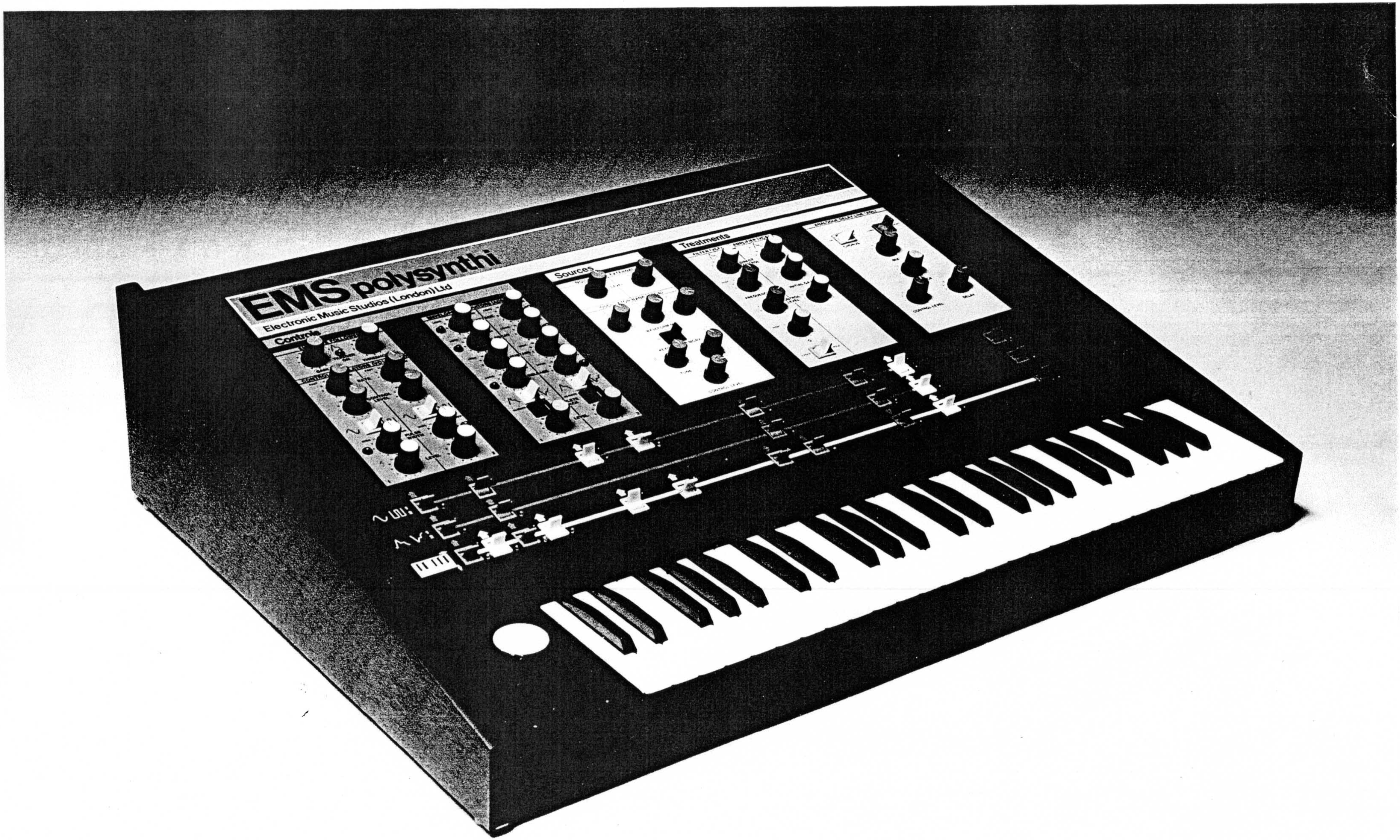
POLYSYNTHI
Users Manual

Information from

EMS


EMS polysynthi
Electronic Music Studios (London) Ltd
Controls
Sources
Treatments

Introduction

The electronic music synthesizer has recently celebrated its tenth birthday. During the first of what we can expect to be many decades of life, the instrument has evolved from an unwieldy cable-infested gargantuan into a trim device with few controls. This has been in response to the demands of musicians who do not wish to become scientists, and the competing of manufacturers who are busy streamlining the products to keep pace with the latest silicon chip technology.

