A USERS GUIDE TO THE BUCHLA SYSTEM

Technology in Music and Related Arts Program

1974

ejm

UNIT 1 - GENERAL DESCRIPTION

1.1 PREREQUISITE

The user should have a working knowledge of:

a) The MIXER-MONITOR system

b) The TEKTRONIX OSCILLOSCOPE (SCOPE)

c) The FREQUENCY COUNTER (FC)

1.2 THE BUCHLA SYSTEM

This system is a collection of the 200 SERIES modules designed and constructed by Buchla Associates. The system has three physical levels. Each level is tilted at a different angle to the observer and contains several modules. The three levels, from bottom to top, will be referred to as level 1, level 2, and level 3.

1.3 CONNECTIONS BETWEEN MODULES

The modules are not internally connected. Connections between modules are made by using patch cords or double banana plugs. There are two types of double banana plugs, stacking and non-stacking.

1.31 Two types of patch cords are used:

a) One-connector cables terminating in banana plugs. Most of these are stacking patch cords. All are used to connect DC control voltage outputs to DC control voltage inputs and pulse inputs.

b) Two-connector cables terminating in miniature phone plugs (mini-phone). These are used for AC voltages.

1.32 There are three types of input/output jacks on the modules:

a) Red banana jacks which are inputs or outputs for (nominal) 15V trigger pulses.

b) Black banana jacks which are inputs or outputs for control voltages ranging from 0 to +15V.

c) Mini-phone jacks which are inputs or outputs for VAC. These can range from 0 to about 4V, peak-to-peak.

1.33 The system is designed so that an output will not inadvertantly be connected to the wrong type of input:

a) A pulse output (red banana jack) should be connected only to a pulse input (red banana jack).

b) A DC control voltage output (black banana jack) should be connected only to a DC control input (black banana jack).

c) An AC (signal) output (mini-phone jack) should be connected only to an AC (signal) input (mini-phone jack).

1.4 CONNECTIONS BETWEEN THE BUCHLA SYSTEM AND OTHER SYSTEMS

The three types of BUCHLA inputs/outputs can be connected to other synthesizing systems but voltages should not exceed the maximum for each system. These are:

ARP	VDC	-10V to +10V
	VAC	-5 to +5V, peak-to-peak and 0 to +10V, peak-to-peak
MOOG	VDC	-4V to +8V
	VAC	-1V to +1V, peak-to-peak

1.41 Connections between the BUCHLA and the ARP systems can be made without harm to either system.

1.42 Connections from either BUCHLA or ARP to the MOOG system should be made through an interface because it is possible to exceed the MOOG power supply voltages (-6 and +12 VDC) and thus damage the components.

1.5 MONITORING THE BUCHLA SYSTEM

The BUCHLA system does not contain power amplifiers and speakers. Audio signals can be monitored in four ways:

a) Connect an AC output (mini-phone jack) to an input in the monitoring system on the CENTRAL RACK (CR). This method requires a patch cord with a mini-phone plug on one end and a quarter inch phone plug on the other end.

b) Connect a stereo headset (having a stereo quarter inch phone plug) to one of the HEADSET outputs (quarter inch phone jacks) on the upper right side of level 1.

c) The OUTPUT AMPLIFIER (OA) outputs l (left) and r (right) are connected by cables at the back of the system to the CR. The output jack panel on the CR contains two (dual) jacks labelled "BUCHLA AMPS". Output jack "1" is BUCHLA OA l(left). Output jack "2" is BUCHLA OA r(right). Patch cords with quarter inch phone plugs can be used to connect these outputs to the MIXER-MONITOR system or any other inputs on the CR.

d) The QUAD LOCATOR outputs are connected by cables at the back of the system to the CR. The output jack panel on the CR contains four (dual) jacks labelled "1-NW", "2-NE", "3-SE", and "4-SW". Patch cords with quarter inch phone plugs can be used to connect these outputs to the MIXER-MONITOR system or any other inputs on the CR.

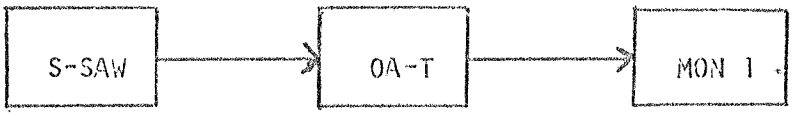
UNIT 2 - PRELIMINARY INFORMATION FOR MODULE DESCRIPTIONS AND EXERCISES

2.1 BLOCK DIAGRAMS

Abbreviated module names are used in the block diagrams. The abbreviations are given in parentheses after a module name. For example, see paragraph 1.1 (SCOPE and FC). All abbreviations are listed on page 3.

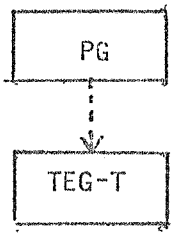
2.11 An AC (signal) output is indicated by an arrow extending away from the right side of a module. An AC input is always on the left side of a module:

S-SAW is the SINE-SAWTOOTH OSCILLATOR
OA-T is the OUTPUT AMPLIFIER, top section
MON 1 is MONITOR 1



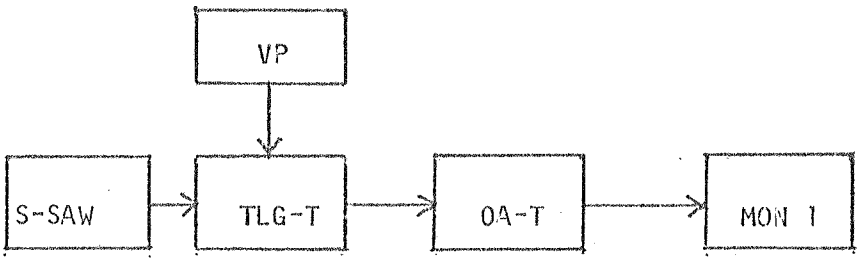
2.12 A pulse output is indicated by a dotted line arrow extending away from the bottom of a module. A pulse input is always on the top of a module:

PG is the PULSE GENERATOR
TEG-T is the TRIPLE ENVELOPE GENERATOR, top section



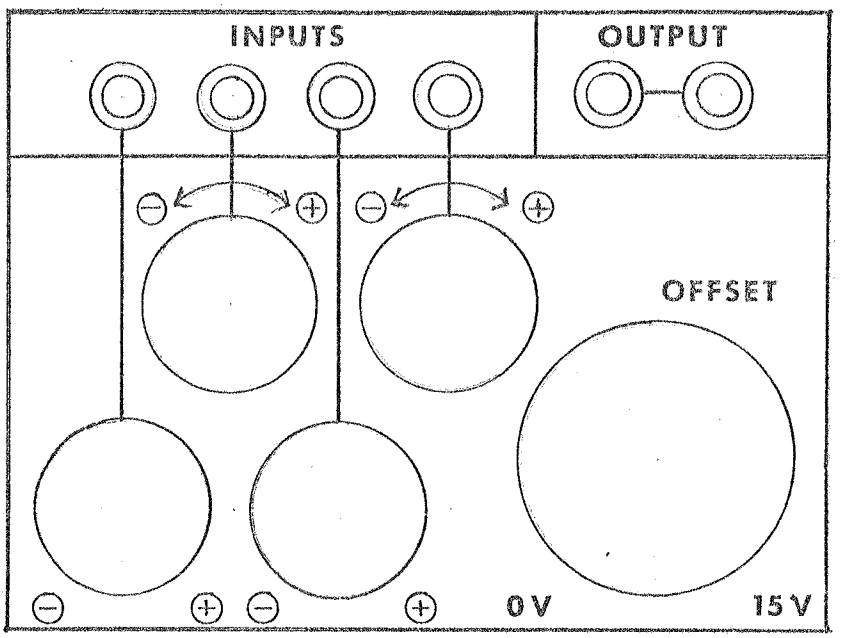
2.13 A DC control voltage output is indicated by an arrow extending away from the bottom of a module. A DC control voltage input is always on the top of a module:

VP is a VOLTAGE PROCESSOR
TLG-T is the TRIPLE LOPASS GATE, top section



2.2 DC CONTROL VOLTAGE SOURCE - VOLTAGE PROCESSOR (VP)

2.21 LOCATION - There are two VP modules located in the middle of level 3. Each looks like this:



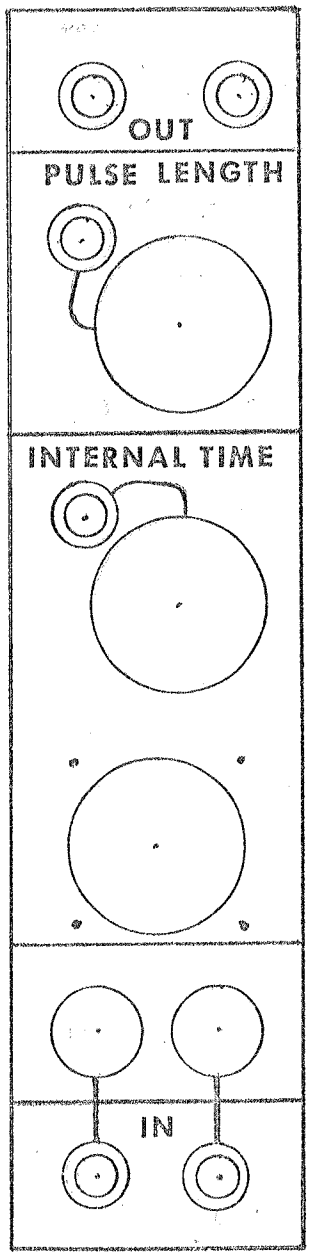
2.22 OFFSET CONTROL - Each VP has a large control knob labelled "offset." With no input, this control knob determines the amount of voltage to appear at the output. The extreme counter-clockwise position (labelled "0V") will cause 0 volts to appear at the output. The extreme clockwise position (labelled "15V") causes +15V to appear at the output.

