a good start but even a complex audio signal is suitable for the first tests
- ❐ Set the controls of the filter section to suitable positions: full amplitude, medium filter frequency, small or medium resonance
- ❐ Now you will hear alternatively the two filters that were programmed to step 01 und 02 of the chain (see first item above),
- ❐ Turn up slowly the morph control to find out how the switching between the two filters turns more and more into morphing.
- ❐ Alter the setting of the filter section (filter frequency, resonance, amplitude) to hear the effect of these controls
- ❐ Increase the LFO frequency that controls the step CV. From a certain LFO frequency (depends upon the setting of the morphing time) the filters of step 01 and 02 will not be reached as the morphing time is longer than the LFO period. Instead of this one obtains an "interim" filter that has a bit of both filters
- ❐ Use other control voltage sources (e.g. LFO, ADSR, Random CV) to control the parameters of the A-107 by external voltages: morphing time, filter frequency, filter resonance, amplitude
- ❐ Extend the filter chain by adding filters to step 03, 04, 05 ... and try different filter types in the chain

Now you should experiment with a real filter chain (so far only two filters were used) and try more sophisticated controls:

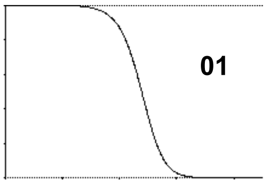
- ❐ Extend the filter chain by adding new filters to step 03, 04, 05 ... and try different filter types in the chain. You may also use the factory setting of the chains (step 1 = filter 2, step 2 = filter 2 ...)

- Try different waveforms for the LFO that controls the step CV and increase the effect of the step CV by turning up the attenuator. This increases the range of filters that were covered by the LFO CV.
- Adjust LFO frequency and attenuation, manual step and morphing time to obtain a complete pass through the complete chain.
- By different settings of the manual step control and the step CV attenuator one reaches any position within the chain (e.g. step 16) and varies the range of filters around this position (e.g. 14...16...18 10...16...22)
- Any control voltage sources of the A-100 can be used to control the 5 parameters of the A-107. There are no limits to the user's imagination.
- One may control step CV, morphing time, filter frequency, resonance and amplitude from the CV outputs of a sequencer (e.g. A-155 or MAQ16/3), add a little bit envelop (e.g. from the VC-Decay A-142) to control the filter frequency, control even the decay from a sequencer track and you will discover "filter sequences" you never heard before.
- The voltage controlled polarizer A-133 is a suitable tool to adjust envelopes dependent on the current filter type. A LP with a low basic frequency requires another envelope (normally positive) than a HP (e.g. a negative envelope). The A-133 is very useful to change the envelope polarity and level individually for each filter within a sequence.

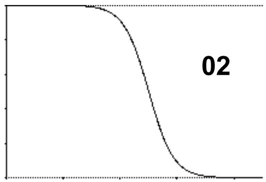
7. Filter types

The **36 filter types** of the A-107 are shown on the next pages. For each filter the frequency response curve (X/frequency versus Y/amplitude) is shown and a short comment is added. For some filters customary names are available, e.g. xxdB lowpass/highpass, bandpass, notch or allpass. For the new filters without customary names we tried to find an explanation that describes the filter as good as possible.

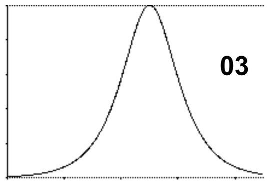
The filters are divided into **two groups**. The filters of the first group (01...18) allow **self-oscillation**. The filters of the second group (19...36) do not include this feature.



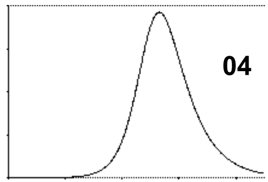
24 dB Lowpass



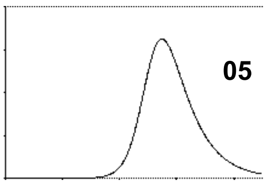
12 dB Lowpass



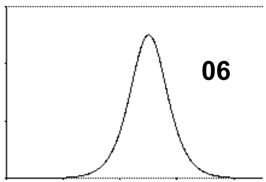
Bandpass
(6 dB LP + 6 dB HP)



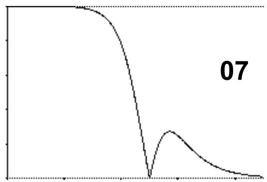
Asymmetric Bandpass 1
(12 dB LP + 6 dB HP)



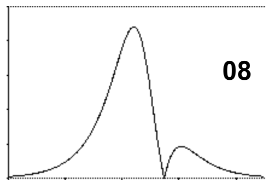
Asymmetric Bandpass 2
(18 dB LP + 6 dB HP)



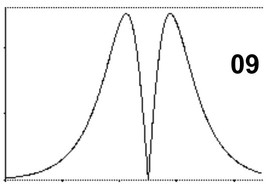
Bandpass
(12 dB LP + 12 dB HP)



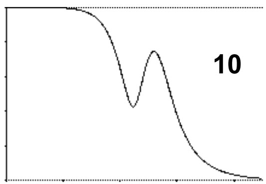
Notch + 6 dB Lowpass



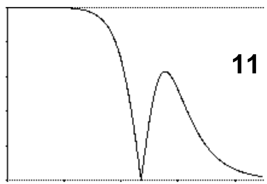
Allpass + 6 dB Lowpass



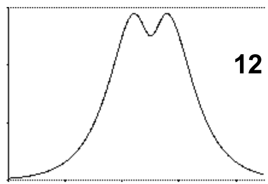
2 Bandpasses separated by a notch ("fast food filter")



