RESERVE

SYNTOVOX

SPX 216

VOCODER & SOUND EFFECTS

PROCESSOR

Users Manual

Preliminary Version
04-07-1985

SPX 216
Users Manual
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INTRODUCTION

Until now vocoders have been used mostly to create the "talking instrument" effect, where speech is imposed upon a carrier signal, typically a keyboard sound. Other effects, such as artificial speech, robot voices and cross-synthesis, could only be obtained with highly accurate, expensive vocoders, featuring many channels of high order filtering.
Syntovox SPX 216 is the latest vocoder design by Synton where two concepts merge: the famous intelligibility of the Syntovox 221, and the cost-effectiveness of the Syntovox 222.
Syntovox SPX 216 carries more features than any other vocoder on the market, obsoleting not only its competitors, but also its predecessors 221 and 222.
Like its predecessor, Syntovox 221, the SPX 216 has been given as many control inputs and outputs as possible, by means of a 32 pin multiconnector, opening up the unit to the electronic music studio, and creating new ways of making numerous, often un-vocoder-like effects. For information about connecting the SPX 216 and how to use the control inputs and outputs please read this manual carefully.

DESCRIPTION

The Syntovox SPX 216 basically consists of an audio analyzer and a synthesis filter bank, and an input/output circuit with an electronic patching and bypass switching system. The analyzer and the synthesizer section each contain fourteen specially designed filters, trimmed and tuned within tight specifications for center frequency, bandwith, gain and flatness.
A special circuit has been provided for the synthesis of unvoiced sounds (S, P, K, T, F,etc) which contain a lot of high frequency energy, often lacking in typical carrier sound sources like musical instruments. Syntovox SPX 216 features its own built-in microphone pre amplifier for balanced and unbalanced low impedance microphones, and a LF roll off filter which is indispensable when close miking the speech input. Speech can be mixed with the vocoder effect by means of the cleanfeed control.

START-UP INSTRUCTIONS

1) Before connecting power cord to mains outlet, check voltage requirements at back panel.

2) Connect a microphone to the 'MIC' input and a musical instrument (guitar, organ, synthesizer, strings ensemble, bass, etc.) to the 'CARRIER' input. Connect the outputs of the vocoder 'OUT L + R' to a power amplifier.

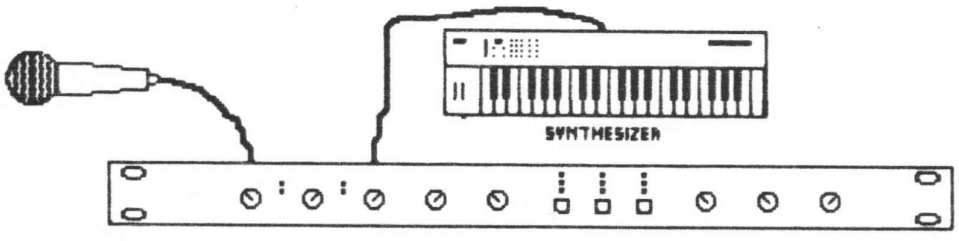
3) Switch to 'OSC' or 'DBL' with the 'CARRIER' button, and set 'STATUS' to 'VOCODER'.

4) Set the output level with the 'OUT' control, and turn up 'SPEECH GAIN' until the yellow led flashes as you speak or sing into the microphone. The red led indicates overload.

5) You should hear the vocoder effect now. Add 'CARRIER NOISE' to enhance sibilants and fricatives and change the pitch turning the 'OSC PITCH' control.

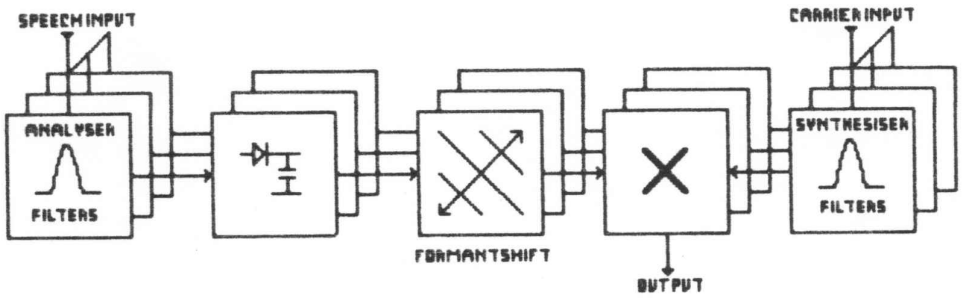
6) Press the 'CARRIER' button until none of the leds above it are lit. Play the instrument you have connected to the 'CARRIER' input and turn up the 'EXT CARRIER' until the red led flashes at peak levels. The instrument is now processed by the vocoder under control of the microphone signal.

7) Adjust the 'SPEECH HPF' filter to control the balance between low and high end; press the 'FORMANT' button to shift the spectrum up or down.



