PROGRAMING AND META-PROGRAMING THE ELECTRO ORGANISM

AN OPERATING DIRECTIVE FOR THE MUSIC EASEL

Programming and Metaprogramming in the Electro-Organism

An Operating Directive for the Music Easel

by Allen Strange

Forward

Two years ago, we decided it was time to stop dreaming about and actualize a new electronic musical instrument. We had ample experience in electronic music hardware and software, our needs and objectives were well defined, and the necessary technology was imminent. Our goal was to create an instrument for performance. One with a vocabulary that was unpresumptive, varied, and accessible. We weren't particularly interested in imitation of any extant instruments, either functionally or acoustically. We did want the potential for expressive, real-time performer - instrument interaction.

We succeeded. The Music Easel is the realization of our goal. To familiarize you with the scope and intricacies of our instrument, Allen Strange has written this manual. With it you can begin your exploration of the Music Easel's vast potential. May your adventure in playing it be as exciting as ours in creating it.

The transition from dream to reality was through the efforts of many. My thanks to everyone, especially Paul DeMarinis, Ken Ellis, Bruce Holcombe, Clint Jurgens, Charles MacDermed, Karl Severeid, Varya Simpson, Mort Subotnick, and Kamala.

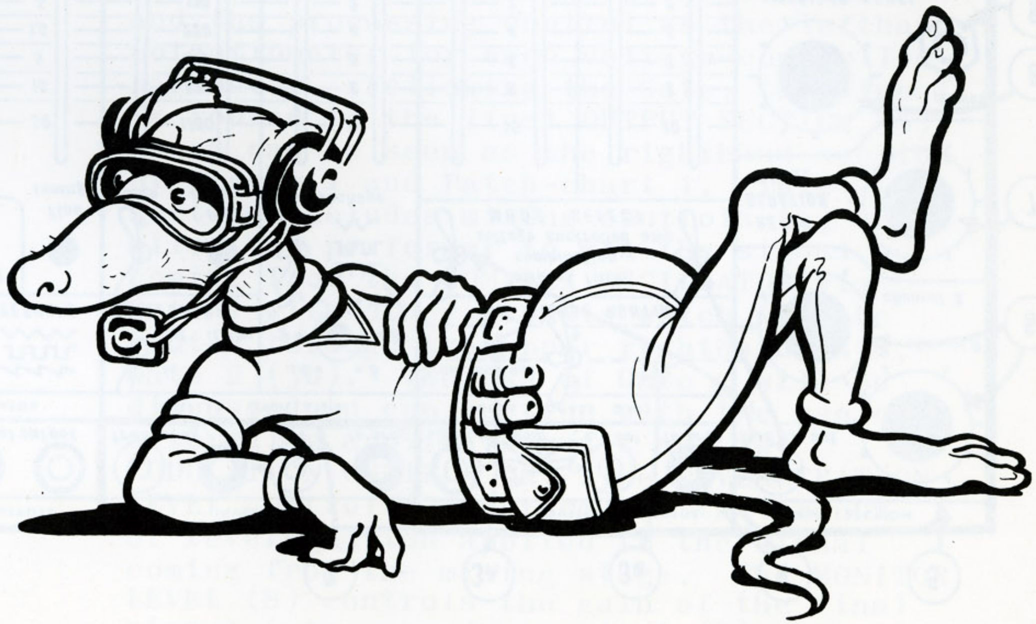
And special thanks to Allen Strange, for implementing this vital link between designer and performer.

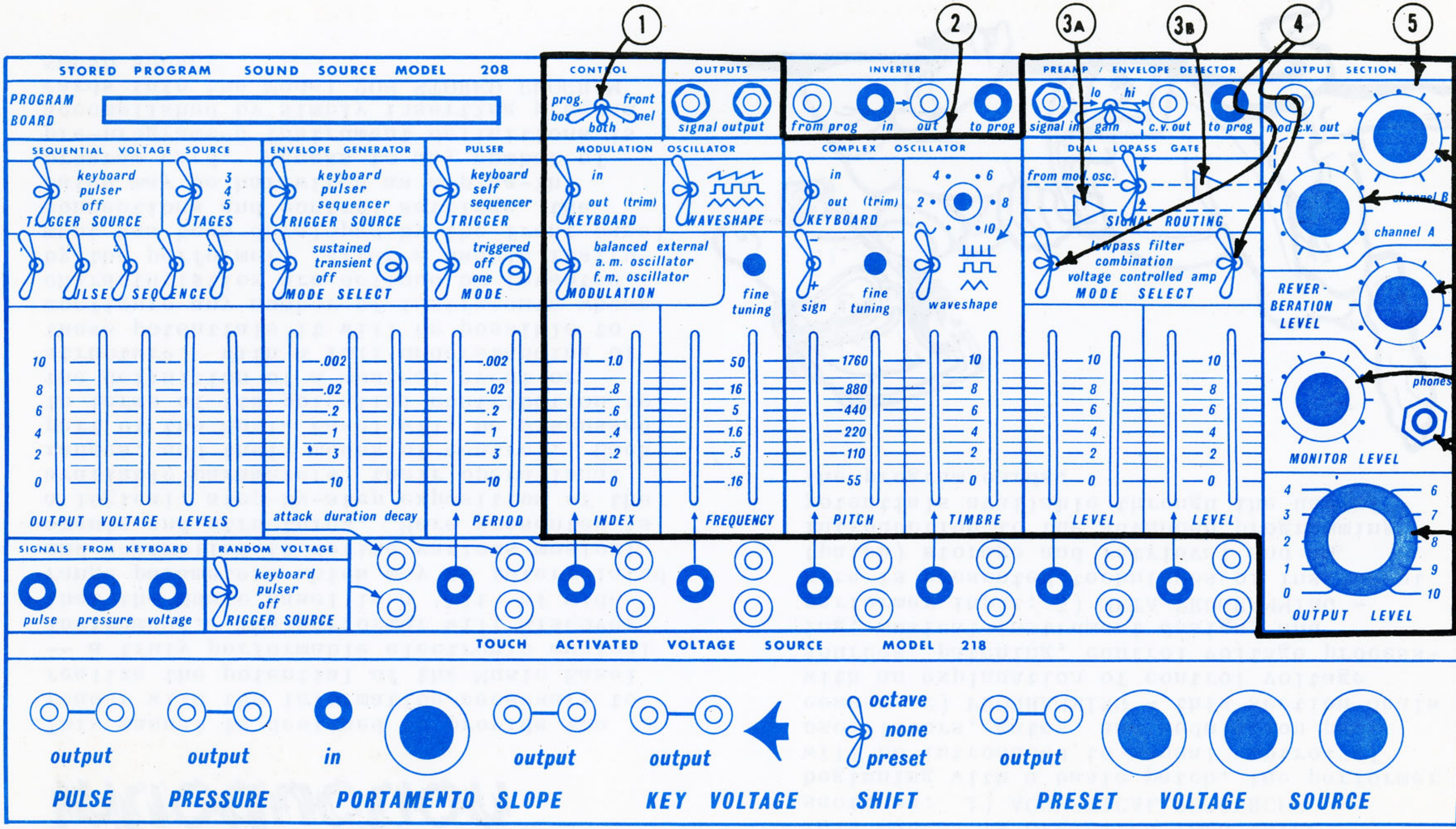
D. Buchla
Berkeley, 1974

Introduction

This manual is designed to provide the reader with the information necessary to realize the potential of the Music Easel -- a truly performable electronic musical instrument. The performer will discover that the Music Easel is a 'kit' of wide-range parameters which may be interrelated and controlled to define various musical events and structures. Here presented is a logical, step-by-step exposition of the available parameters, their operational ranges, and their modes of control. Each part of the Music Easel will be discussed in terms of its potential contribution to the definition of a musical event or structure. With a full understanding of these potentials it will be possible to configure any number of instruments whose characteristics are defined or invented by the performer. After a usable instrument has been developed by the front panel connections and control settings, the patch may be hardwired as a plug-in program card. Access to any number of pre-programmed instrument definitions is accomplished by simply inserting program cards into the Model 208 STORED PROGRAM SOUND SOURCE.

This manual is organized into three sections: 1) ACOUSTICAL RESOURCES - beginning with a basic patch, the performer will be introduced to manual control of oscillators, gates, and modulation processes; 2) PROGRAMMING - this section deals with an explanation of control voltage sources, patching, control voltage processing, musical instrument design, and performer input; 3) META-PROGRAMMING - here is presented techniques of instrument (patch) storage and retrieval and an introduction to the advanced programming potentials available through the use of the program cards.



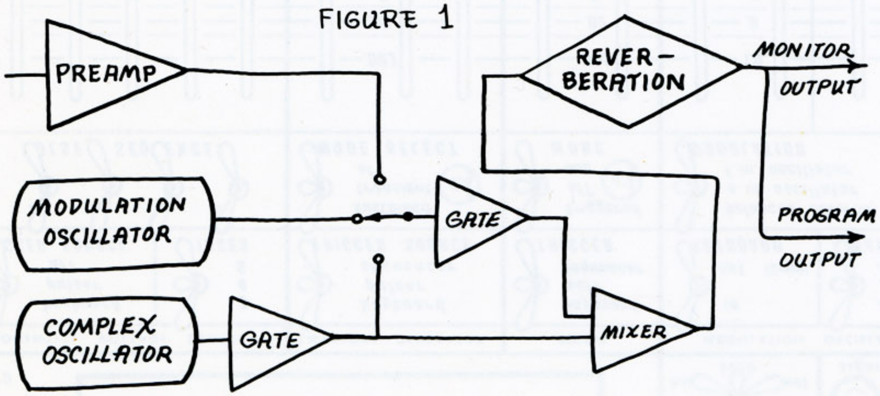

STORED PROGRAM SOUND SOURCE MODEL 208
PROGRAM BOARD
SEQUENTIAL VOLTAGE SOURCE
keyboard pulser off
TRIGGER SOURCE
3 4 5
STAGES
PULSE SEQUENCE
OUTPUT VOLTAGE LEVELS
ENVELOPE GENERATOR
keyboard pulser sequencer
TRIGGER SOURCE
sustained transient off
MODE SELECT
attack duration decay
PULSER
keyboard self sequencer
TRIGGER
triggered off one
MODE
PERIOD
CONTROL
prog. box both front panel
OUTPUTS
signal output
MODULATION OSCILLATOR
in out (trim)
KEYBOARD
WAVESHAPE
balanced external a. m. oscillator f. m. oscillator
MODULATION
fine tuning
INDEX
FREQUENCY
INVERTER
from prog in out to prog
COMPLEX OSCILLATOR
in out (trim)
KEYBOARD
sign
fine tuning
waveshape
PITCH
TIMBRE
PREAMP / ENVELOPE DETECTOR
signal in lo hi gain c.v. out to prog
DUAL LOPASS GATE
from mod. osc.
SIGNAL ROUTING
lowpass filter combination voltage controlled amp
MODE SELECT
LEVEL
LEVEL
OUTPUT SECTION
mod c.v. out
channel B
channel A
REVERBERATION LEVEL
phones
MONITOR LEVEL
OUTPUT LEVEL
SIGNALS FROM KEYBOARD
pulse pressure voltage
RANDOM VOLTAGE
keyboard pulser off
TRIGGER SOURCE
TOUCH ACTIVATED VOLTAGE SOURCE MODEL 218
output output in output output
octave none preset
output
PULSE PRESSURE PORTAMENTO SLOPE KEY VOLTAGE SHIFT PRESET VOLTAGE SOURCE
1 2 3A 3B 4 5 6 7 8 9 10

PC 1

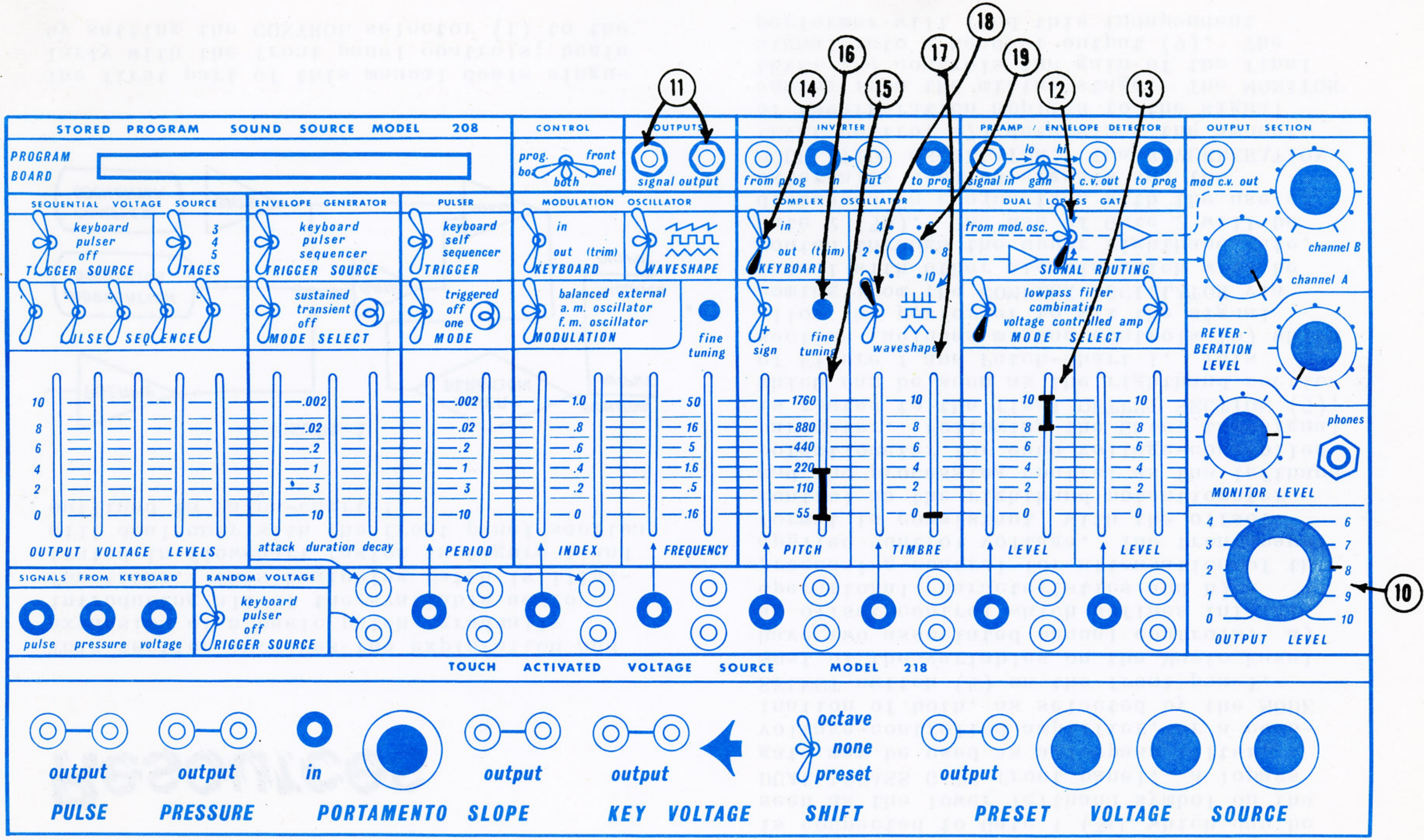
Acoustic Resources

This section involves the exploration and expansion of a basic patch, gradually introducing all of the available audio functions. This beginning patch is illustrated in flowchart fasion in Figure 1 and will deal only with the front panel section outlined in Patch-chart 1.

FIGURE 1



The first part of this manual deals singularly with the front panel controls; begin by setting the CONTROL selector (1) to the 'front panel' position. The Music Easel's primary sound source is the COMPLEX OSCILLATOR (2), which, as the performer will discover, provides a range of timbres far exceeding that of conventional electronic sound sources. This oscillator is connected to Gate 1 (3a), which can be seen as the lower lefthand symbol on the DUAL LOPASS GATE front panel. A lopass gate may be used as a lowpass filter, a voltage-controlled amplifier, or a combination of both, as selected by the MODE SELECT switch (4) on the front panel. Most of the variables on the Music Easel have two associated manual controls: a) an offset control which defines initial operational characteristics and b) a processing control for attenuation of the applied control voltage. The front panel format is consistant, with the offset control as the righthand potentiometer and the processing control as the lefthand potentiometer for each voltage-controlled parameter. Following the Gate, the signal is routed to the final OUTPUT SECTION (5), which can be seen as the righthand section of Figure 1 and Patch-chart 1. This section includes mixing controls (6) which allow the performer to mix the signal coming from the COMPLEX OSCILLATOR via Gate 1 with other signals which will be routed through the upper righthand gate, Gate 2 (3b). The use of Gate 2 will be discussed in conjunction with the use of externally applied signals and the MODULATION OSCILLATOR. The REVERBERATION LEVEL control (7) determines the amount of reverberation applied to the signal coming from the mixing stage. The MONITOR LEVEL (8) controls the gain of the final signal into a headset output (9). The performer will find this independent


STORED PROGRAM SOUND SOURCE MODEL 208
PROGRAM BOARD
CONTROL
prog. board
front panel
both
OUTPUTS
signal output
INVERTER
from prog
in
out
to prog
PREAMP / ENVELOPE DETECTOR
signal in
gain
lo
hi
c.v. out
to prog
OUTPUT SECTION
mod c.v. out
channel B
channel A
REVERBERATION LEVEL
MONITOR LEVEL
phones
OUTPUT LEVEL
SEQUENTIAL VOLTAGE SOURCE
keyboard
pulser
off
TRIGGER SOURCE
3
4
5
STAGES
PULSE
SEQUENCE
OUTPUT VOLTAGE LEVELS
ENVELOPE GENERATOR
keyboard
pulser
sequencer
TRIGGER SOURCE
sustained
transient
off
MODE SELECT
attack
duration
decay
PULSER
keyboard
self
sequencer
TRIGGER
triggered
off
one
MODE
PERIOD
MODULATION OSCILLATOR
in
out (trim)
KEYBOARD
WAVESHAPE
balanced
external
a. m. oscillator
f. m. oscillator
MODULATION
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FREQUENCY
COMPLEX OSCILLATOR
in
out (trim)
KEYBOARD
sign
fine tuning
waveshape
PITCH
TIMBRE
DUAL LOPASS GATE
from mod. osc.
SIGNAL ROUTING
lowpass filter
combination
voltage controlled amp
MODE SELECT
LEVEL
LEVEL
SIGNALS FROM KEYBOARD
pulse
pressure
voltage
RANDOM VOLTAGE
keyboard
pulser
off
TRIGGER SOURCE
TOUCH ACTIVATED VOLTAGE SOURCE MODEL 218
output
PULSE
output
PRESSURE
in
PORTAMENTO
SLOPE
output
KEY VOLTAGE
octave
none
preset
SHIFT
output
PRESET VOLTAGE SOURCE
10
11
12
13
14
15
16
17
18
19

PC 2

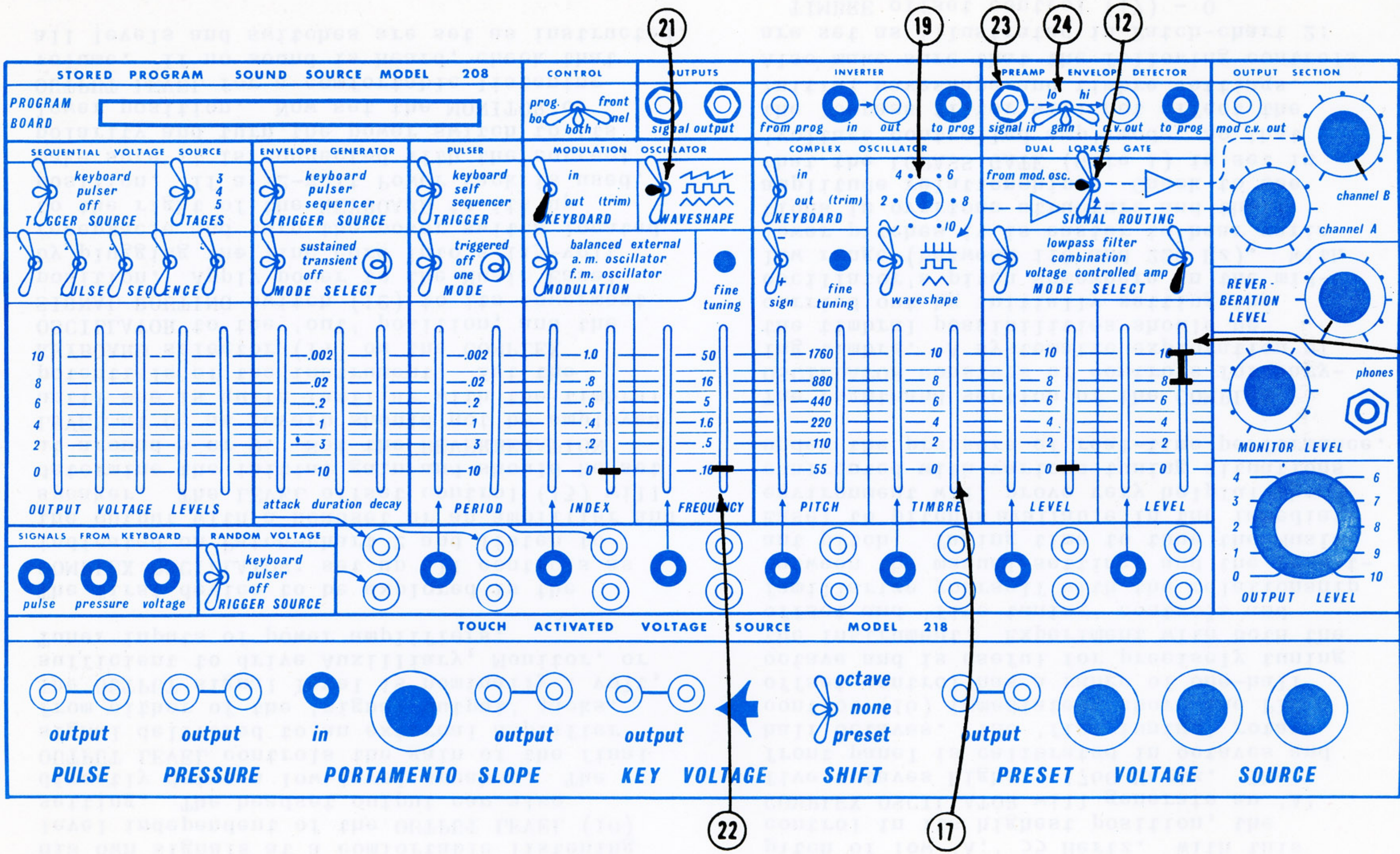
MONITOR LEVEL very useful in live performance situations, as it will allow him to monitor his own signals at a comfortable listening level independent of the OUTPUT LEVEL (10) setting. The headset output can also directly drive a low-level speaker. The OUTPUT LEVEL controls the gain of the final signal delivered to an external amplifier from either of the 'signal output' jacks. The OUTPUT signal level is nominally 1 volt, sufficient to drive Auxilliary, Monitor, or Tuner inputs of power amplifiers.

The first device to be explored is the COMPLEX OSCILLATOR; set up all controls as indicated on Patch-chart 2 and listen to the output with a headset or an amplifier and speaker. The LEVEL offset control (13) will determine the initial gain and should be set at around 8 or 9. Set the REVERBERATION LEVEL at 0, as reverb should not be employed until one is quite familiar with the timbral potentials of the instrument. Set the KEYBOARD selector (14) on the COMPLEX OSCILLATOR to the 'out' position, and the SIGNAL ROUTING switch (12) to its lowermost position. Apply power to the Music Easel by plugging the line cord into a 115-volt receptacle and turn the power switch located to the right of the KEYBOARD to its up position. If a 12-volt Power Pack is used, make sure it is connected with the correct polarity and turn the power switch to its lower position. Now set the MONITOR or OUTPUT LEVEL for a comfortable listening volume. If no sound is heard, check that all levels and switches are set as instructed.

The pitch of the COMPLEX OSCILLATOR is established by the linear offset control indicated as PITCH (15). This control, in its lowest position, will produce a pitch of low 'A,' 55 Hertz. With this control in its highest position, the COMPLEX OSCILLATOR will generate an 'A' five octaves higher, 1760 Hertz. The front panel is calibrated in octaves and half octaves. The 'fine tuning' rotary control (16) immediately above the PITCH offset control has a range of one-half octave and is useful for precisely tuning the instrument. Experiment with both the offset and 'fine tuning' controls and familiarize yourself with the relationship between the manual settings and the resultant pitch. Taking time to tune the Music Easel to pitches available in the immediate environment will prove very helpful when confronted with various tuning situations under the pressure of real-time performance.