2.23 OUTPUT - Each VP has two black banana jacks labelled "output." The connecting line indicates that the voltage at both jacks is identical.

2.24 PRELIMINARY FUNCTION - One VP will be used in some of the exercises in the USERS GUIDE.

2.3 PULSE SOURCE - PULSE GENERATOR (PG)

2.31 LOCATION - The PG is located on the extreme left side of level 2. It looks like this:



2.32 REFERENCE OUTPUT - The white banana jack labelled "ref" should not be used.

2.33 PULSE OUTPUT - The red banana jack labelled "pulse" emits a 15V trigger pulse immediately followed by a 7.5V pulse of varying length.

2.34 PULSE LENGTH, % OF PERIOD CONTROL - This control determines the "on time" (in relation to the frequency) of 7.5V appearing at the pulse output immediately after the 15V trigger. In other words, it determines pulse width or duty cycle. The pulse length (width, duty cycle) will affect other modules (such as the TRIPLE ENVELOPE GENERATOR in sustain mode) sensitive to pulse length.

2.35 INTERNAL TIME CONTROL - The lower internal time control knob varies the frequency of the pulse appearing at the output from 2 milliseconds (extreme counter-clockwise position) to 10 seconds (extreme clockwise position).

2.36 START SWITCH - The blue pushbutton switch over the red banana jack labelled "start" starts the PG.

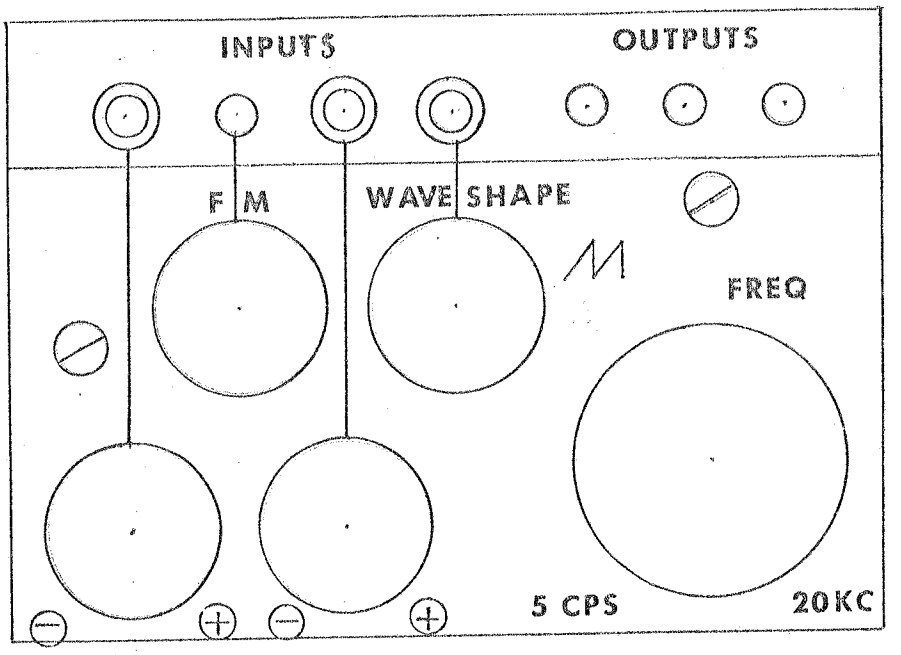
2.37 STOP SWITCH - The red pushbutton switch over the red banana jack labelled "stop" stops the PG. It also functions as a single pulse source. One push equals one pulse at the output.

2.38 PRELIMINARY FUNCTION - The PG will be used in some of the exercises in the USERS GUIDE.

2.39 A more detailed description will be given later.

UNIT 3 - OSCILLATORS

3.1 LOCATION - There are two oscillators in the system. The SINE-SAWTOOTH OSCILLATOR (S-SAW) is located at the upper left side of level 1. The SINE-SQUARE OSCILLATOR (S-SQ) is at the lower left side of level 1. Each oscillator looks like this:



3.2 FUNCTION - The two oscillators are identical in function except for the waveshape appearing at the outputs. Each oscillator provides an AC signal of programmable waveshape and frequency at its outputs. This VAC can be used both as an audio signal and a control signal for frequency modulation (FM).

3.3 SINE-SAWTOOTH OSCILLATOR (S-SAW)

3.31 INPUTS - The S-SAW has four input jacks. Each is connected (by a line) to a control knob that affects the influence of the input on the S-SAW. From left to right, the inputs can be described as follows:

a) Black banana jack. Receives control voltages from 0 to +15V. Influences frequency of S-SAW.

b) Mini-phone jack. Receives AC up to 4V, peak-to-peak. Influences frequency of S-SAW.

c) Black banana jack. Receives control voltages from 0 to +15V. Influences frequency of S-SAW.

d) Black banana jack. Receives control voltages from 0 to +15V. Influences waveshape of S-SAW.

3.32 OUTPUTS - The S-SAW has three mini-phone output jacks. These are internally connected and therefore equal in waveshape, frequency, and amplitude.

3.33 AMPLITUDE - There is no amplitude control on the S-SAW. The amplitude at the outputs is about 4V (peak-to-peak) regardless of frequency and waveshape.

3.34 WAVESHAPE - The waveshape is continuously variable from sine to sawtooth. It can be controlled in two ways:

a) A voltage is determined by the position of the (internal) waveshape control knob (labelled "waveshape"). The extreme counter-clockwise position is sine (0 volts). The extreme clockwise position is sawtooth (15V).

b) An external DC control voltage can be connected to the black banana jack input labelled "waveshape.

The two methods of controlling waveshape are additive. Therefore b) above is most effective when a) is in the sine position. When both methods are used simultaneously, the setting of the internal control knob acts as a "minimum" waveshape control.

3.35 FREQUENCY - The frequency can be controlled in three ways:

a) An (internal) voltage is determined by the position of the larger frequency control knob (labelled "freq"). This control is equivalent to a "center" frequency control and can be used for transposing external frequency controls.

With no external frequency controls, the extreme counter-clockwise position yields about 5 CPS and the extreme clockwise position about 20K CPS.

The smaller frequency control knob (with the screwdriver slot) is for fine tuning. It can vary the frequency by about 1/4 of an 8tave.

b) External, 0 to 15V control voltages can be connected to either or both of the black banana jack inputs to the left and to the right of the FM input jack.

The control knob associated with each of these inputs (connected by a line) determines oscillator sensitivity to the input voltage. The control knob is capable of compressing and inverting the input voltage.

The extreme clockwise position of a knob is for maximum, uninverted sensitivity. The input voltage will influence the S-SAW over its full frequency range if the larger internal frequency control knob is in the counter-clockwise position. The frequency increases as the input voltage increases.

The input voltage can be compressed by turning the sensitivity control knob counter-clockwise. This means that the sensitivity of the S-SAW to the input voltage is decreased and the frequency range is diminished. When the control knob is in the 12 o'clock position (facing the line), the input voltage will be completely compressed and have little or no effect on the frequency of the S-SAW.

The extreme counter-clockwise position of the sensitivity control knob yields manimum but inverted sensitivity. The input voltage will influence the S-SAW over its full frequency range if the larger internal frequency control knob is in the clockwise position. The frequency decreases as the input voltage increases.

The input voltage can be compressed by turning the sensitivity control knob clockwise toward the 12 o'clock position. A series of voltages applied to an input with the sensitivity control knob in a clockwise (+) position will yield a contour inversion if the sensitivity control knob is turned to a comparable counter-clockwise (-) position.

The control input on the left has (in addition to the larger sensitivity control knob) a smaller control knob (with a screwdriver slot) for fine tuning of sensitivity.

c) VAC can be connected to the FM mini-phone input jack. The control knob is for sensitivity. The extreme counter-clockwise position completely negates any influence of the input on the frequency of the S-SAW. Rotating the control knob clockwise will increase the sensitivity of the S-SAW to the FM input.

The three methods of frequency control described above are additive.

3.4 EXERCISE 1 - S-SAW, WAVESHAPE

3.41 Before patching:

a) Review paragraphs 2.2 through 2.24.

b) Set the input level control knob on MON 1 to about 2.

c) Set the offset control knob on the VP to 0V.