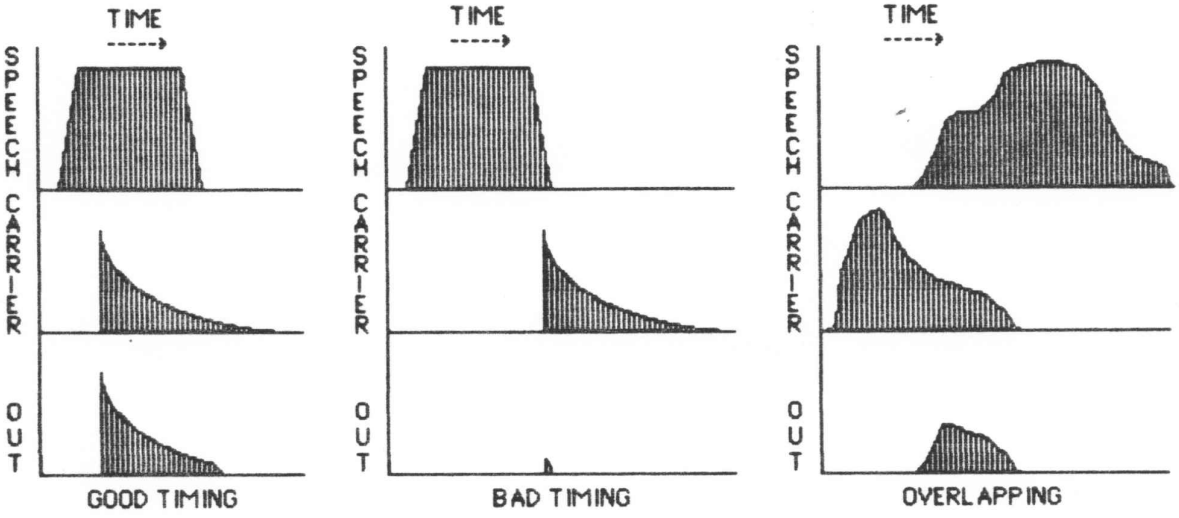
VOCODER BACKGROUND

The SPX 216 contains two identical filter banks. One of these filter banks is used to split up the speech input into 14 frequency bands. The outputs of these filters feed into 14 envelope followers, which convert the 14 audio signals into control voltages. When there is a signal at the speech input, the 14 control voltages represent the spectrum of this sound. This part is called the analyzer section.
The other filter bank processes the carrier input. Its effect could be thought of like a voltage controlled graphic equalizer, except these band filters are more selective than normal equalizer filters. During normal operation, the 14 control voltages that are derived from the speech input are used to control the level of the corresponding frequency bands of the carrier input. This part is called the synthesizer section.
This causes the carrier signal to follow the spectrum of the speech input. When the speech input is connected to a microphone, and the carrier input is connected to an instrument, this produces the "talking instrument" effect.
The patching between the analyzer filter bank and the synthesizer filter bank can be changed for other, more complicated effects. See also the sections concerning the 'FORMANT' button and the multiconnector.
Shown below is a section with three of the 14 vocoder channels.

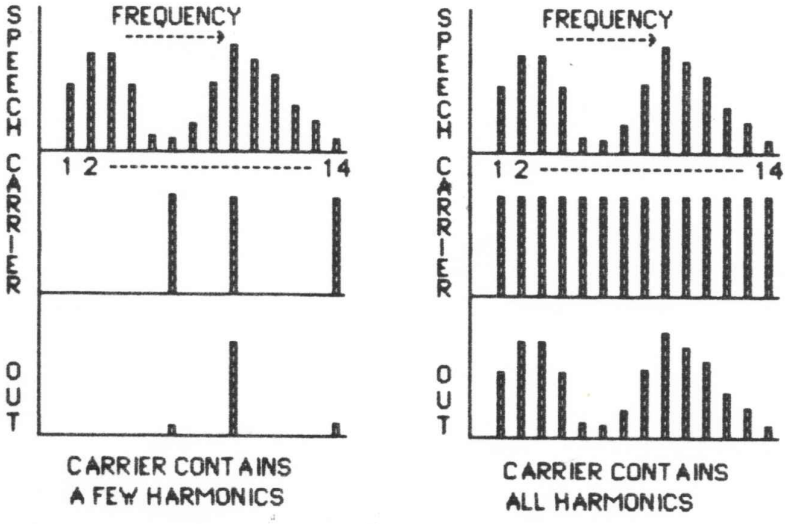


Picture 1

Because a vocoder is a modulator, it is very important that the speech input and the carrier input are used at the same time (unless the internal oscillator or 'voice' circuit is used). If the SPX 216 is used with a keyboard, a sustain pedal or 'hold' feature might be usefull to ensure that there is always a carrier signal.



It is equally important that the two input signals have overlapping spectrum, so there will be energy in at least some of the frequency bands. If you can adjust the equalizing on the carrier signal, it is usually a good idea to boost the high frequency or, for instance, using a guitar you can patch in a distortion pedal to add harmonics. Feel free to experiment.



Picture 3

FRONT PANEL CONTROLS

SPEECH INPUT CONTROLS

The sensitivity of the two inputs (speech and carrier) can be set by the two input controls ('SPEECH GAIN' and 'CARRIER EXT') so that the yellow leds are lit during normal operation. The red leds will flash if the inputs are overloaded. The speech input is equipped with a high pass filter ('HPF'). This filter attenuates the low end response and reduces the "boominess" caused by close miking. It is least effective when turned fully counter-clockwise. The 'CARRIER NOISE' control lets you add a noise source to the carrier input. When a sibilant is spoken or sung (like S, P, K, T,etc.), the filtered noise can be heard momentarily.
This is used to improve the intelligibility of the vocoder when the carrier input has little or no high frequency content.

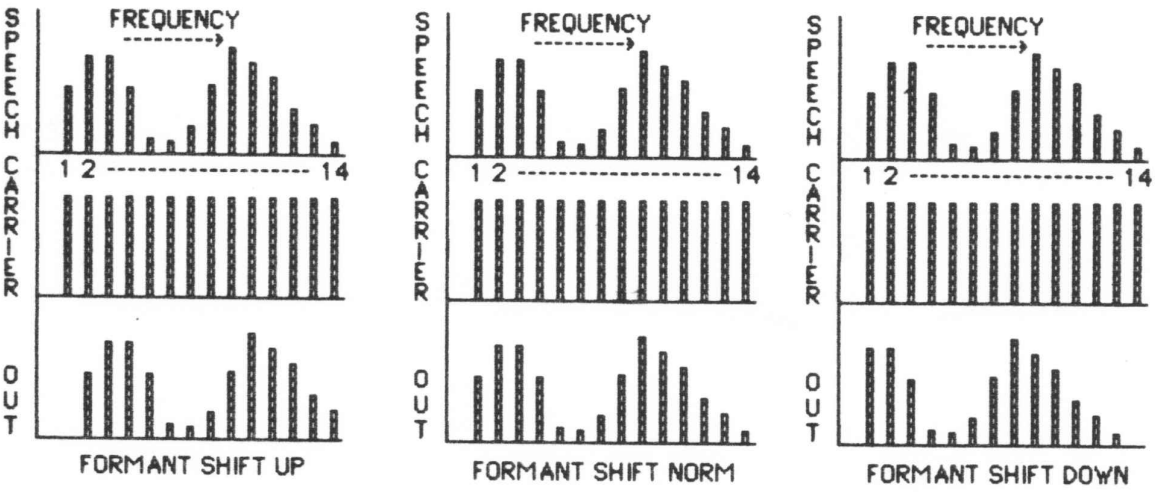
CARRIER INPUT CONTROLS

The SPX 216 has a built-in oscillator, a doubling circuit and a speech processing circuit. Tapping the 'CARRIER' button selects one of these sound sources, which are added to the 'EXT' carrier input.
When the 'VOICE' led is lit, the speech input is fed into a distortion circuit that adds harmonics to the sound, making it suitable to use it as carrier as well as speech signal.
When the 'OSC' led is lit, the internal oscillator is patched into the synthesizer section. The pitch of the oscillator can be controlled by the 'OSC PITCH' control.
When the 'DBL' led is lit, the internal oscillator is first fed into a doubling circuit, making it sound like two oscillators in unison, and then into the synthesizer section.
When none of the above leds are lit, only the external carrier input is active.

