# Specifications

**JP-4 SERVICE NOTES**

**Second Edition**

---

### Key Features
- **Keyboard** (49 keys, 4 octaves, C scale)
- **Synthesizer Modules**
- **VCO/Voltage Controlled Oscillator**
  - VCO Range: MS, 81, 4x
  - Pulse Width: 50%, 40%, 20%, 10%
- **VCF (Voltage Controlled Filter)**
  - HPF, LPF, OFF, 2KHz, 10KHz
  - Key Follow: 10%, 40%, 70%, 100%
- **LFO (Low Frequency Oscillator)**
  - LFO Rate (Over 0 Hz: 80Hz)
- **Envelope Generator**
  - Envelope Generator for VCF, VCA
  - Attack Time: 10.6 ms, 3 Sec
  - Decay Time: 14.4 ms, 10 Sec
  - Sustain Level: 100%
  - Release Time: 14.4 ms, 10 Sec
- **Trigger**
  - Trigger Rate: 1.5 Hz
- **Delay/Bend**
  - Delay Time: 10 Sec

---

### Design Changes

- **Controller**
  - Portamento: 0.5 Scale/Ball
  - Transpose: Normal, 100, Down
  - VCF: Over 0 Hz
  - VCA: Over 2KHz
  - Resonance Pitch
  - VCA: Over 2KHz

- **Tuning**
  - ± 50 cents, ± 1%

- **Connection Jacks**
  - Output Jacks
  - Input Jacks
  - Power Jacks

- **Power Requirements**
  - 20W

### Overall
- **Size**
  - 946 (W) x 410 (D) x 179 (H) mm

### Accessories
- 2.5mm Knob Caps: 2

---

### Parts List

- **Switches**
  - SD5F (001-158)
- **Buttons**
  - No. 8 (Gray: 016-008)
  - No. 91 (Black: 016-081)
  - No. 9 (White: 016-085)
- **Knobs**
  - No. 56 (016-065)
  - No. 61 (016-061)
  - No. 97 (Green: 016-087)
  - No. 98 (Yellow: 016-088)
- **Panel Numbers**
  - Panel No. 2185 (072-2185)
  - Panel No. 2193 (072-2195)
- **Keyboard Assy.**
  - SK-191A
- **Cabinet Assy.**
  - O81-108H
- **Felt No. 27**
  - (102-027)
- **Knobs No. 56**
  - (016-065)
- **Panel No. 2208**
  - (072-2208)
- **Nylon Rivet**
  - NRP-335 4 pcs (122-001)
- **Bender Unit PB-4**
  - (029-022)
- **Connector Assy. No. 264**
  - (181-009)
- **Control Board Holder**
  - No. 2044 (064-204B)
- **LEDs**
  - GL-3AR1 (019-022)
  - or LR051-R (019-009)

---

Screws (2), (2'): Keyboard and Left control unit removal.
For only Left control unit removal: Screws (2'), (3)
**CIRCUIT DESCRIPTION**

1. **Operational Principle:**
   In the conventional synthesizer, the circuits (VCO, VCF, VDA, etc.) are directly controlled from the control panel.
   In the Comp. Phonic synthesizer, it is the computer that comes in between and provides control voltages suitable to those VCO, VCF, VDA, ENV, GEN, etc.

2. **Hardware:**
   Comp. Phonic Synthesizer is composed of the "Synthesizer Control Circuits" with µP8048B as its central point and the "synthesizer circuits" which are fully controlled by voltage.

2-1. **Control Section:**
   - Switches and Sliders -
     Sliders and switches on the control panel are now not for the production of the synthesizer control signals directly, such as the production of the time constants, ON/OFF switching, etc. They serve only for letting the computer know of their positions or the states they are in.

2-2. **Voltage Controlled Synthesizer Circuits:**
   Such parameters as the time constant, ON/OFF switching, or signal levels, etc., have so far been produced on the control panel there are sliders and switches to obtain directly of such.

   *In JP-4, the Poly Phonic synthesizer, 8048B is adopted on its key-assigner circuits too.*

**Function of Mother Board**

In the Mother Board included are the microcomputer 8048-012 and its peripheral circuits.

(1) Scanning all the switches on the Control Panel such as Memory Write SW, Manual SW, Comp. Memory SW, Per-Jet Selection SW, etc.
(2) Converting the analog signals obtained from Sliders and Switches of the Programmable Section on the Control Panel, into 6-bit digital data (A/D conversion). (This data reading is repeated 16 divided times to complete them all.)
(3) Storing these A/D converted data of the POTs and SWs into memory for use afterward upon retrieval.
(4) Converting back again these digital data into analog voltage (D/A conversion) to send them out into Synthesizer Modules.
   All these functions stated above are performed under the control of 8048-012.

