XR22 VCO FT

VCO with AM Input and FSK (Frequency Shift Keying)

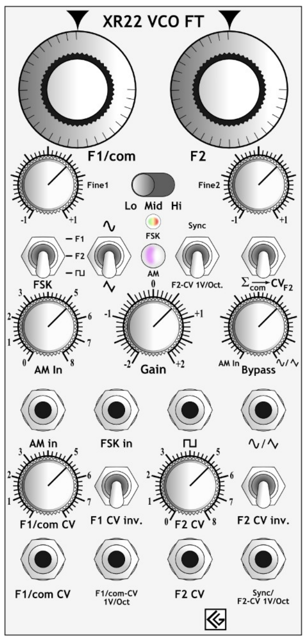
I. Features

- **AM (Amplitude Modulation) Input**
  - Ring modulation
  - CV controllable sine/triangle volume level
  - Advanced waveform generation by AM
  - RGB-LED for optical control
- **FSK (Frequency Shift Keying)**
  - Pulse and ramp generation
  - Switching between two different frequency CVs
  - Advanced waveform generation by FSK
  - Dual-color LED for FSK-mode indication
- **LFO/Bass/High Frequency Mode**
- **Switchable Sync-Mode**

- Eurorack Module
- Width: 12 HP
- Dimensions: 128,5 x 60,6 mm
  Depth: 40mm
- Supply Voltage: ±12V
- Current: +12V:<103mA; -12V:≈42mA
- Available with banana or 3,5mm minijack sockets

Minijack Version

Banana Version



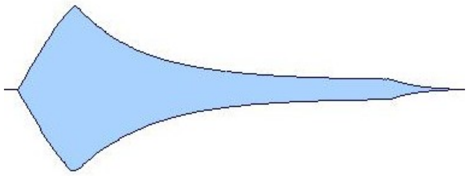
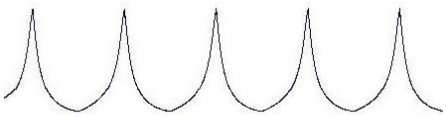
Drawing

2. AM and FSK

2.1 AM (Amplitude Modulation)

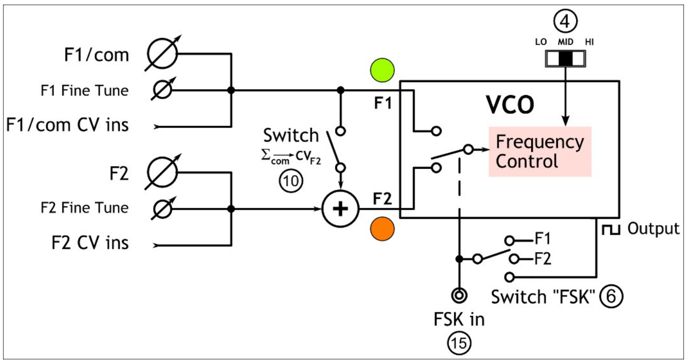
The ∿ / ∿ output (⑰) amplitude varies linearly (≙multiplication) with the internal DC voltage set by knob 'Gain' ⑫ or by a control voltage applied to "**AM in**" (⑭). The modulation amount of this input can be adjusted with knob 'AM In' ⑪ (See chapter *3.Functions*). Negative CVs will cause phase inversion of the ∿ / ∿ waveform. The behaviour is optically indicated by the rgb-LED '**AM**' ⑨ .

