

SERIES 3000  
MODULAR SYNTHESIZER  
INSTRUCTIONS  
MANUAL

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## 1. INTRODUCTION

This Instructions Manual is not meant to be a concise handbook on control voltage, but is aimed at applications and use of the available modules.

For basic control voltage techniques we refer to standard literature.

As the range of modules extends, more descriptions will be published and more applications for existing modules may appear. Please keep in touch with us or your dealer.

The Series 3000 Modular System features many different modules for audio and control voltage processing.

One of the misunderstandings about this kind of synthesizer system should be dealt with here and now.

A modular synthesizer is not just an intricate device with which musical or sound effects can be generated.

It is more. With the right types of modules it is possible to experiment and set-up audio or CV processors which are not available as commercial products.

It is also possible to insert certain types of modules in an audio or control chain as simple gating or triggering devices.

Understanding the routine of voltage control will be a contribution to the inventiveness of the recording engineer who has to deal with problems which range from syncing to fattening or alienating musical sounds, voices or sound effects.

## 2. CONNECTING SERIES 3000 MODULES

All modules of the Series 3000 need a well regulated power supply, delivering plus and minus 15 Volt. The total current which has to be supplied depends on the quantity and kind of modules used.

A VCO draws more current than an MXA, and some passive modules do not need power at all.

The Power Supply PSU 401 is capable of supplying approximately 40 modules. Exact figures are obtained easily by adding all positive and negative currents, drawn by the modules. (+12 mA +8 mA +23 mA totals +43 mA and -9 mA -16 mA -17 mA totals -42 mA).

The first step is to connect the Power Supply Distribution Boards (each has 8 Molex 3-way connectors) to the PSU 401.

The three wires running from the Distribution Boards are color coded (Red = Positive; Blue = Negative; Black = Ground) and have to be connected to the correspondingly colored barrier strips on the Power Supply Unit.

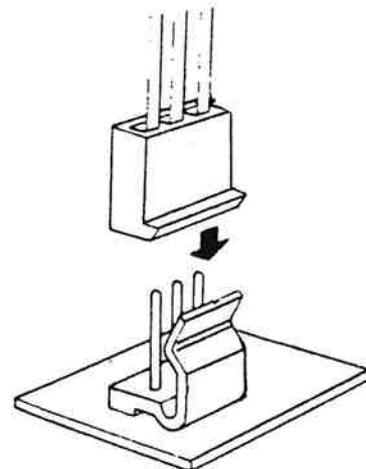
Next the 3-way Molex plugs on the modules can be plugged on to the Distribution Board. Please pay attention to the locking ramp and the clip and make sure that the connection is not reversed or shifted.

Never try to connect modules with switched on power supply. A reversed plug may result in a damaged module!

BLACK = 0 Volts

BLUE = -15 Volts

RED = +15 Volts



Since all patch points on the modules are single-ended it is necessary to always make a ground connection with the power supply or one of the distribution boards. An example is the Quad Attenuator, which does not need powering, but still needs a ground connection in order to function properly.

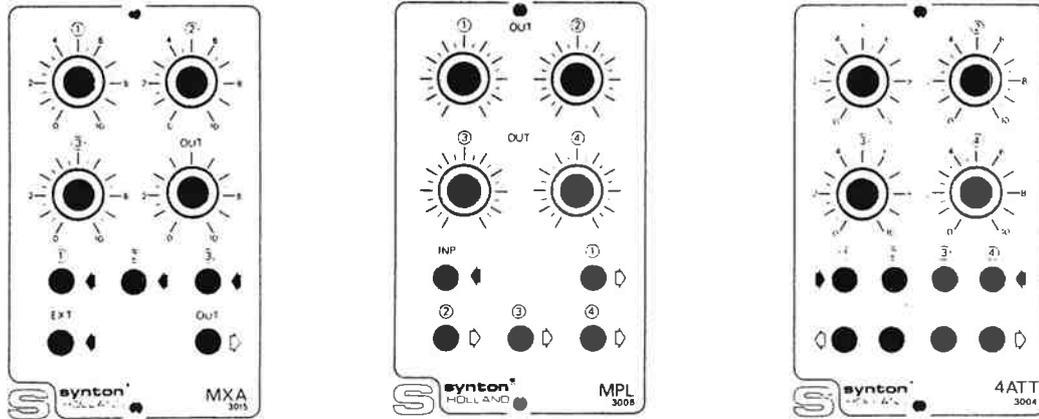
The same precautions should be taken when connecting modules to external equipment by means of the banana sockets, In that case it is also necessary to make a ground connection between the system and the ancillary equipment.

When a system or a studio is growing and more equipment is connected, it is likely that ground loops occur, usually recognizable by disturbing hum or high frequency oscillation which could result in a high noise level. Most ground loops are made by grounded or shielded mains leads, connected to grounded outlets, and then by a grounded connection between two systems. The easiest way to avoid this kind of problem is to disconnect all grounds in mains cords, EXCEPT ONE! For safety reasons it is absolutely necessary that there is a solid connection to ground from at least one of the systems in the studio.

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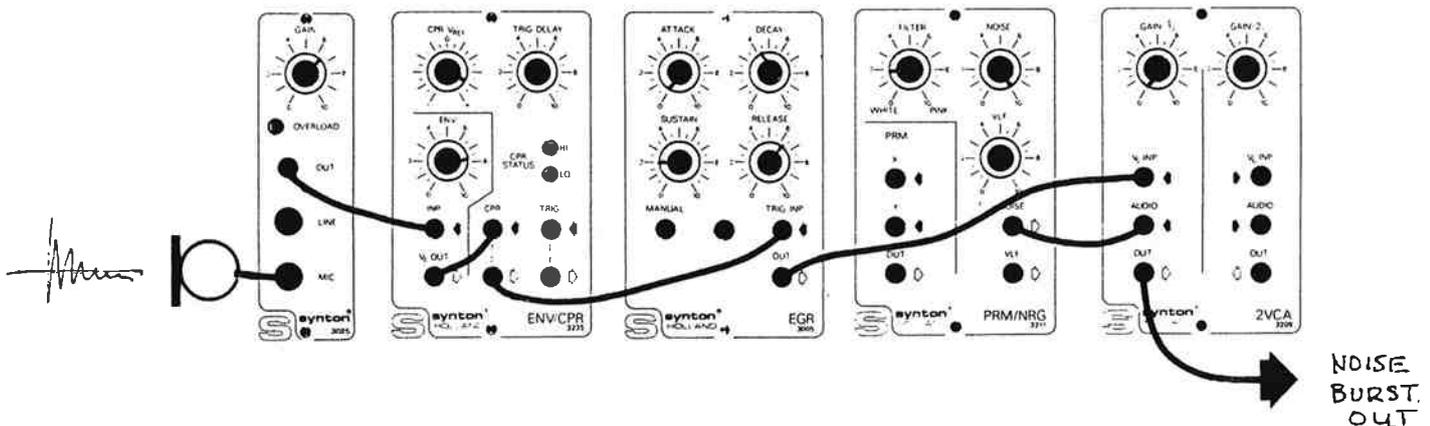
Interconnecting the modules of the Series 3000 will not be difficult. The system features a simple color coding for inputs and outputs (black and blue). Since all inputs are voltage inputs, it is not possible to connect more than one output (blue) to one input socket (black). In general there is the rule that blue sockets never should be connected to each other, not directly, nor by a common black input socket. Accidentally made connections between outputs, however, will not harm the modules since all outputs are short-circuit proof.