   - Functions of 8048-012
     ( Tone color setting controller )

   These operations of 8048-012 are shown in the flow chart. The 8048-012 repeats such flow chart cycle. The following numbers refer to those in flow-chart.

1. When the power is turned on, 8048-012 starts its reading and puts into memory the data of the positions it reads of Memory Write Switch, Manual Switch, Comp-Memory Selection Switch and Per-Jet Selection Switch.
2. The 8048-012 takes in at first the voltage data of one of the "Slider pots" on the Control Panel and converts it into 6-bit digital data. At the same time, it reads out the "Switch Positions" on the Control Panel and converts it too, into 2-bit digital data. The two data thus obtained are combined to make a total 8-bit data. These are held there for a while.
3. If the MANUAL Switch was OFF at step 3, the program proceeds to step 4, or if ON, to 7. During this process, the data obtained in step 2 is maintained.

4. When the Memory Write Switch was OFF at step 1, the program goes to step 5, if ON, to 6. The step 2 data is still maintained.

5. Based on the data being held in step 2, the 8048-012 accesses to either RAM (Random Access Memory) when a switch in Compu-Memory was pushed in, or ROM (Read Only Memory) when one of Reset switches was in. It then reads out from the address corresponding to the switch depressed, the data to give control to the Synthesizer Modules.

6. Based on the data in step 1, it writes the data held in step 2 to RAM, selecting the address over there which is corresponding to the switch position on the COMPU-MEMORY SW.

7. The 8048 divides the 8-bit data (data in step 2 or data retrieved in step 5) into two formats: 2-bit switch data and 6-bit slider data.

The 6-bit data then proceeds to D/A conversion.

These two signals of analog converted voltage and of switches are fed to the Module Boards.

6. The 8048 checks to see whether it completed all 16 cycles to read out all data divided into 16 at the previous stage. If all are completed it goes back to step 1. If not, to 2.

Switch Reading - The 8048-012 scans the matrix made of the diodes and switches on the Control Board P to find out which switch is depressed among those of 64bits through MEMORY PROTECT.

1. Diode-Switch Matrix

On the Control Board P, switches (each accompanying diode) are grouped into 4 blocks consisting of 2 to 8 switches. These blocks are then connected through the data bus to DB0, DB1, DB4, DB6 on 8048-012. The blocks are also routed through the pins of P20-P27 on Port 2 of 8048-012.

They are then making a matrix. (Refer to the Circuit Diagram, Control Board P).

2. To Scan the Switches

The 8048-012 outputs "L" onto DB0 alone and "H" on all other DB2-DB7.

They are out on the data bus and latched on I27, I26, 74138175 by the pulses from pin ALE (Address Latch Enable) to be put out onto DB0-DB7 of 28E.

Next, 8048-012 reads the Port 2 (P20-P23) if it finds here that the P20 alone "L" while all others are "H", then it can know of that the SW1 is on.

The above process is repeated to go over all of DB0 to DB7, but four of them are connected to switches. MEMORY WRITE Switch (SW1) is so wired that it is only enabled when Compu-Memory selection switch is ON with the PROTECTION switch (SW2) being depressed at the same time.

(See circuit diagram, CONTROL BOARD P)

- Reading of CONTROL PANEL -

The 8048-012 reads the patching on the Control Panel and converts them into digital data of 16 bytes. (3 bytes = 8 bits)

Of the Control Panel, the section named "PROGRAMMABLE" consists of 16 pots and 14 switches, these 16 pots produce different kinds of analog voltage varying between 0V to 5V. The 14 SW's, on the other hand, produce binary digital data of "H" or "L", given by +5V or 0V, respectively. The 16 analog voltages that comes in parallel to each other are re-arranged into the analog multiplexer(MUX) 105, 106, 4051, to be put on a single line in time sequence.

These outputs of the MUX go into the A/D converter (will be described later) to become 6-bit data of 16 kinds.

The binary data of the switches are also re-arranged into 2 groups of 7 kinds (total 14) with each group entering each respective MUX 103, 104 where they are made to 2-bit data and be output from there in time sequence as above. These 2-bit data are combined to become an 8-bit data. That is to say, the patching first made on the Control Panel Become to be represented by all digital data of 16 bytes in all. (Refer to Memory Map on page 13)

- D/A and A/D Conversion -

1. D/A Converter

The D/A Converter used on the Mother Board is the one called "0-28 type". The converter here is only making use of higher significant 6 bits among those of 8 bits given here, leaving the least significant 2 bits unused.

2. A/D Converter

The A/D Converter on the Mother Board is referred to as "Successive Approximation Type Converter" which makes use of the D/A converter and a comparator.

