EMS SPECTRON

V I D E O SYNTHESIZER

HANDBOOK

EMS
Electronic Music Studios

PREFACE – EMS SPECTRON

WHAT DOES THE SPECTRON DO?

SPECTRON is, like all synthesizers (whether for music or visuals) a combination of a variety of different "instruments" each of which has its own functions and capabilities. It is up to the user to decide how to combine these different parts: without instructions from an operator, SPECTRON will do nothing. Certain parts of SPECTRON are designed to deal with form, with defining images on the screen. Other functions deal with colour and brightness. The user is then free to apply any colour to any particular area defined by the pattern or image that has been created. With a proper understanding of all these different parts and how they function, the operator is then free to go ahead and use the tools at his/her disposal to produce a preconceived design, or to experiment with new possibilities.

HOW TO USE THIS MANUAL

This manual is designed to introduce the user to each function of the EMS SPECTRON and to offer the theoretical understanding necessary to make effective use of SPECTRON'S capabilities. Therefore, the book is divided into sections to deal with various areas of SPECTRON'S operation. Examples are included in each section to illustrate the function being discussed. We encourage the readers to try each of the examples on their own machines. After the user is familiar with the basic operation of each function, much is gained by experience and experimentation. It would be impossible for us to illustrate every possible use of these functions – mathematically, the number of possibilities is too numerous to catalogue here.

At the last section of the book, we have compiled several complex patches to suggest the various ways in which different functions may be used in combination. However, we wish to emphasize that these are only suggestions. Once one has mastered this theory that is so important in understanding this synthesizer, it is possible to create images and patterns of one's own original design – which are certain to be more rewarding then any "packaged" designs we might offer.

INTRODUCTION

THE FACE PANEL

The face panel has two different functions:
1. To allow the connection of different signals and processors of SPECTRON (via the pin matrix patchboards).
2. To allow manual control over certain functions and settings (via the sliders).

THE PATCHBOARDS

The patchboards are operated by means of inserting pins into the holes, which cause a connection to be made between the signal paths which cross that point. Signals coming OUT of sources or processors appear along the horizontal row of holes with the appropriate labelling on the left-hand side of the panel. Inputs TO functions are the vertical column of holes below the appropriate label at the top of the panel**

There are two different patch panels, each to deal with a different part of SPECTRON'S operation. The smaller board is the ANALOGUE CONTROL MATRIX. This allows the connection of the voltage control sources of SPECTRON to be patched into a chosen analogue function. The voltage controllable analogue functions of SPECTRON are the shape generators, the comparator level spacing and the video outputs. Control sources are the oscillators, the random generator, the control sliders, the audio input and external input. It is also possible to route digital signals, in filtered form, to the Analogue Control Matrix, where they appear on the rows labelled From Signal Matrix. Note that each of the control functions labelled at the left side of the ACM (with the exception of the external input and From Signal Matrix) also has slider controls on the face panel.

***On the Digital Signal Matrix, the labelling Video Input at the left, and Output A and B at the top, may be confusing to someone unfamiliar with this patching system. However, the labelling is valid if one thinks, for the former, of an output FROM an external input; and for the latter of the input going TO the final output.*

There are also slider controls for the Comparator Level Spacing and the video outputs. The larger patchboard, the DIGITAL SIGNAL MATRIX, allows the selection of colour and luminance levels to be assigned to any form. It also allows the patching of signals to the various digital processing treatments available. The digital functions are not voltage controllable in the analogue sense, but may be manipulated by digital logic operation. Of the face panel sliders, only the shape selects and comparator level spacing pertain directly to functions on this patchboard.

The heart of the Digital Signal Matrix are the columns labelled output A and output B. It is these that determine the colour and brightness of an image. IF THERE ARE NO SIGNALS PATCHED INTO THESE COLUMNS, NO IMAGE WILL APPEAR. In SPECTRON, digital and analogue signals pertaining to forms are separate from the digital signals that produce colour and luminance. These signals are combined just before the final output of SPECTRON according to the patch setup at Output A or Output B. It is the use of digital logic and signals, and the way in which colour and luminance outputs behave, that give SPECTRON its versatility and make it possible to create such an unlimited variety of images under the direct control of the user.
x x
The next section of the manual deals with the operation of the Digital Signal Matrix, and gives an explanation of digital logic as it is applied in SPECTRON.

THE BACK PANEL
The back panel allows connection of external signals, including external sync, to SPECTRON, and provides SPECTRON output signals to be connected to monitors and recorders. The external video input accepts any standard black and white video signal, with or without sync. The external video input passes through a 7-stage comparator in SPECTRON, and is translated into digital signal outputs appearing on the DSM. The use of these digital outputs, and the ways in which a black and white picture may be processed with SPECTRON, are explained in detail in Section II of this book. The audio input accepts any standard audio level signal (1 volt p.p., speaker level). This signal is then split into treble and bass ranges, with a balance control on the face panel to determine their relative amplitudes. These signals then pass through an envelope follower, which puts out two signals with the amplitude contours of both ranges. These are available on the ACM, along with a filtered version of the composite audio signal. The use of these signals is dealt with in Section III of this book.

The external input accepts any signal of +/- 3 volts maximum. The signal will appear directly out on the ACM. It is designed mainly for use with direct signal sources, such as an external oscillator or audio synthesizer. SPECTRON may receive sync internally or from an external source. It will apply sync to the monitor and to the black and white camera. A socket for receiving an external sync signal is on the back panel, along with a switch to determine the sync source.

There are three types of outputs available from SPECTRON: red-green-blue signals, an encoded signal (PAL or NTSC as ordered), and a modulated UHF signal. The choice of output is determined by which kind of signal one's monitor or recorder is prepared to receive.

SECTION I: USING THE DIGITAL SIGNAL MATRIX

BASIC DIGITAL THEORY
SPECTRON has three types of digital signals, called luminance, colour 1 and colour 2, which combine to form particular analogue signals (red, green, blue) that appear as the final output of SPECTRON. The three digital signals are present at the moment SPECTRON is turned on. IT IS BY MANIPULATING THESE DIGITAL SIGNALS THAT WE PRODUCE IMAGES ON THE MONITOR SCREEN. In order to operate SPECTRON effectively, it is necessary to understand how digital signals work.