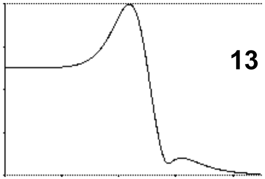
Lowpass + shifted Bandpass



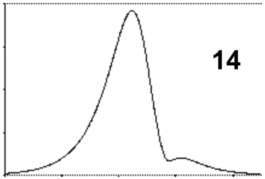
Lowpass + Notch I



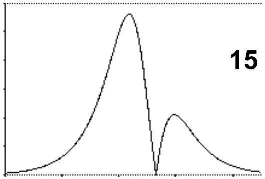
"Tooth"
2 shifted Bandpasses



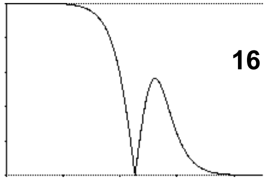
Lowpass + 2 shifted Bandpasses with different amplitudes



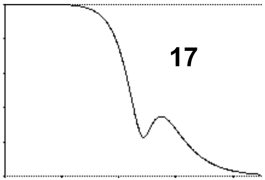
2 shifted Bandpasses with different amplitudes



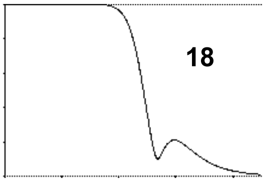
Lowpass + Notch + Highpass



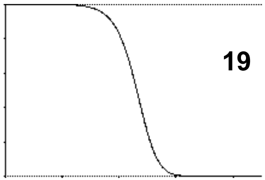
Lowpass + Notch II



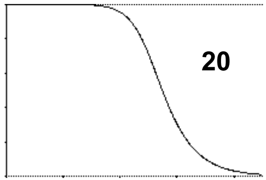
Lowpass + Soft Notch + Bandpass



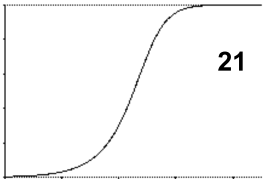
Lowpass with shifted Bandpass (smaller amplitude)



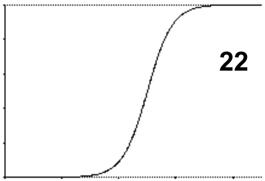
18 dB Lowpass



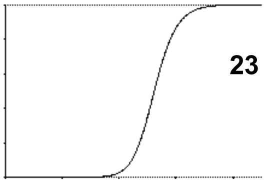
6 dB Lowpass



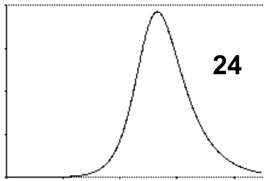
6 dB Highpass



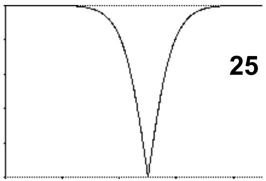
12 dB Highpass



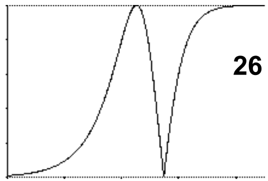
18 dB Highpass



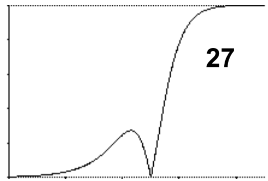
Asymmetric Bandpass 3
(12 dB LP + 6 dB HP)



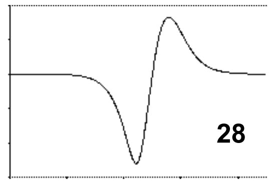
12 dB Notch



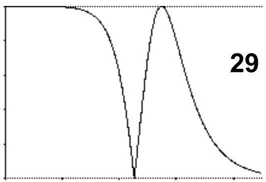
Allpass (lower frequencies attenuated)



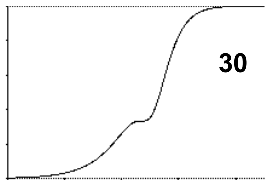
Notch + Highpass



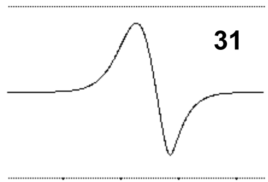
Soft Notch + shifted Bandpass



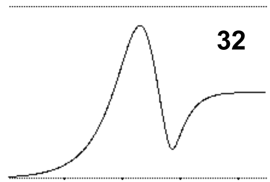
Allpass (higher frequencies attenuated)



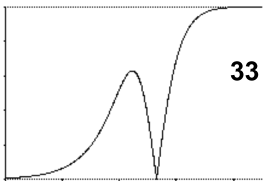
Highpass with "step"



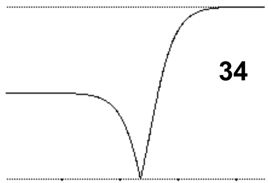
"Wave" filter



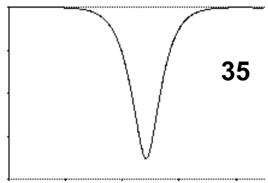
Lowpass + Soft Notch + Bandpass



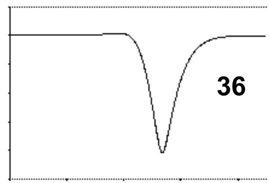
Notch + Highpass



Lowpass + Notch + Highpass



Soft Notch I



Soft Notch II