To proceed on with conversion, 8048-012 starts deciding the data at first for the most significant bit, then down to those lesser significant bits. 105, 1030 serve as an inverter, making the input to follow negative logic. The output is +5V maximum, therefore, when it receives the input LLLLL0, or 0V minimum when HHHHHH. (XX are for those least significant bits that are made all.)
(Numbers below in this section refer to those at top in figure right)

The 8048-012 tries at first putting DB7 to "L", thus making the digital data at first to L1B11101010111, tentively. These are latched on L0175 by the pulse from ALE pin, then out onto the D/A converter. On the one hand, 8048-012 reads the output level of the comparator, IO13 S11, through TL1 pin.

It makes comparison between these two, of the A/D input and of D/A converted output to L1B11101010, if the A/D input is to be as shown in figure (a straight line a little over 2.5 V), the comparator finds that the D/A converted output L1B1110101011 is less than that of A/D input. It is to instruct 8048 to decide that the "L" previously put on tentative base can be firm so that "L" is to remain on D7 hereafter.

Now, 8048 turns to DB6 in putting here again "L" tentatively, to output L1B11101010111. With this data, the D/A output becomes higher than the A/D input as in step 2 on figure. It makes the output of the comparator S11 turn to "H". That means, that 8048 has now to decide that DB6 in "L" is too large, so it must be reset back to "H" again. The same process continues through the lesser significant bits, as on step 3-6 on figure.

- Memory -

Here provided on this Compu-Phonic Synthesizer are "CSSM RAM", IO1, 5101 for memory of the tone color (tissue) data to be used on Compu-Memory and ROM which resides in 8048-012 for use in FABES node.

8 bits ACCESS TO 5101

<table>
<thead>
<tr>
<th>Memory Address</th>
<th>101</th>
<th>100</th>
<th>011</th>
<th>010</th>
<th>001</th>
<th>000</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>101</td>
<td>100</td>
<td>011</td>
<td>010</td>
<td>001</td>
<td>000</td>
</tr>
<tr>
<td>IO3</td>
<td>101</td>
<td>100</td>
<td>011</td>
<td>010</td>
<td>001</td>
<td>000</td>
</tr>
<tr>
<td>X Timing</td>
<td>101</td>
<td>100</td>
<td>011</td>
<td>010</td>
<td>001</td>
<td>000</td>
</tr>
<tr>
<td>Enable</td>
<td>101</td>
<td>100</td>
<td>011</td>
<td>010</td>
<td>001</td>
<td>000</td>
</tr>
<tr>
<td>Address Latch</td>
<td>101</td>
<td>100</td>
<td>011</td>
<td>010</td>
<td>001</td>
<td>000</td>
</tr>
</tbody>
</table>

8048-012 outputs from Port 1 the address data to turn the Chip Enable 8 bits data on 5101. Then, 8048-012 outputs the pulse from ALE pin to make IO175 (101, 100) latch the data and define the memory address on 5101. While the memory address being defined by IO175, 8048-012 outputs onto DB2 to DB5 the data to be written. These data are then written onto 5101 by turning WR to "L", and are read by 8048 through DB2 to DB5 when WR is "L". The digital data on the Control panel are then transferred to DB5. 8048-012 completes these all for DB7 to DB2 for bits, it has decided the data on the nearest approximation to be equal to that of input of the A/D converter.

- Generator -

The control data that were A/D converted to kinds of analog volatages and 14 kinds of binary 8-bit digital data are re-converted to 16 signals before they are sent to the Module Board(s).

1. The 8048-012 reads out these digital data of 16 bytes successively from RAM or ROM, upper 6 bits (DB7 to DB2) among them are made to analog voltage through D/A converter and are put on a single line in time sequence and are sent to 16-output analog demultiplexer, DMX 1031, 1037, 4091. 8048 completed then all for DB7 to DB2 for bits, it has decided the data on the nearest approximation to be equal to that of input of the A/D converter.

- 15 Level Shift Circuits -

DMX is to separate the input data into 16 at the control signals from 8048-012 (1031, 1037, 4091). They are held at 1032, 1032, 1032, 1032 to be sent out to the Module Controller and the Module Board.

- 2. The lower 2 bits data, DB1, DB0 are fed in time sequence to the input pin of each respective address data latch 4099, 1031, 1012. The two 4099s latch them in separate 7 groups under the control signals from 8048-012 (to pins 4, 5, 6, 7). The outputs of 14 kinds go into the level shift circuit following 4099 where they are shift into levels each suitable for the purpose to each. (Section surrounding Q1-QUA)

- 3. Of the 14, those of YO:WAVE 1, 2, and LPO:WAVE 1, 2 are fed to the Wave form selector, 1039, 1020 and LPO Select Decoder, 1033, 1034 to receive each respective decoding, YO:WAVE 1, 2 go into Transpose Subtractor where the contents of the 2-bit data of YO:WAVE 1, 2 are converted when the Transpose Input is turned to "L". Refer to Table for what conversion is meant on this transverse. In effect, it is to go down by l octave on YO range as shown by arrows. Thus, the Switch control signals in 14 kinds become to control the Module Boards after passing through these circuits as above.