BINARY NUMBERS AS SYMBOLS FOR DIGITAL SIGNALS
Digital signals have only two states: we say they are either high or low. Binary numbers use only two symbols, 1 and 0, and thus are useful as expressions of digital signals (it is simply easier to write 10110, than high, low, high, high, low). Complex digital signals may have several "places" each of which can assume either the high or low state. These places are properly termed "bits" (for binary digits). Combining bits in different ways gives us a wide variety of signal possibilities.

COUNTERS

Counters are simply an orderly way of producing all the possible combinations of bits for a signal with a specific bit length (number of bits per unit). A four-bit counter is diagrammed below:

0	1	2	3	
0	0	0	0	1
0	0	0	1	2
0	0	1	0	3
0	0	1	1	4
0	1	0	0	5
0	1	0	1	6
0	1	1	0	7
0	1	1	1	8
1	0	0	0	9
1	0	0	1	10
1	0	1	0	11
1	0	1	1	12
1	1	0	0	13
1	1	0	1	14
1	1	1	0	15
1	1	1	1	16

Each bit is numbered at the top of the diagram – 0 being the first or "most important" bit. Each combination of bits has a particular place in the sequence, and is numbered accordingly at the right of the diagram.

As you can see, there are sixteen different possibilities for a four-but signal. Each individual bit has only two possibilities, but every new bit combined with it doubles the number of possible combinations: i.e., a two-bit signal has four possibilities; three bits have eight possibilities, five-bits, thirty two and so on.

By following down the columns for each bit in the diagram, note that each bit changes state at twice the frequency of the one before it. That is, bit 3 changes state with every new combination, bit 2 changes after every two combinations, bit one after every four.

EXAMPLES OF COUNTERS AS USED IN SPECTRON

The shape selects on the face panel each have two four-bit counters. They are used to select which of sixteen different signals will appear at the shape outputs on the DSM. The selection is indicated by a combination of four panel lamps. By clocking slowly through one of the selectors, you can see that the panel lamps form the same combinations (in terms of on and off) as the numbers in the diagram, and proceed in the same order.

Another function in SPECTRON that operates as a counter is the X-Y generator. X signals divide the screen vertically, changing state from low to high as they count across the screen. Y signals count down the screen, dividing it horizontally. The changing of the signal state from low to high produces horizontal and vertical bands. In this instance, the nine bits of each counter are available to us separately: the 0 bit will produce one band on the screen (changing state from low to high once) and the 8 bit will produce 256 bands.

THE OUTPUT SIGNALS

On the DSM, each input column to Output A or Output B represents one bit of the digital signals that are eventually translated into visual images on the monitor. There is a four-bit signal for

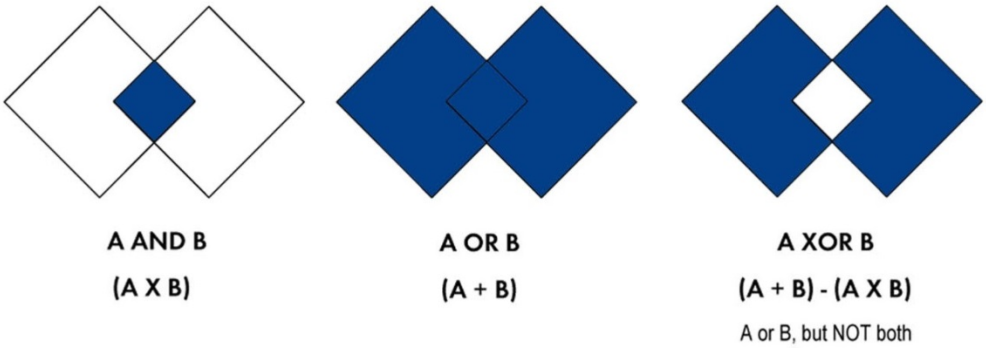
Luminance, therefore, sixteen different possible levels. Colour 1 and Colour 2 each have 3 bits, therefore eight possibilities each, and 64 different colours by combining the two.

COMBINING DIGITAL SIGNALS

With the colour and luminance information, we do not count through the possible combinations, but select the desired colour by changing the state of the bits to produce the appropriate signal. When we patch a signal for a particular form to one of the columns of the outputs, we are combining that signal with the output signal.

LOGIC OPERATIONS

There are three types of operations used to combine digital signals and produce a particular output. These are:



The AND operation: the output is high only when ALL inputs are high: where any input is low, the output is low.
The OR operation: the output is high where any input is high: output is low only if all inputs are low.
The XOR (Exclusive OR) operation: the output is high where only one of two inputs is high: where the two inputs are in the same state, the output is low.

We can diagram these operations with binary numbers. A and B are inputs, Output is the final result:

OR		
A	B	OUTPUT
1	1	1
0	1	1
1	0	1
0	0	0

AND		
A	B	OUTPUT
1	1	1
0	1	0
1	0	0
0	0	0

EXCLUSIVE OR		
A	B	OUTPUT
1	1	0
0	1	1

1	0	1
0	0	0

HOW LOGIC APPLIES IN SPECTRON

With nothing patched on the Digital Signal Matrix, all the digital outputs (and their respective bits) “float” high. Signals patched into an output column are combined by the AND operation, so that output bit will go low wherever the input signal is low. We are, in effect, carving forms into a black screen. To illustrate this, we will set up a few simple patches (as shown in the next few pages) and diagram their effects.

PATCH No. 1
With no patching, the screen appears dark. Patching X position 2 (a signal which counts low, high low, high, low across the screen) to luminance bit 0 will produce light vertical bands:

0	1	0	1	0

The light bands indicate where the luminance bit has been pulled low.

PATCH No. 2
Patching X2 also to colour 1 bit 1, will pull that bit low, so that the light bands have now a hue that is the combination of a particular luminance signal (0111), colour 1 signal (101) and colour 2 signal (111 – nothing is patched to this signal, so it still floats high). Where X2 is high, nothing is changed and the dark bands remain.

The diagram the signals for each area defined on the screen by X2:

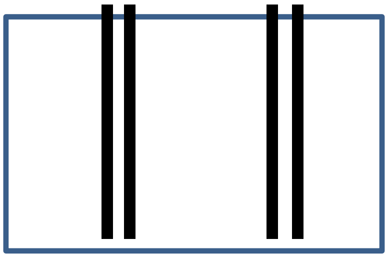
	0	1	0	1	0
LUMINANCE	**0111**	**1111**	**0111**	**1111**	**0111**
COLOUR 1	**101**	**111**	**101**	**111**	**101**
COLOUR 2	**111**	**111**	**111**	**111**	**111**

Input signals patched to the same column combine by the AND operation before being combined with the output signal.

