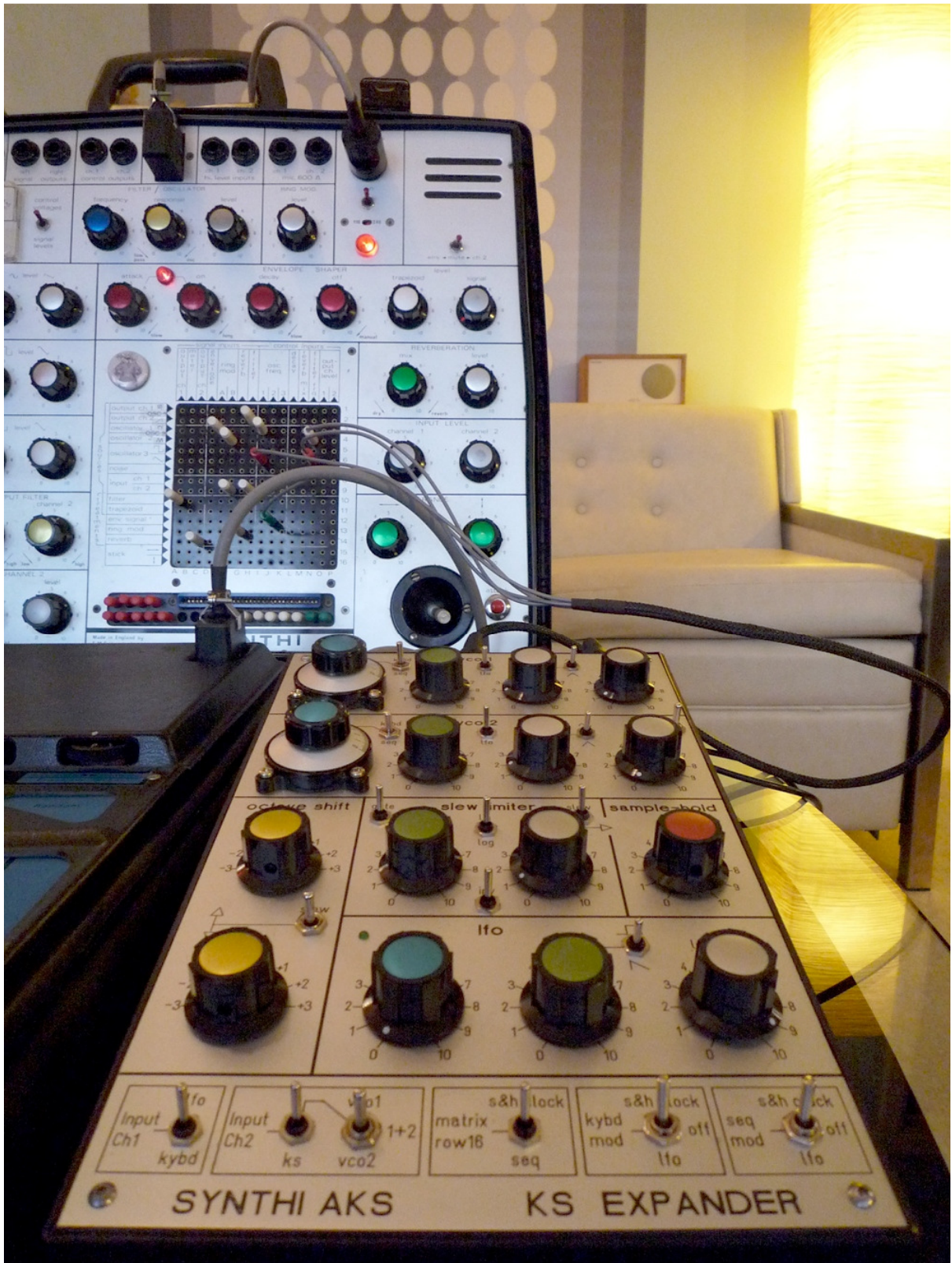






## **Acknowledgements**

My sincere thanks go to Constantin Papageorgiadis for his thorough testing of the first production unit and his insightful suggestions and comments, all of which have made the Synthi KS Expander even better than I had originally envisaged. Thanks also to Zeitdehner for his ace photography and for providing the coolest retro apartment in Brussels as a backdrop for the Expander photos used on my website!.



**Every Synthi AKS needs a Synthi KS Expander...**

## **Preface**

The Synthi AKS KS Expander is a new 'Expansion' unit for the Synthi AKS Keyboard Sequencer (KS). It could work equally with an EMS TKS (the version of the KS EMS made as a standalone unit to be used with a VCS3 mk2). The KS is a great feature of the Synthi AKS and while it's no great shakes compared to modern hardware sequencers it's what makes the Synthi AKS arguably the most desirable of all the portable Synthi's. What the KS offers is 3 channels of CV into the Synthi Matrix: two pitch CV channels via Input Ch1 and the Seq Input (the latter recordable via the sequencer the former real time via the touch sensitive keyboard) in addition to a dynamic envelope CV via Input Ch2 whose amplitude varies with how hard the touch keys are played.

What is lacking from the KS compared to the EMS DK1/2 is the additional VCO that is a great feature of these keyboards. Whilst comparing a KS with a DK1/2 is hardly fair, I thought it would be great to be able to add additional oscillator(s) to the KS, available to the matrix via a switchable option on Input ch2. This was the starting point of the KS Expander project but as is often the case things quickly develop into something bigger and one thinks of other features such a "KS Expander" might have! Of course there are many voltage processing effects besides additional VCO's one can imagine adding like Sample and Hold, Slew Limiters, Inverters, Octave Shift all of which are incorporated in the KS Expander.

This user guide gives an in-depth look at all the features of the Expander, how they integrate with those already present in the Synthi AKS and how they may be used in practice. Example dopesheets are presented for the user to try and which will hopefully encourage further experimentation. Experimentation is, after all, what the Synthi surely stands for.

Steve Thomas

Digitana Electronics

St Albans, England, 2011.

