DARK ENERGY

Owners Manual

Safety Instructions

Please follow the given instructions for use of the instrument carefully because this will guarantee correct instrument operation. Due to the fact that these instructions touch on Product Liability, it is absolutely imperative that they be read carefully. Any claim for defect will be rejected if one or more of the items was observed.
Disregard of the instructions can endanger the two years warranty.

The instrument may only be operated with the voltage written on the power input on the rear panel. Before opening the case disconnect the power plug and power adaptor.

All eventual modifications must only be carried out by a qualified person who will follow the valid safety instructions. With the introduction of a third person the warranty will be lost. In case of a destroyed warranty seal, any warranty claim will be rejected.

The instrument must never be operated outdoors but in dry, closed rooms. Never use the instrument in a humid or wet environment nor near inflammables.

No liquids or conducting materials must get into the instrument. If this should happen the instrument must be disconnected from power immediately and be examined, cleaned and eventually be repaired by a qualified person.

Never subject the instrument to temperatures above +50° C or below -10° C. Before operation the instrument should have a temperature of at least 10 øC. Do not place the instrument into direct sun light. Do not install the instrument near heat sources.

Keep the top side of the instrument free in order to guarantee proper ventilation, otherwise the instrument could be overheated.

Never place heavy objects on the instrument.

Transport the instrument carefully, never let it fall or overturn. Make sure that during transport and in use the instrument has a proper stand and does not fall, slip or turn over because persons could be injured.

Never use the instrument in the immediate proximity of interfering electronic devices (e.g. monitors, power supplies, computers) since this could create disturbances within the MS-404 and corrupt memory data.

The instrument should only be shipped in the original packaging. Any instruments shipped to us for return, exchange, warranty repair, update or examination must be in their original packaging! Any other deliveries will be rejected. Therefore, you should keep the original packaging and the technical documentation.

The instrument may only be used for the purpose described in this operating manual. Due to safety reasons, the instrument must never be used for other purposes.

When using the instrument in Germany, the appropriate VDE standards must be followed. The following standards are of special importance: DIN VDE 0100 (Teil 300/11.85, Teil 410/11.83, Teil 481/10.87), DIN VDE 0532 (Teil 1/03.82), DIN VDE 0550 (Teil 1/12.69), DIN VDE 0551 (05.72), DIN VDE 0551e (06.75), DIN VDE 0700 (Teil 1/02.81, Teil 207/10.82), DIN VDE 0711 (Teil 500/10.89), DIN VDE 0860 (05.89), DIN VDE 0869 (01.85). VDE papers can be obtained from the VDE-Verlag GmbH, Berlin.

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DARK ENERGY

Owners Manual

Content:

1. Introduction

1.1. Preface

Welcome to Dark Energy. As you expect without any doubt, your recently purchased Dark Energy is not a tool for space research, neither suitable for astrophysical studies. Nevertheless we find these topics as fascinating as music technology – reason enough to celebrate Hubble & Co's amazing discoveries a bit and to call our brandnew synthesizer Dark Energy.

Doepfer says „Thank You!"
First of all we would like to thank you for purchasing Dark Energy! We really appreciate your decision and promise you an exemplary support, including useful information, easy service and innovative product deve- lopement. Hopefully, your Dark Energy will be an importand source of creative power for a long time.

What's that?
Dark Energy is a monophonic analogue synthesizer with USB- and MIDI interface. The entire soundgene- ration as well as all it's modulationsources are 100% true analogue. Only the USB/MIDI interface uses, of course, digital components. Dark Energy is housed in a rugged black steel case with wooden sidepanels. Only high quality potentiometers with metal shafts are used. Each poti is screwed to the chassis. The space between the knobs ist larger as with the A-100 modular system and we used knobs with a neat vintage look. So Dark Eneryg is as beautiful to see as to hear and well made for extensive live tweaking. You get all the advantages of a true analogue soundgeneration as well as direct access to all soundparameters – for- get about confusing menues and small sized displays. Nevertheless Dark Energy is a modern soundgene- ration tool and, thanks to it's built in MIDI/USB interface, it can easily be linked to every modern computer based studio or live setup. Hooking up Dark Energy to classic analogue vintage equipment or to a Doepfer A-100 modular system is also easy.

R.t.f.m.!
We guessed it: User manuals are your first choice in literature. Congratulations – we talk the same langua- ge! If you might have any doubts about the entertaining qualities of this manual, please consider that it's study will become quite useful, since it will highly increase the entertaining qualities of your new synthesi- zer. So please do us – and yours – a big favour: Read (and understand) the f... manual. Thank you!

In the first section you will find all neccessary information to hook up Dark Energy into your setup. Next to this you will find a brief overview of it's functionality. Synthesizer experts may use this as a quickstart guide. Nevertheless you should not miss the complete description of the entire functionality in the next chapter – Dark Energy hides some interesting features. Next to this, you will find useful soundsetting examples. If synthesizer technology and the secrets of subtractive soundgeneration might be totally new to you, please check out „Basics of soundgeneration" in the back of this manual.

Enough talk – here we go...

1.2. Preparations

When you first put Dark Energy out of the box, please check if everything is complete. You will find the following components in the *box*:

• Dark Energy Synthesizer
• Power adapter 12-15V AC/min. 400mA
• Instrument cabel with 3,5mm and 1/4" plugs
• USB cabel (A-B type)
• Two A-100 patch cabels
• This owners manual

You will also need:
• A suitable audiosystem (mixer, amplifier, speaker or keyboard amp)

To run Dark Energy via MIDI-DIN socket you will also need:
• A MIDI cable to connect suitable a MIDI controlling device / keyboard / computer and Dark Energy.
• A MIDI-keyboard and / or computer with suitable MIDI sequencer application

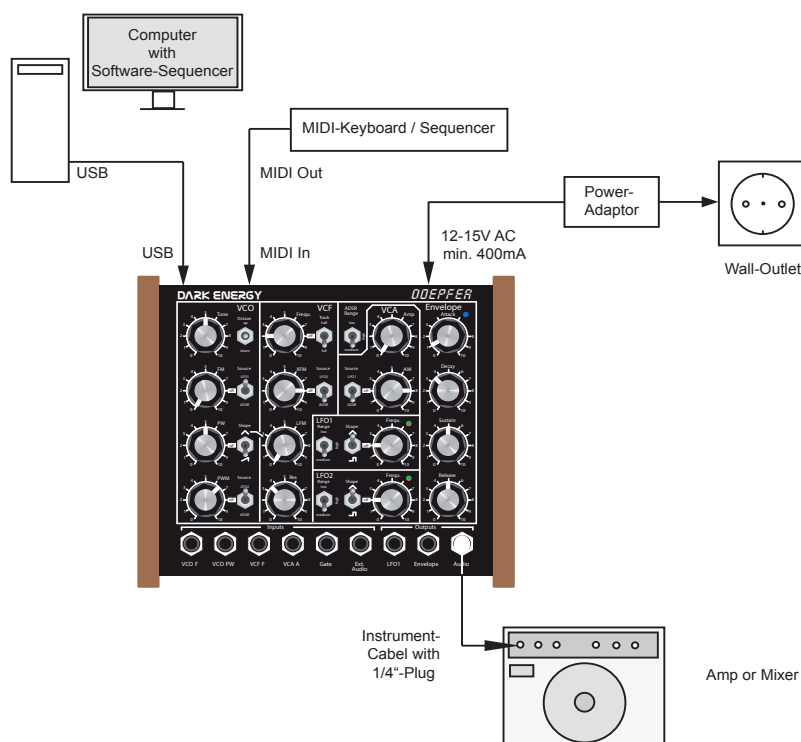To run Dark Energy via CV/Gate connections you will also need:
• At least two 3,5 mm plug patch cabels and a suitable sequencer (e.g. the Doepfer sequencer module A-155) or a CV/Gate keyboard (e.g. the Doepfer model A-100).

Setup:
Use Dark Energy in a lying or stand up position. Please use a suitable support. The wooden sidepanels can be dismantled in order to connect two or more units mechnically to one big device. More information on this can be found later in this manual.

Connections:
To run Dark Energy, you do not need necessarily all it's built in sockets. For a basic setup, you will need just the ones shown in the picture below. Make use of the additional connection facilities and you will expand Dark Energy's sonic capabilities a lot. They will be described together with the corresponding modules later on in this manual.

• Power supply:
Connect the included power adaptor to the 15V AC socket in the rear panel of Dark Energy.
Importand: Only use this power adaptor or an equal one with exactly the same specs!
A powersupply via USB is not possible since the internal analogue circuits of Dark Energy run with +/-12V.
If two or more units run in parallel, each units needs it's own power supply with power adaptor. If there will
be a demand, we may consider offering a bigger power adaptor with several connections.

• USB:
Connect Dark Energy's USB socket to your computer. Any configuration work or driver installation is not
needed.

• MIDI:
To run Dark Energy in a conventional MIDI setup without USB, please connect Dark Energy's MIDI-in so-
cket to the MIDI-out socket of your MIDI controller device (e.g. masterkeyboard, synthesizer, sequencer).
The default setting of Dark Energy's MIDI channel is Channel 1. Changing this setting is described on
page 19 in the chapter „USB/MIDI interface".

• Audio:
Connect the Audio output socket on Dark Energy's frontpanel to the audio input of your mixer, amp, etc.
Please use the included connection cable.

• CV/Gate:
To run Dark Energy with a CV/Gate sequencer / keyboard, you have to connect at least Gate- and
VCO F sockets. Gate triggers the notes, VCO F determines the pitch of the notes. Using additionally
VCO PW, VCF F and VCA A connections, Dark Energy's corresponding soundparameters can be
controlled dynamically via control voltages. More on this topic later on in this manual.

1.3. Check it out

Please bring all frontpanel controls to it's basic setting as shown in the picture below. The default MIDI
channel setting is 1 and should not be changed at this moment.

As soon as the power adaptor is connected, Dark Energy is powered on. The LEDs in both LFO sections should now light up and toggle between red and green. The LED on the back panel should flash for approx. 2 seconds and light up permanently.

First contact:

Turn the volume control of your amp / mixer fully OFF, BEFORE powering it up. Turn up volume control of your mixer / amp slowly and play a note on your keyboard. You should now hear a static tone. Choose a comfortable volume. And now – Ladies and Gentlemen, have a warm welcome to Dark Energy!

The currently generated sound depends on the setting of all knobs and switches. It will be most easy to create musically useful patches, if you start at this basic setting and „compose" your sounds step by step from that point on.
We will now take a brief look at Dark Energy's sound generation and sound manipulation modules.
A detailed description of all functions follows later on.

Now that you brought all knobs and switches into their basic settings, you will hear a simple and static tone. The oscillator generates a simple squarewave, that is audible at the audio output, yet without being manipulated in any way. Now move the VCO tune knob and the octave switch. You can control the tuning and the pitchrange of the tone.
As soon as you crank up the FM knob, you will notice an „automatic" change in tuning: LFO1 is selected as a modulation source and it's control voltage generates a periodic change in tuning, resp. VCO frequency.
Now turn the LFO1 Freq. knob. You will hear a change in the modulation speed resp. LFO1 frequency.
Now let's take a brief look at the filter section (VCF): Turn it's Frq. knob slowly counterclockwise. You will hear the sound becomming more and more „dull" until it gets inaudible. Now turn the Freq. knob in 12 o'clock position and crank up the XM knob slowly. You will hear a periodic modulation of the timbre, done by LFO2. Again, you can alter the modulation speed with the LFO2 Freq. knob. Play a couple of notes and change the settings of the envelope section. You wil notice a change in the loudness contour of the notes. If you switch the Source switches in the VCO and VCF section into the ADSR position (the knobs FM and XM have to be cranked up at least to 10 o'clock position), the envelope will control not only loudness but also pitch and timbre.

Please note:

Dark Energy's parameters mostly interact with each other. That means, there are often more than just one way to achieve a specific result. In other words: To enable a certain parameter to generate a wanted result, it might by necessary to set other parameters into a specific setting. This might be a bit confusing from time to time. An example: If the ADSR's sustain knob is set to it's maximum, turning the decay knob will not have any influence to the sound. All the ADSR controls will not have any influence to the timbre of the sound, as long as the Source switch of the VCF section is set to LFO2. The same goes for the Source switch in the VCA section. To make use of Dark Energ's full sonic potential, it is importand to understand these interaction of parameters. Please do not get worried – explore systematically each parameter and it's interaction with others. You cannot do anything wrong.

If analogue soundsynthesis is totally know to you, please refer to the section „Basics of Soundgeneration" in this manual.

2. Overview

Dark Energy's architecture ties up with a classic monophonic modular synthesizer. It's signal paths are wired internally, thus Dark Energy is very compact and easy to use. The most importand modulation paths can be set via toggle switches, additional sockets deliver control voltages and allow the connection of external modulation sources. The internal MIDI/USB interface allows the easy use within a MIDI setup. Dark Energy can also be used as a MIDI to CV/Gate interface.

triangle waveform based VCO
- tuning knob
- range switch -1 / 0 / +1 octave
- FM (frequency modulation) knob with selectable modulationsource (LFO1 / off / ADSR)
- pulswidth knob for squarewave
- PWM (pulswidth modulation) knob with selectable modulationsource (LFO1 / off / ADSR)
- waveform switch (saw / off / triangle)

The sum of the squarewave signal and the waveform selected with the waveform switch is fed into the audio in of the filter module (to disable the squarewave both PW- and PWM-knobs have to be turned fully counterclockwise).
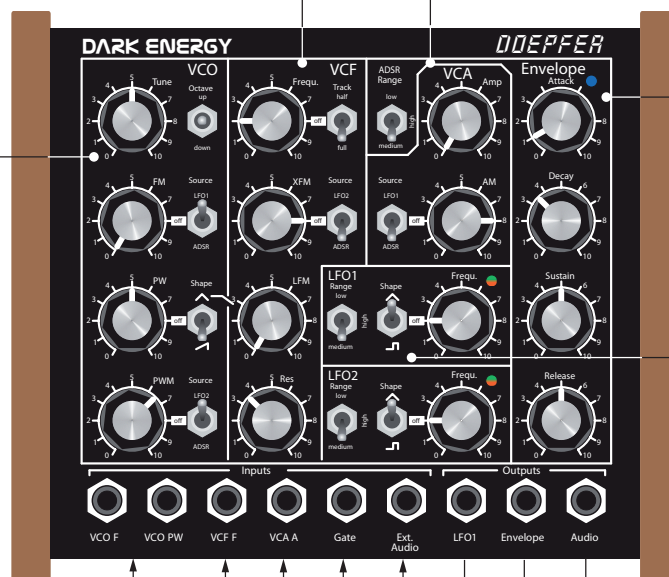
24 dB lowpass VCF
- cutoff knob (freq.)
- tracking switch half / off / full (internally connected to the VCO control voltage)
- XM: exponential frequency modulation knob with selectable modulationsource (LFO1 / off / ADSR)
- LM: linear frequency modulation knob; modulationsource is the VCO's trianglewave (resp. the VCF gets linear FM from the VCO with adjustable intensity)
- resonance knob (up to selfoscillation)

VCA
- amplitude knob
- AM (amplitude modulation) knob with selectable modulationsource (LFO1 / off / ADSR)

ADSR
- knobs for Attack, Decay, Sustain and Release
- range switch long / short / medium
- blue LED for envelope activity

LFO1 and LFO2
- frequency knobs
- waveform switches (triangle / off / square)
- range switches: low (up to several minutes per cycle) / audio (up to 5 kHz) / medium (normal LFO range from some seconds up to several 10th hertz)
- dual LEDs yellow/red show positive and negative halves of the LFO waves

