CIRCUIT DESCRIPTION

SPV-355, on its main portion, is divided functionally into: 1) the FET-to-voltage conversion section and 2) the Synthesizer section. The former is further subdivided into these circuit groups:

1. Fundamental Detector
2. Time to Voltage (2/V) Converter
3. Logarithmic Converter
4. Gate Generator
5. Envelope generator

It is assumed that the reader has some knowledge on the synthesizers, and we would confine our devoted effort to those points alone that are particular to this SPV-355.

1. FUNDAMENTAL DETECTOR
   (refer to Block Diagram A)

Audio signals that are produced at some external musical instrument are partly fed to IC1b, IC1a for amplification, (the rest to direct out). They are then go through LPF (IC2b) to attenuate unwanted high frequency.

When INPUT SELECTOR switch is in WOOD/HARM MODE, there is one more stage of LPF (IC2a) that the signal has to go through. After LPF, the signals are fed to the AGC (IC1a, IC4 and Q6) where they are put to a constant voltage level at about 17.5Vp. (Diagram not shown)

- Voltage Controlled Low Pass Filter (VC-LPF) & High Pass Filter (VC-HPF) -

These two filters constitute a band pass filter. They extract from input signal a fundamental tone alone while suppressing all other unnecessary high harmonics and low noises, etc. (see fig. below)

- VC-LPF (IC4-IC7) -

They are all of the same type. The particular point here is that they are made to have such frequency response characteristic controllable so that the input signal falls always at 10dB down point on the slope of high frequency of its characteristic curve. (We will further discuss how the frequency response band can be swept in accordance with incoming signal frequencies in later section.)

This makes the passing signal amplitude reduced and it is now to about 1/3 of the input signal level, or to 57Vp at 400Hz. On its result, almost all high frequency components can be removed to leave only the fundamental remained.

2. TIME TO VOLTAGE CONVERTER
   (refer to Block Diagram B)

At the comparator (1011a) the fundamentals (a) are converted to rectangular waves (b). They then go through the pulse generators (J2x2) to generate pulses (c) and (d).

Between them, (d) lags behind (c) by about 4μs.

Voltage (e) increases in positive going direction at the rate determined by R3x1 time constant. It is reset and turned to 0V every time (b) is closed by (d). Here (d) synchronize with the input signals.

Jumpers in the interval (4μs) are becoming longer as the frequency goes higher. Accordingly, potential of (e) decreases as the input signal increases in frequency. (Diagram not shown)

Q2 is in the meantime, switched on by the pulse (c). During the interval between (c) and (d) (of 4μs), (e) is sampled out. The sampled voltage is almost the highest voltage level (e) has reached before it is reset to 0V by (d).

1011a on the stage next is a low-leak voltage follower. It outputs (f) in the same voltage level that was charged at Q2.
S3 is gated by (1), and conveys (f) to IO15b. The voltage variation here lags behind the variation in input signal due to the R2, C3 time-constant. More about these R2 and C3 discussion will be later.

To reduce detrimental effect results from this, S4 is provided to be closed by the pulse (g) which is generated on the trailing edge of the delayed GATE. It is to make the circuit equivalent as having R2 being shorted. In practice, (i), (j) occur exactly at the same time but with a little delay behind the trailing edge of GATE, as can be seen on the waveforms illustrated.

This is in order to eliminate unstable pitch in the initial part of the musical sound where also tended are other sounds to be included than its own during the transient. R2 and C3 are filter which smooth the undulating voltage in the same pitch in(f) output. The reason for the occurrence and its adverse effect are as follows:

Although (a) is the fundamental, it is not at all an ideal sine wave but somehow distorted by noises, or hums, etc. When these have effect on (c) and (d), the same would also appear on (f). When the synthesizer is set at the higher range, it would cause its sound output to become muzzy.

- HOLD -

When HOLD ON is set, (1) becomes CV, S3 is to open and the output of (f) is disconnected from C5. Although (i, -L) together with this, the trailing edge of (i) lags behind (k), this is to help avoiding undesired sound, which comes in before the desired sound, becomes HOLD ON when the switching timing happened to be too early.

3. LOGARITHMIC CONVERTER

As in common, SYNTH section of SPV-355 is controlled by CV (control voltage) of logarithmic in the rate of 1V/dec. However, so far the output of fundamental through TV circuit is simply a linear. There is therefore a need to convert this to such CV to suit for controlling RESYNTH. When from TV output the log curve output is obtained, it becomes possible to control SYNTH in such a way that having 1V change is to have VCO frequency doubled or halved on SYNTH section.