- Transpose by the Subtractor -

Transpose by the Subtractor

<table>
<thead>
<tr>
<th>Transpose</th>
<th>Range 1</th>
<th>(input)</th>
<th>1020-4099</th>
<th>1021-4098</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>(input)</td>
<td>1020-4099</td>
<td>1021-4098</td>
<td>Transpose</td>
</tr>
<tr>
<td>(output)</td>
<td></td>
<td>1020-4099</td>
<td>1021-4098</td>
<td>Transpose</td>
</tr>
</tbody>
</table>

- Control Signal -

IO20-IO20

- Control Signal -

IO20-IO20

- Control Signal -

IO20-IO20

- Control Signal -

IO20-IO20
- OTHERS -  Reset Circuit

The circuit is to protect 6848-012 from running program inadvertently. When S18 is turned to "OFF", it makes 6848-012 reset back to the initial state. This is also connected to 6840-011 through the common line. (6840-011, JP-4 only)

- MODULE BOARDS -

1. VCO and its Peripherals

IO16 (pin 1, 2, and 3) makes the vibrato voltage VOO 0087 and keyboard key voltage KVU mixed and sends them out onto the antilog transresistor IOD which outputs antilog current from pin 9. This antilog current is then compared at the Comparator IODA (pin 5, 6, 7) with the current flowing in from pin 6 of IOD thru R115A. The output of the comparator IODB is made to control the VCO generator oscillation frequency produced from IOD, Gate IO. Here, however, the VOO has to make the oscillation in such a frequency that it always keeps the difference at zero in values between the current IGM from pin 6 of IOD and the antilog current I-EXP from the antilog IOD. The VCO output is in the pulse form of the constant width converted by the one shot multivibrator IOJ (555).

It is therefore necessary to double the number of pulses if the antilog current is doubled. IO7A watches this to keep the balance at this pin 6. And, if losing the balance, it sends an additional voltage onto VOO to make it regain the balance. These are the process how to output the frequency which is antilog-proportional to the input voltage. The pulse output here is of so narrow width as yet. It is necessary therefore to provide further wave conversion, IO6 is a frequency divider. IO7 is a multiplexer to make selection from those divided frequency.

- CIRCUIT DESCRIPTION -

JP-4

2. VCF and its Peripherals

VCF here is not much different from those on the conventional synthesizer. IO11 is the high-pass filter. IO12-IO15 are the low-pass filters. IO17 is the circuit for setting Q for the low-pass filters.

IO18 is the electronic potentiometer to control the depth of the cutoff frequency modulation. IO19 (pins 5, 6, 7) is the cutoff frequency control mixer. Q8 and Q9 are the antilog current generation circuit.

3. Envelope Generator

There are two Envelope Generators, one each for VCF and VCA.

They are basically the circuits to voltage-control the time or the level of A, D, S, R. Since the signals are now in the pulse form, being voltage-pulse converted on the Module Control Board, the A, D and R controls are to be achieved by controlling the number of pulses in a given time. Note that, these pulses here are of so narrow width that it may easily be lost of sight from scope on the oscilloscope if the pulse intervals were extended a little long.

IO25 is the flip-flop which inverts itself on arriving at the attack level. IO24 is the gate selecting the pulse for each of A, D, and R by the timing of the flip flop. IO22 is the analog switch which turns on only when there is a pulse arrival, thus making C20 to charge-discharge, accordingly. On such charge/discharge, envelopes are developed. The envelopes from C20 are fed through buffer IO21 to obtain low output impedance.

- MODULE CONTROLLER -

Module Controller Board is to control those on Module Board as follows:

VCO modulation
VCF modulation
VCA modulation
Generation of the clock signals to control
BMV OB
Cutoff frequency of IHP
Pulse width modulation of VOO

The Module Controller performs those functions by converting the control signals fed from the Mother Board or those fed from the Bender Board into such signals to suit for controlling the modules.

Here also included are the Noise Generator and LFO Delay Circuit.

JAN. 31, 1980

6
Figure below is part of CP9, 11, 12, 17 and 13 at the left showing functions and timings of A/D, D/A conversions and the Switch reading.