The righthand section of the COMPLEX OSCILLATOR consists of controls for varying timbre. A systematic exploration of the timbral possibilities should be carried out by initially setting the oscillator's pitch somewhere in the mid-low range (between 110 and 220 Hz). With lower pitches it is easier to hear variations in overtone structure and their amplitude relationships. Check to see that the LOPASS GATE (Gate 1) is set in 'voltage controlled amp' mode, so that the lowpass filter will not affect the initial waveshape and timbre settings. Also make sure that the following controls are set as illustrated in Patch-chart 2:

TIMBRE offset control (17) - 0
WAVESHAPE selector (18) - to spike (uppermost position)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mod c.v. out
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balanced external
a. m. oscillator
f. m. oscillator
MODULATION
fine tuning
COMPLEX OSCILLATOR
in
out (trim)
KEYBOARD
4
6
2
8
10
sign
fine tuning
waveshape
DUAL LOPASS GATE
from mod. osc.
SIGNAL ROUTING
lowpass filter
combination
voltage controlled amp
MODE SELECT
REVERBERATION LEVEL
phones
MONITOR LEVEL
10
8
6
4
2
0
OUTPUT VOLTAGE LEVELS
.002
.02
.2
1
3
10
attack duration decay
PERIOD
1.0
.8
.6
.4
.2
0
INDEX
50
16
5
1.6
.5
.16
FREQUENCY
1760
880
440
220
110
55
PITCH
TIMBRE
LEVEL
LEVEL
4
3
2
1
0
6
7
8
9
10
OUTPUT LEVEL
SIGNALS FROM KEYBOARD
pulse
pressure
voltage
RANDOM VOLTAGE
keyboard
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TRIGGER SOURCE
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PRESSURE
in
PORTAMENTO
output
SLOPE
output
KEY VOLTAGE
octave
none
preset
SHIFT
output
PRESET VOLTAGE SOURCE
21
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24
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17

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WAVESHAPE control (19) - to sine (far left)

The oscillator will now produce a sine wave output with inaudible harmonic content. By turning the WAVESHAPE control to its maximum righthand position the output will be a spike wave rich in high-ordered harmonics. The WAVESHAPE control does not change the function of the basic oscillator, but, rather, implements a mix between the sine wave and the selected waveshape. By turning back to the sine position and then gradually turning the control clockwise, the performer will be adding to the sine wave the constant spectrum of overtones contained in the spike wave. The performer should become familiar with the effect of this control on the perceived timbre throughout the pitch range of the COMPLEX OSCILLATOR.

Turning back to a mid-low range, with the WAVESHAPE control in the sine (counter-clockwise) position, switch the WAVESHAPE selector switch to squarewave. By then turning the WAVESHAPE control clockwise, the output will gradually become a square-wave, containing only odd-numbered harmonics. With the WAVESHAPE selector set to the triangle position, the WAVESHAPE control produces a mix of any proportion of a sine wave and a triangle wave. Again, it is stressed that the performer understand that the WAVESHAPE control only provides a mix between a sine and the selected wave-shape. The performer is provided with further control over the quality of the sound by means of the TIMBRE offset control (17). With the WAVESHAPE pot set completely to sine (zero), gradually raise the TIMBRE offset pot. A gradual introduction of lower-order harmonics will be perceived, and their relative amplitude relationships will be continually varied as the offset is increased. This process is essentially the opposite of filtering, involving the introduction and selected accentuation of various harmonics and generating sounds that are virtually impossible to achieve through filtering. Note that the TIMBRE control affects only the sine and triangle waveforms, and thus has no audible effect when the WAVESHAPE control is at maximum spike or square position. The COMPLEX OSCILLATOR provides a wide range of timbral variation and it would serve the performer well to explore all of the possibilities made available with each waveform.

The MODULATION OSCILLATOR, due to its sub-audio frequency range, is usually used as a dedicated modulation source. In its upper range, however, it may be used as an additional source of audio signals. The output of the MODULATION OSCILLATOR may be heard by setting the SIGNAL ROUTING switch on the DUAL LOPASS GATE at its center position. As illustrated in Patch-chart 3, turn 'channel B' mix level to maximum and raise the LEVEL offset (20) for Gate 2. Set the MODULATION OSCILLATOR'S WAVESHAPE SELECTOR (21) to squarewave (middle position) and the FREQUENCY offset pot (22) to .16 Hz. The snapping sound that is heard is the transient edges of the square wave at a sub-audio frequency of .16 Hz. Raise the FREQUENCY pot to various points above 16 Hz. and the snaps will integrate into perceivable audio frequencies up to 50 Hz. The MODULATION OSCILLATOR can be driven much higher than the front panel indications by the use of control voltages, and this will be discussed later. Since this is a frequently useful sound source, the performer should become familiar with the various waveshapes in the audio range.

Thus far, the DUAL LOPASS GATE has only been dealt with in terms of the 'voltage controlled amp' mode. Now that the basic timbral resources of the oscillators are understood, the performer should familiarize himself with further characteristics of the LOPASS GATE. First, set the COMPLEX OSCILLATOR to any desired rich waveshape. With either of the gates in 'voltage controlled amp' mode, the LEVEL offset provides control in the amplitude domain -- no gain at 0 and maximum gain at 10. Leaving Gate 1's control at 10, turn the MODE SELECT switch to 'lowpass filter.' The LEVEL offset now defines the cut-off frequency of a 12 db per octave lowpass filter. As with gain in the 'voltage controlled amp' mode, the cut-off frequency in 'lowpass filter' mode is proportional to the illumination of the lamp. By gradually lowering the LEVEL offset control, the performer will begin to attenuate the higher part of the frequency spectrum. If the output of the COMPLEX OSCILLATOR is a squarewave set at about 220 Hz., lowering the LEVEL offset to about 3 will effectively remove all harmonics and the output will approximate a sine wave. Further reduction in level will then attenuate this fundamental, finally resulting in silence.

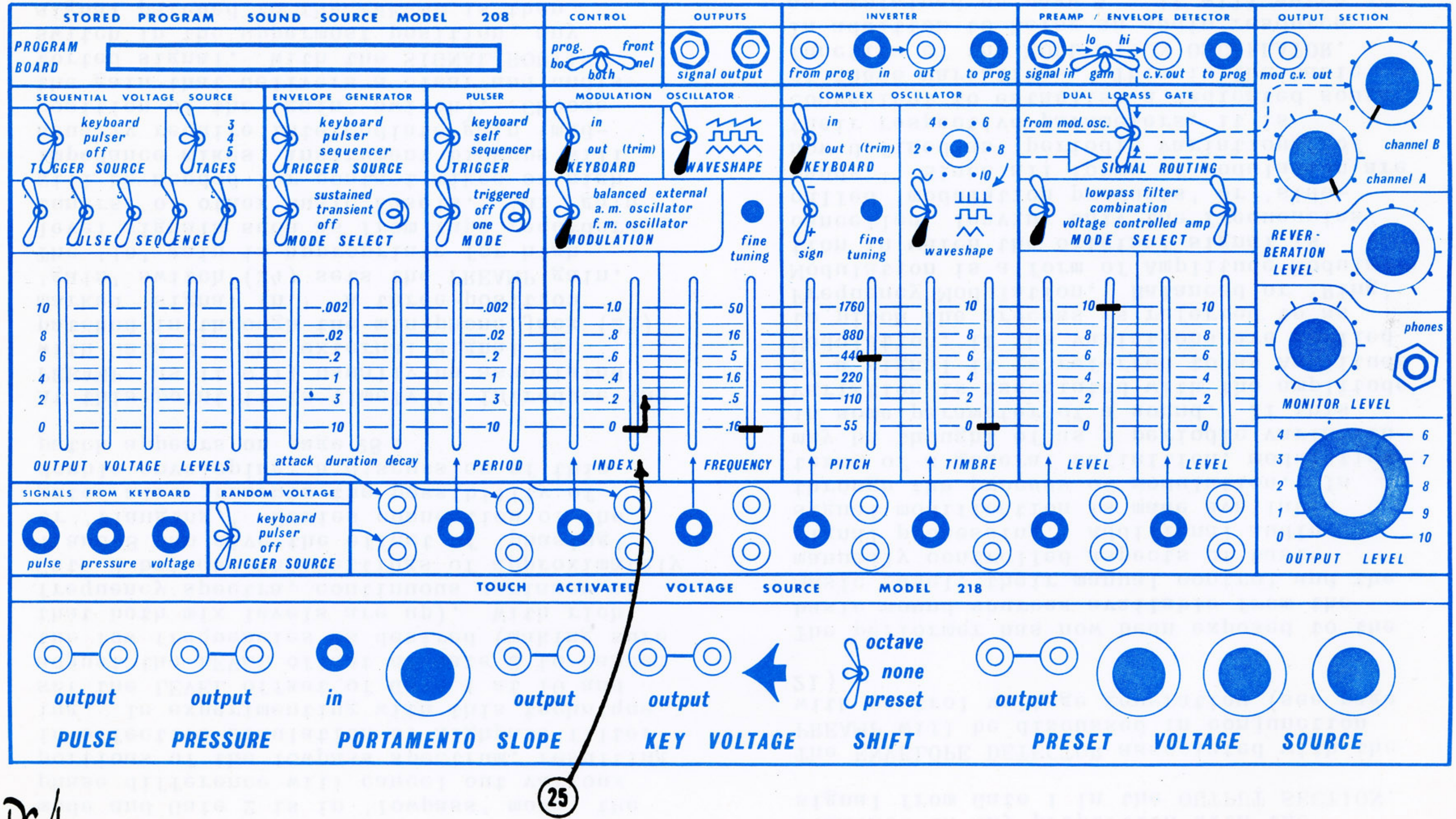
By setting the MODE SELECT switch to 'combination,' the Gate will function simultaneously in the amplitude (voltage controlled amp) and frequency (lowpass filter) domains. As the LEVEL offset is lowered the higher frequencies are attenuated faster than lower frequencies. The process is that the spectrum is attenuated by two simultaneous functions, and this gives the effect of more pronounced low frequencies as the LEVEL offset is lowered. Under the limitations of manual control, this function cannot really be fully explored, as its most striking use is in the production of attack and decay transients. In other words, this function will prove to be most useful when the levels are being rapidly varied. This will be discussed later in this manual. In the meantime, the performer should become familiar with the effect of the 'combination' mode on various available timbres.

The SIGNAL ROUTING switch (12) determines what signal will be routed to Gate 2. With this switch in its lowest position the signal from Gate 1 will also be routed to Gate 2. This manner of routing provides the possibility of one gate affecting gain, while the other operates on the frequency spectrum of the signal. With the two gates in this 'quasi-series' connection the signal is still available from Gate 1 in the OUTPUT SECTION mixer channel A. Also keep in mind that, with this manner of patching, if channel A mix level is at 0, both gates must be open to transmit any signal to the output. This part of the instrument is designed so that the two gates are 180° out-of-phase, thus providing for some interesting possibilities. With both gates in series as explained above and both in 'voltage controlled amp' mode, careful balance of the LEVEL offsets and output mix will result in phase cancellation of the signal. If Gate 1 is in 'voltage controlled amp' mode and Gate 2 is in 'lowpass' mode, the phase difference will cancel out various portions of the lowpass spectrum, resulting in effective simulation of highpass filtering. In experimenting with this technique, set the LEVEL offset of Gate 1 at 10 and adjust the LEVEL offset of Gate 2 to cancel the low frequencies as desired (making sure that both mix levels are up). With rich frequency spectra, continuous variance of Gate 2 between the settings of approximately 4 and 8 can give the effect of 'phasing' or 'flanging.' Series connection of the gates also presents the possibility of double enveloping; a discussion of this patch appears on page **28** .

At this point it is timely to introduce the PREAMP, as it will usually be associated with Gate 2. The external signal is patched in through the miniphone jack (23) marked 'signal in.' A three-position 'gain' switch (24) sets the PREAMP gain. The 'lo' gain is appropriate for high-level signals such as from tape recorders, tuners, or other Music Easels. 'Hi' gain will be needed for contact mikes or high-impedance mikes; instrument pickups will usually require intermediate gain (mid-position of the 'gain' switch). Choose the gain that delivers a clear and undistorted signal. With the SIGNAL ROUTING switch in the uppermost position, any signal patched to the PREAMP is then routed through Gate 2 and is subject to any of the three processing modes. If the external signal is to be utilized in its original form, simply set the LEVEL control of Gate 2 at 10 in the 'voltage controlled amp' mode. The signal may then be combined in any proportion with the signal from Gate 1 in the OUTPUT SECTION.

The ENVELOPE DETECTOR associated with the PREAMP will be discussed in conjunction with control voltage generation (see page **21**).

The performer has now been exposed to the basic sound sources available from the Music Easel, their manual control and the manually controlled aspects of basic signal processing. Additional audio signal modification is made available through the process of modulation. In terms of a general definition, modulation may be thought of as a periodic variation in some parameter of a sound. If this variation is associated with the amplitude of a signal it is referred to as Amplitude Modulation; if the variations are applied to pitch the process is referred to as Frequency Modulation. Balanced or 'Ring' Modulation is a form of Amplitude Modulation in which the original signal is cancelled, leaving only the frequencies called 'modulation products' or 'sidebands.' Since all forms of modulation are now defined as 'periodic variations' of their respective parameters, it is convenient to establish a dedicated source of these variations. This is the basic function of the MODULATION OSCILLATOR. In addition to being an audio resource, as explained on page **5** , it will serve as the modulating source, producing periodic variations in either the pitch (F.M.) or loudness (A.M.) of the COMPLEX OSCILLATOR signal. It will also serve to amplitude modulate ('balanced external' mode) any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PULSE
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PRESSURE
in
PORTAMENTO
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SLOPE
output
KEY VOLTAGE
octave
none
preset
SHIFT
output
PRESET VOLTAGE SOURCE
25

PC4

signal applied to the PREAMP.

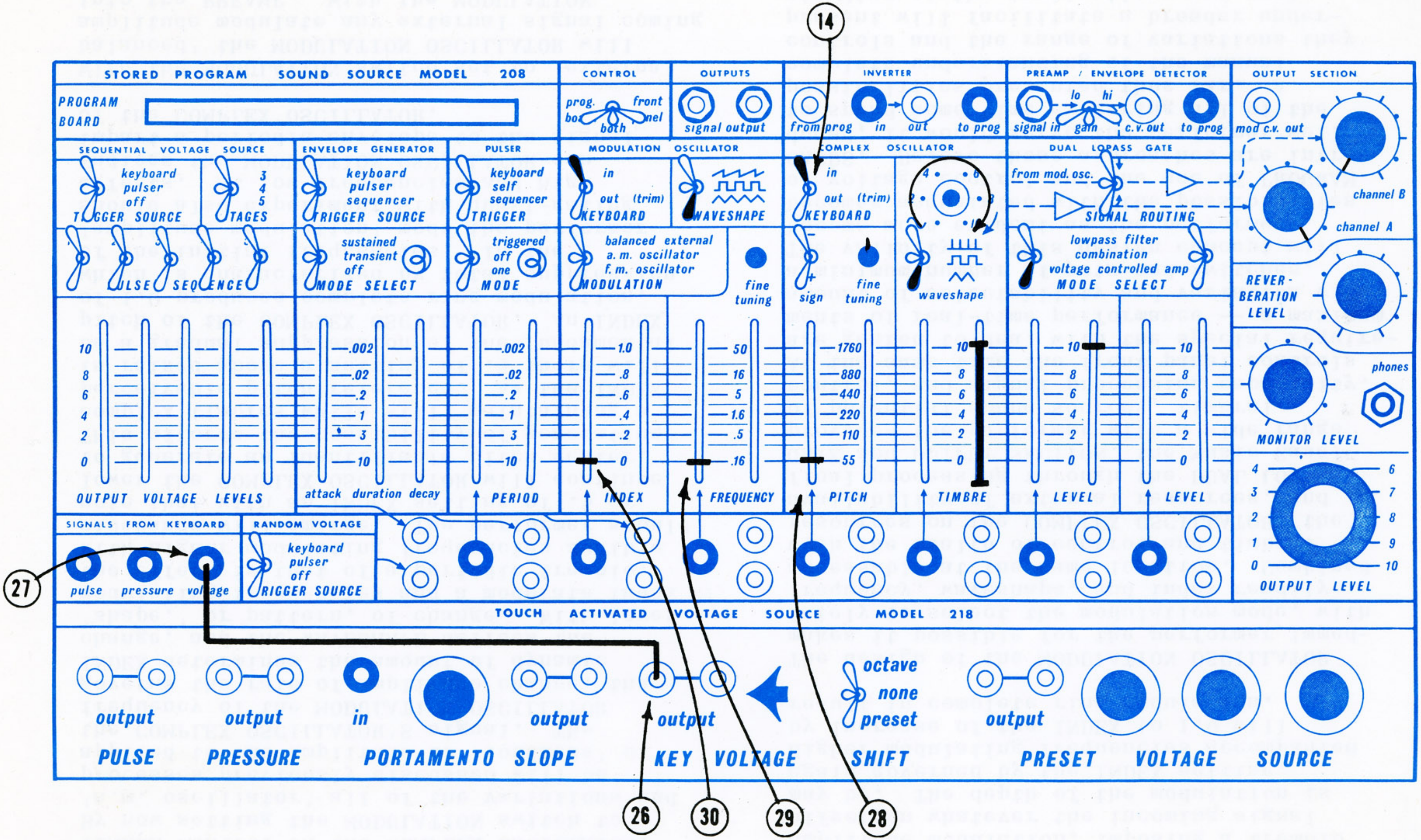
To illustrate use of the MODULATION OSCILLATOR as a modulation source, set the patch illustrated in Patch-chart 4. A patch has now been established which will periodically change the pitch of the COMPLEX OSCILLATOR symmetrically around A-440 at an approximate rate of $1\frac{1}{2}$ times every second, which is the frequency of the MODULATION OSCILLATOR. The amount of modulation, or symmetric deviation from the center frequency of the COMPLEX OSCILLATOR, is referred to as modulation index and is governed by the INDEX offset control (25). With all controls set as illustrated in Patch-chart 4, raise the INDEX offset to a setting of .2. As this is being done the performer will begin to hear a slight vibrato in the pitch of the COMPLEX OSCILLATOR. The width or depth of the vibrato is determined by the INDEX control. At a setting of .2 the pitch will rise and fall about 25 Hz (about a semitone) from the nominal 440 Hz. This change is periodically repeated every $1\frac{1}{2}$ seconds. As the performer gradually raises the INDEX offset the frequency modulation will become more pronounced, producing a wider excursion above and below the center pitch. As the frequency of the MODULATION OSCILLATOR is increased the rate of change will accelerate. As the index approaches a maximum setting of 1.0, the center pitch will be less obvious, due to the very wide sweep. With higher modulation rates (frequencies of about 20 Hz and above) and higher modulation indices, clangorous sounds with extremely complex spectra may be produced. With lower modulation indices the partials are not as pronounced and can serve as effective coloration of the pitch of the COMPLEX OSCILLATOR. With a modulating frequency of about 6 Hz and a minimal index the result is a pleasing vibrato. (Also try this with a touch of reverb.)

With the frequency of the MODULATION OSCILLATOR set below 1 Hz and the INDEX approaching maximum, the pitch of the COMPLEX OSCILLATOR will periodically be driven above and below its center, producing various 'siren' effects. When listening to modulation with this low a rate one can directly perceive the waveshape of the MODULATION OSCILLATOR. By maintaining a low frequency setting and switching the WAVESHAPE selector to squarewave (middle position), the frequency and index will remain the same, but the effect will be characterized by a switching back and forth around the center pitch, thus articulating the shape of the square wave. By the same token, the sawtooth waveshape will define a different modulation shape. Each modulating waveshape, in different audio frequency ranges, produces a different kind of modulation product, or spectrum. The performer should experiment with the various waveshapes available on both oscillators and familiarize himself with the frequency modulation characteristics in different frequency and pitch ranges.

The performer should realize that the waveshapes of both oscillators will determine the richness and densities of the modulation products (or sidebands). Note that the quality of the resultant sound can also be greatly influenced by the TIMBRE control on the COMPLEX OSCILLATOR. By now setting the MODULATION switch to 'a.m. oscillator' all of the variations and processes previously discussed will be applied to the amplitude or 'loudness' of the COMPLEX OSCILLATOR'S signal. The frequency of the MODULATION OSCILLATOR governs the rate of amplitude change, the INDEX determines the amount of dynamic change, and the WAVESHAPE defines the 'shape,' or pattern, of change. With lower modulating frequencies and a moderate index the effect is that of a periodic tremolo. With higher modulating frequencies audible sidebands will emerge. The performer should note that with an INDEX setting of .5 or lower the COMPLEX OSCILLATOR will continue to generate an identifiable pitch center. This affords the possibility of generating complex timbres while still maintaining a perceivable pitch reference. As the INDEX is raised above a setting of .5 there will be a gradual suppression of the fundamental pitch of the COMPLEX OSCILLATOR. An INDEX of 1.0 produces complete ring modulation, which is characterized by total suppression of the initial frequencies. In the 'amplitude modulation' mode the performer should also experiment with quasi-gating effects. At low frequencies and high indices the MODULATION OSCILLATOR can impart a periodic envelope to the signal of the COMPLEX OSCILLATOR.

With the MODULATION switch set to 'external balanced' the MODULATION OSCILLATOR will amplitude modulate any external signal coming into the PREAMP. With the MODULATION OSCILLATOR set at about 5 Hz the effect on the incoming signal will be the same as amplitude modulation, imposing a tremolo effect on whatever the incoming signal may be. The depth of the modulation is again governed by the INDEX setting. Higher modulating frequencies accompanied by increase of the INDEX to 1.0 will result in complete ring modulation.

The design of the MODULATION OSCILLATOR makes it possible for the performer immediately to select the modulation mode, with frequency, waveshape, and index readily accessable at the same location. Combined with the wealth of control and timbral resources on the COMPLEX OSCILLATOR, the availability of external resources, and final processing through the DUAL LOPASS GATE and OUTPUT SECTION, the Music Easel provides the performer with a wide range of potential sound sources, timbral control, and signal processing capability. At the same time the front panel controls are geared to deal with the special requirements of real-time performance -- a maximum amount of selectability and variation with a minimum number of pots and switches. The validity of this design concept will become more evident as the performer becomes acquainted with the possibilities of voltage control and the use of PROGRAM CARDS. Before these approaches are introduced, it would serve the performer well to spend some time exploring all of the possibilities presented thus far. A complete understanding of the manual controls and the range of variations they present will facilitate a broader understanding of the implications and ramifications of control voltage programming.


STORED PROGRAM SOUND SOURCE MODEL 208
PROGRAM BOARD
CONTROL
prog. board
front panel
both
OUTPUTS
signal output
INVERTER
from prog
in
out
to prog
PREAMP / ENVELOPE DETECTOR
signal in
lo
hi
gain
c.v. out
to prog
OUTPUT SECTION
mod c.v. out
channel B
channel A
REVER-BERATION LEVEL
phones
MONITOR LEVEL
OUTPUT LEVEL
SEQUENTIAL VOLTAGE SOURCE
keyboard
pulser
off
TRIGGER SOURCE
3
4
5
STAGES
PULSE SEQUENCE
OUTPUT VOLTAGE LEVELS
ENVELOPE GENERATOR
keyboard
pulser
sequencer
TRIGGER SOURCE
sustained
transient
off
MODE SELECT
attack
duration
decay
PULSER
keyboard
self
sequencer
TRIGGER
triggered
off
one
MODE
PERIOD
MODULATION OSCILLATOR
in
out (trim)
KEYBOARD
WAVESHAPE
balanced external
a. m. oscillator
f. m. oscillator
MODULATION
fine tuning
INDEX
FREQUENCY
COMPLEX OSCILLATOR
in
out (trim)
KEYBOARD
sign
fine tuning
waveshape
PITCH
TIMBRE
DUAL LOPASS GATE
from mod. osc.
SIGNAL ROUTING
lowpass filter
combination
voltage controlled amp
MODE SELECT
LEVEL
LEVEL
SIGNALS FROM KEYBOARD
pulse
pressure
voltage
RANDOM VOLTAGE
keyboard
pulser
off
TRIGGER SOURCE
TOUCH ACTIVATED VOLTAGE SOURCE MODEL 218
output
PULSE
output
PRESSURE
in
PORTAMENTO
output
SLOPE
output
KEY VOLTAGE
octave
none
preset
SHIFT
output
PRESET VOLTAGE SOURCE
14
27
26
30
29
28

PC 5

Programming

The sonic characteristics of musical instruments can be defined 'parametrically' -- a particular instrument develops its expressive range through variation of parameters such as amplitude, pitch, and timbre. A musician provides a combination of stimuli (input, or playing) and the instrument provides correlations between these inputs and the resultant sounds. Thus, an instrument may be thought of as a set of structurally defined correlations between stimulus and response. The Music Easel is so designed that the structure of a particular 'instrument' is defined and implemented by the performer. The various parametric responses are determined by the performer through the selection and application of voltages. The correlations are defined by networks of control settings and interconnections, so that several parameters may respond in different manners to a single stimulus. At the same time the state of a single parameter may be determined by a combination of stimuli -- either articulated directly by the performer or from pre-programmed control settings. This section of the manual will acquaint the performer with the voltage sources available on the Music Easel, their control, routing, and suggestions for possible applications.

An important source of control voltages is the Model 218 KEYBOARD. The KEYBOARD provides various control outputs which may be used in a variety of ways. Each one of these voltages is paralleled into two identical jacks, so they may be simultaneously routed to different parts of the instrument. Connections between the KEYBOARD and the PROGRAMMED SOUND SOURCE are made with banana-plug patch cords. Connect the KEY VOLTAGE output (26) to the front panel marked SIGNALS FROM KEYBOARD - 'voltage' input (27) as illustrated in Patch-chart 5. This patch makes it possible to control the pitch and frequency of the two oscillators directly from each of the 29 voltage keys on the KEYBOARD. To complete this connection the KEYBOARD switch (14) on the oscillators must be set to the 'in' position, connecting the key voltages directly to the oscillators. In order to demonstrate the process of voltage control the initial application of the KEYBOARD will be in conjunction with the COMPLEX OSCILLATOR. With the KEYBOARD switch at the 'in' position the interaction between conjunct KEY VOLTAGES and the oscillator will produce equal-tempered half-step pitch relationships over a range of 2-1/3 octaves. The tuning reference is variable and may be adjusted to suit any performance situation. This adjustment is achieved in the following manner: First, see that all front panel settings agree with the specifications given on Patch-chart 5. Touch key #1 (lowest 'C'). The pitch of the COMPLEX OSCILLATOR is now determined by the voltage from that particular key. The voltage will be 'memorized' by the system and held until another key is touched. The KEY VOLTAGES may be made to coincide with various tuning references by means of the 'fine tuning' control. Course changes in pitch reference may be accomplished by changing the position of the PITCH offset. If the initial tuning is done with the PITCH offset in its lowest position the performer will always be able to return to that exact reference without having to use the 'fine tuning' control. 'Fine tuning' and PITCH offset only shift the reference of the KEY VOLTAGE. The individual pitch relationships are not affected and they will maintain their equal half-step intervals.