FORMANT SWITCH

The SPX 216 contains an analyzer filter bank and a synthesizer filter bank. Normally these are patched so that analyzer filter 1 is connected to synthesizer filter 1, 2 to 2, etc. The 'FORMANT' button repatches the filter banks so that in the 'UP' position analyzer filter 1 is connected to synthesizer filter 2, 2 to 3, etc. This causes the spectrum to be shifted upwards, so the sound will be brighter and more nasal.

In the 'DOWN' position, analyzer filter 2 is connected to synthesizer filter 1, 3 to 2, etc. This causes the spectrum to be shifted down, so the sound will be duller and more guttural (see picture 4).
See also the section about the multiconnector for other possible patches.



Picture 4

STATUS SWITCH

The 'STATUS' button switches the vocoder effect on and off. It has three settings: If the 'BYPASS' mode is selected, the speech and carrier inputs will be mixed and fed directly to the left and right outputs. The balance of speech and carrier is controlled by the 'MIX' control. The output signal is monophonic, but it is present at both outputs.
Selecting the 'VOCODER' position of the 'STATUS' switch brings in the vocoder effect. The input signals are not present at the outputs; only the processed sound. The vocoder signal is stereo.
The third position of the 'STATUS' switch is labeled 'VOC/CLFD', its effect is similar to the 'VOCODER' position, but the speech signal can be added to the vocoder signal with the 'SPEECH CLEANFEED' control. The cleanfeed signal is monophonic, but it is present at both outputs.

OUTPUT CONTROL

The levels of the two outputs can be simultaniously adjusted with the 'OUT' control.

INPUTS AND OUTPUTS

INPUTS

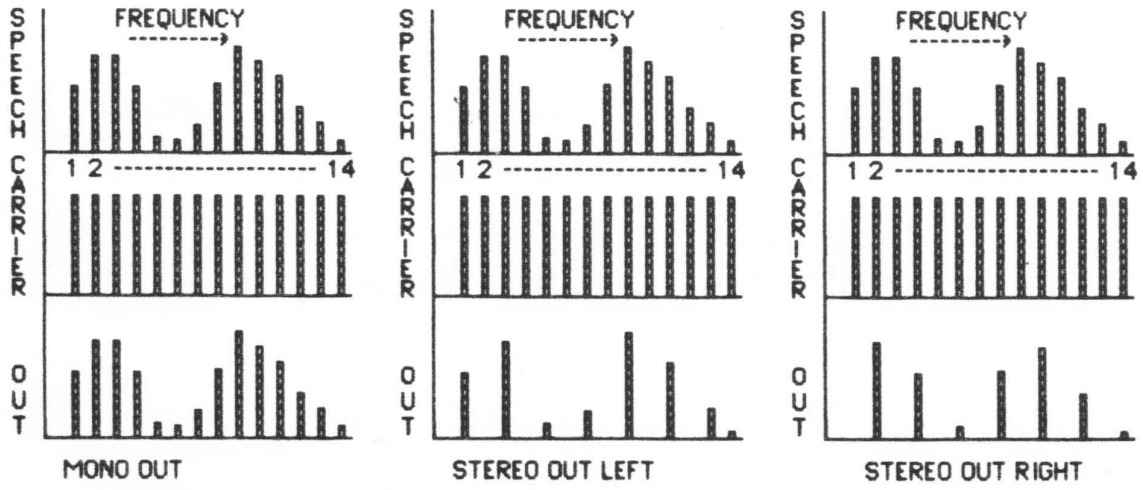
The SPX 216 has a line input for the carrier signal, and two inputs for the speech signal. The microphone input (balanced XLR) can be used simultaneously with the line input (unbalanced jack), but the level of both inputs is controlled by the same input control ('SPEECH GAIN').

BYPASS INPUT

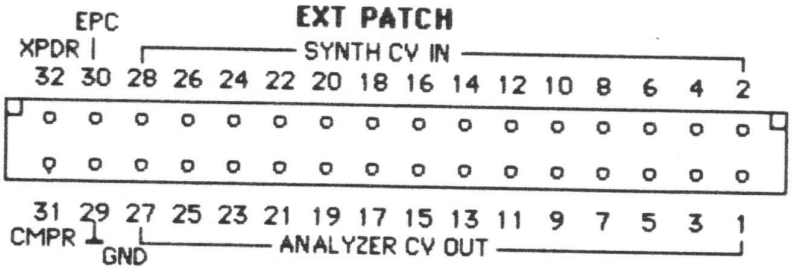
This input overrides the front panel 'STATUS' switch. If the tip of the bypass input is switched to ground, the vocoder will switch to bypass mode, and the front panel status led will also indicate the bypass mode. Releasing the bypass input sets the vocoder back to the status selected before the bypass input was used and switches the led back accordingly. This means that when the front panel led already indicates the bypass mode if the input is not used, the bypass input will have no effect.

OUTPUTS

The SPX 216 has two outputs. If only the left output is connected, the vocoder is monophonic; if both outputs are connected, the left output contains the outputs of the odd filter channels and the right output contains the outputs of the even filter channels. This causes the stereo effect. The bypass and cleanfeed signals are always monophonic (the same signal at both outputs).



MULTICONNECTOR



The 32 pin connector offers access to 14 CV outputs,14 CV inputs, one compressor output, one expander input, one external patch control input and one ground pin.

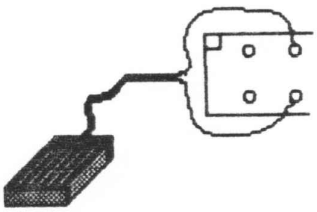
XPDR/CMPR

The CMPR is the output of the speech compressor. It contains the envelope of the speech input. The XPDR is the CV input of the expander.

EPC

The EPC (external patch control) is an input that activates the outputs of the multiconnector. There are two ways to use this input;

1 Switching to ground by using a (foot) switch (see picture 6).
2 Using a control voltage (+3 volts up to +12 volts . A logic high sets the SPX 216 to internal (front panel control) patching; A logic low (0 volts) selects external patching via the multiconnector.



Picture 6

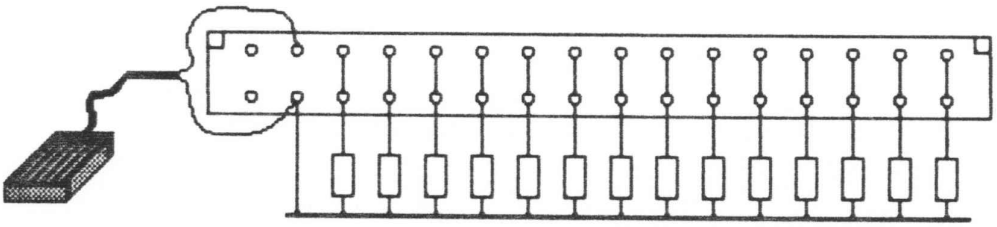
SYNTH CV IN

The synthesizer inputs can be used to control the volume of each of the 14 frequency bands separately. Contrary to the CV outputs, the inputs are always active, irrespective of the EPC status.These inputs can therefore be used to modulate any or all of the channels of the vocoder while using the speech input at the same time.