To express this in mathematical formula is:

\[ F = \frac{1}{2} \quad \text{or} \quad V_F = \frac{1}{1/2} \] (constant is omitted for clarity). Therefore,

\[ CV = log \quad \log \frac{1}{2} \quad log \frac{1}{2} = \frac{1}{2} \quad log \quad \frac{1}{2} \]

This conversion is performed through IC7a, b and IC8. As in seen, the TV here is inverted. It is because that the output of TV is reverse proportional to the frequency of the input signal.

4. GATE GENERATOR

GATE Generator consists of IO9a, b, Q22, 23 and IO10. R8 flip-flop (IC10) is set by the signal from IO9a when it turns to "H", GATE ON. The Y-P is reset when Q23 (C39) turns to "H" (approx. 7.5V or more), GATE OFF.

Signal from IC1 is fed to the (+) pin of IO9a. When this negative half becomes lower than that on the (+) pin (negative) determined by R102, R103, IO9a output becomes "H". It is fed to IO10 pin B, and causes G output to become "H". It set at the same time the green light of LED (D11) being lit to indicate the GATE ON.

When the input level at this (+) pin of IO9a goes positive with respect to the (+) pin, the output of IO9a turns to L, but IO10 still holds G terminal at H.

Q39, C39 are the quasi-sixteenth wave generator. The voltage charged at C39 through VR-2 and R101 is discharged every time Q33 conducts at the input signal frequency rate. IO10 is reset when this wave peak reaches H (4VDD). There are two possible occurrences for this to become H.

(1) When the signal frequency turns to low: With it intervals between positive-going pulses at Q23 base becomes longer, more charging current into C39 through VR-2, R102, which in turn makes the wave more positive. In practice it is adjusted by VR-2 to turn to H at the frequency range of 65Hz or lower.

(2) When the signal level decreases: It also decreases the voltage level fed to Q23 base, not enough for Q23 to conduct. As a result, C39 does not discharge but continues its charging so as to obtain higher voltage level and becomes H.

As can be seen from the figure right GATE signal turns on/off at the different musical signal levels. As for turn-off level, there is another trick to meet sudden input signal variation in amplitude. Suppose that, when a guitar play is suddenly stopped by depressing strings, gate signal must turn off, before the signal level drops to predetermined normal "off" point A, to shut off being sustained non-musical sounds.

IO9b is such that it incorporates Q22 in parallel with R97 in its feedback loop. Since the impedance of Q22 (C-B junction) increases in reverse proportion to the input, the circuit in this configuration can be regarded as an AGC circuit.

When the IO9b output voltage increases above 1.2V (forward voltage: D9, Q22 C-B junction), the current flows through Q22. It makes the C-B resistance decrease, to decrease thereby in the gain of IO9b. Total effect is to maintain the output in constant level, approx. 1.2V.

On the illustration as above, let's suppose firstly that the sounds drop at a slow rate. The output decreases, and Q22 base voltage and the current flow through it both decrease too. It makes the impedance in sum with R97 increase, and with it, the gain of IO9b is increased. If, however, the sound drop is so sudden, there would appear a certain delay in decreasing the base voltage of Q22. It is because of the time constant of R99, C98. While hold here, the gain of IO9b does not increase. With no change in gain here, the output too drops suddenly as the signal decays to point B.

5. ENVELOPE FOLLOWER

IO9b, 22b are a full-wave rectifier. The pulsed wave from there are further flattened out while passing through the filter (IO22a) to become an output that follows very similar envelope to that of input signal. IO16 is an analog switch which is turned on/off in response to the GATE signal. The switch is to prevent unnecessary prolongation on the output of the ENVELOPE FOLLOWER which occurs due to the filter circuit time constant.