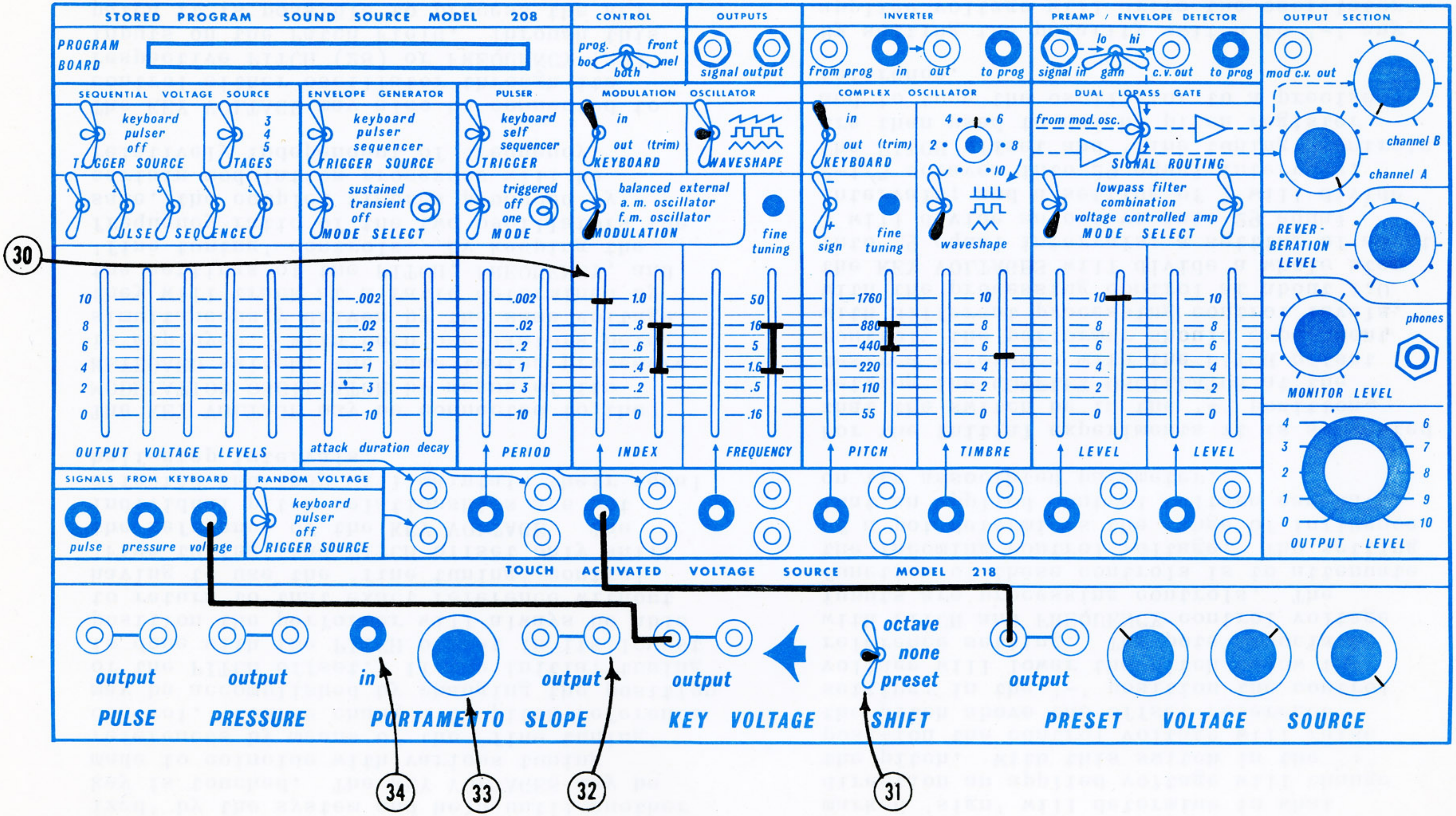
The KEY VOLTAGE may be connected to the MODULATION OSCILLATOR by means of its KEYBOARD switch; the same tuning procedure is employed. With both oscillators being simultaneously driven by the same voltage they will track at a ratio determined by the settings of the PITCH, FREQUENCY, and 'fine tuning' controls. By keeping the frequency ratio of the two oscillators the same, the complex timbres produced by certain modulation processes will be relatively independent of frequency.

The KEY VOLTAGE may also be connected to control either oscillator through its respective PITCH (28) or FREQUENCY (29) inputs on the Patch Field. Through this patch it is possible to process the KEY VOLTAGES to produce some interesting tunings. With the COMPLEX OSCILLATOR'S KEYBOARD switch 'off' the PITCH offset and 'fine tuning' controls are used to establish an initial reference. The polarity switch marked 'sign' will determine in what direction an applied voltage will change the pitch. With this switch in the '+' position the control voltage will raise the pitch above the offset reference setting; in the '-' position the control voltage will lower the pitch below the reference setting. The pots associated with PITCH and FREQUENCY control voltage inputs are processing controls. The function of these controls is to attenuate the incoming control voltage. The setting of a pot determines the range of influence that an applied control voltage can have on its associated parameter.

For the initial experiments it is suggested that the switch be in the '+' position. Setting the COMPLEX OSCILLATOR at the desired reference with the PITCH offset control, the performer should experiment with different processing control levels. With the processing control at about 1.0 the KEY VOLTAGES will divide a whole step into 29 equal intervals; a setting of about 3 will divide an octave into 29 equal intervals; and a setting of 7 will divide 2-1/3 octaves into 29 equal intervals. The PITCH offset and 'fine tuning' controls are then used to define pitch register and to tune the oscillator to a precise reference.

By setting the polarity switch to '-' any applied voltage will drive the oscillator below the reference setting -- the higher the KEY VOLTAGE the lower the pitch.

Since the purpose of the MODULATION

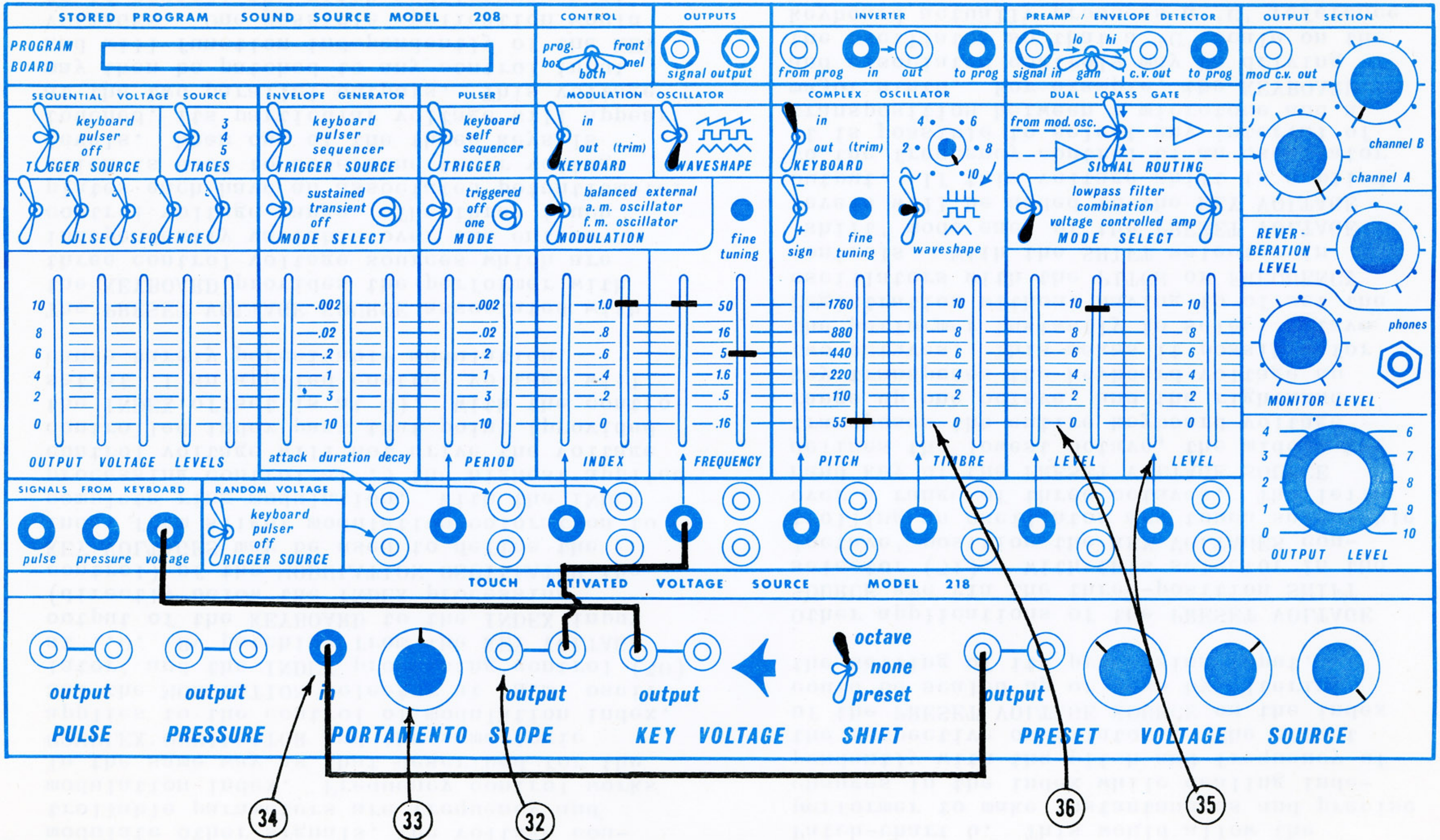

STORED PROGRAM SOUND SOURCE MODEL 208
PROGRAM BOARD
CONTROL
prog. board
front panel
both
OUTPUTS
signal output
INVERTER
from prog
in
out
to prog
PREAMP / ENVELOPE DETECTOR
signal in
lo
hi
gain
c.v. out
to prog
OUTPUT SECTION
mod c.v. out
SEQUENTIAL VOLTAGE SOURCE
keyboard
pulser
off
TRIGGER SOURCE
3
4
5
STAGES
PULSE SEQUENCE
ENVELOPE GENERATOR
keyboard
pulser
sequencer
TRIGGER SOURCE
sustained
transient
off
MODE SELECT
PULSER
keyboard
self
sequencer
TRIGGER
triggered
off
one
MODE
MODULATION OSCILLATOR
in
out (trim)
KEYBOARD
WAVESHAPE
balanced external
a.m. oscillator
f.m. oscillator
MODULATION
fine tuning
COMPLEX OSCILLATOR
in
out (trim)
KEYBOARD
4
6
2
8
10
sign
fine tuning
waveshape
DUAL LOPASS GATE
from mod. osc.
SIGNAL ROUTING
lowpass filter
combination
voltage controlled amp
MODE SELECT
channel B
channel A
REVERBERATION LEVEL
phones
MONITOR LEVEL
10
8
6
4
2
0
OUTPUT VOLTAGE LEVELS
.002
.02
.2
1
3
10
attack duration decay
PERIOD
1.0
.8
.6
.4
.2
0
INDEX
50
16
5
1.6
.5
.16
FREQUENCY
1760
880
440
220
110
55
PITCH
TIMBRE
LEVEL
LEVEL
4
3
2
1
0
6
7
8
9
10
OUTPUT LEVEL
SIGNALS FROM KEYBOARD
pulse
pressure
voltage
RANDOM VOLTAGE
keyboard
pulser
off
TRIGGER SOURCE
TOUCH ACTIVATED VOLTAGE SOURCE MODEL 218
output
PULSE
output
PRESSURE
in
PORTAMENTO
output
SLOPE
output
KEY VOLTAGE
octave
none
preset
SHIFT
output
PRESET VOLTAGE SOURCE
30
31
32
33
34

PC6

OSCILLATOR is to amplitude or frequency modulate other signals, the voltage controllable parameters are frequency and modulation index. Frequency control works in the same way as that described for the COMPLEX OSCILLATOR and the same logic applies to the control of modulation index. Set the MODULATION selector at 'a.m. oscillator' and the INDEX processing control (30) at 1.0. By patching from the KEY VOLTAGE output of the KEYBOARD to the INDEX input (directly below the INDEX processing control) of the MODULATION OSCILLATOR the KEY VOLTAGES may be used to define the index from slight modulation coloration to complete ring modulation. With the INDEX processing control at .5 the highest applied control voltage will not drive the voltage controlled index past that point (provided the INDEX offset is at 0). With the control set at .1 an applied control voltage will cause barely perceivable modulation.

The PRESET VOLTAGE SOURCE associated with the KEYBOARD provides the performer with three control voltage sources which are independently variable over the entire control voltage range. The three touch plates each have an associated potentiometer which is used to determine their voltage levels. When one of the three keys is touched, its particular voltage will appear at the two parallel outputs. This voltage may then be patched to any control input and will function independently of the KEY VOLTAGES. One possible application would be to control the pitch and frequency of the two oscillators with the KEY VOLTAGES (patched through the KEYBOARD switches). A modulation mode could then be selected and its index could be governed by the PRESET VOLTAGE SOURCE as illustrated in Patch-chart 6. This would allow the performer to make instantaneous and precise changes in the index while dealing independently with the pitch and frequency of the respective oscillators. The effect of the PRESET VOLTAGE SOURCE on the index could be scaled up or down by altering the setting of its processing input.

Other applications of the PRESET VOLTAGE SOURCE are via the three-position SHIFT selector (31). With this selector in the 'octave' position the KEY VOLTAGES controlling an oscillator are touch selectable over a range of three octaves. The left-hand key of the PRESET VOLTAGE SOURCE defines the lowest octave, the middle key transposes the entire keyboard voltage range up one octave, and the righthand key transposes the keyboard voltage up two octaves. This makes it possible for the performer instantly to select octave registration without having to offset the oscillators with the PITCH or FREQUENCY controls. With the SHIFT selector in 'shift' mode each of the PRESET VOLTAGE levels will be added to the KEY VOLTAGE output. If this voltage shift is applied to the frequency control of an oscillator it is possible to select any interval of transposition between a microtone and a major ninth. For example, the KEYBOARD and associated controls may be driving the oscillator so that a 'C' scale on the keyboard actually produces a 'C' reference scale. With the SHIFT selector in the 'none' position the PRESET VOLTAGE SOURCE will have no effect on the output voltages. With the first Preset key control set at about 11:00, turn to the 'shift' mode and

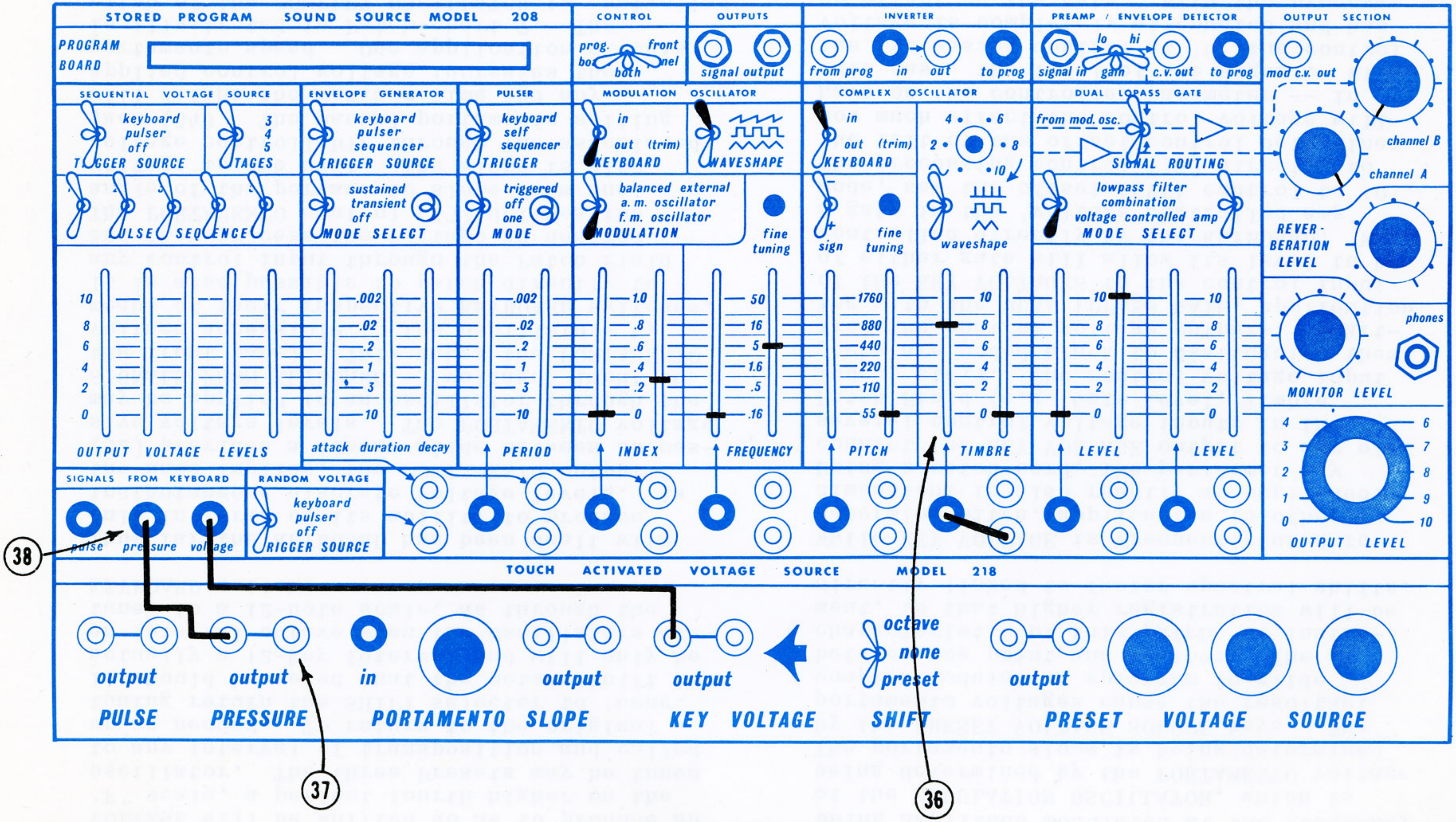

STORED PROGRAM SOUND SOURCE MODEL 208
PROGRAM BOARD
CONTROL
prog. front
both
OUTPUTS
signal output
INVERTER
from prog in out to prog
PREAMP / ENVELOPE DETECTOR
lo hi
signal in gain c.v. out to prog
OUTPUT SECTION
mod c.v. out
SEQUENTIAL VOLTAGE SOURCE
keyboard pulser off
TRIGGER SOURCE
3 4 5
STAGES
PULSE SEQUENCE
ENVELOPE GENERATOR
keyboard pulser sequencer
TRIGGER SOURCE
sustained transient off
MODE SELECT
attack duration decay
PULSER
keyboard self sequencer
TRIGGER
triggered off one
MODE
PERIOD
MODULATION OSCILLATOR
in out (trim)
KEYBOARD
WAVESHAPE
balanced external a.m. oscillator f.m. oscillator
MODULATION
INDEX
fine tuning
FREQUENCY
COMPLEX OSCILLATOR
in out (trim)
KEYBOARD
sign
fine tuning
waveshape
PITCH
TIMBRE
DUAL LOPASS GATE
from mod. osc.
SIGNAL ROUTING
lowpass filter combination voltage controlled amp
MODE SELECT
LEVEL
LEVEL
channel B
channel A
REVERBERATION LEVEL
phones
MONITOR LEVEL
OUTPUT LEVEL
OUTPUT VOLTAGE LEVELS
SIGNALS FROM KEYBOARD
pulse pressure voltage
RANDOM VOLTAGE
keyboard pulser off
TRIGGER SOURCE
TOUCH ACTIVATED VOLTAGE SOURCE MODEL 218
output PULSE
output PRESSURE
in PORTAMENTO
output SLOPE
output KEY VOLTAGE
octave none preset
SHIFT
output PRESET VOLTAGE SOURCE
34
33
32
36
35

RC7

touch the first key. The output of the KEY VOLTAGE will be shifted so as to produce an 'F' scale, a perfect fourth higher on the oscillator. The three Presets may be tuned to any interval of transposition and called up as needed. To return to the original tuning return the SHIFT selector to 'none.' It should be noted that the octave shift is actually a 12-key interval and will only be an integral octave when the oscillators are tuned to a 12-note scale, as through the KEYBOARD switch.

Thus far the KEYBOARD has been dealt with only in terms of its ability to produce instantaneous discrete voltage levels. As the name implies, the PORTAMENTO output (32) provides a linear glide between successive voltage levels. The PORTAMENTO voltage may be applied to an oscillator through the SIGNALS FROM KEYBOARD - 'voltage' input on the front panel. This makes the PORTAMENTO voltage accessible to the oscillators by means of their respective KEYBOARD switches. It is also possible to patch directly to any control input through the Patch Field and then process the voltage as desired. The PORTAMENTO control (33) defines the angle of the portamento slope from one voltage to the next. The slope is also voltage controllable through the associated jack (34). The manual portamento setting will define the maximum time and any applied control voltage increases the portamento speed. One application of this is illustrated in Patch-chart 7. The pitch of the COMPLEX OSCILLATOR is controlled directly from the KEY VOLTAGES via the KEYBOARD switch. The SHIFT selector is in the 'octave' mode, so registration is selectable. The COMPLEX OSCILLATOR is being amplitude modulated at the frequency of the MODULATION OSCILLATOR, which is being determined by the PORTAMENTO voltage. The portamento slope is being determined by the PRESET VOLTAGE SOURCE keys. The portamento voltages cause the resultant complex modulation spectrum to glide between one point and another. The characteristic of this patch, or instrument, is that higher registration will be directly linked to faster spectral shifts.