# THE KS EXPANDER MAIN SECTIONS

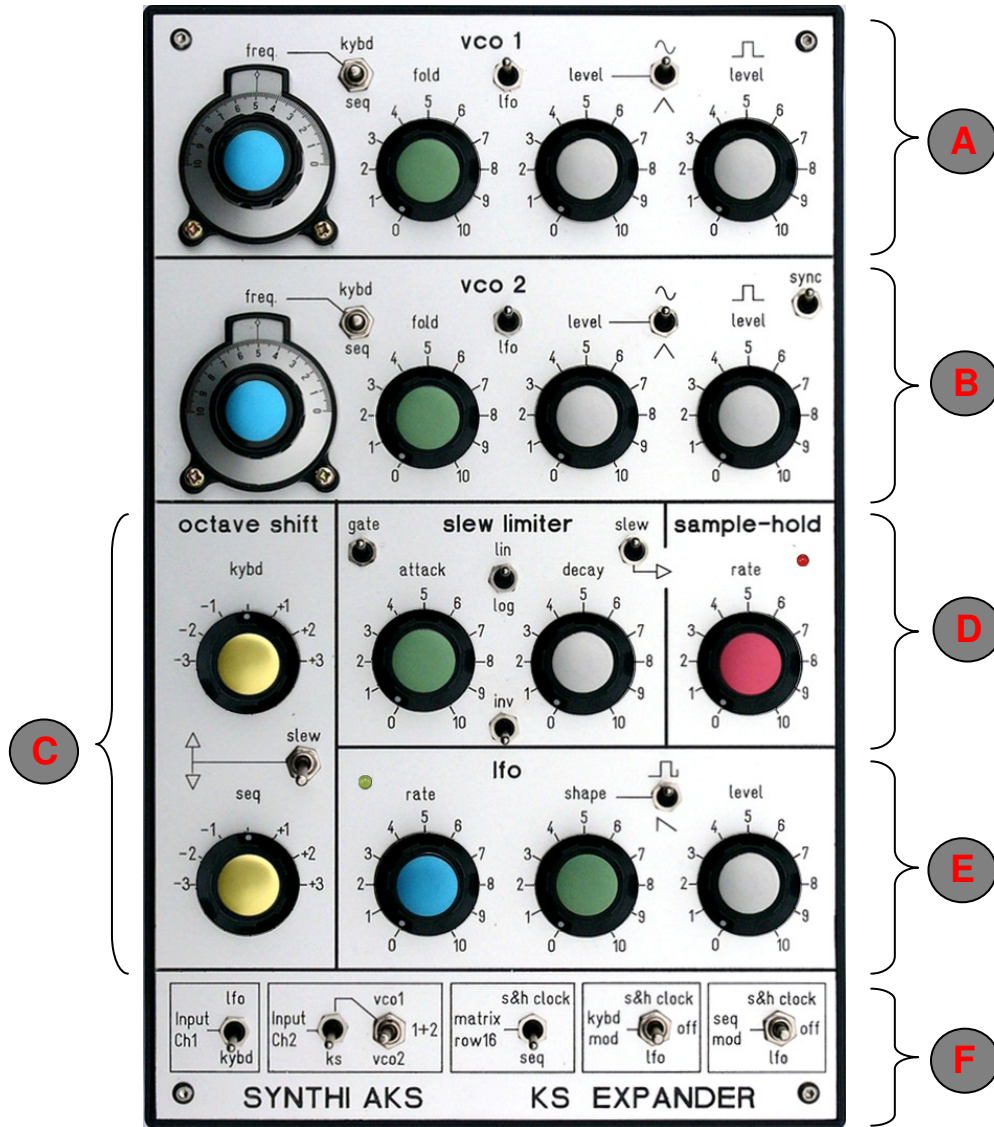


Fig. 1

- A** VCO1 featuring sine/triangle and square waveforms with individual level control; CV source from either the KS keyboard or KS sequencer or free running; wave-folding of sine/tri waves with LFO modulation of folding.
- B** VCO2 with the same specification as VCO1. Additionally this section has a synch switch. Two types of synch; standard synch and wave-folding synch between VCO1 and VCO2.
- C** Octave shift section. Independent shifts by up to +/-3 octaves on keyboard and sequencer CV of the KS. Additional switch allows processing of the octave shifted CV by the Slew Limiter.
- D** Slew Limiter and Sample&Hold sections. The Slew Limiter involves adjustable attack and decay times and a linear or logarithmic response. Also includes optional inverter. Additionally the gate pulses generated by the KS (either via keyboard and/or sequencer) can be slewed to produce attack/decay envelopes. The Sample&Hold section has usual variable clock rate ranging from a few milliseconds to about 2 seconds. Finally the output of the Slew Limiter can be fed into the S&H section via a toggle switch.
- E** LFO section. Variable shape triangle and pulse waveforms with level control.
- F** Control switches section. Allows different routing possibilities for VCO1, VCO2 output mix, S&H clock (provides a triangle LFO wave whose rate is controlled by S&H rate knob) and LFO output into the Synthi Input channels 1 and 2, or the sequencer input to the matrix (row 16) or as modulation sources for both keyboard and sequencer CV generated by the KS.

## **THE KS EXPANDER REAR PANEL**

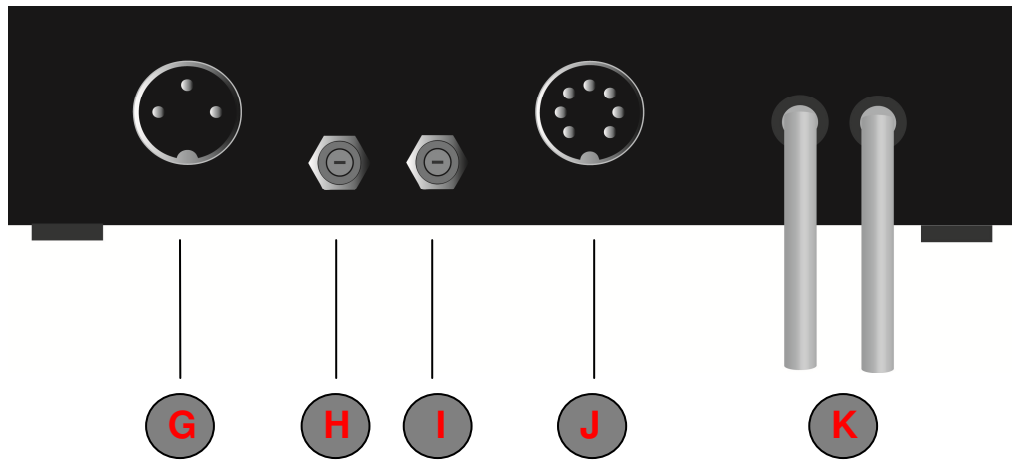


Fig. 2

- G** 3 pin power connector . Unit uses +/-12V provided by the custom external power supply unit described below.
  
- H** Multi-turn precision trimmer for calibrating the sequencer CV from the KS so as to produce chromatic pitches when controlling Synthi oscillators 1 and 2 at 0.32V/octave.
  
- I** Multi-turn precision trimmer for calibrating the sequencer CV from the KS so as to produce chromatic pitches when controlling Expander oscillators 1 and 2 at 1V/octave.
  
- J** 7 pin connector for the special E.M.S. pin cable (described in more detail below)
  
- K** Cables connecting the Expander unit to both the KS and the Synthi.