PATCH No. 3
Beginning as in Patch No. 1, with X2 patched to luminance 0. Now patch X4 also to luminance 0. X4 goes low, high, four times as fast as X2, producing narrower bands. The bands of X4 will appear only in the high areas of X2. The dark area on the screen now represents the combined high output of X2 and X4:

X2 0000111100001111000 Patch No. 4

X4 01010101010101010101



By combining a sequence of X and Y signals to the colour bits, we can produce a matrix on the screen which will display all 64 colour possibilities. First patch the X signals 2, 3 and 4, to colour 1bit 0, 1 and 2 respectively. You have now produced the eight possible combinations in order:

Where X2 is:	0	0	0	0	1	1	1	1	= C1 0
Where X3 is:	0	0	1	1	0	0	1	1	= C1 1
Where X4 is:	0	1	0	1	0	1	0	1	= C1 2

COLOUR	000	00 1	010	011	100	101	110	111

Colour 1 is a “blue” axis, as you see from the range of colours produced. Now, remove those pins, and try the Y positions patched to colour 2 as in the patch illustration. Colour 2 is a “red” axis. With all the pins inserted as in the patch illustrations, the 64 colours are produced by the ADDING of the signals as they cross.

PATCH No. 5
This is simply an example of a more complex kind of pattern, using only X and Y counters as signal sources.

WHY OUTPUT A AND OUTPUT B?

Up to this point, it has not been necessary to distinguish between output A and output B. However, there is inverted (low goes high, high goes low) and combined with output A by the Exclusive OR operation, to produce the final digital output of the synthesizer. Therefore, a signal patched to one side of the output will appear the same as if patched to the other. To illustrate this:

Luminance signal 0111 is produced at output A. It combines with inverted output B (0000) by the Exclusive OR, so the final result is 0111:

Output A	0111
Inverted Output B	0000
Final Output Out	0111

Conversely, luminance 0111, produced at output B, is inverted (to 1000) and combined with output A (1111) by the Exclusive OR:

Inverted Output B	1000
Output A	1111
Final Output	0111

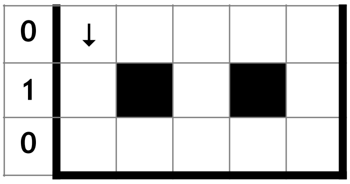
Where output A and output B have the same information (inputs) they will cancel each other out:

Output A	0111
Inverted Output B	1000
Final Output	1111

And so the screen appears as if nothing were patched. However, patching different signals to opposite outputs will produce different effects than patching them to the same output. To illustrate:

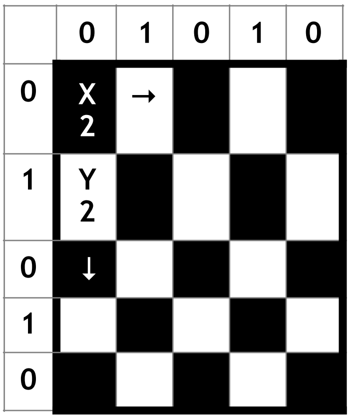
PATCH No. 6
Patching X2 and Y2 to luminance 0 at the same output (A or B) will produce this effect on the screen:

		0	1	0	1	0
0		X 2	→			
1		Y 2				



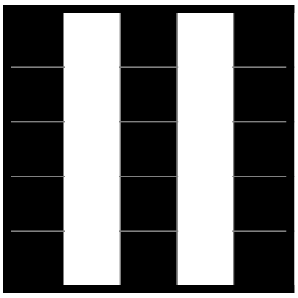
They combine by AND, so that the output is high only where both are high.

PATCH No. 7
Patching X2 and Y2 to luminance 0 at opposite outputs will produce this effect:



Y is at output B, so is inverted. They combine by the Exclusive OR, so that the output is low where they are in the same state, high where they are in the opposite states.

PATCH No. 8
The effect of any input signal may be reversed by grounding the bit to which it is patched at the opposite output. Patching to Ground causes a bit to be pulled low at that output for the whole screen. Beginning as with Patch No. 1, with X2 patched to luminance 0 at output A, now patch luminance 0 at output B to Ground. The result:



Recall from the first patch that the luminance signal producing the light bands was 0111; the dark bands 1111. Now, by grounding luminance 0 at output B, we have changed the luminance signal of B from 1111 to 0111. Output A combines with <u>inverted</u> output B, which is now 1000. Thus:

Where output A is: 0111 where output A Is: 1111
Inverted output B is: <u>1000</u> inverted output B is: <u>1000</u>
Final result by the Exclusive OR 1111 final result by the Exclusive OR
0111

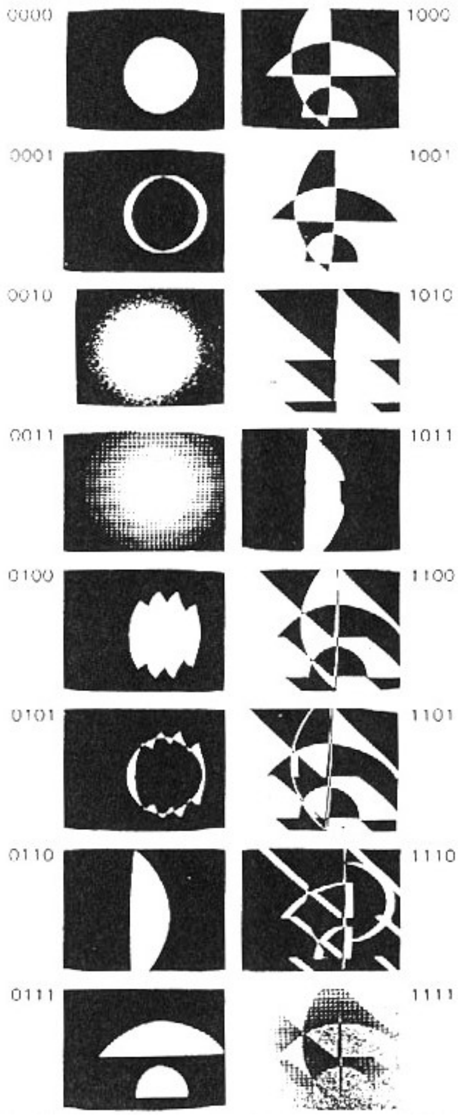
And there is your reversed image.

