

RS450

CV RECORDER/SEQUENCER



In the early days of synthesis, sequencers were perhaps more important in creating and replaying sounds than they have become in recent years. No self-respecting modular synth would venture out without a sequencer or, at the very least, a hole where one should be installed. In the 1960s, these were purely analogue devices - you turned a knob at a given step to an appropriate position and a CV was generated when that step was played. In general, you could then use this CV to control the pitch of the note, its tone, or its loudness, or to trigger devices such as contour generators to determine when notes were played. If the sequencer had multiple rows, you could perform multiple functions simultaneously, giving rise to many of the famous sequenced sounds of the era.

Things began to change in the 1970s when the earliest - and very primitive - digital technology was introduced. The company at the forefront of this was EMS, whose Synthi sequencers were so far ahead of their time that very few people could afford them, and even those who could had very little idea of what to do with them. But the sound of one Synthi generated sequence will be known to almost every fan of rock music. It's the line that runs throughout Pink Floyd's 'On The Run' from the album Dark Side Of The Moon, and it was generated by an EMS Synthi AKS (a Synthi 'A' with a Keyboard and Sequencer).

A member of the RS Integrator's line of Synthi derived modules (which includes the RS95E, the RS500E and RS510E), the RS450 CV Recorder/Sequencer is based upon the AKS sequencer, albeit with a much extended recording capability, the addition of memories, and a number of innovations inspired by the sequencer built into the Roland SH101.

OVERVIEW

The RS450 records and replays CVs with 16-bit precision. It offers two modes of operation.

Real-time mode

In this mode the module operates as a 4-channel, real-time sampler of analogue voltages. The four channels can be recorded simultaneously or individually (which allows users to create multi-track sequences) and the channels can be turned on or off during replay. The playback rate can be controlled using a CV, which offers many unusual possibilities. At high clock rates the RS450 performs as a lo-fi audio sampler. CV control of the FREQUENCY than permits conventional replay of the stored waveform.

Note: If you record channels individually, the length of the first to be recorded in a given memory determines the length of the sequence. All channels must be erased in that memory before a longer sequence can be recorded into it.

Step-time mode

In this mode, the RS450 operates by storing a CV into a single location each time that a clock pulse is received at the CLOCK IN input. This pulse need not be a traditional clock - it could just as easily be a Gate or Trigger from the keyboard generating the CV to be recorded, and in this way the RS450 operates similarly to other step-time recorders. An external clock or LFO can be used to replay the stored CVs, according to the settings elsewhere on the control panel.

MEMORIES

The RS450 offers ten independent memories (selected using the MEMORY knob) with four separate channels per memory. There is a fifth, invisible channel (see CLOCK IN) dedicated to recording and replaying clocks and triggers. The choice of sequence being replayed can be changed on the fly during playback to create complex sequences and evolving patterns.

All voltages are stored with 16-bit precision so the total recording time available depends upon the type of sequence, the number of channels used and the sample rate selected. The module is supplied with a 4GB memory card that, at the fastest sample rate of 14kHz, offers approximately 40 minutes of real-time recording, and almost unlimited step-time recording. The sequence memories are non-volatile. They are retained when the RS450 is switched off and when the SD memory card is removed from the unit.

Memory card

The memory card may be removed from the RS450 and connected to a computer for data transfer and long term storage of sequences. It may also be used to receive firmware upgrades. However, it cannot be accessed while the module is mounted in its rack so, if you wish to insert a larger capacity card you should do so before installation. SDHC cards sold for use in a high-definition video cameras should be suitable; low-cost unbranded cards should be avoided since these may fail to meet their specifications and limit the maximum sampling frequency of the RS450.

REFERENCE SECTION

It would now be usual to describe the operation of the module followed by a reference section of the various controls, inputs and outputs. However, it would be hard to describe example set-ups without explaining the controls first. Furthermore, it would be difficult to describe the operations of the controls independently because they are heavily dependent upon one another. So we have taken the unusual step of presenting the reference section first. We recommend that you read this in full before attempting the examples below or moving on to use the RS450.

The Buttons



START

Initiates the replay of a stored sequence.

STOP

Stops the replay of a stored sequence.