## Power Supply

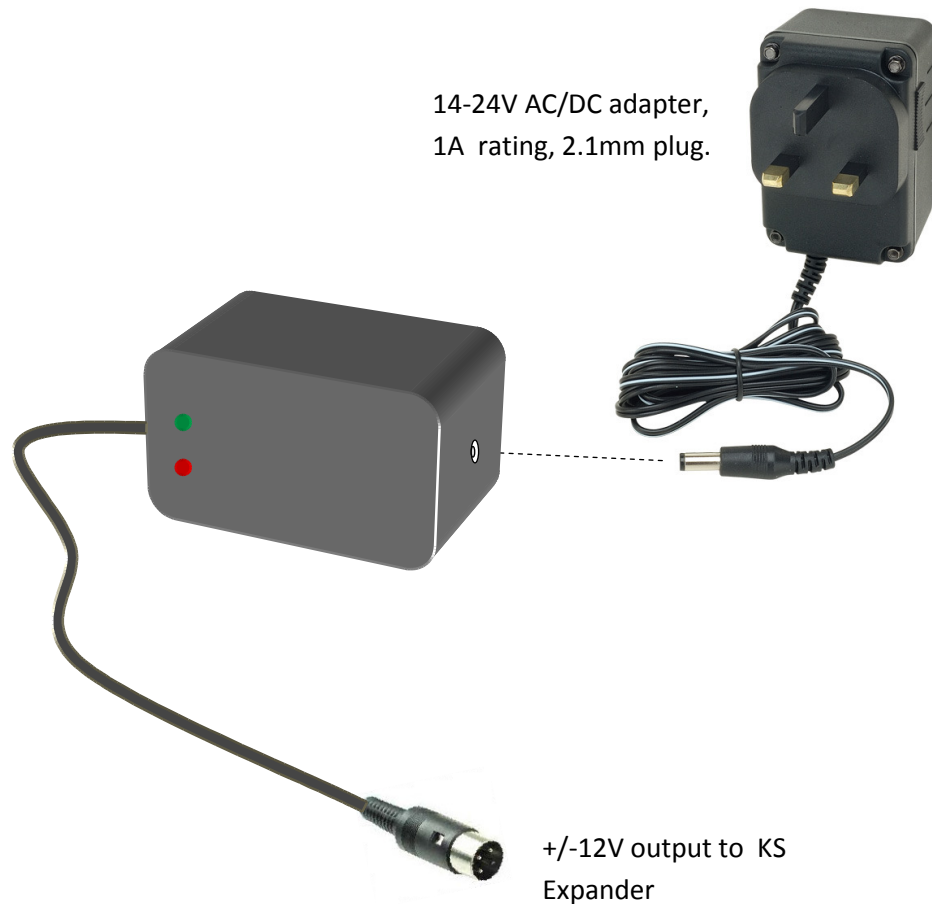


Fig .3

The KS Expander is powered by split +/-12V power rails. Since it doesn't draw much current (about 150ma) a convenient and stable split supply can be created by the use of industry standard LM2575T switching power regulators made by National. The converter circuit is housed in a small box and takes any DC voltage input ranging from 14-24V and converts it to a split, regulated supply of +/-12V. These regulators can supply up to 1A current if heat-sinked. But since as mentioned the total current draw is nowhere near that, the regulators do not get very hot and the box itself only mildly warm in use. The +/-12V output is via a 3-pin DIN plug. The DC supply is easily provided by an ac/dc adapter (or 'wall wart') in the 14-24V range. An adapter of maximum current rating around 1A is best. Although this power rating might seem unnecessarily high, it's better not to put a strain on any ac-dc adapter as its voltage output will tend to droop. When powered up, red and green led's on the power unit light to indicate the +/-12V voltages are present.

Finally note that it's better to connect the ac/dc adapter output to the psu box **before** powering on. This is because the switch mode circuit provides inductive loads which can cause surges on initial switch on.

## E.M.S. Pin Cable

The special pin cable, which connects to the rear of the unit via 7-way DIN plug, is used to route signals from any of row of the Synthi AKS matrix into the Slew Limiter and the Sample&Hold sections of the Expander. The plugs are colour coded:-

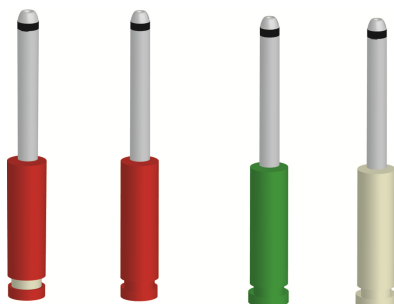


Fig. 4

The red pins are associated with the S&H section (which has a red knob for the clock rate control). The green pin with the Slew Limiter section and finally, as an additional feature, there is a white pin which allows any signal to be inverted.

The way the pins route signals is as follows. When you insert any standard resistor patch pin into the Synthi mk2 matrix, the 'base' of the pin connects to the signal coming into the row of the matrix where it is inserted, which then passes through the resistor and emerges via the 'tip' of the pin and then into the column where the pin was inserted, as shown in Fig. 5 below. So the base of the pin connects to matrix rows and the tip of pins to the matrix columns (as an aside: unfortunately E.M.S. for some reason chose to wire up mk1 matrices found on VCS3(mk1) and Synthi A's the opposite way around compared to mk2 matrices! That is, for mk1 matrices, the base of a patch pin connects to the matrix *column* and the tip to the *row*! Very confusing but true. But this isn't a problem here because the Expander is designed specifically to work with a Synthi AKS which has mk2 matrix.)

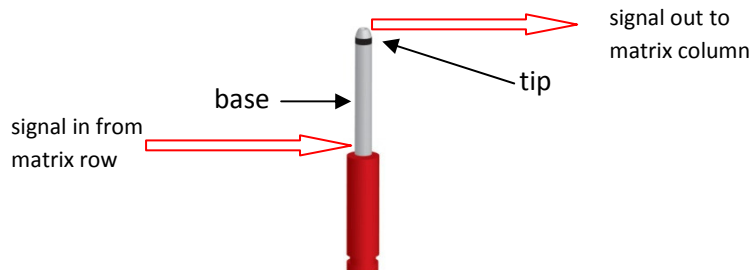


Fig. 5

In the pin cable, there are no resistors in the pins, but instead each pin's base and tip have cables connected to them that make up the loom. The wires connecting to the base of the pins are connected to the inputs of the Sample& Hold circuit (red pins), or Slew Limiter (green pin) or an inverter circuit (white pin). The outputs of the each circuit are connected to the corresponding pin tips. You may wonder 'why two red pins'? Well one red pin is 'plain' while another is marked with a white band. The plain red pin routes signals from the matrix into the S&H circuit but then out through the pin tip. The red pin marked with white band does the same but in addition the output from the S&H is *inverted*. The pins are illustrated in Fig. 6 below.