Examples:

 Ring modulation with external triangle signal	 VCO volume control with external envelope generator	 **AM in** ⑭ patched with ∿ / ∿ output ⑰ (Feedback)

2.2 FSK (Frequency Shift Keying)

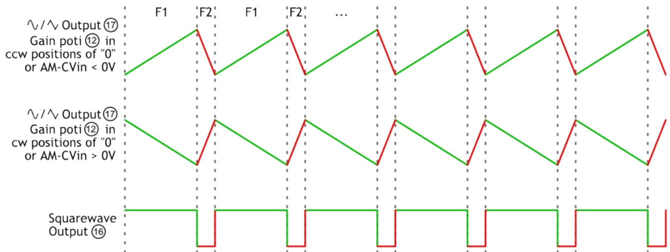
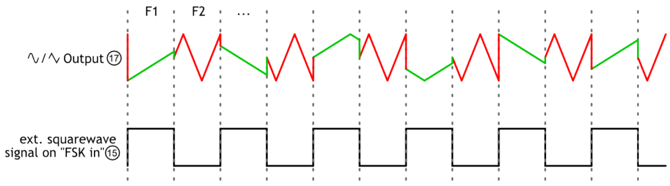
The frequency of the XR22 VCO is controllable by two independent frequency control sections *F1* and *F2* with independent manual frequency controls and CVins; either one or the other of these routes can be activated by an external logic signal applied on socket "**FSKin**" ⑮ and/or by switch "**FSK**" ⑥ .

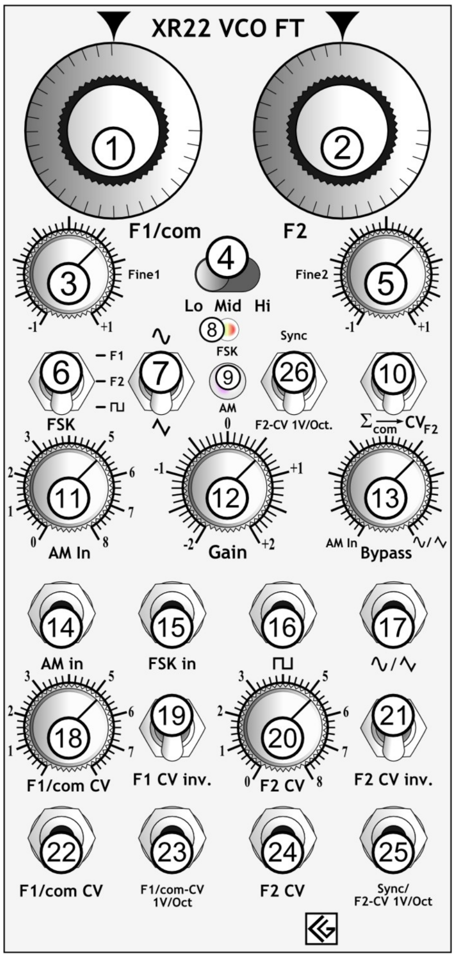


Switch "**FSK**" ⑥ selects the FSK mode: F1, F2 or self-switching by the VCO's ⊓⊔ -output. In this self-keying mode, the rising and falling edges of the triangle waveform (and the hi/lo times of the squarewave) can be separately and independently controlled.

Switch "$\Sigma_{com}\rightarrow CV_{F2}$" ⑩ is adding the F1-CVs to F2; this will ensure 1V/oct. tracking if both routes are used simultaneously (for example in the self-switching ⊓⊔ -mode).

Examples:

F1 activated. LED= ● green (Switch "**FSK**" ⑥ up) 	**F2** activated. LED= ● red (Switch "**FSK**" ⑥ mid) 
⊓⊔ - Mode (**F1**+**F2** activated) (Switch "**FSK**" ⑥ low). The oscillator is frequency-shifting itself.  **F1** and **F2** (≙ falling and rising edges of the triangle waveform) can be separately adjusted.	With external FSK control signal applied on "**FSK in**" ⑮ (Switch "**FSK**" ⑥ middle position).  The oscillator switches between **F1** and **F2**, depending on the logic control signal applied to **FSK in** ⑥ .



3.