Here, pin 4 of IO10 is not directly grounded but slightly biased at negative. This is only because that the circuits including the other IO16a are requiring negative source. So far as this switch is concerned, however, it can be regarded as equivalent to a direct grounding.
PARTS LIST

072-282 Panel no.282
065H060 Cover (case) H60
108H003 Handle H3
111-037 Rubber foot K-15
061-261 Chassis no.261

KNOB
016-009 Button no.9 black power switch
016-048 No.48 slider
016-077 No.77 rotary small
016-078 No.78 rotary large

SWITCH
001-215 SDG5P001-1 power 100V
001-216 SDG5P001-2 power 117V
001-217 SDG5P-502 power 220/240V
001-280 SLR-022 lever up-throw
001-278 SLR-043 lever
001-279 SLR-023 lever

POWER TRANSFORMER
022-085A-C No.85A-C 100/117V
022-085A-D No.85A-D 220/240V

FUSE HOLDER. FUSE
008-026 SGA0001 1A 100/117V
008-064 CEE 750mA 220/240V
012-003 Clip TP-758

PCB
149-140 OF-140 (052-483)
052-425 AUDIO MIXER-1
052-486- 1, 2, 3 LED Mounting
052H195 LED Mounting
052H185A Prim. Fuse Mounting
052-484- 1, 2, 3, 4 Pot. Mounting
* 052-xxx means PCB only.

Add word "assy" when ordering assembled one.

SEMI CONDUCTOR
Transistor
017-016 2SK304AT-GR FBT
017-017 2SK510 FBT
017-018 2SK117-GR FBT
017-016 2SC8185-GR
017-015 2SA1015-Y
017-011 2SA1015-GR
Diode
018-078 1SH4523
018-072 1SH473
018-082 W-02 bridge rectifier
018-015 STD-1000 thermistor
019-028 TLR-124 red LED
019-029 TLR-124 green LED
IC
020-097 μPC4558C dual op amp
020-153 NJM4589 high slew rate op
020-100 TL0820P FET dual op amp
020-208 LF354N FET dual op amp
020-106 μA7150C regulator
020-110 μA7150C regulator
020-052 μA726HC
020-169 MC140101BCP
020-170 MC140111BCP
020-210 MC14066BCP
020-179 MC140138BCP
020-160 BA662A
020-096A BA662B selected VCF

Replaced exist BA662B with only one dotted in the same color.

POTENTIOMETER
026-490 EVH6PAP20R15 100KΩ TUNE
026-499 EVH6PAP20A54 50KΩ

Slider
029-592 EVAHHP20R15 100KΩ
029-603 EVAHHP20A54 20KΩ
029-606 EVAHHP20A16 1MA
029-609 EVAHHP20A15 100KΩ
w/center -tap -click

Trimmer
026-004 EVTH44AB14 (SR19R) 10KΩ
026-007 EVTH44AB15 (SR19R) 100KΩ
026-008 EVTH44AB25 (SR19R) 200KΩ
026-009 EVTH44AB55 (SR19R) 500KΩ
026-491 CR19R 2.5KΩ
026-495 CR19R 10KΩ metal film
026-499 CR19R 47KΩ
026-501 CR19R 100KΩ
030-630 PNB22H202H 2KΩ metal
030-632 PNB22H502H 5KΩ film
030-629 PNB22H102H 1KΩ cubic

RESISTOR
044-830 CRB25FX 1KΩ selected
044-846 CRB25FX 10KΩ selected

When replacing, replace all resistors in the affected group with 1% resistors which have been tested and are within 0.1% of being identical in value.
(refer to Printed Wiring Layout)

EVTH4  SR19R  CR19R  PNB22H—H
blue  blue  blue

CAPACITOR
Bi-polar
032-190 EBC50N1 1mfd 50V
032-241 EBC516NO1 10mfd 16V
032-244 EBC25N10 10mfd 25V

Tantalum
032-224 1mfd 35V
032-226 2.2mfd 35V
032-227 3.3mfd 35V

Polypropylene film
035-091 BCQ2334M2 0.33mfd

Poly styrene film
035-279 BCQS1102K2 0.001mfd 10%
035-321 BCQS1222K2 0.0022mfd 10%
035-274 BCQS1151K2 150pF 10%
035-097 BCQS1102J2 0.001mfd 5%

MISCELLANEOUS
042-041 Terminal no.41 earth
065-262 Cover (dust cover) no.262 PORTAMENTO CONT.
065-263 Cover no.263 w/10 slits
065-264 Cover no.264 MIXER-2 Pedal cont.
061-015 Long(sleeve) nut no.15 3x12mm
048-069 Heat sink nos.69
065-261 Cover no.261 lever
*: Factory selected components in a unique serial number have almost the same characteristic or value. When replace, BA662- in the same color - Resistors - two or three together.

ID17, 28, 31: LP353N or TL082CP or (LP353N selected)
ADJUSTMENT

ADJUSTMENT and CHECKING should proceed in the order listed below; accurate adjustment of each section depends on proceeding adjustment.

