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ILLUSTRATIONS

THE EMS SPECTRE COLOUR VIDEO SYNTHESIZER

is a unique and revolutionary new product: an instrument capable of producing exciting graphic images on an ordinary television screen.

The complete SPECTRE package consists of the synthesizer itself, plus a Sony Trinitron colour monitor, and a Sony black-and-white TV camera. The synthesizer is compact (38"x23½"x7"), portable (about 35 pounds), and unequalled in its simplicity and versatility.

WHAT IS A VIDEO SYNTHESIZER?

Television "special effects" have been familiar to all of us for some time now. Such effects have, up until this time, required the use of a variety of bulky and expensive equipment. Other less familiar visual effects have been acheived in the video medium, but only with the aid of complicated computer programs.

The SPECTRE Synthesizer is similar in concept to the now well-known music synthesizer. It incorporates a number of separate functions which can be selected and combined by the user by means of a patch board on the face panel. The number of possible combinations is virtually infinite, allowing an unlimited variety of images, colours, and patterns to be produced.

Some of these functions can be used to alter or manipulate an image coming from a TV camera. Others can be used to create images of an abstract and evocative nature, without the need for any external signal source.

The idea of a synthesizer is to offer the user a variety of different tools within one instrument, which can be combined to give direct control over the various parameters of the medium - in this case, colour, shape, texture, space and timing. SPECTRE is the first video product in the world to acheive that goal.

APPLICATIONS FOR SPECTRE

Spectre is versatile enough to have applications in many diverse fields. Video has already become an aid to education and industry in many ways; Spectre, as a low cost, self-contained video studio is ideal for the school or business wishing to take advantage of video technology.

For any educational institution, Spectre will be invaluable as a tool for teaching principles of design, color, and concepts of digital logic. Students can create works which are easily stored, permanently or temporarily, on videotape, and can be duplicated as easily as with audio recordings.

For artists and video production studios, the applications are obvious. As well as being able to perrorm special effects with less hardware than is usual, Spectre can be used as a live performance instrument, for which there is no comparable system presently available.

In industry, Spectre will be extremely useful in fields such as fabric and wallpaper design, where a simple photograph of the monitor screen would substitute for painstaking artist's renditions. Black and white images of products or advertisements can be colourized, and particular colours or combinations thereof substituted or recalled in an instant.

To add to its commercial applications, Spectre is entertaining as well as useful. Its accesibility to even the most inexperienced of users will make it a unique attraction in any situation where entertainment is sought.

OPERATION OF SPECTRE

All patching of functions in Spectre is done by means of pin board matrix connections. Signals coming out of functions appear at horizontal positions (rows) and inputs to functions, as well as to the final output, are at vertical positions (columns). Outputs are labelled at the left side of the pin matrix, inputs at the top.

In order to produce an image on the monitor screen, signals must eventually reach the input columns of either Output A or Output B on the Digital Signal Matrix.

Spectre has three types of digital output - luminance, colour 1 and colour 2 - which combine to send particular signal levels to the video output. There are 16 levels of luminance, eight levels of each colour, making a total of 64 colour possibilities at any of 16 luminance levels. It is by manipulating the digital signals that produce these levels that we form images on the monitor screen.

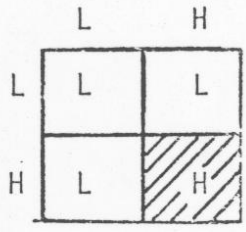
In order to operate Spectre effectively, it is helpful to have a basic understanding of digital logic:-

Digital signals have only two states: they are either high or low. There are three kinds of operations used to combine digital signals and produce a particular output. These are:

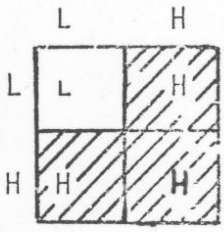
> The AND Operation: The output is high only where all inputs are high; where any input is low, the output is low.
>
> The OR Operation: The output is high where any input is high; output is low only where all inputs are low.
>
> The Exclusive OR Operation: The output is high where only one of two inputs is high; where the two inputs are in the same state the output is low.

We can diagram these operations as graphs:

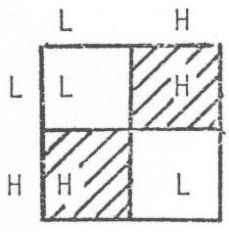
AND



OR



Exclusive OR



With nothing patched on the Digital Signal Matrix, all the digital outputs 'float' high. Signals patched to an output column are combined by the AND operation, so that the output will go low wherever the input signal is low. We are, in effect, 'carving' images out of a black screen.

To illustrate this with a simple patch:

With no patching, the screen will appear dark. Patching X position 2 (a signal which goes low, high, low, high, low across the screen) to Luminance 0 will produce light vertical bands:

The light bands indicate where the luminance signal has been pulled low. Patching X2 also to one of the colour outputs will pull that colour signal low, so that the light bands now have a hue that is the combination of Luminance 0 and one Colour input in the low state, all others in the high state.