From the outset EMS has catered for the musician who prefers to experiment with sounds. We have watched the pattern emerging of a trend towards simplicity, and are offering with Polysynthi what we believe to be a happy compromise. Polysynthi combines fully polyphonic keyboard playing and a simple operating system to allow both conventional and abstract sounds to be easily generated. Furthermore it is available at a price which does not exclude the semipro or amateur from taking advantage of it. We have also developed as a companion to Polysynthi the world's first truly polyphonic sequencer, Polysequencer (available late 1979).

We hope that you will get much pleasure from your Polysynthi which has been designed with the live performance situation in mind, and wish you many years of trouble-free music making.

Polysynthi Specification.

Power supply	:	240 or 115 Volts AC.
Output	:	2V p-p. Output impedance less than 20 ohms.
Input	:	MIC ; 80 mV into 600 ohms. LINE; 2V p-p into 50 kohms.
VCOB Range	:	15-8000 Hz.
Filter slope	:	4-pole ; 24 dB/octave. 2-pole ; 12 dB/octave.
ADSR times	:	5 mS - 10 seconds (All parameters).
VCLFO Ranges	:	VCLFO1 ; 0.08-20Hz. VCLFO2 ; 0.04-10Hz.
ADL Delay time	:	100mS - 1 second.
VCOB Mod. range	:	10 semitones (a sixth).
Weight	:	25kg.
Dimensions	:	83 x 59 x 21 cm.

Basic System Description.

To start off we will describe the basic organisation of electronic devices which go together to make Polysynthi. This will provide an impression of the system as a whole, enabling comparisons with other synthesizers and forming the basis for the more detailed descriptions which follow. Please read it carefully.

Polysynthi is a pre-patched synthesizer. This means that the audio signal connections between the Oscillator Bank(VCOB), Filter(VCF), Amplifier(VCA) and Analogue Delay Line(ADL) are internally wired, and do not need to be patched or switched in. Looking at the front panel, all signals originate in the central SOURCES section which is connected to the VCF in the TREATMENTS section. The VCF output passes to the VCA, and the VCA output feeds the ADL via its MIX control before the signal goes to the main output jack on the back panel.

On the left side of the front panel are a group of devices under the title CONTROLS. Along with the keyboard and the Pitchbend knob these devices provide all the necessary control voltages which enable the SOURCES and TREATMENTS to perform their many functions in shaping the final sound. The different ways in which these controls are connected to the SOURCES and TREATMENTS (and even to themselves) are determined by the positions of the three rows of coloured switches which are called 'control busses'. The top row represented by the symbols ∿ and ⊔⊔ refers to the outputs from the two low frequency oscillators (VCLFOs) and if any switch along this row is selected so that the led next to it comes on, then the VCLFO has been connected to control the function of the device immediately above the switch. Moving one of these switches up connects the output of VCLFO1, whereas moving it down connects VCLFO2. Similarly for the middle row of switches with the symbols /\ and \/ which refers to the outputs of the two envelope generators (ADSRs). In this case it is not useful for the ADSR to control itself so no switches are provided on the bus, making a gap in the row. The bottom row deals with the various keyboard outputs. The symbol ↓ refers to a pressure voltage which is created by pushing the keys down beyond their normal travel. This function is invaluable in adding subtle modulations to a sound. Switching up, the → symbol stands for the topnote voltage, or a monophonic output voltage from the highest note played. Once a control is switched in from one or more of the busses, the depth of its effect can be regulated using the CONTROL LEVEL knob provided in the device being controlled.