1. DC SUPPLIES
2. RANGE PRESET CONVERTER
3. INPUT LEVEL
4. GATE GENERATOR
5. VOLTAGE CONTROLLED FILTERS
6. TIME to VOLTAGE VR-2
7. VCOs
8. VOF
9. VCA
10. OUTPUT LEVELS

CAUTION

Allow about 15 minutes for a warm-up.

Keep room temperature stable during servicing SPV-355.

Do not expose the SPV-355 being adjusted to the direct heatings and coolings since F/V, VOO and VOF circuits are temperature sensitive.

NOTE

Replacing a particular IC with a new one will involve re-adjustment of the following trimmer pot(s) pertaining to that circuit.

<table>
<thead>
<tr>
<th>IC replaced</th>
<th>Pot. to be readjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td>IO10</td>
<td>VR-2 GATE GEN.</td>
</tr>
<tr>
<td>I012 I013</td>
<td>VR-7 F/V LINEARITY</td>
</tr>
<tr>
<td>I014 I015</td>
<td>VR-9 F/V LINEARITY; VR-8 F/V WIDTH; VR-9 Freq.</td>
</tr>
<tr>
<td>I018</td>
<td>VR-11 VCO-2 WIDTH; VR-12 VCO-1 FREQ.; VR-13 VCO-1 LINEARITY</td>
</tr>
<tr>
<td>I027</td>
<td>VR-16 VCO-2 WIDTH; VR-17 VCO-2 FREQ.; VR-18 VCO-2 LINEARITY</td>
</tr>
<tr>
<td>I030</td>
<td>VR-27 VCA DC BAL.</td>
</tr>
<tr>
<td>I039</td>
<td>VR-35 10V ADJ.; VR-7 F/V LINEARITY; VR-8 F/V WIDTH; VR-9 F/V FREQ.</td>
</tr>
</tbody>
</table>

SHEET of ADJUSTMENT

With some adjustments, interaction takes place between or among adjustments, or certain effects are brought to other adjustments. In the list below, "AB" indicates associate VR(s) and "E" indicates affected VR to be readjusted.

<table>
<thead>
<tr>
<th>DESIGNATION &amp; TRIMMER POT</th>
<th>WHAT IS ADJUSTED</th>
<th>REMARK</th>
</tr>
</thead>
<tbody>
<tr>
<td>GATE GEN VR-2</td>
<td>GATE CUTTOFF FREQ.</td>
<td></td>
</tr>
<tr>
<td>FUNDAMENTAL VR-6</td>
<td>VO-LPF 10dB DOWN POINT FREQ.</td>
<td></td>
</tr>
<tr>
<td>P/V LINEAR. VR-7</td>
<td>CV LINEARITY at HIGH FREQUENCY</td>
<td>AB - VR-8</td>
</tr>
<tr>
<td>P/V WIDTH VR-8</td>
<td>CV 1/4 OCT CONVERSION</td>
<td>AB - VR-7</td>
</tr>
<tr>
<td>P/V FREQ. VR-9</td>
<td>CV = 0V at E 32 Feet</td>
<td>E - VR-12, 17</td>
</tr>
<tr>
<td>RANGE VR-10</td>
<td>RANGE PRESET</td>
<td></td>
</tr>
<tr>
<td>VCO-1 WIDTH VR-11</td>
<td>1/4 OCT OUTPUT</td>
<td>AB - VR-12, 13 E - VR-12</td>
</tr>
<tr>
<td>VCO-1 FREQ. VR-12</td>
<td>32° B PITCH with CV CV INPUT</td>
<td>E - VR-12</td>
</tr>
<tr>
<td>VCO-1 LINEAR. VR-15</td>
<td>DEVIATION at HIGH FREQUENCY</td>
<td>AB - VR-11</td>
</tr>
<tr>
<td>VCO-2 WIDTH VR-16</td>
<td>1/4 OCT OUTPUT</td>
<td>AB - VR-17, 18 E - VR-17</td>
</tr>
<tr>
<td>VCO-2 FREQ. VR-17</td>
<td>32° B PITCH at CV CV INPUT</td>
<td>E - VR-17</td>
</tr>
<tr>
<td>VCO-2 LINEAR. VR-18</td>
<td>DEVIATION at HIGH FREQUENCY</td>
<td>AB - VR-16</td>
</tr>
<tr>
<td>VOF RESONANCE VR-23</td>
<td>OSCILLATION INITIATIVE POINT</td>
<td></td>
</tr>
<tr>
<td>VCA DC BAL. VR-27</td>
<td>CLICK REDUCTION</td>
<td></td>
</tr>
<tr>
<td>VOF WIDTH VR-31</td>
<td>1/4 OCT CUTOFF</td>
<td>E - VR-32</td>
</tr>
<tr>
<td>VOF FREQ. VR-32</td>
<td>CUTOFF FREQUENCY</td>
<td></td>
</tr>
<tr>
<td>+10V VR-35</td>
<td>REFERENCE VOLTAGES</td>
<td>E - ALL P/V &amp; VOA</td>
</tr>
</tbody>
</table>