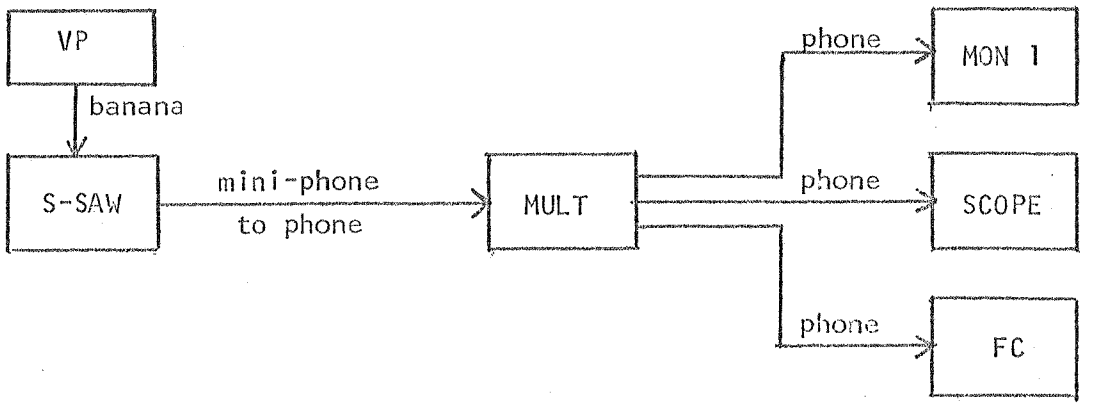
d) Set the waveshape control knob on the S-SAW to sine (extreme counter-clockwise position).

3.42 Patch:

a) Output of VP to waveshape input of S-SAW (banana).

b) Output of S-SAW to a MULTIPLE (MULT) on the CP (miniphone to phone).

c) MULT to MON 1, SCOPE, and FC (phones).



3.43 INTERNAL WAVESHAPE CONTROL - Using the two (internal) frequency control knobs, watch the FC and find a frequency close to A 440.

Slowly rotate the (internal) waveshape control knob. Listen to the sound and watch the SCOPE. This is the method of changing the waveshape by using the (internal) waveshape control knob.

Turn the waveshape control knob back to the sine position.

3.44 EXTERNAL WAVESHAPE CONTROL - Slowly rotate the offset control knob on the VP from 0V to 15V. Listen to the sound and watch the SCOPE. This is one method of changing the waveshape by using an external control voltage.

3.45 Simultaneously use internal and external controls. Listen to the sound and watch the SCOPE.

The operations above demonstrate methods of changing the waveshape on the S-SAW. When internal and external controls are used simultaneously (3.45 above), they are additive.

3.5 EXERCISE 2 - S-SAW, FREQUENCY

3.51 Before beginning:

a) Set the offset control on the VP to 0V.

b) Disconnect the banana plug from the waveshape control input on the S-SAW. Connect it to the control input to the left of the FM input jack.

c) Set the sensitivity control knob associated with the input you are using (connected by a line) to the 12 o'clock position (facing the line).

d) Set the small sensitivity control knob (with the screwdriver slot) on the left side of the S-SAW to about halfway between the extreme positions.

e) Set the waveshape control knob to the sawtooth position.

3.52 INTERNAL FREQUENCY CONTROLS - Turn the small frequency control knob (screwdriver slot) to the extreme counter-clockwise position.

Slowly rotate the large frequency control knob counter-clockwise. You should hear the pitch getting lower. When the large frequency control knob is in the extreme counter-clockwise position, you should hear about 5 beats per second.

Turn the small frequency control knob to the extreme clockwise position.

Slowly sweep the S-SAW through its range by turning the large frequency control knob to the extreme clockwise position. The FC should register about 20,000 CPS.

The operations above demonstrate the use of the internal frequency controls of the S-SAW to achieve the extremes of the range without using external controls. Lower and higher frequencies are possible by adding external controls.

3.53 Set the small frequency control knob to about halfway between its extreme positions.

Using the large frequency control knob, watch the FC and find a frequency close to A 440.

Rotate the small frequency control knob back and forth between its extreme positions. You should hear a difference of about 1/4 8tave.

The operations above demonstrate the use of the small internal frequency control knob.

3.54 EXTERNAL CONTROL VOLTAGES FOR FREQUENCY - Slowly rotate the offset control knob on the VP clockwise. If the frequency of the S-SAW changes, adjust the small sensitivity control knob (slightly to the right or left) so that any position of the offset control knob on the VP has no effect on the frequency of the S-SAW. In this condition, any amount of voltage into the left control voltage input will be completely compressed and have no influence on the frequency of the S-SAW.

3.55 Turn the offset control knob on the VP to the 15V position (the frequency of the S-SAW should not change).

Slowly rotate the sensitivity control knob (for the left control input of the S-SAW) to the extreme clockwise position. This increases the sensitivity of the S-SAW to the external control voltage. The frequency should sweep to 20K CPS or higher.

Slowly rotate the offset control knob on the VP counter-clockwise to the 0V position. As you do this, the S-SAW frequency will sweep down to the original frequency (about 440 CPS).

Repeat 3.51 c), 3.51 d) and 3.54.

Turn the offset control knob on the VP to the 15V position (the frequency of the S-SAW should not change).

Slowly rotate the sensitivity control knob (for the left control input of the S-SAW) to the extreme counter-clockwise position. As you do this, the frequency should decrease.

Slowly rotate the offset control knob on the VP from 15V to 0V. As you do this the frequency should increase until it reaches the original frequency (about 440 CPS). This demonstrates the inverted sensitivity of the S-SAW to an external control voltage. The lower the input voltage, the higher the frequency.

3.56 Using 12 o'clock + positions and 12 o'clock - positions of the sensitivity control knob and various positions of the offset control knob on the VP, rotate the small (screwdriver slot) control knob associated with the left control voltage voltage input to determine its influence on the frequency of the oscillator.

3.57 The other control voltage input (to the right of the FM input) and its sensitivity control knob function in the same manner as described in 3.55 above. There is no small sensitivity control for this input. Experiment with a control voltage to this input.

3.58 FM - FREQUENCY MODULATION - Before continuing:

a) Disconnect the banana patch cord from the VP to the control input on the S-SAW.

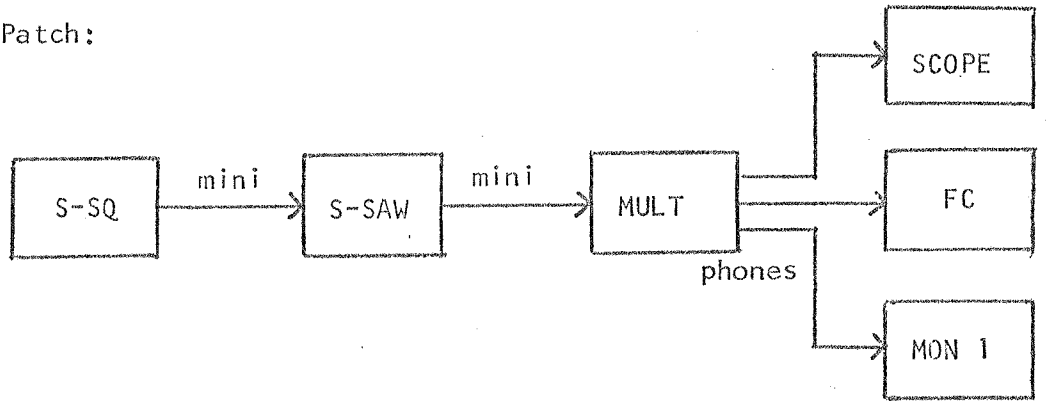
b) Turn both internal frequency control knobs on the SINE-SQUARE OSCILLATOR (S-SQ) to the extreme counter-clockwise position. The S-SQ is located just below the S-SAW.

c) Set the FM input sensitivity control knob on the S-SAW to the extreme counter-clockwise position.

d) Set the internal waveform control knob on the S-SAW to the sawtooth position.

e) Set the internal waveform control knob on the S-SQ to the sine position.

Patch:



Slowly rotate the FM input sensitivity control knob of the S-SAW clockwise. This demonstrates the increasing sensitivity of the S-SAW to an AC input, depending on the position of the FM input sensitivity control knob. The same effect may be achieved by turning the control clockwise and (externally) controlling the amplitude of the input signal.

3.59 Experiment with various positions of:

a) The internal frequency control knobs of the S-SQ.

b) The internal waveform control knob of the S-SQ.

c) The FM input sensitivity control knob of the S-SAW.