Note that all the knobs and switches on Polysynthi are colour-coded so that each colour is assigned to a function. These are: Red - Frequency control, Yellow - Envelope and Triggering, White - Amplitude Control, Green - Audio levels, Grey - ADSR amplitude, Blue - Waveform, and Black - Memory options. Consider the front panel controls in the light of this and what seems at first to be a forest of switches and controls begins to resolve into a system with different levels of importance. Some switches are normally on while others are rarely used. For instance, the yellow bus switches are for the ADSR triggers and since the keyboard is normally triggering the ADSRs, the two keyboard → switches below the ADSRs are usually on. Similarly, the keyboard → switch below the SOURCES section is normally on since it routes the polyphonic keyboard information to the Oscillator Bank(VCOB) for normal playing (see Patch No.1). These three switches can therefore be considered as a separate group from the other. The next layer will be the VCLFO switches, which are frequently used to produce vibrato and repetitive sweep effects. Every user will have different preferences of switch patching but a selection of sounds and their control settings is given later in the handbook to help start this process off. You will find that once your favourite sounds are established, the action of switching becomes very familiar, needing a minimum of thinking time.

Now that you have the rough framework of Polysynthi, it is time to look into the special facilities offered which are not normally encountered on other synthesizers.

The two Voltage Controlled Low Frequency Oscillators(VCLFOs) merit special attention since both frequency (RATE) and output amplitude (LEVEL) can be voltage controlled. Red bus switches here control the VCLFO RATE and white switches the output LEVEL.

The two ADSR control waveforms are pre-routed to control the VCF and VCA via the two yellow knobs called DIRECT CONTROL. Of all the different patch connections used in synthesizers these two are the most commonly used, and are therefore hardwired to avoid repetitive switching. They can be disabled simply by turning down the yellow DIRECT CONTROL knobs. The ADSR control bus outputs can also be inverted, enabling a wider range of control functions to be generated.

The Filter(VCF) can be switched to either 4-pole or 2-pole modes, producing a marked variation in filter characteristics and therefore wider timbral control.

Finally, the Analogue Delay Line is a novel 'in-synthesizer' device featuring voltage controllable Delay, to produce an impressive array of modulated echo and flanging effects.

Setting up and Starting to make Sounds.

Setting up. Unpack Polysynthi and store the carton safely since it may be of use in transporting the synthesizer. Find the mains lead and check that the voltage marked on the carton is suitable for your area before switching on. The mains selector is housed inside to eliminate accidental movement. Looking at the back panel locate the OUTPUT jack and connect this to an amplifier or mixer. The output delivers line level signal, so that when a guitar type amplifier is used a resistor pad may be necessary to avoid input-stage overload. Always use the least sensitive input where there is a choice.

Finally check that the dummy plug is in position in the SEQUENCER multiway socket on the back panel. This plug should only be removed if a Polysequencer is connected, and without it no triggers or polyphonic keyboard information can be delivered.

If you have purchased the optional dual footpedal unit, connect the two jack leads into two of the three sockets provided on the back panel. These are VCA/SWELL, VCF, and PITCHBEND, which allow pedal regulated control of these three functions. See Diagram 1.

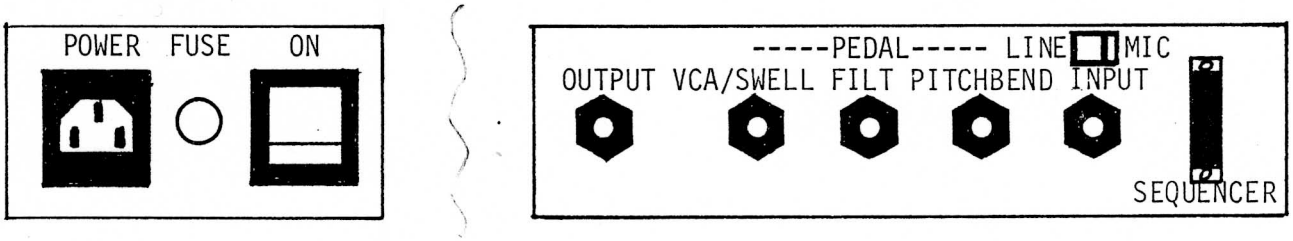


Diagram 1.