1. The computer 8048-012 reads Sliders set positions through A/D conversion.
2. The computer reads between A/D and D/A conversions, Panel switches status.
3. In Manual Mode, at CP13, final of A/D and D/A outputs are equal in level.
   This means that Panel Data are fed into Synthesizer Modules as they are.
   However, in other modes, A/D and D/A show different values because they are out of relation to each other, D/A converter transforms digital data from the memory.
4. During D/A conversion, sliders data being D/A converted from 6-bit format and switch data from 2-bit format are held (latched) and output to the synthesizer modules.
Signals Flow Diagram on the Mother Board

Indicate Data Flows from the Control Panel. Will be output to the Synthesizer Modules only in Manual Mode.

Show Data to/from the Memories in CPU-Memory and Reset Modes. Will not be output to the Synthesizer Modules in Manual Mode.

Common lines for the data from the Control Panel and the Memories.

---

**Circuit Description**

**JAN. 31, 1980**

<table>
<thead>
<tr>
<th>DESIGNATION</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATA BUS</td>
<td>Switches/Data, Panel</td>
</tr>
<tr>
<td>PORT 1</td>
<td>I/O address, 1080</td>
</tr>
<tr>
<td>PORT 2</td>
<td>Switch Scan, Reading Data</td>
</tr>
<tr>
<td>XTAL 1</td>
<td>Inputs for internal clock oscillator</td>
</tr>
<tr>
<td>XTAL 2</td>
<td>Reset pulse input</td>
</tr>
<tr>
<td>T1</td>
<td>Comparator output signal input during A/D conversion</td>
</tr>
<tr>
<td>WR</td>
<td>Memory/Write timing signal output</td>
</tr>
<tr>
<td>ALE</td>
<td>EB Data latch pulse output</td>
</tr>
</tbody>
</table>

**µPD8048**
The µPD8048 is an 8-bit parallel computer fabricated on a single silicon chip. The 8048 contains a 18 x 8 RAM program memory, 27 I/O lines, an 8-bit timer/counter and clock circuits. Used in the Cosmos-Phonic Synthesizers are µPD8048-012 and µPD8048-011 (JP-4 only) versions in which programs and data dedicated to the Cosmos-Phonic are stored in the program memory.
FUNCTIONS OF KEY ASSIGNED BOARD

The microcomputer 8048-011 (IO1) is a central point of the Key Assigner Circuit.

1. Main Functions of Key Assigner Board

   Followings are its main functions:
   (1) Scanning the keyboard
   (2) Generation of KEY and GATE signals, and
easigning them to four Voice Synthesizers
   (3) Generation of KEY, GATE signals for use in
       Arpeggio

   All of these are performed under the control
   of 8048-011.

2. Scanning of Keyboard Data:

   The 8048-011 finds out what key is depressed by
   scanning the keyboard. Scanning of the keyboard is done in the same manner as with
   the scanning of Switches by 8048-012 on the Mother
   Board. The latch pulses, in this case, is output
   from WE pin of 8048-012 to LS179.

   The keyboard bus is divided into 7 sections
   with 8 keys per bus section except the right-
   most - only one for the highest note.

   Every key contacts in all of the sections are connected to Port 1. The lowest key in each
   section and the section which consists of only one key are connected to P10; the second keys
   are connected to P11, etc.

   The signal flows are the sequence to start at the connector D1 (Bus Bar) then go to D2
   (key contact). Arrangements on D1 and D2 are that to go left is toward lower notes.

3. Generation of KEY and GATE Signals, and
   Assigning to four Voice Synthesizers:

   After detecting the depression on the keyboard, 8048-011 proceeds with generating KEY and GATE
   signals in accordance with the Assign Mode
   selected among the four modes provided.
4. ARPEGGIO MODE:

When IO pin is turned to "L", 8048-011 becomes to Arpeggio Mode and it starts reading the levels of F24 and F25 to see whether these are on "H" or "L".

<table>
<thead>
<tr>
<th>TO</th>
<th>F24</th>
<th>F25</th>
<th>F26</th>
<th>F27</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arpeggio</td>
<td>UF</td>
<td>H</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Arpeggio DOWN</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>UF &amp; DOWN</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>RANDOM</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

When Arpeggio Select Switch is depressed, Key Assign Mode is turned to POLY II, too, because of the Selector's contacts wiring (refer to Control Board F circuit diagram).

Under Arpeggio Mode, 8048-011 sends out EOV and GATE signals following the Arpeggio pattern with one note each at the rise time of the clock pulse on T1 pin.

When the mode is UF mode, EOV is output with addition of 1 volt each. Or on DOWN mode, it subtracts 1 volt each. Or with UF DOWN mode, it is with the combination of these addition and subtraction of 1 volt each. Still the other way such that there are either the addition of 1 volt and the subtraction by 2 volts is called RANDOM mode.

(See the Owner's Manual, "Arpeggio") The clock signals that enter T1 are generated from IO6(pin 1-6) of 7404/03. These clock signals are reset by the Total Gate Signal from reset circuit of IO6 to start when a keyboard is depressed.