Introduction

For better understanding, please read first about the switch **'FSK'** ⑥ *and LED* **'FSK'** ⑧ *:*

⑥ **FSK mode switch** (frequency shift keying)
In upper position: Only **F1** is active; LED **'FSK'** ⑧= ● green
In middle position: Only **F2** is active, LED **'FSK'** ⑧= ● red
In lower position ("⊓⊔") the squarewave output of the VCO is internally connected to the FSK input and the oscillator automatically shifts between frequencies **F1** and **F2.** In this mode, the oscillator produces ramp and pulse signals, provided on output ∿/∿ ⑰ (ramp) and ⊓⊔ ⑯ (pulse). The rising and falling time of the ramp edges (and also the duration of high and low levels on ⑯) are separatly adjustable with the frequency knobs for F1 and F2 (and CVin's1 and CVin's2).
(Also see chapter 2.2 about FSK and ⑩)

⑧ **LED FSK mode**
● Green = F1, F1 CV ins (left half on the module panel).
● Red = F2, F2 CV ins (right half on module panel).

Functions

① **F1/com** Coarse manual control of frequency **F1**. Range is ≈ 8 octaves. If switch "$\Sigma_{com} \rightarrow CV_{F2}$" ⑩ is in lower position, this knob also affects frequency **F2**. See more under ⑩, ⑥.

② **F2** Coarse manual control of frequency **F2**. Range is ≈ 8 octaves.

③ **F1 fine tuning** for frequency **F1**. Range is ≈ two half notes.

④ **Frequency range selector** The oscillator has 3 switchable main frequency ranges with each 4 octaves distance between the switch positions:
1. Lo (switch in left position) for LFO applications and/or tremolo-like ringmodulated sounds
2. Mid (switch in middle position) for bass or sub-bass sounds
3. Hi (switch in right position) for mid-range and high audio frequencies
Because the frequency CV-ins of the internal VCO chip are not linear over the entire audio range, it is recommended to use the **'Mid'** position for bass sounds and the **'Hi'** mode for higher frequencies (although it is possible to produce low frequencies in the **'Hi'** mode too). This ensures better 1V/oct. tracking in the lower frequency regions.

⑤ **F2 fine tuning** for frequency **F2**. Range is ≈ two semi notes.

⑥ **FSK mode switch** *see above ("Introduction")*

⑦ ∿/⋀ **Waveform selector** switches between ∿ (sinewave) or ⋀ (triangle) oscillator waveform on output socket ⑰ .

⑧ **FSK mode LED**: *see above ("Introduction")*

⑨ **LED 'AM'** for optical control of the amplitude modulation on output socket ∿ / ⋀ ⑰ :
- **blue**: negative voltages on the oscillator's output
- **red**: positive voltages on the oscillator's output
- **green**: AM input voltage amount on "**AM in**" ⑭; both for negative and positive voltages

In 'normal' audio-range oscillations (with poti "**Bypass**" ⑬ turned cw) the color will become purple-like as a mixture of red and blue; while the knob "**Bypass**" ⑬ is turned ccw (and a signal is applied on '**AM In**' ⑭) it will change into white and green, indicating the original signal proportion (from AM input) on output ∿ / ⋀ ⑰ .

⑩ $\Sigma_{com} \rightarrow CV_{F2}$ **switch** changes the routing between the frequencies F1 and F2. In the upper position, both frequencies F1 and F2 work independently and will be controlled separately by their respective frequency knobs and/or CV inputs.
In the lower position, knob "**F1/com**" ① and sockets "**F1/com CV**" ㉒ "**F1/com CV 1V/Oct**" ㉓ affect both F1 and F2. This coupling ensures that the ratio between F1 und F2 remains the same, and tracks 1V/oct. using both frequencies within the FSK option. The ratio can only be changed by the "**F2**" knob ② or the **F2 CV** inputs ㉔, ㉕.
Note that in this mode the frequency range is expanded and that for F2 four independent CV inputs are now available.

⑪ **AM in level** Input level control for the signal applied on socket '**AM In**' ⑭ for amplitude modulation of the sinewave/triangle , provided on output ∿ / ⋀ ⑰.
Note: This voltage is added to the DC voltage set by knob 'Gain' ⑫ .