Starting to make Sounds. With Polysynthi powered up the two yellow VCLFO leds should be flashing and others may be permanently on elsewhere. To zero all the controls and switches set them according to Patch No.1. Specifically ensure that all the bus switches are off with the exception of the two yellow Keyboard to ADSR1 and ADSR2 switches and the red Keyboard to VCOB switch. Touching the keyboard should now make the two sets of ADSR leds light up. The Filter (VCF) has been bypassed by turning the yellow DIRECT CONTROL knob to zero, FREQUENCY to 10 and Q to zero (CONTROL LEVEL is only effective when one of the three red bus switches below the VCF is selected). It would be possible to bypass the VCA by setting DIRECT CONTROL to zero and INITIAL GAIN to 10. The Analogue Delay Line(ADL) is bypassed by turning MIX to zero.

With the controls set in this way the raw material from the SOURCES section can be monitored without any treatment. Play the keyboard to try out the three basic waveforms. Note the difference in harmonic quality between them. Try different settings of the RANGE switch. The TUNE knob adjusts the pitch of Polysynthi to other instruments. With KEYBOARD MEMORY 'ON' the last note or chord will sustain indefinitely if the VCA is bypassed. This feature allows notes to be enveloped after the keys are released. NOISE is unaffected by this and can be mixed in as desired. Use of the External Input facility is described in the section entitled 'Description of the Devices'.

Now re-set the controls of both ADSR envelope generators (e.g. Attack 1, Decay 4, Sustain 6, Release 6). With KEYBOARD MEMORY 'ON', VCA DIRECT CONTROL at 8, and INITIAL GAIN at zero, ADSR2 is delivering the envelope to the VCA, and DIRECT CONTROL acts as an overall volume control. Try out different ADSR settings. Set DIRECT CONTROL in the VCF to around 6 and reduce the FREQUENCY setting from 10 whilst playing until the effect of the filter is heard. Try different settings of Q and also the 4-pole/2-pole switch. Although the blue waveform invert switch is not effective on the DIRECT CONTROLS, the black COMPLETE

ATTACK switch does have an effect. If a long attack is set on either ADSR and the switch set to ALWAYS, then the playing of successive notes will not re-start the envelope cycle until the Attack phase is completed. This facility is useful in creating long sweep functions while retaining a normal envelope with the other ADSR. Now set MIX in the ADL to 10. With CHORUS 'ON' and FEEDBACK at zero a preset-speed rotating loudspeaker effect is produced. The DELAY and CONTROL LEVEL knobs are bypassed until CHORUS is switched 'OFF'. With CHORUS 'OFF' try out different settings of DELAY, FEEDBACK and the LONG/SHORT switch. Be careful of the howlaround effect when the FEEDBACK knob is near 10. To try out the VCLFOs select the red bus switch immédiately below the CONTROL LEVEL knob in the VCOB section. Switching it up will connect VCLFO1, switching it down will connect VCLFO2. In this instance there are two level controls to be adjusted. The white VCLFO output LEVEL knob and the VCOB input CONTROL LEVEL should both be turned up to allow the VCLFO to control the VCOB pitch. Experiment with different settings of RATE, LEVEL and using the blue waveform switch to select the Square/Pulse output, PULSE WIDTH. Note that VCLFO2 is twice as fast as VCLFO1 at equivalent RATE knob settings.

Finally, experiment with the Keyboard pressure (↓) and top-note (→) voltages. Use the same set-up as before with VCLFO1 controlling the VCOB pitch, except also switch the Keyboard voltage to VCLFO1 RATE red control bus switch up. Depending on the setting of the CONTROL LEVEL KNOB in VCLFO1 the RATE of the oscillator will alter according to the position of the highest key struck. Similarly, if the same red bus switch is moved down, the pressure voltage is engaged to control VCLFO RATE and pressing down on the keyboard will speed up the VCLFO RATE to a degree determined by the CONTROL LEVEL setting.