SIGNAL SOURCES FOR FORM

REVIEWING X AND Y COUNTERS
PATCH Nos. 9 and 10:
You are familiar by now with the effects of the X and Y counter. Patches 9 and 10 illustrate patterns that may be obtained with these, using different colour combinations and opposite outputs.

USING INVERT X AND INVERT Y
PATCH No. 11

As was mentioned earlier, inverting a digital signal means that it will go low where it was high before and vice versa. In this case, we can invert the X and Y counter positions according to the input signal at the Invert X and Invert Y columns. That is, with a signal patched to an invert position, the corresponding output of X or Y will be inverted wherever the input signal is low. In this patch, we can produce the same effect as in patch No. 8 by different means. The X2 signal inverts wherever it overlaps the low area of Y2. The output of X2 may now be patched to any combination of colour and luminance bits, and still produces the checkerboard. Now try patching other signals to Invert X2.



PATCH No. 12
Here is a more complicated pattern that may be produced with the aid of invert X and Y. though only a few X outputs are finally used to combine with colour and luminance outputs, interesting effects are achieved by the fact that the Y outputs used to invert the X are themselves inverted by the X signals. It is important to note here that invert X and invert Y are the only digital "processing" effects that do not require a separate output, but operate by directly affecting the outputs of the X and Y counters.

THE SHAPES

SPECTRON has two shape generators, each of which can produce 16 different analogue signals. These are then converted into digital signals that may appear out at any of the four output rows on the DSM. At this point, we are not concerned with how the signals are generated, but how they may be selected. Any one of the 16 shape signals may appear at one or more of the shape outputs. Shape Select 1 controls shape outputs 1A and 1B, Shape Select 2 controls 2A and 2B.

PATCH No. 13
With the patch pins set as in the illustration, use the Advance button of Shape Select 1A. Every time the button is pressed, the output signal will change to the next form, as programmed by the Shape Selector counter. (Remember from previously, that the counter position is indicated by the four panel lamps above the Advance button).

PATCH No. 14
In this patch we use two shape outputs, each patched to a different colour. Note that when the different shape signals overlap, they ADD together, and a third colour is produced. Using the sliders on the Shape Select panel, you can have each output clock through the 16 signals at the same rate, or different rates.

PATCH No. 15
Shape signals may also be used in combination with X and Y signals. Here we use the circle form to invert X and Y signals, so that a different pattern appears within the circle form. Try setting up your own patches, using combinations of shape signals and X-Y signals.

DIGITAL SIGNAL PROCESSORS

The signal processors available on the DSM are EDGE, DELAY, INVERT, OVERLAY GATES, FLIP-FLOP and the SLOW COUNTER. With the exception of the SLOW COUNTER, each of these functions is capable of taking a digital signal input, and manipulating it in a specific way to produce an output signal that is related to, but separate from, the original digital input. Again, excepting the slow counter, each of the functions named <u>must</u> have an input signal in order to produce an output signal. The edge generator will create a form signal of the border of the signal input. This border may be of two different sizes, according to whether the narrow or wide output is used.

PATCH No. 16
As we scan the monitor from left to right, we can speak of a signal as "rising" where it changes from low to high state, and "falling" where it changes from a high to low. The + output of edge is

the border of the rising side of the input signal – in this case, the right side of the circle, which is low inside, and high outside. The – output of edge is the border of the falling side.

Note also that each edge output may be coloured separately. In this case though, they are patched to the same colour bits, the + and – outputs do not appear the same. This is because the – edge output combines with the colour signal produced by the shape output directly from Shape 1A, but the + edge output combines with the colour of the area outside the circle. If you now remove the pin patching Shape 1A direct to the colour bits, you will see only the edge signals, now both the same colour.

DELAY

Delay reproduces the input signal delayed by 800μs, which in terms of the monitor, means an image offset by about one quarter of an inch to the right of the original image.

PATCH No. 17
This is just a very simple use of the delay. By removing the pins patching the circle output to the colour bits, you will see only the output of the delay. There are many interesting effects that can be obtained by using delay in combination with other digital processing effects. The next patch is another simple one, and more patches using delay are described under other sections of the book.

PATCH No. 18
This is a kind of “loop” patch, with both a delayed edge, and edge on the delayed image.

PATCH No. 19
In this patch, the direct circle output is active only within the circle form, which appears blue. The inverted signal is active outside the circle form, and can be separately patched to colour bits, producing a red background.

PATCH No. 20
Here, two shapes are patched into the same inverter. The shapes may be coloured separately, while the background produces a third colour.

PATCH No. 21
Another kind of “loop” patch – the delay patched into an inverter, and then back into the delay. By introducing the circle signal into this loop at any point (we have chosen to patch it into the inverter, but if the circle is patched instead to the delay input, the same effect should be achieved) the pattern is interrupted at the active area of the circle, and repeats the circle outline on the right.

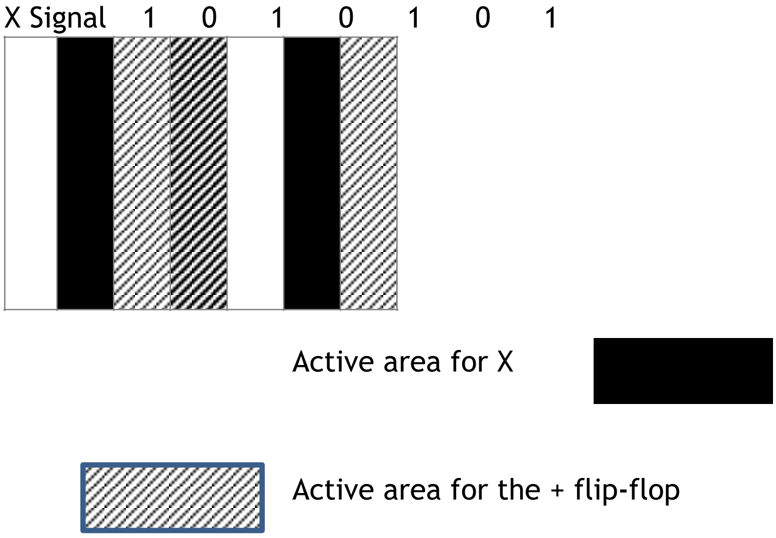
PATCH No. 22

In this example, we have used the same basic set-up as in Patch 21, but by first patching the circle signal into another inverter, then into the “loop”, the active area is now outside the circle, and the delay appears only within this form.