⑫ **Gain adjustment** regulates a internal DC voltage for level control of the ∿ / ⋀ oscillator signal:
In middle position, the oscillator signal is almost surpressed and can be used for ring modulation or oscillator volume level control by a signal applied on '**AM In**' ⑭; the denter in middle position "0" may be used as orientation.
This knob regulates an internal DC offset voltage of ca ±2,5V (added to the AM-input signal, which level is adjustable by knob ⑪); - a positive in clockwise and a negative voltage in ccw positions. In ccw positions the ∿ / ⋀ - phase is becoming inverted (See also "Examples" in chapter 2.2 "FSK").
In some applications the "Gain" knob may be used to alter the waveshape (by adding more or less voltage to your input signal); e.g. if you feedback the ∿ / ⋀ output ⑰ to the AM-Input ⑭ and adjust ⑪ and ⑫ carefully)

⑬ **Bypass** Ratio between the signal input "**AM in**" ⑭ and the oscillator ∿ / ⋀ output. The mixed signal output socket is ∿ / ⋀ ⑰. For optical control the rgb-LED **'AM'** ⑨ is showing the mixed signal behaviour: ● green for the AM input amount (with knob "**Bypass**" ⑬ turned ccw) and ●/● red/blue for the oscillator's output signal ("**Bypass**" ⑬ turned cw)

⑭ **AM input** Amplitude modulation input for the ∿ / ⋀ section of the VCO. The input level can be adjusted with knob ⑪ . The input signal proportion can be mixed to the waveform output with **Bypass** control ⑬, provided on output ∿ / ⋀ ⑰ (also see chapter 2.1 about amplitude modulation). The input signal (both negative and positive polarites) , when it is becoming active at the ∿ / ⋀ output ⑰ (with knob "**Bypass**" ⑬ turned ccw), is visually indicated by the ● green colour of the rgb-LED **'AM'** ⑨.

⑮ **FSK in** is a logic input. When the "**FSK**" ⑥ switch is in the middle position ("F2") and a voltage greater than ≈+2V is applied to the FSK input (e.g. gate signal, squarewave), the internal switch will be switched from **F2** to **F1** (F2/ F2 CV (Led **'FSK'** ⑧ → ● red) to F1/F1 CV (Led **'FSK'** ⑧ → ● green) .
Note: If switch "Com" ⑧ is active, the "F1/com" knob ① and the inputs "F1/comCV" ㉒ and "F1/comCV 1V/Oct" ㉓ affect both frequency channels F1 *and* F2.

⑯ ⊓⊔ **Squarewave output** Level between ≈ 0V (GND) and +5V. In FSK mode "⊓⊔" (Switch "**FSK**" ⑥ lower position): *pulse waveform* output.
Note: In F1 mode (● Green) the LED **'FSK'** ⑧ is indicating the *peaks* (+5V) of the squarewave or pulse signal, while in F2 mode the LED (● Red) is indicating the *gaps* (0V).

⑰ ∿ / ⋀ **(sine/triangle) output** or *ramp waveforms* output when switch "FSK mode" ⑥ is in lowest position ("⊓⊔").
The controller "**Bypass**" ⑬ adjusts the AM-Input ↔ ∿ / ⋀-oscillator output ratio. Fully clockwise: The ∿ / ⋀-oscillator output is 100%. Fully counterclockwise: The ∿ / ⋀-oscillator output is 0%, AM-input (⑭) is 100%. Thus, the original to the "effect" signal can be mixed (≙ "dry/wet") when the oscillator is used as a ringmodulator, or for modulation options when it is used as a CV-source.
The output voltage range of the ∿ / ⋀-oscillator is adjustable with trimmer $\boxed{5}$ on the backside pcb (See chapter *4.Adjustment*). The rgb-LED **'AM'** ⑨ is for optical control of this output.