RECORD

Press this button once to arm the recorder, whereupon the red LED will flash. The RS450 will now start to monitor the four CV Inputs, and any voltages presented to these will be echoed to the appropriate CV Outputs. A second press of the button starts recording. The red LED will be permanently illuminated while recording.

REST/RESET

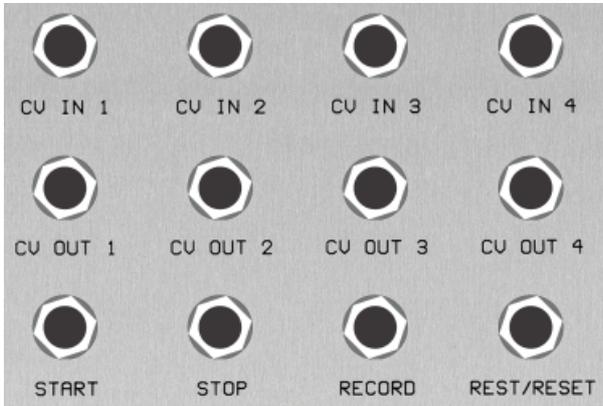
During the recording of a step-time sequence, pressing this button places a rest into the sequence. No clock or trigger pulse is recorded at this step, and the previously stored CV is held. The LED will light briefly each time that a rest is encountered during playback of a step-time sequence.

During playback of a real-time or step-time sequence, pressing this button forces the sequence to reset to its start. The LED will light briefly to indicate that a reset has occurred.

CHANNELS 1 - 4 ENABLE

Enable recording to and playback from each channel individually. An enabled channel will be shown by the presence of an illuminated green LED.

Inputs and outputs



CV IN 1 - 4

When enabled using the CHANNEL 1 - 4 buttons, voltages presented here are available for recording on their appropriate channels. All voltages in the range $\pm 10V$ are acceptable, so you can record timing signals (triggers and gates of any duration), modulators and contours, as well as conventional CVs such as pitch and filter controllers.

Note: Voltages greater than +10V or lower than -10V may cause unexpected operation.

CV OUT 1 - 4

When enabled using the CHANNEL 1 - 4 buttons, these sockets output the CVs recorded on each of the four channels. During recording they echo the CVs being received at the matching CV INs, allowing you to monitor what is being received and stored.

START

Depending upon the Trigger/Gate Mode (see below), a trigger presented here will start/stop a sequence.

STOP

Depending upon the Trigger/Gate Mode (see below), a trigger presented here will stop the replay of a sequence.

RECORD

Depending upon the Trigger/Gate Mode (see below), a trigger presented here will start/stop recording.

REST/RESET

A pulse presented to this socket during playback resets the sequence to its start but does not stop playback.

A pulse presented to this socket during step-time recording will place a rest into the sequence.

Control switches



SEQUENCER MODE - Single/Repeat/Hold

Single: The sequence replays once and then stops.

Rpt: The sequence loops until a Stop command is received.

Hold: The sequence loops but, if a Stop command is received it stops at the point it has reached. Upon receiving a Start command, it will continue from the point at which it stopped.

SEQUENCER DIRECTION - Forward/Reverse/Bi-directional

Forward: The sequence plays in the direction in which it was recorded.

Reverse: The sequence plays in the opposite direction to which it was recorded.

Bi-directional: The sequence plays in alternating directions.

TRIGGER/GATE MODE - IND/SR/SSR

IND (independent) triggering:

- A trigger received at the START CV IN initiates playback.
- A trigger received at the STOP CV IN ends playback.
- A trigger received at the RECORD CV IN places the RS450 into record mode.

SR (start/record) triggering:

- A trigger received at the START CV IN initiates playback.
- A second trigger received at the START CV IN ends playback.
- A trigger received at the RECORD CV IN places the RS450 into record mode.
- A second trigger received at the RECORD CV IN ends record mode.
- The STOP CV IN is not used.

SSR (start/stop/record) gating:

- A high Gate voltage received at the START CV IN initiates playback.
- Removing the Gate at the START CV IN ends playback.
- A trigger or Gate received at the STOP CV IN also ends playback.
- A high Gate voltage received at the RECORD CV IN places the RS450 into record mode.
- Removing the Gate at the RECORD CV IN ends record mode.