VCO CV inputs
- VCO frequency (1V/octave)
- pulswidth of squarewave

VCF CV input
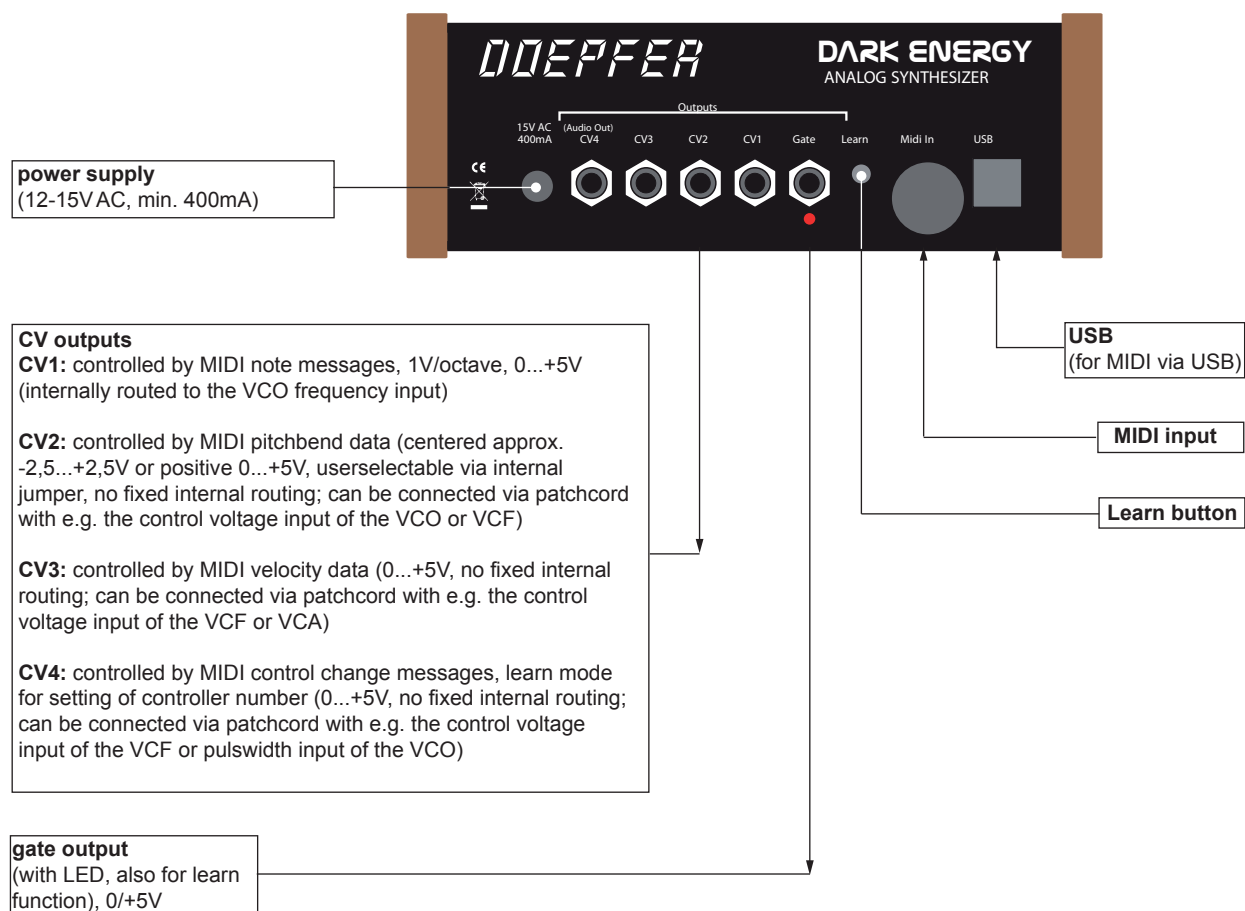- VCF frequency (1V/octave)

VCA CV input
- VCA amplitude

gate input

audio input
(the connected signal is mixed into the VCF input)

audio output

ADSR CV output

LFO1 CV output (inverted)

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ANALOG SYNTHESIZER

Outputs

15V AC   (Audio Out)
400mA   CV4   CV3   CV2   CV1   Gate   Learn   Midi In   USB

power supply
(12-15V AC, min. 400mA)

USB
(for MIDI via USB)

MIDI input

Learn button

CV outputs
CV1: controlled by MIDI note messages, 1V/octave, 0...+5V
(internally routed to the VCO frequency input)

CV2: controlled by MIDI pitchbend data (centered approx.
-2,5...+2,5V or positive 0...+5V, userselectable via internal
jumper, no fixed internal routing; can be connected via patchcord
with e.g. the control voltage input of the VCO or VCF)

CV3: controlled by MIDI velocity data (0...+5V, no fixed internal
routing; can be connected via patchcord with e.g. the control
voltage input of the VCF or VCA)

CV4: controlled by MIDI control change messages, learn mode
for setting of controller number (0...+5V, no fixed internal routing;
can be connected via patchcord with e.g. the control voltage
input of the VCF or pulswidth input of the VCO)
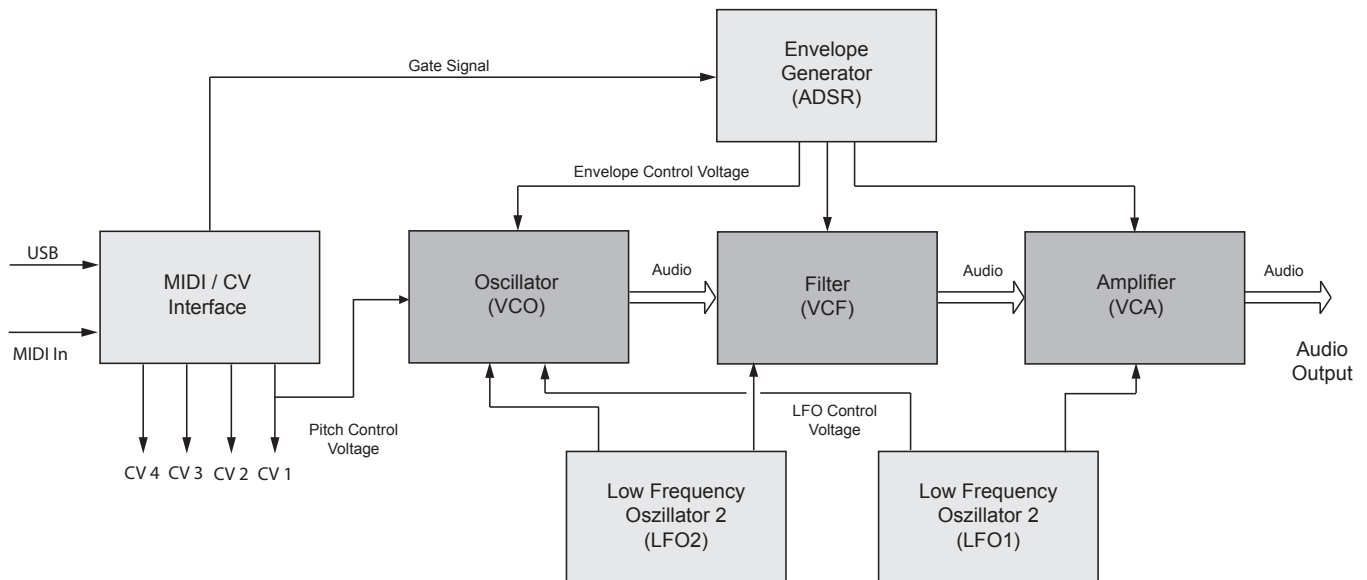
gate output
(with LED, also for learn
function), 0/+5V

3. Functionality

In this section, we will explore all of Dark Energy's modules and functions in detail. We will also have a close look on the modules interaction and finally the MIDI functionality.

3.1. Signalflow

The figure above shows a brief overview of Dark Energy's signalflow.

The darker coloured boxes show all modules that generate or process the sound resp. the audio signal. They are labelled VCO, VCF and VCA and form the audiopath. The light grey boxes are control modules. Instead of audiosignals, they generate control voltages, which modulate the audiomodules. The envelope generator can send control voltage to VCO, VCF and VCA, the low frequency oscillators (LFO1 and LFO2) can send their control voltages to both oscillators and to the filter (LFO2) resp. the amplifier (LFO1).
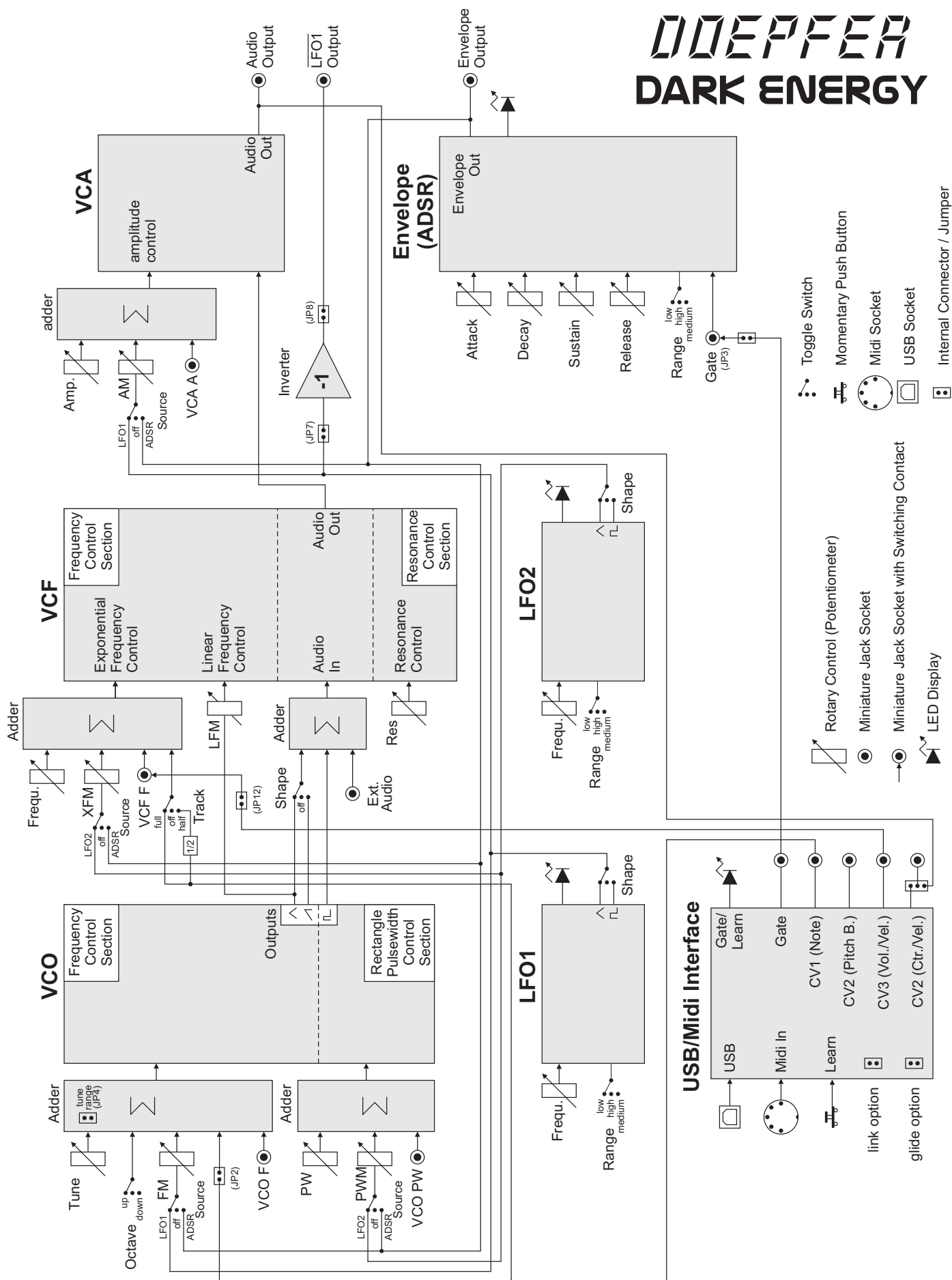
The MIDI to CV/Gate interface „translates" incomming MIDI data into control voltages that can be accessed at the sockets CV 1 – 4. CV 1 is also fed into the VCOs input to control the oscillator pitch. Next to this, the MIDI to CV/Gate interface generates a gate signal which triggers the envelope and starts a tone.

The figure on the following page shows the complete signalpath in all it's beauty. Users with some technical skills may easily reenact all routings. All inputs and outputs, knobs and switches as well as all internal submodules, such as adders and inverters, are shown in the grafics.

The functionality of all moduls is described in the following section from page 12 on. A more general and easy to understand description of the basics of analogue sound generation can be found in section 4 „Basics of Soundgeneration".

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DARK ENERGY

VCA

Audio Output

LFO1 Output

Envelope Output

amplitude control

Audio Out

adder

Amp.

AM

VCA A

LFO1 off ADSR Source

Inverter

-1

(JP8)

(JP7)

Envelope (ADSR)

Envelope Out

Attack

Decay

Sustain

Release

Range low high medium

Gate (JP3)

VCF

Frequency Control Section

Audio Out

Resonance Control Section

Exponential Frequency Control

Linear Frequency Control

Audio In

Resonance Control

Adder

Frequ.

XFM

VCF F

LFM

LFO2 off ADSR Source

full half 1/2 Track

(JP12)

Shape off

Adder

Ext. Audio

Res

LFO2

Shape

Frequ.

Range low high medium

VCO

Frequency Control Section

Outputs

Rectangle Pulsewidth Control Section

Adder

tune range (JP4)

Tune

Octave up down

FM

LFO1 off ADSR Source

(JP2)

VCO F

Adder

PW

PWM

LFO2 off ADSR Source

VCO PW

LFO1

Shape

Frequ.

Range low high medium

USB/Midi Interface

Gate/ Learn

Gate

CV1 (Note)

CV2 (Pitch B.)

CV3 (Vol./Vel.)

CV2 (Ctr./Vel.)

USB

Midi In

Learn

link option

glide option

Toggle Switch

Momentary Push Button

Midi Socket

USB Socket

Internal Connector / Jumper

Rotary Control (Potentiometer)

Miniature Jack Socket

Miniature Jack Socket with Switching Contact

LED Display

3.2. The Modules

3.2.1. VCO

The VCO, or alternatively the external audio input, is the source of Dark Energy's „raw" soundmaterial. The VCO provides the basic waveforms triangle, sawtooth and square with variable pulswidth. The module has modulation inputs for frequency (pitch) and pulswidth. The frequency range covers approx. 10 Hz to 12 kHz.

The VCO provides the following controls:

• Manual tuning knob
This knob is used for sharp or flat finetuning of the pitch. An internal jumper selects the range between approx. +/- 1/2 octave or +/- 2,5 octaves. The default setting is +/- 1/2 octave.

• Range switch -1 / 0 / +1 octave
This switch selects the tuning range.

• FM (frequency modulation) knob
This knob is located in the pitch control input of the VCO. It adjusts the pitch modulation depth of a selected modulation source (LFO1 or envelope/ADSR). This knob uses an exponential characteristic to achive a higher resolution in the lower pitchrange.

• FM Source switch
This switch selects the frequency modulation source of the VCO. The choices are LFO1, envelope (ADSR) or no source (off). The ADSR generates an „one shot" pitch contour, which is characteristic for e.g. certain drum- and percussion-sounds. LFO1 forms a periodic and continous modulation. Low LFO1 frequency settings will result in vibrati. If LFO1 runs in the audiorange (high), the VCO generates very noisy textures.
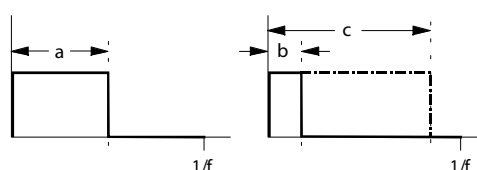
• Manual Pulswidth knob
This knob changes the pulswidth of the square signal. Altering the symetry of the waveform from square to sharp peaks changes it's harmonic content and thus the timbre of the signal. In center position, the VCO provides a rectangular (square) signal (a). Turning clockwise resp. counterclockwise first narrows the pulses until, at it's extreme positions, the VCO stopps oscillating and no pulswave signal is audible.

• PWM (Pulswidth modulation) knob
Modulating the pulswidth provides very interesting textures. This knob is located in the pulswidth control input of the VCO.
It adjusts the pulswidth modulation depth of the selected modulation source (LFO2 or envelope/ADSR). With high modulation depths and/or narrow pulswidth settings (manual pulswidth knob close to fully clockwise / fully counterclockwise), the modulation depth might exceed the maximum value of the pulswidth range and the waveform will break down. As a result, you will hear dropouts in the audiosignal. This is normal and can be used creatively as an interesting „gate"-like effekt.

• PWM Source switch

This switch chooses the source of the square wave's pulswidth modulation. The switch toggles between LFO2, envelope (ADSR) and no source (off). The ADSR generates an „one shot" pulswidth modulation, LFO2 forms a periodic and continous modulation. Low LFO2 frequency settings will result in „wide" and „lush" textures which are very useful for huge pad sounds. If LFO2 runs in the audiorange (high), the VCO generates noisy textures that will differ sonically from FM-effects.

• Waveform switch (saw / off / triangle)

Next to the squarewave, the VCO generates a triangle- and sawwave. The sum of the squarewave signal and the waveform, selected with the waveform switch, is fed into the input of the filter. To disable the squarewave, move the PW-knob in fully clockwise or fully counterclockwise position and shut off PWM by turning the PWM knob into fully counterclockwise position. Now, only the saw- or triangle wave is audible, depending on the setting of the waveform switch.