The user should now have a basic understanding of how Polysynthi works. The remaining sections of the handbook deal with detailed descriptions of each device and some ready made patch sheets.

Description of the devices

a) Envelope Follower

b) Voltage controlled Low Frequency Oscillators

c) Envelope Generators

d) Noise generator and External Input

e) Voltage controlled Oscillator Bank

f) Filter

g) Amplifier

h) Analogue Delay Line

a) Envelope Follower

The Envelope Follower is located in the red CONTROLS section at the extreme top left of the front panel. It allows an external instrument input to trigger ADSR1 when the input level reaches a variable threshold. Filtering, Delay and Envelope effects can then be triggered off as each note is played.

Two knobs control the functions of the Envelope Follower. GAIN adjusts the input sensitivity of the external signal preamplifier to suit the level of the input signal. All possible signal levels can thus be matched to Polysynthi when GAIN is adjusted and the MIC/LINE switch on the back panel is set appropriately. To do this GAIN is increased as far as possible , to produce a clean undistorted sound when the EXTERNAL INPUT knob in the SOURCES section is turned up and the VCF, VCA and ADL are bypassed (as described in 'Starting to make Sounds). THRESHOLD sets a level which if exceeded causes a trigger pulse to be delivered to ADSR1, and the yellow TRIGGER ON led of the Envelope Follower to light. THRESHOLD should generally be set so that the player can control the formation of envelope trigger pulses without difficulty. Once GAIN and THRESHOLD have been set, the external input level should be controlled by the knob marked EXTERNAL INPUT in the SOURCES section.

b) Voltage controlled Low Frequency Oscillators(VCLFO1 and VCLFO2).

There are two low frequency control oscillators in Polysynthi and these are located below the Envelope Follower in the left-hand most CONTROLS section.

Sine and variable Pulse waveforms are generated over a frequency range of 0.08 - 20Hz for VCLFO1 and 0.04 - 10Hz for VCLFO2. Both frequency and output level are voltage controllable independently on each VCLFO. Associated with each VCLFO are four knobs, one function switch, and four control bus switches. RATE sets the repetition frequency, and using the three red bus switches it can be controlled by either keyboard top-note voltage or pressure, ADSR1 or ADSR2,, as well as the other VCLFO. CONTROL LEVEL regulates the amount of rate control applied to the VCLFO from however many controlling sources have been selected on the busses. A blue switch selects either Sine or Pulse output. PULSE WIDTH alters the mark-space ratio of the pulse output, a display of which is shown by the yellow led next to the knob. If the Sine output is selected, this will not be affected by PULSE WIDTH. LEVEL adjusts the amplitude of the of the VCLFO putput, but can also be voltage controlled by either the keyboard top-note voltage or pressure if the white bus switch is selected. Note that even when the LEVEL knob is at zero an output can still be produced from the VCLFO by voltage control from the keyboard.

c) Envelope Generators(ADSR1 and ADSR2).

Two ADSR-type Envelope generators are located in the right-hand part of the CONTROLS section. Both are identical in specification, using the conventional ADSR format to give 5ms to 10sec on each of the ATTACK, DECAY and RELEASE parameters. SUSTAIN level is variable from off to fully on. In addition to these four basic controls, each ADSR has a blue output invert switch, a black COMPLETE ATTACK switch and an output level knob. The triggers to each ADSR are routed via the two yellow bus switches which can connect either VCLFO and the keyboard as trigger sources. Additionally ADSR1 can be triggered from the Envelope Follower when an external input is being used. Three led indicators show the duration of each phase of Attack, Decay and Release while the ADSRs are in action, giving a useful visual chech of the envelope's state. The output of each ADSR can be inverted using the blue switch to produce many different control waveforms, all available on the busses to modulate VCLFO rate, Filter frequency, Amplitude, and Delay time. For a conventional patch though, it is unnecessary to use the busses to route the ADSR outputs since a DIRECT CONTROL is provided to both the Filter and VCA from ADSR1 and ADSR2 respectively. These controls cannot be inverted and are the only prepatched control voltages in Polysynthi along with the PITCHBEND knob. Because of this and the fact that no signal patching is necessary one need only select the yellow keyboard trigger bus switches and turn up both DIRECT CONTROL yellow knobs to achieve a regular patch. Different types of triggering are available through the provision of the COMPLETE ATTACK switch which determines whether each envelope cycle proceeds to completion of the attack period before a new gate can reset it, as in the ALWAYS position, or whether it gets reset to begin a new cycle by each new gate from the keyboard or VCLFO selected. Note that when adjusting the Sustain level with a note held down the loudness of the signal can only change at the rate determined by the Decay time setting.