TEST POINTS (FP-***) and ADJUST TRIMMERS are red printed on Printed wiring assembly drawing on page 9.

1. DC SUPPLY

Connect Digital Meter to W60 check within the range of -14.25V to -15.75V
W61 check +14.25V to +15.75V
W66 adjust VR-35 for +10V ± 0.003V
W67 check -9.800V to -10.200V

2. RANGE PRESET VOLTAGE

Connect Digital Meter to TP-6. Usage RANGE HEADING:

Net RANGE switch at 4'. 4' 0.00X
Note the reading (call this X). 8' 1.00X 20mV
Adjust VR-10 for the voltages 16' 2.00X 20mV
in the table right with the switch set at proper position.

3. SIGNAL LEVELS vs LED ON/OFF TIMING

As can be seen from the figure right input signal versus green LED on/off GATE signal has non-linear hysteresis characteristic. Once green LED lights, it will stay on until the signal decays at point "O".

Check input signal levels for the figures of table below at 400mV sine wave with THRESHOLD turned full clockwise.

| INPUT Selector at GUITAR, WOOD/SHAS | -56.54dBV -54.54mV 1.5mV rms green LED ON |
|                                       | -56dBV -56mV 12.5mV rms red LED ON |
| INPUT Selector at VOICE               | -82dBV -800mV 0.25mV rms green LED OFF |

unmeasurable
5. FUNDAMENTAL GENERATOR (VCO-LPF CUTOFF)

Connect: 400Hz square wave into INPUT jack.
Scope to Q9 source.
Adjust V9-6 for 5Vpp at Q9 a.
Make sure that Q9 output: Increases to 6.5-7.5Vpp
at 100Hz input signal.
Decreases to 3.5-4.5Vpp
at 1kHz input signal.

6. TUNING INSTRUMENT

For the adjustments concerned with P/Y and VCO circuits
a precise tone generator is required - B note is preferable.
Shows below is an example of B scale generator circuit configuration.
It draws DC from SPV-355 -15V supply.
Alternatively, an electronic organ or piano delivering the range of 32' to 2' X(F) can be used.
In this case the organ/piano must be set to provide simple
waveform sounds without frequency modulated like vibrato.

7. PITCH TO VOLTAGE CONVERTER (TIME to VOLTAGE)

Observe precautions:
- plenty of warmup (15 minutes or more)
- avoiding direct heating/cooling
- taking steps in order of number
Connect: Digital Meter to CV OUTPUT jack.
Reference Note into INPUT jack.
Set INPUT Selector to GUITAR.
Keep input signals at a level just before Red LED goes on
and turn OFF each time for different feet.

COARSE
1) Set the generator at 32' to 32'.
2) Set VR-9 for approx. 0.333V(R) or 0.427V(F), (call this Y)
3) Set generator at 16' and adjust VR-8 for 1' + Y.
   Y will vary according to VR-8 turning; but leave it varying
   and keep VR-9 untouched. Only by turning VR-8 try to obtain
   1', e.g., Y = 0.546, 1' + Y = 1.546Y.
4) Set generator at 2' and adjust VR-7 for 4' + Y.

FINE
1) By turning VR-7 and VR-8 in turn at individual feet,
obtain the voltages listed below with Y checked every time
after VR-8 is turned.

   VR-9 (FRQ) 32' Y 36' The tolerance of 36' to 2'
   VR-8 (WIDTH) 16' 1' + Y should be less than 3mV for
   VR-7 (TIME) 4' 2' + Y practical applications.
   4' 3' + Y 2' 4' + Y 2) Set VR-9 for 0.333V at 32'.