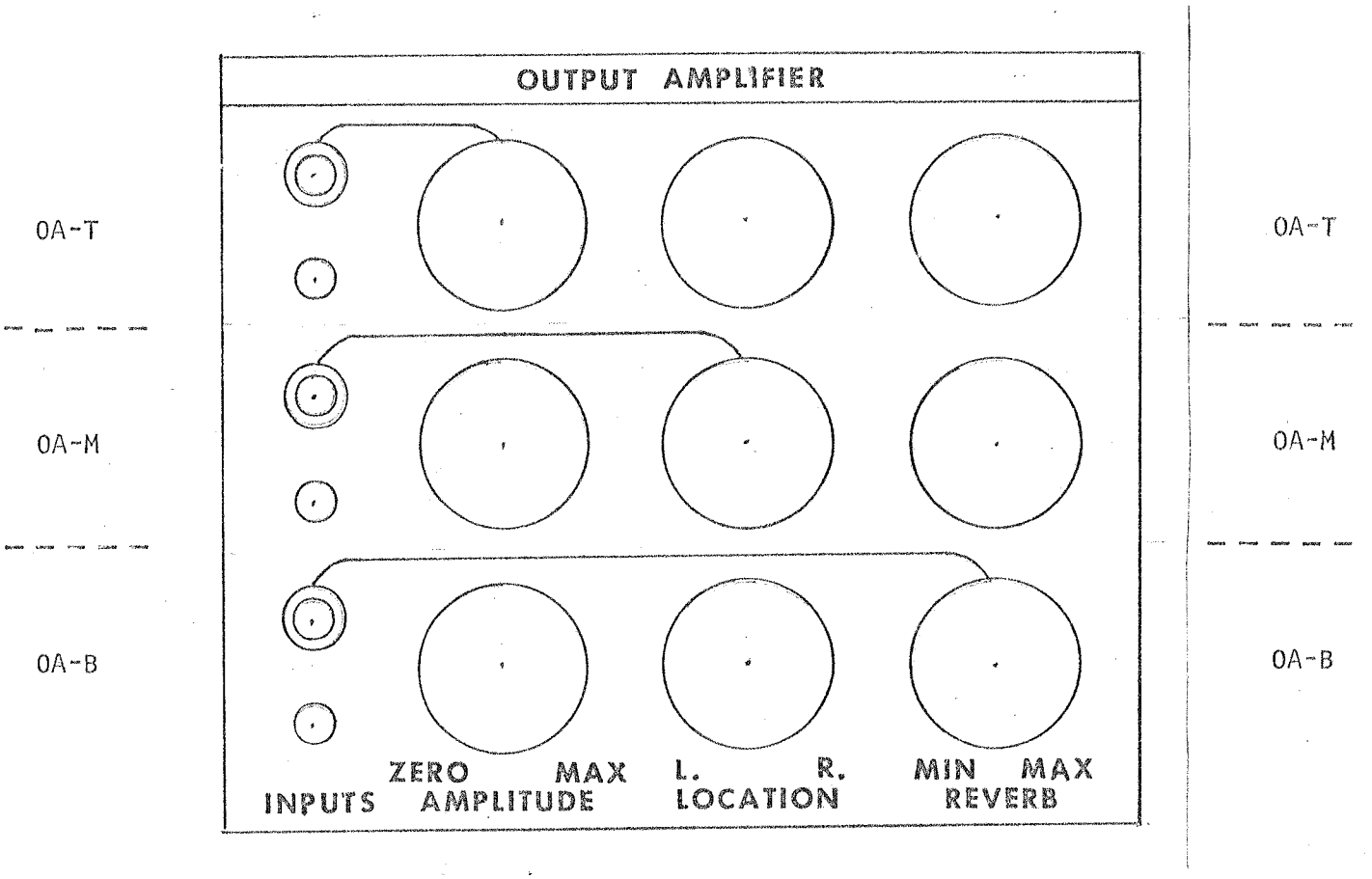
3.6 EXERCISE 3 - S-SQ, WAVESHAPE CONTROLS - Repeat 3.4 using the S-SQ instead of the S-SAW.

3.7 EXERCISE 4 - S-SQ, FREQUENCY CONTROLS - Repeat 3.5 using the S-SQ instead of the S-SAW. For 3.58 use the S-SAW for FM.

Remove all patch cords.

UNIT 4 - OUTPUT AMPLIFIER (OA)

4.1 LOCATION - The OUTPUT AMPLIFIER is located at the right side of level 1. Its three sections will be referred to as OA-T (T is the top section), OA-M (M is the middle section), and OA-B (B is the bottom section). Each section has, from left to right, a control input (black banana jack) with a signal input directly under it (mini-phone jack), an amplitude control knob, a location control knob, and a reverb control knob. The OUTPUT AMPLIFIER looks like this:



4.2 FUNCTION - The OA serves as a processor for as many as three signal inputs. The three areas of signal processing are: amplitude, location, and reverberation. The inputs and controls for each section function independently. The signal inputs are added at the outputs.

4.21 CONTROL VOLTAGE INPUTS - Each section has a control voltage input (black banana jack) which can control one of three functions: amplitude, location, or reverb when an external control voltage source is connected to it. The externally controllable function differs in each section of the OA as indicated by the connecting lines on the module.

4.22 SIGNAL INPUTS - Each section has an input (mini-phone jack) for an audio signal.

4.23 AMPLITUDE CONTROLS - Each section has a control knob that determines the signal level (of an input signal) to appear at the output(s). The extreme counter-clockwise position (labelled "zero") prevents an input signal from appearing at the output(s). Rotating the control knob clockwise increases the signal level at the output(s). The extreme clockwise position (labelled "max") results in maximum signal at the output(s). This level is roughly
to peak-to-peak.

4.231 The top section (0A-T) has a control voltage input (black banana jack) for amplitude. An external control voltage connected to this input will be added to the setting of the internal amplitude control knob. Thus, the external control is most effective when the internal control knob is on zero. The internal control knob can be used to set a minimum amplitude level.

4.232 When the internal control knob is on zero:

a) 0V to the control input results in no signal at the output(s),

b) +15V to the control input results in maximum signal at the output(s), and,

c) intermediate signal levels result from control voltages between 0V and +15V.

4.24 LOCATION CONTROLS - Each section has a control knob that determines the location of an input signal at the outputs. The extreme counter-clockwise position (lebelled "1") of a control knob causes the signal to appear at the left output. The extreme clockwise position causes the signal to appear at the right output. When the control knob is in the 12 o'clock position, the input signal is distributed equally into both outputs. Other positions result in unequal distribution of the input signal at the outputs.

4.241 The middle section (0A-M) has a control voltage input (black banana jack) for location. An external control voltage connected to this input will be added to the setting of the internal control knob for location. Thus, the external control is most effective when the internal control knob is on 1.

4.242 When the internal control knob is on 1:

a) 0V to the control input causes the signal to appear at the left output,

b) +15V to the control input causes the signal to appear at the right output,

c) +7.5V to the control input causes the signal to appear equally in both outputs, and

d) other voltages result in unequal distribution at the outputs.

4.25 REVERB CONTROLS - Each section has a control knob that determines the mixture of reverb and unreverbed signal to appear at the output(s). The extreme counter-clockwise position of a control (labelled "min") causes the unreverbed input signal to appear at the output(s). The extreme clockwise position (labelled "max") causes the fully reverbed input signal to appear at the output(s). Other positions result in various mixtures of reverbed and unreverbed signal to appear at the output(s).

4.251 The bottom section (0A-B) has a control voltage input (black banana jack) for reverb. An external control voltage connected to this input will be added to the setting of the internal reverb control knob. Thus, the external control is most effective when the internal control knob is on min.

4.252 When the internal control knob is on min:

a) 0V to the control input results in no reverb.

b) +15V to the control input results in maximum reverb, and

c) other voltages result in various amounts of reverberation.

4.26 OUTPUTS - The 0A has two outputs, left and right.

4.261 PHONE JACKS - The outputs are connected to the phone jacks on the back of the system. These have been connected to the lowest jack panel on the CENTRAL RACK. There they are labelled "Buchla Amps 1 and 2." Both jacks labelled "1" are connected to the left output. Both jacks labelled "2" are connected to the right output.

4.262 HEADSET OUTPUTS - In addition to the outputs on the CR, the outputs are connected to the stereo phone jacks for headsets. These are located on the upper right side of level 1.

4.3 EXERCISE 5 - OUTPUT AMPLIFIER, AMPLITUDE

4.31 Before patching:

a) Set the large frequency control knob on the S-SAW to about midrange.

b) Set the waveshape control knob on the S-SAW to sawtooth.

c) Set the offset control knob on VOLTAGE PROCESSOR to 0V.

d) Set the amplitude control knobs of the three sections of the 0A to zero.

e) Set the location control knobs of the three sections of the 0A to 1 (left).

f) Set the reverb control knobs of the three sections of the 0A to min.

g) Set the MON 1 and MON 2 input level controls to about 2.

h) Locate the two PARALLELED CONNECTORS at the lower right side of level 2. Each of these is a 1-in, 4-out multiple. Either may be used for the OA exercises.

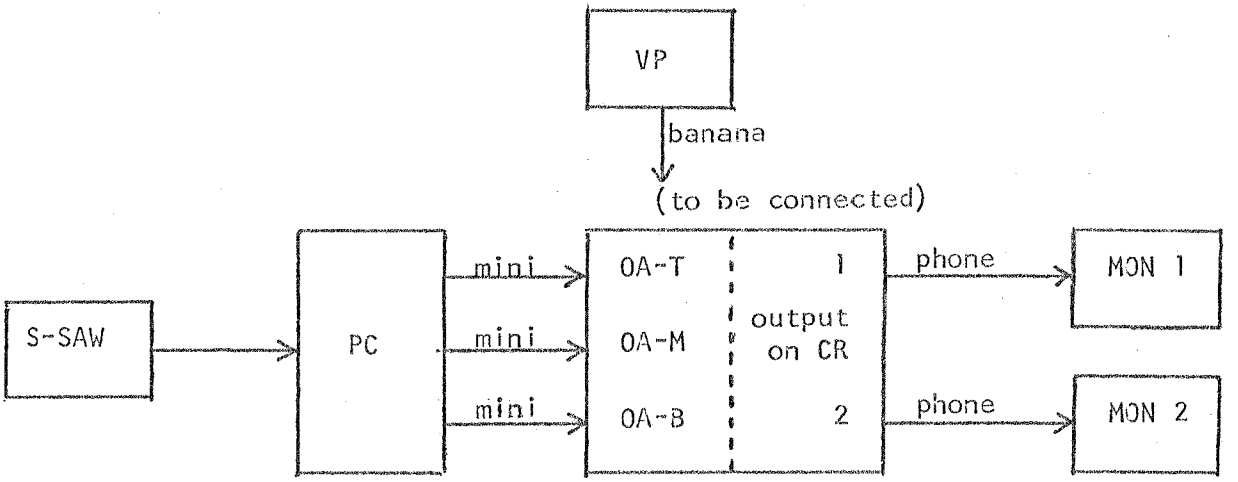
4.32 Patch:

a) Output of S-SAW to one of the PARALLEL CONNECTORS (PC) (mini-phone).

b) Three outputs of the PC to the three signal inputs (one in each section) of the OA (three mini-phones).

c) Output of the VP to nothing (banana). Other end to be connected later.

d) OA outputs on the CENTRAL RACK to MON 1 and MON 2 auxiliary inputs. Buchla Amp 1 (left) to MON 1. Buchla Amp 2 (right) to MON 2. Both with phones.