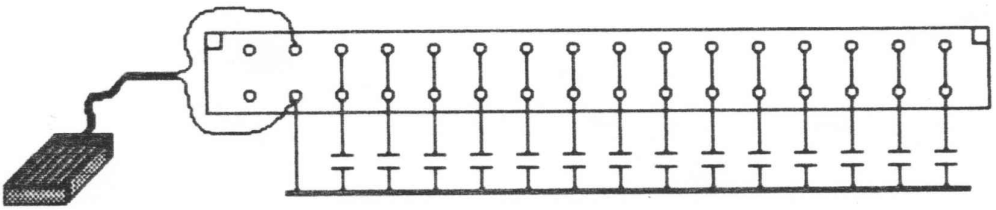
Because the expander controls the overall output level, the sound is only heard when there is a signal at the speech input, unless a DC voltage is applied to the expander input.

ANALYZER CV OUT

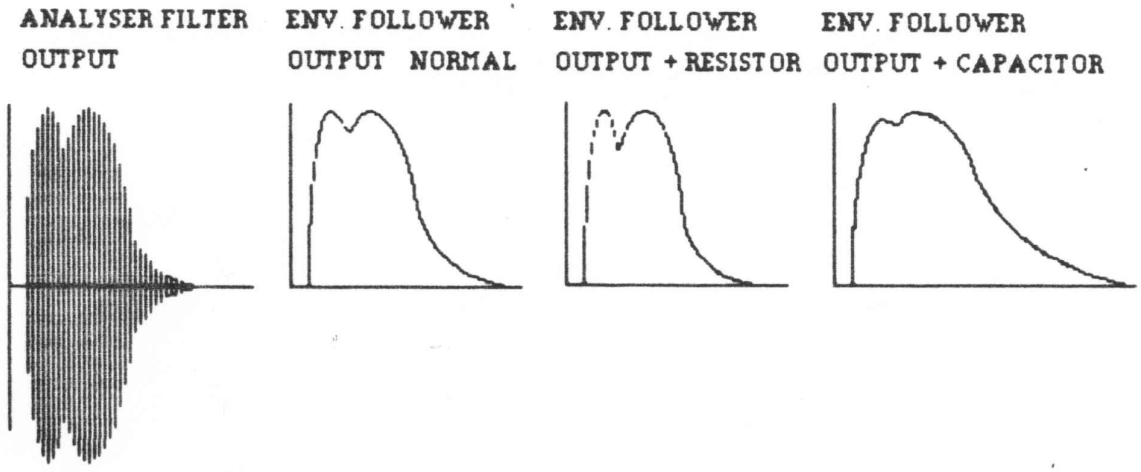
The CV outputs are taps from the envelope followers in the analyzer filterbank.These outputs are only connected if the external patch control input is connected to ground.
Because the outputs are a part of the envelope followers, the slew rate of the voltages, and therefore the response speed of the vocoder may be altered by adding resistors (approx. 10k-100k) to increase the slew rate (picture 7), or by adding capacitors (approx. 1uF-100uF) to decrease the slew rate (picture 8). In both cases the effect can be switched with a foot switch that connects the external patch input to ground.



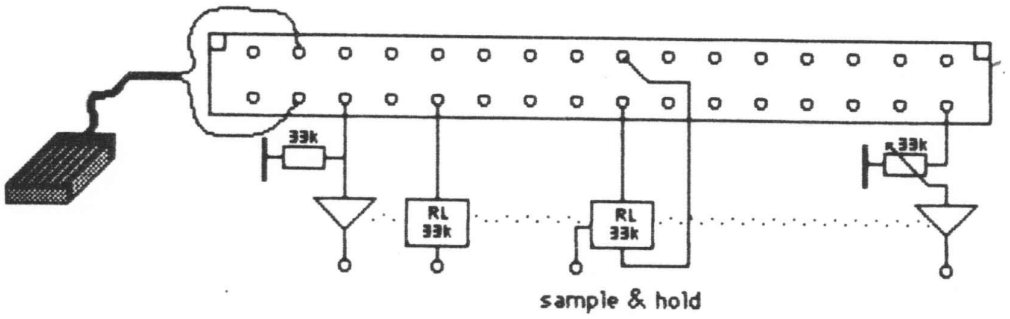
Picture 7



Picture 8

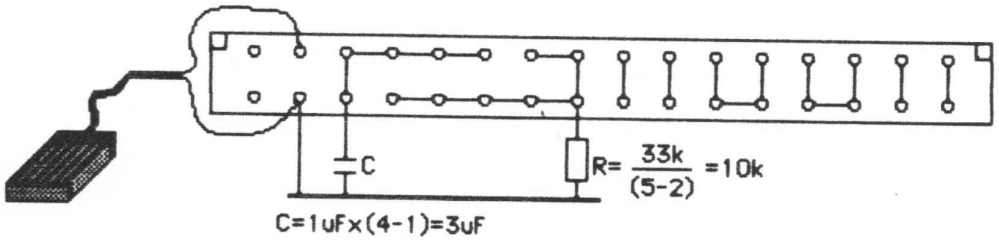


If the CV outputs are used to drive another device (such as display, computer peripheral , buffer sample & hold) it is important that the input impedance is 33k , in order not to affect the before mentioned slew rate (picture 10).
The voltages from the CV outputs do not reflect the exact level of the analyzer input signal, since this signal is compressed before being analyzed.



Picture 10

All inputs, outputs, or any combination thereof can be interconnected, but if there are several in and outputs linked together and there are more outputs than inputs, an extra resistor should be added (see picture 11). Its value should be approx. 33k divided by the number of outputs minus the number of inputs (see example picture 6). Similarly, if there are more inputs than outputs, an extra capacitor should be added (see picture 11); its value should be approx. 1uF times the number of inputs minus the number of outputs.