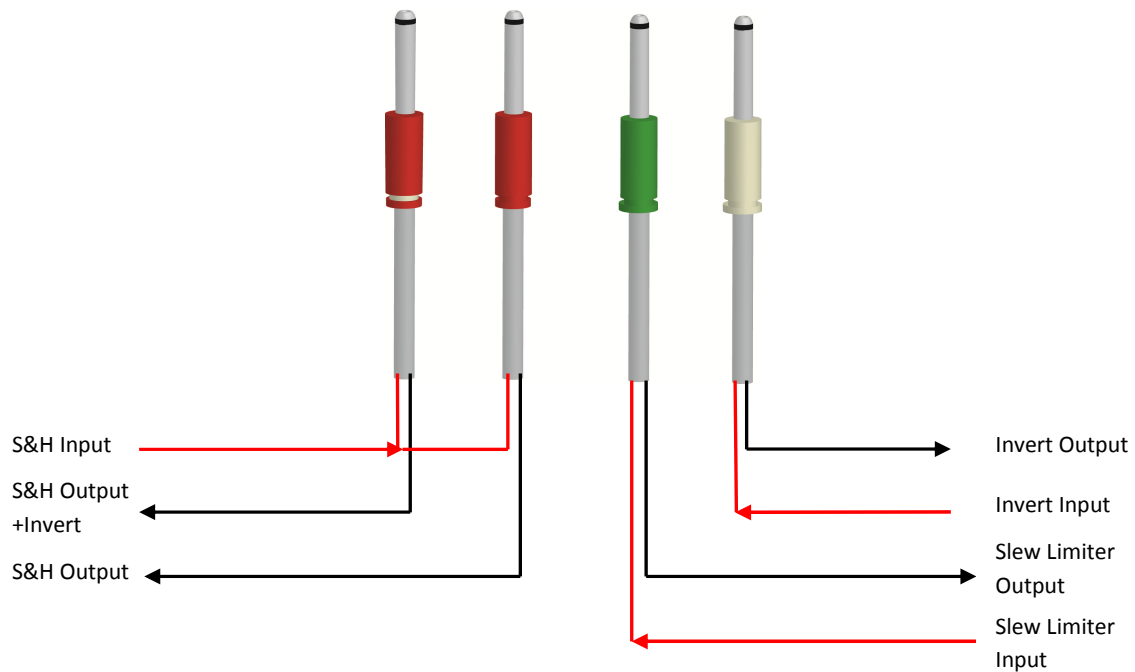


Fig. 6



## DETAILED DISCUSSION OF EACH SECTION



Section **A** and **B** contain the two VCO's of the Expander. They are both built around the XR2206 VCO IC produced by Exar. This chip is a monolithic function generator capable of generating very accurate sine, triangle and square waveforms. The accuracy of the sine shape is typically 0.5%. A wide frequency range under voltage control is available up to 2000:1. This allows these VCO's to range from LFO through to the audio range. Even without special temperature compensation, the temperature stability of the 2206 waveforms is about 20ppm/°C. The exponential converters used in both VCO's (these are discrete circuits separate from the XR2206) use tempco resistors so that the resulting VCO is very stable and accurate. In addition the 2206 has a very useful feature that allows for amplitude modulation of the output wave via any external voltage. What is particularly novel, is that the modulated amplitude can be reversed in sign when the control voltage exceeds about  $V_{cc}/2$  ( $V_{cc}$  being the positive supply rail). Thus a waveform can be made to go through zero smoothly and then reverse its phase! This feature can be used to allow voltage controlled wave-folding in each VCO as well as some very novel synching between VCO1 and VCO2 which we will describe below. A plot of this amplitude modulation as a function of control voltage is given in Fig. 8 :-

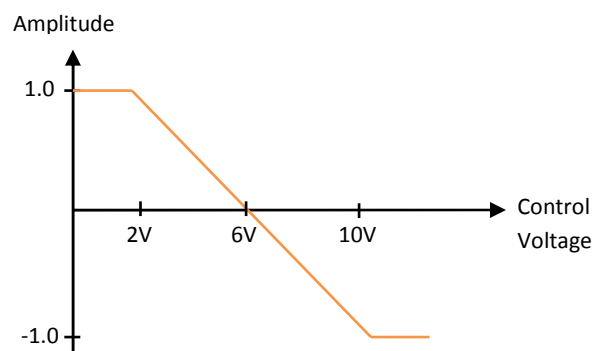


Fig. 8

The novel feature, as mentioned is the reversal of the phase of the wave if the control voltage exceeds  $V_{cc}/2$  (which is about 6V because in the case of the Expander,  $V_{cc}=+12V$ ). This can be used to do some very nice wave-folding, a feature I believe was first suggested by Thomas Henry who showed how the XR2206 can make a wonderfully musical VCO. The wave-folding can be achieved on either the sine or triangle waveform by using as the square wave as the control voltage! How this works can be seen if you look at the phase relationship between the three waves:-

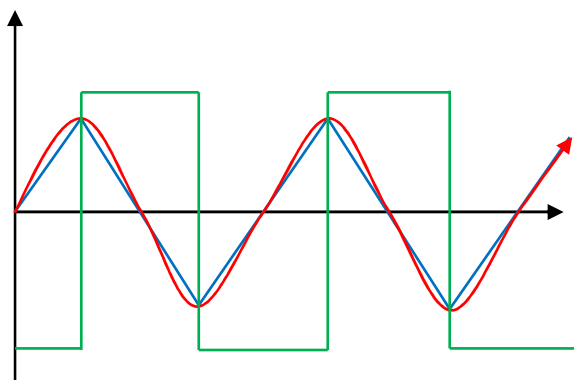


Fig. 9

An important point is that the phase of the square wave generated by the XR2206 is shifted by  $90^\circ$  compared to the sine and triangle waveforms. Thus if you use the square wave itself to modulate the amplitude of e.g. the triangle wave, then because of the phase-reversal feature displayed in Fig. 8, we can fold the wave continuously by increasing the amplitude of the square wave. The following figure illustrates this:-