To disable the VCO completely, set the waveform switch into off-position, the PW knob into fully clockwise or counterclockwise position and the PWM knob into fully counterclockwise position. Use this setting, if you e.g. want to feed an external audiosignal into the filter of Dark Energy.

• VCO F Input

Usually, the VCOs internal pitch CV input is connected to the output CV1 of the built in MIDI/USB interface. This VCO-input uses the standard 1Volt/Octave scaling which is commen for most of all analogue synthesizers. This enables you to play Dark Energy just like any other keyboard instrument with temperated tuning resp. in half tone steps. You do not have to scale or tune anything.

In case you want to use Dark Enery without MIDI, but connected to a CV/Gate sequencer or a Doepfer A-100 modular synthesizer, you will make use of Dark Energy's CV-inputs. The VCO F socket provides an external CV-input for the VCO frequency (tuning). As soon as you plug in a cable, the VCOs pitch is controlled via this input.

Please note that this socket is not normalised. This means that the connection between the MIDI/USB interface and the VCO is not disabled when a cable is plugged in. The external CV is added to the value, provided by the MIDI/USB interface. This is very useful to e.g. transpose a sequence, which is played by an A-155 stepsequencer, with the help of a MIDI/USB keyboard in realtime.

Instead a CV/Gate sequencer or a keyboard, you may also use any other suitable CV or even audiosignals as modulation source.
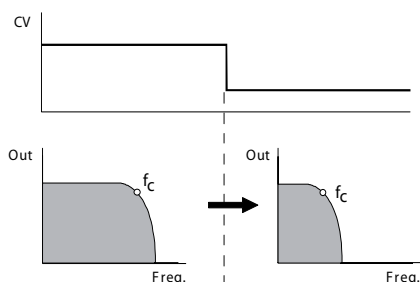
• VCO PW Input

If you wish to control the pulswidth of the squarewave signal with an external CV, use this input socket. A change of 5 Volts covers the entire modulationrange.

If an external control voltage might not fit to the specifications of the Dark Energy's CV inputs (VCO F, VCO PW, VCF F, VCA A, ext. Audio), resp. it is too high or too low, please use an external attenuator (e.g. Doepfer A-183-1) or amplifier (e.g. Doepfer A-183-3). These additional modules can easily be housed in a Doepfer A-100 Minicase.
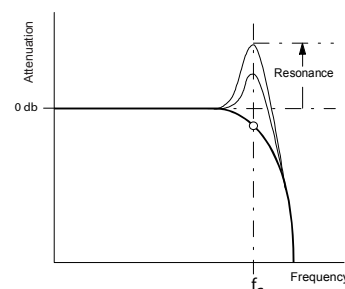
3.2.2. VCF

Filters are a very important tool in every analogue synthesizer. Filters modify sounds by rejecting some frequencies while allowing others to pass through in order to manipulate the harmonic content of the sound. There are different types of filters; the most common and most musically useful filter type is the 24 dB 'low-pass', which is used in Dark Energy. According to this termination, a lowpass filter passes all frequencies below the so called „cutoff frequency" and rejects frequencies above the cutoff. This point can be controlled by a knob or modulated by a control voltage in order to achieve dynamic timbres.

Another important filter term is 'resonance'. The resonance function emphases the overtones (or harmonics) close to the cutoff frequency. The sound becomes more and more „sharper". At a certain level, the filter starts to self oscillate and generates a waveform close to a sine wave. Dark Energy's VCF can also be driven into self oscillation in oder to use it as an additional signal source to provide certain, very popular sound effects.

Thecutoff frequency of alowpass filter depending on the control voltage

The resonance characteristics of a lowpass filter

The VCF provides the following controls:

• Manual frequency knob (Freq.)
This knob manually controls the cutoff frequency of the VCF. In other words you „open" and „close" the pass-through „window" of the filter. At fully clockwise position, the filter is completely opened and the entire frequency range of the incomming signal is passed through. At fully counterclockwise position, the filter is closed so far, that all audible frequencies are rejected and no output signal is audible. The entire frequency range of Dark Energy's filter covers approx. 12 octaves. The more this knob is turned into clockwise direction, the smaller is the effect of the envelope (ADSR) to the sound.

• XM knob
In order to achieve dynamic and periodic changes in timbre, the cutoff frequency can be modulated via control voltages. The XM knob sets the modulation depth. Set fully counterclockwise, no modulation appears, while fully clockwise position means maximum modulation depth. The modulation depth is added to the setting of the manual frequency knob. Since the sum of both cannot exceed the maximum value of the cutoff parameter range, the setting of the „Freq." knob influences the modulation depth: The higher it's setting, the lower the effect of the XM knob to the sound. The XM function uses exponential frequency modulation.
In some cases, the FM has to be controlled in a very fine way, especially when the filter is self oscillating (resp. working as a sinewave oscillator) and modulated by LFO2 in the audiorange. In order to optimize the parameter scaling, the XM knob works in an exponential way. Thus, audible modulation might need settings above „5", especially when using the ADSR as a modulation source.

• XM Source switch

This switch selects the source for exponential modulation of the cutoff frequency. The switch toggles between LFO2, envelope (ADSR) and no source (off). Controlling the cutoff frequency with the ADSR is one of the most commen modulations, since it provides simulation of the typical characteristics of most acoustic instruments timbres from bright to dull. Of course Dark Energy's envelope generator provides much more ways to shape the timbre.

LFO2 forms a periodic and continous modulation. Low frequencies provide vibrati in timbre. Using the LFOs high range, XM generates very noisy sounds that cannot be played tonally. This way of modulation is great for unique and interesting soundeffects. Feel free to experiment with the settings of cutoff frequency, LFO2 speed and XM knob.

• LM knob

This knob sets the modulation depth of the linear frequency modulation - a very special feature on analogue synthesizers. Modulation source is always the VCO trianglewave signal. In contrast to exponential FM, linear FM allows tonally playable sounds, as long as VCF cutoff and VCO signal run in certain frequency proportions. Highly interesting sounds can be achieved with the selfoscillating filter (high resonance settings). Feel free to experiment with cutoff frequency, resonance, VCO tuning and LM knob setting. Please note that even small parameter changes can result in drastic new timbres.

• Resonance knob (Res)

This knob sets the resonance intensity of the filter. This effect depends a lot on the cutoff setting and is most intense at Freq. knob settings between 1 and 5. At high resonance settings, the filter starts to self oscillate and generates a waveform close to a sine wave. It can be used as an additional signal source to provide certain popular sound effects, e.g. typical synthesizer percussion sounds when the cutoff is modulated with a suitable ADSR setting.

• When the filter is self oscillating (high resonance) and the VCO is disabled (waveform switch in center position and PW knob in fully clockwise or counterclockwise position), the filter runs as a sinewave oscillator and can be linear modulated by the VCO and exponential modulated by LFO2 at the same time! The VCO frequency can follow the filter cutoff. Very complex sounds are possible.

• Tracking switch

The tracking switch has the positions „half / off / full". It determines, if or how much the filter cutoff depends on the played notes (resp. VCO pitch). When set to „full", higher notes sound more and more brighter, lower notes more and more dull. This fits to the typical character of acoustic instruments. When set to „half", this effect is weaker. If the filter is self oscillating and should be played tonally as an oscillator via MIDI keyboard, this switch has to be set to „full". So it recieves the same control voltage as the VCO. This setting is also useful when linear frequency modulation (LM) is used with the self oscillating filter.

• VCF F Input

To modulate the filter cutoff frequency with an external control voltage or an external audiosignal, please use this socket. This input also uses an (exponential) 1V/Oct scaling. So the self oscillating VCF can be played (almost) tuned in half tones (the scaling is not as precise as the VCO because of technical reasons but much better as found in many other analogue synthesizers). The control voltage fed into this input is added to the internal CVs (Freq. knob, tracking switch, XM knob). Please note, that the sum of these CVs cannot exceed the maximum value of the modulation depth range.
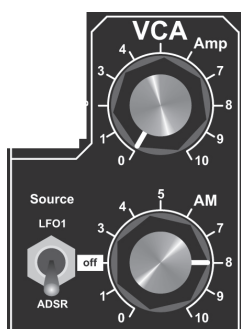
• Ext. Audio Input

It can be very interesting and musically useful to process external audiosignals, such as acoustic instruments, drumloops or even complete tracks, with the components of a synthesizer. You guessed it – Dark Energy offers an input socket for external audiosignals, that can be used as a sound source next to the VCO signals. Signals connected to this socket are fed directly into the filter. The input is mono and processes levels up to 1Vpp without distorsion.

When using an external audiosignal please note: To disable the VCO, put the waveform switch to „off"
(center position), move the PW-knob in fully clockwise or counterclockwise position and shut off PWM by
turning the PWM knob into fully counterclockwise position. To make a connected audiosignal audible, Dark
Energy's VCA has to be opened. Crank up the VCA knob and / or play a note on your keyboard, which will
open up the VCA via gate signal and ADSR control voltage. Of course you can use the external input and
the VCO in parallel. So you may add a second VCO (e.g. Doepfer A-110, controlled by the CV1 socket)
or a noise generator (e.g. Doepfer A-117 or A-118) as an additional soundsource.

3.2.3. VCA

The VCA provides dynamic control over a third importand parameter – the loudness. A VCA is a voltage
controlled amplifier. Dark Energy's VCA is somewhat special: It's characteristics are exponential from
approx. –90 dB to –20 dB and linear between –20 dB and 0 dB. This results in a different and musically
more useful behaviour compared to ordinary VCAs.

The VCA provides the following controls:

• Amplitude knob
This knob controls the level of the outputsignal initially independent from the ADSR /
LFO1 controls. If only this knob is cranked up, you will hear a static tone, not yet
influenced by the envelope or LFO1 settings.

• AM knob (amplitude modulation)
This knob adjusts the loudness modulation depth of a selected modulation source
(LFO1 or envelope/ADSR). Please note: Above the center position the modulation
depht decreases again. The highest output level with maximum dynamics can be
achieved in settings around the center position. The reason for this effect is: The
maximum amplification of the VCA is factor „1". The AM knob value is added to the
amplitude knob value. If the sum of the control voltages becomes greater then „1",
they get „compressed" or „flattened". This results in a new and different envelope- or
LFO shape with reduced dynamics and – if LFO1 is selected as modulation source
and AM knob is set above 7-8 – in a trapezoid shaped voltage contour. To achieve a
symmetrical LFO modulation, the amplitude knob should be around its center setting.
So, next to the modulation intensity, the VCA knobs can also be „abused" to shape the
modulationcurve to a certain degree.

• AM Source switch
This switch selects the source for the amplitude modulation of the VCA. The switch toggles between LFO1,
envelope (ADSR) and no source (off). The ADSR as AM source provides a „one shot" loudness contour.
This modulation – you may remember the filter section – is one of the most importand standarts in sound-
synthesis, since it simulates the typical characteristics of the loudness contour of acoustic instruments from
loud to soft. LFO1 again generates periodic modulations. Low LFO1 frequency settings will result in tremoli.
If LFO1 runs in the audiorange (high), AM generates noisy textures.

• VCA A Input
This socket provides an input for external CVs to control the VCA amplitude. This socket is normalised, that
means that a plug disconnects the ADSR or LFO1 from the VCA control input in place of the external CV.
The modulationdepth is again controlled with the AM knob. This input processes signal levels between 0
Volt and +5 Volt.
Again, this CV is added to the internal CV provided by the AM knob.

• Audio Output
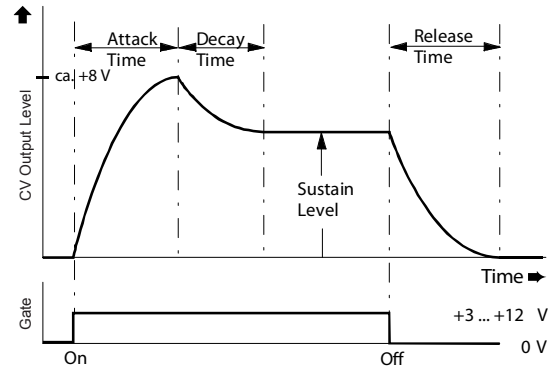Here you can pick up Dark Energy's output signal. Maximum level is approx. 1 Vpp.

Up to this point we studied modules that generate or process the audiosignal itself. The following modules generate control voltages in order to modulate the soundforming parameters of VCO, VCF and VCA in a dynamic way.

3.2.4. ADSR

Dark Energy's envelope generator (or „ADSR") forms a sequence of four control voltages, everytime a key on a connected keyboard is pressed and Dark Energy generates or receives a MIDI note-on command or a gate signal. The envelopes control voltages are used to give the sound a dynamic shape.

The envelope provides four parameters:

- Attack

- Decay

- Sustain

- Release

As soon as the envelope generator gets a gate-on signal, it's outputted CV rises from 0 Volt to maximum. The rise time is adjustable and called „Attack". When the maximum value has been reached, the voltage falls down within the „Decay"-time to the „Sustain"-level. The envelope control voltage stays on this level until the key is released, then it falls down to 0 Volt within the adjusted „Release"-time.

The envelope generator provides the following controls:

- Knobs for Attack, Decay, Sustain and Release.
Please note that Attack, Decay and Release are periods of time while Sustain is a level value.

- ADSR Range switch
This switch provides three different ranges (long / short / medium) for the time-related parameters Attack, Decay and Release. Use „short" for extremely percussive sounds, „long" is most useful for slowly evolving pad-sounds, medium for everything inbetween.

- A blue coloured LED shows the activity of the envelope generator.

- Gate Input socket (back panel)
Instead of the internal gate signal, derived from an incomming MIDI-note, the envelope generator can also be triggerd by an external gate signal via this socket (0/+5 to +12V). Use this socket, if you wish to play Dark Energy with a CV/Gate sequencer or keyboard.
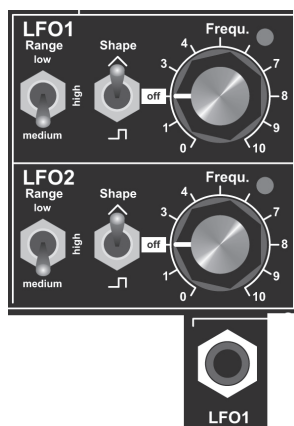
- Envelope Output socket
At this socket, the control voltage generated by the envelope generator can be picked up and used for additional modulation paths.

3.2.5. LFO1 and LFO2

A Low Frequency Oscillator produces a pulsating signal, mostly in the subaudio range, which can be used to generate periodic changes of several soundparameters. Dark Energy provides two identical LFOs.

The LFOs provide the following controls:

• Frequency knob
This knob controls the LFO frequency resp. modulation speed.

• LFO range switch
This switch provides three different ranges for the LFO frequency: „Low" (periods of up to a minute) / „Audio" (above 5 kHz) / „Medium" (usual LFO range – several seconds up to some 10th Hertz).

Since Dark Energy's LFOs produce frequencies up to the audiorange, they can be used to generate FM-effects with VCO-pitch, VCO-pulswidth and VCF-frequency as well as AM-effects (VCA). Use this feature to create interesting and noisy soundeffects.

• Dual coloured LED (yellow/red) show positive and negative waveform halfs. Above frequencies of approx. 30 Hz, the LEDs seem to light orange.

• Waveform switch
This switch selects the waveform of the LFO signal (triangle / off / square) or shuts the LFO off. Triangle suits soft modulations, square generates „jumps".

• LFO1 Output socket
The inverted output signal of LFO1 is provided at this socket. You may use it for additional modulation paths.

Internal jumpers provide the non-inverted signal of LFO1 or the ADSR control voltage at this socket. You may configure this jumper to your needs, but please keep in mind that opening Dark Energy's casing needs some basic skills in handiwork. If you cannot cope with this, please feel free to contact Doepfer anytime. You will find some more information in the section 3.5. „Modifications" on page 25.

3.3. USB/MIDI Interface

3.3.1. Connection / MIDI channel

Quite likely, you want to play your Dark Energy via MIDI – there are two easy ways to do so:

> • MIDI via USB or
> • the „classic" MIDI-connection via DIN socket.

• *USB*: To hook up Dark Energy in your MIDI-setup via USB, simply connect the included USB cable to Dark Energy and to a free USB port on your Mac or Windows PC.
Mac OSX, Windows XP (SP2 or higher) and Windows Vista provide the necessary drivers and Dark Energy will be mounted as soon as it is connected. You will find a new MIDI port in your MIDI application, named „USB audio device" (Windows XP) or „Dark Energy" (OSX, Windows Vista) and you are ready to go.

