XR1-E

Ring Modulation Oscillator

The *XR1-E* is an analog ring modulator with internal oscillator, preamp and LFO in a nice hand-made casing.

Offering a wide variety of control options, it may be used to generate sounds from the typical ring modulation and tremolo-like waveforms to glissando and random-like patterns or distortion.

An integrated low-noise preamp (with much headroom) is allowing to adapt many kinds of input sources such as microphones, e-guitars or electronic instruments.

Optical overview of the oscillator's and preamp's overdrive behaviour provides a bicolor LED.

The frequency is manually adjustable by knobs for coarse and fine tuning and a switch for high or low (tremolo) range. An envelope follower, a LFO and a Sample+Hold may be used for frequency modulation. The envelope CV can be optionally replaced by an external signal or a voltage from a foot pedal, appliable on a jack on the rear. Further, a minijack 1V/oct. input is available for controlling the *XR1-E*'s frequency by an external CV.

The *XR1-E* has a footswitch input on its front to apply an external footswitch (not included) for switching between the effect and the original (true bypass). The output level of the processed signal can be aligned by a knob on the rear.

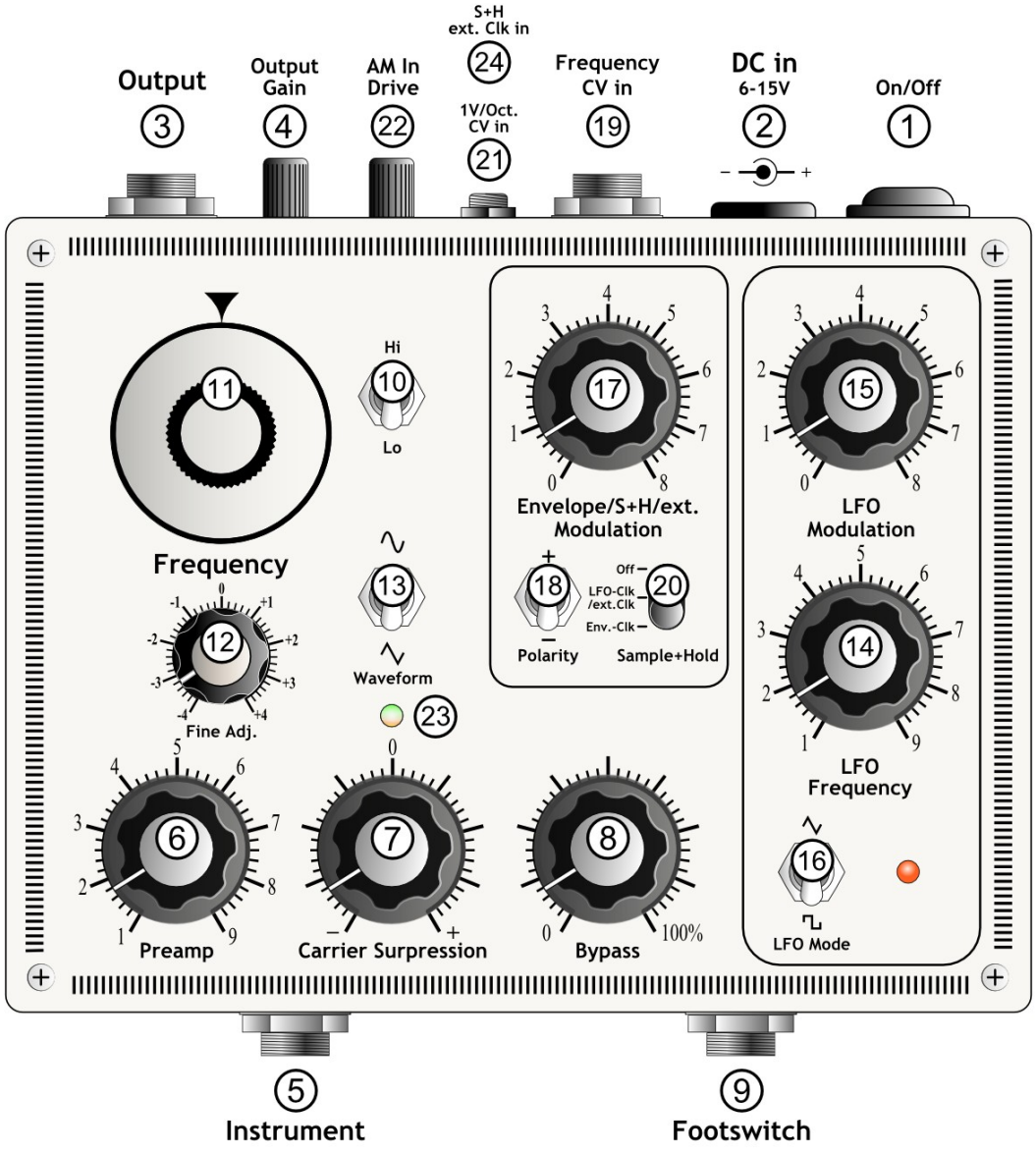
Due to the ability of battery operation the device is independent from external power supply, but there is a socket for a DC adaptor too (DC adaptor not included).