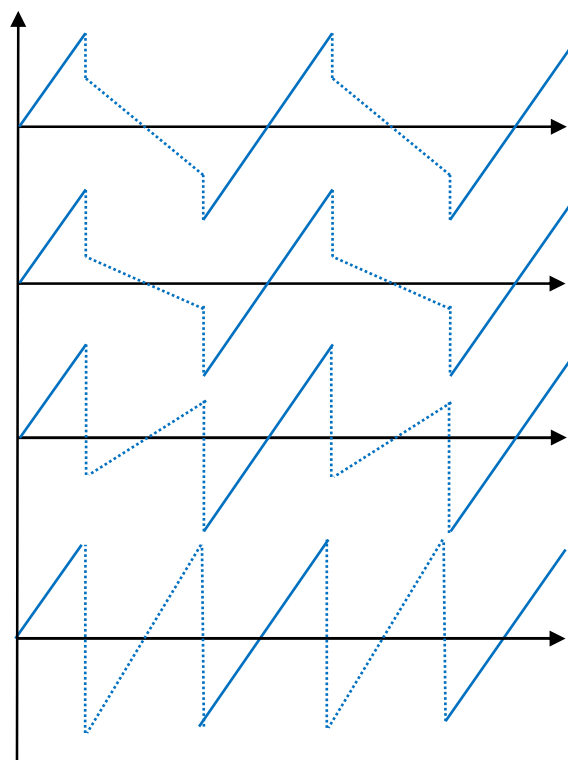


Fig. 10

Fig. 10 shows the triangle waveform on applying varying amounts of wave-folding via the square wave. New harmonics are added to the wave as the amount of folding increases. Eventually when the folding is large enough, a new wave is produced having precisely twice the frequency of the un-folded triangle wave! Because the folding only occurs when the square wave is positive, the resulting wave is an up-ramp rather than a triangle. A similar affect is obtained by folding the sine wave, although different harmonics will be produced.

Thus in turning the wave-folding pot from 0 through to 10, you hear great new harmonics entering as the folds start to appear and eventually you get a perfect doubling of the frequency which makes this effect extremely musical and 'sweet' sounding! Even better is the implementation of voltage controlled wave-folding via the toggle switch labelled 'lfo'. In the off position, wave-folding is adjusted by the fold pot setting. In the on position, the waveform from the LFO section is used to control the amount of wave-folding. By adjusting the level of the LFO output and the position of the fold pot, you can control the amount of wave-folding 'swept' by the LFO.

The vernier dial adjusts the initial frequency of VCO1. A 3-way toggle switch allows the oscillator to free-run (i.e. frequency remains as set by the vernier) or to be controlled either by Keyboard CV from the KS ('kybd') or via the Sequencer CV (labelled 'seq') from the KS. Finally in this section, there is a toggle switch that switches between sine or triangle waveforms and pots to adjust the level of the sine/triangle and square waves.



Section **B** contains VCO2 which has all the features of VCO1 described above.

## Synch

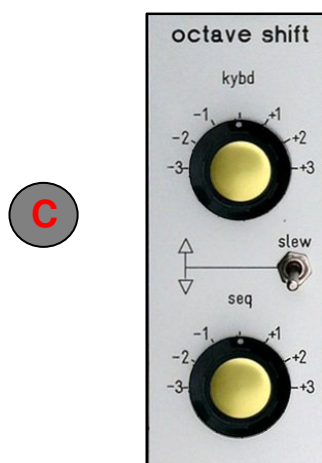
The new feature of this section is a toggle switch to control the syncing of VCO2 with VCO1. In the off (centre) position of this switch, there is no syncing. In the up position, VCO1 and VCO2 are synced. The XR2206 IC has a pin which can be used to effectively synch the oscillator via an external square wave. This square wave provided by VCO2 is used to synch VCO1. This gives the familiar tones of two

synched oscillators with complicated waveform being generated with rich harmonic content as the relative frequency of the two oscillators are varied.

## Fold-synch

A new kind of synch is available when the sync toggle is in the down position. This synch, called 'fold-synch' for want of a better word, makes use of the wave-folding features described in section **A** above. What happens is that instead of using the square wave of VCO1 to implement the folding of the sine/triangle waves of VCO1 (as illustrated in Figs. 9 and 10), the square wave from VCO2 is used to fold the sine/triangle waveforms of VCO1. The difference should hopefully be clear. You can now freely adjust the frequency of the sine/triangle waves of VCO1 and the square wave from VCO2. If the frequencies are the same then the wave-folding of sine/triangle will look as in Fig.10. But if you now change the relative frequency of the square wave from VCO2 (either to be less than or greater than VCO1) new waveforms will be generated many of which have very hard-synch type timbres. In order to make use of this you have to have the fold pot of VCO1 in the 'active' position so that wave-folding can take place. This fold-synching does not affect the square wave of VCO1 and also note the folding of VCO2 remains unchanged

Experimenting with adjustment of the relative frequencies of VCO1 and VCO2 along with the fold pot of VCO1 and VCO2 will produce some fascinating and bizarre timbres!



Section **C** contains the Octave Shift rotary switches for both Keyboard and Sequencer CV generated by the KS. Each of these switches can independently shift the octave range of the CV by +/- 3 octaves. This is a very useful feature because the KS keyboard is rather limited in its note range. Thus one can immediately transpose note sequences in real time as they are played back through the KS sequencer as well as transposing the keyboard. Additionally there is a 3-way toggle switch labelled 'slew'. The normal position is centre (off). In the up/down position it routes either the Keyboard or Sequencer CV through the slew limiter, thus allowing

glissando to be applied to played notes. In order to use this feature make sure the 'gate' switch in the SL section is up (off).



Section **D** has two separate sub-sections namely the Slew Limiter (SL) and Sample and Hold (S&H) .

### Slew Limiter

The Slew Limiter is basically a voltage follower with variable attack and decay times. That is, the circuit detects when a signal is increasing and delays or 'slews' the rise by an amount controllable by the 'attack' pot. Similarly it also detects when a signal through it is decreasing in amplitude (decaying) in time and again has a circuit that slews the decay time by an amount controlled by the 'decay' pot. Two response are also available: linear slew or logarithmic slew. The difference is illustrated in Fig. 11 below :-

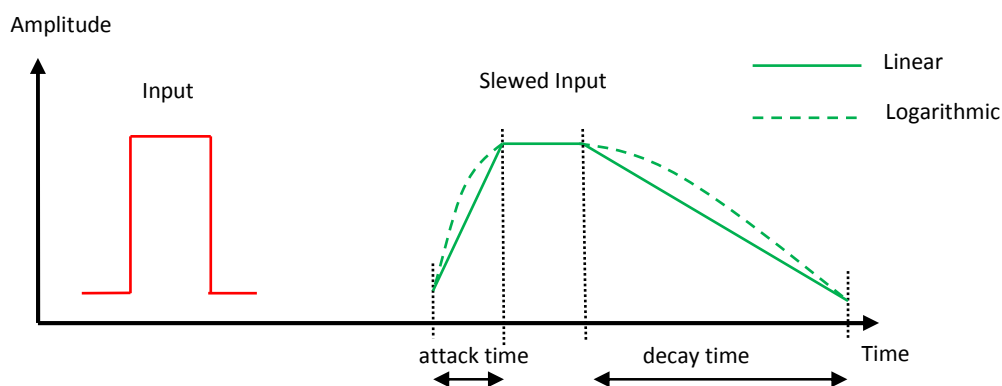


Fig. 11

Logarithmic slewing can produce much longer attack/decay times than linear which is useful. The SL sub-section also has a toggle switch labelled 'invert' that switches between regular slewed output (as shown in Fig. 11) or an inverted version. The inversion option was added because it's well known that the Synthesizer's control inputs (such as filter frequency) often respond differently when an applied control voltage is inverted compared to when it is not. So the inverter adds more creative features.