5. PORTAMENTO CIRCUIT:

Output from the D/A converter goes through DNFX, is held at the capacitor, then applied to the portamento circuit, IO13-IO18.

Figure above represents simplified Portamento circuit.

In the figure, A2 is the transconductance amp. It can be regarded as equivalent to a variable resistor whose resistivity changes according to amount of current flow coming to control terminal.

The portamento time is decided upon the time constant consists of C and internal resistance R of A2.

6. OTHER CIRCUITS

(1) Control Signal Circuit

This is the circuit through which the control signals to DNFX, IO11 4052 and Total Gate signals are drawn from Data Bus (DB1-BDB) as instructed by the pulses from ALS and WR pins.

(2) D/A Converter

On the Key Assigner, there is also the 6-bit D/A Converter of the type called "The current summing type". The D/A Converter, IO8, IO9 4049 is enabled by either OV or -15V. But, the signals are either OV or +5V when they come out from the Latch output.

It therefore become necessary to have a means here of a voltage shift to make +5V and OV down to OV, -15V, respectively. The circuits for this task are Q6 to Q11. Also, here needs, inversely, a shift from OV, -15V to be back again to +5V, OV.

On the output buffer UL-082.IO10 this is done together with the adjustment of tuning and width.

(3) Hold Switch

To depress the Hold Switch on the JP-4 control panel is to turn the IBT pin to "L". When this is done, 8048-011 is made to hold the outputs from GATE 1-4.
FEB. 23, 1981

MODIFICATIONS ON MOTHER BOARD
other than those described on the left

4. Disconnecting ground path from Control Boards A, B and C
   The jumper wire leading to pin 1 of terminal A4 is removed to
   prevent noises from being induced on control boards.
   With Serial Number 820950. Refer to Illustration on back
   page.

5. Direct wiring to avoid loose connections
   For stable VCO performance, lead wires (-15V and ground)
   from power supply board 181-024 are directly soldered at
   terminal A27.
   With Serial Number 871600. See pp. 16-2, 26-1.

MOTHER BOARD 181-019C/D (pcb 062-364C/D)
With Serial Number 993400
(C and D: the same circuit, but minute pattern differences)
Interchangeable with B version with small modifications.
Refer to no. 3 above, and pp. 12-2, 13 and 19.

Protecting IC20 against breakdown
With S/N 891900
(181-019B)

Preventing IC13 and IC14 from misreading D/A outputs
With S/N xx3800
(181-019 C/D)

Primary Circuit Change
Circuits in dash circles concern VCF control system.
The modifications show constant voltage application for use together with Module
board 181-020 -D, -E or -F, while original ones for 181-020 -A, -B or -C.
(Refer to pp. 12 and 19.)
### INFORMATION ON DESIGN CHANGES

Some of circuit-design-changes involve modification on more than one PCB, causing matched parts to be used. Replacement PCBs supplied from the factory may be the latest version and can fulfill the purpose with or without minor modifications.

### PART 1 PCB IMPROVEMENTS & COMBINATIONS

See page 16-2 (PART 2) for:
Details for the PCB listed below
Design changes on sole board
Other major improvements

#### BASIC COMBINATION

<table>
<thead>
<tr>
<th>MOTHER BOARD</th>
<th>MODULE BOARD</th>
<th>MODULE CONTROLLER</th>
<th>SERIAL NO.</th>
<th>KEY ASSIGNED</th>
<th>CONTROL BOARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>181-019B (052-364B) with Q15 and Q16</td>
<td>181-020B or C (052-314B or C) without Q20, Q21</td>
<td>181-021 A, B or C (052-235 A, B or C) R36 = 22K</td>
<td>750100</td>
<td>181-022 A or B (052-032 A or B) IC (PORTA.) VR3 = 2MA</td>
<td></td>
</tr>
<tr>
<td>181-019 B (052-364 B) without Q15, Q16</td>
<td>181-020 D (052-314 D) with Q20 and Q21</td>
<td>R36 = 47K</td>
<td>790799</td>
<td>181-009 C or D (052-331 C or D) BA662 VR3 = 50KB</td>
<td></td>
</tr>
<tr>
<td>181-019 C or D (052-364 C or D) with translator mounting holes to accommodate Q15 and Q16 for modification</td>
<td>181-021 D or E (052-235 D or E)</td>
<td>R36 = 47K</td>
<td>800800</td>
<td>181-009 D (052-331 D)</td>
<td></td>
</tr>
</tbody>
</table>

VCF: current control by Q15, Q16 (constant current sources) needs some modifications (see P.19)

just change R36

VCF: voltage control by IC027, IC28 via Q20, Q21 (V-T converters)

VCF IC: BA662

VCF IC: 1R3109

VCF ADJUSTMENT: partially different from B/G/D versions Additional ADJ. SECTION 25 VOF INV. (VR11) effective with S/N 4100

---

#### INTERCHANGEABLE

REDUCING NOISES ON GROUND PATH
CONTROL BOARD A, B, C

Noises are induced on GND of these PCBs while the ground path is passing through Mother board to DC source, causing ripples to be superimposed on Control board output voltages.