If this message is missing or an error message is shown, e.g. „USB device not found", the necessary driver is most likely not installed or not working properly on this computer. In this case, Dark Energy's USB port unfortunately cannot be used on this specific computer. We apologize for not being able to support this problem, since there will be multiple causes, very specific and depending on the computer. Of course you can run Dark Energy in such a case via the MIDI DIN-connection without any problem. The same goes if you use an older Windows or Mac System that does not provide the necessary drivers.

• *DIN socket:* You may connect Dark Energy alternatively via MIDI cable to a MIDI interface, a MIDI keyboard or a MIDI hardware sequencer.Simply connect the MIDI output of your MIDI device to Dark Energy's MIDI port. Please do not use USB and DIN connections in parallel.

• *MIDI channel selection (Learn button):* In order to enable Dark Energy to receive incomming MIDI data, the MIDI channel of both the MIDI device and Dark Energy have to be identical. You may select Dark Energy's MIDI channel like this:

– Select the desired MIDI channel on your MIDI device / software application. Please refer to their user manuals.
– Press the Learn button on the back of Dark Energy and keep it pressed down for at least one second. The LED starts flashing, showing that Dark Energy is in learn mode. The delay of one second avoids unintended enabling of the learn mode. The flashing LED always indicates Dark Energy's active learn mode. To press the learn button easily, you may use a pen or a plug.
– Press the key on your keyboard with the lowest note, that Dark Energy should be able to play. This note will set CV1 (pitch CV) to 0 Volt. This is approx. equivalent to 65 Hz / „C", when tuning knob and range switch are both in centerposition. The available range covers five actaves above that note. The default setting is MIDI note number 36.
– Done – Dark Energy's MIDI channel now fits to the one of the connected MIDI device. Dark Energy disables the learn mode automatically and changes to usual running mode. If you might enable the learn mode unintended, simply hit the learn button again to leave learn mode.

When Dark Energy receives a MIDI note, the learn LED goes off for a short moment. You may use this as a MIDI-in indicator, without the need to connect a soundssystem.
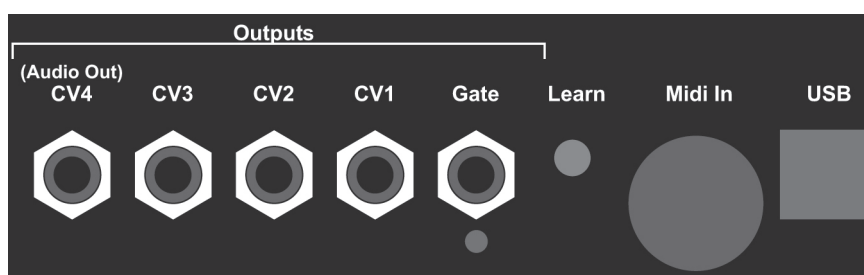
3.3.2. MIDI to CV/Gate interface

Since Dark Energy's soundgeneration works entirely real analogue and real analogue control voltages and gate signals are used internally, the unit features a complete USB/MIDI to CV/Gate interface.
This integrated USB/MIDI to CV/Gate interface generates not only a pitch control voltage and a gate signal to trigger the envelope, it also provides several control voltages derived from incoming MIDI velocity and MIDI controller data. The MIDI to CV interface also features a simple but useful arpeggiator and a so called reference tone. You have met the reference tone before to select the MIDI channel – it is the MIDI note, that sets Dark Energy's pitch CV1 to 0 Volts and thus becomes the lowest note of Dark Energy's note range.

All CVs and gate signals are provided via sockets on the backpanel of Dark Energy. Use patch cords to connect them with the module inputs on Dark Energy's frontpanel. So you can control the most importand soundparameters dynamically via MIDI velocity and a MIDI controller.
You may „abuse" Dark Energy's MIDI to CV/gate interface to control another, not MIDIfied analogue synthesizer that fits to the specifications of Dark Energy.

Depending on the incomming MIDI data (note on/off, notenumber, pitchbend, MIDI controller, velocity) the interface generates:

• The gate signal for the envelope generator,

• CV1: controlled by MIDI note numbers; 1V/oct scaling (internally connected with the VCOs pitch control input)

• CV2: controlled by MIDI pitchbend data (ranges approx. -2,5V to +2,5V or 0V to +5V, selectedable via internal jumper). CV2 has no internal connection, it can be patched to the control inputs on Dark Energy's frontpanel as desired.

• CV3: controlled by volume or the product of volume and velocity (selectable via learn mode). CV3 has no internal connection, it can be patched to the control inputs on Dark Energy's frontpanel as desired. Please refer to page 20, section (2).

• CV4: controlled by a free selectable MIDI controller or the product of controller data and velocity (controller number selectable via learn mode). CV4 has no internal connection, it can also be patched to the control inputs on Dark Energy's frontpanel as desired. Please refer to page 20, section (2).
By changing an internal jumper, the CV4 socket can become a second audio output. In this case, CV4 is not available any more. This mod enables you to use Dark Energy without any cable plugged into the frontpanel. The default setting is CV4.

3.3.3. Learn Mode / MIDI Functions

In learn mode you decide, how Dark Energy processes incomming MIDI data. Next to this, you control the settings of the internal arpeggiator and set the reference tone, which determines the lowest note in Dark Energy's note range.

You may access each function via MIDI program changes. The table below lists all functions. The notes (1) to (10) explain all functions in detail.

Function	MIDI-Message	Count 1-128	Count 0-127	Note	Short Explanation
MIDI-Channel/Reference note (CV1=0V)	Note on			(1)	
CV3 Velocity off	Program Change	#1	#0	(2)	CV3=Volume
CV3 Velocity on	Program Change	#2	#1	(2)	CV3=Volume*Velocity
CV4 Velocity off	Program Change	#3	#2	(2)	CV4=Ctr.X
CV4 Velocity on	Program Change	#3	#3	(2)	CV4=Ctr.X*Velocity
Retrigger					
Off	Program Change	#5	#4	(3)	
On	Program Change	#6	#5	(3)	
Key-Assign-Mode					
Highest note	Program Change	#15	#14	(6)	
Last note	Program Change	#16	#15	(6)	
Reference note	Program Change	#17	#16	(6)	
Stack note	Program Change	#18	#17	(6)	
Arp. Mode On/Off	Program Change	#19	#18	(7)	Arpeggiator
Arp. Mode Hold	Program Change	#20	#19	(7)	Arpeggiator
Arp. Mode Overwrite	Program Change	#21	#20	(7)	Arpeggiator
Arpeggiator Sync - Internal	Program Change	#22	#21	(8)	Tempo - internal
Arpeggiator Sync – External (MIDI Realtime/Clock)	Program Change	#23	#22	(9)	Tempo - external
Controller for CV4	Free MIDI-Controller (not Bank Change-Controller Ctrl-0/32)			(10)	

Notes:

(1) MIDI channel/reference for CV1=0V

In case of an incoming note event in the learn mode the note number and the channel of the event are taken over as the new reference tone and MIDI channel of Dark Energy. The reference note is the MIDI note number that belongs to 0V CV1 output. In practice you simply enter the learn mode and press the key on your MIDI keyboard that should belong to 0V CV1. MIDI note events below the reference note or more than 5 octaves above the reference note are ignored as the CV1 voltage range of Dark Energy is 0...+5V. The factory default settings of reference note and MIDI channel are note number 36 (C) and channel 1.

For the setting of these parameters MIDI Program Change messages coming from your MIDI device are used. Normally you will have to press the program change keys on your MIDI keyboard or MIDI synthesizer while beeing in the learn mode. Pay attention that some manufacturers count the MIDI program change numbers from 0....127 rather than 1...128 as usual and defined in the MIDI standard. If the lowest program change number you can send with your MIDI device is 0 (zero) you have to subtract 1 from the program change numbers in the table above as in this case the program changes of your device range from 0...127 instead of 1...128. For some devices (especially software sequencers) the type of program change numbering can be selected. In this case you should use the 1...128 range to agree with the numbers in the table above.

The program change messages must be sent on Dark Energy's MIDI channel (please refer to section „MIDI channel selection / learn mode" on page 19).

(2) Velocity on/off

These program change messages are used to select whether the note on velocity affects the control voltages CV3 resp. CV4. If velocity is „off" only volume (CV3) resp. the free chosen controller (CV4) is used to generate the control voltage. If velocity is „on" the volume or controller value is multiplied with the note on velocity, i.e. the CV value changes with every new note event as the velocity of the note event is used to calculate the control voltage together the volume message (CV3) resp. the free controller (CV4).

(3) Retrigger on/off

With this parameter you may select whether a new gate/trigger pulse is generated when playing legato (i.e. playing a new note on the keyboard while the key of the former note is still pressed). The factory default setting is retrigger off. Additionally the MIDI controllers legato (controller #68) and sustain (controller #64) affect the gate output in the usual manner.

(6) CV1 Key Assign Mode (Note Priority)

These program change messages adjust the type of assign modes for CV1. If highest note is selected the highest key pressed on the MIDI keyboard is used to calculated CV1 if more than one key is pressed down. In the last note mode always the last note (chronological) is taken for CV1. Reference note means that only the reference note is accepted. This feature is useful if you want to trigger different devices on the same MIDI channel using two or more Dark Energy. In this case you have to set the reference notes for Dark Energy's to different values.

Stack note means that Dark Energy is filtering out the note event that is used by Dark Energy to generate CV1. The note event in question is not transmitted to the (internal) MIDI Thru output of the interface. Stack mode is used to control more than one synthesizers on one MIDI channel and enables polyphonic control of different synthesizers on the same MIDI channel.

Please note that using this mode needs the internal Link-interface of Dark Energy. It is only accessable via an internal hardware modification. please refer to page 25 for further infos.

(7) Arpeggiator

Dark Energy offers an internal arpeggiator. An arpeggiator splits the notes of a played chord into a successive pattern of single notes. In music, the split of chords into a pattern of successive notes is in general named „arpeggio".

Dark Energy's Arpeggiator uses the following parameters:

• Tempo of the arpeggio can be determined by Dark Energy itself or synced to an external MIDI device.

• Direction is defined like this: The notes are played back in the same order, they have been played on the keyboard.

• Playback Mode:
On/off: Enables the arpeggiator. Set to on, a key has to be pressed down to become part of the arpeggio. As soon as a key is released, the note is deleted from the arpeggio pattern. In other words: Only pressed down keys are played back as arpeggio.

• Hold: In opposite to the „On" mode, notes are still played back, after the corresponding key has been released. The notes are deleted from the pattern, as soon as they are played a second time. You can picture this function as a „toggle switch".

• Overwrite: Again, the notes are played back in the same order, they have been played on the keyboard. After the sixth note (maximum capacity) has been reached, the arpeggio starts all over again. This mode „collects" played keys, selective deleting of notes is not possible. If the arpeggiator is stopped, the whole pattern will be deleted.

(8) Arpeggiator Sync – intern

Dark Energy's arpeggiator generates it's own clock signal. The tempo can be controlled via MIDI Modwheel data. Since a modwheel can be found on almost every MIDI keyboard, it is a useful controller to set the arpeggiators tempo in realtime (see below).

(9) Arpeggiator Sync – extern (MIDI clock)

The arpeggiator receives tempodata from an external device via USB/MIDI input. It processes the so called MIDI realtime events: MIDI Start, Stop, Continue, Clock. Please note: The arpeggiator will only run, when these events are generated and send by the master MIDI device!

The following realtime parameters can be controlled with several MIDI controller messages (These parameters cannot be saved. After powering down/up Dark Energy, they will return to their default settings).

• Tempo

> - MIDI controller 1 (Modwheel)

> - Value range: 0 – 127

> - Value 0 = Stop

• Gate length (note length)

> - MIDI controller 0

> - Value range: 0 – 127

> (Devides the MIDI-clock value or the value of the internal clock. Devider is 1/96.)

• Octave

> - MIDI controller 0

> - Value range: 0 – 6

> (The pattern will be transposed up to 7 octaves, until it starts again with note „one".)

Since Dark Energy's note range covers a maximum of 5 octaves, higher notes will be ignored and cause „pauses" within the pattern. This effect can be used in a creative way to create musical phrases.

Example: With the setting „octave 1", the played chord A3-C4-F4-G4 will provide exactly the same pattern. Using „octave 2" instead, provides the pattern A3, C4, F4, G4, A4, F5, G5 and so on.

(10) MIDI controller for CV4

If Dark Energy receives a MIDI controller message (except bank controller 0 & 32) while being in learn mode the controller no. of these message defines the controller no. for CV4. I.e. the CV4 output of Dark Energy corresponds from now on to these controller no. The controller message must be sent on Dark Energy's MIDI channel (see section „MIDI channel / Learn mode" on page 17). Controller 0 and 32 (Bank Change) will be ignored and cannot be „learned".

Whenever Dark Energy receives one of the MIDI messages listed in the table above, the parameter in question is changed and Dark Energy returnes to the normal play mode, i.e. the LED stops flashing. Pay attention that not unintentional MIDI messages appear while beeing in the learn mode (e.g. from a sequencer) as you change the settings of Dark Energy with such MIDI messages. All parameter changes made while beeing in the learn mode are stored non volatile in Dark Energy parameter memory. When Dark Energy is turned on next time the parameter settings are taken from this memory.

3.3.4. Resetting Dark Energy

To obtain the factory settings for all parameters one has to reset the device. This might be useful if you e.g. do not remember the last parameter settings (e.g. MIDI channel, reference note, controller # for CV4, key assign mode) or if they are misadjusted. If your Dark Energy seems to behave strange and you do not know how to solve the problem resetting the device may help as the values of all parameters are known after the reset.
To reset the device press down and hold the learn button while the power supply is plugged in. The LED will turn on and one has to keep down the button a few seconds until the LED starts to flash. Pressing the button again leads to the normal operation mode and the LED will turn off.

After the reset Dark Energy's parameters are set to these default values:

- MIDI channel 1
- Reference note 36 (i.e. the lowest „C" on a standard 5-octave keyboard)
- Retrigger: on
- CV3: volume (controller #7)
- CV4: modulation (controller #1)
- Key assign mode: highest note
- Internal Arp-Tempo: approx. 120 BPM
- Gate length: 6
- Octave: 1
- Arppeggiator Sync: internal

These values are identical to the factory default settings.

3.4. Link / stack several Dark Energy's

In parallel on the same MIDI channel:
You may run several Dark Energys in parallel. When all devices use the same MIDI channel, they will all sound simultanously when a note is played. Stacking Dark Energy's this way may create even more complex and richer sounds. It is also interesting to program only slight sonic differences between the units. This can be useful for very expressive and rich pad-sounds. Stacking Dark Energy's this way is done most easy with the help of a MIDI-THRU box, a MIDI interface with multiple outs or an USB hub.

Stack Mode:
Stack Mode (p. 19, 20) runs several Dark Energy's in the manner of one polyphonic instrument. Every unit plays one voice. Since Dark Energy's casing is too packed, it has no MIDI-THRU socket but an internal link-connector. Holes in the sides of the box provide access to these connectors as soon as the wooden sidepanels have been dismantled. You may mount several units mechanically together side by side.

The use of these internal link-connectors needs some hardware modifications, that are described in an additional technical documentation of Dark Energy. Please download this documentation from our website here:

       www.doepfer.de -> Products -> Dark Energy -> Additional technical documentation

Importand: Please do not tinker around with your Dark Energy without having read and fully understood this additional technical documentation! Otherwise you may damage your instrument, loose your warranty, risk your health etc.

3.5. Modifications

Dark Energy provides several hardware modifications to customize the unit to your specific needs. Besides the Link-connection (see above) this is the configuration of the CV output sockets and the calibration of some parameters. Next to this, you may mount the casings of several units together in order to get one big and even more „darker" Energy.
All this is described in detail in the additional technical documentation of Dark Energy. Please download this documentation from our website here:

       www.doepfer.de -> Products -> Dark Energy -> Additional technical documentation

Again: Please do not tinker around with your Dark Energy without having read and fully understood this additional technical documentation! Otherwise you may damage your instrument, loose your warranty etc.