MODE - Step-time/Real-time

Selects the mode of operation.

Sequence Controls



MEMORY

There are ten non-volatile memories available, each containing four channels. Use the memory selector to choose the memory that you wish to record into, or replay.

SEQ START & SEQ START CV IN

This knob allows you to alter the start point of the sequence during playback. The associated CV IN allow you to control the start point using a CV in the range $\pm 5V$. The voltage generated by the knob and any voltage presented to the associated CV IN are summed.

To play the whole sequence from its start, this knob should be in its fully counter-clockwise position when no voltage is applied to the CV IN.

SEQ END CV IN

This knob allows you to alter the end point of the sequence during playback. The associated CV IN allow you to control the end point using a CV in the range $\pm 5V$. The voltage generated by the knob and any voltage presented to the associated CV IN are summed.

To play the whole sequence to its end, this knob should be in its fully clockwise position when no voltage is applied to the CV IN.

FREQUENCY & FREQUENCY CV IN

Step-time mode:

These controls have no function in step-time mode.

Real-time mode:

The FREQUENCY knob adjusts the sample rate of the recording in the range 0Hz to 14kHz, and also acts as the playback speed control. The associated CV IN allows you to control the frequency using a CV in the range $\pm 5V$. The voltage generated by the knob and any voltage presented to the associated CV IN are summed.

CLOCK IN

Step-time mode:

A pulse of +3V or greater applied to the CLOCK IN will cause the sequence to step forward one event. When using the RS450 as a conventional step sequencer, you should direct the keyboard's pitch CV to one of the CHANNELS, and its Trigger or Gate output to the CLOCK IN so that, each time you play a note, the RS450 steps forward one event and records the pitch CV.

When replaying a step-time sequence, a suitable source of +3V (or greater) pulses should be applied to the CLOCK IN.

Real-time mode:

The CLOCK IN is not required for timing purposes because sequences derive their timing from the high frequency clock within the RS450 itself. However the CLOCK IN may then be used as a fifth recording channel input to record real-time clocks and gates without tying up one of the main channels for this purpose. Pulses or other received voltages in the range +3V to +10V are accepted and will be replayed through the CLOCK OUT (see below) as +12V pulses of the same duration.

CLOCK OUT

Step-time mode:

Any pulse received at the CLOCK IN when the RS450 is armed or recording is echoed to the CLOCK OUT as a +12V pulse of the correct duration.

Real-time mode:

Any pulse of 'high' voltage received at the CLOCK IN when the RS450 is armed or recording is echoed to the CLOCK OUT as a +12V pulse of the correct duration, irrespective of the shape of the original voltage.

Note: You can record Triggers and Gates into CHANNELS 1 to 4, but these are then replayed exactly as presented. CLOCK IN and CLOCK OUT differ from the conventional channels by reshaping the pulses (or other received voltages) into 'square' Gates.