As explained previously, input and output of the SL is via the green pin of the special pin cable. Inserting this pin into a point in the matrix will route the signal from the row it is inserted into and send it through the SL with the output appearing in the column where the pin is located.

Also in the SL section you will notice a toggle switch labelled 'gate'. What this does when activated (down) is to sample the gate pulse generated by the KS (which triggers the Synthesizer envelope shaper) and slew it. The result is a basic attack/decay envelope as illustrated in Fig. 11 above. The SL can handle bi-polar voltages so any waveform from the Synthesizer can be slewed. Typical uses are for creating portamento/glissando on notes, for creating simple attack/decay modulation envelopes from slewing pulse/square waveforms. Slewing of the trapezoid means you can create longer envelopes for modulation than dictated by the attack/decay pots on the Synthesizer, etc. *Note that when the gate toggle switch is activated, the input to the SL via the green pin is disconnected, whereas the output is still via the pin tip.*

Finally, you will have also noticed a toggle switch labelled 'slew' with an arrow pointing to the S&H circuit. The normal (off) position of this switch is up. In the down position, the output of the SL is fed into the S&H circuit. In this arrangement the two sub-sections are joined in series and the signal fed into the SL via the green pin is then processed by Slew AND S&H and the output emerges via the tip of the red pins. More on using this feature is explained below in the S&H section.

## Sample and Hold

This section is based on the excellent LF398 monolithic S&H IC by National. An accurate pulse waveform (with 1ms wide pulse) is used to sample the incoming waveform. The rate of the sampling can be adjusted from approximately a few seconds right up to near audio. A red led gives a visual indication of the rate set by the rate pot. S&H is a 'classic' processing effect found on many analogue synthesizers. It can be used to produce many interesting new sounds by processing a variety of signals fed into it via the red pins of the pin cable. These signals are normally control voltage waveforms such as the output of an LFO (such as Osc 3 on the Synthesizer) or control envelopes such as the trapezoid generated by the Synthesizer Envelope Shaper or even Sequencer CV from the KS. The sampled CV in all these cases can then be used to control e.g. oscillator pitch, filter frequency, Envelope decay, etc. Probably the most well known effect of S&H is its ability to produce 'quantization' of a continuous waveform into a stepped or 'staircase' shape. E.g. feeding in an up, down ramp or triangle (up+down) waveform from Synthesizer Osc3 can produce the staircases illustrated in Fig. 12 below

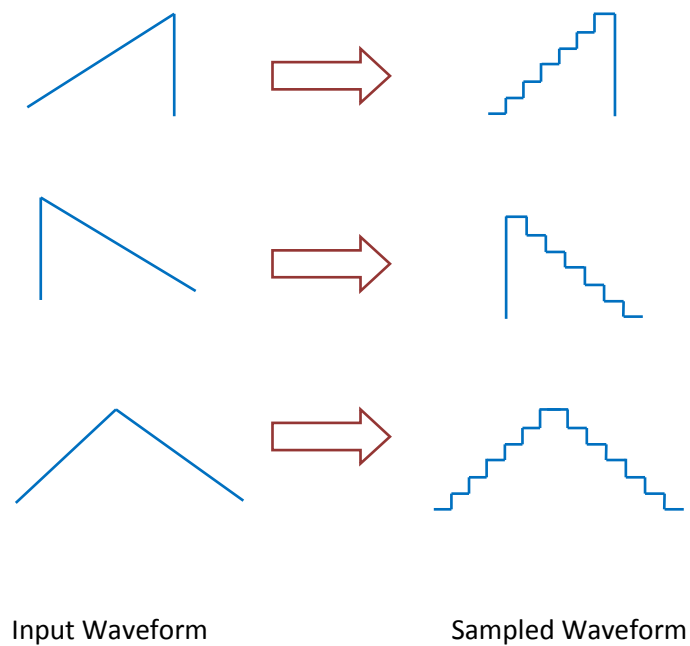
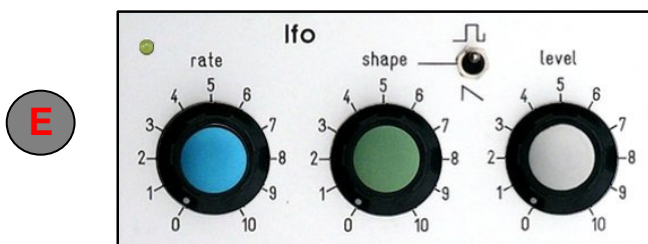


Fig. 12

The number of 'steps' is controlled by the S&H rate vs. the frequency of the sampled waveform.

Input and output to the S&H is via the red pins in the pin cable. As explained earlier there are two such pins, the only difference is that the red pin with white stripe additional inverts the output of the S&H.

As mentioned in the description of the Slew Limiter, the toggle switch labelled 'slew' effectively joins together the SL+S&H in series. In this situation, the green pin is placed anywhere in the row of the matrix where the signal to be processed is present. Then either (or indeed both) of the red pins are used to route the processed signal to the required control inputs of the Synthi.



Section **E** has a variable wave shape LFO. There is a choice of two basic waveforms: pulse and ramp via a 2-way toggle switch. Three pots control the LFO rate, the waveform shape and also waveform level. The shape control allows you to

morph between increasing ramp, triangle and decreasing ramp waveforms. On the pulse wave it controls the pulse duty cycle. Finally there is a green led that indicates visually the LFO rate. The rate can be adjusted from a few seconds to near audio frequency ranges.



Section **F** contains the main control toggle switches for routing various signals and modulations to the Synthi. There are five sections labelled 'Input Ch1', 'Input Ch2', 'matrix row 16', 'kybd mod' and 'seq mod'.

### Input Ch1

This switches between either Keyboard CV from the KS on Synthi Input Ch1 or the output of the LFO section.