FLIP-FLOPS

There are two separate flip-flops, each with its own input and output. One (the +) is activated by the rising side of an input signal, the other (- flip-flop) is activated by the falling side of the signal input. Think of the flip-flop signal as starting out on the left side of the screen, moving to the right. It always starts out “high”, or inactive, and will remain in this state until it is activated by an input signal.

PATCH No. 23
Here we use the + flip-flop, which will be activated by the rising edge of the input signal. We have chosen vertical X stripes as the input. The flip-flop output remains inactive until it meets the rising edge that is the right side of the first stripe on the left. The flip-flop output now becomes “low” and active. It remains in this state until it meets a rising edge, which flips it back to inactive:



PATCH No. 24
Here we use the same setup as in Patch 23, but have added the – flip-flop, activated by the circle output, as well as the original stripes. Try removing the pins patching the stripes and circle direct to Output A. You will now see only the flip-flop outputs, each of which produces a separate form. Basically, flip-flops are capable of producing an active signal for any area of the screen that can be defined by two rising or falling signals.

OVERLAY GATES

Overlay gates provide a means of blocking off an area of one signal with another, so that it is possible to have one form appear behind another, without overlapping colours. Overlay gates take two input signals, one to DIS (for disenable) and one to SIG (for signal) to produce an output signal. This output signal will be active where the SIG input is active, but inactive wherever the DIS input is active. This signal produces the image of the SIG form with the DIS form “cut out of it”.

PATCH No. 25
A simple overlay gate output here: the circle form disenabled by X stripes. The output of X3 may now be patched to any colour without disturbing the colour of the gated circle.

PATCH No. 26
Using two overlay gates, you can arrange three forms to appear one behind the other. An inverter is also used so that the background of the three forms may also have an independent colour.

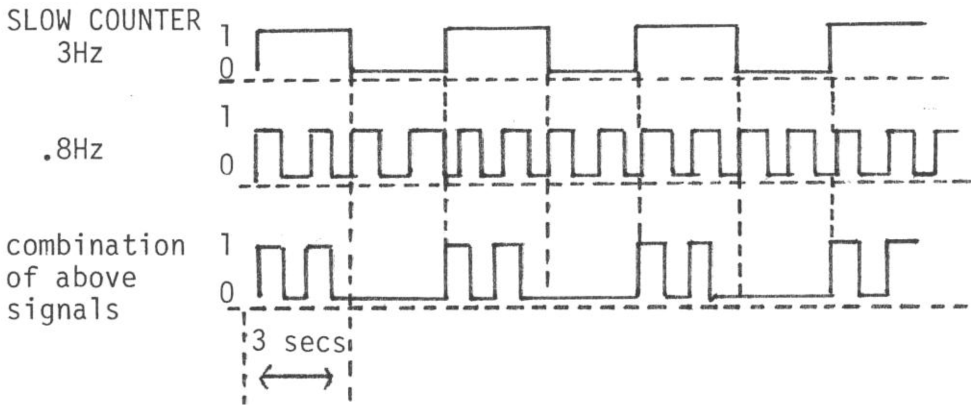
SLOW COUNTERS

Slow counters do not affect form as such, but are a timed control device: the output changes from low to high at regular intervals. There are six different frequencies available, each being twice the rate of the one below it. The 6 Hz output changes state six times per second, 0.2 Hz changes once every five seconds.

PATCH No. 27
Here, we use the 3 Hz slow counter as the DIS input of an overlay gate. The SIG input, X3, will be disenabled every time the counter output goes low.

PATCH No. 28
A more complex patch on the same theme: two patterns are setup, and disenabled at different rates. Each pattern will appear only when the slow counter controlling its gate is high, so when both counters are high, both patterns will appear and overlap each other.

PATCH No. 29
By combining two frequencies of the slow counter at the same input, we can produce a different rate of change by the ADDING of the signals. The signal reaching Colour Swap will be high only when both counters go high. We can diagram the resulting frequency like this:



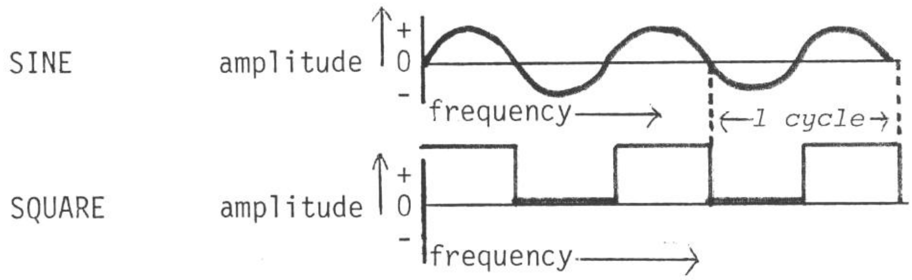
SECTION II: USING THE ANALOGUE CONTROL MATRIX

VOLTAGE CONTROL
Analogue signals differ from digital ones in that they are not limited to two states, but function on a continuum, from a lowest to highest point. An analogue signal may be modulated by a voltage so that it will change states along its continuum according to the amount of voltage applied.

CONTROL SLIDERS
PATCH No. 30
The Control Sliders (of which there are four) produce a simple, unfluctuating voltage. The voltage level may be changed manually by moving the appropriate slider up and down. In this patch, one slider is used to control the horizontal position of Shape 1A, another to control the vertical position. By moving both at once in opposite directions, the shape will appear to move around the screen diagonally. Note that the sliders will now control any shape selected by Shape Select 1A or 1B. They will not affect shapes 2A or 2B, which have separate control inputs.

THE OSCILLATORS AND RANDOM VOLTAGE
The control signals available from the control sliders will change only if the slider is moved manually. The control signals available from the oscillators and random source are voltage waveforms. Waveforms are fluctuating voltages that may be measured according to frequency (number of fluctuations per second) and amplitude (amount of fluctuation from lowest to highest point). A waveform may have a characteristic pattern of fluctuation, called its shape. The oscillators provide two different waveshapes, a sine wave and a square wave.