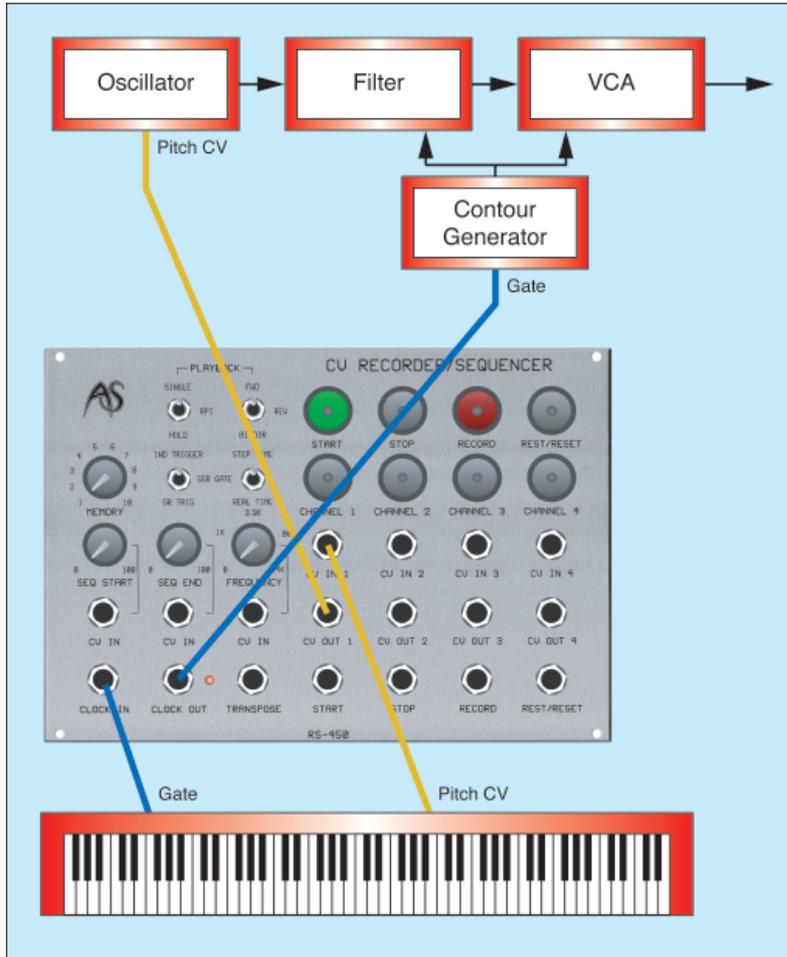
TRANSPOSE

You may offset the playback voltages using a CV in the range $\pm 10V$ applied to the TRANSPOSE socket. The input should be calibrated to the conventional 1V/oct scale so you can transpose the sequence in semitones steps. The TRANSPOSE function is global and affects all four channels equally at all times.

Note: The CV applied to the TRANSPOSE socket is not recorded, but you must take care to avoid presenting a CV during recording as this will offset the monitored signal and cause confusion when you replay the sequence.

IN USE

The following tutorial examples will help you to start using the RS450. There are, of course, many other ways of using it, and you are encouraged to experiment.



Patch #1: A basic real-time patch

The EMS Synthi AKS sequencer was the initial inspiration for the RS450 because it provided a simple 'scratch pad' for ideas, which could be recorded in real-time mode and then replayed with a minimum of fuss. So we'll start these tutorials by investigating a simple real-time patch.

To begin, create a simple synthesiser by connecting a single VCO to a VCF and VCA, using a contour generator to shape the filter and amplifier in the usual fashion.

Normally, you would now connect the CV from a keyboard controller to the 1V/oct input of the VCO, and its Gate or Trigger to the appropriate inputs of the contour generator. However, you should now connect the CV output from the keyboard to the CV IN 1 input on the RS450. Likewise, instead of connecting the Gate output directly to the contour generator,

you should patch it to the CLOCK IN socket on the RS450. To monitor what you're playing/recording and to be able to replay the sequence once recorded, you must now connect CV OUT 1 to the VCO and the CLOCK OUT to the Gate input on the contour generator. If you study this patch, you can see that you have simply placed the RS450 between the keyboard and the sound generating/shaping modules.

To set up the RS450 for real-time recording and playback, select REAL TIME using the appropriate switch on the RS450, together with FWD, RPT and IND TRIGGER. (Please refer to the reference section if it is not obvious why this combination of functions has been chosen.) Now select memory #1 by turning the MEMORY knob to the "1" position.

To choose a sensible sampling rate and to ensure that the whole sequence is replayed, rotate the FREQUENCY knob to (approximately) the 11 o'clock position, and ensure that the SEQ START and SEQ END knobs are turned fully anticlockwise and fully clockwise, respectively.

Finally, ensure that all four channels are activated by pressing their buttons. (All four LEDs will be lit.) Everything is now primed and you are ready to start recording

Note: You must prime and record all four channels when making a new recording, or the duration may be constrained by whatever previously existed in that memory.

Press the RECORD button once. You will notice that the associated LED is now blinking slowly to indicate that the RS450 is armed, and it will allow you to monitor your playing. Now press the RECORD button a second time. The LED will remain constantly lit, and anything you play will be recorded within CHANNEL 1 and the CLOCK IN track of the RS450. When you have finished playing, press STOP to end recording.