The *XR1-E* is based on a function generator chip, which warm and smooth sound makes it excellently suitable for ring modulation and electronic music.

- Low noise preamp
- Bicolor LED for visual control
- Frequency modulation with envelope follower, LFO and/or Sample+Hold
- 1V/oct minijack input and 2nd input for external frequency control
- Footswitch input – true bypass
- Output gain adjustable
- Battery (6x AA) or with external DC supply (Current @9V ≈155mA)
- Unique handmade casing

Quick start guide

1. Insert batteries or accus (6x AA Mignon) or connect a power adaptor ② (DC 9–16V, +pole: the outer side of the plug). Set the power switch ① upwards to "**On**". Connect an amplifier, mixer etc. to the **Output** ③ and connect an instrument or microphone to the **Instrument** input ⑤.
2. Turn the knobs '**Output Gain**' ④ and '**AM in Drive**' ㉒ on the backside in ≈middle position.
3. Set the frequency selector switch ⑩ on "**Hi**". Turn the **Bypass** pot ⑧ in fully right position : "**100%**" and the envelope and LFO modulation knobs ⑰ and ⑮ in fully left position: "**0**". Move knob '**Carrier Surpression**' ⑦ in middle position = "**0**" on the scale/ denter locked; watch the LED ㉓ for indication).
   Adjust the "**Preamp**" input gain controller ⑥ while playing your instrument and listen for optimal performance. Watch LED ㉓ – it should even not light red.
4. When using an external footswitch for dry/wet control, adjust '**Output Gain**' knob ④ (on the back) for same output amplitude of the effect and the original signal.



Functions

① On/Off Switch

Switches the power supply on or off.
Note: In combination with an external power adaptor only the **XR1-E** will be switched off and *not* the power adaptor itself.

② External Power Supply Input

For operation of the ***XR1-E*** with an external DC power adaptor. The connection is a standard DC plug with 2.1mm diameter hole. The "+"pole is the outer contact, which is almost common for effect pedals etc.. The internal batteries will be switched off when this socket is in use. The input voltage range is 6V-15V. Typical current dissipation at 9V: ≈ 140mA.

③ Output

For connecting the ***XR1-E*** to an amplifier, mixer or another following stage.
The output level is adjustable by the knob '**Output Gain**' ④ on the rear.
Maximum output voltage is ≈ 8Vpp (Knobs ④ and '**AM In Drive**' ㉒ fully turned up)
When using a footswitch applied on ⑨ and the oscillator is shut off (or if the ***XR1-E*** is switched off), the output provides directly the original signal applied on instrument input ⑤ ('*true bypass*' - the signal it is not flowing through any electronic circuit when bypassed)

④ Output Gain

(on the back) controls the final output amplitude provided on **Output** ③ . When using an external footswitch inserted to ⑨ ('**Footswitch**'), this knob allows to align the effect signal to the dry input signal. Further, it may be useful to add some extra amplification if needed.

⑤ Instrument Input

Input jack for instrument or microphone. Max. input voltage without distortion: ≤8Vpp; impedance: ca. 600kΩ.