While KEY VOLTAGE is frequently used to determine pitch, application to other dimensions is also readily accomplished. Using a patch cord, the performer may connect the KEY VOLTAGE output to any of several control voltage inputs in the Patch Field (e.g. Gate Level, Timbre, Index, etc.). The control voltage input jacks are coded black to distinguish them from the control voltage outputs. Starting with the DUAL LOPASS GATE, application of the KEY VOLTAGES to the control input of either gate will allow its level to be controlled directly by the KEYBOARD. With a gate in the 'voltage controlled amp' mode, set the offset LEVEL control to '0'. The processing control (35) directly to the left of the offset control determines how much effect the control voltage will have on the controlled parameter -- in this case, the level of the signal. With the processing control at '0' the control voltage is completely attenuated and has no effect on the gate. With the processing control at some minimal setting (around 2 or 3) the high end of the keyboard will produce barely audible



STORED PROGRAM SOUND SOURCE MODEL 208
PROGRAM BOARD
CONTROL
prog. board both front panel
OUTPUTS
signal output
INVERTER
from prog in out to prog
PREAMP / ENVELOPE DETECTOR
signal in gain lo hi c.v. out to prog
OUTPUT SECTION
mod c.v. out
channel B
channel A
SEQUENTIAL VOLTAGE SOURCE
keyboard pulser off
TRIGGER SOURCE
3 4 5
STAGES
PULSE SEQUENCE
ENVELOPE GENERATOR
keyboard pulser sequencer
TRIGGER SOURCE
sustained transient off
MODE SELECT
PULSER
keyboard self sequencer
TRIGGER
triggered off one
MODE
MODULATION OSCILLATOR
in out (trim)
KEYBOARD
WAVESHAPE
balanced external a. m. oscillator f. m. oscillator
MODULATION
fine tuning
COMPLEX OSCILLATOR
in out (trim)
KEYBOARD
4 6 2 8 10
sign
fine tuning
waveshape
DUAL LOPASS GATE
from mod. osc.
SIGNAL ROUTING
lowpass filter combination voltage controlled amp
MODE SELECT
REVER-BERATION LEVEL
phones
MONITOR LEVEL
10 8 6 4 2 0
OUTPUT VOLTAGE LEVELS
.002 .02 .2 1 3 10
attack duration decay
.002 .02 .2 1 3 10
PERIOD
1.0 .8 .6 .4 .2 0
INDEX
50 16 5 1.6 .5 .16
FREQUENCY
1760 880 440 220 110 55
PITCH
10 8 6 4 2 0
TIMBRE
10 8 6 4 2 0
LEVEL
10 8 6 4 2 0
LEVEL
4 3 2 1 0 6 7 8 9 10
OUTPUT LEVEL
SIGNALS FROM KEYBOARD
pulse pressure voltage
RANDOM VOLTAGE
keyboard pulser off
TRIGGER SOURCE
TOUCH ACTIVATED VOLTAGE SOURCE MODEL 218
output
PULSE
output
PRESSURE
in
PORTAMENTO
output
SLOPE
output
KEY VOLTAGE
octave none preset
SHIFT
output
PRESET VOLTAGE SOURCE
38
37
36

PC 8

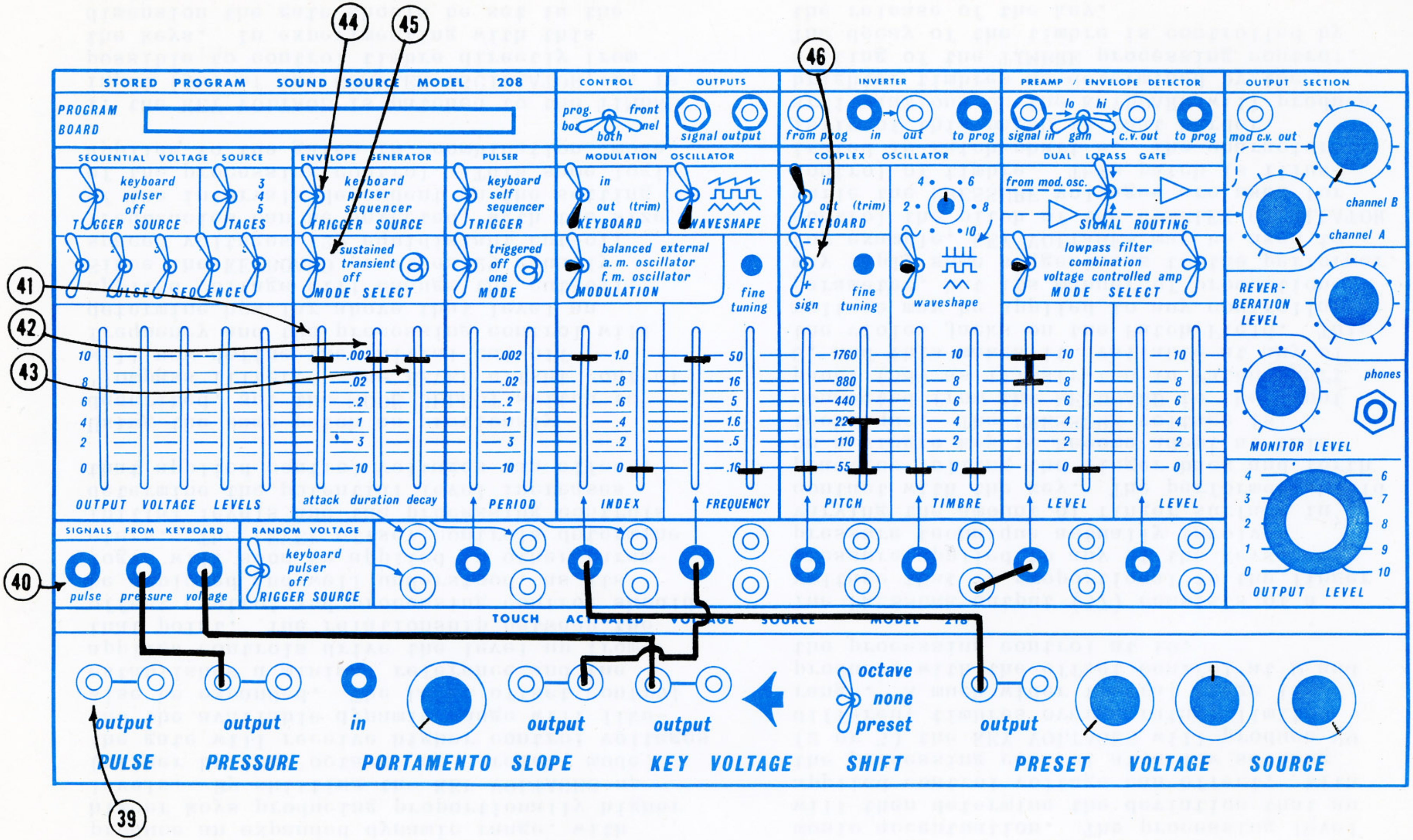
signals. With the processing input set at around 9 or 10 the keyboard voltages will produce an expanded dynamic range, with higher keys producing proportionally higher levels. By shifting the KEY VOLTAGES up (either by the 'octave' or 'preset' mode) the gate will receive higher control voltages and the available dynamic range will likewise be expanded. The LEVEL offset control establishes a minimal reference and the applied controls drive the level up from that point. The relationship between the offset control and processing control should be explored and well understood, as its logic will soon be applied to other parameters. The LEVEL offset controls determine initial levels and the processing controls determine the potential level increases that applied control voltages can effect.

Using the same patch as previously described, set the MODE SELECT switch to 'lowpass filter.' The LEVEL offset control will now define the initial cut-off frequency and the processing control will determine how far above that level an applied voltage will change the cut-off. Since the KEYBOARD provides 29 equally spaced voltages, 29 equidistant cut-off frequencies can be selected, with the size of the intervals dependent on the setting of the processing control. This same logic applies to the gates in 'combination' mode.

If the KEY VOLTAGE is patched to the TIMBRE input (36) of the COMPLEX OSCILLATOR, it is possible to control timbre directly from the keys. In experimenting with this dimension the gate should be set in the 'voltage controlled amp' mode, so it does not affect the timbre at that stage. The setting of the TIMBRE offset control will define the minimum amount of lower harmonic accentuation. The processing level will then determine the deviation that an applied control voltage can effect. With the processing control at a low setting (2 or 3) the KEY VOLTAGES will produce 29 different timbres over a rather limited range. A much wider timbral range is produced with the offset control at 0 and the processing control at 10.

The PRESSURE output (37) consists of a voltage that is proportional to the finger pressure applied to any of the keys. Key pressure technique actually involves varying the amount of finger surface in contact with the key. The performer should practice rolling the finger back and forth on a single key to become adept at this technique. The PRESSURE voltage is connected from the KEYBOARD to the front panel (38) as illustrated in Patch-chart 8, and this makes it available at any of the violet jacks on the Patch Field. This voltage may be applied to any controllable parameter, but its manner of production may imply some suggestions to the performer. For example, KEY VOLTAGES may be used to control the pitch of the COMPLEX OSCILLATOR while the PRESSURE voltages are used for control of timbre. This patch is illustrated in Patch-chart 8. The characteristic of this patch is that harder articulations on the KEYBOARD will produce brighter timbres as determined by the setting of the TIMBRE processing control. The decay of the timbre is controlled by the release of the key.

Another approach would be to have the gate


STORED PROGRAM SOUND SOURCE MODEL 208
PROGRAM BOARD
CONTROL
prog. front
board panel
both
OUTPUTS
signal output
INVERTER
from prog
in
out
to prog
PREAMP / ENVELOPE DETECTOR
signal in
lo hi
gain
c.v. out
to prog
OUTPUT SECTION
mod c.v. out
SEQUENTIAL VOLTAGE SOURCE
keyboard
pulser
off
TRIGGER SOURCE
3
4
5
STAGES
PULSE SEQUENCE
ENVELOPE GENERATOR
keyboard
pulser
sequencer
TRIGGER SOURCE
sustained
transient
off
MODE SELECT
PULSER
keyboard
self
sequencer
TRIGGER
triggered
off
one
MODE
MODULATION OSCILLATOR
in
out (trim)
KEYBOARD
WAVESHAPE
balanced external
a. m. oscillator
f. m. oscillator
MODULATION
fine tuning
COMPLEX OSCILLATOR
in
out (trim)
KEYBOARD
sign
fine tuning
waveshape
4
6
2
8
10
DUAL LOPASS GATE
from mod. osc.
SIGNAL ROUTING
lowpass filter
combination
voltage controlled amp
MODE SELECT
channel B
channel A
REVER-BERATION LEVEL
phones
MONITOR LEVEL
10 8 6 4 2 0
OUTPUT VOLTAGE LEVELS
.002 .02 .2 1 3 10
attack duration decay
.002 .02 .2 1 3 10
PERIOD
1.0 .8 .6 .4 .2 0
INDEX
50 16 5 1.6 .5 .16
FREQUENCY
1760 880 440 220 110 55
PITCH
10 8 6 4 2 0
TIMBRE
10 8 6 4 2 0
LEVEL
10 8 6 4 2 0
LEVEL
4 3 2 1 0 6 7 8 9 10
OUTPUT LEVEL
SIGNALS FROM KEYBOARD
pulse
pressure
voltage
RANDOM VOLTAGE
keyboard
pulser
off
TRIGGER SOURCE
TOUCH ACTIVATED VOLTAGE SOURCE MODEL 218
output
PULSE
output
PRESSURE
in
PORTAMENTO
output
SLOPE
output
KEY VOLTAGE
octave
none
preset
SHIFT
output
PRESET VOLTAGE SOURCE
39
40
41
42
43
44
45
46

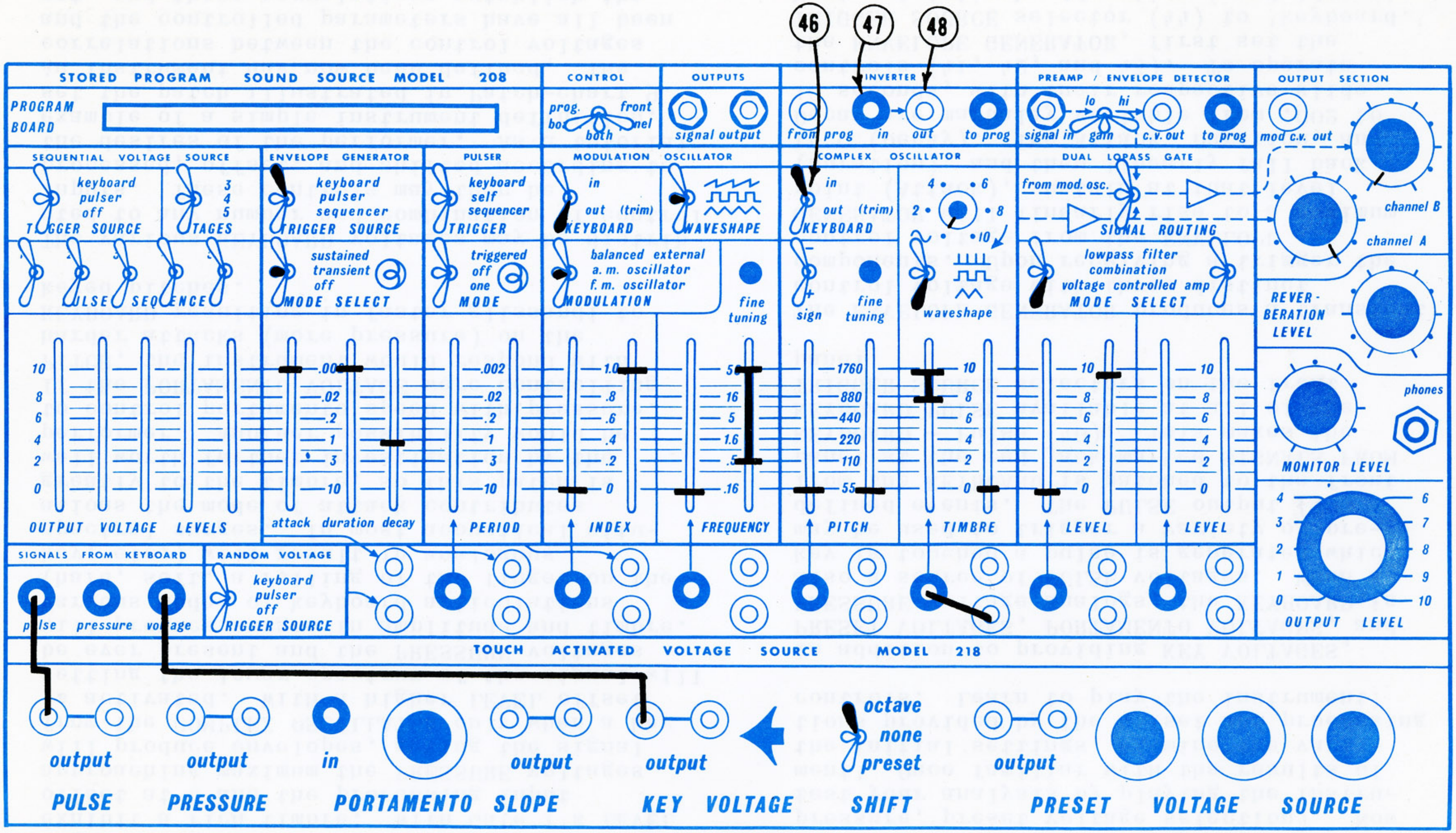
PC 9

in 'lowpass filter' or 'combination' mode and controlled by PRESSURE voltages. To make this patch more effective, the initial signal from the COMPLEX OSCILLATOR should exhibit a rich timbre. With Gate 1's LEVEL offset at 0 and the processing input approaching maximum the PRESSURE voltages will produce envelopes, gating the signal from the COMPLEX OSCILLATOR only when a key is activated. With a higher LEVEL offset setting the lower spectrum of the signal will be ever present and the PRESSURE voltages will produce surges in amplitude and timbre. Various modes of keyboard articulations (hard, soft, a rolling of the finger on the key, etc.) will result in analogous spectral surges. In most acoustical situations the mode of attack contributes greatly to the timbre, so this patch is well worth further investigation by the performer. Another possibility would be to control portamento speed with pressure. If the PORTAMENTO VOLTAGE were controlling PITCH, the instrument would respond with harder attacks (more pressure) on the KEYBOARD resulting in faster glissandi to keyed pitches.

The various KEYBOARD voltages may be distributed to any number and combination of control inputs. These controls may then be processed, offset, and shifted according to the desires of the performer. As a tutorial example of a simple instrument definition, set the patch illustrated in Patch-chart 9. An instrument has now been defined. The correlations between the control voltages and the controlled parameters have all been set, and these correlations establish the characteristics of the instrument. Before applying the necessary stimulus to the KEYBOARD, analyze the patch. Re-examine all of the connections and control settings and try to determine the result of the various stimuli (key selection, pressure, preset voltage selection). Now test your analysis by playing the instrument! Once familiar with the results of the initial settings, examine the variations provided by the offset and processing controls. Learn to play the instrument!

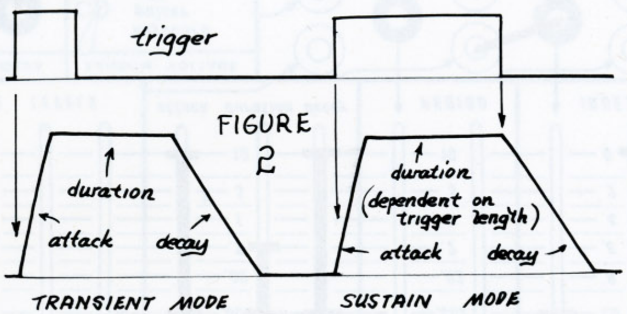
In addition to providing KEY VOLTAGES, PRESET VOLTAGES, PORTAMENTO VOLTAGES, and PRESSURE voltage analogs, the KEYBOARD is also a source of PULSE voltages. When a key is touched a pulse is generated which may be used to trigger a variety of predefined events. The PULSE output (39) from the KEYBOARD is patched to the front panel at the red jack marked SIGNALS FROM KEYBOARD - Pulse (40). This makes the KEYBOARD PULSE available at all of the TRIGGER SOURCE selectors on the front panel.

The ENVELOPE GENERATOR produces a transient control voltage with three distinct components. Upon receiving a trigger the control voltage from the ENVELOPE GENERATOR will linearly rise to a maximum point (Attack), sustain at that level (Duration), and then linearly fall back to 0 (Decay). The Attack, Duration, and Decay are manually variable from .002 to 10 seconds, with their respective slide controls (41, 42, and 43). To operate the ENVELOPE GENERATOR, first set the TRIGGER SOURCE selector (44) to 'keyboard.' Next set 'attack,' 'duration,' and 'decay' times as desired. Then set the MODE SELECT switch (45) to 'transient' or

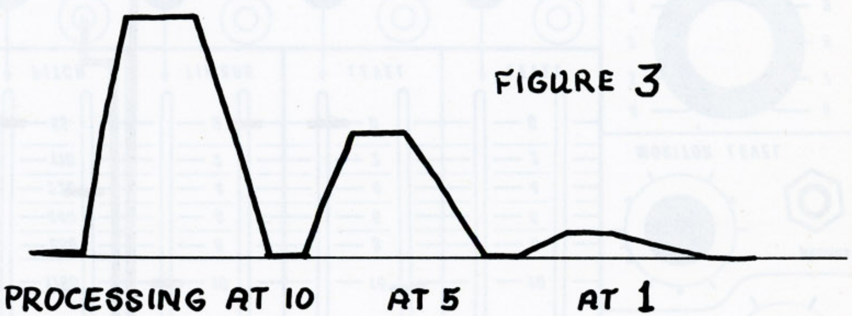

46
47
48
STORED PROGRAM SOUND SOURCE MODEL 208
PROGRAM BOARD
CONTROL
prog. board
front panel
both
OUTPUTS
signal output
INVERTER
from prog
in
out
to prog
PREAMP / ENVELOPE DETECTOR
signal in
lo
hi
gain
c.v. out
to prog
OUTPUT SECTION
mod c.v. out
channel B
channel A
SEQUENTIAL VOLTAGE SOURCE
keyboard
pulser
off
TRIGGER SOURCE
3
4
5
STAGES
PULSE SEQUENCE
ENVELOPE GENERATOR
keyboard
pulser
sequencer
TRIGGER SOURCE
sustained
transient
off
MODE SELECT
PULSER
keyboard
self
sequencer
TRIGGER
triggered
off
one
MODE
MODULATION OSCILLATOR
in
out (trim)
KEYBOARD
WAVESHAPE
balanced external
a. m. oscillator
f. m. oscillator
MODULATION
fine tuning
COMPLEX OSCILLATOR
in
out (trim)
KEYBOARD
sign
fine tuning
4
6
2
8
10
waveshape
DUAL LOPASS GATE
from mod. osc.
SIGNAL ROUTING
lowpass filter
combination
voltage controlled amp
MODE SELECT
REVERBERATION LEVEL
phones
MONITOR LEVEL
10
8
6
4
2
0
OUTPUT VOLTAGE LEVELS
.002
.02
.2
1
3
10
attack
duration
decay
PERIOD
1.0
.8
.6
.4
.2
0
INDEX
50
16
5
1.6
.5
.16
FREQUENCY
1760
880
440
220
110
55
PITCH
TIMBRE
LEVEL
LEVEL
4
3
2
1
0
6
7
8
9
10
OUTPUT LEVEL
SIGNALS FROM KEYBOARD
pulse
pressure
voltage
RANDOM VOLTAGE
keyboard
pulser
off
TRIGGER SOURCE
TOUCH ACTIVATED VOLTAGE SOURCE MODEL 218
output
output
in
output
output
octave
none
preset
output
PULSE
PRESSURE
PORTAMENTO
SLOPE
KEY VOLTAGE
SHIFT
PRESET VOLTAGE SOURCE

PC 1D

'sustained.' In 'transient' mode the segment times will be as indicated by the front panel settings. In 'sustain' mode the duration will depend on the length of the applied trigger. Upon reception of a trigger the envelope voltage will rise according to the 'attack' time setting, sustain as long as the trigger pulse is active, and will enter the 'decay' portion of the cycle when the trigger is released. In 'transient' mode the duration time is governed only by the 'duration' pot and is independent of trigger length (see Figure 2).

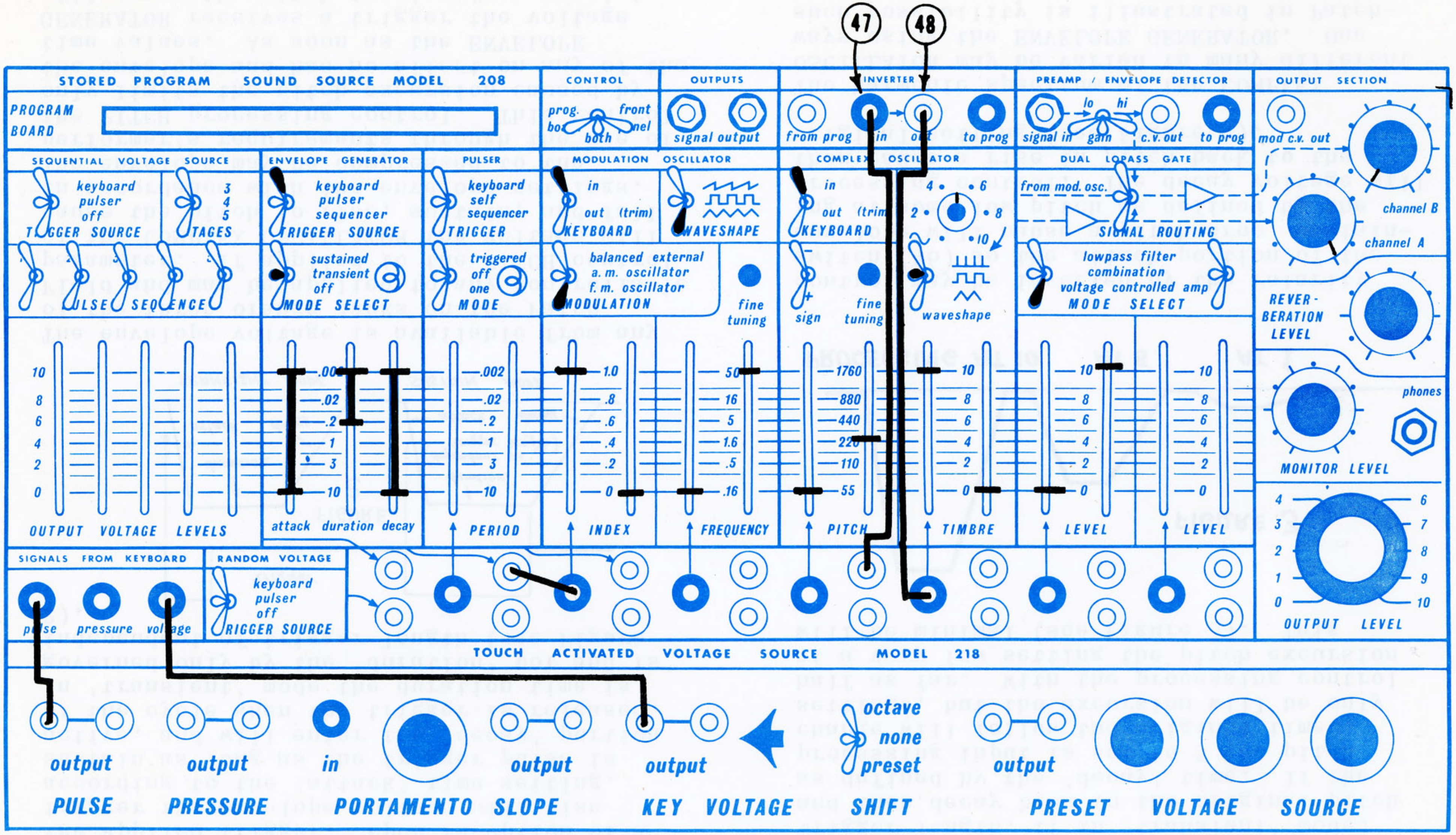


The envelope voltage is available from any of the three orange jacks on the Patch Field and may be applied to any controllable parameter. If applied to the PITCH control of the COMPLEX OSCILLATOR the voltage will cause the pitch to rise, sustain, and fall in accordance with the envelope settings. The envelope may be compressed to the performer's requirements through the use of the PITCH processing control. This control only limits the pitch excursion caused by the envelope and has no effect on any of the time values. As soon as the ENVELOPE GENERATOR receives a trigger the voltage will cause the pitch to rise from a point determined by the offset control. With the processing input at 10 the envelope voltage will cause maximal pitch excursion of the oscillator. It will sustain according to the 'duration' setting (or trigger length, if in 'transient' mode) and then decay back to the original pitch as defined by the 'decay' time. If the processing input is set to 5 the pitch change will follow the original time settings, but the excursion will be only half as far. With the processing control at a very low setting the pitch excursion will be minimal (see Figure 3). This



control may be inverted by the Polarity switch (46) so the attack portion of the envelope will cause a pitch drop, sustaining at some low pitch as defined by the processing control. The decay voltage will then cause a rise in pitch back to the original setting (see Figure 4).