If you now press START, your recording will be replayed. Once completed, it will then loop (because you set the switch to RPT) and you can experiment with the replay speed (adjust the FREQUENCY) the REV and BI-DIR settings (to change the way in which the notes are replayed) and the SEQ START and SEQ END knobs (to determine start and end points of the sequence).

Patch #2: A multi-channel real-time patch

Set up the patch described above. You are now going to add some modulation to this, recording and replaying it together with the notes in the sequence.

In addition to the existing cables, connect the CV output from a modulation controller such as a joystick or modulation wheel to the CV IN 2 on the RS450. Then patch the CV OUT 2 to the CV IN VARY of the VCO. This will allow you to create pitch bends using the controller. (If you do not have a joystick or modulation wheel, the principle will still apply if you use, say, an LFO or any other modulator to create vibrato or special effects.)

Arm all four channels on the RS450 in the usual fashion and you will again be able to hear what you play, but now with expression added using the controller. Again, press RECORD a second time to begin recording, and STOP to end it.

When you now replay the sequence, you will hear how the notes were modified by the controller. To hear the performance without the pitch bend press the CHANNEL 2 button to disable that channel, whereupon you will hear the notes replayed without modification. Press the CHANNEL 2 button a second time to reactivate that channel.

Patch #3: Adding further channels to an existing sequence

Let's now add some filter modulation to the recording made using patch #2. To do so, you must first choose the desired waveform and frequency on a low frequency oscillator and then connect its output to the CV IN 3 input on the RS450. Next, connect the CV OUT 3 on the RS450 to the CV IN VARY on the filter already in use in the patch. (If you have followed these tutorials from the start, you should be seeing a pattern emerge here.)

Since you want to add the filter modulation to the existing sequence, you must disable CHANNEL 1 and CHANNEL 2 so that you don't overwrite them when recording the filter modulation. Only the LEDs for CHANNEL 3 and CHANNEL 4 should now be lit.

Press the RECORD button twice in the usual fashion to arm the RS450 and start recording. You will hear CHANNELS 1 and 2 being replayed, and you can simultaneously hear - and record - the effect of the CV being generated by the LFO. When you have finished recording, press the STOP button.

To replay all three channels (notes, pitch bend and filter modulation) ensure that CHANNEL 1 and 2 are re-enabled together with CHANNEL 3, and press START. You will now hear your performance with the added enhancement of filter modulation.

Patch #4: A simple step-time patch

Return to patch #1 by removing the pitch bend and filter modulation cables, and then set the appropriate switch to STEP TIME. Now activate all four channels and press record twice, firstly to arm the RS450 and secondly to begin recording.

You can input notes at your own pace, which will be entered with equal durations unless you use the REST/RESET button to add a rest on any given step. When you have entered all the notes, press STOP to finish the recording.

If you now press START (as you did in patch #1) nothing will happen. This is because the RS450 requires an external clock to drive the recorded sequence in step-time mode.

To provide this, remove the Trigger/Gate cable from the CLOCK IN input (which, while recording, told the RS450 to move forward a step each time that you played a note) and replace it with a clock source such as a clock generator or LFO. Having done so, you can press PLAY to replay the sequence at the tempo determined by the clock source. The clock rate can usually be modified by applying a suitable CV to the source, allowing you to add tempo changes and expression to the replayed sequence.

You can also change the nature of the sequence creatively by applying CVs to the SEQ START CV input and SEQ END CV input as well as the TRANSPOSE input.

Note: The rest/reset LED will flash each time that a rest occurs during playback.

Patch #5: Sampling

The RS450 was not designed as an audio sampler but, at its maximum sampling rate, it will perform as one, albeit without the audio quality normally associated with digital sampling.

To perform sampling, patch the audio to be sampled into CV IN 1 and connect CV OUT 1 to your mixer, amplifier or other device in the audio path. Now select REAL TIME and set the FREQUENCY knob to (or near to) its maximum. As before, prime all four channels when making the recording to ensure that the duration is not constrained by whatever previously existed in that memory, and check that the SEQ START knob is set fully anticlockwise and the SEQ END knob is set fully clockwise.

Press the RECORD button once to arm the recorder. Due to the constraints of the RS450, it is likely that you will hear a significant amount of background noise, which will also be present in the replayed audio. If higher quality is required, you should use a device designed specifically for audio frequency sampling.