⑥ Preamp Gain Control

Input level control for the instrument input's ⑤ preamp, which is sourcing the oscillator's amplitude modulation input. The preamp is able to process larger input levels (such as coming from electronic instruments), as well as smaller ones (such as coming from dynamic microphones). The bicolor LED ㉓ signalizes - if lighting red - when the preamp is becoming overdriven. For best signal-to-noise ratio the level should be even below the point when the LED is lighting red. The preamp shows soft clipping behaviour.

⑦ Carrier Surpression Control

For 'standard' operation, this knob is in its middle position (denter locked, '**0**' on scale). When turning it cw or ccw, the oscillator's tone will appear. This may be used for special sound effects; furthermore when using a very low frequency input signal (such as e.g. pulse patterns), the adjusting may influence the sound behaviour.

Note: There will always remain a little bit of the oscillator sound (2nd harmonics etc.). For best performance, make sure that the input signal level is high.

⑧ Bypass

This 'dry/wet' control knob is changing the ratio between input signal (preamplified) and the ring modulated effect signal. Turning the knob fully left will provide only the preamplified input signal; by turning the knob clockwise the effect will be mixed with original. Fully right position = "**100%**": the pure ring modulation effect signal.

⑨ Footswitch Input

An external 2pole footswitch (not included) can be applied.

- Switch closed: The dry original input signal (*true bypass*)
- Switch opened: The effect signal (also depending on postion of the "**Bypass**" control knob ⑧)

The switching is also controllable by an external logic signal (0V = effect , +5V = dry), e.g. a gate signal from a synthesizer.
To align the output amplitudes of the dry and wet signal, adjust the output signal with **'Output Gain'** knob ④ (on the back) .

⑩ Oscillator Frequency High/Low Switch

Hi: ≈ 15Hz – 20000 Hz (Audio range)
Lo: ≈ 0,3Hz – 400 Hz (Tremolo/Bass)
(without modulation and/or CV)
In "**Hi**" position, the oscillator is mainly working in audio range. The amplitude modulation will generate additional audio frequencies – sum and difference tones of the input signal and the oscillator frequency.
In "**Lo**" position, the oscillator is working with subaudio and bass frequencies. The amplitude modulation result is a tremolo-like sound. Volume of the input signal will change constantly with the oscillator frequency.

⑪ Oscillator Frequency Control

Coarse adjustment of the amplitude modulation (AM) oscillator frequency.

⑫ Oscillator Frequency Fine Adjustment Control

Fine tuning of the oscillation frequency. Range is about 4 – 5 semitones (quarte).

⑬ Oscillator Waveform Switch

The ring modulator oscillator waveform can be selected between sinewave and triangle. In " ∿" (sine) position, the effect is a more smooth sound with less overtones; in "∧ " (triangle) mode the generated sounds are rougher and with more overtones. Knob 'AM In Drive' ㉒ (on the rear) also affects the behaviour of these modulations.

⑭ LFO Frequency Control

Speed control of the internal LFO (low frequency oscillator) for frequency modulation of the ring modulation oscillator. Frequency is from ≈0.06Hz (left position) to ≈ 44Hz (right position)

The LFO frequency is also displayed by the orange LED for visual control.

⑮ LFO Modulation Depth Control

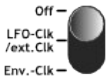
Adjusts the LFO's frequency modulation depth.

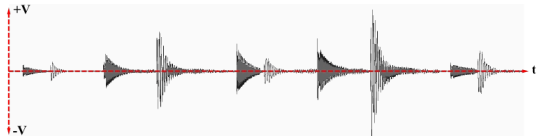
⑯ LFO Waveform Switch

The LFO waveform is selectable between triangle ("⩘") and squarewave ("⊓⊔"). "⩘" provides a continously up-and down gliding pitch, while " ⊓⊔ " makes the oscillator shifting between two tones.

⑰ Envelope Follower / Sample+Hold / ext. CV Modulation Depth Control

The internal envelope follower converts the volume level of the audio signal on the instrument input ⑤ into a control voltage, which can be used for modulating the oscillator frequency.