### Input Ch2

This section has two separate toggle switches. This first is a simple 2-way switch that toggles between either the KS generated CV on Input Ch2 (which is the 'dynamic envelope' used to produce pseudo-velocity control of the touch keyboard) or to the output of the Expander VCO's. For the latter, a three way toggle switch can allow either VCO1 only, VCO1+VCO2 or VCO2 only. The mix between VCO1 and VCO2 can of course be adjusted using the level pots of the various waveforms. But sometimes it can be useful to be able to switch off VCO1 or VCO2 quickly without disturbing previously set levels. Also recall that both VCO1 and VCO2 are wide ranging oscillators that can also be used as modulation sources via patch pin connection to the control input columns on the Synthi matrix.

### matrix row 13

This section has a 2-way toggle switch that allows you to choose the source into row 16 of the mk2 matrix on the Synthi. The options are either the Sequencer CV generated by the KS or the triangle LFO waveform that has the same frequency as

the S&H clock. Note: the frequency of this triangle wave can only be adjusted via the S&H rate pot, but nevertheless is a useful additional modulation source.

### **kybd mod**

A 3-way toggle switch allows you to modulate the Keyboard CV from the KS. Two waveforms are available 'S&H clock' which refers to the triangle wave described above and the output wave of the LFO section. No modulation is applied in the centre(off) position of the switch.

### **seq mod**

As above but now applied to the Sequencer CV from the KS.

## USING THE KS EXPANDER IN PRACTICE

### Calibration of the KS Expander, Tunings etc.

In order to use the Expander alongside your AKS, you will need to set the calibration multi-turn potentiometers found on the rear panel. There are two of these marked as 'H' and 'I' in Fig. 2. Before we discuss the procedure (which should only be necessary to carry out from time to time) it's useful to explain how the Expander processes the various sources of CV from the KS.

Firstly the KS unit sends out two kinds of 'pitch CV'. Firstly there is 'real time' pitch CV generated when the KS touch keys are played, via Input ch1. In order to control oscillator(s) frequency in real time, patch pin(s) need to be inserted to send this keyboard CV to the relevant oscillators frequency control. The second kind of pitch CV is from notes recorded to the sequencer and subsequently played back. This appears in the matrix via row 16 when the vertical joystick scale pot has been switched fully anticlockwise and 'clicked' off. Again to control an oscillators frequency using sequencer CV, patch pins are inserted connecting row 16 to the relevant oscillators frequency control. There is a final CV generated by the KS which is the dynamic envelope available via Input ch2. From the Expander's viewpoint, we won't really be making use of this CV.

Now in designing the Expander, I wanted VCO 1 and 2 to be able to have their frequency controlled either by keyboard CV **or** sequencer CV (or indeed 'free running' ). This immediately present a technical problem due to the 'odd' scaling of Synthi Oscillators 1 and 2, namely 0.32V/Oct. not the standard 1V/Oct. found on many later analogue synthesizers.

To appreciate the issue, it's a fact that the keyboard CV of the KS actually is scaled at 1V/Oct. You can make fine adjustments to this scaling via the 'Real Time' pitch spread thumbwheel on the KS, but the basic scaling is 1V/Oct. To scale this down to the 0.32V/Oct. needed to produce chromatic pitches via Synthi Osc1 or 2 you have to adjust Input ch1 level pot. By contrast, the sequencer CV that emerges from the KS **is** scaled at 0.32V/Oct, with again fine adjustment possible via the 'Sequence' pitch spread thumbwheel on the KS.

So basically in trying to use both keyboard and sequencer CV produced by the KS, we have the issue that one is scaled at 1V/Oct the other at 0.32V/Oct! I decided to opt for the standard 1V/Oct scaling for VCO1 and VCO2 on the Expander and this is precisely adjusted via 4 25-turn trimpots on the PCB. Since tempco's are also used on both of the exponential converters controlling these VCO's, the 1V/Oct tracking is very robust. Using keyboard CV to produce chromatic scales on the Expander

oscillators is thus straightforward. But to use sequencer CV we need to rescale it to 1V/Oct from 0.32V/Oct. This is achieved by adjusting the multi-turn trimmer labelled 'I' in Fig. 2. So why is second trimpot 'H' needed? Well the Expander actually **processes** both keyboard and sequencer CV from the KS before returning these to the Synthesizer. This processing involves things like octave shifting, and modulation of CV either via the LFO or another triangle wave whose frequency is controlled by the S&H rate pot. Thus having scaled the Sequencer CV from the KS to 1V/Oct. and then processing it, it must be scaled **back** to 0.32V/Oct before being fed to the Synthesizer otherwise it will not be able to play chromatic pitches on the Synthesizer Oscillators 1 and 2 because, as we know, they are scaled at 0.32V/Oct. This is achieved by adjusting trimpot 'H'

The following diagram will hopefully help to visualize the KS CV paths:-

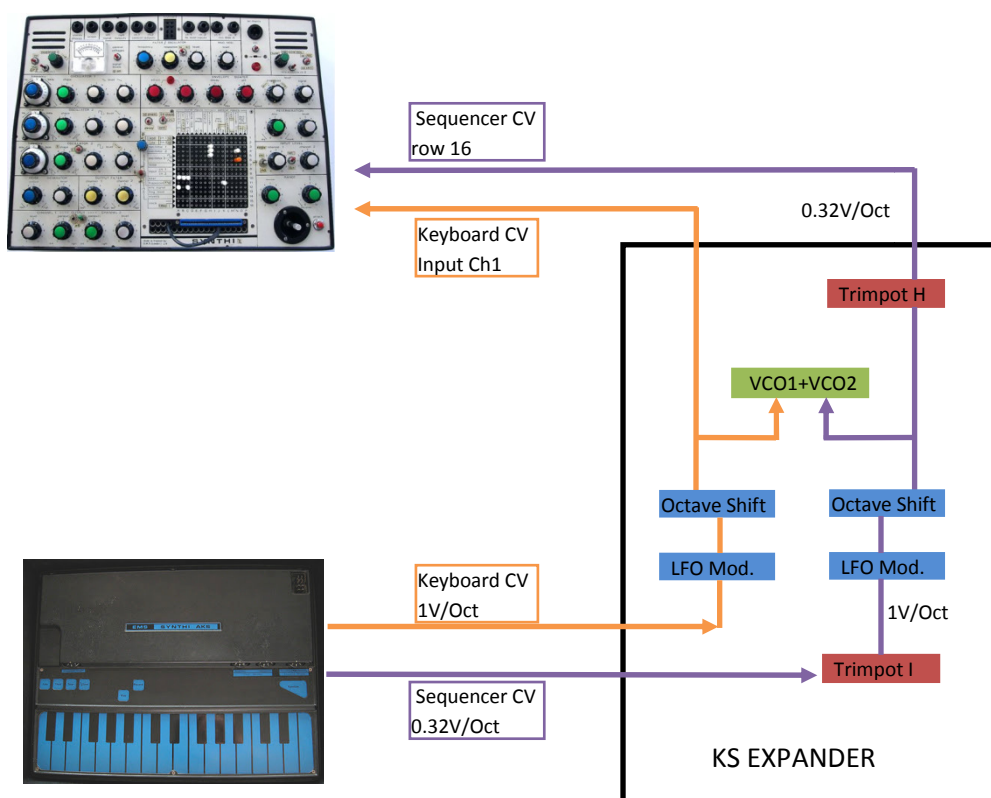


Fig 13





If Osc1 and 2 don't track properly, the only solution is a re-calibration of their tracking which requires adjusting various trimpots on the Synthi PCB. The procedure is described, for example, in Tristram Cary's 'The Putney' User Guide.