To by-pass N board, the jumper leading to A4 pin no.1 is removed. A wire is placed between the GND and ground lug on top panel as shown below.

This modification would be effective if frequency fluctuates during VOF oscillation with RMS knob raised.
All Sliders on the PROGRAMMABLE section are set at "0"

Control Panel

A/D CONV

Memory
B/A CONV

1 or 2-bit Data

Latches

D/A CONV

Microcomputer

3-bit Data

Synthesizer

Figure in TP column in the table to immediate right and figures at top of the other tables refer to test points shown in the PCB layout below. The following applies:

1. For sliders: voltage will vary within the range of 0V to +5V as the designated slider is being moved.

2. For switches: the output will be a logical 0 (low) or 1 (high)

(0V,+2.5V),(-5V,+5V), (0V,+5V), depending on the lever position.

In replacing the Mother board, check both the existing board and the new replacement board for existence or absence of Q15 and Q16. If different, see page 19 for modification.
SUPPLEMENT PAGE 16

IC3 106 Designation
MM4069R8 is dominant because of its greater S/N ratio, but
its threshold varies from IC to IC within slightly larger
range when compared with other brands.
These variations in threshold are compensated for by changing
the value of R52 and R53 from 530k to 390k ohms.

CHORUS ENSEMBLE BOARD 181-023E
(Etch mask 052-236E)

Compatible with 181-025C
(Effective S/N is not set forth at the date of issue.)
Clock Oscillators and BBD drivers are different from those on
181-025C and are disabled during ENSEMBLE "off" mode. No Clock
leakages in off-mode.
IC SPECIFICATION

Although most of ICs of various makers are interchangeable, because of JP-4's seven design factors, some of them must be selectively used in accordance with designations on the circuit diagram for sufficient performance.

1. Brand Classifications

<table>
<thead>
<tr>
<th>PCB</th>
<th>DESIGNATION</th>
<th>MANUFACTURER</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODULE CONTROLLER 161-021</td>
<td>101-103 ODA069UBB</td>
<td>RCA</td>
</tr>
<tr>
<td>MODULE BOARD 161-020</td>
<td>105 Y04069UBB</td>
<td>Toshiba</td>
</tr>
<tr>
<td>CHORUS ENSEMBLE 161-025</td>
<td>A B C</td>
<td>06</td>
</tr>
<tr>
<td>KEY ASSIGNED 161-022</td>
<td>1012 Y04069UBB</td>
<td>Toshiba</td>
</tr>
<tr>
<td>1011</td>
<td>ODA069UBB</td>
<td>exclud RCA</td>
</tr>
<tr>
<td>1014</td>
<td>Y04013</td>
<td>Toshiba</td>
</tr>
</tbody>
</table>

READ THROUGH ADDITIONAL PAGES

(with a suffix)

Even if they seem to have no relation to the work being done based on original pages. Some of the contents on additional pages will supplement or correct those on the original pages; may include improvement on early products, since originals are kept unchanged as possible.

Often on several pages, will appear the same explanation that makes it well understood. These pages have interrelations in terms of alteration, job combination and so forth.

2. Quadruple-use of the same IC

The quadruplicate stages in the 4-voice JP-4 circuits require the same IC to be mounted for the same tonal characteristic.

MODULE BOARD 161-020, 161-024 4076 for concurrent 161-020 161-024 4075 ATTACK TIME

the same brand for four modules

BA662 factory selected with a point dot

Ideally, each of the following groups must be in complete set of the same color, but one or two ICs on a PCB would be of a color in a range 2 of the group grade. See color code shown in the table below.

MODULE BOARD 161-020 A/B/C/D 161-021 161-024 161-020 X 161-022 of the same color for four modules for simultaneous tonal change

KMT ASSIGNED 1013-1016 161-020 for synchronous Portamento time

BA662 color code

<table>
<thead>
<tr>
<th>grade</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>color</td>
<td>red</td>
<td>red</td>
<td>red</td>
<td>red</td>
<td>red</td>
<td>red</td>
<td>red</td>
<td>red</td>
<td>red</td>
</tr>
<tr>
<td>or</td>
<td>yellow</td>
<td>white</td>
<td>black</td>
<td>black</td>
<td>black</td>
<td>black</td>
<td>black</td>
<td>black</td>
<td>black</td>
</tr>
</tbody>
</table>

Mixed use of BA662A and BA662B is allowed for above applications.