4.33 INTERNAL AMPLITUDE CONTROL - Slowly rotate the OA-T amplitude control knob clockwise to the max position. The signal should now emanate from MON 1. Adjust the MON 1 input level control for more or less signal. Be sure that the MON 1 selector switch is on the aux position. Turn the OA-T amplitude control knob back to zero.

4.34 Perform similar operations using the OA-M amplitude control knob.

4.35 Perform similar operations using the OA-B amplitude control knob. Set all OA amplitude control knobs back to zero.

4.36 The operations above demonstrate the use of the internal amplitude controls of the three sections of the OA.

4.37 EXTERNAL AMPLITUDE CONTROL - As stated in 4.231 and 4.232, the control voltage input for OA-T is for amplitude control by an external voltage source. Connect the banana patch cord from the VP to the control input (black banana jack) of the OA-T.

Slowly rotate the offset control knob on the VP clockwise to the +15V position. The signal from MON 1 should increase as you do this. This demonstrates the effect of an external control voltage on the OA-T.

Turn the offset control knob on the VP back to 0V. Remove the banana patch cord from the control input of the OA-T.

4.4 EXERCISE 6 - OUTPUT AMPLIFIER, LOCATION

4.41 INTERNAL LOCATION CONTROL - Turn the amplitude control knob for OA-T to max. The signal should emanate from MON 1. Slowly rotate the OA-T location control knob clockwise to the r position. The signal should move from MON 1 to MON 2 as you do this. Adjust the MON 2 input level control for more or less signal. Turn the OA-T amplitude control knob back to zero. Turn the OA-T location control knob back to 1.

4.42 Perform similar operations using the OA-M amplitude and location control knobs.

4.43 Perform similar operations using the OA-B amplitude and location control knobs. Set all OA controls back to their original positions.

4.44 The operations above demonstrate the use of the internal location controls of the three sections of the OA.

4.45 EXTERNAL LOCATION CONTROL - As stated in 4.241 and 4.242, the control voltage input for OA-M is for location control by an external voltage source. Connect the banana patch cord from the VP to the control input (black banana jack) of the OA-M.

Turn the OA-M amplitude control knob to max. The signal should now emanate from MON 1. Slowly rotate the offset control knob on the VP clockwise to the +15V position. As you do this, the signal should move from MON 1 to MON 2. This demonstrates the effect of an external control voltage on the location of a signal in the OA-M.

Turn the offset control knob on the VP back to 0V. Remove the banana patch cord from the OA-M control input. Set all OA controls back to their original positions.

4.5 EXERCISE 7 - OUTPUT AMPLIFIER, REVERB

The decay time of a reverberated signal is most apparent when the signal can be abruptly terminated. Since this is not possible without using other modules, it will be necessary to sweep the large frequency control on the S-SAW in order to hear the effect of the OA reverb controls.

4.51 INTERNAL REVERB CONTROL - Turn the OA-T amplitude control knob to max. Sweep the S-SAW frequency control knob right and left in a siren-like fashion. There should be no noticable reverb. Set the OA-T reverb control knob to about midrange. Sweep the S-SAW frequency control right and left. As you do this, the mixture of reverbed and unreverbed signal should be audible. Set the OA-T reverb control knob to max. Sweep the S-SAW frequency control knob right and left. As you do this, the fully reverbed signal should be audible. Set all OA-T controls back to their original positions.

4.52 Perform similar operations using the OA-M amplitude and reverb control knobs.

4.53 Perform similar operations using the OA-B amplitude and reverb control knobs. Set all OA controls back to their original positions.

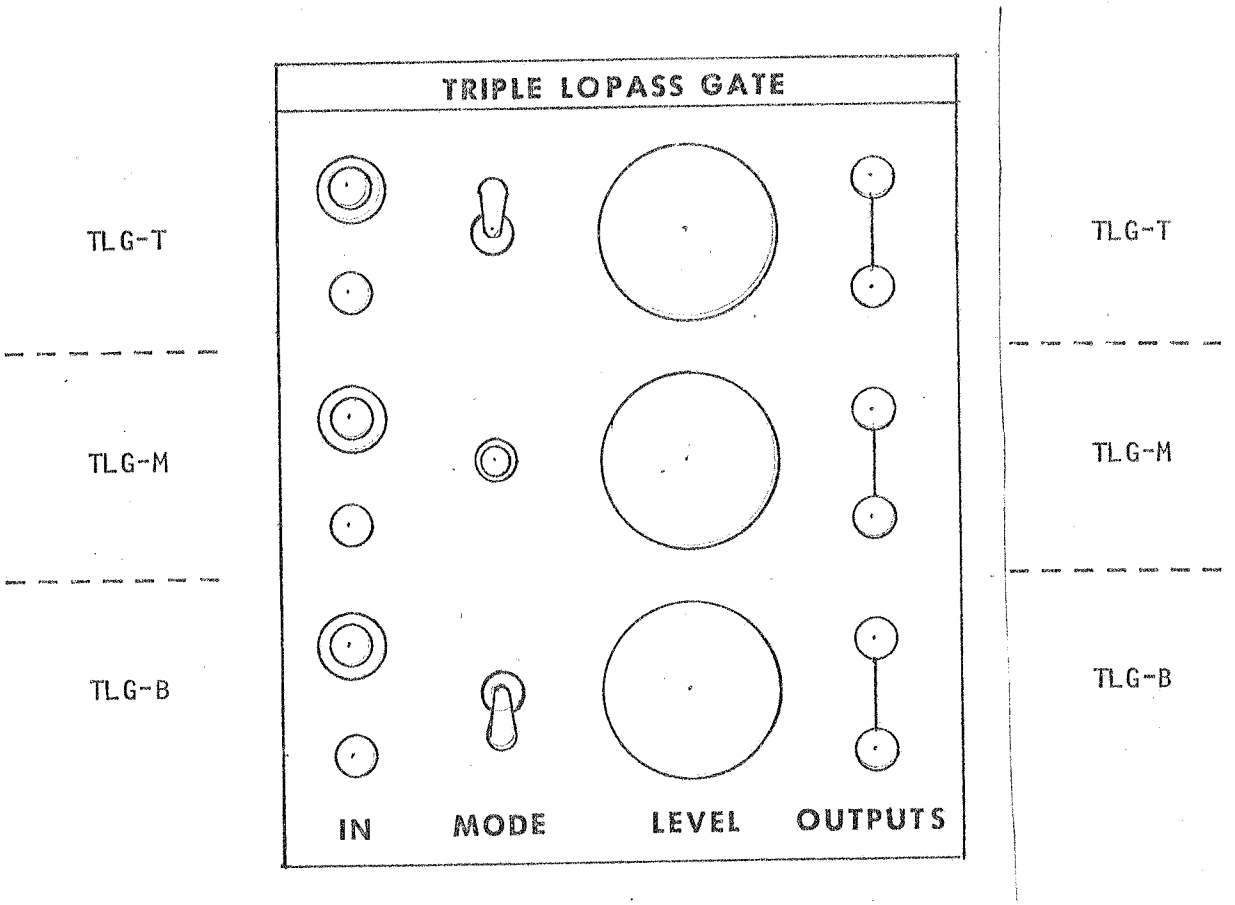
4.54 The operations above demonstrate the use of the internal reverb controls of the three sections of the OA.

4.55 EXTERNAL REVERB CONTROL - As stated in 4.251 and 4.252, the control voltage input for OA-B is for reverb control by an external voltage source. Connect the banana patch cord from the VP to the control input (black banana jack) of the OA-B.

Turn the OA-B amplitude control knob to max. Sweep the S-SAW frequency control knob. No reverb should be audible. Turn the VP offset control knob to about 7.5V (midrange). Sweep the S-SAW frequency control knob. The mixture of reverbed and unreverbed signal should be audible. Set the VP offset control knob to +15V. Sweep the S-SAW frequency control knob. The fully reverbed signal should be audible. This demonstrates the effect of an external control on the amount of reverb in the OA-B. Reset all controls. Remove all patch cords.

UNIT 5 - TRIPLE LOPASS GATE (TLG)

5.1 LOCATION - The TLG is located to the left of the OUTPUT AMPLIFIER on level 1. Its three sections will be referred to as TLG-T (top section), TLG-M (middle section), and TLG-B (bottom section). Each section has, from left to right, a control input (black banana jack) with a signal input directly under it (mini-phone jack), a three-position mode switch, a level control knob and two signal outputs (mini-phone jacks) connected by a line. The TLG looks like this:



5.2 FUNCTION - Each section of the TLG is capable of functioning independently in any one of three ways. These are:

a) a voltage-controlled amplifier,

b) a voltage-controlled lopass filter, and

c) a combined voltage-controlled amplifier and lopass filter.