Input signals patched to the same column also combine by the AND operation.

Beginning as before, with X2 patched to Luminance 0, now patch X4 also to Luminance 0. X4 goes low, high, faster than X2, so producing narrower bands. The bands of X4 will appear only in the positive (high) areas of X2. The dark area on the screen now represents the combined high output of X2 and X4.

Output A and Output B are identical, and are combined by the Exclusive OR operation to produce the final digital output of the synthesizer.

To produce a simple checkerboard effect, then, we would patch X2 to Luminance 0 at Output A. Now, by patching Y2 to Luminance 0 at Output B, the high level will appear wherever X and Y are in opposite states, the low level wherever they are in the same state. Referring to the graphs at the bottom of page 2, the screen appears like the Exclusive OR graph, repeated several times, dark at the high level, and light at the low level:

The effect of any signal may be inverted by grounding the respective input column of the opposite Output. That is, if X2 is patched to Luminance 0 at Ouput A, patching Luminance 0 at Output B to Ground will produce this:

SPECTRE FUNCTIONS

Digital Signal Matrix

X and Y positions

Produce horizontal and vertical bands. Each level (0-8) is twice the frequency of the level above it, thus producing bands half the width of the one before.

Overlay Gates (1-4)

Allows superimposition of images. Inputs to SIG appear only where the input to DIS is low.

Inverts (1-4)

Signals sent to Invert inputs appear inverted (high goes low, low goes high)at the Invert out row.

Edge

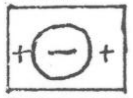
Creates an image of the border of the signal at the Edge input. If we scan the screen from left to right, we can speak of signals as "rising" where they change from low to high, "falling" where changing from high to low. The + output of the Edge is the border of the rising side of the input signal, - is the border of the falling side.

Delay

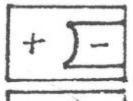
Creates "echoes" of signals by reproducing the input signal in the state it was in a microsecond before.

Flip- Flop

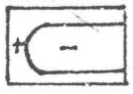
Similar to Edge, creating a low signal where the input signal changes state, but extending the the edge of the screen. If we send a circle as signal input:



The Flip-Flop + output appears:



The Flip-Flop - output appears:



Slow Counter

A signal going high and low at six different frequencies. Can be combined with other functions to produce various timed effects, such as to disenable a signal at an overlay gate.

Shape Outputs

There are four separate shape outputs, each of which can produce any of sixteen different signals, as determined by the Shape Select on the right side of the face panel.

Each of these sixteen signals is a basic form which can be modified by a control voltage (such as an Oscillator or Audio signal). Control signal inputs are available on the Analog Control Matrix (see Shape Select and Shape Generator Control).

Video Input

An input from an external black and white video source (connected via the back panel socket) passes through a comparator in the synthesizer. The comparator divides the grey scale of the video image into seven different levels. These levels appear as digital signal outputs on the Digital Signal Matix, so that each of the levels can be individually coloured or patternised. The video outputs may also be processed through any of the SPECTRE functions, such as Edge or Flip-Flop, for other special effects.

Invert X and Y

Signals at these inputs will cause the corresponding X or Y output to change state wherever the input signal is low.

Another way of producing the checkerboard pattern used as an example on page three, is to patch X2 to any level, then patch Y2 to Invert X2.

Colour Swap

Signals patched to any colour are switched to the same level of the opposite colour whenever the input at Colour Swap is low.

Analog Control Matrix and Sliders

Oscillators 1 and 2	Produce sine and square waves, with slider controls for coarse and fine frequency and amplitude level. Frequency can be switched to one of three ranges. Sync control allows the oscillator to be synched to integer multiples of either the line or frame frequency of the monitor. This allows the effect of the oscillator on an image to remain stable.
Audio Input	Produces an amplitude contour of the treble and bass ranges, or their composite, of any external audio signal. This signal may then be used to alter any voltage controllable parameter of an image.
Control Sliders	Produce voltages which remain constant at the level set on the slider.
From Signal Matrix	Signals directed to the input labelled To Control Matrix (on the Digital Signal Matrix) will appear at this output, with the choice of either the high or low state of the digital signal. Thus, for one instance, the outputs of the Slow Counter may be routed to the control matrix to control an analog function.
Video Out	Signals at these inputs control the level of the final outputs luminance, colour 1 and colour 2, as they affect the monitor. Levels for these signals may also be set by face panel sliders.
Comparator Level Spacing (Video Input)	This affects the level of the external video input that is directed to the comparator (described on page 5 under Video Input). At maximum, the entire video signal will pass through and be divided into seven levels. At minimum only the darkest areas of the image will pass through and be divided. As the Comparator Level slider or control voltage is changed the colours selected on the Digital Signal Matrix for any level will move from one area of the video image to the next.

Shape Select and Shape Generator Control

The Shape Selects allow the user to choose one of sixteen different signals to appear at one of the four shape outputs on the Digital Signal Matrix. The output chosen is indicated by a combination of four LED's on the Shape Select panel. The Shape Selects and Shape outputs are in pairs: outputs 1a and 1b are controlled by Shape Generator 1, like wise for outputs 2a and 2b controlled by Shape Generator 2.