⑱ **F1/com CV** Manual control adjusts the input level of **F1/com CV in** ㉒ **.**

⑲ **F1/com CV inversion switch** Inverts the polarity of the signal on socket **F1/com CV in** ㉒ **.**

⑳ **F2 CV** Manual control adjusts the input level of **F2 CV in** ㉔ **.**

㉑ **F2 CV inversion switch** Inverts the polarity of the signal on socket **F2 CV in** ㉔ **.**

㉒ **F1/com CV in** Frequency control voltage input for **F1/com.** Level can be adjusted by knob ⑱ and the polarity inverted with switch ⑲ . See also ⑩, ⑥.

㉓ **F1/com CV 1V/Oct in** 1V/Octave input for **F1/com.** See also ⑧, ⑥. (1V/oct. adjustment, if necessary, see chapter ***4.Adjustment***)

㉔ **F2 CV in** Frequency control voltage input for **F2**. Level can be adjusted by ⑳ and the CV polarity inverted by switch ㉑ .

㉕ **Sync in ↕ F2 1V/Oct in** (‘***Sync mode***‘ *new from Rev.6*) The functionality of this socket can *either* be a logic input for resetting the oscillator (**Sync mode**) *or* be a1V/octave input for **F2**, depending on the state of switch ㉖ **.**

•In upper position of switch ㉖ ‘**Sync**’, a positive-going trigger signal will reset the oscillator- wave and restart it.

- ▸ The ∿ / ∿ – wave will restart from its maximum deflection point (positive edge with knob ‘**Gain**’ in cw position or positive AM CV; negative edge with knob ‘**Gain**’ ccw or negative AM CV)
- ▸ The squarewave (⊓⊔**)** will restart the oscillation on the positive edge (+5V).

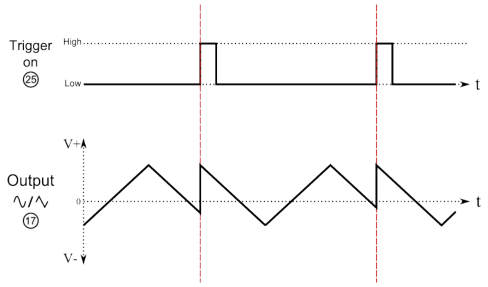
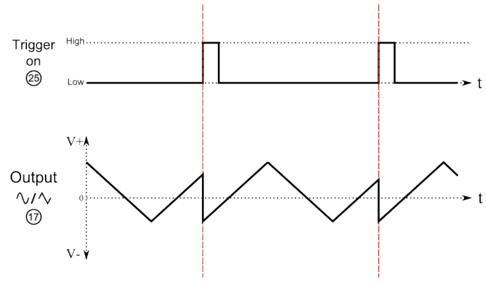
• In lower position of switch ㉖ ‘**F2-CV 1V/Oct.**’, the plug is working as a 1V/octave input for F2 (as known from previous versions of the XR22VCOFT)

㉖ **Switch Sync ↕ F2-CV 1V/Oct.** *(new from Rev.6)* This switch determines the function of socket ㉕ :