If you are concerned to have „two left hands", you may easily give these modifications in the hands of a qualified and authorised tech. You may find all information on our website (www.doepfer.de)
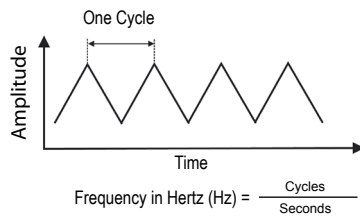
3.6. Firmware Update

Dark Energy's firmware can easily be updated via USB. In case a new firmware version is available, you may download it from our website (www.doepfer.de). A detailed description of the update process can be found in the additional technical description of Dark Energy. You may download this documentation here:
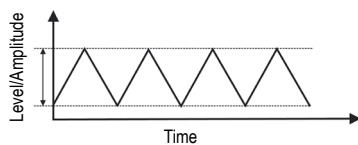
       www.doepfer.de -> Products -> Dark Energy -> Additional technical documentation

4. Basics of Soundgeneration

In case analogue synthesizers or synthesizers in general are new to you, please read this section. You may learn some basics about analogue / subtractive soundsynthesis that will help you to fully understand Dark Energy's little secrets.

Sound is, very generally spoken, a change of air pressure. If these changes happen continously and with a certain frequency, they can become an audible noise or tone. Frequency is measured in Hertz (Hz). The human ear percepts frequencies approx. between 20 Hz and 20.000 Hz. The frequency of an audible signal determintes it's musical **pitch**.

$$\text{Frequency in Hertz (Hz)} = \frac{\text{Cycles}}{\text{Seconds}}$$

Another basic parameter that is percepted by our ears is **loudness** resp. the level of an audible signal. Loud tones or noises move more air than weak ones. Thus, the "size" of the signal is called amplitude and is measured in Dezibel (dB).

The third importand parameter to define a sound is the **timbre**. The is no special definition, it is usually described with associative terms, such as sharp, dull, bright, dark, thin or rich.
The timbre is determined by the so called overtone content of the sound. In general, bright sounds contain more overtones, dull sounds lesser.
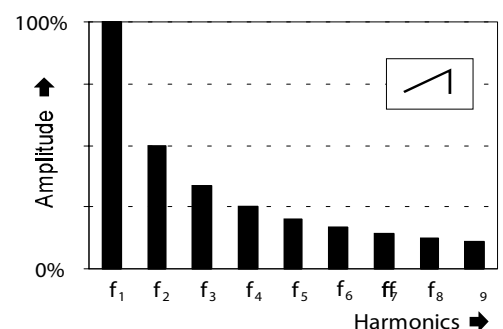
As we see, the "raw material" of a sound is defined by the three parameters frequency or pitch, loudness or level and timbre resp. overtone content.

Oscillators and Waveforms
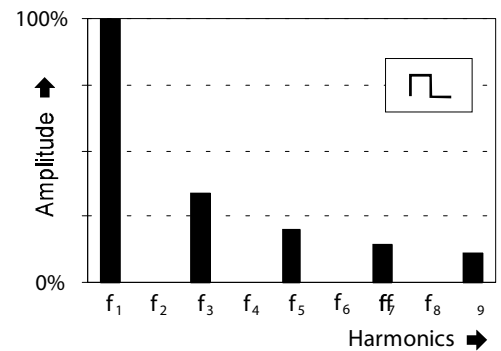
With analog synthesizers the tonal "raw material" is produced by voltage-controlled oscillators (VCOs). Normally, a VCO provides several waveforms. Standard waveforms are pulse, sawtooth and triangle. These are most useful in soundgenaration, since they offer a rich but different overtone content and therefor they sound very different from each other. Thus Dark Energy uses them. Less used waveforms (sine, spaced sawtooth, graphically editable wave forms) are not dealt with here.
As said above, the waveforms differ in their overtone spectrum, i.e. they contain different harmonics. An overtone is called harmonic if its frequency is an integer multiple (2, 3, 4, ...) of the base tone frequency.
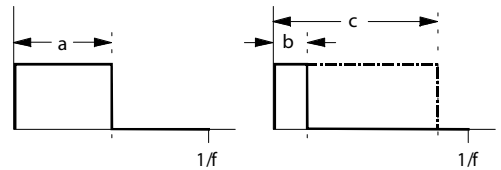
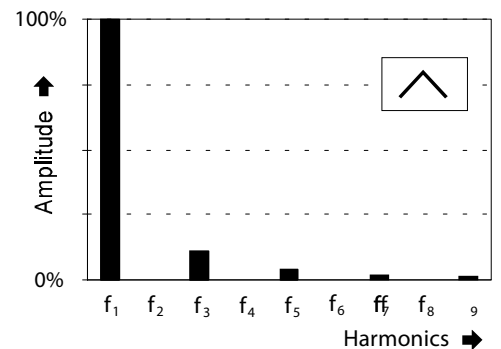A **sawtooth wave** contains all harmonics with descending amplitudes.

The symmetrical **pulsewave** (or "**squarewave**", pulsewidth = 50 %) contains odd harmonics only (see Fig.). An unsymmetrical pulsewave (often simply called "pulsewave") contains all harmonics with their amplitudes being dependant on the pulsewidth. The more the pulsewidth differs from the symmetrical 50 %, the stronger the higher harmonics emboss the sound, i.e. its timbre becomes more "nasal".

The **width of a pulsewave** can be modulated by a low frequency oscillator (LFO) or, less common, by an envelope generator. Then the overtone spectrum of the pulsewave continuously changes. The resulting sound is similar to a beat wave which is the result of two, nearly equally tuned oscillators. The modulation frequency must be very low (approx. 1 Hz or lower) since the oscillator seems detuned otherwise.
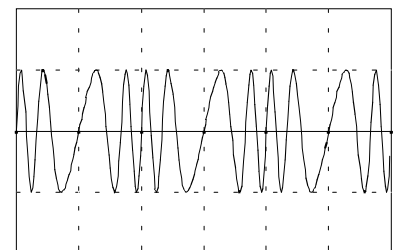
The **triangle** and sine waveforms have only a weakly pronounced harmonic structure resp. no harmonics at all (sine). The triangle waveform contains only the odd harmonics like the sawtooth but their amplitudes decreases by the power of two while with the sawtooth they are decreasing linearely in their numerical order and therefore much slower.

Modulation

The amount of overtones of the base material is decisive for the possibilities in sound shaping with the subsequent voltage-controlled filter (VCF) since subtractive sound synthesis with a VCF (see below) only allows to cut-out or amplify overtones that exist. Therefore, the sine and triangle wave only play a minor part here. Under the condition that a VCF works as sine wave oscillator when resonance is set to maximum, it can be used in this way if a sine wave oscillator is required for a special sound.

If a low frequency oscillator is available, it can be used for modulating either the VCO pitch (frequency modulation = FM, also called "vibrato") or the pulse width (pulse width modulation = PWM). Simple LFOs provide frequencies in the range of 0.1 Hz to 10 Hz while better ones have a significantly wider range (0.01 Hz to 5 kHz) with switchable frequency bands for better adjustment.

Modulation frequencies within the audio range should be dealt with in more detail since their result are very special sounds. If a VCO is modulated with a frequency close to its own, a completely new sound characteristic is established. In this case the VCO also produces non-harmonics, i.e. tones whose frequencies are non-integer multiples of the VCO frequency. This acoustical characteristic is the basis for the so-called FM Synthesis which is used with several digital synthesizers. If e.g. a VCO, oscillating at 1 kHz (1000 Hz), is modulated with a frequency of 400 Hz, so-called "side bands" around the the VCO frequency are created which are grouped symmetrically around the VCO frequency as integer multiples of the modulation
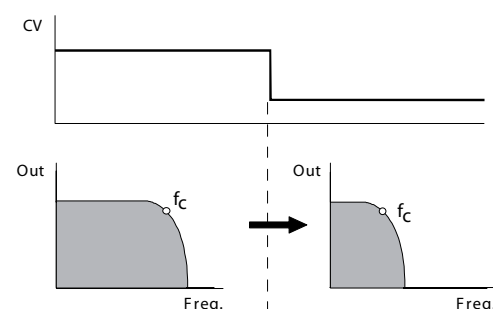
frequency. For the given example this would result in: 1000 Hz, 1400 Hz, 11800 Hz, 200 Hz, etc... Strictly speaking this only applies to pure sine wave frequeny modulation, i.e. if both, VCO and LFO, are sine wave oscillators. With other wave forms additional (non-)harmonics will be added. Unharmonic sounds, similar to frequency modulation, are also produced by pulse width modulation with high frequencies. In practice this priciple is used for creating extreme, unharmonic sounds. The degree of being unharmonic depends on the strength (amplitude) of LFO modulation as well as on the frequency ratio of VCO and LFO. "Practice is better than theory" applies here. You should try various settings for LFO frequency and LFO amplitude. Most probably the resulting wave forms are not suited for sweet, "beautiful" sounds but can be used for extreme, "vigorous" sounds instead.

Filters

With subtractive sound synthesis the further processing of the tonal "raw material" (VCO signal) will be done by a voltage controlled filter (VCF) first which is usually followed by a voltage controlled amplifier (VCA).

There are different **types** or characteristics of filters. The basic types are lowpass, bandpass and highpass while the types notch and allpass are less common. The filter types differ in how they feed the frequency through resp. which frequency ranges are rejected. A lowpass passes all frequencies that are below the cutoff frequency and cuts off all frequencies above. The highpass works just the opposite way since it passes all frequencies that are above the cutoff frequency and cuts off all frequencies below. A bandpass passes all frequencies within a certain range (band) and rejects all frequencies outside this range. A notch cuts out a certain frequency range (inverse function of the bandpass).
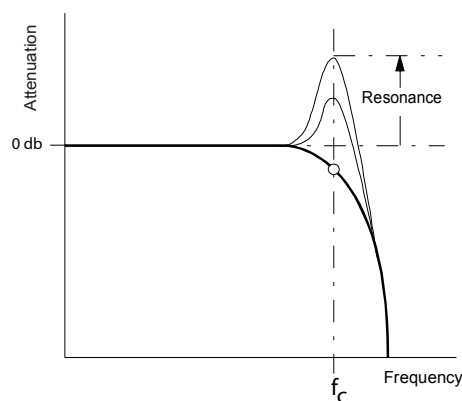

Charakteristics of a lowpass filter

An allpass passes all frequencies but it performs a phaseshift dependant on the frequency. For musical purposes the lowpass is by far the most efficient filtertype, thus it is used in Dark Energy.

Next to the filtertype, another important parameter of a filter is **slope** which is measured in dB/Octave. It describes how steep the transition from passing to recection occurs. The "ideal" filter would have an infinite slope, i.e. the transition occurs immediately (e.g. 999 Hz would pass totally while 1000 Hz would be supressed totally). In reality this transition is not a jump but a gliding, depending on the filter's slope. For musical purposes, a filter with a high value would have a slope of 24 dB/Octave but 12 dB/Octave are also useful for special applications (usually for high pass, band pass and notch). Dark Energy uses a 24 dB/Octace filter, since it worked out to be the most musical useful and efficient.

A further filter parameter is **resonance** (or emphasis). If the filter provides an adjustable resonance, frequencies close to the cutoff point can be emphasized. The filter becomes more of a bandpass with an underlaid low pass. For musical applications it is very important that the filter resonance is able to be adjusted. VCFs without adjustable resonance are seldomly used. Overtones close to the cutoff point are emphasized the bigger the resonance is set (see fig. XX). This results in the typical resonance and tweet sounds of an analog filter. With many filters the resonance can be set to such a high degree that self oscillation of the filter occurs (even without any input). This allows you to use the filter as a sine wave oscillator instead of the VCO for special purposes. You guessed it – also Dark Energy's filter is capable to self oscillate and thus to create a lot of typical sounds.

Resonance changes the filter characteristics

There are several ways to **control the filter's cutoff frequency**. First, it can be adjusted manually with the Freq. knob. Furthermore the ADSR as well as LFO 2 can influence the cutoff frequency with any intensity. The intensity is set by the XM knob. Additionally, the filter is controllable via MIDI, i.e. its cutoff frequency can be controlled by any MIDI controller and / or by the velocity data of the incoming MIDI notes. Finally, using a switch, you can determine whether the VCF cutoff frequency tracks the VCO frequency fully, half or not at all (keyboard tracking, keyboard follow). Filter resonance can be adjusted until self oscillation of the filter occurs. Similar applies to the VCO-LFO (LFO 1) with regard to the LFO for the filter (LFO 2). LFO 2 can also produce frequencies up to the audio range. The tonal results of VCF frequency modulation with audio frequencies are similar to those of the VCO. You can create typical FM metallic sounds especially with high frequencies whether you use tonal base material (VCO / external audio signal) or not. You can even create voice-similar sounds when setting the VCF to the appropriate setting and using slowly progressing ADSR envelopes. The sound will become realy extreme, if you use frequency modulation with audio frequencies for both VCF and VCO. The tonal results are nearly unpredictable. There is only one way: try it out; very often the results are totally surprising.

Very unusual in analogue synthesizers but musically useful is the linear frequency modulation, featured by Dark Energy. Here the VCFs cutoff frequency is modulated in a linear matter by the triangle wave of the VCO. Intensity is set by the LM knob. This feature is very useful for FM sounds with the filter working as a sinewave oscillator (self oscillating) that keep their harmonic content while the sound is e.g. played by a sequencer, keyboard or USB/MIDI interface.
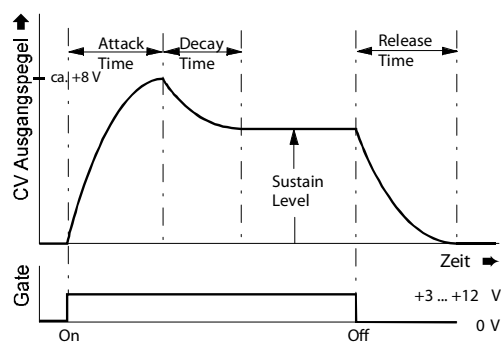
Amplifiers

The voltage contropled amplifier (VCA) emphases the sound between the factor 0 and 1, depending on a control voltage, usually provided by the envelope generator and/or the LFO. The VCA controls the loudness contour of the sound, resp. their articulation, to use a musical term.

The above described components VCO, VCF and VCA generate resp. process the audiosignal itself. Next to this, we already mentioned components that do not generate any audible signals, but provide control voltages to modulate the parameters of the soundprocessing modules. These are the envelope generator (or ADSR) and the Low Frequency Generator (LFO).

Envelope Generators

Envelope generators, typically of the ADSR type (attack - decay - sustain - release), produce a sequence of four voltages which can be used for controlling the VCO pitch, VCF cutoff frequency and the VCA amplification. The ADSR produces a "one shot" contour in opposite to an LFO, which generates a frequent modulation. The envelope consists of 4 parameters: attack time, decay time, sustain level and release time. When pressing a key on a keyboard (note-on command / gate = on), the envelope rises within a period of time which can be set by the attack control. After reaching its maximum the envelope decays down to the sustain level within a period of time adjustable by the decay control. The envelope stays on this level until the key is released (note-off command / gate = off). Then it decreases to zero within a period of time adjustable with the release control.
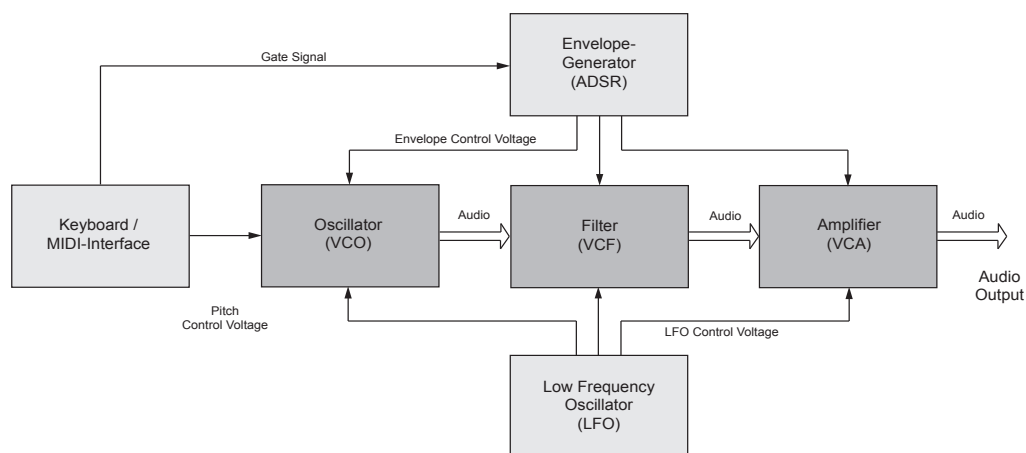

: ADSR-Hüllkurve und ihre Parameter

Low Frequency Oscillators

An LFO is a Low Frequency Oscillator which generates frequent control voltages over a wide range. It can provide several waveforms. Both LFOs of Dark Energy provide triangle and square waveforms. The latter can be used for "jumps" in modulation while the triangle wave creates continous modulations. The LFOs can be used as modulations sources for all of Dark Energy's importand sound parameters.