The Series 3000 Modules do not provide for multiple audio or control voltage inputs per module or per function. It is not possible to foresee how many inputs will be needed, and complex modulation patterns should not be excluded because of just two or three VC inputs. Moreover this concept results in a lower cost per module. Mixing, splitting and attenuating both audio and control signals is provided by special modules like the MXA, MPL and 4ATT, which are inexpensive and which guarantee optimal flexibility.



When a 3000 System configuration should be connected to peripheral equipment, or musical instruments or microphones, there are versatile modules like the Mic/Line Input Amp and the Line Output Amp, which have 1/4 inch jack sockets. In this case it is not necessary of course to make a separate ground connection, as described previously.

All modules of the Series 3000 are open, in the sense that the front panel connectors can be reached easily when hard wiring to other equipment is needed. Behind the front panel there are two printed circuit boards (on most modules) of which one is used to connect the inputs and outputs to the banana sockets. On these boards small spots can be found next to the banana sockets, to which leads can be soldered easily when for instance a remote patching facility or a matrix programmer has to be connected.



In applications where a dedicated system is laid-out with Series 3000 Modules, this hard-wiring facility will prove to be indispensable and easy to handle. Examples of dedicated systems are Bass or Snare Drum Enhancers, Gates, Voice or Instrument-triggered devices, etc.

### 3. Voltage Controlled Oscillator VCO 3021

The VCO is one of the most important building bricks of a sound synthesis system. Typical for a VCO is that the frequency or pitch is determined by the magnitude of a voltage applied to a control input. When this voltage is changed, the frequency will also change. In most VCOs this relationship is 1 Volt per Octave, which means that for a linear change in voltage the pitch will change exponentially.

On the 3021 the control input is labeled FM, and in general voltages applied to this input should vary between 0 and +10 Volt, covering a 10 octave range which roughly comprises the audio spectrum from 16 Hz...16 kHz. Frequencies below and beyond can be obtained by using the frequency presets, labeled PITCH COARSE and FINE. When these controls are set to their lowest values, it is possible to obtain sub-audio frequencies by applying slightly negative control voltages to the FM input, around -2 V. Although these sub-audio signals may be used as control signals, the 3021 mainly was designed to be used as an audio generator.

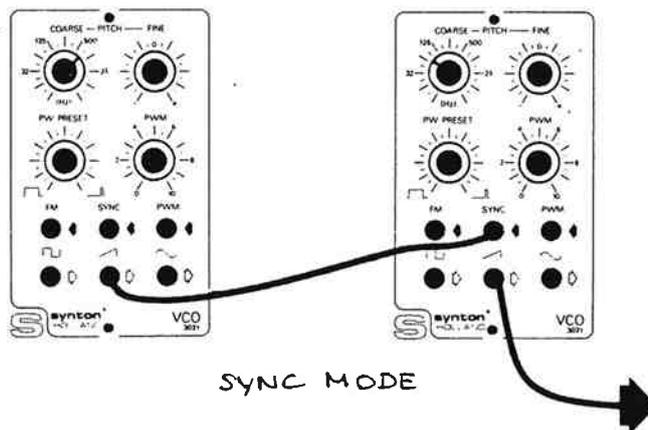
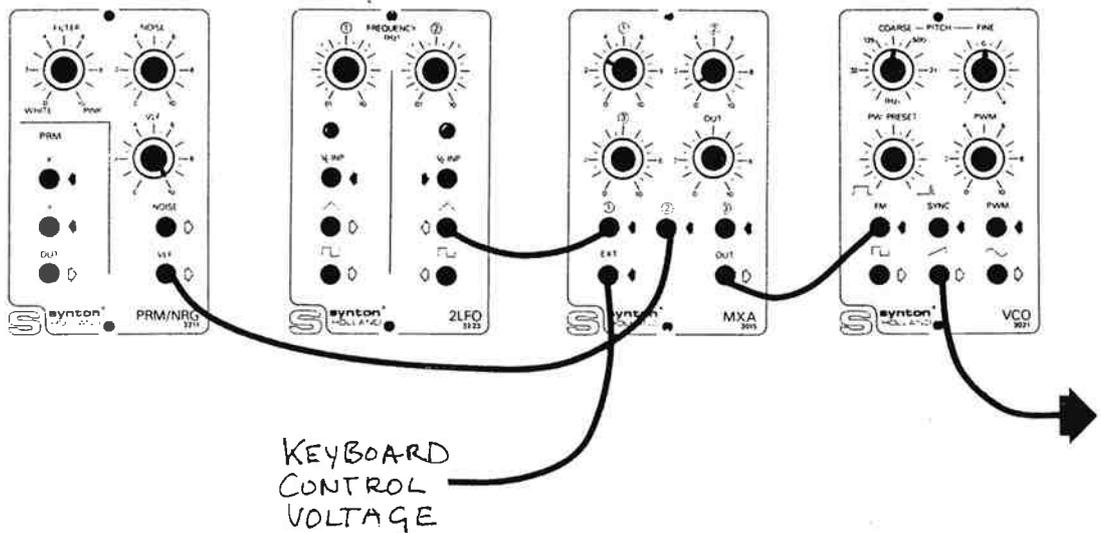
When the 3021 has to be controlled with a keyboard it is necessary that this keyboard delivers 1 Volt/Octave, as mentioned before. The KBCV (Keyboard Control Voltage) can be applied to the FM input directly, however, when also modulation by other controlling devices has to be added (LFO, ADSR, Random, etc.) a mixer has to be used. The MXA 3015 features three inputs with independent controls, and moreover it has a special input which is calibrated for a gain of exactly 0 dB, in order not to disturb the 1 Volt/Octave ratio. This input is labeled EXT.