<table>
<tr><td rowspan="2"> 

Switch S+H' ⑳ in upper position</td><td>The preamplified audio signal</td><td> 
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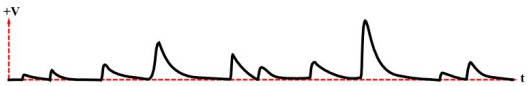
<tr><td>The generated envelope signal for frequency modulation</td><td> 
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With switch '**S+H**' ⑳ in upper position, the amount of the envelope modulation is adjustable by this knob (Or alternatively, the amount of Sample+Hold modulation can be adjusted, depending on the position of switch '**S+H**'; please read the referring point ⑳).
If the external frequency CV (= Control Voltage) input ⑲ is used, the internal envelope follower will be switched off and replaced by the signal applied on ⑲ - e.g. from a pedal (or the respective S+H modulation).

⑱ Envelope Follower/Sample+Hold /ext. CV Modulation Inversion Switch

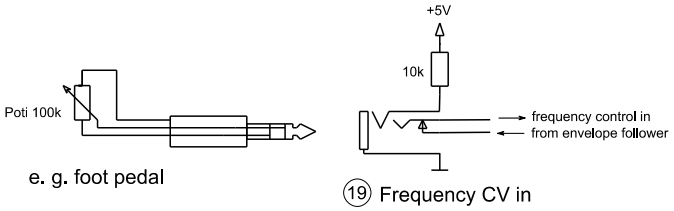
Switches the modulation polarity (from the envelope follower, Sample+Hold or an external source on ⑲) from positive to negative. If the switch is in upper position, the pitch of the AM oscillator will increase with higher voltage of the modulation signal. With the switch in lower position 'Inv' (="**Inversion**") the pitch will decrease with higher input voltage. The inversion switch works also for a control voltage signal connected to ⑲.

⑲ External Frequency Control Input

Allows to control the oscillator pitch by an external control voltage (CV) or an external resistor. By connecting a jack to this input, the internal envelope follower/S+H will be shut off and instead the applied control voltage will modulate the oscillator's frequency (with switch 'S+H' in upper position); the modulation depth can be adjusted by knob ⑰; the modulation CV's polarity can be inverted by switch ⑱.

Further, a +5V DC voltage (via 10kΩ resistor) is provided on ⑲, available on the middle connector of a 3pole jack plugged in ⑲. Thus may be useful, for example, in combination with a sensor or a pedal. In the latter case, a common passive foot pedal (e.g. the Moog ‚EP-3') with 3pole jack should work.

When using the Sample+Hold (switch **'S+H'** ⑳ in **middle** or **lower** position), the external signal will replace the envelope follower's voltage for the Sample+Hold's analog input (please read the referring point ⑳).