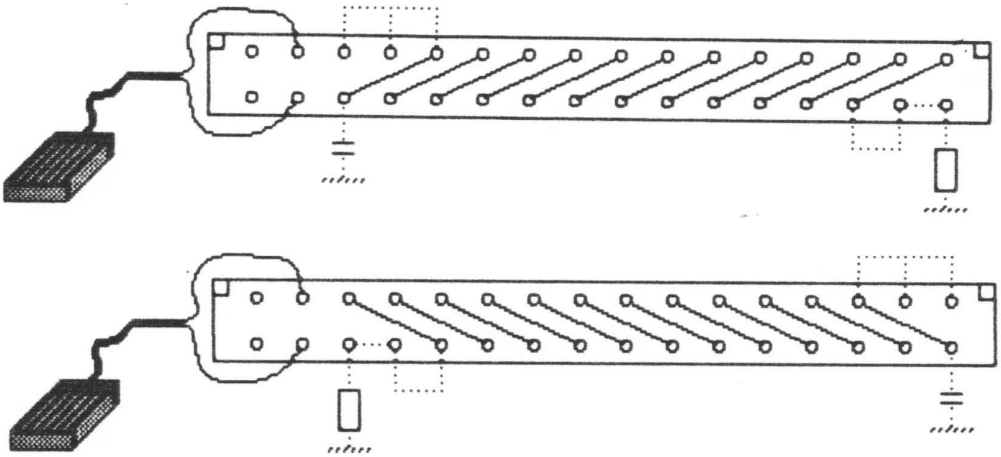


Picture 11

EXAMPLES

FORMANT SHIFT

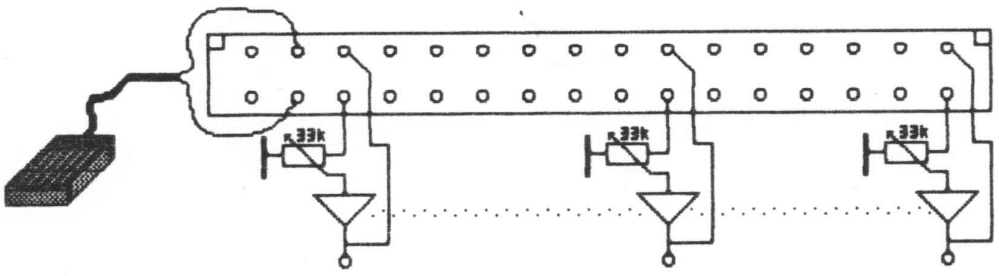
Like many multiconnector fuctions, formant shift can be switched on and off with a foot switch. The two illustrations depict the wiring of the connector for shifting two channels down and two channels up.



If the multiconnector is used for formant shifting, there will always be inputs or outputs that are not connected. These can be connected to the adjacent terminals as shown.

VOCODER EQUALIZING

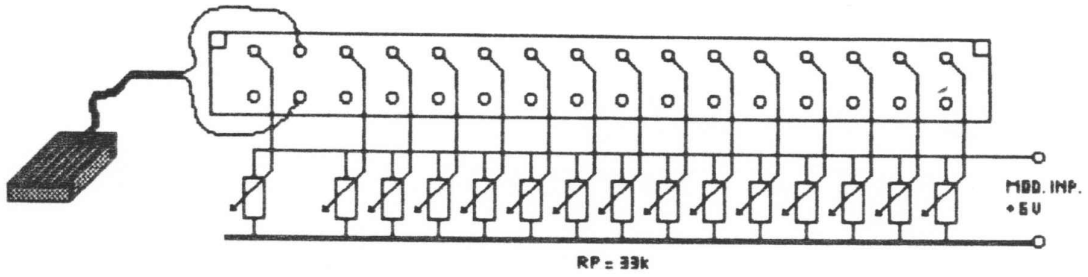
By adding 14 potentiometers and 14 buffers, the control voltage inputs of the synthesizer can be attenuated, thus giving control over the spectrum of the output signal.
This equalizing function can be switched on and off with a foot switch.



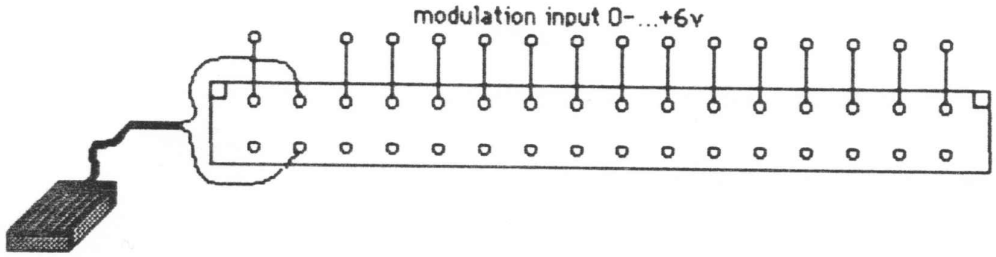
MODULATING CV INPUTS

The synthesizer inputs can be used to control the volume of each of the 14 frequency bands separately, creating a VC filter bank/equalizer.

A DC voltage (max. 6 volts) controls the gain of the VCA following each filter (see picture 15). Applying different voltages (LFO, noise, sample & hold, sequencers, etc.) to several inputs will cause the timbre to change accordingly (picture16). These effects are added to the vocoder effect only when the foot switch is off (not connected). If the foot switch is on, only the externally applied modulation will be effective.



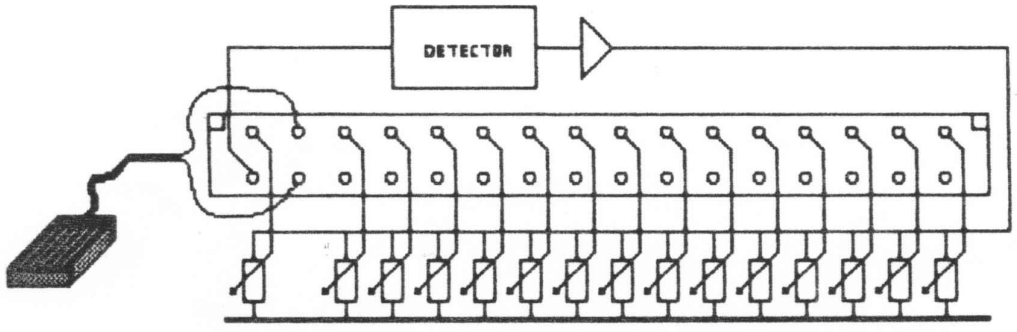
Picture 15



Picture 16

FILL-IN

With the circuit as given in picture 17, it is possible to do automatic fill-in. This means that the carrier signal will be fed through, even if there is no speech input.
The fill-in (or pause-stuffing) signal can be equalized with the 14 potentiometers. The amount of fill in is controlled by the potentiometer connected to the expander input.