TRUTH TABLE

<table>
<thead>
<tr>
<th>INPUTS</th>
<th>OUTPUTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CL</td>
<td>PR</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>M</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

* Don't care * No change

MC14013B
DUAL TYPE D FLIP FLOP

MC14018B Quad 8-input NAND Data
MC14066B Quad 8-input NOR Data
MC14018B Quad 8-input CMOS

µA726

JAN. 10, 1980
- DIRECT LEVEL -

With 400Hz being INPUT, check that OUTPUT jack's signal is
equal to that at INPUT jack in amplitude in the following conditions:

AUDIOMIXER-2 Selector
MIX(D+D) DIRECT
SYNTH knob at "0". SYNTH knob anywhere
DIRECT knob at "7". DIRECT knob anywhere

- AGC OUTPUT WAVEFORM, LEVEL -

With 400Hz square wave input into INPUT jack, connect an
oscilloscope to R99 (IC 1 pin 1).
Screen will display waveforms similar to those in figures
shown below when THRESHOLD is set just before red LED lights.
While decreasing the input signal gradually, check that the
waveform disappears from the scope at exactly the same time
green LED goes out, or Q3 ceases to conduct.

INPUT SELECTOR
GUITAR VOICE (and WOOD/BRASS alike)

17.5Vpp 17.5Vpp

4. GATE GENERATOR

Feed a 65Hz square wave into INPUT jack (INPUT selector
anywhere).
Set generator and THRESHOLD knob for just before red LED
blinking.
Connect scope to TR-2.
Adjust VR-2 for the narrowest pulse width.
- VCO-1 -
Set panel as indicated above.
Connect: Scope and Amp + Speaker to OUTPUT jack.
Reference Generator into INPUT jack.
1. With the reference generator set at 4', adjust VR-12 for zero beat sound between Direct and Synth sounds.
2. Set the note at 8' and turn VR-11 for zero beat then advance it for few beats - amount of turning degrees after zero beat is proportional to deviation.
3. In the same manner produce few beats by turning VR-12 with the note set at 4'.
4. Repeat steps 2 and 3 for zero beat at 8' and 4'.
5. Apply the same procedure for the following combinations.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4'</td>
<td>VR-12</td>
</tr>
<tr>
<td>16'</td>
<td>VR-11</td>
</tr>
</tbody>
</table>
6. Check 32' to 2' for beat sounds. Adjust VR-13 to reduce them at 4' and 2'.
7. If the adjustment results in undesirable, re-adjust from step 1.
8. Finally, adjust VR-13 for the least beats at 4' and 8'.

- VCO-2 -
Set: VCO-1 knob in AUDIO MIXER-1 at 0.
VCO-2 knob at 10. TUNING B at its center.
The rest at the same as for VCO-1.
1. Follow the steps in VCO-1 section reading VRs:
VR-11 as VR-16, VR-12 as VR-17, VR-13 as VR-18.

Set controls as shown above.
Feed a signal within the range of 200Hz-1kHz.
Set THRESHOLD just before INPUT Red LED goes on.
Connect oscilloscope into OUTPUT jack.

- RESONANCE -
1. Place RESONANCE knob at "0" grade.
3. Slide RESONANCE down at "2.5", if oscillation does not cease, reverse VR-23 slightly.

- WIDTH -
1. Set RESONANCE at "10".
2. Set CUTOFF FREQ knob for 1kHz oscillation.
3. While quickly switching RANGE switch 8' to/from 4', adjust VR-31 so that 4' wave form becomes twice 8' cycle.

- FREQUENCY -
Set PITCH FOLLOWER knob at "0". CUTOFF FREQ knob at "HIGH".
1. Adjust VR-32 for 20kHz oscillation.(50% per cycle)
2. Slide CUTOFF FREQ down at "LOW". The oscillation must be retained with its amplitude decreased.

Typical levels with panel set as above (input 400Hz).

<table>
<thead>
<tr>
<th>AUDIO MIXER-1</th>
<th>OUTPUT jack</th>
<th>EFFECT jack</th>
<th>OUTPUT jack</th>
<th>EFFECT jack</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCO-1, -2</td>
<td>-20dBv</td>
<td>-21.5dBv</td>
<td>-41dBv</td>
<td>-21.5dBv</td>
</tr>
<tr>
<td>VCO-1, -2</td>
<td>-18dBm</td>
<td>-19.5dBm</td>
<td>-39dBm</td>
<td>-19.5dBm</td>
</tr>
<tr>
<td>VCO-1, -2</td>
<td>-19dBv</td>
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