You can now insert a pin into location D9 which will mix in the output of VCO1+2 of the Expander with Synthi Osc1 and 2. Adjust the Input Ch2 level pot and/or the VCO1+2 square wave levels to get a good mix of all 4 oscillators. If the setting up procedure outlined has been successful, playing notes on the KS you will hear a fat stack of 4 Oscillators with correct chromatic scaling!

### **Adjusting Sequencer CV scaling and the trimpots H and I**

Having outlined in some detail the procedure for setting the scaling of Keyboard CV from the KS, to chromatically control the frequency of all 4 oscillators (Synthi Osc 1+2 and Expander VCO1+2) we now move on to setting the Sequencer CV scaling to achieve the same task.

First we shall set trimpot I. Setup the patch as in Fig. 14. On the Expander, set VCO2 levels to zero (tri/sine and square). Set VCO1 CV to 'seq' setting, tri/sine level to zero and square wave level to about '2'. Set VCO1 vernier to about '5'. Make sure that on lower row of toggle switches, 'row 16' toggle is set to 'seq' and that 'seq mod' is off (centre). Make sure that the KS is in record mode, so that playing keys will generate both Keyboard CV and Sequencer CV. You will hear VCO1 square wave through the Synthi. There are two pots that will change the scaling of the notes played., The first is the 'seq' pitch spread thumbwheel on the KS itself, which makes fine adjustments to the approximate 0.32V/Oct scaling of the Seq CV. The second is the trimpot 'I' on the rear panel of the Expander. The latter is adjusted by inserting a very small flat tipped screwdriver into its mounting bracket where a small screw is engaged.

Now the idea is to adjust both these trimpots to a) obtain a chromatic scaling of the notes played and b) adjust the tuning so that the same pitch of VCO1 is obtained either through Sequencer CV or Keyboard CV, when the same key is played on the KS. This process take a little bit of work. Basically as you adjust both the thumbwheel and trimpot I, you should compare the pitch of the played note as you toggle the pitch CV applied to VCO1 between the 'kybd' and 'seq' settings. So you not only will be achieving standard doubling of frequency as you play two notes 1 octave apart, but you are also adjusting the absolute tuning of Sequencer CV to match that of the previously adjusted Keyboard CV, so they are synched. This is important because if you record a sequence of notes to the KS sequencer and play them back, ideally you also want to be able to play notes in real time on top of this via the KS keyboard CV. Once you have achieved this make a note of the position of the 'seq pitch spread' thumbwheel as if its accidentally moved in the future you can quickly relocate it.

You can now also test the Octave Shift feature on 'seq' cv. You should find that you get correct scaling even if you shift up or down by several octaves. As a further test

that correct relative tuning of Keyboard and Sequencer CV do the following. Keeping the same setup as above, raise the level of VCO2 square wave to about '2' and switch the CV toggle to the 'kybd' setting. Playing notes on the KS you will hear a mix of VCO1 and VCO2 square waves through the Synthi, one under Sequencer CV control the other under Keyboard CV control.

So basically these adjustments have scaled up Sequencer CV from the KS to 1V/Oct from 0.32V/Oct, required to control VCO1 and VCO2 chromatically. But since this Sequencer CV then passes out of the Expander to the Synthi unit (see Fig. 13), we need to rescale it back down again to 0.32V/Oct so that it can be used, in the normal way, to control the pitch of Synthi oscillators 1 and 2. This rescaling is achieved through the second trimpot 'H'.

So the procedure is to start with the patch shown in Fig. 16 below:-

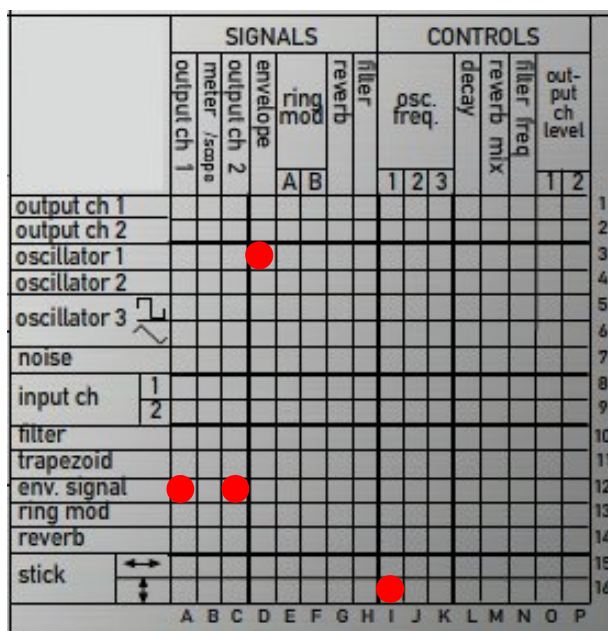


Fig. 16

Make sure that in the lower row of toggle switches, 'row 16' is source is set to 'seq' and that 'seq mod' toggle switch is off (centre). Playing notes on the KS keyboard you will hear Synthi Osc1. Now by adjusting trimpot H (again using a small screwdriver) you should be able to achieve correct chromatic pitches. Do not disturb the 'seq pitch spread' thumbwheel in this process. You can check the scaling by inserting further patch pins in positions D4 and J16 to add Osc2 under Sequencer CV control. By tuning Osc1 frequency to Osc2 you should hear good tracking between the two (assuming they were already properly calibrated) as you play notes on the KS, including applying Octave Shift via the Octave Shift switch on the

Expander. Note that the pins you insert in the matrix to control Osc1 and 2 frequency should be the high precision type, the variation of resistance in 'standard' pins is too great for use in accurate and repeatable frequency control.

This ends the description of calibration procedures. This process may seem rather long-winded but in practice it should be straightforward. I have described the process in some detail because it is an important to get it right if the Expander is to be used alongside the Synthesizer in producing chromatically accurate pitched notes.

To be added: samples of sheets demonstrating the Expander features which would also encourage further experiments...