5.21 CONTROL VOLTAGE INPUTS - Each section has a control voltage input (black banana jack) which, when connected to an external voltage source, can determine the signal level appearing at the outputs. The signal level appearing at the outputs of a section may result from that section functioning in any one of the three ways described in 5.2.

5.22 SIGNAL INPUTS - Each section has a mini-phone jack (directly under the control voltage input) for an input signal.

5.23 MODE SWITCHES - Each section has a three-position mode switch that determines the mode of operation (function) of that section. The three positions of a switch will be referred to as positions 1, 2, and 3 (respectively top, middle, and bottom positions).

5.231 LOPASS MODE - When a switch is in position 1, that section of the TLG will function as a voltage controlled lopass filter. The level of an input signal appearing at the outputs results from the width of the frequency band passing through the filter. The low end is constant. The high end is dependent on the amount of control voltage, either internal or external. The higher the voltage, the greater the bandwidth.

The timbre of an input signal rich in harmonics will be influenced by the filter. A relatively low control voltage (either internal or external) will result in something close to a sine at the outputs. A high control voltage will result in something close to the original signal at the outputs.

Since the low end of the filter is fixed, the effects described above will vary according to the frequency of the input signal.

5.232 VCA MODE - When a switch is in position 3, that section of the TLG will function as voltage-controlled amplifier. The internal and external voltage controls will only influence the level (and not the timbre) of an input signal appearing at the outputs. The higher the voltage, the higher the level.

5.233 MIXED MODE - When a switch is in position 2, that section of the TLG will function as a combined voltage-controlled lopass filter and voltage-controlled amplifier. The differences between positions 1 and 2 of a switch will be most apparent when the input signal is of relatively low frequency and the control voltage is not near either extreme (0V or 15V).

5.24 INTERNAL LEVEL CONTROLS - Each section has a control knob that can determine the level of an input signal appearing at the outputs. The counterclockwise position of a control knob (labelled "zero") results in no signal at the outputs. The clockwise position (labelled "max") results in full signal at the outputs. Other positions result in various signal levels at the outputs.

The setting of an internal level control knob of a section is always added to an external voltage control connected to that section. Thus, the internal control knob may be used to set a minimum signal level appearing at the outputs. An external control will have the greatest effect when the internal control knob for that section is on "zero."

5.25 OUTPUTS - Each section has two signal outputs (mini-phone) connected by a line. The line indicates that the jacks are internally connected and therefore equal.

5.3 EXERCISE 8 - TLG-T, VCA MODE

5.31 The exercises in unit 5 demonstrate the use of the top section of the TLG. The middle and bottom sections (TLG-M and TLG-B) function in precisely the same manner as the top section.

5.32 Before patching:

a) Set the waveshape control knob on the S-SAW to sawtooth.

b) Set the offset control knob on a VP to 0V.

c) Set the TLG-T level control knob to "zero."

d) Set the TLG-T mode switch to position 3.

e) Set the MON 1 input level control to about 3.

5.33 Patch:

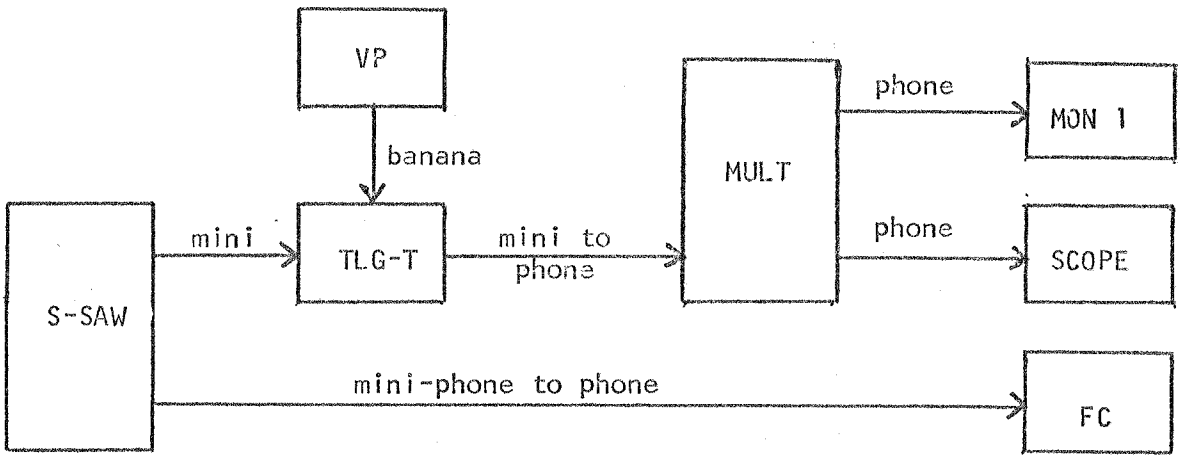
a) One output of the S-SAW to the FREQUENCY COUNTER (FC) (mini-phone to phone).

b) Another output of the S-SAW to the signal input of the TLG-T (mini-phone).

c) Output of the VP to the TLG-T control voltage input (banana).

d) One output of the TLG-T to a MULT on the CR (mini-phone to phone).

e) MULT to MON 1 aux input and MULT to SCOPE (phones).



5.34 After patching, watch the frequency counter and use the frequency controls on the S-SAW to get about 100 CPS.

5.35 INTERNAL LEVEL CONTROL - Slowly rotate the internal level control knob to "max." Adjust the MON 1 input level control for a reasonable maximum signal level. The waveshape should remain sawtooth. Turn the TLG-T internal level control back to "zero." There should be no signal emanating from MON 1.

5.36 EXTERNAL LEVEL CONTROL - Slowly rotate the VP offset control knob to 15V. As you do this the signal level should increase. The waveform should remain sawtooth. Turn the VP offset control knob back to 0V.

5.37 The operations above demonstrate the use of the TLG-T as a voltage-controlled amplifier (VCA MODE). Control voltages, either internal or external, will affect only the level and not the waveshape of an input signal appearing at the outputs.

5.4 EXERCISE 9 - TLG-T, LOPASS MODE

5.41 Set the TLG-T mode switch to position 3. This causes the TLG-T to function as a voltage-controlled lopass filter.

5.42 INTERNAL LEVEL CONTROL - Slowly rotate the TLG-T internal level control knob to "max." As you do this, the signal level should increase and the waveshape should change from sine to sawtooth. Turn the level control knob back to "zero."

5.43 EXTERNAL CONTROL - Slowly rotate the VP offset control knob to 15V. As you do this, the signal level should increase and the waveshape should change from sine to sawtooth. Turn the offset control knob back to 0V.

5.44 The operations above demonstrate the use of the TLG-T as a voltage-controlled lopass filter. Control voltages, either internal or external, will affect both the level and the timbre of an input signal appearing at the outputs.

5.5 EXERCISE 10 - TLG-T, MIXED MODE

5.51 Set the TLG-T mode switch to position 2. This causes the TLG-T to function as a combined voltage-controlled amplifier and voltage-controlled lopass filter.

5.52 INTERNAL LEVEL CONTROL - Perform 5.42 above.

5.53 EXTERNAL CONTROL - Perform 5.43 above.

5.54 Set the internal level control knob to about halfway between the extreme positions. Watching the SCOPE, put the mode switch in position 3 and then back to position 2. Observe the difference in effect between the two positions.

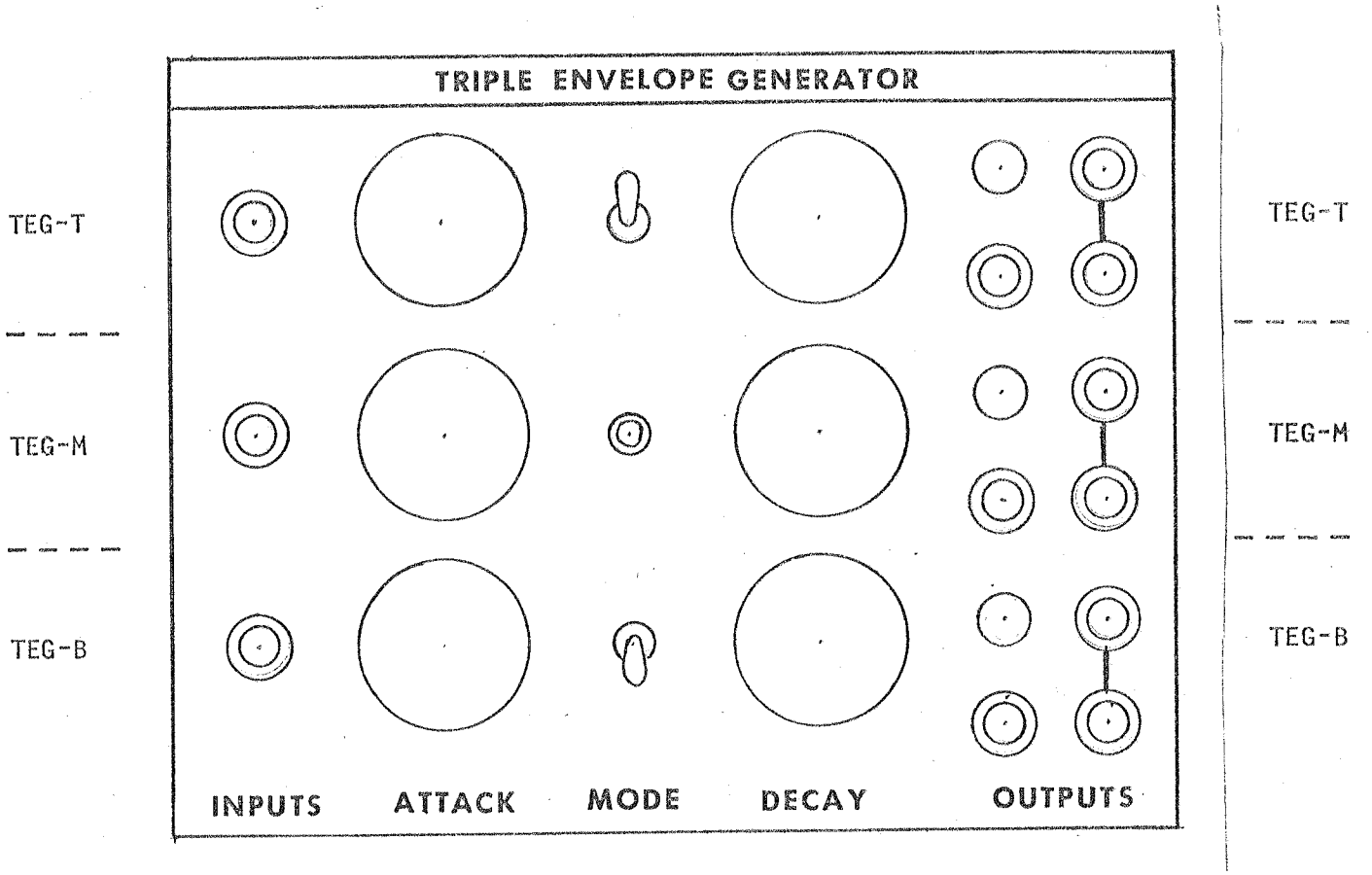
5.55 Perform similar operations using different settings of the internal level control knob and different frequencies on the S-SAW.