The 3021 has three different audio outputs delivering a square wave, a sawtooth and a sine wave. The sine wave is the purest signal without harmonics, except for a slight distortion which is typically below 1.5%. In case this distortion is too high it can be removed with a tracking low pass filter.

The sawtooth contains all harmonics (odd and even) of which the amplitudes decrease with increasing frequency. The square wave only contains odd harmonics, but by changing the symmetry or duty cycle of this type of signal more even harmonics can be added. This control is labeled PW PRESET (Pulse Width Preset) but also this parameter can be controlled dynamically by applying a control voltage to the PWM (Modulation) input socket, in which case the PWM rotary control will set the amount of modulation.

A different way of changing the timbre of the sounds generated by the VCO is by Frequency Modulation and by synchronization. Frequency Modulation is obtained by connecting the audio output of one VCO to the FM input of another VCO. In general the effect will be richer the higher the modulating frequency will be.

Instead of connecting the audio output to the FM input, it can also be patched to the SYNC input. Depending on the kind of signal applied (square wave, pulse or sawtooth) a very rich sound will be the result. Syncing two oscillators means that one VCO is forced to also generate the frequency of the other VCO. When both VCOs are tuned in unison, they will always have the same phase relation when in sync mode.



#### 4. Voltage Controlled Filters 3017 & 3224

The VCF 3017 is a state variable filter, featuring separate low pass, high pass, notch and band pass outputs. Although the roll-off characteristics are only 12 dB/Octave this type of filter is very popular because of its flexibility.

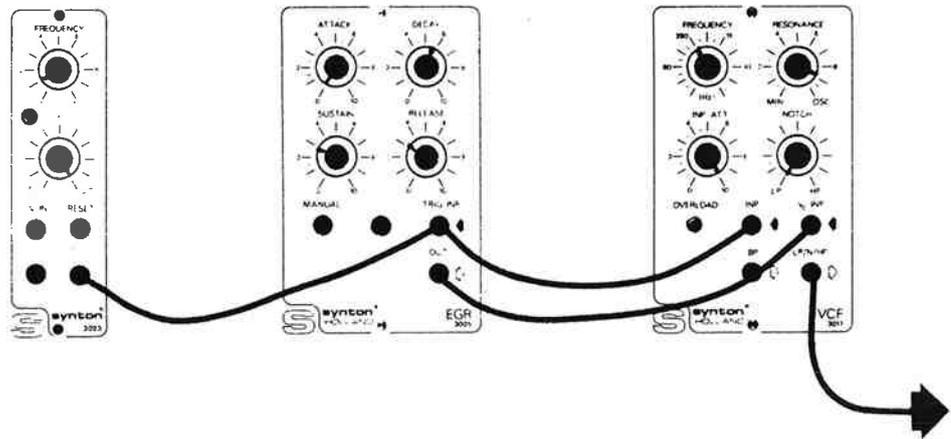
The output functions on the 3017 are available at two sockets, labeled LP/N/HP (for low pass, notch and high pass) and BP (for band pass). The LP/N/HP output function has to be set with the control labeled NOTCH. At the extremes and center of the dial the before-mentioned functions can be obtained. When the knob is in between these positions, also varieties like elliptic transfer (Cauer) functions can be obtained.

The filter cut-off frequency can be adjusted with the control labeled FREQUENCY, which functions as a preset to control voltages applied to the VC INP.

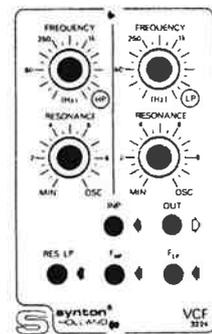
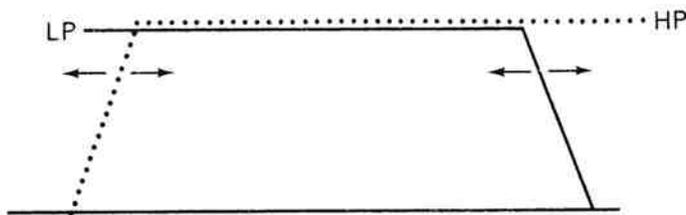
The filter resonance or Q-factor can be trimmed with the RES control. On MIN frequencies near the cut-off frequency ( $F_c$ ) are attenuated. When the control is turned clockwise these frequencies will be amplified more and more and near the OSC side of the dial the filter will tend to oscillate. Oscillation usually does not occur at low cut-off frequencies due to phase errors in the electronic circuit. When the filter does not start to oscillate immediately it is sufficient to apply a pulse or audio signal to the audio input, or to turn up the FREQUENCY control briefly.

When the filter is used with high Q-values (high resonance) it will tend to overload when the audio input level is high. This status is indicated by a red LED, and when this occurs the audio input signal should be trimmed down with the INP ATT control.

At high Q-values the filter will be an excellent percussion sound generator when the audio input is excited by a short pulse. The decay rate will depend on the setting of the RES control, while the pitch is determined by the FREQUENCY control. Applying a control voltage to the VC INP (e.g. from an envelope generator) will result in rototom-like effects.