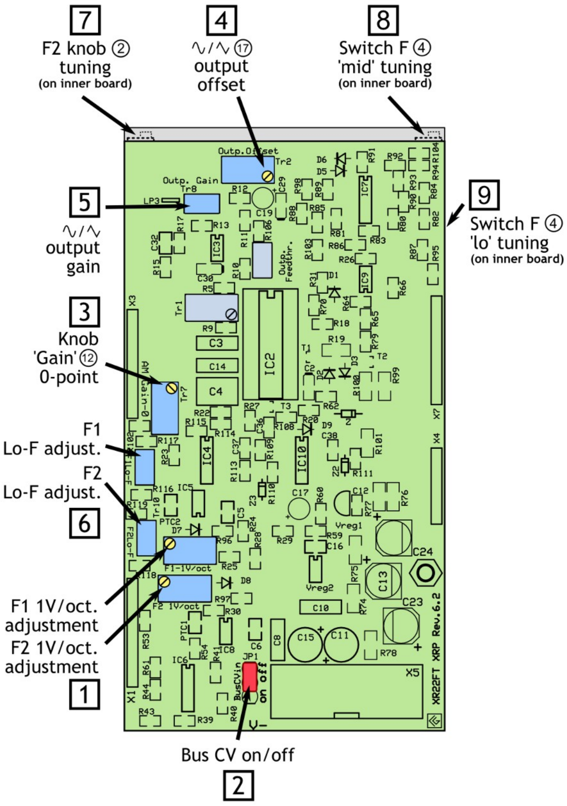
- Switch in upper position: ***Sync Mode***
  A positive-going trigger on socket ㉕ will reset the oscillator (Read also under point ㉕).
- Switch in lower position: ***F2 CV 1V/Oct. Mode***
  The socket ㉕ is working as a 1V/Octave CV input for **F2** (as previous).

Sync Mode *(from Rev.6)*

With switch ㉖ in upper direction ‘**Sync**’; socket ㉕ will become a logic signal input (for trigger/ gate/ squarewave or similar). A positive going edge from 0V→+5V (min.) is resetting the oscillator:

	
With knob ‘**Gain**’ ⑫ in *cw* position or a positive AM CV , the oscillation will restart at its *positive* peak.	With knob ‘**Gain**’ ⑫ in *ccw* position or a negative AM CV , the oscillation will restart at its *negative* peak.

4. Adjustment



The XR22 VCO FT is already carefully adjusted, no further calibrations should be needed; for better understanding or in the case of unintended detuning, here is an overview of the adjustment control elements:

$\boxed{1}$ and $\boxed{6}$: 1V/Octave Adjustment

The VCO is already carefully adjusted to 1V/Oct. If you realize that the **XR22 VCO FT** isn't in tune with your other analog synthesizer equipment, it may be necessary to adjust it.

Procedure (Suggestion):

1. Put range switch ④ in right position **'Hi'**. Adjust F1 & F2 knobs ① & ② to ≈ 4,2 on scale or ≈1000Hz (this is corresponding to 0 volts CV internally)
2. Connect a CV from a keyboard (or a similar CV source) both to your favorite VCO's 1V/oct. input and to the **XR22 VCO** F1/com 1V/oct. input ㉓ . Put switch "$\Sigma_{com}\to CV_{F2}$" ⑩ in lower (F1-F2 common mode) and switch "FSK" ⑥ in upper position ("F1").
3. Play a note on your keyboard in the middle range, e.g. "c", or "c1". The note should be nearby to the tone you have adjusted on the **XR22 VCO**.
4. Adjust poti "F1" ① and fine tuning ③ or adjust the frequency of the reference VCO, until the pitch of both oscillators is the same.
5. Play a note ≈ 3 octaves higher (≙8000Hz). Adjust trimmer "F1 1V/oct" $\boxed{1}$ until the XR22 VCO is tracking to the 2nd VCO.
6. Go back to step "**4**" and repeat the next steps until both oscillators are in tune.
7. Calibrate XR22 VCO and the reference oscillator again to a tone around 1000Hz (≈4,2 on scale).
8. Play a note 3 octaves lower (if this is not possible, turn the knob F1 ① to a lower frequency and play a 3 octave higher note on your keyboard, so that it will be almost the same tone like it would be without keyboard and with the frequency knob in 4,2-scale position or ≈1000Hz).
9. Calibrate the trimmer $\boxed{6}$ (Lo-F adj.) until the 3-octave lower notes are in tune (e.g. starting from 1000Hz, 3 octaves lower will be 125Hz).
10. Repeat from step 7 and/or optionally from step 4 until best matching is achieved.
11. Repeat the same procedure with "**F2**" (with switch "FSK" ⑥ in middle position and the respective knobs and trimmers) – *Note:* With switch "$\Sigma_{com}\to CV_{F2}$" ⑩ in lower position the F1 knob ① and the 1V/oct CV input ㉓ are both working for F1 and F2.
12. Compare **F1** and **F2** by switching the FSK switch ⑥ from one frequency to the other; repeat the tuning and adjustment steps 1.– 11. until both frequencies are perfectly matching and in tune with the external keyboard/VCO.