d) Noise Generator and External Input.

Noise Generator. A white noise source is provided in the SOURCES section. The green NOISE level knob controls the amount of white noise which is mixed with any selected amount of External Input and Oscillator Bank waveforms before the whole signal passes into the Filter. Noise is used to produce wind, sea and percussion effects.

External Input. A stereo jack socket on the back panel marked EXT INPUT can be used to connect an external instrument input to Polysynthi. All types of balanced, unbalanced, high or low impedance, microphone or line level signals can be connected. First set the the MIC/LINE switch on the back panel to suit the type of input level being used (less than 80mV is mic, more is line). If a balanced signal is used, the jack should be wired in the conventional tip to inphase, ring to antiphase and sleeve to screen way. If an unbalanced jack is inserted, the sleeve and ring are automatically shorted together. The GAIN control in the far left Envelope Follower section can now be adjusted to match the level of the incoming signal. Increase GAIN as far as possible to produce a clean undistorted signal when the EXTERNAL INPUT knob in the SOURCES section is turned up and the VCA, VCF and ADL are bypassed (as described in Starting to make Sounds). The desired mix is now adjusted by the knob EXTERNAL INPUT to pass through the VCF.

e) Voltage controlled Oscillator Bank (VCOB).

In the central SOURCES section below the noise source and external input controls is found what is essentially the heart of Pllysynthi. All the notes are derived from one single master Oscillator and it is possible to play as many notes simultaneously as can be held down. Three waveforms can be mixed together to form the basis of material to be filtered and amplitude modulated into final shape. From the left, Pulse is shaped like a narrow 'blip' and causes a very nasal tone quality with much high frequency harmonic energy. Square,in the middle, is the classic reedy sound of all synthesizers with odd harmonics only, giving rise to a hollow tone quality. Finally, to the right, the Triangular wave output is the purest in quality, having nearly all its energy in its fundamental frequency with only a slight presence of upper harmonics.

In order to produce a sound on an electronic keyboard which decays like a plucked string after the key is released it is necessary to electronically remember which notes have just been played. With KEYBOARD MEMORY 'ON', the last last note or chord will be continued until the next new note is played. In the 'OFF' position the keyboard will behave similarly to a regular electronic organ with each note cutting off as soon as it is released. Six octave ranges are available from 32' to 1' by altering the RANGE switch, giving a total span of nine octaves from subsonic bass to the tinkliest highs. In addition, using the TUNE control it is possible to vary the overall pitch of Polysynthi over a continuous range of a sixth, within which numerous pitchbend, vibrato and frequency modulation effects are possible. Due to the stable linear master oscillator, Polysynthi will not go out of tune like conventional synthesizers. The large red PITCHBEND knob to the left of the keyboard is permanently connected to control the VCOB pitch and will spring back to its central position when released. Pitch bending both up and down over a range of 10 semitones is possible (the return point of the PITCHBEND effect will depend on the setting of TUNE).