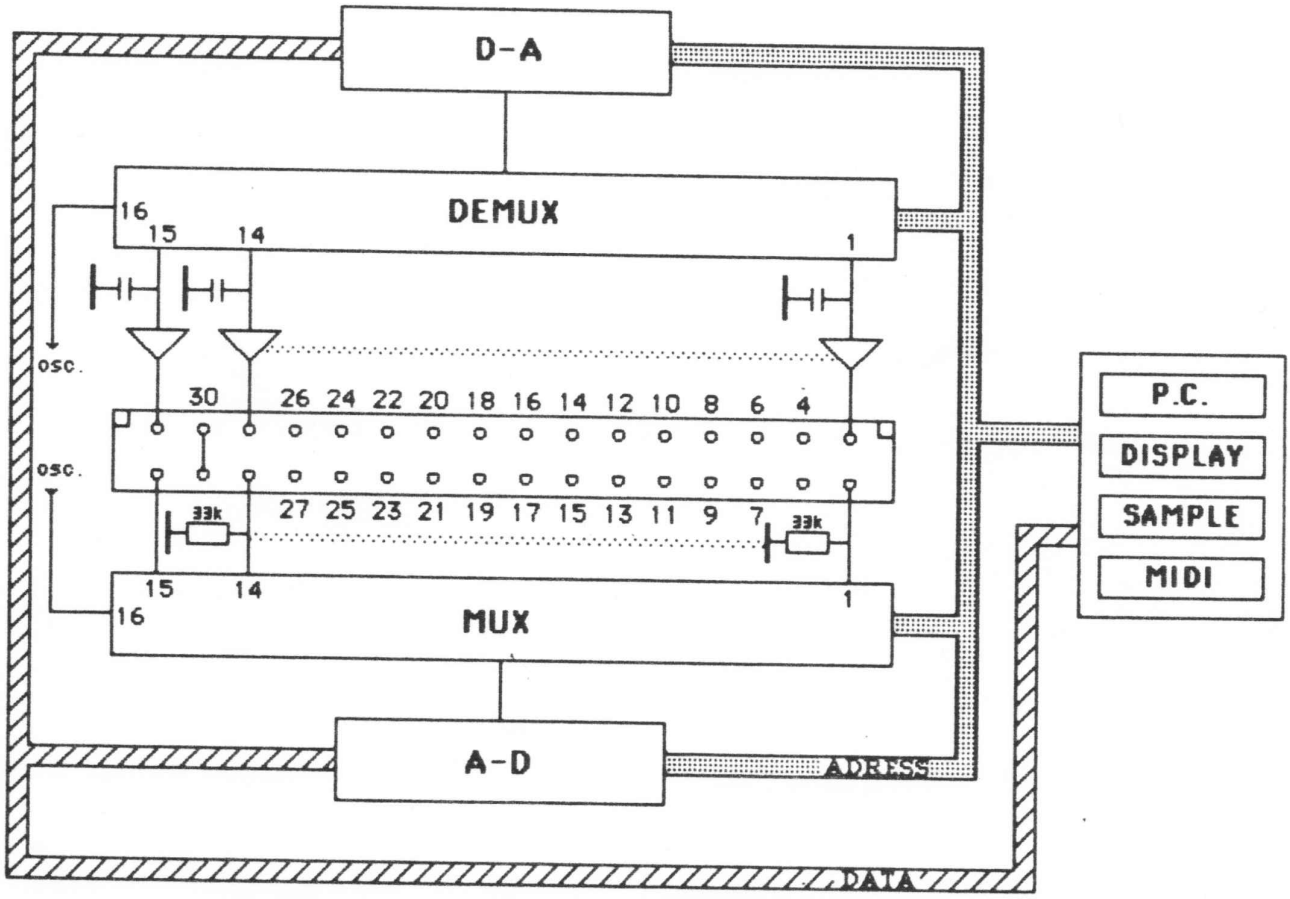


Picture 17

COMPUTER INTERFACE

A more complex application of the multiconnector is its use as a link to the computer. For this, a 16 channel multiplexing A/D converter and a 16 channel demultiplexing D/A converter are needed (and a computer, obviously). With such a set-up a whole new range of functions becomes available, including sampling the control voltages, allowing

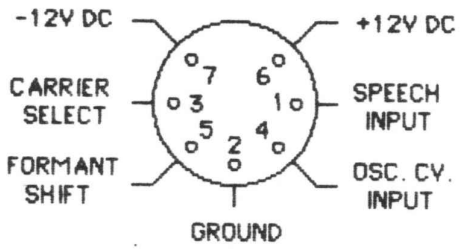
- graphic display of the speech input spectrum
- storing of the voltage envelopes for triggered playback
- generating envelopes from the computer
- formant shifting
- cross patching
- delaying
- inverting, or otherwise manipulating the voltages.



Due to the fact that the voltages only control the spectrum of a sound (that changes with a rate of approx. 100 Hz), and not the sound itself (ranging up to 20,000 Hz), you can get away with a much lower sampling rate than if you were to sample the actual sound itself. Using a normal home computer, this allows you to make relatively long samples.

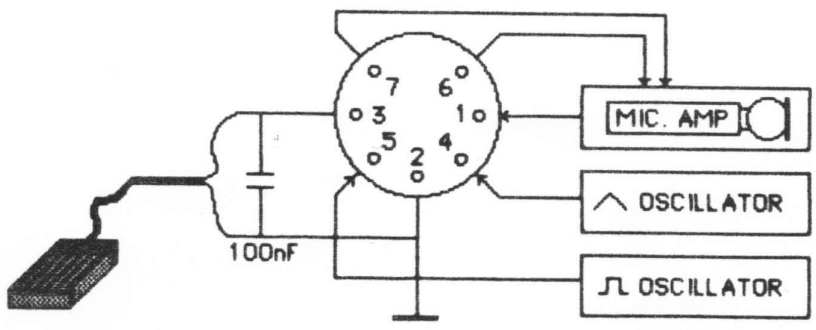
The pitch of the sound is not recorded with this spectrum sampling technique. This is because the vocoder does not affect the pitch, but only the spectrum of a sound. It is possible to control the pitch of the output sound by controling the internal oscillator with one of the D/A outputs.

DIN CONNECTOR



The 7 pole DIN connector contains all the inputs and outputs that are needed for hookup of a special hand controller, which will be available soon. This controller will contain a small microphone that feeds into the speech input (pin 1), a fader and a miniature one octave music keyboard to control the pitch of the internal oscillator (pin 4), a switch to patch the internal oscillator into the synthesizer (pin 3) and a switch to shift the formant up and down (pin 5). The function of these switches is identical to their front panel equivalents.
The DIN connector also supports two power supply pins (-12 volts at pin 6, +12 volts at pin 7) and a ground terminal (pin 2). These can supply the power for the microphone amplifier, switching logic and pitch control.