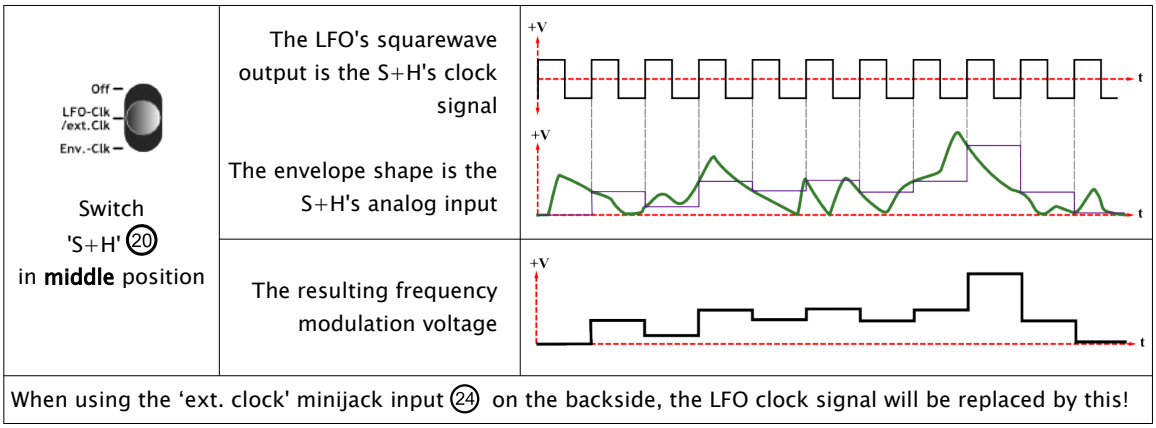
⑳ S+H Sample+Hold switch

Alternatively to the modulation with the envelope shape (with switch in upper position **'off'**; see ⑰), a Sample+Hold circuit can be activated for frequency modulation (switch in middle or lower position).

A Sample+Hold has two inputs, an analog voltage input and a clock input, and an output providing the generated Sample+Hold voltage. Each time when the clock signal is activating the S+H, the S+H is reading the momentary voltage from its analog input and holds it until the next clock impulse is coming. The results are staircase- or glissando-like sound patterns, if the S+H is used for frequency modulation. The XR1-E's Sample+Hold is using the internal LFO and the envelope follower (with a threshold function) for sourcing the S+H inputs. The switch 'S+H' determines if the S+H is active, and whether the LFO is providing the clock signal and the envelope shape is the analog input of the S+H, or vice versa; alternatively an external clock signal may be used which will replace the LFO-Clock (from Rev.5.4).

- *Upper position* **Off**: The S+H function is switched off, for envelope modulation.
- *Middle position* **LFO-Clk**: The squarewave signal of the LFO (or an external clock signal applied on 'S+H Clk in' ㉔; *from Rev.5.4*) is the clock of the S+H and the envelope shape is its analog input.
- *Lower position* **Env.-Clk**: The envelope shape converted to a trigger signal (from a certain level of the envelope shape) is the S+H's clock and the trianglewave of the LFO is going to its analog input.

When using the external frequency control input ⑲, the envelope follower's signal will be replaced by the the applied input signal.



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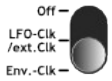
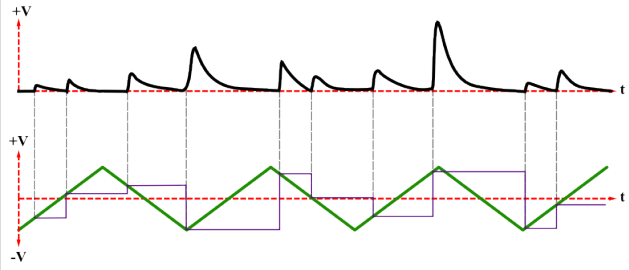
<td rowspan="2"> 

Switch
'S+H' ⑳
in lower position</td>
<td>The envelope follower
(from a certain threshold)
is triggering the S+H

The LFO's triangle output
is the S+H's analog input</td>
<td> 
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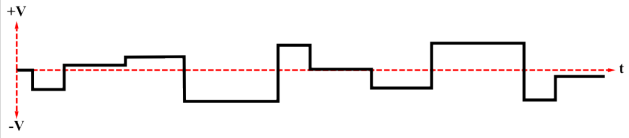
<tr>
<td>The resulting frequency
modulation voltage</td>
<td> 
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㉑ 1V/Octave minijack input

If intended, the oscillator's frequency can be controlled by an external control voltage, for example from a modular synthesizer, with 1V/octave calibration. There is a trimmer above this socket (behind the hole in the casing) for adjustment [1] . The oscillator's 1V/oct. behaviour is not very linear over its whole range, best results will be achieved with the frequency knob ⑪ set to ≈ 2–5 on its scale.

㉒ AM In Drive knob

Together with the preamp knob, the preamplification for the oscillator's amplitude modulation input can be adjusted. This 2nd controller is allowing to overdrive the oscillator's amplitude modulation input and enhances the sound possibilities, especially in combination with wavefrom switch '∿ / ⩘' ⑬.

㉓ Bicolor LED 'AM'

The green lightning signalizes normal and no overdriven operation. Red lightning indicates that the *preamp* is becoming overdriven, this may result in distortion.
Yellow or orange colors signalize when the *oscillator*'s amplitude modulation input comes into saturation and starts to overdrive – regarding to knob 'AM In Drive' ㉒.