The harmonic spectrum of the COMPLEX OSCILLATOR may be varied in many different ways using the ENVELOPE GENERATOR. One such possibility is illustrated in Patchchart 10. PITCH is controlled directly from the KEY VOLTAGES, and the ENVELOPE


47
48
STORED PROGRAM SOUND SOURCE MODEL 208
PROGRAM BOARD
CONTROL
prog. front
both
OUTPUTS
signal output
INVERTER
from prog
in
out
to prog
PREAMP / ENVELOPE DETECTOR
signal in
lo hi
gain
c.v. out
to prog
OUTPUT SECTION
mod c.v. out
channel B
channel A
SEQUENTIAL VOLTAGE SOURCE
keyboard
pulser
off
TRIGGER SOURCE
3
4
5
STAGES
PULSE
SEQUENCE
ENVELOPE GENERATOR
keyboard
pulser
sequencer
TRIGGER SOURCE
sustained
transient
off
MODE SELECT
PULSER
keyboard
self
sequencer
TRIGGER
triggered
off
one
MODE
MODULATION OSCILLATOR
in
out (trim)
KEYBOARD
WAVESHAPE
balanced external
a.m. oscillator
f.m. oscillator
MODULATION
fine tuning
COMPLEX OSCILLATOR
in
out (trim)
KEYBOARD
sign
fine tuning
waveshape
DUAL LOPASS GATE
from mod. osc.
SIGNAL ROUTING
lowpass filter
combination
voltage controlled amp
MODE SELECT
REVER-BERATION LEVEL
phones
MONITOR LEVEL
OUTPUT VOLTAGE LEVELS
attack
duration
decay
PERIOD
INDEX
FREQUENCY
PITCH
TIMBRE
LEVEL
LEVEL
OUTPUT LEVEL
SIGNALS FROM KEYBOARD
pulse
pressure
voltage
RANDOM VOLTAGE
keyboard
pulser
off
TRIGGER SOURCE
TOUCH ACTIVATED VOLTAGE SOURCE MODEL 218
output
PULSE
output
PRESSURE
in
PORTAMENTO
output
SLOPE
output
KEY VOLTAGE
octave
none
preset
SHIFT
output
PRESET VOLTAGE SOURCE

PC 11

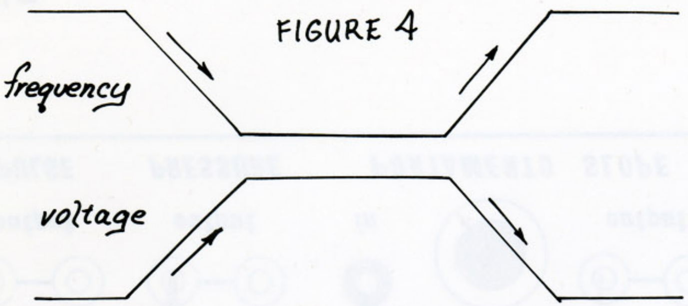
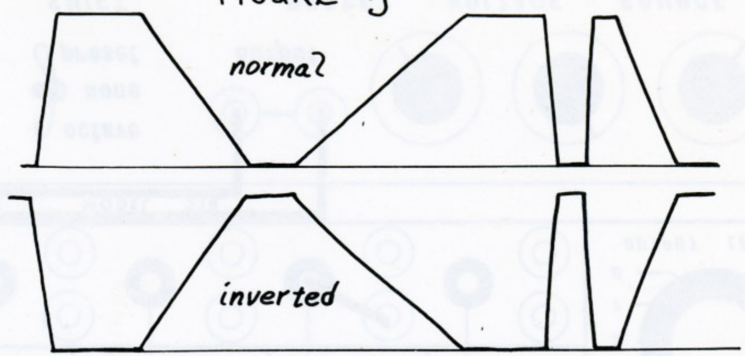


FIGURE 4

desired control voltage input by means of a second banana patch cord.

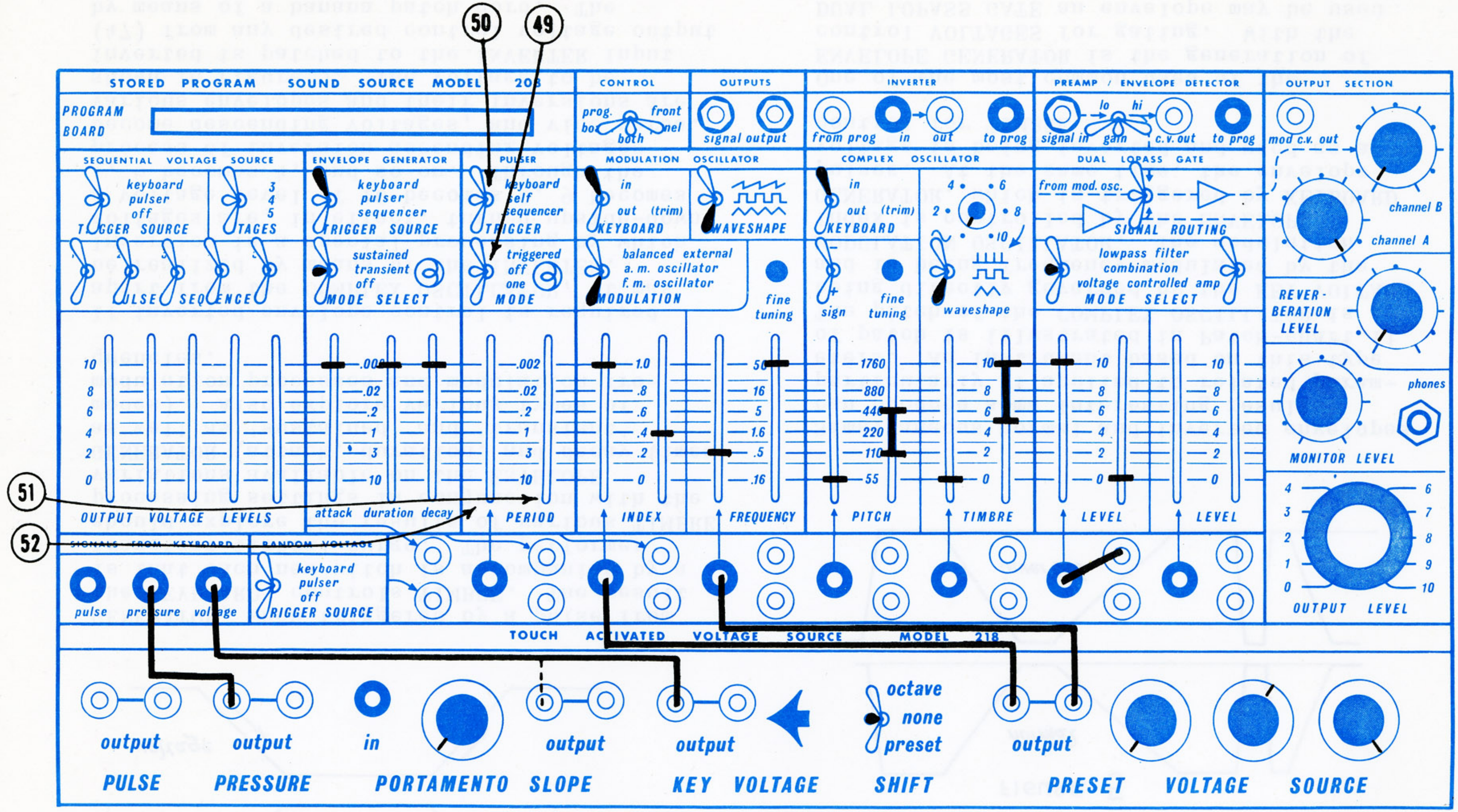
FIGURE 5


GENERATOR, when triggered by a pulse from the KEYBOARD, controls TIMBRE. The result is that each new pitch is accompanied by a transient timbral surge. The performer should explore the results of various TIMBRE processing settings in conjunction with the variations available on the ENVELOPE GENERATOR (attack, duration, and decay times as well as 'sustained' and 'transient' modes). Also explore various types of modulation processes and modulation frequencies.

If inverted envelope control is required apart from the COMPLEX OSCILLATOR, it may be realized by means of the INVERTER. Inversion is a special processing by which voltages are, in effect, turned upside-down. A voltage level of 10 becomes 0, 9 becomes 1, 6 becomes 4, and so on. Through the process of inversion ascending voltages become descending voltages, and vice versa. Various envelopes and their inversions are shown in Figure 5. The voltage to be inverted is patched to the INVERTER input (47) from any desired control voltage output by means of a banana patch cord. The inverted voltage then is taken from the INVERTER output (48) and patched to any

Simultaneous normal and inverted envelopes can produce some interesting results, particularly if applied to related parameters. An instrument based on this type of patch is illustrated in Patch-chart 11. The pitch of the COMPLEX OSCILLATOR is being directly governed by the KEY VOLTAGE and is being frequency modulated by the MODULATION OSCILLATOR. The modulation index is controlled by the ENVELOPE GENERATOR, which is triggered by KEYBOARD pulses. At the same time, the envelope voltage is being inverted and used as a control for TIMBRE.

One of the most common uses of the ENVELOPE GENERATOR is the generation of control VOLTAGES for gating. With the DUAL LOPASS GATE an envelope may be used to determine a transient amplitude contour ('voltage controlled amp' mode), lowpass



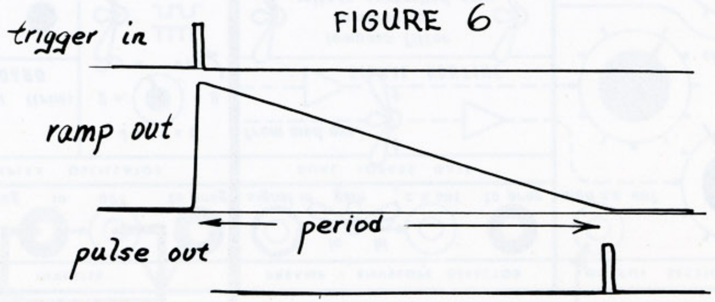
STORED PROGRAM SOUND SOURCE MODEL 208
PROGRAM BOARD
CONTROL
prog. board front panel both
OUTPUTS
signal output
INVERTER
from prog in out to prog
PREAMP / ENVELOPE DETECTOR
signal in lo gain hi c.v. out to prog
OUTPUT SECTION
mod c.v. out
channel B
channel A
SEQUENTIAL VOLTAGE SOURCE
keyboard pulser off
TRIGGER SOURCE
3 4 5
STAGES
PULSE SEQUENCE
ENVELOPE GENERATOR
keyboard pulser sequencer
TRIGGER SOURCE
sustained transient off
MODE SELECT
PULSER
keyboard self sequencer
TRIGGER
triggered off one
MODE
MODULATION OSCILLATOR
in out (trim)
KEYBOARD
WAVESHAPE
balanced external a. m. oscillator f. m. oscillator
MODULATION
fine tuning
COMPLEX OSCILLATOR
in out (trim)
KEYBOARD
sign
fine tuning
waveshape
DUAL LOPASS GATE
from mod. osc.
SIGNAL ROUTING
lowpass filter combination voltage controlled amp
MODE SELECT
REVER-BERATION LEVEL
phones
MONITOR LEVEL
OUTPUT VOLTAGE LEVELS
attack duration decay
PERIOD
INDEX
FREQUENCY
PITCH
TIMBRE
LEVEL
LEVEL
OUTPUT LEVEL
SIGNALS FROM KEYBOARD
pulse pressure voltage
RANDOM VOLTAGE
keyboard pulser off
TRIGGER SOURCE
TOUCH ACTIVATED VOLTAGE SOURCE MODEL 218
output output in output output
octave none preset
output
PULSE PRESSURE PORTAMENTO SLOPE KEY VOLTAGE SHIFT PRESET VOLTAGE SOURCE
49
50
51
52

PC 12

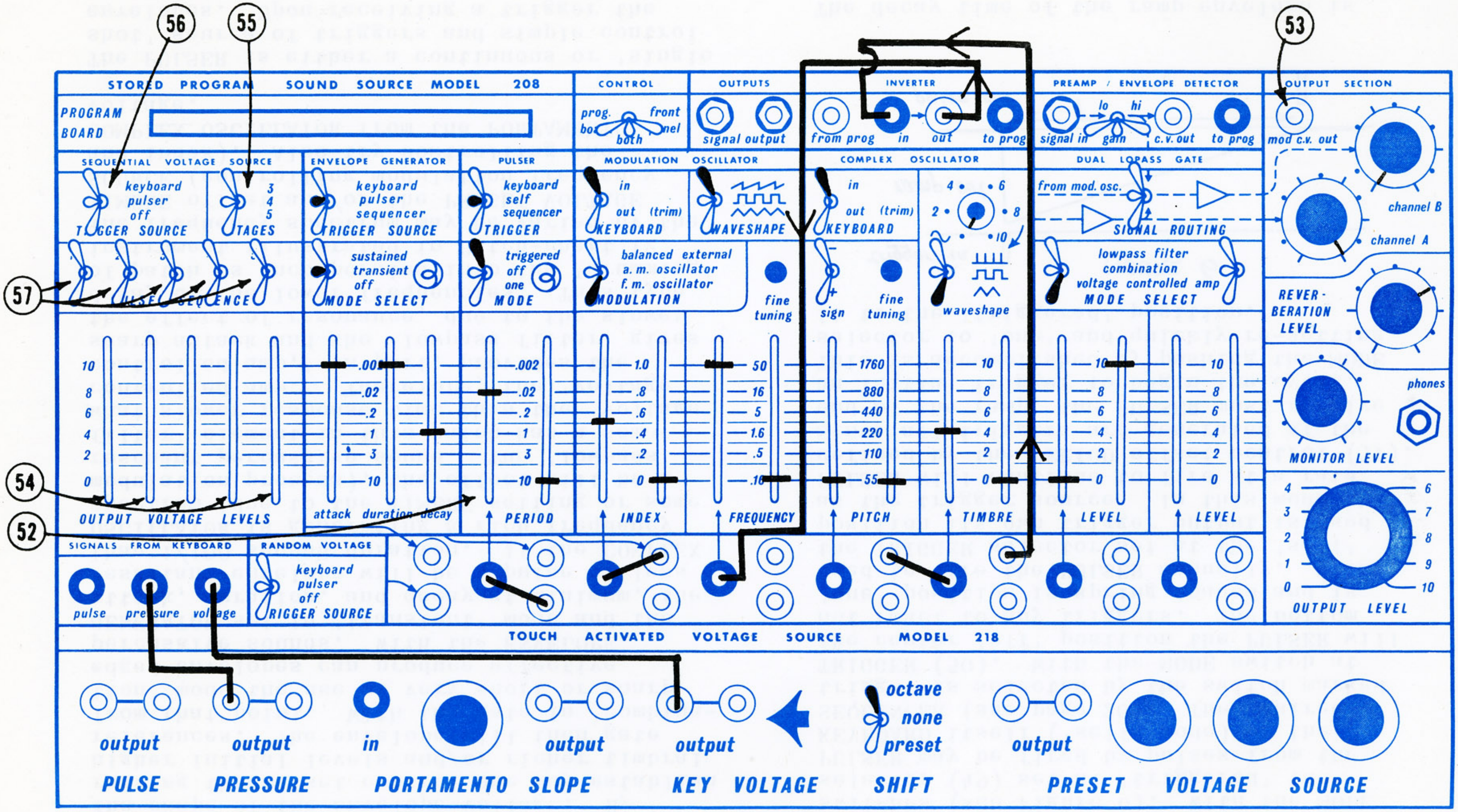
spectrum ('lowpass' mode), or a combination of both ('combination' mode). With the LEVEL offset control at 0 the gating characteristics may be totally defined by the shape of the envelope voltage. By raising the offset control one may establish higher initial levels and/or richer timbral references. The envelope will then gate from that point. With the gate in 'combination' mode the use of very short or sharp-edged envelopes can produce effective percussive sounds. With the ENVELOPE GENERATOR set in 'transient' mode and the attack, duration, and decay at minimum, the resultant envelope will be a pulse of less than 1/100 second duration. If the COMPLEX OSCILLATOR is generating a rich frequency spectrum (due to the TIMBRE setting or some modulation process), the effect will be a resonant percussive sound. The 'lowpass filter' element in this patch has a somewhat slower response time than the 'voltage controlled amp.' Therefore, the 'voltage controlled amp,' in part, provides the sharp attack and the 'lowpass filter' gives the effect of resonance, due to the slower decay of the lower frequencies. This type of patch is incorporated into the 'drumming' instrument illustrated in Patch-chart 12. The frequency spectrum may be varied by the TIMBRE offset and/or the PRESET VOLTAGE SOURCE (controlling modulation frequency and index). Also try controlling the COMPLEX OSCILLATOR from the PORTAMENTO voltage.

The PULSER is either a continuous or 'single shot' source of triggers and simple control envelopes. Upon receiving a trigger the PULSER will generate a linearly descending 'ramp' voltage that is available at the yellow jacks on the Patch Field. When the ramp, or envelope, voltage reaches 0 the PULSER produces a trigger which is available at any of the TRIGGER SOURCE switches (see Figure 6). With the MODE selector (49) set at 'triggered' the PULSER may be fired by pulses from the KEYBOARD itself ('self' mode) or the SEQUENCER (see page 20). The desired trigger is selected by the switch marked TRIGGER (50). With the MODE switch at the center 'off' position the PULSER will not react to any triggers. The bottom 'one' position is spring loaded and is used to fire the PULSER manually. With the TRIGGER selector set at the 'self' position its own trigger output is used as the trigger source. In this mode the PULSER will continue to fire at a rate defined by the PERIOD offset control (51). Since all triggers are generated at the end of the ramp, the PULSER must receive an initial trigger to begin the cycle. This is accomplished by pushing the MODE selector to 'one' and quickly re-setting it to the 'triggered' position.

FIGURE 6



The decay time of the ramp envelope is called the PERIOD and may be varied from .002 to 10 seconds. The PERIOD is also


56
55
53
57
54
52
STORED PROGRAM SOUND SOURCE MODEL 208
PROGRAM BOARD
CONTROL
prog. board
front panel
both
OUTPUTS
signal output
INVERTER
from prog
in
out
to prog
PREAMP / ENVELOPE DETECTOR
signal in
lo
hi
gain
c.v. out
to prog
OUTPUT SECTION
mod c.v. out
channel B
channel A
REVERBERATION LEVEL
MONITOR LEVEL
phones
OUTPUT LEVEL
SEQUENTIAL VOLTAGE SOURCE
keyboard
pulser
off
TRIGGER SOURCE
3
4
5
STAGES
PULSE SEQUENCE
OUTPUT VOLTAGE LEVELS
ENVELOPE GENERATOR
keyboard
pulser
sequencer
TRIGGER SOURCE
sustained
transient
off
MODE SELECT
attack duration decay
PULSER
keyboard
self
sequencer
TRIGGER
triggered
off
one
MODE
PERIOD
MODULATION OSCILLATOR
in
out (trim)
KEYBOARD
WAVESHAPE
balanced external
a. m. oscillator
f. m. oscillator
MODULATION
fine tuning
INDEX
FREQUENCY
COMPLEX OSCILLATOR
in
out (trim)
KEYBOARD
sign
fine tuning
waveshape
PITCH
TIMBRE
DUAL LOPASS GATE
from mod. osc.
SIGNAL ROUTING
lowpass filter
combination
voltage controlled amp
MODE SELECT
LEVEL
LEVEL
SIGNALS FROM KEYBOARD
pulse
pressure
voltage
RANDOM VOLTAGE
keyboard
pulser
off
TRIGGER SOURCE
TOUCH ACTIVATED VOLTAGE SOURCE MODEL 218
output
PULSE
output
PRESSURE
in
PORTAMENTO
output
SLOPE
output
KEY VOLTAGE
octave
none
preset
SHIFT
output
PRESET VOLTAGE SOURCE

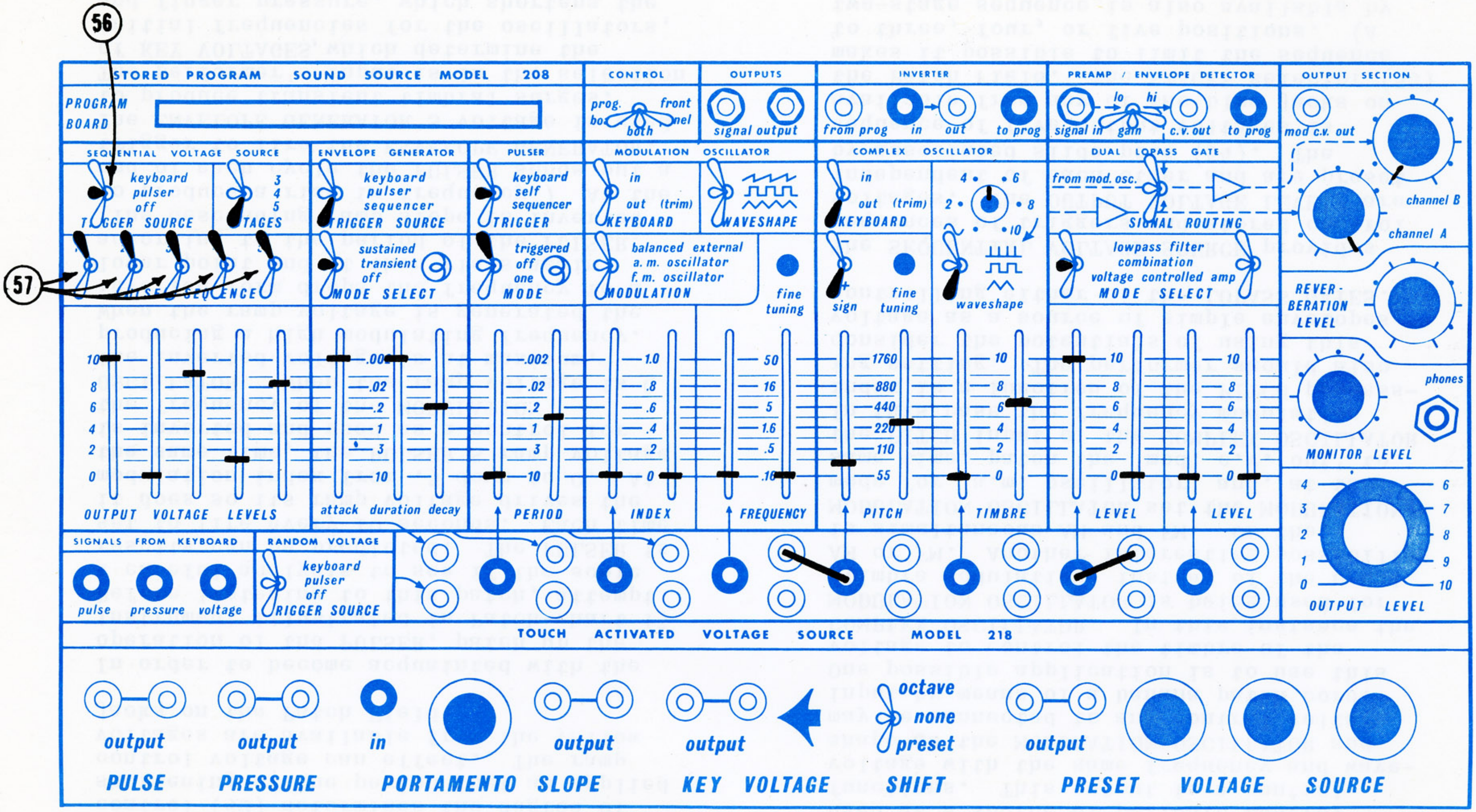
PC 13

voltage controllable through its control voltage input on the Patch Field. The PERIOD offset establishes the initial (maximum) period, and the processing control (52) determines the degree of shortening of the period that an applied control voltage can effect. The ramp voltages are available from the yellow jacks on the Patch Field.

In order to become acquainted with the operation of the PULSER, patch up the instrument illustrated in Patch-chart 13. Before listening to this patch, attempt a careful analysis to see if the sonic results can be predicted. The PULSER is set to fire every 10 seconds. Each time it does so its ramp voltage drives the modulation index from .5 down to 0. At the same time, the PULSER'S ramp voltage is inverted and used as a control for the frequency of the MODULATION OSCILLATOR. When the ramp voltage is 0 the inverted voltage is at maximum, producing a high modulating frequency. When the ramp voltage is generated the inverted form drops the frequency to a lower point and it then rises again according to the period of the PULSER. (The descending ramp slope is inverted to produce a rise in frequency.) At the end of each cycle the PULSER sends out a trigger to fire the ENVELOPE GENERATOR. The ENVELOPE GENERATOR'S voltage is used to produce transient timbral surges. The performer's input is in the selection of KEY VOLTAGES, which determine the initial frequencies for the oscillators, and finger pressure, which shortens the PULSER'S period. Experiment with various offset and processing settings and the various octave shifts on the KEYBOARD.

The MODULATION OSCILLATOR has another front panel output (53), which may be used as a source of periodic control functions. This output is a control voltage with the same frequency and wave-shape as the MODULATION OSCILLATOR and may be connected to any control voltage input by means of a banana patch cord. One possible application is to use this voltage to control the timbre of the COMPLEX OSCILLATOR. In this instance the MODULATION OSCILLATOR is being used for 'timbre modulation' instead of the usual AM or FM. Another interesting possibility is simultaneous AM and FM. On the MODULATION OSCILLATOR set the MODULATION mode for 'a.m. oscillator' and, at the same time, patch the 'mod. c.v. out' to the PITCH input of the COMPLEX OSCILLATOR. In this case the frequency modulation index is a function of the PITCH processing setting. The performer should also consider the potentials of using this voltage as a source of simple envelopes, controlling either of the LOPASS GATES.

The SEQUENTIAL VOLTAGE SOURCE provides sequences of triggers and stored control voltages. The OUTPUT VOLTAGE LEVELS are independent of each other and are preset by associated slide pots (54). The sequence of five output voltages is available from any of the blue jacks on the Patch Field. The STAGES selector (55) makes it possible to limit the sequence to three, four, or five positions. (A two-stage sequence is also available by use of the PROGRAM CARD.) The SEQUENCER is advanced from one stage to the next by


56
57
STORED PROGRAM SOUND SOURCE MODEL 208
PROGRAM BOARD
CONTROL
prog. board
front panel
both
OUTPUTS
signal output
INVERTER
from prog
in
out
to prog
PREAMP / ENVELOPE DETECTOR
lo
hi
signal in
gain
c.v. out
to prog
OUTPUT SECTION
mod c.v. out
channel B
channel A
SEQUENTIAL VOLTAGE SOURCE
keyboard
pulser
off
TRIGGER SOURCE
3
4
5
STAGES
PULSE SEQUENCE
ENVELOPE GENERATOR
keyboard
pulser
sequencer
TRIGGER SOURCE
sustained
transient
off
MODE SELECT
PULSER
keyboard
self
sequencer
TRIGGER
triggered
off
one
MODE
MODULATION OSCILLATOR
in
out (trim)
KEYBOARD
WAVESHAPE
balanced external
a. m. oscillator
f. m. oscillator
MODULATION
fine tuning
COMPLEX OSCILLATOR
in
out (trim)
KEYBOARD
sign
fine tuning
waveshape
DUAL LOPASS GATE
from mod. osc.
SIGNAL ROUTING
lowpass filter
combination
voltage controlled amp
MODE SELECT
REVERBERATION LEVEL
phones
MONITOR LEVEL
OUTPUT
VOLTAGE
LEVELS
attack
duration
decay
PERIOD
INDEX
FREQUENCY
PITCH
TIMBRE
LEVEL
LEVEL
OUTPUT LEVEL
SIGNALS FROM KEYBOARD
pulse
pressure
voltage
RANDOM VOLTAGE
keyboard
pulser
off
TRIGGER SOURCE
TOUCH ACTIVATED VOLTAGE SOURCE MODEL 218
output
PULSE
output
PRESSURE
in
PORTAMENTO
output
SLOPE
output
KEY VOLTAGE
octave
none
preset
SHIFT
output
PRESET VOLTAGE SOURCE

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the application of triggers from either the KEYBOARD or the PULSER as defined by the TRIGGER SOURCE selector (56). With the TRIGGER SOURCE switch at the 'off' position the last incremented voltage will continue to be available at the output jacks. When setting the various output voltages it may be easiest to use the KEYBOARD as the trigger source. In this way each voltage level may be carefully 'tuned' and then advanced to the next stage by touching a key.