With the exception of the bottom left keyboard bus switch all the red bus switches below the SOURCES section are devoted to the voltage control of the VCOB pitch. Possible sources of control are either VCLFO, with either ADSR and keyboard pressure. Only in special instances will the polyphonic bottom left switch be turned off since this connects the keyboard polyphony to the VCOB. If the switch is deactivated in the middle of a chord with KEYBOARD MEMORY 'ON', those notes will remain sounding so that both hands are freed to alter the control settings. Keyboard pressure and top-note voltage can then be utilised without fear of altering the held chord. All the other three red switches below the VCOB are mixed through the CONTROL LEVEL knob and control the TUNE function of the VCOB. CONTROL LEVEL is used to set vibrato depth if the top VCLFO bus switch is on, or the pitch rise if the pressure voltage from the keyboard is switched in. An accessory footpedal can also be connected to the back panel socket marked VCOB, which will allow pitchbend effects to be foot controlled (not affected by CONTROL LEVEL).

f) Filter (VCF).

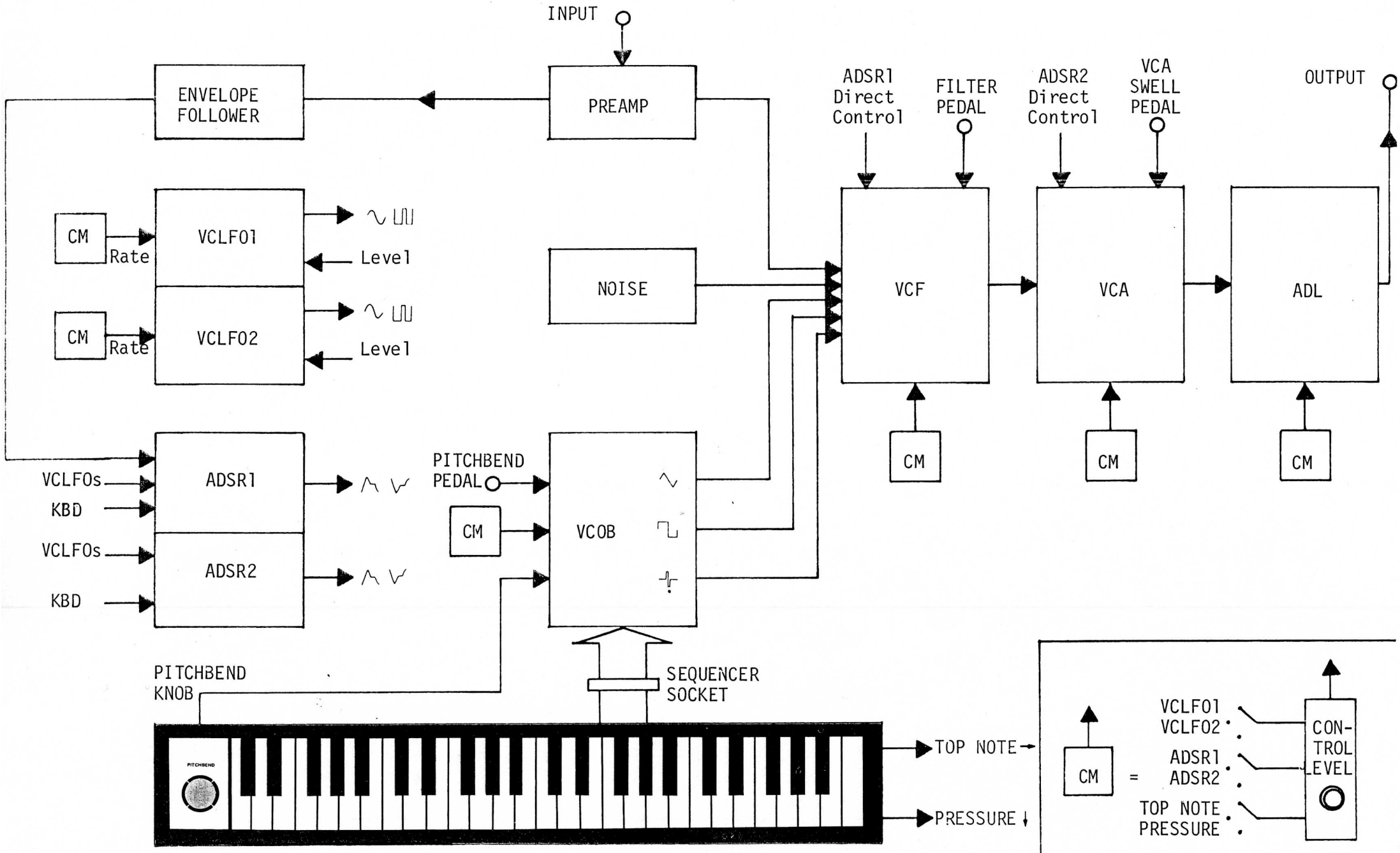
First in the TREATMENTS section comes the filter, which is fed by the combined outputs of the VCOB, Noise generator and External Input. The VCF is a low-pass switchable two pole (12 dB/octave) or four pole (24 dB/octave) voltage controlled device and its Q or resonance is variable from flat to highly resonant (not quite oscillating). Since the cut-off of the filter in the four pole mode is twice as steep as in the two pole mode a more distinctive filtering is produced, resulting in a richer and more mellow sound quality. The two pole position does not offer such a contrast of tone colours in a sweep and so is used when a brighter sound or a gentle change of timbre is required. DIRECT CONTROL introduces a variable amount of ADSR1 output to sweep the filter FREQUENCY as a prewired patch connection. Remember that DIRECT CONTROLS cannot be inverted. CONTROL LEVEL sets the amount of control affecting the filter frequency from the selected bus switches. A choice of either VCLFO, either ADSR, keyboard top-note voltage or pressure voltage can be routed to control it. A jack socket on the back panel marked VCF also allows an accessory footpedal to bypass the CONTROL LEVEL knob and control the filter frequency. When the keyboard top-note voltage is used to control the filter frequency the higher notes on the keyboard will open the filter further to give a brighter sound, and if CONTROL LEVEL is adjusted to about 6 the keyboard can be made to tune to a particular harmonic, and to preserve that same quality over the keyboard range.