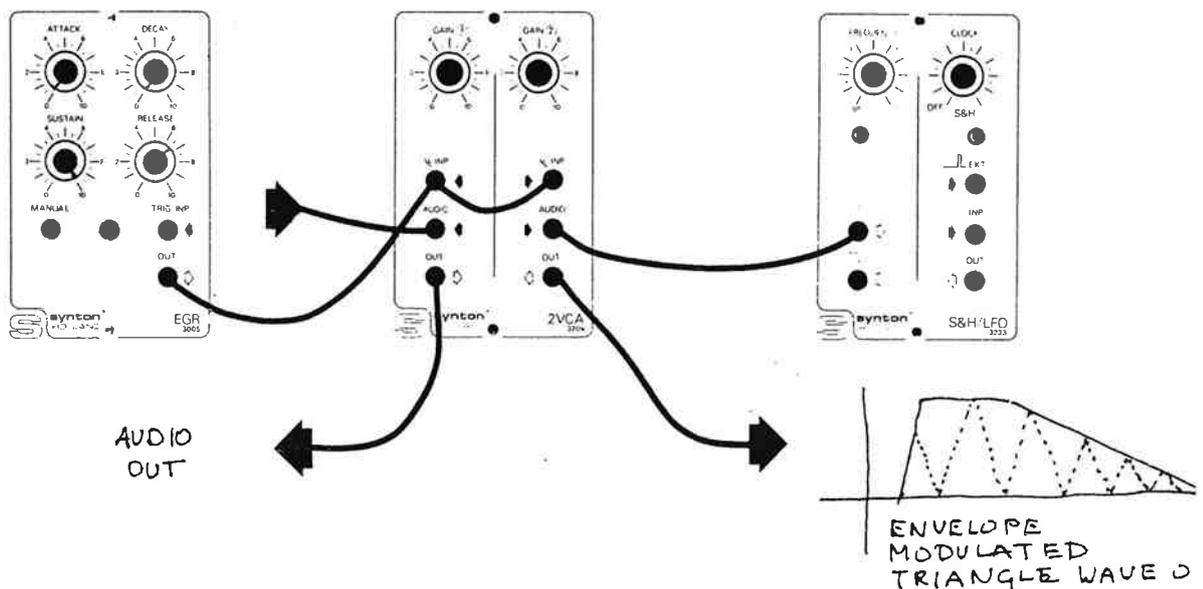
The 3224 VCF is also a voltage controlled filter, but instead of offering a 12 dB/Octave roll-off it features 24 dB/Octave performance which gives it a distinct sound quality over 12 dB filters. It is designed as a variable bandwidth filter, combining a high pass and a low pass filter with independent control inputs. Frequency and resonance controls function similarly to the 3017 VCF, but as an addition on the 3224 also the resonance of the low pass filter can be controlled by a voltage, applied to the RES LP input.



## 5. Voltage Controlled Amplifier

This module has two independent voltage controlled amplifiers which can be used to process both audio and control signals. The controls labeled GAIN 1 and 2 respectively are for presetting the pass-through level of signals applied to the AUDIO inputs, in conjunction with control signals applied to the VC INP.

Although the VCA generally is used to envelope audio signals according to a control voltage cycle (e.g. low frequency oscillators, envelope generators, etc.) it can also be used to modify control voltages, or even as a control voltage switch or gate.

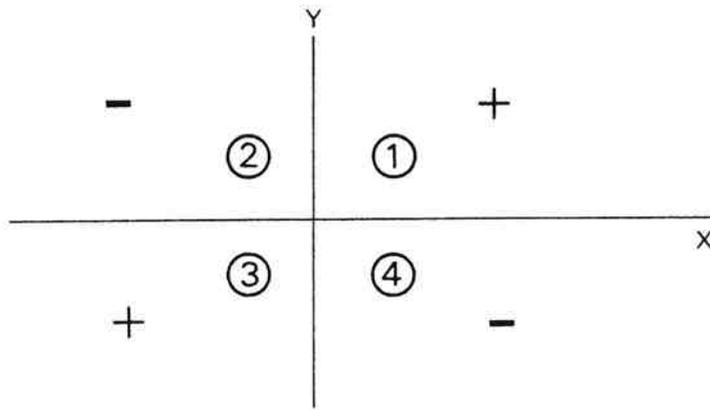


## 6. Ring Modulator & Noise/Random Generator

The PRM is the Product or Ring Modulator section of this module, the 3211.

Its function is multiplication of two signals, either audio, control voltage, or both.

A simple example of this kind of modulation is VCA action. When an audio signal is applied to either the X or Y input, and a control voltage is applied to the other input, whichever is free, a similar effect as with a standard VCA will be obtained. The difference, however, with a normal VCA is that instead of working in two quadrants, the multiplier is active in four quadrants.

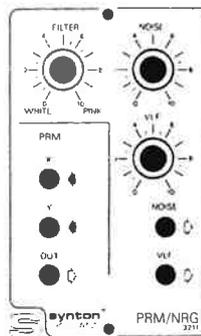


For positive X and Y inputs the output signal will be positive too, but also two negative inputs will result in a positive output. This means that also the phase of an input signal can be reversed, simply by applying a control signal of different sign.

The output function of the PRM is  $X \times Y = XY/K$ , where K is a factor to avoid clipping of signals when XY is greater than the maximum output level, which is limited to approximately 14 Volt by the power supply voltage.

One of the most common applications of this kind of multiplier is modulating two audio frequencies, in which case the output signal will contain the original two input signals plus their sum and difference frequencies of their fundamentals and harmonics, resulting in bell or steel tube-like sounds.

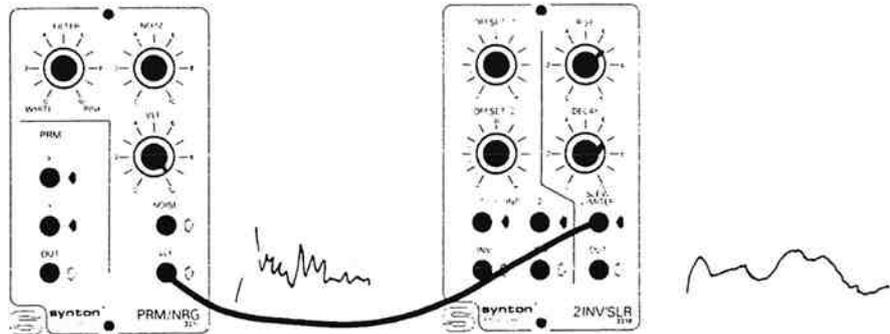
Frequency doubling of a sine wave can be achieved easily by applying the same sine wave to both X and Y inputs.



In the same module there is also a Noise/Random Generator NRG. This circuit delivers both audio and very low frequency noise (VLF) to separate outputs. The audio noise can be filtered with a built-in low pass filter of which the control is labeled FILTER - WHITE/PINK. This signal appears at the NOISE socket, and it can be attenuated with the NOISE level control.