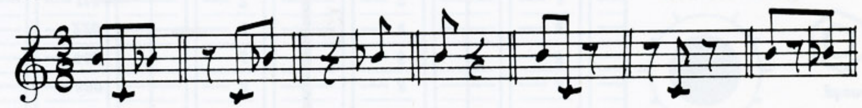
When incremented, each stage sends out a pulse which may be used to trigger the PULSER or the ENVELOPE GENERATOR. (Other routing is available on the PROGRAM CARD.) The trigger from any selected increment may be disabled by having the corresponding PULSE SEQUENCE switch (57) in the down position. One application of this feature is to use the SEQUENCER'S various triggers to articulate rests in a pitch sequence. Referring to the patch illustrated in Patch-chart 14, the SEQUENCER'S Output Voltages are defining the following pitch pattern for the COMPLEX OSCILLATOR:

The various pulses from the SEQUENCER are triggering the ENVELOPE GENERATOR which, in turn, is opening Gate 1. By switching the various pulses in and out, and by varying the number of stages in the sequence, the following patterns are possible:

5 STAGES

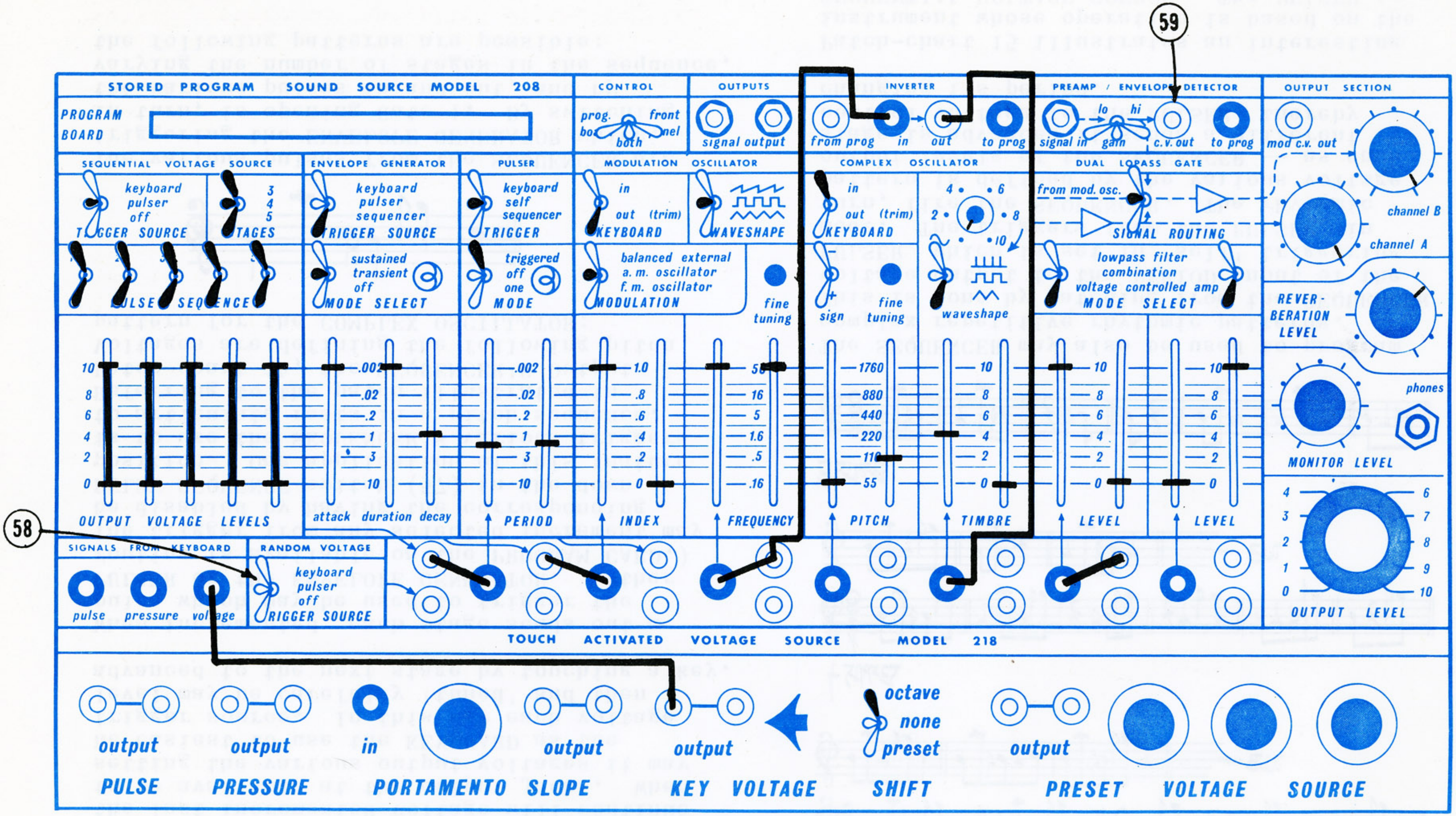
4 STAGES

3 STAGES



The SEQUENCER may also be used to program complex repetitive rhythmic patterns. This is done by patching from the SEQUENCER voltage output to the PERIOD input of the PULSER, which is set in 'self' triggering mode. The triggers from the PULSER, in turn, fire the SEQUENCER. The rhythmic pattern is defined by the various voltage output levels of the SEQUENCER -- as each stage is advanced it sends a different control voltage to the PULSER, thereby changing its period.

Patch-chart 15 illustrates an interesting instrument whose operation is based on the SEQUENTIAL VOLTAGE SOURCE. The PULSER is in 'self' trigger mode and is supplying



WITHIN THIS INSTRUMENT THE VARIOUS SETTINGS ON THE SEQUENCER ARE VARIABLE.

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triggers to the SEQUENCER. The SEQUENCER, in turn, determines the period of the PULSER and also is inverted, programming the timbre of the COMPLEX OSCILLATOR. The INVERTER is used so shorter periods are correlated with less complex timbres. The SEQUENCER is also supplying voltages to the MODULATION OSCILLATOR, thus varying its frequency. The SEQUENCER is also supplying triggers to fire the ENVELOPE GENERATOR, the voltage output of which is varying the modulation index. By switching different SEQUENCER triggers in and out, various timbral patterns resulting from INDEX variation may be played. The frequency of the MODULATION OSCILLATOR is being driven up into the audio range and is audible via Gate 2 and 'channel B' mix level. Explore the various pulse sequences, SEQUENCER voltage output levels and offsets, and discover the range of musical possibilities inherent in this patch.

RANDOM VOLTAGE is a source of stored random voltage levels. When triggered by either the KEYBOARD or the PULSER a new, uncorrelated, random voltage appears at each of the four white outputs on the Patch Field. These voltages will remain at a constant value until another trigger is applied. With the TRIGGER SOURCE selector (58) at the 'off' position the RANDOM VOLTAGE SOURCE will not react to any triggers and will hold the last triggered voltage. A possible application of this voltage source is illustrated in Patch-chart 16. The PULSER is set in the 'self' triggering mode and fires the RANDOM VOLTAGE SOURCE. One random voltage determines the pitch of the COMPLEX OSCILLATOR, another random voltage determines timbre, and a third random voltage defines the gate level. The amount of randomness that each new voltage imparts to each parameter is determined by the processing input pot. With the processing pot at 1 that particular character of the sound will randomly vary a slight amount beyond the reference set by the offset pot. As the processing input is raised the degree of randomness will proportionally increase.

The ENVELOPE DETECTOR provides the performer with a direct means of control voltage generation. An audio signal patched into the PREAMP will produce a control voltage proportional to the amplitude of the applied signal. This voltage is then available at the control voltage output marked 'c.v. out' (59) and may be patched to any control input. Figure 7 illustrates various input signals and the resultant control voltages.

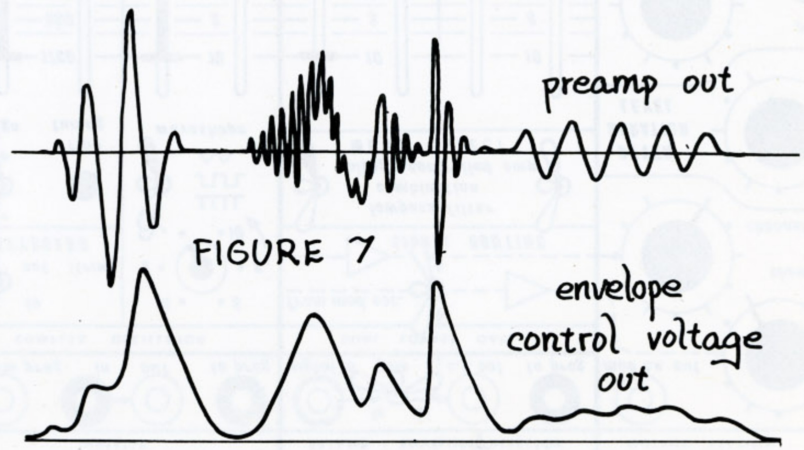
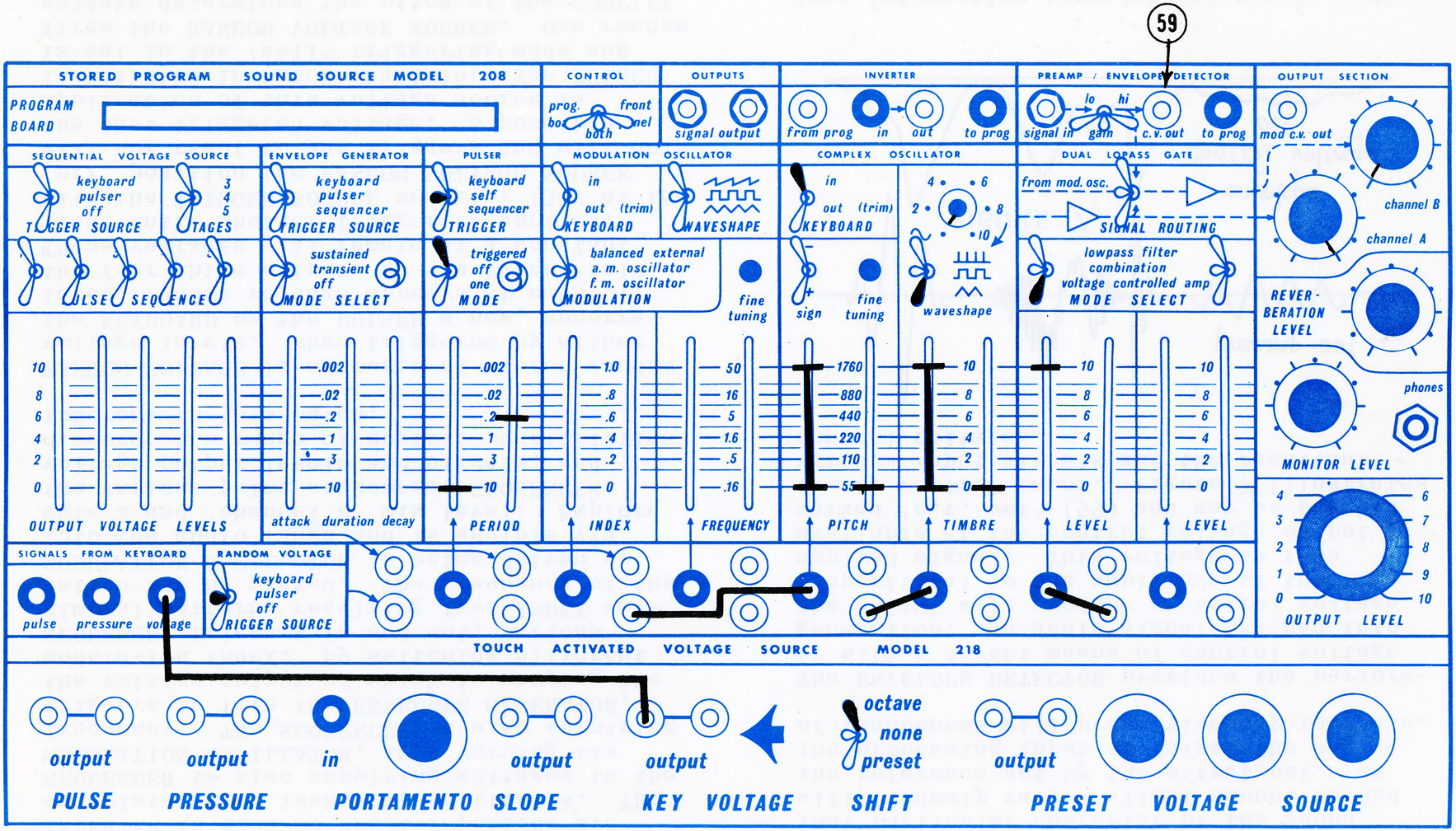


FIGURE 7

Some interesting correlations may be made by coupling external signals to the Music Easel and simultaneously using them to


59
STORED PROGRAM SOUND SOURCE MODEL 208
PROGRAM BOARD
CONTROL
prog. board
both
front panel
OUTPUTS
signal output
INVERTER
from prog
in
out
to prog
PREAMP / ENVELOPE DETECTOR
signal in
lo
hi
gain
c.v. out
to prog
OUTPUT SECTION
mod c.v. out
SEQUENTIAL VOLTAGE SOURCE
keyboard
pulser
off
TRIGGER SOURCE
3
4
5
STAGES
PULSE SEQUENCE
ENVELOPE GENERATOR
keyboard
pulser
sequencer
TRIGGER SOURCE
sustained
transient
off
MODE SELECT
PULSER
keyboard
self
sequencer
TRIGGER
triggered
off
one
MODE
MODULATION OSCILLATOR
in
out (trim)
KEYBOARD
WAVESHAPE
balanced external
a. m. oscillator
f. m. oscillator
MODULATION
fine tuning
COMPLEX OSCILLATOR
in
out (trim)
KEYBOARD
sign
fine tuning
4
6
2
8
10
waveshape
DUAL LOPASS GATE
from mod. osc.
SIGNAL ROUTING
lowpass filter
combination
voltage controlled amp
MODE SELECT
channel B
channel A
REVERBERATION LEVEL
phones
MONITOR LEVEL
10
8
6
4
2
0
OUTPUT VOLTAGE LEVELS
.002
.02
.2
1
3
10
attack duration decay
PERIOD
1.0
.8
.6
.4
.2
0
INDEX
50
16
5
1.6
.5
.16
FREQUENCY
1760
880
440
220
110
55
PITCH
TIMBRE
LEVEL
LEVEL
OUTPUT LEVEL
SIGNALS FROM KEYBOARD
pulse
pressure
voltage
RANDOM VOLTAGE
keyboard
pulser
off
TRIGGER SOURCE
TOUCH ACTIVATED VOLTAGE SOURCE MODEL 218
output
PULSE
output
PRESSURE
in
PORTAMENTO
output
SLOPE
output
KEY VOLTAGE
octave
none
preset
SHIFT
output
PRESET VOLTAGE SOURCE

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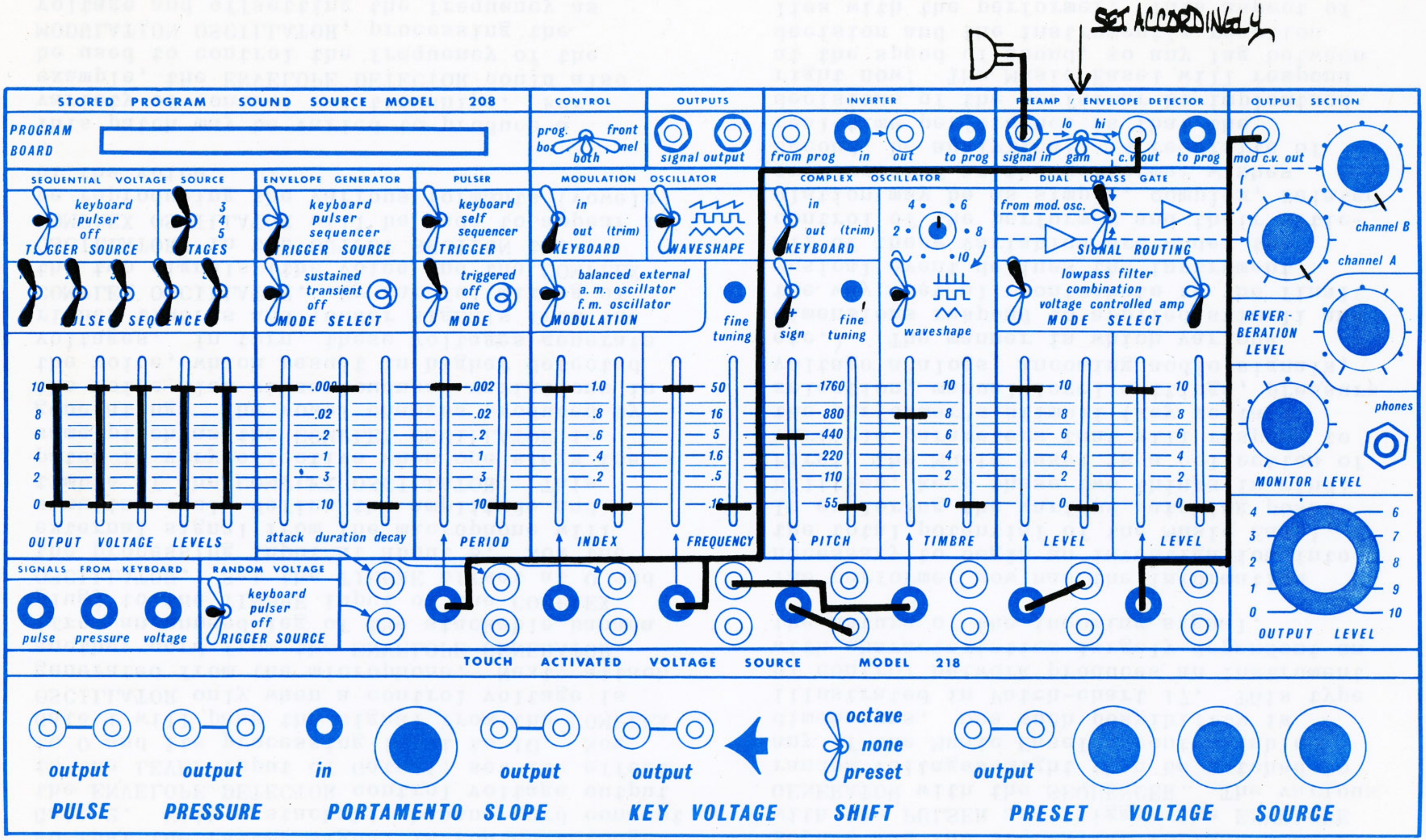
generate control voltages. As an example, connect a microphone to the PREAMP and select a suitable gain setting as described on page 7. Set the DUAL LOPASS GATE Routing switch so that the PREAMP signal is routed through Gate 2. With a stackable banana cord connect the ENVELOPE DETECTOR control voltage output to the LEVEL input of Gate 1; set its effect to 0 and its processing input to 10. Now Gate 1 will pass the signal from the COMPLEX OSCILLATOR only when a control voltage is generated from the microphone. Next, attach another cord from the ENVELOPE GENERATOR (from an unused leg of the stackable banana plug) to the TIMBRE input of the COMPLEX OSCILLATOR. Set the TIMBRE offset at 0 and the processing input at about 8. Now the external signal from the microphone will simultaneously define the amplitude and timbre of the COMPLEX OSCILLATOR. This patch is very effective when one sings the same pitch as the COMPLEX OSCILLATOR is generating. The vowel changes produced by the voice also cause loudness variations in the voice, which result in higher detected voltages. In turn, these voltages generate richer timbres and louder signals from the COMPLEX OSCILLATOR. By careful mixing of the two signals (the voice and the COMPLEX OSCILLATOR) in the OUTPUT SECTION the COMPLEX OSCILLATOR will be made to appear to be reproducing the various formants (vowels) of the voice.

This patch may be varied to produce a variety of control relationships. For example, the ENVELOPE DETECTOR could also be used to control the frequency of the MODULATION OSCILLATOR, processing the voltage and offsetting the frequency as desired. Or, one might experiment with controlling the INDEX with the PULSER'S ramp voltage and the PULSER'S period with the ENVELOPE DETECTOR. It would then be possible to trigger the RANDOM VOLTAGE SOURCE and the SEQUENTIAL VOLTAGE SOURCE with the PULSER and trigger the ENVELOPE GENERATOR with the SEQUENCER. The various random voltages might then be patched to any of the Music Easel's controllable dimensions. One such possibility is illustrated in Patch-chart 17. This type of control network produces an instrument with characteristics largely dependent on the nature of the incoming signal.

The performer now has the information necessary to begin an investigation into the total potential of the Music Easel. In exploring the various patching possibilities, keep these two things in mind: First, the Music Easel is a collection of variable parameters that will respond to the performer's stimuli (key voltage selection, manual level settings, pressure voltage analogs, incoming audio signals, etc.). The manner in which various dimensions respond to applied stimuli and the way they all contribute to the final musical event defines the instrument. All of these variables are under the control of the performer and their articulation may be as simple, complex, related or unrelated as the performer wishes. Second, be analytical! A requisite of real-time performance is that the decisions of the performer be implemtned right now! The Music Easel will respond at the speed of sound, so any lag between decision and the instrument's reaction lies with the performer. This aspect of real-time technique is only developed



SET ACCORDINGLY
STORED PROGRAM SOUND SOURCE MODEL 208
PROGRAM BOARD
CONTROL
prog. box
front panel
both
OUTPUTS
signal output
INVERTER
from prog
in
out
to prog
PREAMP / ENVELOPE DETECTOR
signal in
lo
hi
gain
c.v. out
to prog
OUTPUT SECTION
mod c.v. out
SEQUENTIAL VOLTAGE SOURCE
keyboard
pulser
off
TRIGGER SOURCE
3
4
5
STAGES
PULSE SEQUENCE
ENVELOPE GENERATOR
keyboard
pulser
sequencer
TRIGGER SOURCE
sustained
transient
off
MODE SELECT
PULSER
keyboard
self
sequencer
TRIGGER
triggered
off
one
MODE
MODULATION OSCILLATOR
in
out (trim)
KEYBOARD
WAVESHAPE
balanced external
a. m. oscillator
f. m. oscillator
MODULATION
fine tuning
COMPLEX OSCILLATOR
in
out (trim)
KEYBOARD
sign
fine tuning
waveshape
DUAL LOPASS GATE
from mod. osc.
SIGNAL ROUTING
lowpass filter
combination
voltage controlled amp
MODE SELECT
channel B
channel A
REVER-BERATION LEVEL
phones
MONITOR LEVEL
OUTPUT VOLTAGE LEVELS
attack duration decay
PERIOD
INDEX
FREQUENCY
PITCH
TIMBRE
LEVEL
LEVEL
OUTPUT LEVEL
SIGNALS FROM KEYBOARD
pulse
pressure
voltage
RANDOM VOLTAGE
keyboard
pulser
off
TRIGGER SOURCE
TOUCH ACTIVATED VOLTAGE SOURCE MODEL 218
output
PULSE
output
PRESSURE
in
PORTAMENTO
SLOPE
output
output
KEY VOLTAGE
octave
none
preset
SHIFT
output
PRESET VOLTAGE SOURCE

PC 11

through a complete understanding of the relationship between the control and the controlled. In a performance situation the performer usually does not have the time to trace through a patch in order to figure out how to increase timbral range or shorten voltage cycles; he must be able to react immediately to implement various on-going decisions about the nature of the instrument. The player of a conventional acoustical instrument learns a set of predefined relationships. The performer on the Music Easel has the option of defining and modifying such relationships in terms of his own musical needs.