Interaction

The following figure shows the interaction of all the above mentioned components. It shows the audiosignal path (darker coloured) with oscillator ("raw sound", pitch), filter (timbre) and amplifier (loudness). Next to these modules you see the modulating or controlling elements (envelope generator, LFO) which provide the necessary control voltages to control the parameters of the aforementioned components.

If you feel like going deeper into the secrets of soundsynthesis, please check out this book:

Allen Strange, Electronic Music – Systems, Techniques and Controls, 2nd edition, Wm. C. Brown Company Publishers, Iowa, ISBM 0-697-03602-2

This is one of most complete and useful publications about sound synthesis and synthesizers, suitable for newcommers and more advanced musicians.

5. Example Sounds
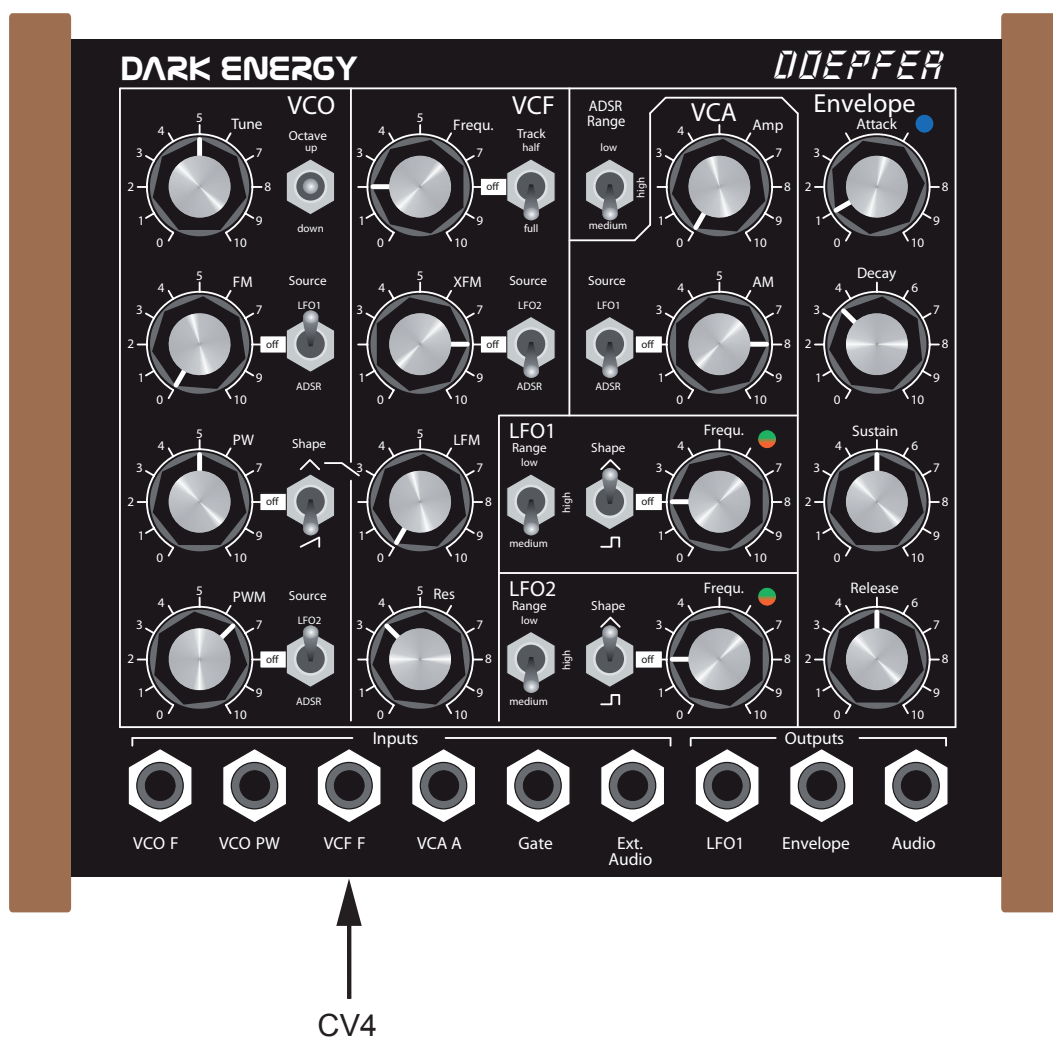
This section shows some example sounds of Dark Energy with a short description of the parameter settings. You may try out and modify these examples in order to get familiar with Dark Energy's sonic capabilities. Have fun!

1. Start Up

The first example shows a very typical and simple synthesizer sound. It is musically useful and a good starting point for your own creations.
The VCO provides a mix of saw- and squarewave signals. The last-named gets a slight pulswidth modulation by LFO2 in order to make the sound richer. The evelope generator controlls both VCF and VCA i.e. timbre and loudness of the sound.
If you connect the CV4 socket in the backside with the VCF F input, you may additionally controll the filter cutoff with the modwheel of your MIDI keyboard.

CV4

2. Basic Bass
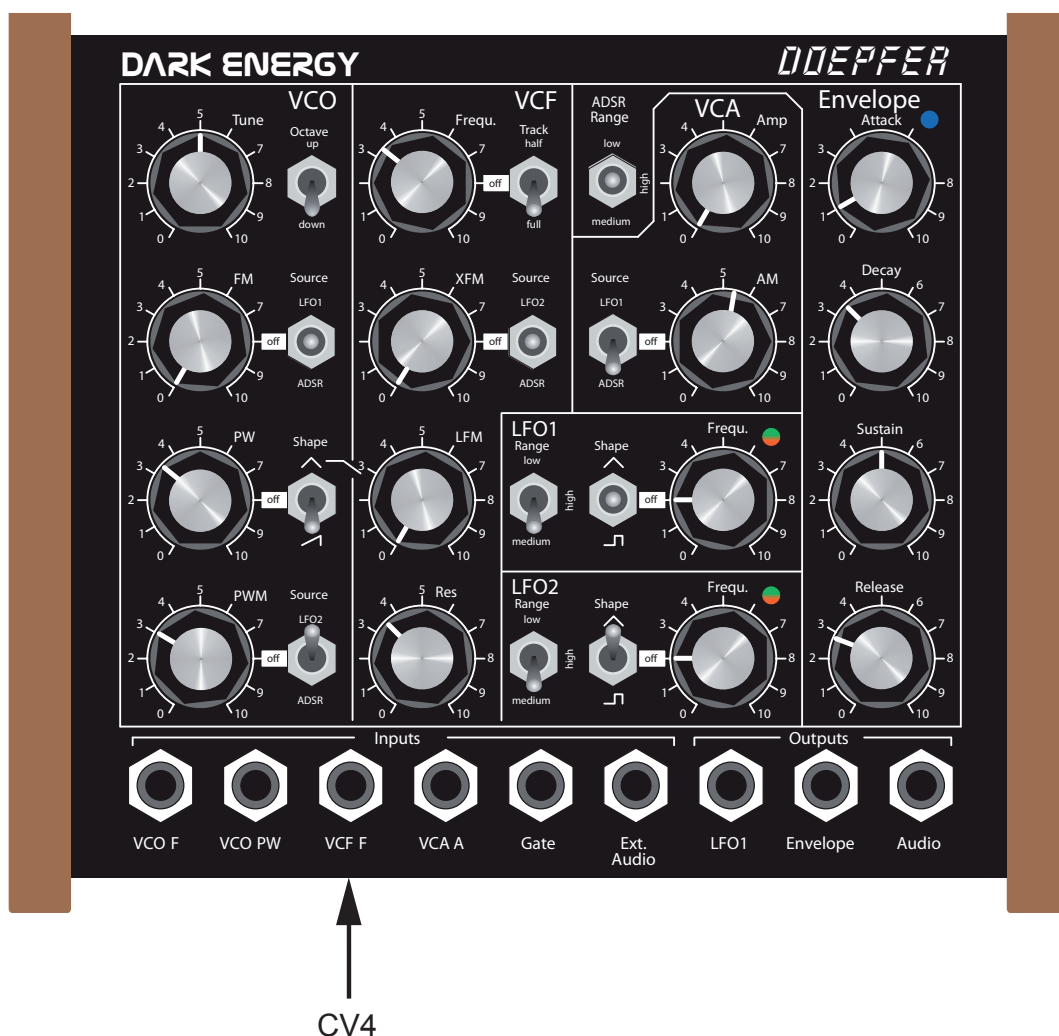
The second example is a simple and useful bass sound.
Again, the VCO provides a mix of saw- and squarewave signals. The last-named gets a slight pulswidth modulation by LFO2 in order to make the sound richer. Experiment with the parameter settings, especially with VCF Freq and resonance as well as with the ADSR parameters.

With very short decay values and low cutoff settings, slight but clearly audible pops may occur. This is normal. If not desired, simply increase these values a bit.
If you connect the CV4 socket in the backside with the VCF F input, you may additionally controll the filter cutoff with the modwheel of your MIDI keyboard.
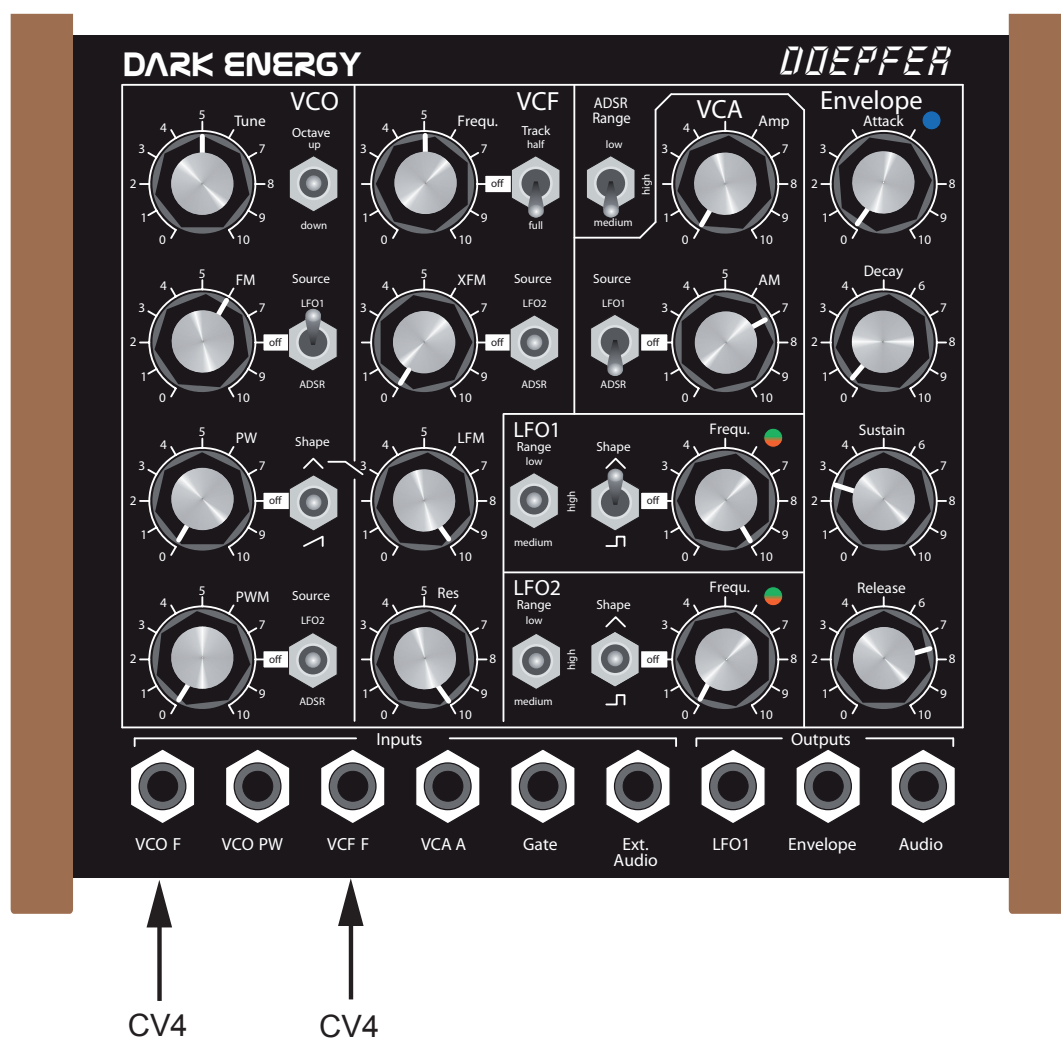
Raise filter cutoff and resonance and crank up the LFM knob (linear FM) slowly to maximum. The sound becomes sharper. Experiment with the filter settings and the range switch of the oscillator.

CV4
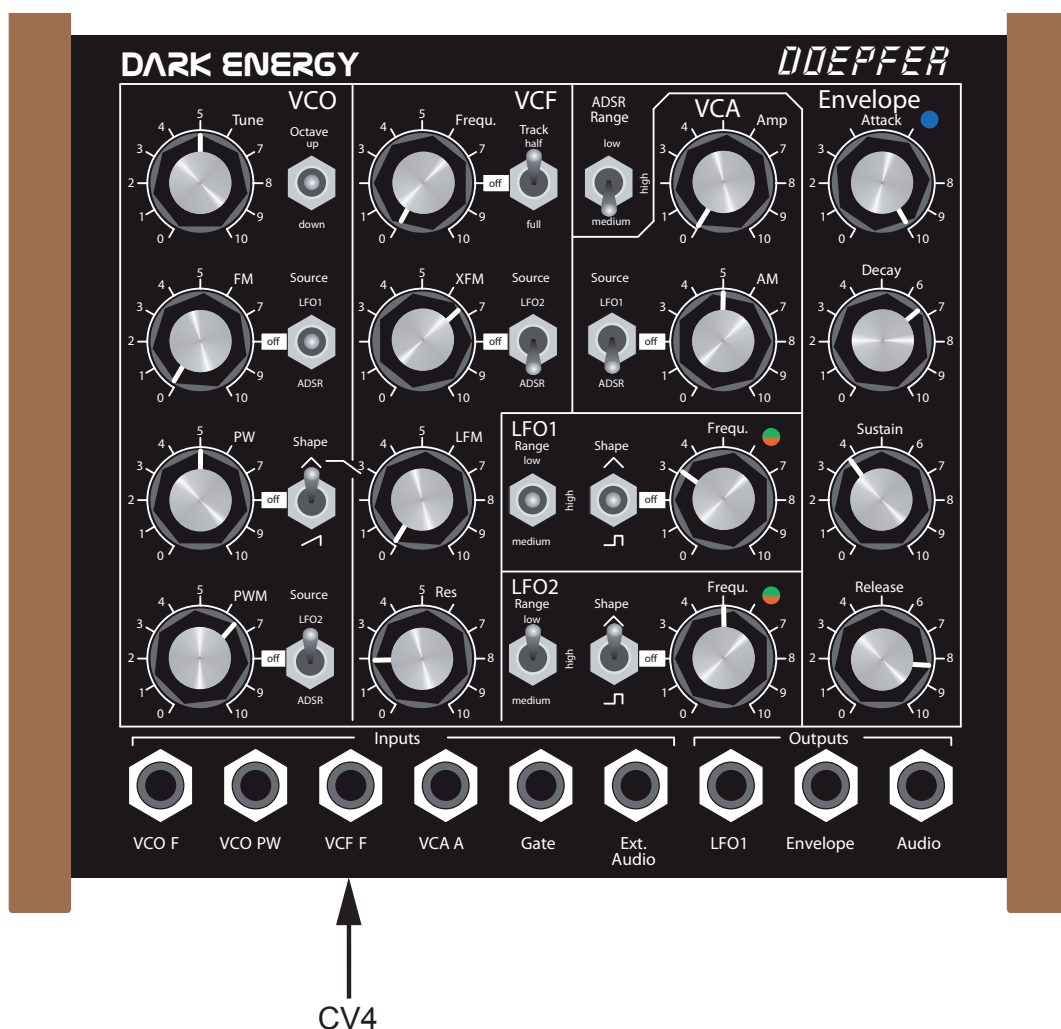
3. Energy Pad

A simple but classic pad sound. If you record and overdub several voices with slightly different settings, you will get very rich pads.

A slow envelope controls both loundness (AM) and filter cutoff frequency (VCF XM). The VCO provides a mix of saw- and squarewave signals. The last-named gets a slight pulswidth modulation by LFO2 in order to make the sound richer. Different ADSR and VCF settings can change the sound into a brassy-like character.

If you connect the CV4 socket in the backside with the VCF F input, you may additionally controll the filter cutoff with the modwheel of your MIDI keyboard.