2 Bus CV

- Jumper "JP1" in "on" position (on backside board 2): The Bus CV (if in use) of the 16pol Header is controlling the XR22 VCO's frequencies.
- Jumper "JP1" in "off" position (on backside board 2): The Bus CV is not connected.

3 Potentiometer 'Gain' ⑫ 0-point adjustment

1. Turn knob 'Gain' ⑫ in middle position (denter locked)
2. Adjust trimmer Tr7 3 for minimum output amplitude on ∿ / ∿ output ⑰ (with no AM-Input signal applied on ⑭ and knob **'Bypass'** ⑬ fully turned clockwise) - check the LED **'AM'** ⑨ for minimum lightning intensity.

4 ∿ / ∿- Output DC-Offset

No DC offset voltage should overlay the oscillator's ∿ / ∿- Output ⑰ (with the knob **'Gain'** ⑫ in middle position, the knob **'AM in'** ⑪ turned fully left and knob **'Bypass'** ⑬ turned fully cw). Apply the ∿ / ∿ - Output to a frequency CV-input of a 2nd oscillator or to the AM-input of a 2nd XR22 VCO. There must occur no change of the 2nd oscillator's frequency or the 2nd XR22 VCO's loudness (for orientation, check the LED **'AM'** ⑨ for minimum lightning intensity).

5 Output Gain of ∿ / ∿ signal

Adjusts the maximum output amplitude level of the oscillator's ∿ / ∿ output (With knob **'Bypass'** ⑬ turned fully cw and knob **'Gain'** ⑫ turned fully cw or fully ccw); from ≈ 8Vpp to 16Vpp for ∿.

6 Low frequency trimmers for 1V/oct adjustment

Adjusts the matching of the 1V/oct. tracking for CVs < 0V (negative CVs, e.g. -1V, -2V, -3V). For adjustment, please read above, under '1V/Octave Adjustment'.

7 F2 knob ② tuning (on inner board, nearby F2 potentiometer)

To ensure that the '0' of the knob's **F1** ① and **F2** ② scales are in accordance to each other, the F2 route is fine-tuned with this trimmer and the knob **F2** ② 0-position may be aligned to **F1** ①.

8 Slide switch ④ 'mid' range tuning (on inner board, nearby F1 potentiometer)

This trimmer fine-tunes the oscillaor's frequency when switch **'Lo-Mid-Hi'** ④ is in **'mid'** position to ensure that the oscillator freq. in **'mid'** position is exactly 4 octaves lower than in **'hi'** position.

9 Slide switch ④ 'lo' range tuning (on inner board, nearby F1 potentiometer)

This trimmer fine-tunes the oscillaor's frequency when switch **'Lo-Mid-Hi'** ④ is in **'lo'** position to ensure that the oscillator freq. in **'lo'** position is exactly 4 octaves lower than in **'mid'** position.

5. Contact & Support

cg-products.de/module/xr22-vco-ft/
cg-products.de

This is the documentation for version Rev.6.2
Versions Rev.6.2 or higher (in comparison to previous versions) have 'Lo-F' instead of 'Hi-F' trimmers on the backside board.

Older versions
https://www.cg-products.de/documentations/XR22FT_Documentation-Rev.6.0.pdf
https://www.cg-products.de/documentations/XR22FT_Documentation-Rev.5.2.pdf
https://www.cg-products.de/documentations/XR22FT-Rev.4_Documentation.pdf

Youtube Video:
https://www.youtube.com/watch?v=ETP8qT1tgrY

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