Meta-programming

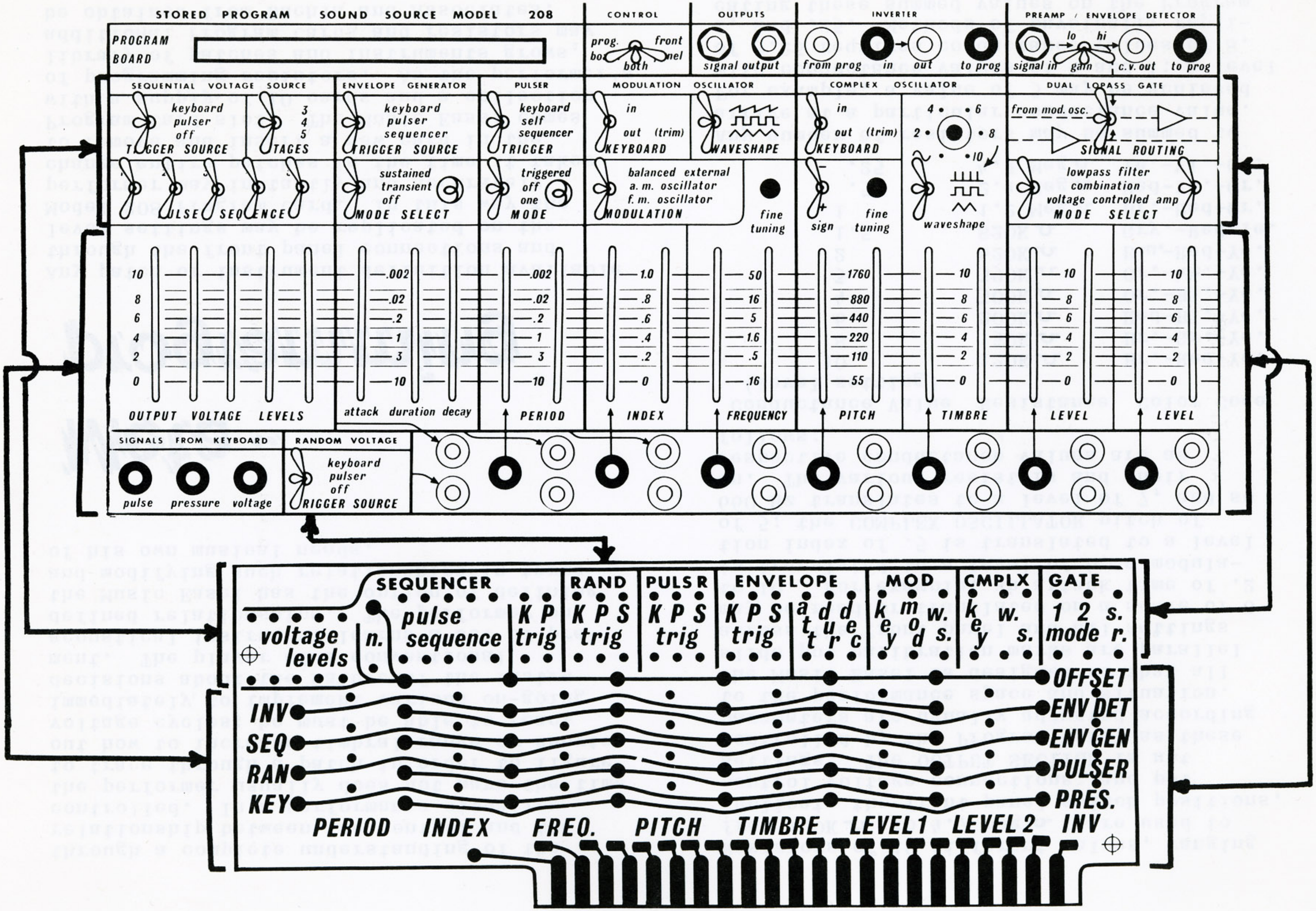
Any patch or instrument definition available through the front panel connections and level settings may be replicated on the Model 208 Program Card. In this way the performer may instantly and accurately change entire patches in the time it takes to remove and insert a new card in the Program Card slot. The Music Easel comes with a supply of 10 cards and a collection of programming resistors. As the performer's library of patches and instruments grows, additional Program Cards and resistors may be obtained from Buchla and Associates.

Resistors of 10 different values, ranging from 120K Ω to 4.7 meg Ω, are used to replicate the front panel switch positions, control voltage connections, and pot settings. The OUTPUT SECTION is not controlled by the Program Card, as these parameters are usually adjusted according to the performance space and situation. The Music Easel is designed so that all slide pot calibration marks are parallel across the front panel and all settings may be read or translated on a scale of 0 to 10. For example, an attack time of .2 is translated to a level of 6; a modulation index of .5 is translated to a level of 5; the COMPLEX OSCILLATOR pitch of 660 Hz translates to a level of 7, and so on. The various resistors and their respective conductance values are as follows:

Conductance Value (level setting)	Resistance	Color Code
10	120K Ω	Br.-Red-Ye.
8	150K Ω	Br.-Gr.-Ye.
6	200K Ω	Red-Bl.-Ye.
4	300K Ω	Or.-Bl.-Ye.
3	390K Ω	Or.-Wh.-Ye.
2	620K Ω	Blu.-Red-Ye.
1.5	820K Ω	Gry.-Red-Ye.
1	1.2 Meg Ω	Br.-Red-Gr.
.5	2.4 Meg Ω	Red-Ye.-Gr.
.25	4.7 Meg Ω	Ye.-Vi.-Gr.

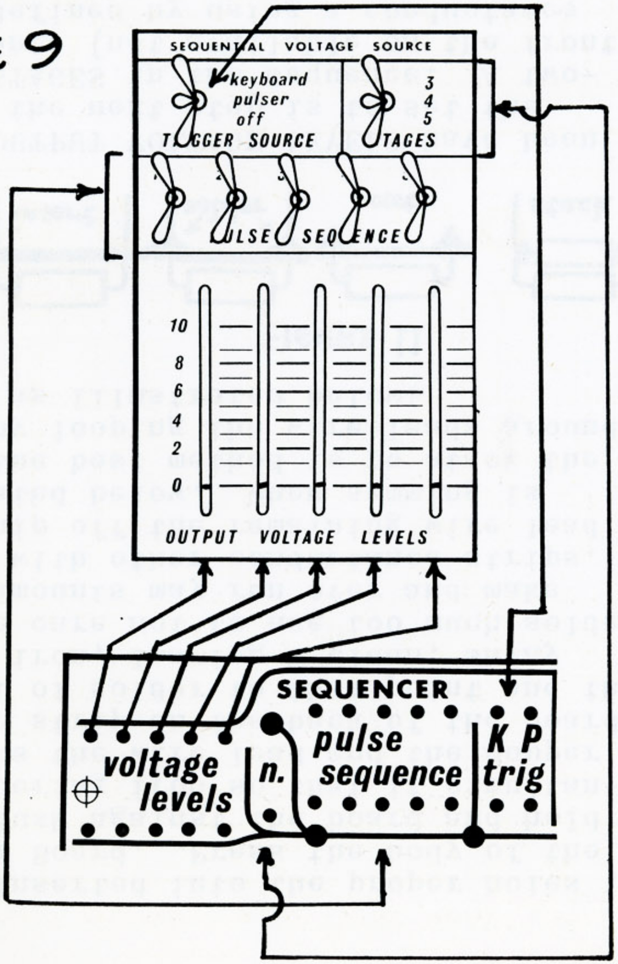
Any number of resistors may be summed to arrive at a particular conductance value. For example, a value of 5 may be achieved with conductance values of 4 and 1; a level of 9.25 requires conductance values of 8, 1, and .25. Methods of physically replicating these summed values on the Program Board will be discussed later. Trigger

FIGURE 8


STORED PROGRAM SOUND SOURCE MODEL 208
CONTROL
OUTPUTS
INVERTER
PREAMP / ENVELOPE DETECTOR
PROGRAM BOARD
signal output
from prog
in
out
to prog
signal in
lo
hi
gain
c.v. out
to prog
SEQUENTIAL VOLTAGE SOURCE
ENVELOPE GENERATOR
PULSER
MODULATION OSCILLATOR
COMPLEX OSCILLATOR
DUAL LOPASS GATE
keyboard
pulser
off
TRIGGER SOURCE
STAGES
sustained
transient
off
MODE SELECT
self
sequencer
TRIGGER
triggered
one
MODE
KEYBOARD
WAVESHAPE
balanced external
a. m. oscillator
f. m. oscillator
MODULATION
fine tuning
sign
waveshape
from mod. osc.
SIGNAL ROUTING
lowpass filter
combination
voltage controlled amp
PULSE SEQUENCE
OUTPUT VOLTAGE LEVELS
attack
duration
decay
PERIOD
INDEX
FREQUENCY
PITCH
TIMBRE
LEVEL
SIGNALS FROM KEYBOARD
pulse
pressure
voltage
RANDOM VOLTAGE
SEQUENCER
RAND
PULSR
ENVELOPE
MOD
CMPLX
GATE
voltage levels
n.
pulse sequence
K P trig
K P S trig
mode
OFFSET
ENV DET
ENV GEN
PULSER
PRES.
INV
INV
SEQ
RAN
KEY
PERIOD
INDEX
FREQ.
PITCH
TIMBRE
LEVEL 1
LEVEL 2

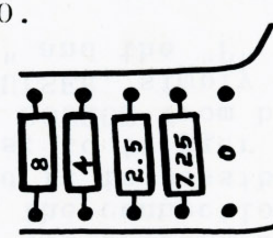
connections require conductance values of 3, and the switch positions are duplicated with values of 6, 3, and 0. (No resistor corresponds to the switches' lowest position.) The top portion of the card is concerned with trigger routing, switch positions, and sequencer programming; the lower section is used to define the control voltage routing, offset and processing levels (see Figure 8).

FIGURE 9



Before complex patches are attempted each one of the programmable parameters should be thoroughly understood. Beginning at the far lefthand side of the card, the first device to be dealt with is the SEQUENTIAL VOLTAGE SOURCE. Figure 9 illustrates all of the SEQUENCER functions and their corresponding locations on the Program Card. The five OUTPUT VOLTAGE LEVELS are replicated by soldering resistors of the appropriate conductance values across each of the five sets of connection points. For example, suppose the voltage levels of 8, 4, 2.5, 7.25, and 0 were to be duplicated on the Program Card. One would simply insert the various resistors as shown in Figure 10.

FIGURE 10



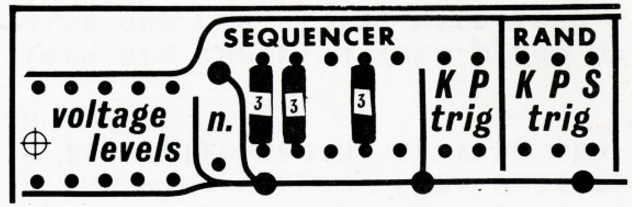
The values 8 and 4 are single resistors. A value of 2.5 may be achieved with either a 2 and .5 or with 1 and 1.5. In this case the values are summed by inserting both resistors in parallel across the common connection as illustrated. A value of 7.25 may be obtained by summing 6, 1, and .25 in the same manner. The voltage level of 0 is replicated by leaving the connection open.

The resistors are inserted into place by first bending one end of the wire lead at a 90° angle with a pair of needle-nose pliers. Measure and similarly bend the other end of the wire so both leads may easily be inserted into the proper holes in the Program Board. Press the body of the resistor flush against the board and hold a heated soldering iron so that it simultaneously heats the wire lead and the copper conductance strip on the back of the board. Apply a bit of solder to that point and then remove the iron, leaving a clean, shiny weld. Take care not to use too much solder, as excess amounts may run over and make connection with other conductance strips. Finally, snip off the remaining wire lead as illustrated below. When summing is necessary the best method is to stack the resistors by looping the wire leads around each other as illustrated below.

FIGURE 11

After all OUTPUT VOLTAGE LEVELS have been replicated the next step is to set the number of STAGES in the sequence. A two-stage sequence (not available on the front panel) is defined by using a conductance value of 10 across the connection marked "N." A three-stage sequence uses a conductance of 6, four stages - 3, and five stages - 0 (no resistor). The settings of the PULSE SEQUENCE switches are duplicated by soldering conductance values of 3 across the appropriate connections. If the PULSE switch positions were to be "on-on-off-on-off," the Program Card would appear as in Figure 12. A value of 3 replicates an "on" position and no resistor replicates an "off" position. Trigger interconnections are established with conductance values of 3.

FIGURE 12



If the SEQUENTIAL VOLTAGE SOURCE is to be triggered by the KEYBOARD, solder a 3 across the "K" connection. If the trigger is to come from the PULSER, solder the resistor across the "P" connection. The "off" position for the TRIGGER SOURCE is defined by leaving the connection open. On the Program Card it is possible to sum the trigger sources; to trigger the SEQUENTIAL TRIGGER SOURCE from both the KEYBOARD and the PULSER, simply solder 3's across both the "K" and the "P" connections.

The next two functions, the RANDOM VOLTAGE and PULSER triggers, are defined in the same manner with conductance values of 3. The Program Board also provides for triggering the RANDOM VOLTAGE SOURCE by the SEQUENCER pulses (the "S" connection), a mode not available on the front panel.

The ENVELOPE GENERATOR requires definition of the TRIGGER SOURCE and the attack, duration, and decay parameters. The three time functions must be translated into their respective conductance values by tracing the pot settings over to the far left numerical indications associated with the SEQUENCER'S OUTPUT VOLTAGE LEVELS. Consequently, .002 becomes 10, 1 SEC. = 4, 10 SEC. = 0, etc. The TRIGGER SOURCE is defined in much the same way as before, except that in this case the conductance value of the resistor also serves to define the mode. A value of 3 across the TRIGGER SOURCE connection defines the 'transient' mode. If a value of 10 is used to make the connection it establishes the 'sustained' mode.

The three switch selectable functions for the MODULATION OSCILLATOR are programmed at the next location on the card. The first connection, marked "key," replicates the position of the KEYBOARD switch; a conductance of 6 for the "in" position and 0 for the "out" position. The "mod" connection determines the type of modulation, with a conductance of 6 for "balanced external," 3 for "a.m. oscillator," and 0 for "f.m. oscillator." The "W.S." connection defines the waveshape of the MODULATION OSCILLATOR with 6, 3, and 0 programming sawtooth, square, and triangle, respectively.

The COMPLEX OSCILLATOR is programmed in much the same way. The "key" connection replicates the position of the KEYBOARD switch, 3 = "in," 0 = "out." The two "W.S." connections define waveshape. The center connection replicates the WAVESHAPE pot position, using corresponding conductance values of 0 to 10. The right connection refers to the WAVESHAPE switch position with spike, square, and sine defined by the respective values of 6, 3, and 0.

The top right section of the Program Card defines MODE SELECT and SIGNAL ROUTING for the DUAL LOPASS GATE. The mode connections for Gates 1 and 2 use conductance values of 10, 3, and 0 for "lowpass," "combination," and "voltage controlled amp." The SIGNAL ROUTING switch position is replicated with the same format -- a value of 6 across the "S.R." connection causes Gate 2 to receive its input from the PREAMP. A value of 3 connects it with the MODULATION OSCILLATOR and a value of 0 connects the two gates in series.

Construction of the Program Card will be facilitated if the performer remembers this format: All analog voltage levels use conductances of 0 to 10; all triggers use 3 (the ENVELOPE GENERATOR "sustained" mode uses 10); all switch positions require values of 6, 3, and 0 (MODULATION OSCILLATOR "Key" = 6, COMPLEX OSCILLATOR "Key" = 3).

The lower portion of the Program Card provides for programming of control voltage routing and offset and processing levels. The layout of this part of the Program Card is a matrix with the inputs lying along the X axis and the outputs along the Y axis. A highlighted diagram of this layout is illustrated in Figure 13. A resistor of

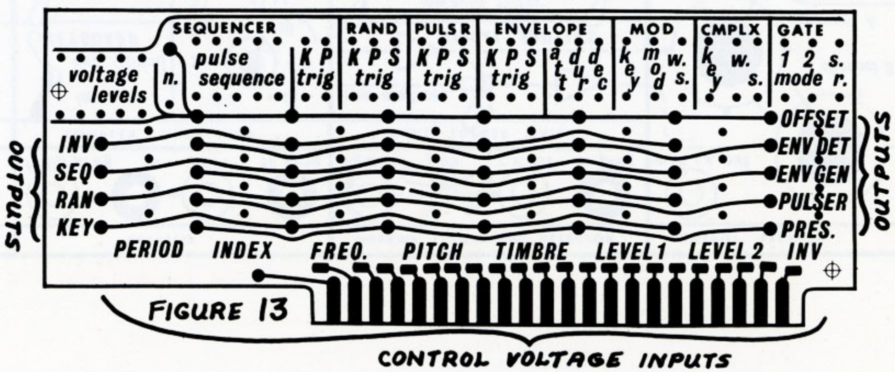
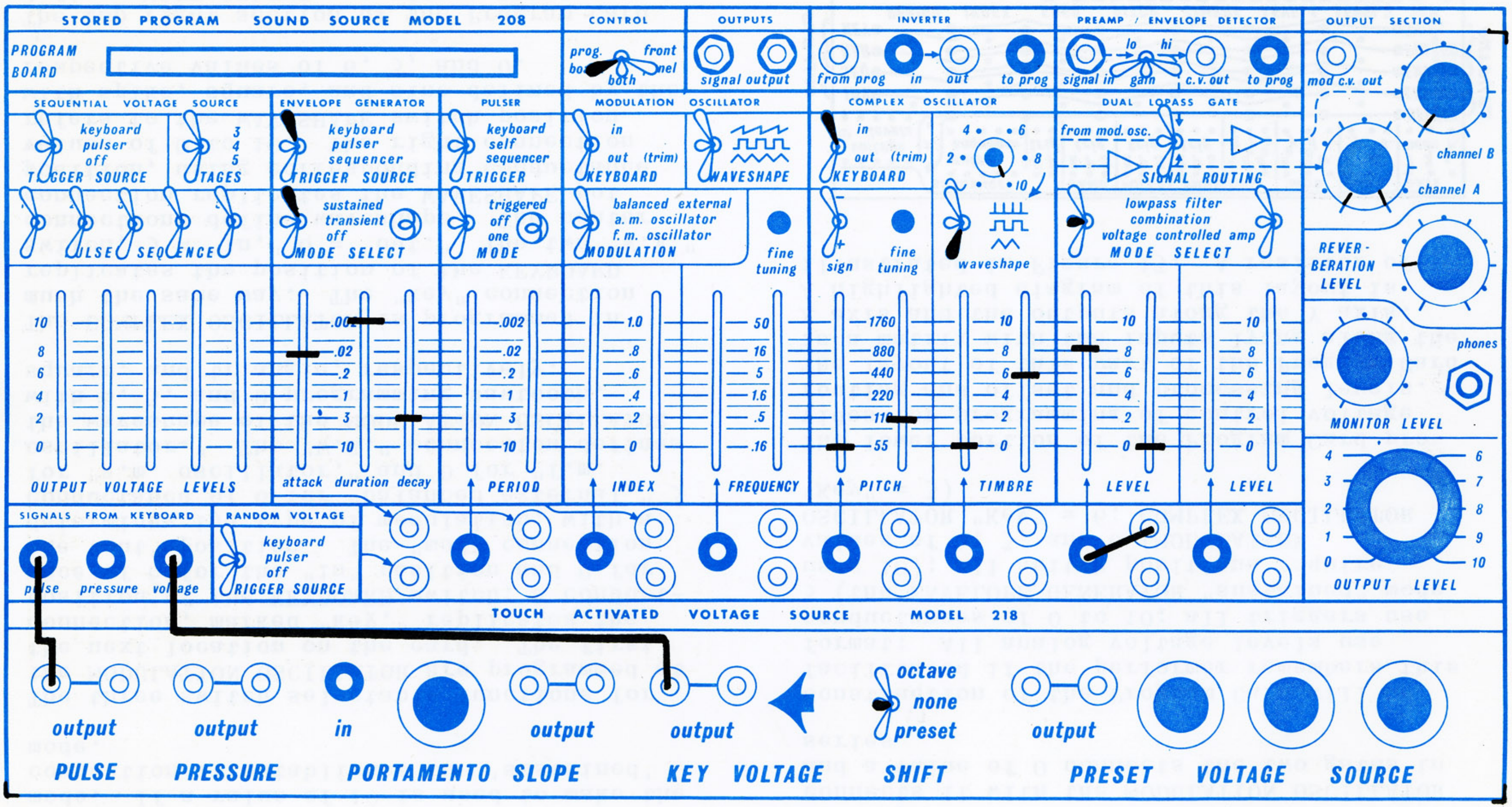


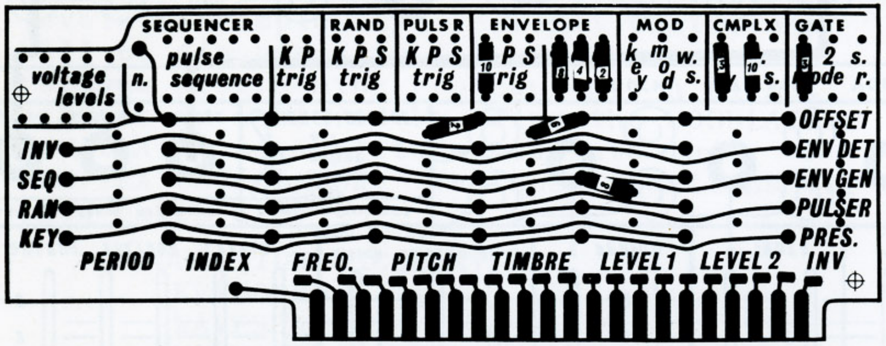
FIGURE 13


STORED PROGRAM SOUND SOURCE MODEL 208
CONTROL
OUTPUTS
INVERTER
PREAMP / ENVELOPE DETECTOR
OUTPUT SECTION
PROGRAM BOARD
prog. front panel both
signal output
from prog in out to prog
signal in lo hi gain c.v. out to prog
mod c.v. out
SEQUENTIAL VOLTAGE SOURCE
keyboard pulser off
TRIGGER SOURCE
3 4 5
STAGES
PULSE SEQUENCE
ENVELOPE GENERATOR
keyboard pulser sequencer
TRIGGER SOURCE
sustained transient off
MODE SELECT
PULSER
keyboard self sequencer
TRIGGER
triggered off one
MODE
MODULATION OSCILLATOR
in out (trim)
KEYBOARD
WAVESHAPE
balanced external a. m. oscillator f. m. oscillator
MODULATION
fine tuning
COMPLEX OSCILLATOR
in out (trim)
KEYBOARD
2 4 6 8 10
sign
fine tuning
waveshape
DUAL LOPASS GATE
from mod. osc.
SIGNAL ROUTING
lowpass filter combination voltage controlled amp
MODE SELECT
channel B
channel A
REVERBERATION LEVEL
phones
MONITOR LEVEL
10 8 6 4 2 0
OUTPUT VOLTAGE LEVELS
.002 .02 .2 1 3 10
attack duration decay
PERIOD
1.0 .8 .6 .4 .2 0
INDEX
50 16 5 1.6 .5 .16
FREQUENCY
1760 880 440 220 110 55
PITCH
TIMBRE
LEVEL
LEVEL
0 1 2 3 4 6 7 8 9 10
OUTPUT LEVEL
SIGNALS FROM KEYBOARD
pulse pressure voltage
RANDOM VOLTAGE
keyboard pulser off
TRIGGER SOURCE
TOUCH ACTIVATED VOLTAGE SOURCE MODEL 218
output output in output output
octave none preset
output
PULSE PRESSURE PORTAMENTO SLOPE KEY VOLTAGE SHIFT PRESET VOLTAGE SOURCE

PC 18

the desired value across any input and output thus functions both as the connection and the level setting. As before, all level settings must be translated to the 0-10 scale and then replicated with resistors of the corresponding conductance value.

FIGURE 14



At this point the programming will best be illustrated by working through a hypothetical patch and discussing its realization on the Program Card. Patch-chart 18 illustrates a simple performance instrument; its Program Card realization appears in Figure 14. There is no special sequence required in setting up the Program Card. The performer, however, may wish to standardize his approach until he is thoroughly familiar with the procedures involved. The sequence to be followed in this manual is to set all triggers and switch positions before dealing with control voltage programming. Beginning with the ENVELOPE GENERATOR, the KEYBOARD trigger in 'sustained' mode is programmed with a conductance value of 10 across the "K" connection as illustrated. If 'transient' mode should be desired, use a conductance value of 3 across the same connection. Tracing the three temporal parameters out to the left side of the front panel, the translations will read, Attack (.02) = 8, Duration (.002) = 10, and Decay (3) = 2. Resistors with these values are then soldered across the appropriate connections. As the COMPLEX OSCILLATOR is to be controlled by the KEYBOARD, replicate the 'keyboard' switch position ('in') with a value of 3 across the 'key' connection as illustrated. The COMPLEX OSCILLATOR is offset to the desired frequency by inserting the corresponding resistor between the horizontal OFFSET line and the PITCH input. Since the oscillator is programmed to receive voltages from the KEYBOARD, no further processing is required. The WAVESHAPE pot position requires a value of 10, and the WAVESHAPE switch position ( ) is replicated by a value of 0. The MODE SELECT for Gate 1 ('combination') requires a value of 3. The TIMBRE offset is specified as 6, and this is programmed by a conductance value of 6 between the OFFSET line and the TIMBRE input on the card. The control voltage from the ENVELOPE GENERATOR is replicated with a connection between the horizontal ENV GEN axis (the ENVELOPE GENERATOR'S output voltage) and the vertical LEVEL 1 axis (Gate 1 control voltage input). Since this processing level has been specified as '8,' be sure to use that particular conductance value resistor for this connection. The offset has been specified as '0,' so no other programming resistor is needed. The final stage of programming simply involves switching the CONTROL selector to 'prog board' and inserting the card into the STORED PROGRAM

SOUND SOURCE. Any deviations in tuning reference may be adjusted with the 'fine tuning' pot, as this control is not affected by the Program Card. The last step is to adjust the OUTPUT SECTION to accommodate the environment.