Press RECORD a second time to start recording, and STOP to finish.

Press PLAY to replay the audio sample. If desired, you can now trim it using the SEQ START and SEQ END knobs, trigger it conventionally by setting the playback switch to SINGLE and applying a suitable Trigger or Gate to the REST/RESET input, and control its pitch by applying a suitable CV to the FREQUENCY CV IN.

OTHER IDEAS WORTHY OF INVESTIGATION

Using the RS450 in real-time mode as a complex modulator

It's not necessary to record notes when using the RS450; you could use it to record and replay four channels of control CVs, whether recorded simultaneously, or individually using the methods outlined above.

To do so, connect the outputs from any desired CV sources (such as joysticks, ribbon controllers, contour generators, and so on) to the CV IN 1 - 4 sockets, and the CV OUT 1 - 4 sockets to any desired destinations in your synthesiser.

In real-time mode, record the dynamic changes in the CVs. These can now be replayed, looped, and if desired modified using the SEQ START, SEQ END, FREQUENCY and REST/RESET CV inputs, making it possible to use the RS450 as a complex modulator when all the conventional modulation sources in the RS Integrator are already in use, and if both your hands are engaged with playing (or other duties) at the same time.

Using the RS450 as a step-time rhythm generator

By connecting a pitch CV and Trigger/Gate to the RS450 in the usual fashion, and its outputs to a suitable CV/MIDI converter connected to a MIDI drum machine, you can use the RS450 to record and replay drum patterns. A simple approach would be to store (for example) all the kick drums on CHANNEL 1, the snares on CHANNEL 2, the toms on CHANNEL 3 and the hi-hats and cymbals on CHANNEL 4. However, you don't need to restrict yourself quite so rigorously, since each channel can store the CVs that play all the instruments - although not two of them at the same time.

Using an external clock to drive the replay and determine its rate, you can use the MEMORY selector to jump between patterns, the CHANNEL 1 - 4 buttons to insert and remove instruments from the mix, and the SEQ START and SEQ END knobs to determine the start points and lengths of the patterns.

If the rhythms you're creating are not too complex, another approach - and one that permits greater expression - would be to store the complete pattern in, say, two channels, and then (if the drum machine supports this) use the other two to store and replay CVs that can control the amplitudes and timbres of the strikes.

Using the RS450 in step-time mode as a patch memory module

You can use step-time mode as a simple patch memory for your RS Integrator (and other synthesisers if they have sufficient CV inputs).

Connect the four CV inputs on the RS450 to controllers determining the values of parameters that you could like to store - say, the pitch CV, filter cut-off frequency, VCA gain, and so on - and store all of their values in a single step. If the RS450's CV outputs remain connected to the appropriate inputs on the synthesiser modules, you can recreate a patch by selecting the appropriate sequencer step. You can link multiple RS450s to create patches with 8, 12, 16... (and so on) patch parameters.

FORMATTING AND CALIBRATING THE RS450

Calibration should be performed when the memory card is replaced or if you notice any CV inaccuracies when replaying recordings. The module will also boot up in calibration mode when you fit a blank card.

Note: Although it is possible to swap cards between RS450s, the data may not replay correctly on any module other than that on which it was recorded unless calibration is performed. However, since the calibration data are stored on the card, this means that you will need to recalibrate it if you then return the card to its original module.

Calibration

Hold STOP and REST/RESET when turning on the power to enter calibration mode. The button LEDs will now flash in a running sequence starting from the top left and ending at the bottom right.

Connect each CV IN to its associated CV OUT and press START. The channel LEDs will flash in sequence a few times while calibration is performed. When calibration is complete, all the LEDs will light. Remove the patch leads and restart the module.

Formatting a memory card

Hold RECORD when turning on the RS450 to reformat the memory card. This will wipe all of its memories but it will not alter the calibration.

Cards are formatted using the FAT32 standard so that they can be read by and backed up to a standard PC or Mac with an appropriate socket or card adapter.

Note: We strongly recommend that you use high quality, branded, class 10 memory cards. At higher sample rates, the requirements of the RS450 may exceed the capabilities of lower quality cards, leading to reduced performance or errors.