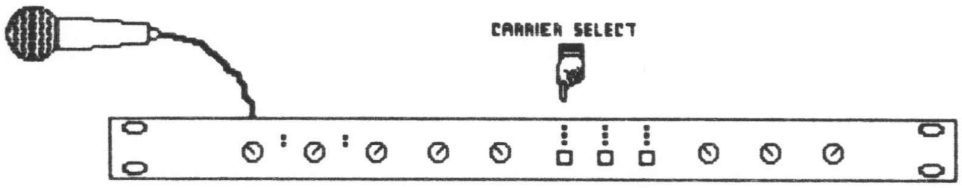
The CV inputs (responding much faster than mechanical controls) can also be operated by an external oscillator, causing patches to be changed at audio rate, creating special modulation effects. Audio rate switching can be applied to either or both switch inputs as well as the pitch input of internal oscillator, the latter causing frequency modulation (FM) of the internal oscillator.
A side effect of the fast reacting switch inputs is that they may bounce when used with a switch. This can be solved with a debouncing capacitor.



SET-UP EXAMPLES

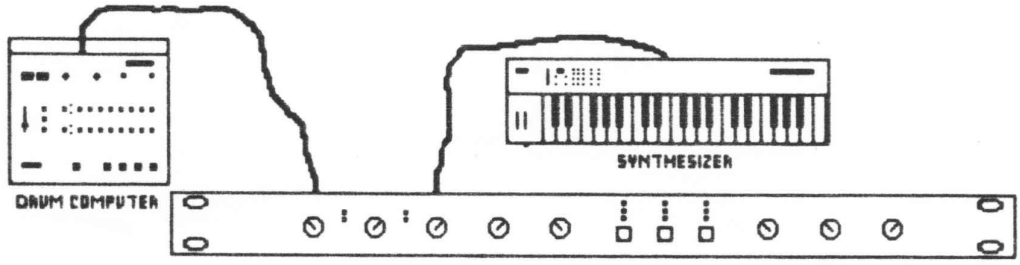
SPEECH INPUT ONLY

Because the SPX 216 has a built in oscillator, a noise source and a speech distortion circuit that can be used as carrier source, it is possible to use the vocoder with only one input. Connecting a microphone to the 'SPEECH' input, and selecting the 'OSC' or 'DBL' position produces a monotone, "robot voice" effect. The pitch can be set with the 'OSC/PITCH' control. Selecting the 'VOICE' position of the 'CARRIER' switch activates the speech distortion circuit for the carrier source. The pitch of the output signal will follow the pitch of the input signal, but the timbre can be changed with the 'FORMANT' button or the multiconnector. The nature and amount of the effect depends largely on the input signal (voice, keyboard, drummachine, etc.).



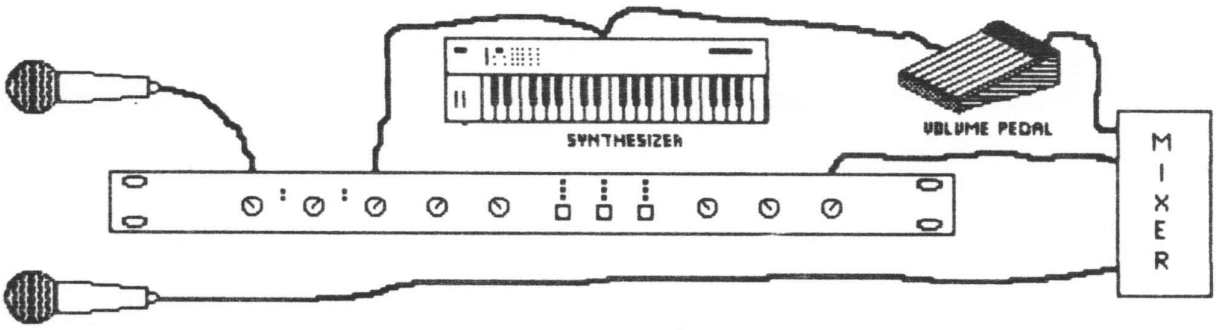
SPEECH AND CARRIER INPUT

The most obvious configuration of the vocoder is described on page 3, Start up instructions, but there are many more musical applications involving two instruments. One of these is depicted below; the carrier input is fed from a keyboard (with a sustained sound), and the speech input is connected to a drumcomputer. When the drumcomputer plays a sound, the keyboard sound will be heard with the same timbre and volume envelope (bassdrum produces a short, dull sound; woodblock produces a narrow band filter sound, etc.).