5.56 The operations above demonstrate the use of the TLG-T as a combined voltage-controlled amplifier and voltage-controlled lopass filter. 5.54 and 5.55 above demonstrate the difference between positions 2 and 3 of the mode switch.

5.6 TLG-M and TLG-B function in the same manner as TLG-T. The three sections of the TLG function independently.

UNIT 6 - TRIPLE ENVELOPE GENERATOR (TEG)

6.1 LOCATION - The TEG is located to the left of the TRIPLE LOPASS GATE on level 1. Its three sections will be referred to as TEG-T (top section), TEG-M (middle section), and TEG-B (bottom section). Each section has, from left to right, a pulse input (red banana jack), an attack control knob, a two-position mode switch, a decay control knob, an indicator lamp with a pulse output (red banana jack) directly beneath it, and two voltage outputs (black banana jacks) connected by a line. The TEG looks like this:



6.2 FUNCTION - The three sections are identical in function and are independent. Each section is capable of providing a control voltage (0 to +15) that can vary over a specified time period. When a section is activated by a pulse at its input, both of its outputs will emit a voltage envelope ("shape") that has been determined by its controls. The voltages can be applied to any module having a control voltage input. They are normally applied, however, to the TRIPLE LOPASS GATE in order to superimpose a dynamic envelope on an audio signal.

In addition, each section can emit a 15V trigger pulse at its pulse output. These may be applied to any module (including itself!) having a pulse input.

6.21 PULSE INPUTS - Each section has a pulse input (red banana jack). When a pulse is applied to an input, it initiates the envelope for that section. The pulse length can influence the envelope when the mode switch for that section is in the "sustain" (upper) position.

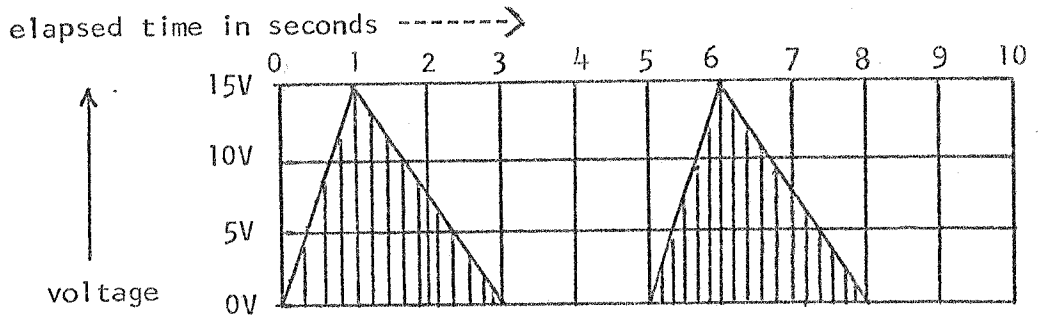
6.22 ATTACK CONTROLS - Each section has an attack control knob that determines the length of time it takes the output voltage to rise from 0 to +15. The attack always occurs at the beginning of an envelope. Attack times can be set anywhere in the range from 1 millisecond to 10 seconds.

6.23 DECAY CONTROLS - Each section has a decay control knob that determines the length of time it takes the output voltage to fall from +15 to 0. The decay always occurs at the end of an envelope. Decay times can be set anywhere in the range from 1 millisecond to 10 seconds.

6.24 MODE SWITCHES - Each section has a two-position mode switch that determines whether or not that section will be sensitive to pulse length. The upper position, labelled "sustain," is used to make a section sensitive to pulse length. The lower, or "transient" position (not lebelled on the module) is used to desensitize a section to pulse length.

6.241 TRANSIENT MODE - When the mode switch of a section is in the lower position, that section will respond in the transient mode. The envelope is initiated by a 15V trigger pulse at the section's pulse input but is not affected by the length of the pulse. The envelope consists of an attack and a decay. There is no steady state at maximum voltage.

For example; if a trigger pulse is applied to the pulse input once every five seconds, and the attack and decay controls are set respectively for one second and two seconds, the output voltage could be graphed as follows:



6.242 SUSTAIN MODE - When the mode switch of a section is in the upper position, that section will respond in the sustain mode. The envelope is initiated by a 15V trigger pulse at the section's input and is affected by the length of the pulse:

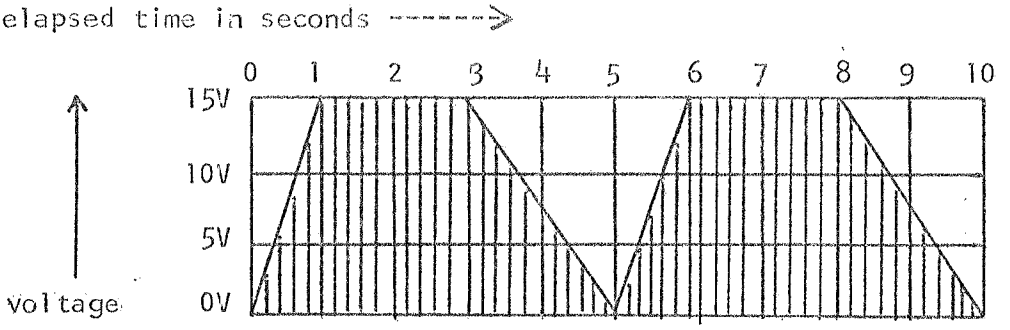
The attack time is subtracted from the pulse length.

The steady state at 15V is the remainder of the pulse length.

The decay starts when the pulse length drops to 0V.

For example; if a trigger pulse is applied to the pulse input once every five seconds, the pulse length is 60% of the period (three seconds), the attack control knob is set for one second, and the decay control knob is

set for two seconds, the output voltage could be graphed as follows:



6.25 INDICATOR LAMPS - Each section has a red indicator lamp. The brightness of a section's lamp is analogous to the amount of voltage appearing at that section's outputs.

6.26 PULSE OUTPUTS - Each section has a pulse output (red banana jack). When the output voltage of a section returns to 0V after the decay of an envelope, that section emits a 15V trigger pulse at its pulse output. This pulse may be applied to any module having a pulse input, including any section of the TEG.

6.27 VOLTAGE OUTPUTS - Each section has two voltage outputs (black banana jacks) connected by a line. The two outputs of a section are identical. The upper voltage output of each section is aligned so that a double banana plug may be used to connect it to the control voltage input of the TRIPLE LOPASS GATE.

6.3 EXERCISE 11 - TEG-T, TRANSIENT MODE

6.31 The exercises in unit 6 demonstrate the use of the top section of the TEG. The middle and bottom sections (TEG-M and TEG-B) function in precisely the same manner as the top section.

6.32 Review the introductory description of the PULSE GENERATOR (PG) in section 5.3 of this manual.

6.33 Before patching, set the controls on these modules:

PULSE GENERATOR(PG)

a) Pulse length control knob to 0% of period (extreme counter-clockwise position).

b) Lower internal time control knob to 10 (extreme clockwise position).

c) Push the stop switch once.

SINE-SAWTOOTH OSCILLATOR (S-SAW)

a) Set the large frequency control knob to about midrange.

b) Set the waveshape control knob to sawtooth.

TRIPLE ENVELOPE GENERATOR, top section (TEG-T)

a) Set the attack control knob to 1 millisecond (".001").

b) Set the mode switch to the transient (lower) position.

c) Set the decay control knob to 10.

TRIPLE LOPASS GATE, top section (TLG-T)

a) Set the internal level control knob to "zero."

b) Set the mode switch to VCA mode (position 3).

MONITOR 1 (MON 1)

Set the input level control to about 3.