㉔ External S+H Clock minijack input *(new from Rev.5.4)*

Instead of the LFO-clock – with switch **S+H** ⑳ in middle position – an external clock signal (squarewave or pulse) can be applied here and may be used for triggering the Sample+Hold. The rising edges of this clock signal will change the S+H's CV state. Analog CV input for the S+H is the envelope signal or an external CV applied on the socket '**Frequency CV in**' ⑲ .

[1] 1V/Octave calibration trimmer

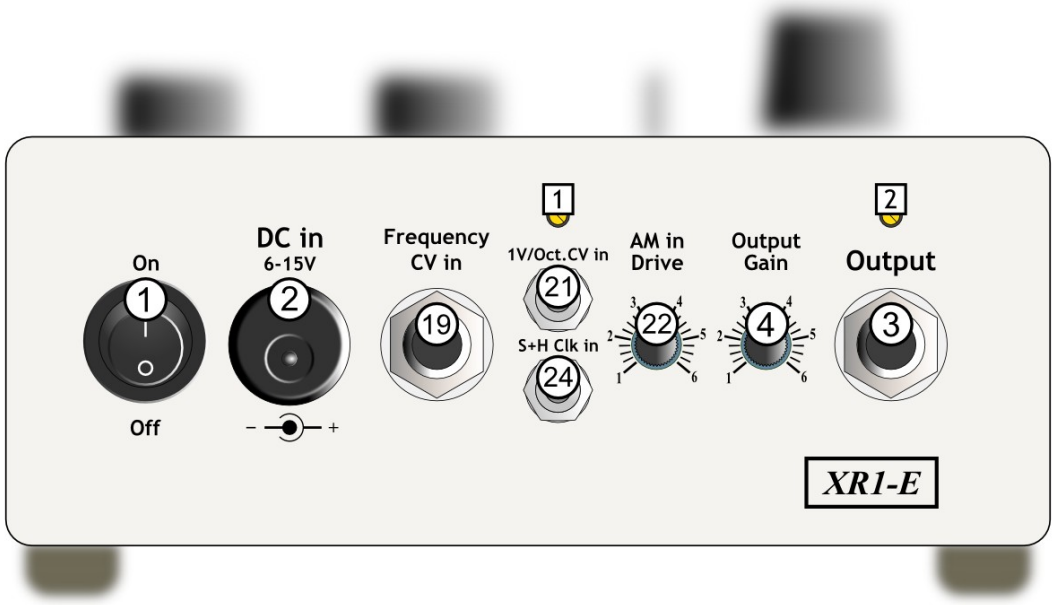
If required, the 1V/octave matching of minijack input ㉑ (on the backside) can be calibrated by the trimmer behind the hole (use a tiny screwdriver).
Calibration suggestion (after a warming-up of ca 5-10mins)*:*
Connect a CV source both to a tuned reference oscillator and to the XR1-E's 1V/oct. input ㉑.

1. Generate a tone of ca 800-1000Hz by the tuned oscillator with e.g. a 1V/oct-keyboard and compare it with the simultaniously sounding ***XR1-E*** (knob '**Carrier Surpression**' ⑦ fully cw or ccw; frequency switch ⑩ : '**hi**'; Setting on knob '**Frequency**' ⑪ scale: ≈ 4-5). Calibrate the XR1-E's or the other oscillator's pitch until they are in tune together.
2. Play a note or tune the CV source 2-3 octaves higher. If both tones are not exactly matching, adjust this trimmer they are in pitch.
3. Repeat procedure from step 1, until best matching is achieved.

[2] Carrier Surpression knob 0-adjustment trimmer

Calibrates the 0-point of the knob '**Carrier Surpression**' ⑦. With the knob in center position (denter locked) and no input applied, the carrier oscillator signal should be as small as possible. If required, the 0-point can be readjusted by this trimmer (after a warmng-up of 5-10min).