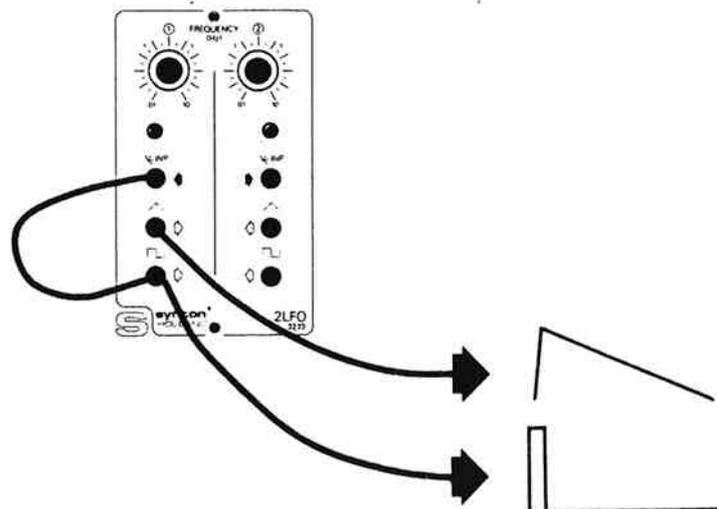
The VLF (very low frequency) output signal appears at the socket labeled as such, and it can be attenuated by the VLF control. This VLF signal still contains rapidly changing

peaks, and if a smoother signal is wanted, it can be filtered with a slew limiter, as can be found in the module 3218.



### 7. Low Frequency Oscillator, 3223

The dual LFO features two independent control voltage generators, delivering triangle and square wave signals at their output sockets. The frequency or rate is controlled by the presets labeled FREQUENCY 1 and 2, and it can also be controlled by a voltage applied to the VC INP, of which the range is about 0...+10 V. In case a sawtooth control signal is necessary there is a simple trick to achieve this with the 3223. When the square wave output is connected to its own control input (VC INP) the output normally delivering a triangular wave now will produce a ramping signal. In case the LFO has to remain voltage controllable, the use of a mixer (MXA) is necessary.



The sawtooth thus generated will ramp down. Inverting the square wave output with an inverter (INV) will create a ramping up signal.

In all these patches the output signal at the square wave socket will now be a narrow pulse which can be used as a triggering signal.

### 3023 LFO

This module features a control voltage oscillator with triangle and square wave output, as does the 3223, but it also has an adjustable duty-cycle and wave shape control to set the outputs to pulses and ramping signals. The frequency or rate can be preset with the FREQUENCY control and dynamically be changed by a voltage applied to the VC INP socket. The range is approximately between 0.05 Hz and 100 Hz, depending on preset and control voltage. An extra facility is offered by the RESET input, where a positive voltage will force the LFO output to 0 Volt. When this reset signal is released, the oscillator will start again. This feature can be very useful when LFO action has to start at a fixed point.



## 8. Envelope Generators 3005 and 3010

The EGR 3005 is a standard ADSR generator which can be gated/triggered manually or at the TRIG INP socket. An ADSR knows four states, named Attack, Decay, Sustain and Release.

During the Attack stage the output will rise to its maximum voltage, which is 10 Volt. The time which this will take can be set by the knob labeled ATTACK, while on the VCEGR 3010 there is also the possibility to control it by applying a voltage to the A input. (The higher the voltage the longer it will take the generator to reach its peak value ).

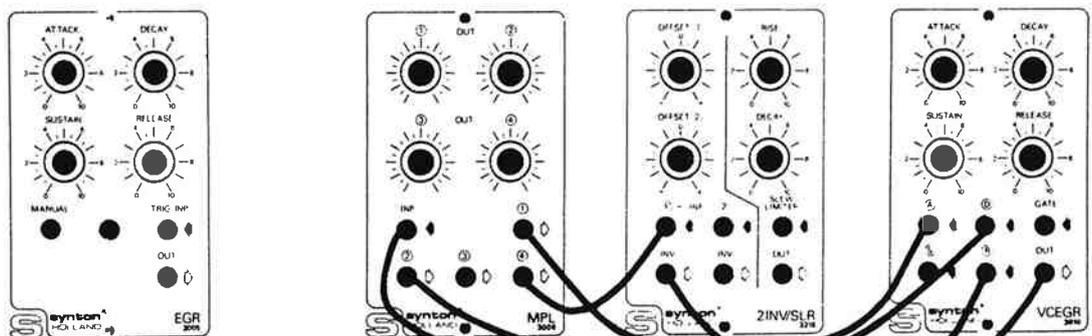
The second stage is called Decay, and it is controlled in a similar way for both types of generators. This Decay stage precedes the Sustain stage, which is a steady-state: the output of the generator will remain at a preset level as long as the TRIG/GATE input is kept high. The time which it takes to decay from maximum level to sustain level is set by the DECAY control or at VC input D. The Sustain stage however, is not controlled time-wise, but level-wise. The SUSTAIN control (or S-input at the 3010) will set the steady-state level.

When the TRIG/GATE input or manual button is released, the generator will go into its final stage, the RELEASE mode, which can be preset by the control named as such, or by the VC input R.

Generally an envelope generator is used to control amplitude and filter contours of audio signals, where the control of filters may be even more important than amplitude shaping with VCAs.

All parameters are important because they ultimately determine the timbre of a sound. Long attack times and zero decay combined with high sustain levels may result in string or woodwind-like sounds, while short attack times combined with decay and lower sustain levels result in plucked or hammered string sounds or percussion effects.

With the Voltage Controlled EGR 3010 it is possible to modify the transfer curves by feeding back the output signal to the VC inputs, either directly or via multiples, mixers, or attenuators.



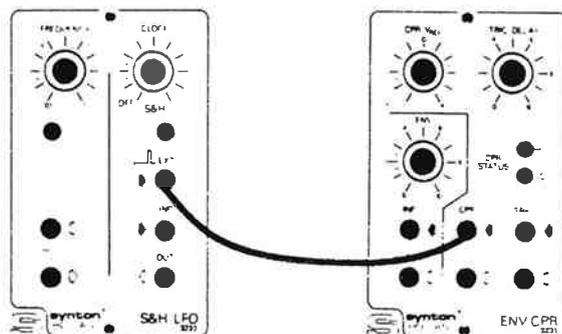
## 9. Sample & Hold and Low Frequency Oscillator

The LFO as can be found in this module is a straightforward control voltage generator with triangle and square wave output and a frequency or rate control. Its range is from approximately 0.1 Hz to 10 Hz, depending on the setting of preset control. It may act as a low frequency input signal to the Sample & Hold unit which is in the same module.

The Sample & Hold unit basically is an analog memory which will look at a signal applied to its input (INP) and remember the momentary value of that input signal when it is commanded to do so, by means of a pulse applied to the EXT input. It will deliver its momentary value to its output, and it will keep this value until a new sampling command has been given.