The sixteen outputs are in turn derived from six basic signals (or forms) produced by the Shape Generators. There are control inputs to each of there six forms, which allow a wide range of modification to any basic form. There are also inputs to control the horizontal and vertical orientation of the forms, making a total of eight control inputs to each Shape Generator. Note that a control signal input to Shape Generator 1 will affect both Shape outputs 1a and 1b, but not 2a or 2b.

SPECTRE SYSTEMS AND ACCESSORIES

SPECTRE may be used with any ordinary television or TV monitor, or adapted to the equipment of an existing video set-up. It includes both an encoded video output (either PAL or NTSC format) and a modulated (UHF) output, as well as an un-encoded output for monitors modified to accept its signals directly.

For those who do not already own video equipment, EMS recommends that SPECTRE be pucnased as a package with a modified Sony Trinitron colour monitor and Sony black and white TV camera.

The Synthi AKS music synthesizer is recommended as a companion to SPECTRE, allowing a greater range of control signal possibilities, as well as audio-visual interaction.

DESCRIPTION OF COLOUR PLATES

All of the colour plates were taken of images produced by the first prototype of SPECTRE, which is now in operation at the EMS studios in Putney.

Plate 1a: Geometric pattern produced with X-Y generators, with circle overlay. Video feedback is combined to produce colour shifts.

Plate 1b: Simple geometric pattern and 'zoom' shape, with feedback superimposed.

Plate 2a: Electronically-generated image using circle, gear and lantern shapes.

Plate 2b: Also purely electronic - using lantern and 'zoom' shapes, stripes produced by X generators.

Plate 3a: Complex electronically generated pattern, making extensive use of signal inverters.

Plate 3b: Black-and-white camera signal colourized and superimposed over an electronically generated background pattern.

Plate 4a: Geometric pattern with circle and feedback used to invert colours.

Plate 4b: Horizontal 'zoom' shape being modulated by the sine wave output of an oscillator, feedback superimposed.

SPECIFICATIONS

I. CONTROL SYSTEM

A. Digital Signal Matrix (allows combination, structuring and modification of basic signals)

1. Digital Signals:

   9 X (Horizontal) Counter Outputs.
   strip width: .12µs - 30µs in binary steps.
   9 Y (Vertical) Counter Outputs
   Strip Width: 2 lines - 512 lines in binary steps
   6 Slow Counter Outputs: 2Hz - 6Hz in binary steps.
   4 Shape Outputs (from two independant Shape Generators)
   each outputs is panel selectable from 16 possible basic shapes, circle, gear, lantern and triangles being just a few of these. These shapes may be modified by using the Analog control Matrix.
   7 Video Comparator Outputs - each active for a particular grey scale band of the video input. This will perform all the functions of a normal colourizer, and many more as its outputs may be combined and modified with all other matrix functions.
   2 External inputs.

2. Digital Signal Modifiers:

   9 X Counter Invert inputs
   9 Y Counter Invert inputs
   2 Flip-Flops (reset with line sync)
   4 Overlay Gates (allow build-up of pattern layers)
   4 Inverters
   1 Edge Generator (with four outputs)
   1 Delay (800µs, reset with line sync)

3. Digital Matrix Outputs:

   The combinations in which a signal is patched to the output columns determines its colour and brightness. There are:

   4 bits for brilliance
   6 bits for colour

   Each bit comes from an "Exclusive OR" gate with both inputs available on the patchboard (named Output A and Ooutput B) This allows the output of each bit to be inverted as required by the user.

   1 Colour Swap Output (swaps round the two colour parameters)

SPECIFICATIONS (CONT.)

B. Analog Control Matrix (allows voltage control of the two Shape Generators, of the hue and brilliance of the final picture, and of the grey scale spacing of the video comparator.)

Control Sources:

4 Panel Sliders
2 Widerange, High Stability Oscillators 0.1Hz to 50KHz with sine or sqaure outputs, syncable to line or frame sync.
2 Random Voltage outputs, with 'recycle' facility.
2 Envelope Follower outputs - one for bass and one for treble range of any audio input.
1 Buffered audio signal
1 External Input
2 Filtered signals from the Digital Signal Matrix

II. INPUTS

Video Input - 1v p.p. with sync. Other levels may be used if internal presets are altered.
Audio Input - 1v p.p. nominal

External Digital Inputs - normal TTL levels

External Control Inputs - $\pm$ 3v maximum

III. SYNC

Internal Sync generator allows full operation without external sync.
If external sync is required, all sync inputs are on one socket and are 2-5 volt -ve going pulses.
Nominal subcarrier input is 2v.

IV. OUTPUTS

Red, Green and Blue Outputs 0.7v with blanking
High Resolution output (to modified Sony monitor)
Composite PAL (or NTSC by request) output 1v p.p.
U.H.F. Output (for direct connection to any colour TV)

All outputs are capable of driving into 75Ω