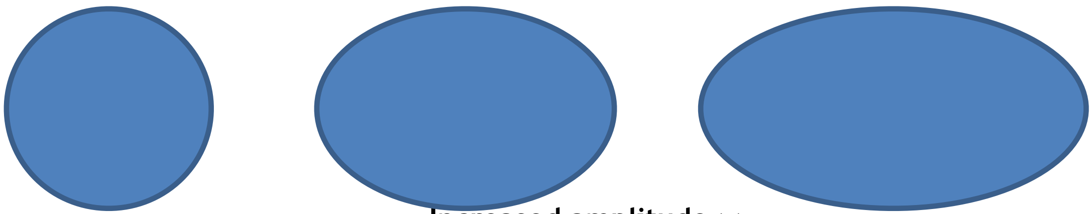
Here we have diagrammed a sine and a square wave, of equal frequency and equal amplitude:



Note that a sine wave will change from positive to negative voltage, where a square wave only changes from positive to zero.

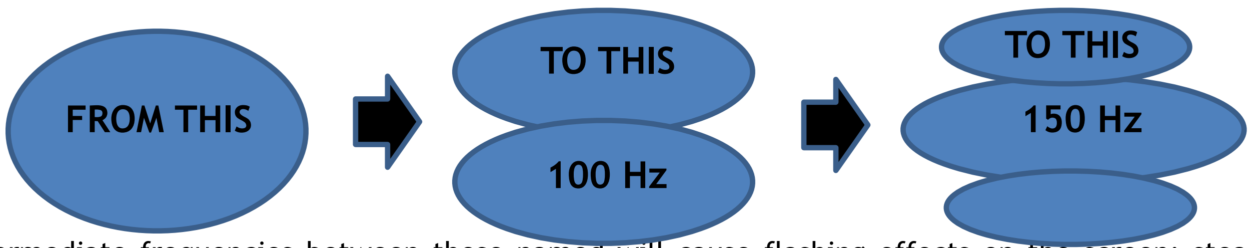
PATCH No. 31
Using a low frequency sine wave from Oscillator 1 to control the horizontal position of Shape 1, try varying the amplitude (or level) of this control signal. Then experiment with different frequencies.

PATCH No. 32
In this patch, we use the same sine wave output of Oscillator 1, this time to control the circle of Shape Generator 1. Starting with a frequency of 50 Hz (50 cycles-per-second), you can change a perfect circle to an ellipse. The diameter of the ellipse is affected by the amplitude of the control wave.



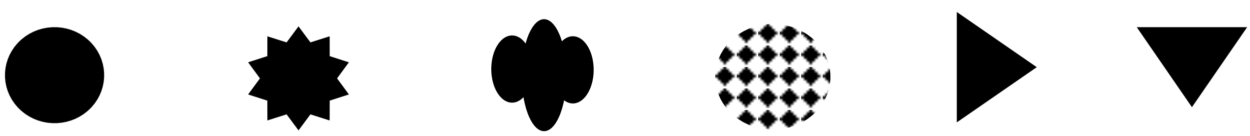
Increased amplitude >>

50 Hz is a special frequency: it is the same as the frame rate of the video signal that goes to the monitor. The monitor is, in fact, producing fifty pictures per second, but as this is faster than the human eye can perceive distinct images, it appears continuous. If you switch the control wave frequency to 100 Hz, the image will change from:



Intermediate frequencies between those named will cause flashing effects on the screen: steady images will appear only when the control signal frequency is an integer multiple of the frame rate. In order to reach these frequencies quickly and simply, the oscillators are provided with a sync switch which will automatically set them to the nearest frequency that is an integer multiple of the frame frequency. A slight offset from this will cause the image to appear to move up or down the screen. At very high control frequencies, it is more useful to sync them to the scan line rate (itself a high frequency). In terms of ordinary television, the frame rate is the “horizontal hold”; the scan line rate, the “vertical hold”. If one is using a control signal in the kilohertz range, it is easier to obtain steadied images by using the line sync, while the frame sync is better for lower frequency controls.

PATCH No. 33
In this patch, two oscillators are used to control different shape generators. By advancing the counter of each shape select, note that the control voltages will affect certain shape outputs, but not others. The six basic signals which can be voltage controlled have been named – circle, gear, lantern, frizz, horizontal zoom and vertical zoom. The panel graphics applying to these are respectively:



The sixteen shape outputs are made up of these different forms, in various combinations and mutations. You should be able to identify them and apply control voltages to the proper inputs with a little experience.

PATCH No. 34
The Random generator provides a control voltage that is just as the name implies: not a "periodic" waveform, such as the sine wave, but one that changes frequency without a detectable pattern. With the panel sliders, you can determine the range of frequencies within which the random generator will operate, and the amplitude of the signal it produces. You can also determine the rate at which it will change from one frequency to the next, and the "slew" which is the time it takes to make this change.

MORE ABOUT THE SHAPE CONTROL

PATCH No. 35
This patch illustrates an effect that can be achieved by using only the Edge output, through which a voltage controlled shape signal has been fed. We wish you to realise that, though the shape outputs are limited to 16, and control inputs to 8, there is an almost unlimited number or forms available to you through the use of control voltages.

PATCH No. 36
In this patch, by modulating both the "gear" control input, and the horizontal position control, a new form is obtained. By patching a control slider also to the gear form, you can change the size of the form, without affecting the modulation produced by the oscillator.

CONTROLLING COLOUR

PATCH No. 37
There is one control input for each of the three final signals, red, blue and green. Three control sliders are used, so you can experiment with the effect on each signal. Try changing the patching of pins at Output A to a different configuration, then altering the control levels.

PATCH No. 38
In this patch, low frequency oscillator signals are used, so that the red level will change as the circle grows larger, and the blue level will change as the horizontal zoom does.

USING SIGNALS FROM THE DSM

On the Digital Signal Matrix, there are two input columns labelled TO CONTROL MATRIX, and on the ACM, two rows labelled FROM SIGNAL MATRIX. As you may have guessed, signals applied to the afore-mentioned input columns, will appear out on the ACM rows, as labelled. In between the input and output, the signal is slightly filtered, to make it more suitable as a control signal.