g) Amplifier (VCA).

After the Filter the sound is passed through the VCA where the envelope is applied to the signal amplitude. DIRECT CONTROL introduces a variable amount of ADSR2 output to modulate the VCA gain and thereby create the envelope of each note. Again remember that the DIRECT CONTROLS cannot be inverted. INITIAL GAIN can be set between zero, when a control voltage is required to raise the gain and produce an output, and 10,when the sound will sustain always and be added with the ADSR output. CONTROL LEVEL once again determines the amount of control affecting the VCA from the bus switches, where either VCLFO, either ADSR, keyboard top-note voltage or keyboard pressure can be routed to control it. Additionally a jack socket on the back panel marked SWELL allows an accessory footpedal to bypass the CONTROL LEVEL knob and affect the VCA gain.

h) Analogue Delay Line (ADL)

The Analogue Delay Line is the last treatment the sound will have before the output jacksocket. The output from the VCF passes into the ADL and the MIX knob determines whether the ADL is bypassed, with the knob set to zero, allowing the VCA output to go out 'dry', or to blend in the signal of the ADL output. The ADL can produce a huge variety of treatment including Flanging, Echo and reverberation because the delay time is a parameter which can be voltage controlled. Either VCLFO, either ADSR, keyboard pressure or top-note voltage can be employed to extract a whole host of novel effects. The CHORUS switch introduces a preset delay time modulated by a preset internal LFO giving a spatial effect to the sound. For the best effect set FEEDBACK to zero. With CHORUS 'OFF', DELAY can be set manually to give delays of up to a half second in the SHORT range, and up to one second in the LONG range. FEEDBACK can be varied to produce single repeats at zero or reiterated repeats as the knob is moved towards 10, ending in a regenerated feedback howlaround (which can only be cleared by reducing the setting of FEEDBACK). CONTROL LEVEL determines the amount of voltage control affecting DELAY from any of the three red bus switches which are selected. To produce flanging set DELAY as short as possible and introduce a VCLFO control from the top red bus switch. Increase FEEDBACK until the effect is optimised. Note that in the CHORUS mode the DELAY and CONTROL LEVEL knobs are inoperative.



Polysynthi Block Diagram.

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