Back Side View



About Ring Modulation

'Ring modulation' and 'amplitude modulation' are different expressions for almost the same operation, the ***multiplication*** of two signals. The audio result is both identical.
The difference between the 2 expressions is: 'Amplitude modulation' describes the multiplication of *any* kind of analog signals, therefore such as control (DC) voltages; while 'ring modulation' is a term for the special case of multiplication of two audio signals (AC) with each other.
Each value of a carrier signal, *C*, is multiplied by a modulator signal, *M*, to create a new *ring-modulated* signal, *R*:

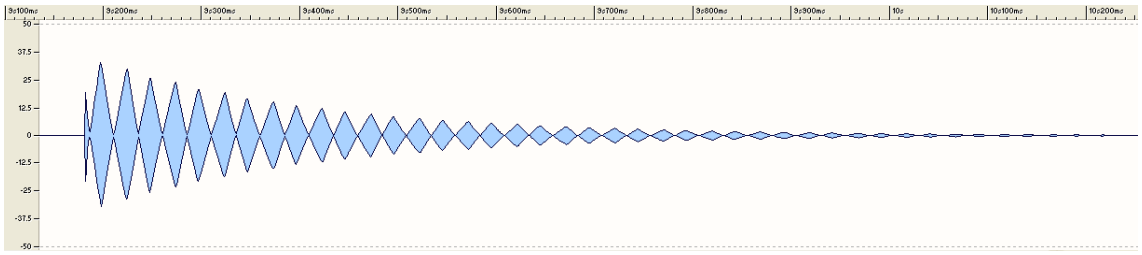
$$R(t) = C(t) \times M(t)$$

(Wikipedia)

Due to the ***XR1-E ,*** the internal oscillator tone ∿ *or* ⩙ is multiplied with the audio input.

Examples

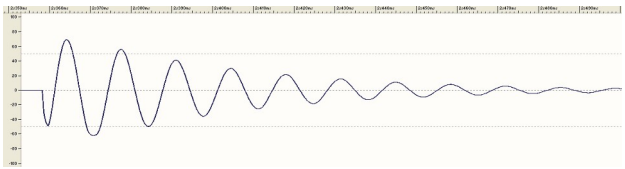
Input (=modulator) signal frequency >> oscillator (carrier) frequency (⩙):



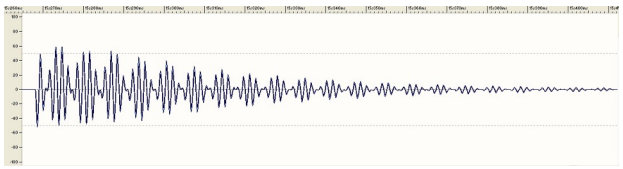
Input signal: metallophone

The volume of the metallophone sound varies with the oscillator amplitude (tremolo).

Input (=modulator) signal frequency << oscillator (carrier) frequency (⩙)



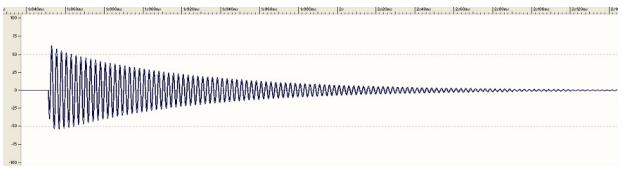
Input signal: "Base drum" from rhythm machine



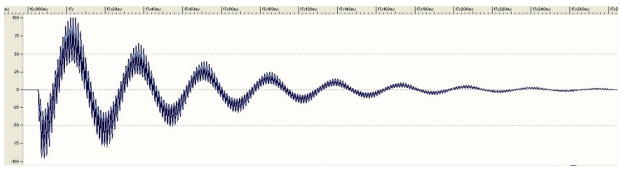
The generated effect signal

The volume of the oscillator sound varies with the amplitude of the input signal

Input (=modulator) signal frequency ≤ or ≥ oscillator (carrier) frequency (⩙)



Input signal: "Mid tom" from rhythm machine



Complexe sound structures are generated, depending on the oscillator frequency.

Contact

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www.cg-products.de
XR1-E : website with video and soundfiles: http://www.cg-products.de/xr1-e/

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