PATCH No. 39
This is a simple one – an X counter bit to control the circle. If it reminds you of another shape output, you are justified: a similar process is used internally in SPECTRON to produce the "gear" signal. Try using the X counter bit to control other shape inputs for experiments sake.

PATCH No. 40
By now, you should understand what is happening in this patch without need for an explanation. We cannot, within the space of this book, explain every possibility of the DSM to ACM signal routing, and so must leave it to you to explore.

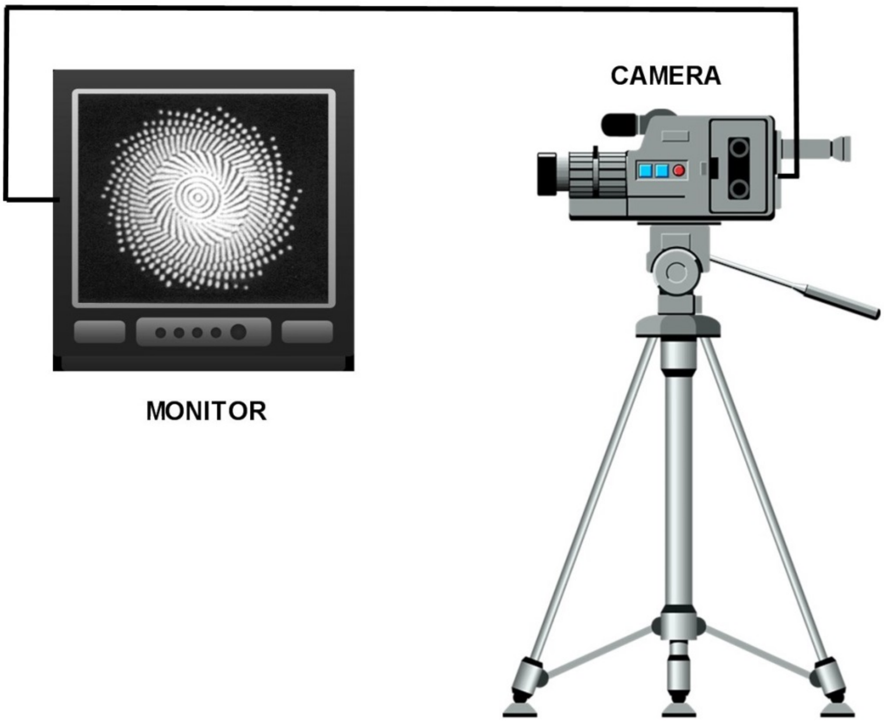
SECTION III: USING EXTERNAL SIGNAL SOURCES & CONTROL SIGNALS

THE VIDEO INPUT

HOW THE INPUT COMPARATOR FUNCTIONS

A black and white video signal modulates only the brightness of the picture tube, and produces a picture with a grey scale. When this signal is fed through SPECTRON, the comparator looks at the grey scale and divides it into seven levels that can be coded as digital signals. These signals then appear out on the DSM, so that the brightest area of the original image corresponds to level 0, the darkest, level 6.

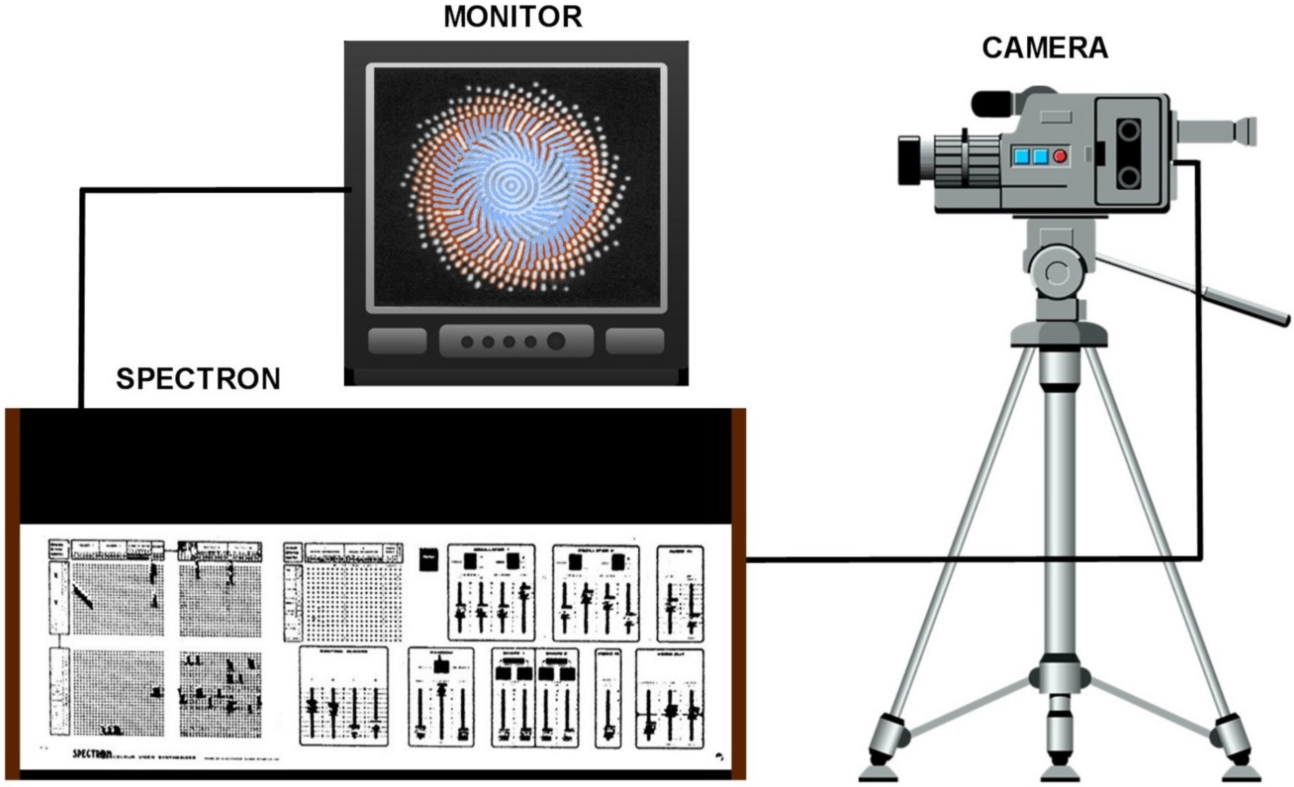
PATCH No. 41
Using a black and white camera focused on a simple, but well lit subject, setup the pins as indicated in the patch illustration. Now move the slider labelled Comparator Level Spacing from minimum to maximum. The Comparator Level Spacing controls the input of the video signal. At minimum, only the darkest part of the grey scale enters the comparator and is divided into 7 levels. At maximum, the entire signal passes through. Each level is patched to a particular colour combination, and retains that colour until the pins are moved. By moving the Comparator Level Spacing, that level now applies to a different area of the picture, so the colours appear to move from one place to another. You will also notice this effect if you change the lighting on the subject, or the aperture of the camera lens.