CV4

4. Metallic Lacquer

Now Dark Energy goes for some metallic percussion sounds. They feature frequency modulation in the audiorange. As you already know, this fits best for inharmonic and noisy timbres. This sound is partly tonal playable.

The filters resonance is fully cranked up, i.e. the filter runs as an oscillator. It's frequency / pitch is controlled by the LM knob. The modulation source is the VCO, which itself is modulated by LFO1 in the audiorange. This corresponds to a 3-operator-FM. The frequency values of VCF, VCO and LFO1 as well as the modulation depths (VCF-LM and VCO-FM) have to be adjusted very carefully to make the sound tonally playable at least over a range of two octaves.
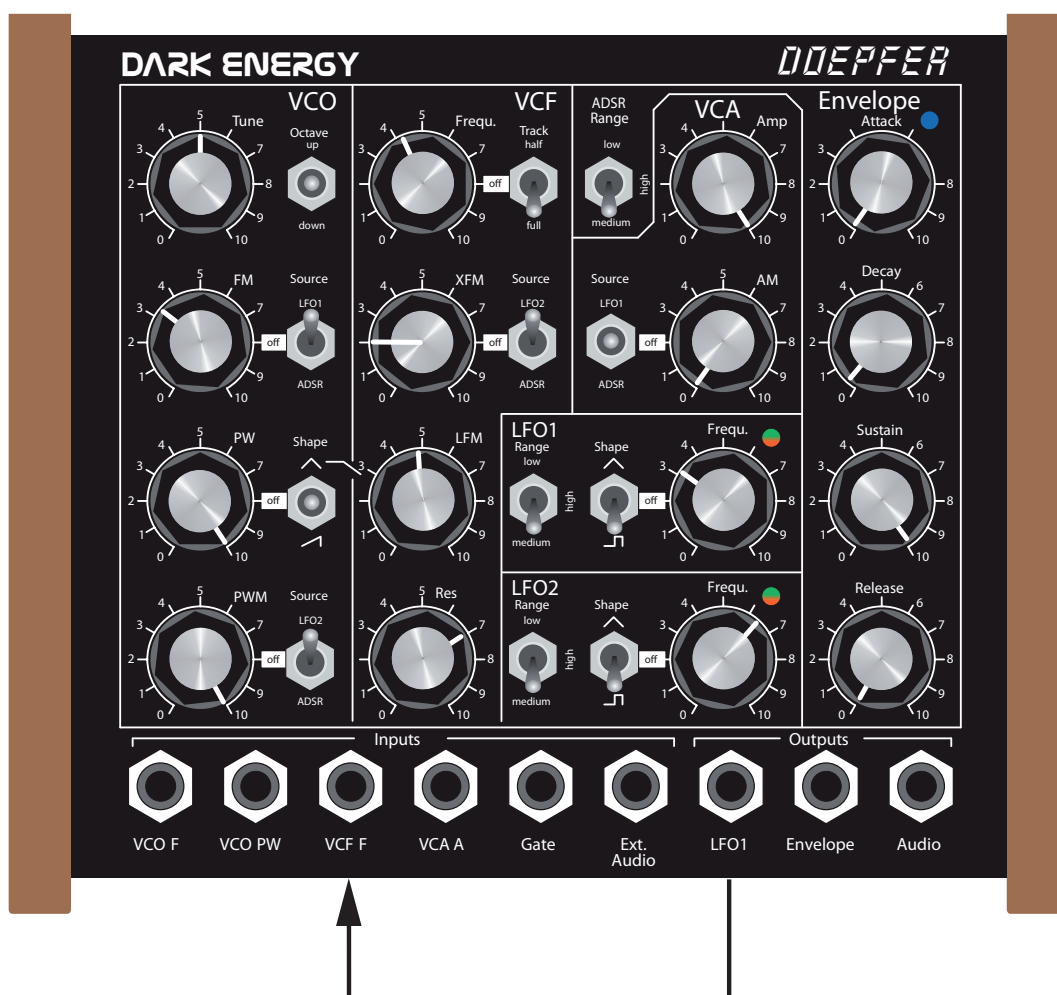
The modwheel (CV4 to VCO F or VCF F) provides wild noise effects.

5. R2D2 On Acid

Here, Dark Energy's LFOs generate some kind of mini-sequence. The oscillator generates only the puls-wave (pulswidth = 0), which is heavily modulated by LFO2s squarewave. The modulation depht exceeds its maximum and the sound gets dropouts within the speed of LFO2. In addition, LFO2 modulates the filter and generates jumps in timbre. LFO1 modulates the VCOs pitch in a way, that it's squarewave performs octave jumps (adjust VCO-FM carefully). The modulation speeds of both LFOs is adjusted in a way, that they generate a simple rhythmic pattern. The cranked up VCA knob provides a static output level, the ADSR is not in use.

Connect the LFO1 output to the VCF F input and listen how the sound changes. Play with the filter parameters.
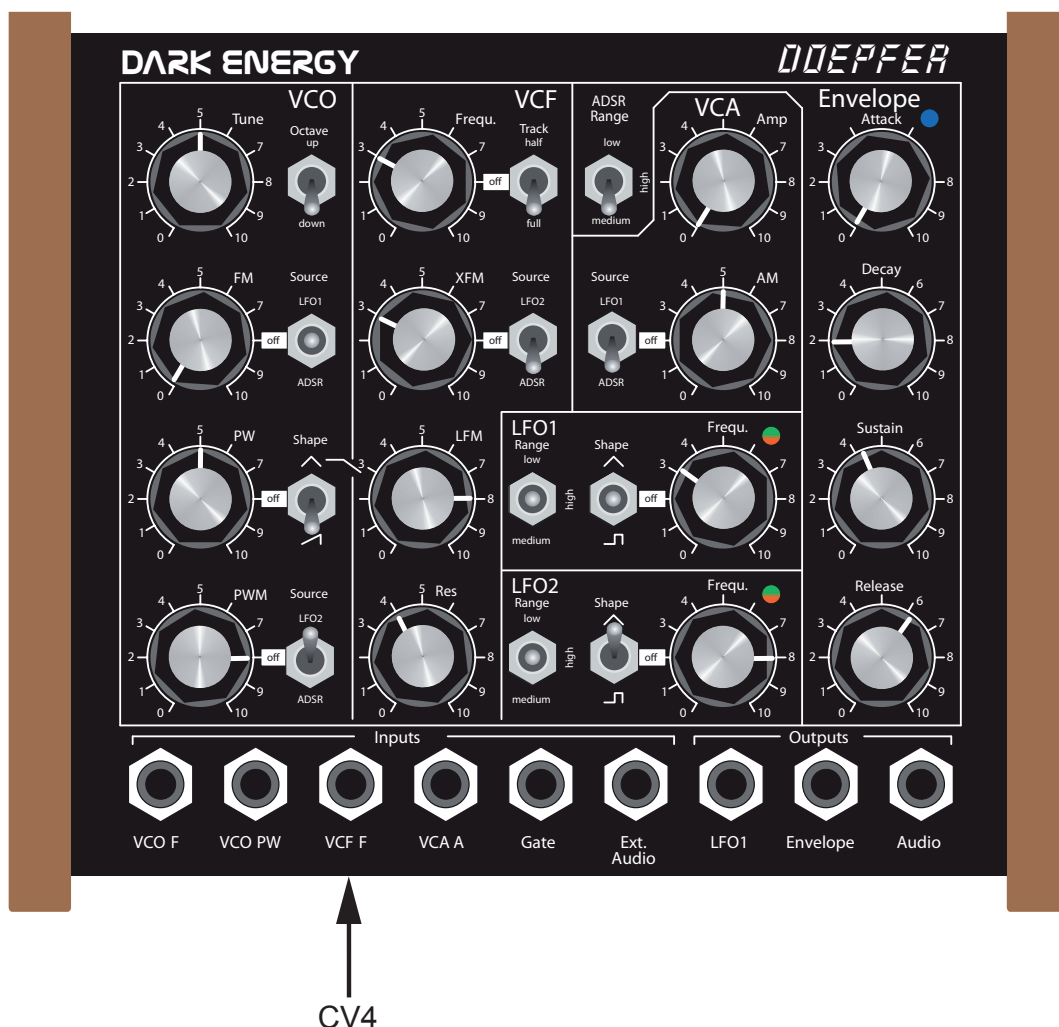
6. Almost Sync

This example sound does a good job as a bass or – in higher ranges – as a powerful keyboard/lead sound.

The pulswidth of the squarewave is modulated in the audiorange by LFO2. Result is a sound, that slightly reminds of the classic „oscillator sync" effect. Filter and VCA are controlled in the usual way by the envelope with a percussive setting. Importand for the sonic characteristics are the settings of all filter parameters, LFO2 frequency and the modulation depth of the pulswidth PM. If you use the trianglewave instead of saw as a second VCO signal, the sound becomes much softer.

If you connect the CV4 socket in the backside with the VCF F input, you may additionally controll the filter cutoff with the modwheel of your MIDI keyboard.
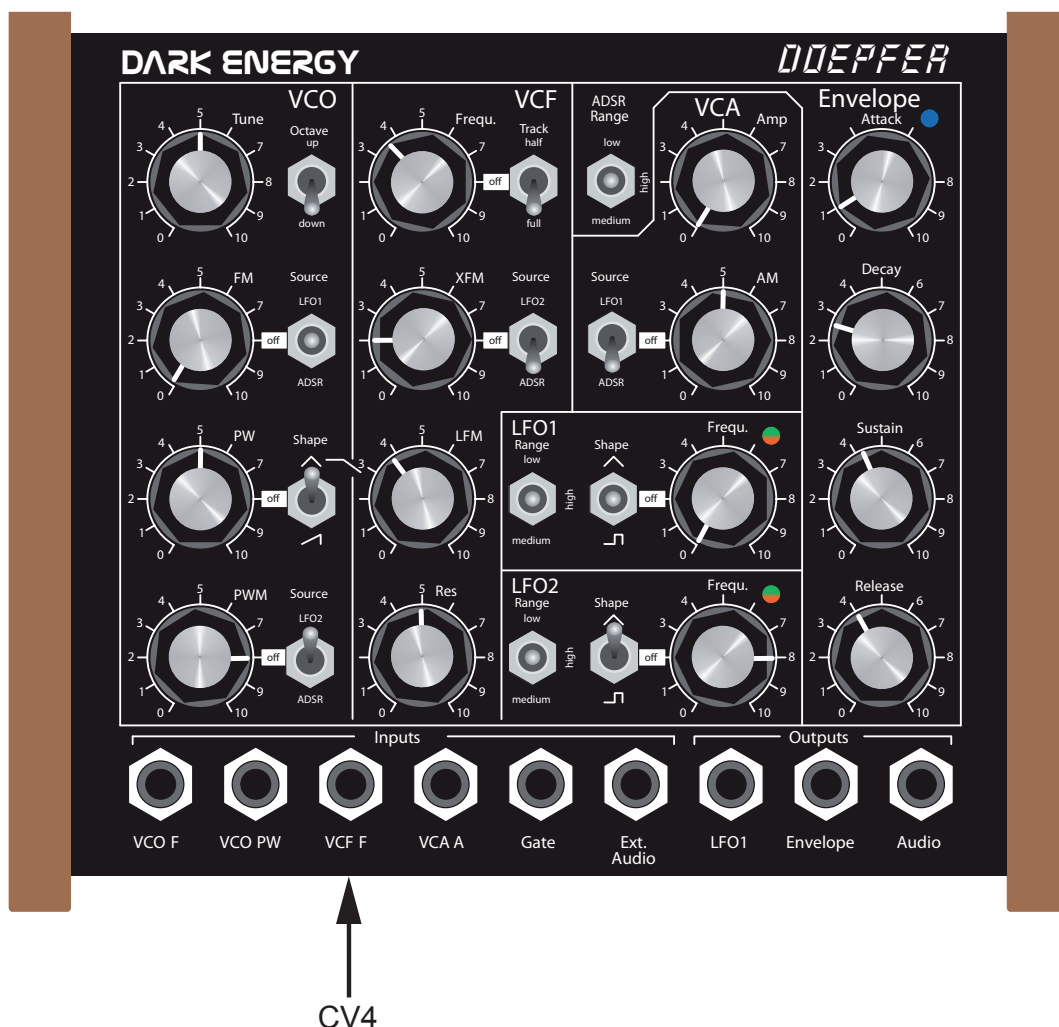

CV4

7. Perco Bass

A modified version of the sound above can be found here. The envelope has a very short and percussive setting, the high resonance value increases the percussive character even more. If you use the ADSRs „hi" range, the envelope parameters can be cranked up a bit more. The envelope setting keeps it's percussive character but unwanted „pops" will be avoided.
Pulswidth modulation (PM) and a bit of linear frequency modulation of the filter cutoff (XM) with LFO2 add an interesting timbre.

If you connect the CV4 socket in the backside with the VCF F input, you may additionally controll the filter cutoff with the modwheel of your MIDI keyboard.
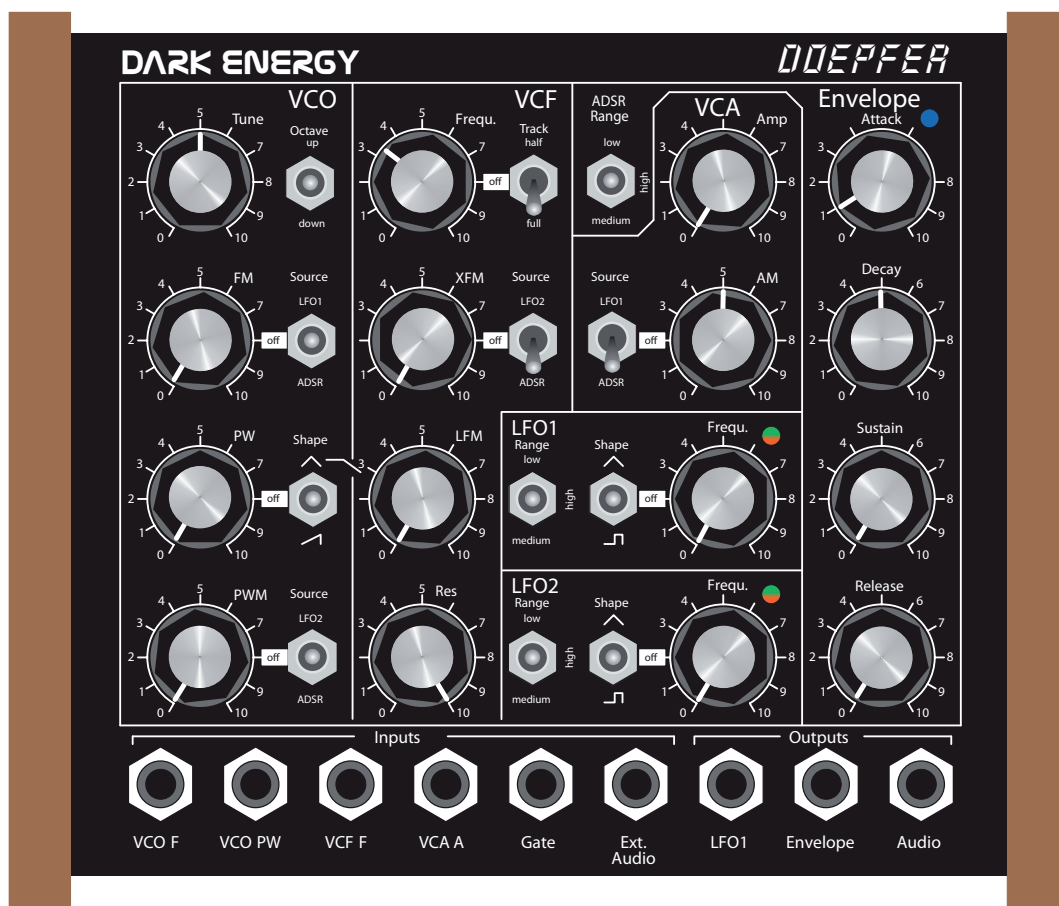