The sampling command can be given by connecting a pulse output or square wave output to the EXT input, but the unit also has its own clock generator, which repetitively will deliver pulses to the triggering input. It can be turned off by setting the CLOCK control to OFF. When it is turned clockwise, the sampling rate will increase. Both internal clock and external pulses can be mixed without problems.

When a comparator is available (CPR) the EXT input of the Sample & Hold unit can be even used as clock pulse output. Since the impedance of this input/output is very high, it can not be loaded too much without affecting its performance, however, when a patch is made from the EXT socket to the CPR input socket, and the CPR VREF is adjusted until the CPR STATUS LEDs start flashing, a usable clock pulse is available at the comparator output.

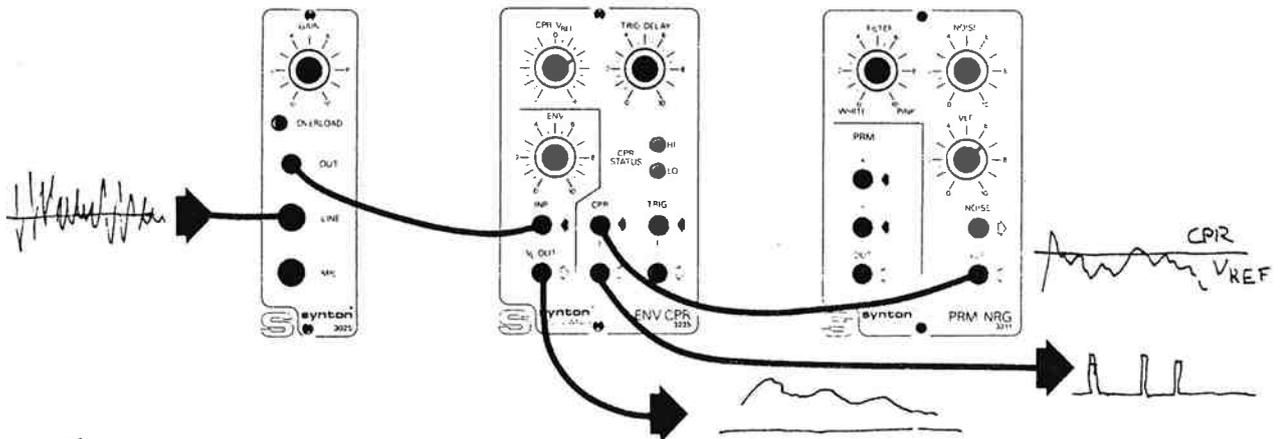


The Sample & Hold unit can be used to generate pseudo-random sequences of control voltages when the input signal and clock frequency have different rates, and it can generate scales when both input signal and trigger signal are synchronized.

10. Envelope Follower, Comparator and Trigger Delay.  
ENV/CPR 3235

This module has been referred to briefly already in the description of other modules, and it may be one of the most versatile control voltage processors in the Series 3000, as yet.

A comparator basically is a reference unit which will change its output status when an input signal exceeds or crosses a preset reference voltage level (CPR VREF). Whether the output status changes from high to low, or vice versa, can be monitored by the red and yellow LEDs. The CPR can be useful in deriving random pulse trains from the VLF noise signal, as shown below. Another application is in the audio field, when it is used as a signal "clipper".



The same module also features an amplitude demodulator or envelope follower. Any audio signal applied to the INP will appear at the output (VC OUT) as a control voltage of which the level is related to the amplitude of the input signal. For practical reasons the output voltage will be limited between 0 and +10 Volt. In conjunction with a microphone pre-amp the envelope follower can be used to control levels, or special filter set-ups can be made, such as wah-wah, de-essing, etc.

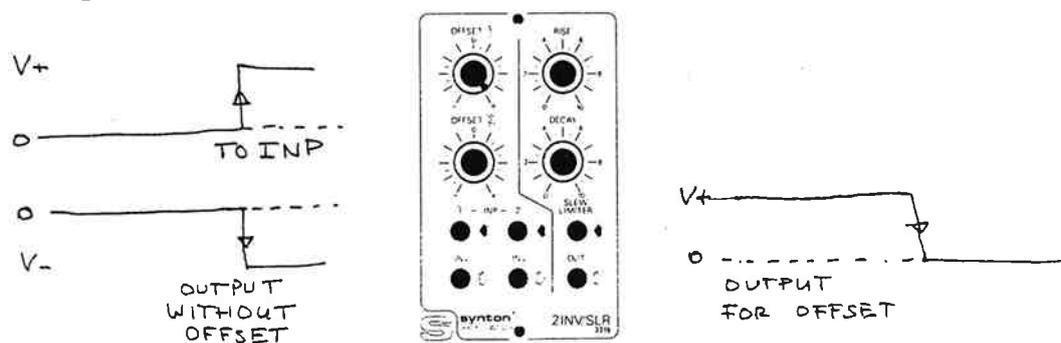
The Trigger Delay section is a one-shot generator which will convert any square wave signal into narrow pulse trains and gating signals into triggering pulses. The delay of the output signal can be varied between 0.25 msec and 250 msec typically.

A useful application of delayed triggering may be for triggering several envelope followers sequentially.

## 11. Inverters and Slew Limiter 3218

Another combination module is the Dual Inverter and Slew Limiter. The inverter section features two independent inverters, which are straight-forward and easy to use. A signal (audio or control voltage) applied to the input (INP 1 or 2) will appear at the output inversed, which means that a positive voltage will become a negative voltage and vice versa (e.g. +3 V becomes -3 V; -1.5 V becomes +1.5 V, etc.) This is true provided that the OFFSET control is in its zero position (center of dial).

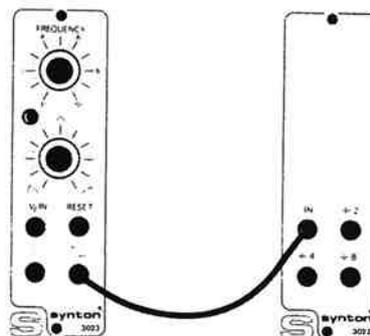
The OFFSET controls have been provided to be able to invert and shift signals, as is sometimes necessary when equipment of different brands has to be patched together. This sometimes is the case with trigger or gate voltages, which in some systems (like the 3000 Series) are positive going (0...+V) and in other systems negative going (+V...0). In these cases an inverter with adjustable offset can be indispensable.