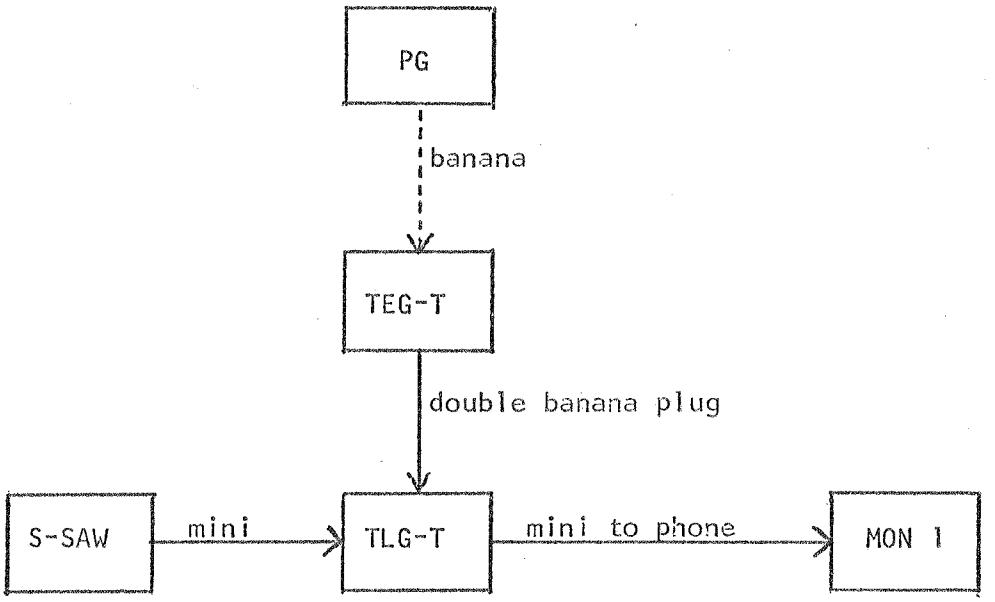
6.34 Patch:

a) PG pulse output (red banana jack) to TEG-T pulse input (red banana jack on the left) (banana).

b) TEG-T upper voltage output to TLG-T control voltage input (double banana plug).

c) S-SAW output to TLG-T signal input (mini).

d) TLG-T output (either one) to MON 1 aux input (mini to phone).



6.35 Give the stop control (red pushbutton switch) on the PG one push. This causes a single pulse to appear at its output. You should hear the signal with a dynamic shape as determined by the TEG-T attack and decay controls. Adjust the MON 1 input level control if necessary.

6.36 Perform similar operations using different settings of the TEG-T decay control knob. When finished, set the decay control knob to 1 millisecond (".001").

6.37 Perform similar operations using various settings of the TEG-T attack control knob.

6.38 Perform similar operations using various settings of both the attack and the decay controls.

6.39 The operations above demonstrate the use of the TEG-T voltage output to control the dynamic shape of a sound event when the TEG-T is in the transient mode. An envelope consists of an attack and a decay.

6.4 EXERCISE 12 - TEG-T, SUSTAIN MODE

6.41 PREPARATION:

a) Set the TEG-T attack and decay control knobs to .001.

b) Set the TEG-T mode switch to the sustain (upper) position.

c) Set the PG pulse length control knob to 50% of the period.

6.42 Give the start control (blue pushbutton switch) on the PG a push. Release quickly. The PG will now emit a pulse about once every 10 seconds. This will continue until the stop control is pushed.

You should hear the signal for about 5 seconds followed by about 5 seconds of silence. This pattern will repeat until the controls on the PG or the TEG-T are changed.

6.43 Experiment with various settings of the TEG-T attack and decay control knobs and the PG pulse length control knob.

6.44 The operations above demonstrate the use of the TEG-T voltage output to control the dynamic shape of a sound event when the TEG-T is in the sustain mode. An envelope consists of an attack, a steady state, and a decay.

6.5 EXERCISE 13 - TEG-T, PULSE OUTPUT

6.51 Before patching, set the controls on the PG, S-SAW, TEG-T, and TLG-T as described in section 6.33. In addition, set the controls on these modules:

SINE-SQUARE OSCILLATOR (S-SQ)

a) Set the large frequency control knob to about midrange.

b) Set the waveshape control knob to square.

TRIPLE ENVELOPE GENERATOR, middle section (TEG-M)

a) Set the attack control knob to ".001".

b) Set the mode switch to the transient position.

c) Set the decay control knob to 10.

TRIPLE LOPASS GATE, middle section (TLG-M)

a) Set the internal level control knob to "zero."

b) Set the mode switch to VCA mode.

MONITOR 2 (MON 2)

Set the input level control to about the same position as the control for MON 1.

6.52 Patch:

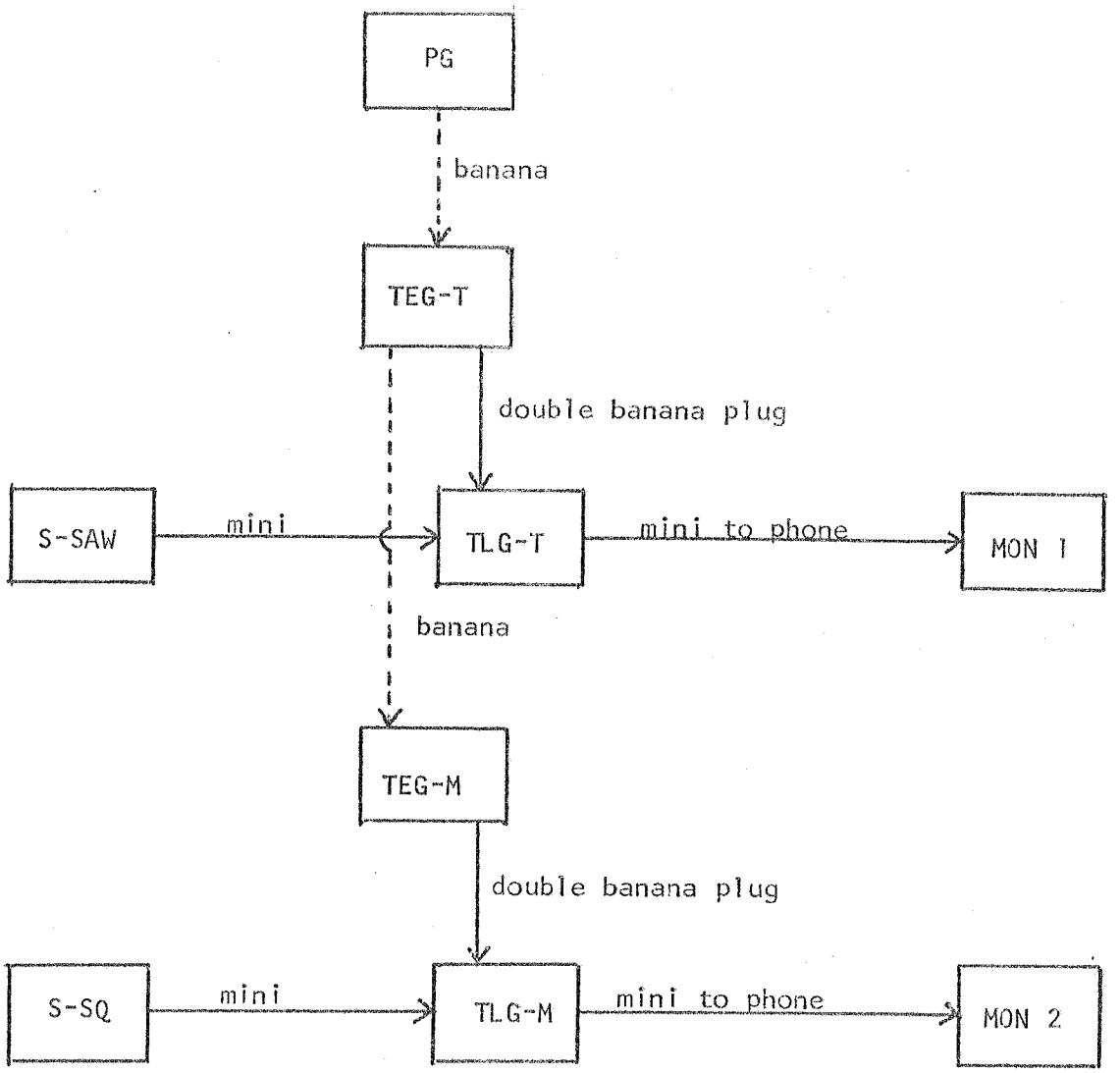
This is the same patch as described in section 6.34 with the following additions:

a) TEG-T pulse output to TEG-M pulse input (banana).

b) TEG-M upper voltage output to TLG-M control voltage input (double banana plug).

c) S-SQ output to TLG-M signal input (mini).

d) TLG-M output to MON 2 aux input (mini to phone).



6.53 Give the stop control on the PG one push. Release quickly. The S-SAW signal should emanate from MON 1. When the 10 second decay is complete, the S-SQ signal should emanate from MON 2. It should have a fast attack and a long decay (about 10 seconds).

6.54 Perform similar operations using various settings of the TEG-T and TEG-M attack and decay controls.

6.55 The operations described in EXERCISE 13 demonstrate the use of the TEG-T pulse output to initiate an envelope in TEG-M. The three TEG pulse outputs may be connected to any modules having pulse inputs.