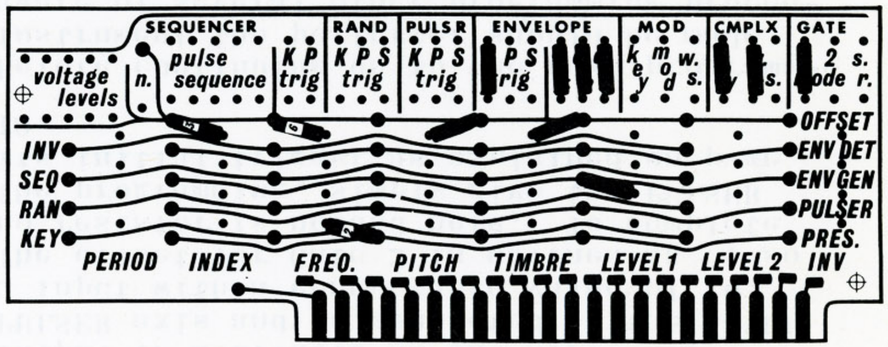
The simple patch used for the previous example may be expanded to define various levels of complexity. Several variations will be discussed to illustrate further various programming procedures. A slight vibrato is achieved by using the MODULATION OSCILLATOR to amplitude modulate the COMPLEX OSCILLATOR. The specifications for this patch are:

MODULATION OSCILLATOR
- KEYBOARD: 'out'
- WAVESHAPE: 'triangle'
- MODULATION: 'a.m. oscillator'
- INDEX offset: .3
- FREQUENCY: 5 Hz

Variations in attack transients may be achieved by using the KEYBOARD PRESSURE voltage as an additional control for either index or modulation frequency. This example will use frequency as the transient variable with the MODULATION OSCILLATOR'S processing input at about .5. The modified patch, as it appears at this point, is illustrated in Patch-chart 19.

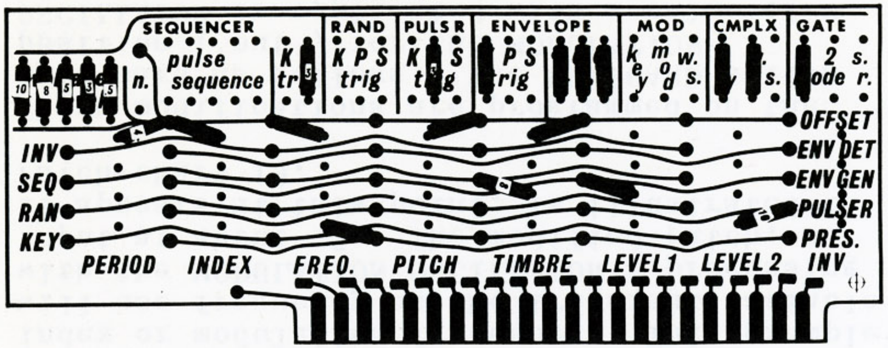
These modifications are programmed on the same card as follows: The KEYBOARD switch position ('out') for the MODULATION OSCILLATOR is replicated with a value of 0 for the "key" connection. WAVESHAPE ( ) is programmed with a value of 0 for the "W.S." connection. MODULATION ('a.m. oscillator') is programmed with no resistor across the "W.S." connection. The INDEX offset is specified as .3, which translates to a conductance value of 3. This is defined on the board by connecting a conductance value of 3 between the horizontal OFFSET line and the vertical INDEX input as illustrated in Figure 15. The specified FREQUENCY offset (5 Hz) requires a conductance of 6 soldered between the OFFSET and FREQ connections. Since KEYBOARD PRESSURE voltage is to affect the frequency with a processing value of 2, solder a conductance value of 2 between the horizontal PRES output and one of the unused FREQ inputs as illustrated.

FIGURE 15



Further modifications of this patch might involve simulated echo with timbre variations on each "echo." The Program Card for this effect is illustrated in Figure 16. The "echo" is achieved by connecting the DUAL LOPASS GATE in series, so the enveloped signal from Gate 1 is routed through Gate 2. For the simulated echo to be effective, turn down mix level 'channel A' so the gates are truly in series. Gate 2, in 'voltage controlled

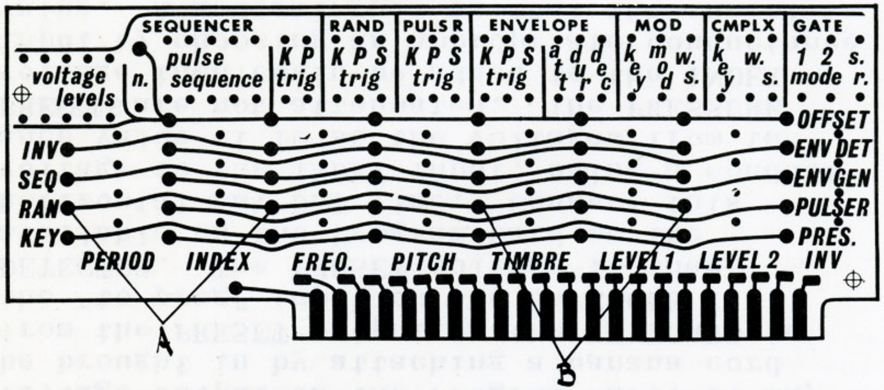
FIGURE 16



'amp' mode, receives its control voltage from the PULSER'S ramp output, the echo rate is defined by the Period, which may be adjusted to the performer's needs. In this example the Period is specified as one second, which translates to a conductance value of 4. The variations in timbre will be determined by the SEQUENCER OUTPUT VOLTAGE LEVELS of 10, 8, 5, 3, and .5, acting as controls for the COMPLEX OSCILLATOR'S Timbre input with a processing setting of 8. The SEQUENCER will be triggered by the PULSER, so that each "echo" calls up a successively different timbre. Beginning with the SEQUENTIAL VOLTAGE SOURCE, set the voltage levels with conductance values of 10, 8, 5, 3, and .5. A value of 5 requires a summing of 4 and 1. Define the number of stages as 5 with a value of 0 across the "N" connection. Since the SEQUENCER is not used as a source of triggers, it is unnecessary to program any pulse sequence. The SEQUENCER will be triggered by the PULSER, so replicate that switch position with a value of 3 across the "P" "trig" connection. The SEQUENCER'S voltage output, the horizontal SEQ line, is then connected to the TIMBRE input with a conductance value of 8 to replicate the specified control voltage processing level. The PULSER is to be self-triggering, so solder a conductance value of 3 across the PULSER "P" "trig" connection. The PULSER'S Period is established with a conductance value of 4 (Period of 1 sec.); solder this resistor between the horizontal OFFSET line and the PERIOD input. The PULSER'S ramp output is available at the horizontal PULSER axis and is connected to the LEVEL 2 input with a conductance value of 10. The offset for Gate 2 is defined as 0, so no resistor is needed here. To complete the programming, simply give the PULSER its initial trigger as explained on page 18.

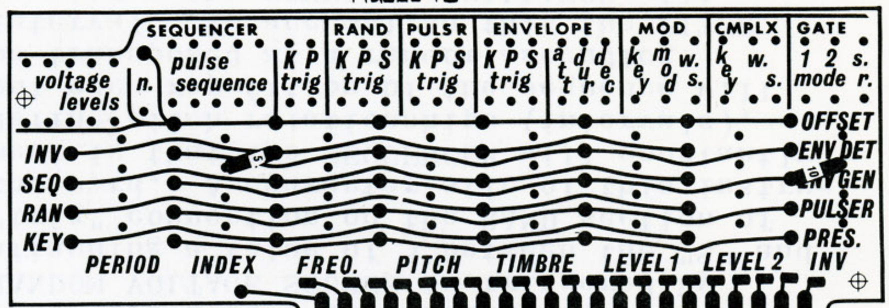
Before continuing on to the next programmed instrument the performer should be made aware of several other programming procedures. The front panel of the Music Easel provides four outputs of uncorrelated RANDOM VOLTAGE (refer to page 21). Two of these voltages are available on the Program Card as illustrated in Figure 17. These two voltage sources are identical to the two lefthand RANDOM VOLTAGE outputs on the front panel. If a third uncorrelated random voltage is needed on the Program Card it is possible to patch from one of the other RANDOM VOLTAGE outputs on the Patch Field to the "to prog" input on the INVERTER front panel. This patches the RANDOM VOLTAGE to what would normally be an inverted voltage source on the Program Card (INV). In this instance the actual inverting circuitry is not used, but its access jack to the Program Card is accommodating the additional random voltage. If a fourth random voltage is needed on the Program Card the same procedure may be applied to the ENVELOPE DETECTOR'S "to prog" input. The voltage is then available on the card from the ENV DET axis.

FIGURE 17



The programming of inverted voltages is done in the following manner: On the card attach a programming resistor from the desired horizontal output to the <u>vertical</u> INVERTER input (INV). The voltage is then available on the front panel INVERTER "from prog" jack. Using a jumper plug, patch this voltage into the INVERTER "in" jack. With a second jumper connect the "out" and "to prog" jacks together. The inverted voltage is then available on the <u>horizontal</u> INV axis on the Program Card. Figure 18 illustrates the card connections for inverted ENVELOPE GENERATOR voltage controlling modulation index. In most cases the programming resistor connecting the desired output to the INVERTER will be a conductance value of 10. Any voltage processing is then done after the inverting stage by using various conductance values as the connection between the INV output and the controlled parameter. By following this

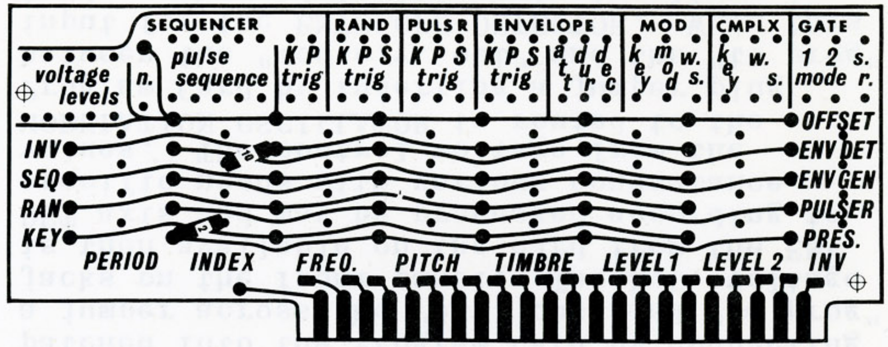
FIGURE 18



procedure the unattenuated inverted voltage is made available on the card to be processed according to the requirements of the individual controlled parameters. Routing the PREAMP signal to the output stage is accomplished by using a conductance value of 6 across the signal routing connection (S.R.) as previously described. The control voltages from the ENVELOPE DETECTOR are patched into the Program Card by connecting a jumper across the "c.v. out" and "to prog" jacks on the front panel. The D.C. voltage is then available on the card from the ENV DET axis and may be processed according to specific needs with various conductance values. The control voltage from the MODULATION OSCILLATOR is routed to the Program Card by inserting a jumper plug between the "mod c.v. out" and the "to prog" input for the ENVELOPE DETECTOR. When this is done the modulation control voltage is available on the card from the horizontal ENV DET strip.

The performer may find it useful to sum together several different control voltages into a single input. The obvious limitation of front panel patching is the availability of only one processing input for each parameter. The Program Card makes it possible to route several different control voltages to a single parameter. Since process levels are replicated by various conductance value resistors, each control voltage may be processed differently. For example, consider a situation in which modulation index is controlled by finger pressure; within the context of a performance one might like to instantly change the offset of the index. One possible solution would be to use the PRESET VOLTAGES to define the different references with pot settings of 9:00, 12:00, and 3:00. (These voltages actually act as offsets, so it would be advisable to have the INDEX offset at 0.) Since there is no preset voltage output on the Program Card, it may be brought in by attaching a banana cord from the PRESET output on the KEYBOARD to the "to prog" input on the ENVELOPE DETECTOR. The PRESET voltage is then available on the Program Card on the horizontal ENV DET line. Connect this voltage to the INDEX input, using a conductance value of 10 so the voltages from the PRESETS are not attenuated. The PRESSURE voltage then could be added to the INDEX input by choosing an appropriate conductance value. A general rule is that the sum of the acting conductance values connected to a particular input should not exceed a value of 10 -- above that point each parameter will become saturated. Since the highest value from the PRESETS is a conductance of about 7, any value of 3 or lower may be used for PRESSURE. The programming for this patch is illustrated in Figure 19.

FIGURE 19



Another interesting application of summing involves the use of the RANDOM VOLTAGE SOURCE and the SEQUENTIAL VOLTAGE SOURCE. On the Program Card it is possible to trigger the RANDOM VOLTAGE from the various SEQUENCER stages. This is done by defining the SEQUENCER'S pulse sequence with conductances of 3. If all five stages are to send triggers, attach the resistors across all five connections; if only stages 1, 3, and 4 are to send triggers, attach resistors across those connections. The RANDOM VOLTAGE SOURCE is triggered by attaching a value of 3 between the "S" and "trig" connection on the RAND section of the card. A characteristic of this instrument is that the SEQUENCER will constantly define pitch relationships (intervals), but each repetition of the sequence will be transposed at a random ascending interval. To accomplish this the PITCH input for the COMPLEX OSCILLATOR will receive controls from both the SEQUENCER and the RANDOM VOLTAGE SOURCE. The patch will be made so that a new random voltage is triggered only by the first stage of the SEQUENCER. The result will be that the pitch ratios produced by the defined sequence will remain constant. However, at the beginning of each sequence the random voltage level is changed (triggered by the first SEQUENCER stage) and therefore the sum of the control voltages will change. Programming for this portion of an instrument is illustrated in Figure 20.

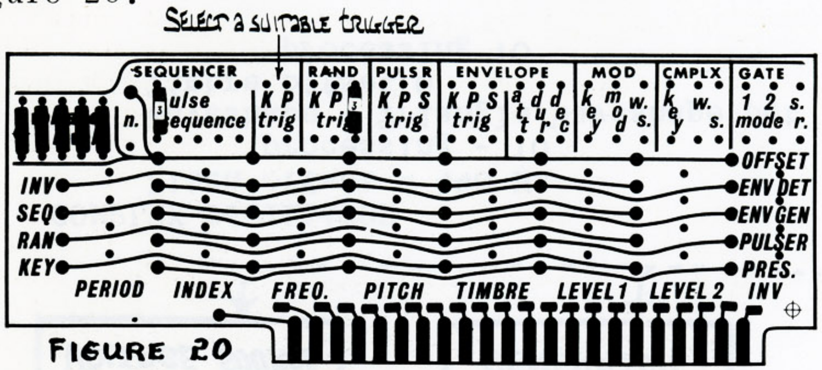


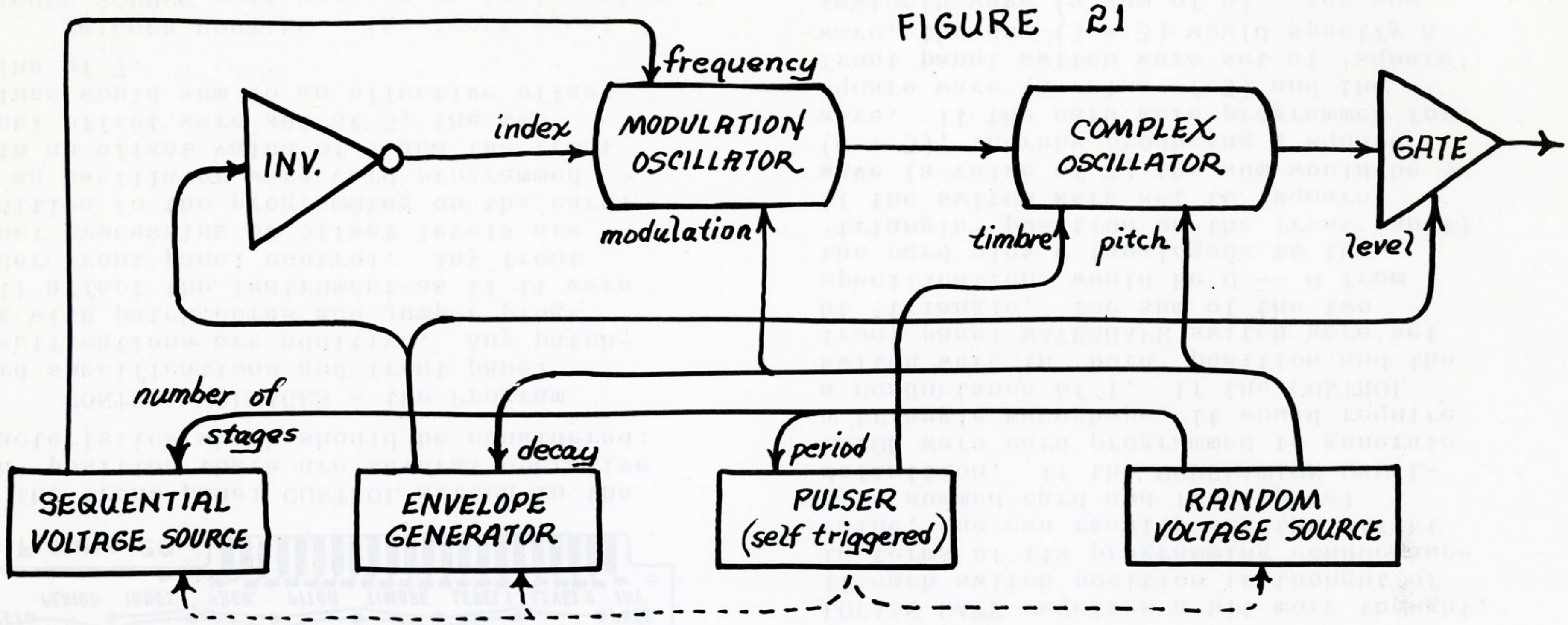
FIGURE 20

With the front panel CONTROL switch in the 'both' position there are several operative characteristics which should be considered:

CONTROL VOLTAGES - the Program Card specifications and front panel specifications are additive. Any patching with patch cords and jumper plugs will affect the instrument as if it were under front panel control. Any front panel processing or offset levels are additive to the programming on the card. If an oscillator were card programmed with an offset value of 4 and the front panel offset were set at 3, the two values would sum to an effective offset value of 7.

TRIGGER ROUTING - the front panel TRIGGER SOURCE switches can be implemented in addition to the card programming. For example, the card may be programmed to have the RANDOM VOLTAGE SOURCE triggered by the SEQUENCER. At the same time the RANDOM VOLTAGE SOURCE may receive triggers from either the KEYBOARD or the PULSER, according to the setting of the RANDOM VOLTAGE SOURCE Trigger switch position.

SWITCH POSITIONS - simultaneous card and front panel control of SEQUENCER stages, ENVELOPE GENERATOR Mode Select, PULSER Mode, MODULATION OSCILLATOR Waveshape and Modulation mode, COMPLEX OSCILLATOR Waveshape (switch) and Mode Select for the DUAL LOPASS GATE requires a bit more thought. If each switch position is thought of in terms of its programming conductance value, one can readily see the effect of a summed card and front panel definition. If the MODULATION OSCILLATOR were card programmed to generate a triangle waveshape, it would require a conductance of 1. If the CONTROL switch were in 'both' position and the front panel WAVESHAPE switch were set at 'triangle,' the sum of the two specifications would be 0 -- 0 from the card plus 0 (analogous to the 'triangle' position on the front panel). If the switch were set to 'square' wave (a value of 3) the sum would be 3 (0 + 3), thereby producing a square wave. If the card were programmed for square wave (a value of 3) and the front panel switch were set at 'square' wave, the sum (3 + 3) would specify a sawtooth wave (a sum of 6). Any sum



COMPLEX OSCILLATOR
    Pitch offset - 440 Hz
        processing - 10
    Waveshape - Triangle/Waveshape pot 10
    Timbre offset 0
        processing 10

MODULATION OSCILLATOR
    Frequency offset - 5 Hz
        processing 10
    Waveshape - Triangle
    Modulation - voltage controlled
    Index offset - .5
        processing - 10

PULSER
    Trigger - self
    Period offset - 2
        processing - 8

ENVELOPE GENERATOR
    Trigger - Pulser
    Attack - .002
    Duration - .002
    Decay - voltage controlled

SEQUENTIAL VOLTAGE SOURCE
    Trigger - Pulser
    Output Voltage Levels 0/4/2/6/10
    Stages - voltage controlled

RANDOM VOLTAGE SOURCE
    Trigger - Pulser

greater than 6 will just saturate the circuit and the effect will be a conductance of 6. This same logic applies to each switch. When applying this principle remember that the DUAL LOPASS GATE Mode conductances are values of 0, 3. and 10. Therefore, a card value of 3 ('combination' mode) and front panel selection of 'combination' mode sums to 6. This does not specify the 'lowpass filter' mode (conductance = 10), but, rather, a new type of combination mode has been programmed and it is certainly well worth investigation.

Certain controls are not affected by the Program Card, as they are usually adjusted to meet specific performance situations and environments. These controls include the PULSE Mode 'one' switch position (so that pulses may be initiated within a card-programmed instrument), oscillator 'fine tuning' controls (to adjust to various ensemble pitch references), and the entire OUTPUT SECTION (usually adjusted according to specific performance requirements).

The final example of programming to be done in this manual involves setting up a self-performing instrument which requires no input other than simply turning it on. This instrument is based on the use of random voltages so that it will never repeat a pattern. Figure 21 is a flowchart diagram of the instrument, illustrating the routing of the various triggers and controls. Since only two of the random voltage outputs are directly available on the Program Card, they will be referred to as RVS 1 and RVS 2. The first unusual characteristic of this instrument is that the number of SEQUENCER stages is voltage controlled. As explained on page 25, the number of stages are usually defined by using conductance values of 10, 6, 4, 3, and 0. Since conductance values are no more than analogs for control voltages, it is then possible to route any voltage into the input of a connection as a substitute for a resistor. Along the top portion of the card the inputs appear as the lower of each connection hole. Therefore, with the connection of a programming resistor between the RVS 1 output and the input for the selection of number of stages ("N") each new random voltage called up potentially defines a different number of stages -- a higher voltage producing a lesser number of stages. When employing this technique choose a conductance value that corresponds to the maximum variation desired on the controlled parameter. In this case a conductance of 3 would produce random 4 and 5-stage sequences, and a conductance of 10 would establish sequences of lengths 2 through 5. The SEQUENCER'S Output voltage levels have arbitrarily been set with values of 0, 4, 2, 6, and 10. The SEQUENCER is also programmed to receive triggers from the PULSER by connection of a "3" between "P" and "trig." The PULSER is a critical part of this instrument, as it generates the rhythmic basis for each event. A great deal of rhythmic variation can be programmed by controlling the PULSER'S Period by RVS 1 and, at the same time, by making a loop, triggering RVS 1 from the PULSER. The effect is that each random voltage defines a new period and at the end of each period the PULSER sends out a trigger, firing RVS 1. At the same time the PULSER triggers the ENVELOPE GENERATOR and RVS 2, and the PULSER'S ramp output controls the Timbre of the COMPLEX OSCILLATOR. A second unusual feature of this instrument is that the Decay time for the ENVELOPE GENERATOR is being controlled by a random voltage (RVS 2). Again, this is just a matter of using a voltage to drive an appropriate conductance value; the same technique may be applied to Attack and Duration if desired. The output of the ENVELOPE GENERATOR is connected to LEVEL 1, controlling Gate 1 set in Combination mode (conductance value of 3). The envelope is also routed through the INVERTER and then used to vary the INDEX of the MODULATION OSCILLATOR. Note also that the Modulation mode is also being determined by random voltages (RVS 2). Since the only two applicable Modulation modes for this instrument are A.M. and F.M. (no external signal is used), a conductance value of 5 will attenuate any higher voltages so that 'balanced external' will never be called up. The frequency of the MODULATION OSCILLATOR is determined by the voltages from the SEQUENCER. The Waveshape for the MODULATION OSCILLATOR is specified as 'triangle,' so no programming resistor is needed. The pitch of the COMPLEX OSCILLATOR is continually being changed by RVS 2 and, in this instrument, offset with a conductance value of 6. The Waveshape is specified as a setting of 4 (a conductance value of 4) in the 'triangle' wave position (a conductance value of 0). The various offset and processing values indicated in Figure 21 are arbitrary and may be adjusted to the desired parametric correlations of the instrument. To activate the instrument all that is left to do is give the PULSER its initial trigger. With the CONTROL switch in the "prog board" position the 'one' position on the PULSER is still active.

Design and programming of such 'auto-instruments' is a most interesting method of exploring the potentials of the Music Easel. In such designs one should also consider various degrees of human interaction, using the 'both' position of the CONTROL switch. As closing words for direction and exploration, "TRY EVERYTHING -- the least that can happen is that something will be learned."

Onward

To further communication among Music Easel owners and users, Buchla and Associates will publish a periodic newsletter called The Easel Weasel. This newsletter will contain advanced programming and performance techniques, new developments in related hardware, interesting patches and instrument definitions, concert dates, scores ... anything related to the Music Easel. We invite you to send us any material that you feel may be of interest -- scores for solo or ensemble Easels (perhaps including other instruments), patch charts, questions, answers, unusual applications, and so on. The Easel Weasel will be an open line of communication between you and other Music Easel owners. Send your contributions to:

The Easel Weasel
P.O. Box 5051
Berkeley, CA 94705

--- possesses and encompasses all other instruments of music - large and small however named - in itself alone. If you want to hear a drum, a trumpet, a trombone, cornetts, a recorder, flutes, pommers, shawms, a dolcian, racketts, sorduns, krummornes, violins, lyras, etc., you can have all these and many more unusual and charming things in this artful creation; so that, when you have and hear this instrument, you think not but that you have all the other instruments one amongst the other.

— Michael Praetorius, Syntagma Musicum II (De Organographia), 1619