The other section of this module is the Slew Limiter. This is in fact a filter for sub-audio frequencies, and it can be used to convert a gate signal into a Rise/Decay generator with independent rise and decay times. It can also be used to cut off the high frequency contents in the random signal as delivered by the VLF generator.

## 12. Binary Divider

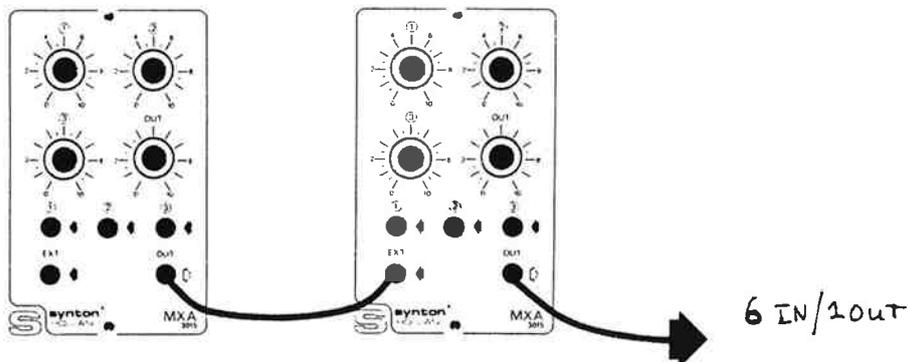
The Binary Divider can be used on both audio and control voltages. When connected to the square wave or pulse output of a VCO it will deliver three output signals which are respectively one, two and three octaves below the original input signal's frequency. Another application for this circuit may be sub-division of rhythm patterns, or just the distribution of trigger pulses.



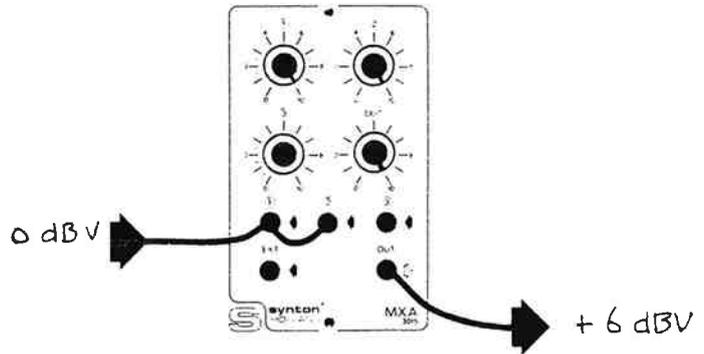
## 13. Mixer, Multiple and Quad Attenuator 3015/3006/3004

These three modules will only be discussed briefly, since their function and purpose is simple and straight-forward. The mixer (MXA) is to add control voltages, or audio signals, just as with any other mixer. It has three inputs with an input level control, and one master output control. It also has a separate input with a fixed gain of 0 dB, which means that the output signal will be equal to the input signal.

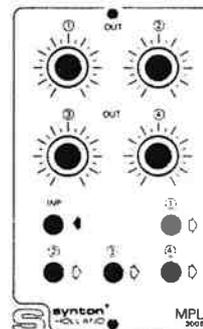
This input is labeled EXT, and has been provided to be able to process keyboard control voltages without affecting the 1 Volt/Octave ratio, and it can also be used to link more than one mixer together, in order to create 6 into 1, 9 into 1, etc.



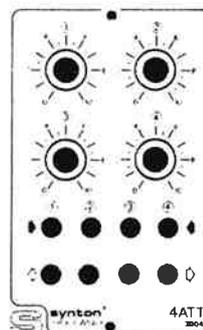
Another interesting application of the MXA module is to use it as an amplifier, when needed. For this purpose inputs can be patched together, and when two inputs are connected this will result in a gain of 6 dB, while for three inputs there will be a gain of 10 dB.



The Multiple module MPL is even simpler than the mixer. It has one input and four buffered outputs, and it can be used when one signal has to be splitted into more paths with different levels.

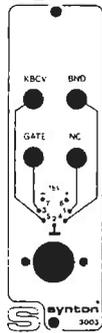


The Quad Attenuator is one of the modules which does not need a power supply, but just the ground connection to operate properly. It consists of four independent potentiometers, which can be patched into any audio or control voltage path.



#### 14. Keyboard I/O Module 3003

This module is for connecting the KBM35 Keyboard to the system. It contains the necessary power supply connections for the keyboard, and it has output sockets which correspond with the keyboard voltages (KBCV, GATE, and BND, which is the Bend Pad). One of the sockets is not connected (NC). One of the sockets is not connected (NC).

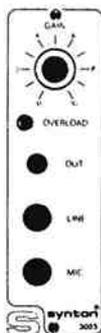


#### 15. Input & Output Amplifiers

When the system has to be connected to external equipment it can be useful to do so via the 3025 Mic/Line Amp and the 3024 Line Output Amp. These modules have 1/4 inch jack sockets at respectively inputs and output, which make it unnecessary to make a separate ground connection, as described in Chapter 2.

The Mic/Line Amp accepts low level microphones of low impedance (200....1,000 Ohms) and line levels at the Line input socket. Gain is adjusted with the GAIN control, and overload is indicated by an LED.

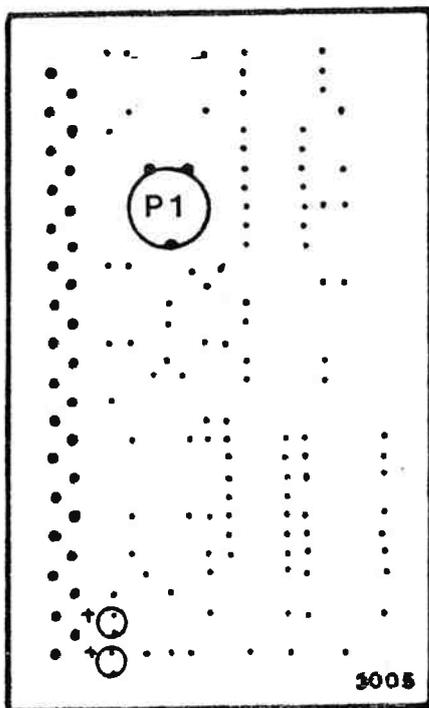
The Line Output Amplifier is to connect the system to a monitor amp or to other peripheral equipment which accepts line level signals. It has an output level control, and it is capable of driving headphones, provided they do not excessively load the amp (impedance higher than 100 Ohms).