CV4

8. Popcorn

This admittedly very simple sound is a classic.
It shows again the „abuse" of the filter as an oscillator: Resonance is fully cranked up, i.e. the filter oscillates. The „full" position of the VCF-tracking switch provides tonal scaling of the VCF and thus playing the filter in halftones over your keyboard. The VCO itself is not in use. The very short envelope only uses a simple AD setting.
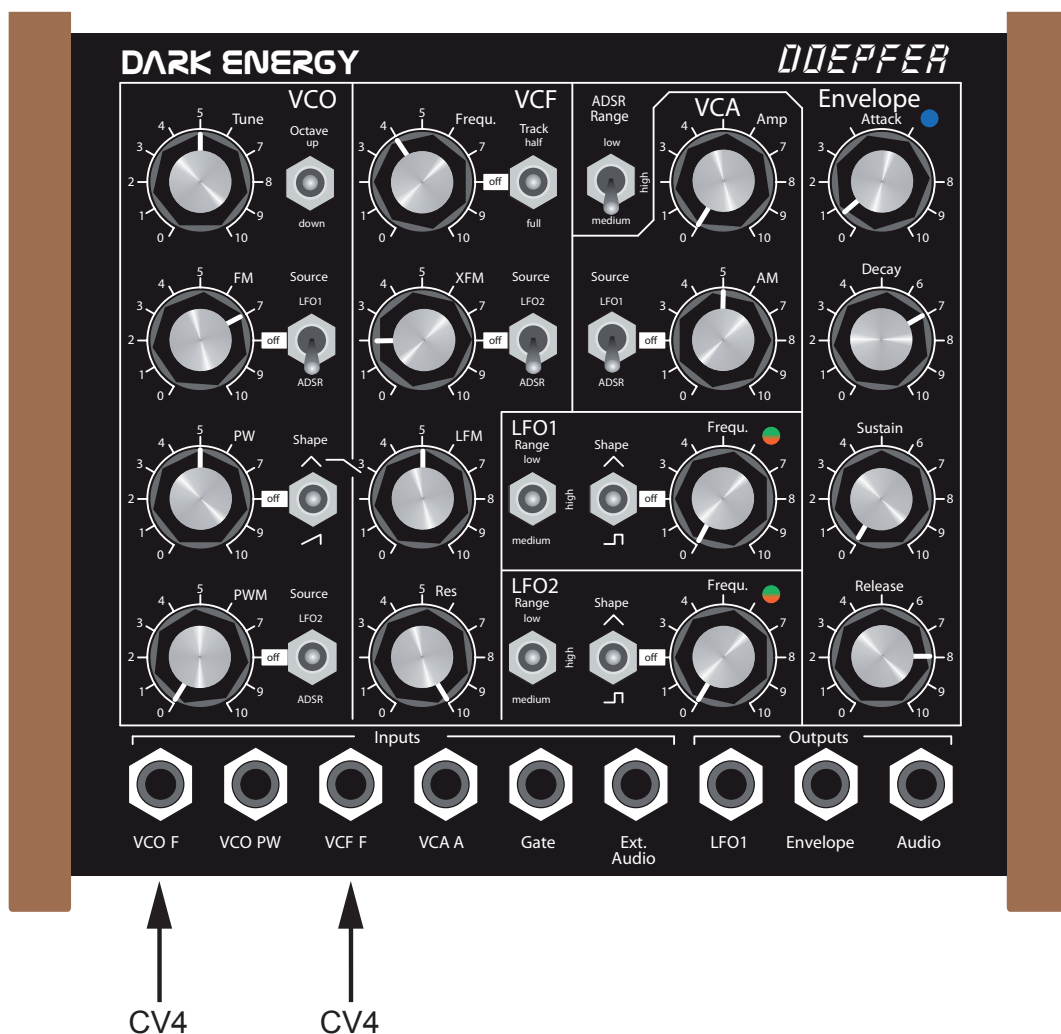
If you modulate the filter cutoff (crank up slowly XM and/or LM), the sound looses it's tonal qualities and you get some very typical synthie percussion sounds.

9. Disco Drum

Let's stay a bit in the 70th sound asthetics and dial in a drum synthie on your Dark Energy.
Depending on the cutoff setting, Dark Energy produces a typical „piuuh" or a soft bassdrum. The envelope modulates the VCO pitch (FM) and the filter cutoff (XM). A bit of linear filter modulation adds some noisy tonecolour. Filter tracking is disabled since this sound does not need to be played in halftones. The decay parameter of the envelope influences also the sound.
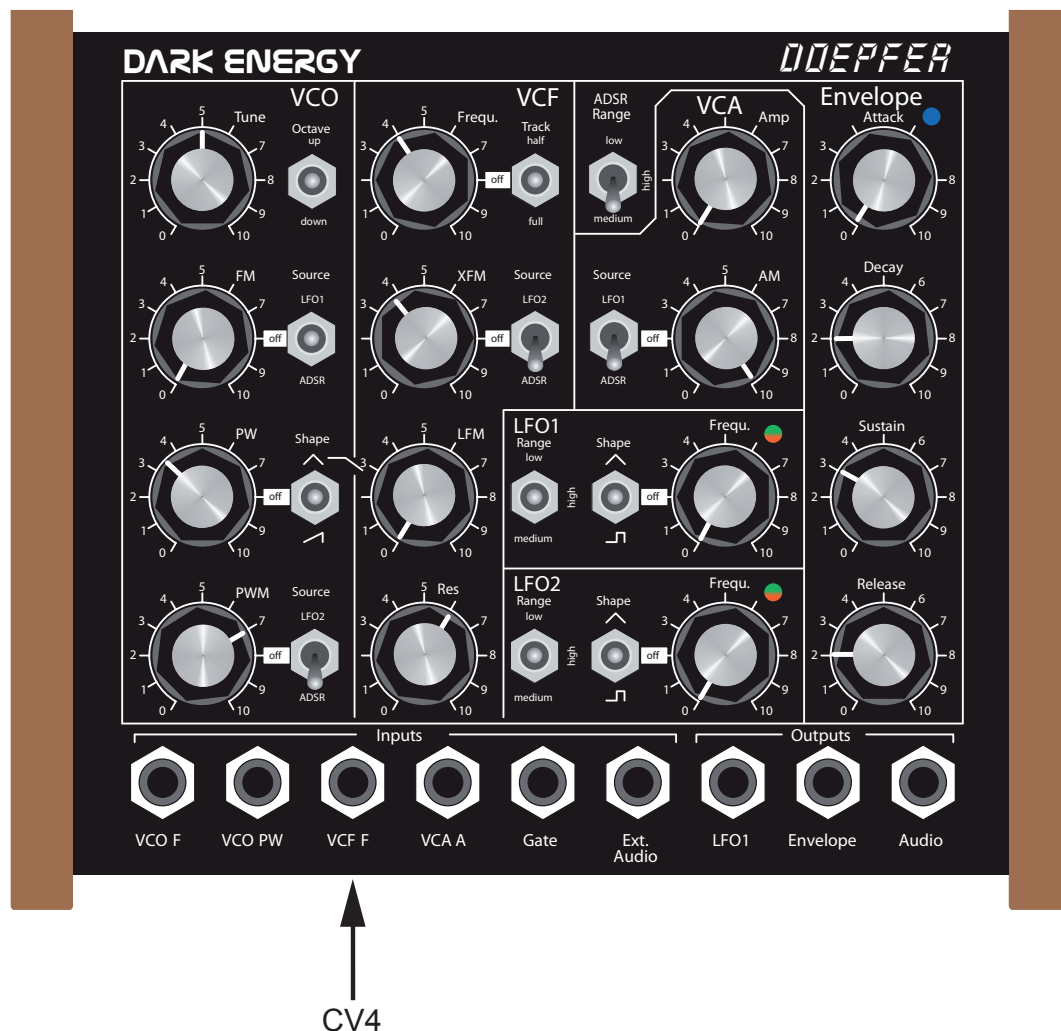
Again, use the modwheel via CV4 socket.

10. Bright Energy

This sound fits perfect to a step sequencer and makes a good job in „modern electronic dance music".

Most effective sound parameters are all filtersettings (Freq., XM and Reso) as well as the decay parameter of the envelope. Careful adjustment of these parameters provides a number of typical sounds. Here, pulswidth of the VCO squarewave is modulated by the envelope. The effect is quite subtil but adds some character to the sound. The AM knob is fully cranked up. This adds some slight saturation to the output signal and makes the sound a bit „phatter".

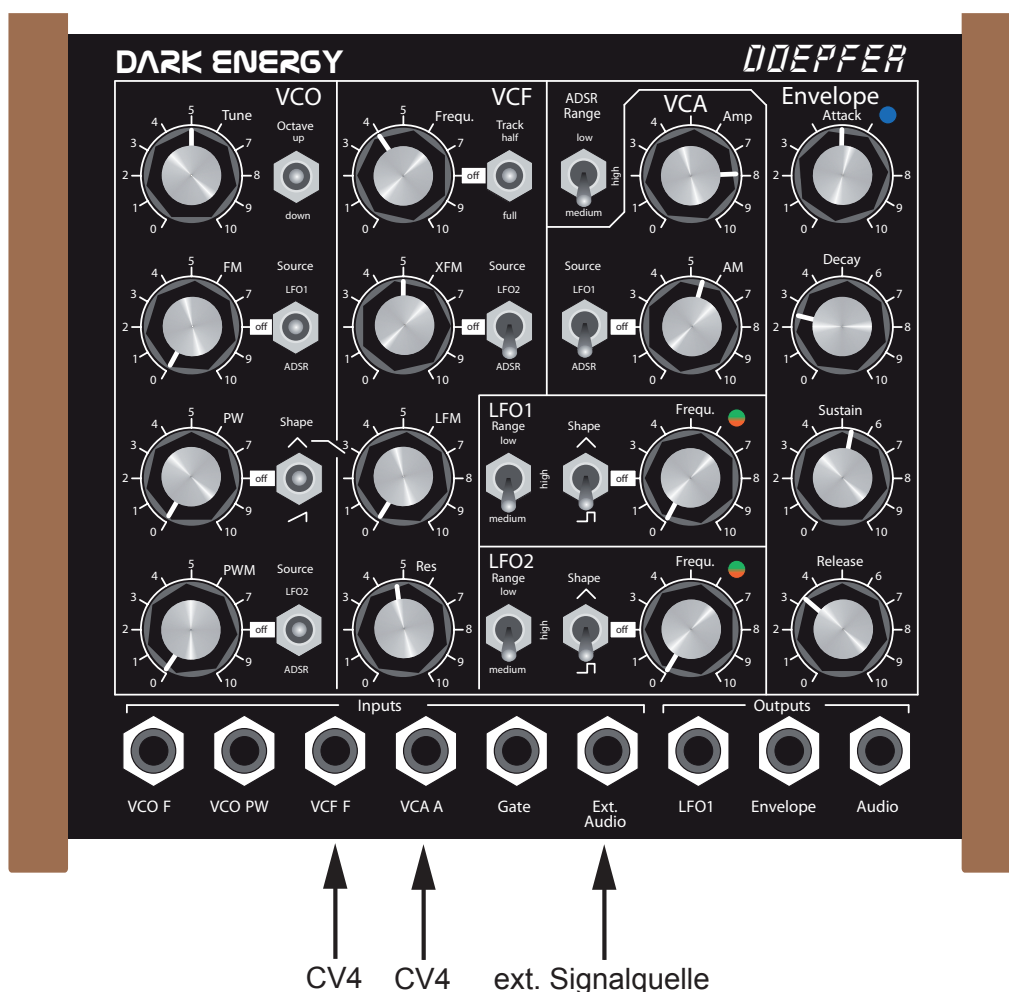Again, use the modwheel via CV4 socket.

CV4

11. Processing external audiosignals

You may use the input socket „external audio" to process audiosignals of other soundsources within Dark Energy.
Connect e.g. a drumcomputer or an output of your soundcard to Dark Energy's external audio input. Start e.g. a drumloop. The signal runs through Dark Energy's filter and is, depending on the Freq.-knob setting, changed in timbre. Since the VCA knob is cranked up, the VCA is open without getting a control voltage from the envelope resp. you do not have to play a note on your keyboard. Use linear frequency modulation of the filter cutoff (LM) to change timbre and add noise to the drumloop.

If you play a note on your keyboard, the envelope opens the VCF and VCA and the loop gets a contour. Loudness can be controlled with the VCA knob. Program notes in your MIDI sequencer „in parallel" to the drumloop or play precise enough on your keyboard to achieve rhythmic effects in sync with the loop. Instead of the envelope, you can also use Dark Energy's LFOs as modulation sources. The squarewaves provide interesting gate-effects, however perfect syncing the effect to the tempo of the external source is not possible. So this works well for non-rhythmical sounds.

Of course you may use an external soundsource together with Dark Energy's internal VCO. A second external VCO (e.g. Doepfer A-117 or A-118 controlled by CV1 of Dark Energy's USB/MIDI-CV interface) or a noise generator (e.g. Doepfer A-183-1) can also be used. These additional modules can easily mounted in e.g. a Doepfer A-100 mini-case.
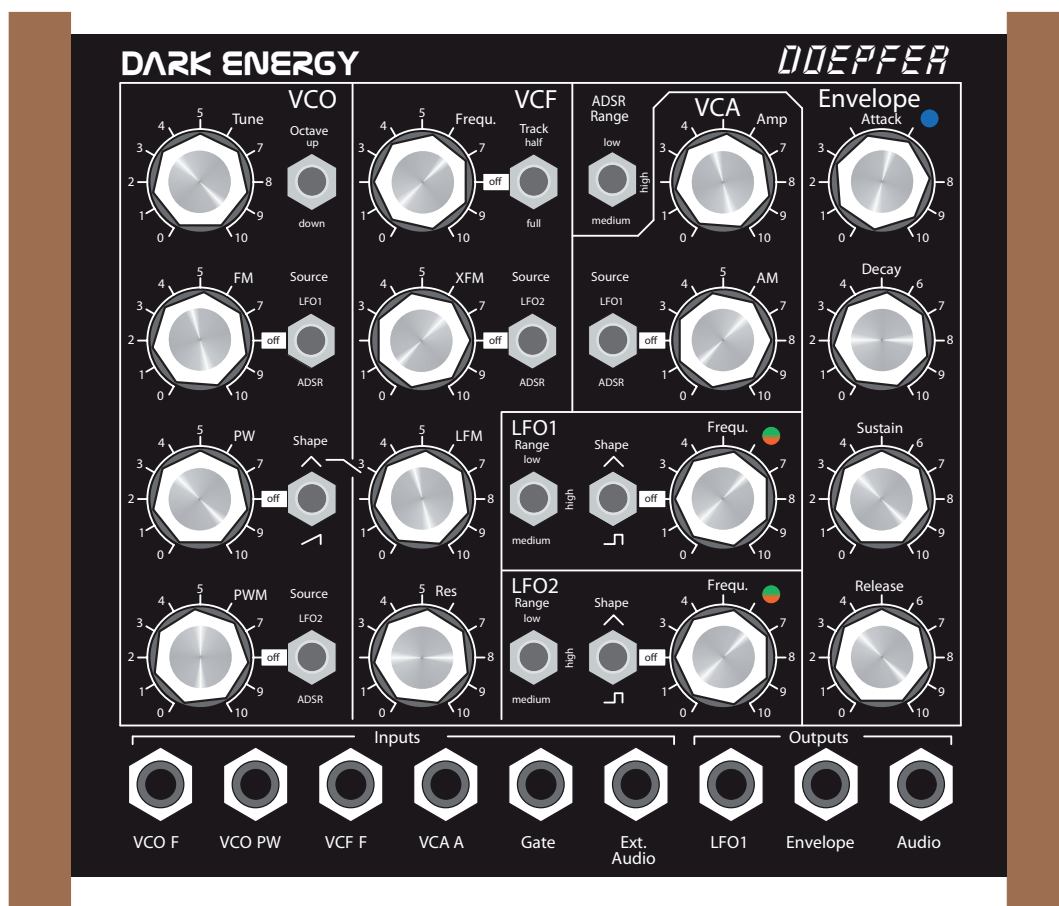
Archieve your own sounds

Congratulations – you did a good job, you read and understood the entire manual, explored all functions of Dark Energy, checked out example sounds and learned a bit about the basics of soundgeneration. Now you are ready to go and explore Dark Energy further. Now you should be able to let your creativity flow freely and to create your own accurate sounds without any problem. Experiment – there's still a lot to explore.

If you found a soundsetting you wish to „save", please use the figure below. Copy this page and draw in the settings of the knobs and switches as well as the patchcords.

Soundname: Category: Note:

6. Appendix

Service and terms of warranty.

Concerning service and warranty conditions, please refer to our terms of business.
You will find our terms of business at:

www.doepfer.de

Doepfer Musikelektronic GmbH
Geigerstr. 13
D-82166 Gräfelfing / Deutschland

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EM 50 082-1: 1992, EN 50 081-1 : 1992, EN60065 : 1995
Please refer to our website „terms of business".

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This device complies to the EU guidelines and is manufactured RoHS conform without the use of led, mercury, cadmium and chrome. Nevertheless this device is special waste and disposal in household waste in forbidden.

For disposal, please contact your dealer or :
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IMPRESSUM

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