PATCH No. 42
Since the video input levels on the DSM are now in digital form, it is possible to use them with any of the processing functions, just like any other signal source. There are unlimited ways of manipulating the original image seen by the camera, besides just colourising it.

PACH No. 43
As the comparator level spacing is an analogue function, it can be voltage controlled: this is a simple and obvious way of using that capability.

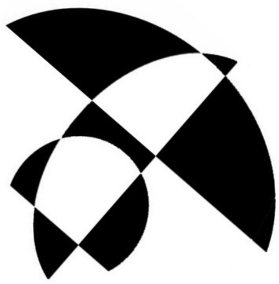
PATCH No. 44
With this patch, use the camera pointed directly at the monitor screen. We are using an effect called VIDEO FEEDBACK. Video feedback has been used for quite a long time by video artists and producers. A simple feedback loop illustrated above. We are all familiar with audio feedback, where a microphone picks up the sound waves from a speaker, and feeds the resultant signal back into the speaker. Video feedback is similar in essence, but properly controlled, the effects will be quite pleasing. With SPECTRON, the loop is created this way:



Remember that the camera sees only a black and white image: it will be effected only by the luminance levels on the screen, not the colours. In setting up feedback patches with SPECTRON, you will find usually it is self-defeating to patch level 0 to the brightest luminance levels: as this already indicates the brightest part of the video signal, making it brighter will cause the feedback to build up until the whole screen is bright, rather like the screaming pitches that will build up with uncontrolled audio feedback. There is an important factor that makes video feedback different from its audio counterpart, however: in video we are always dealing with the scan lines that form the eventual image. By tilting the camera so that it faces the screen at an angle, the feedback image is enormously affected.

PATCH No. 45
Here we have introduced an image from SPECTRON into the feedback loop, to illustrate the effect of tilting the camera in respect to the monitor.

SCAN LINES
MONITOR FACING CAMERA



CAMERA LOOKING AT THE
MONITOR WILL SEE THIS

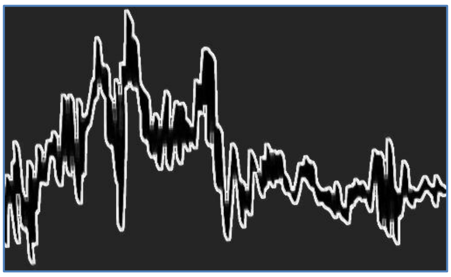
WHICH IS FED BACK INTO
THE MONITOR VIA
SPECTRON, SO WE NOW
HAVE THIS

As … ge … c … le
eac … ma … a … e,
fee … i … k … re
fee … ha … ill
find that the feedback patterns will be quite stable at such angles: at intermediate angles, spiral rotation tends to be uncontrolled. The distance between the camera and monitor in a feedback loop is also critical to the type of image produced. It is useful to have a zoom lens on the camera to experiment with. Using feedback with SPECTRON offers you an even wider range of dynamic patterns. The best clue we can offer the beginner in experimenting with this effect is to pay attention to luminance levels: when using a shape or other electronic image with a feedback loop, the brighter the shape, the more it will affect the feedback.

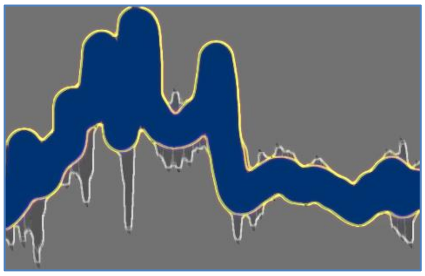
USING THE AUDIO INPUT

HOW THE ENVELOPE FOLLOWER WORKS

An audio input signal fed to SPECTRON appears out on the ACM in three ways: an amplitude contour of the bass, the same for treble, and a filtered composite of the original signal. The amplitude contours are achieved by first splitting the original signal into treble and bass. The relative amplitudes of these are determined by a slider, similar to the "balance" control on a hi-fi system. The signals are then passed through an envelope follower. An envelope follower looks at the amplitude of the signal input, and produces a voltage waveform with the same amplitude contour:



ORIGINAL SIGNAL



AMPLITUDE CONTOUR

Signals controlled by the bass or treble outputs on the ACM will respond to the dynamics of the music or sound used as Audio Input.

PATCH No. 46

As you can see in the patch illustration, more than one control signal can be used for any control input, so that a form may be effected by an oscillator as well as the audio signal. The composite audio signal contains the frequencies of the original signal as well as the amplitude, so its effect as a control signal is different from the amplitude contours of treble and bass.

OTHER EXTERNAL SIGNALS

EXTERNAL INPUT TO ACM

The external input will accept any analogue signal of +/- 3 volts maximum – the kind normally obtained from a music synthesizer or independent oscillator. The signal that appears on the ACM may be used as any control signal, but the signal level must be controlled from outside SPECTRON.

EXTERNAL INPUT TO DSM

This external input will accept digital signals of normal TTL levels, which will appear out on the DSM at the rows labelled "spare". Here again, they may be used as any other digital signal in SPECTRON.

SECTION IV: THE BEGINNING

The whole of this book is simply an introduction, now that you have made the acquaintance of all the various functions that make up SPECTRON, it is time to get to know them. The patch illustrations that follow are intended to suggest some of the more complex ways in which SPECTRON may be used. We hope they will encourage you to try experiments of your own, and to discover new patches that we have perhaps never tried. SPECTRON is essentially a tool for the imagination. The next patches may stimulate your imagination, but it is the understanding of the instrument that (we hope) you have gained from the previous sections that will aid you most in your own experiments.

Have fun!