CALIBRATION

3005

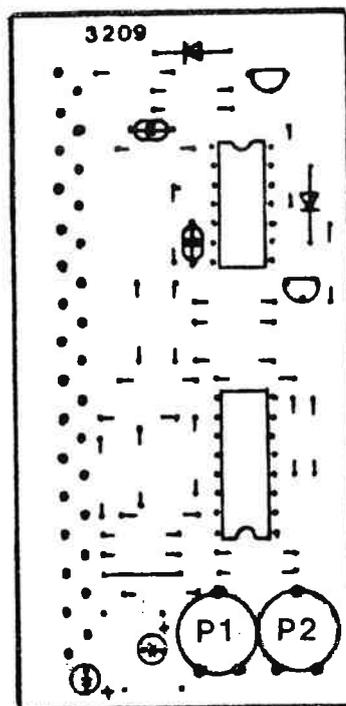
P1 = Release Time



3209

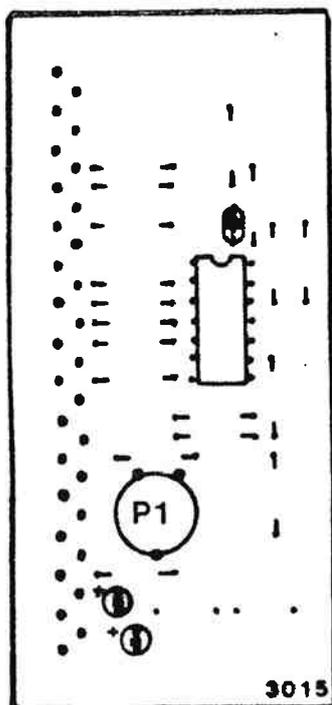
P1=VC break-through to output VCA 1

P2=VC break-through to output VCA 2



3015

P1= gain of EXT input.  
Set to exactly x 1.00

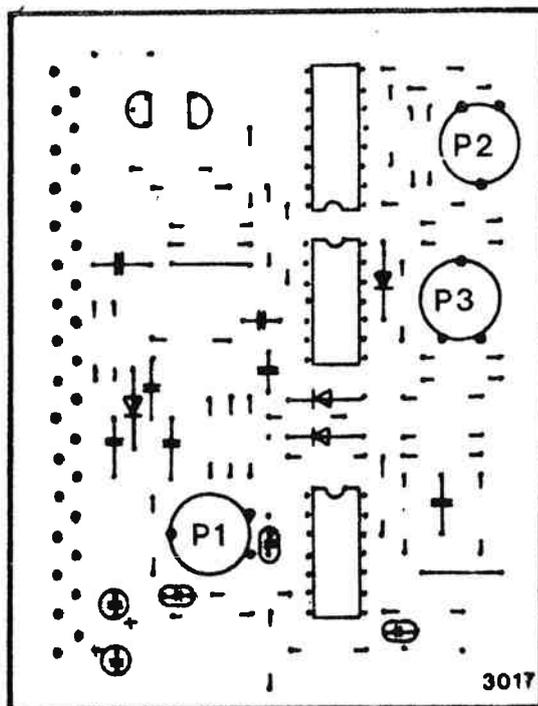


3017

P1=for constant amplitude at HF during oscillation

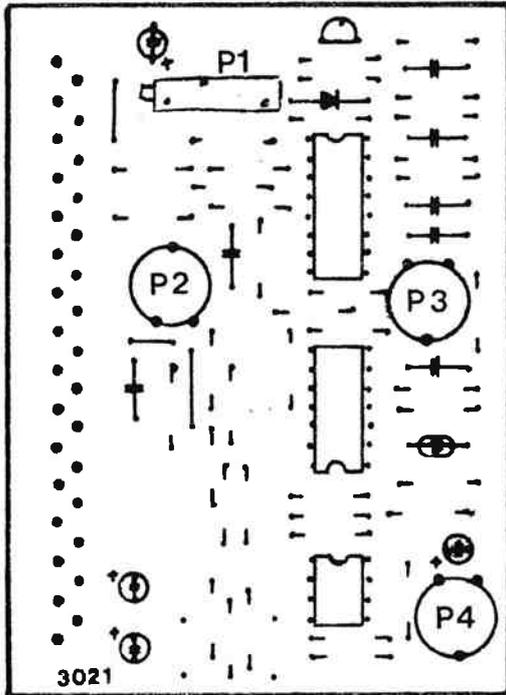
P2=preset frequency

P3=interval trim (1V/octave)



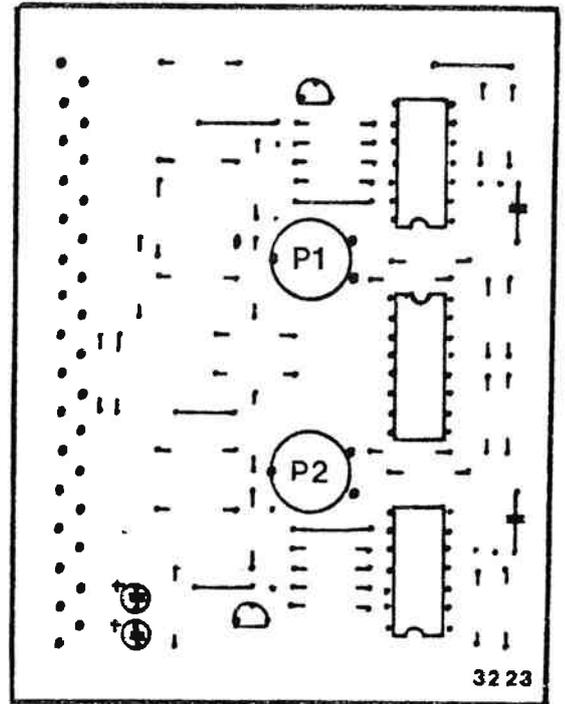
3021

- P1 = 1V/octave 16-800 Hz
- P2 = 1V/octave 4000-16000 Hz
- P3 = triangle-to-sine wave
- P4 = sine wave distortion trim  
set to D less than 1.5%



3223

- P1 = frequency preset LF01
- P2 = frequency preset LF02



3211

- P1 = output level noise generator
- P2 = input Y breakthrough of PRM
- P3 = input X breakthrough of PRM