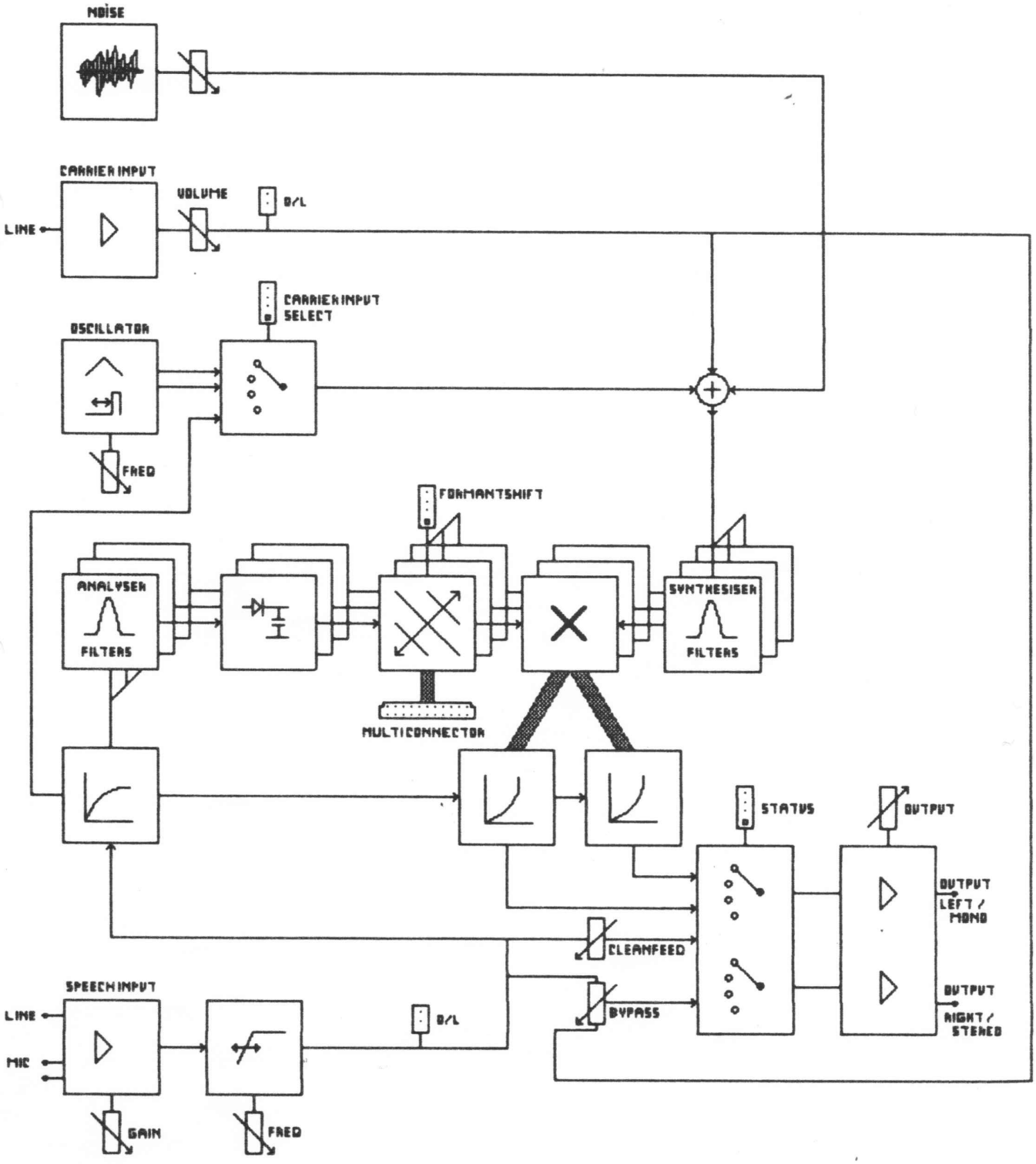
CLEANFEED AND BYPASS

In some cases it would be nice to be able to fade into and out of the vocoder effect or add cleanfeed of the carrier sound while playing or singing. This can be accomplished by using two microphones and a volume pedal. One microphone goes directly to a mixer, and the other microphone goes into the speech input of the SPX 216. The output of the carrier source is split, feeding one of the outputs to the carrier input of the vocoder, the other output goes into a volume pedal and from there to the mixer. The output of the vocoder also goes into the mixer. By speaking or singing into one or the other, you can change the balance between straight speech sound and vocoder sound. By opening the volume pedal, you can add the carrier sound to the output.



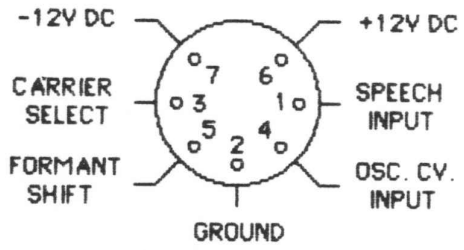
Singing into the bypass microphone and opening the volume pedal produces only the unprocessed speech and carrier sound.
It is also possible to use only one of these two techniques either using two microphones or patching in the volume pedal in combination with the bypass function on the vocoder.

BLOCK DIAGRAM



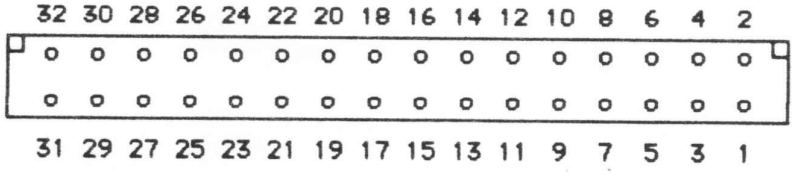
SPECIFICATIONS

DINCONNECTOR



PIN 4 OSCILLATOR 200Hz/VOLT (IMP 10K)
RANGE WITH EXT. CV. 15Hz-4kHz
PIN 1 SPEECH INPUT
-35dBV.... +16dBV INPUT IMP. 4k7
PIN 3-5 EXT CONTROL CARRIER / FORMANT
SWITCHING POSITIVE ("1") TO GROUND ("0")
("1") IS +5V TO +12V , ("0") IS -12V TO +3V OR GROUND
PIN 6-7 POWER SUPPLY OUTPUT
+/- 12V MAX 25 mA
PIN 2 GROUND

MULTICONNECTOR



PIN 1-3-5-..... 27 ANALYZER OUTPUT CHANNEL 1-2-3-..... 14
APPROX 0 .... +6 V DC (at RL = 33k)
PIN 2-4-6-.... 28 SYNTHESIZER INPUT CHANNEL 1-2-3-.... 14
0 ....+6 V DC (INP. 33k)
PIN 29 GROUND
PIN 30 EXT. PATCHING CONTROL
SWITCHING POSITIVE ("1") TO GROUND ("0")
("1") IS +5V TO +12V , ("0") IS -12V TO +3V OR GROUND
PIN 31 COMPRESSOR OUT APPROX. 0 .... +6 V DC
PIN 32 EXPANDER IN 0 .... +6 V DC (IMP. =4K)

SPEECH INPUT

MICROPHONE INPUT

XLR CONNECTOR

-80dBV.... -40dBV INPUT IMP. 3k6

CMRR >70dB AT 30Hz-20kHz

CMRR >80dB AT 1000Hz

LINE INPUT

1/4" PHONE JACK

-30dBV.... +10dBV INPUT IMP. 180k

CARRIER INPUT

LINE INPUT

1/4" PHONE JACK

-12dBV INPUT IMP. 100k

BYPASS

1/4" PHONE JACK

SWITCHING POSITIVE ("1") TO GROUND ("0")

("1") IS +5V TO +12V , ("0") IS -12V TO +3V OR GROUND

OUTPUT

1/4" PHONE JACK

HEADROOM +15dBV

MONO/LEFT CHANNEL 1-2-3-....14/1-3-5-....13-14

RIGHT CHANNEL 2-4-6-....12-14

SPEECH FILTER

RANGE 60Hz - 3000Hz 12dB/OCT.

DYN. RANGE

VOCODER DYNAMIC CONTROL RANGE >65dB

POWER SUPPLY

115V/230V 9VA

FUSE PRIMARY 100mA (EXTERNAL)

FUSES SECUNDARY 315mA (INTERNAL)

DIMENSIONS

482 (W) x 43 (H) x 188 (D) mm

WEIGHT

2,5 Kg (5,5 lbs.)

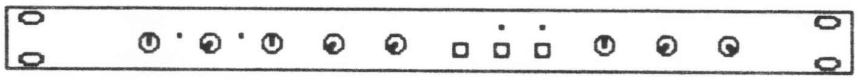
MODEL **SPH 216**

SERIALNR. 044 REV. 1.1 VOLTAGE 220

VOCODER FREQUENCY RESPONSE

For this measurement, a swept sine wave was fed into the speech input and to the carrier input.

FRONT PANEL SETTING



MEASUREMENT AT

CARRIER INPUT **0 dBU** SPEECH INPUT **0 dBU**