1R3109 (top view)

The 1R3109 contains four variable transconductance amplifiers designed for VFO applications in electronic musical instruments.

The device is equipped with four high input impedance buffers, and anti-log circuitry (V-in to I-out) which controls conductances of four amplifiers.

- wide transconductance variable range (μA/mV to 10mA)
- low input offset voltage (less than 1mV) (transconductance amplifier)
- high input impedance. MOS P-channel (buffer)

NOTE:

Unfulfilled serial numbers indicate that no effective numbers are predictable at the issue date of 2nd edition. First 2-digit in serial number increases by 1/month and is reset to 00 after 99.
IMPROVEMENTS on MODULE BOARD and ITS PERIPHERIES

The VCF circuit on the Module Board has been changed for easier Resonance adjustment and this change affects the Mother and Module Controller boards. Simplified circuits shown below illustrate the differences between the new and the old configurations.

Basic differences between the designs:

Old circuit (right) Current from Constant Current Sources Q15 and Q16 is shared with four IGOs. Changing one trimmer changes the loads and upsets the balance of the other modules. Adjusting the trimmer so as to accurately divide the current sources is difficult.

New circuit (left) In the new circuit, the trimmers are independent of each other because they are supplied from constant voltage sources, I027 and I028. Q20 and Q21 serve as V-I converters.

Information about REPLACEMENT, MODIFICATION and ADJUSTMENT

1. Replacement
   Replacement will be a new one, it requires some modifications on its own when it replaces the old one. Or it requires other PCBs to be modified when a "VCP" is needed.
   Note that Modules A, B, C and D in the same JP-4 must be identical.

2. Modification
   - Module Controller -
     Just change R36 in value.
   - Mother Board -
     Being of the same pattern, can easily be modified.

   - Module Board -
     New to Old
     Follow the dotted lines; solder resistors in R70.
     When VR4=47K, R135=22K, 47K and 22K in the dotted parentheses are not required.
     Old to new Practically difficult, no component holes in the PCB to accommodate Q20 and Q21.

3. Adjustment
   Some steps are different between versions:
   Section 11. VCF Resonance
   052-314 A/B/C -- 11-A
   052-314 D/E -- 11-B
   Section 25
   052-314 B only

MODULE BOARD 181-020C (Etch mask 052-314C)
Read description on this page when replace this PCB.

181-020D or E
(052-314 D or B)
Serial number 600800 and higher

181-020C (052-314C)
Serial no. up to 790799
BA662
Besides BA662A and BA662B, there are factory-selected BA662's which are marked with paint in different colors according to their electrical characteristics.
When replacing:
1. BA662A's are good replacements for BA662B's.
2. BA662B's cannot be used for BA662A's.
3. In any Module Board, factory-selected IC's must be a set of the same color.
   (except IC6 -- non selected)

Pins jumper wired:
IC3 pin 3 ---- IC4 pin 14
DIFFERENCES FROM THE PREDECESSORS

Using IC12 IR3109 for VCF in place of BA662 selected.
Adding VCF INV ADJ. for easier preset "VOICE" sound tailoring.

Though interchangeable with former PCBs, the following are involved when replacing:

Different steps for VCF FREQ and WIDTH adjustments
Some alterations on this pcb - when existing one is 181-020 B or C - to meet circuit configuration indicated on p.19 (in this case read 181-020D as 181-020E).

SUPPLEMENT p.21

BA662 (also see p.16-2 "2")

The BA662 is a current controlled variable transconductance (vari-gm) amp custom made for Roland products. Device with A suffix features lower offset coefficient than one with B suffix. "A" can replace "B" except when "gm" is a great factor.

Some devices miss suffix at IC maker and need markings wherever stored for future use.

Factory Selected (colored) BA662
BA662's are further graded based on "gm", painted in a color. Both "A" and "B" in the same color are characterized by a gm in the same range.
Colored IC can replace uncolored one on which no specific gm is placed by the circuits. Factories might use selected ICs for non-selected in assembling PCBs, if colored ICs are surplus, in stock.

CORRECTION

p.20 Trimpot, VR number
RESONANCE VR-4 to VR-5
VCF ENV VR-3 to VR-4

p.21 3. In any Module .... to
3. In any Module Board as well as in four models, factory selected ICs should be a complete set of the same color except IC16.

See p.16-2 IC SPECIFICATION 2.
CHANGING of VCF is to 1R3109 (IC12) involves some modifications on peripheral circuits whose designations are shown in type-written.

SUPPLEMENT on 181-020D Diagram
C36 and C37 S/N 861500-
Filter out pulses induced on 20V IN

uAT26HC (IC2)
Factory selected with color dot
Resistance of R8 is to be determined according to the color on IC2.

Red -- 82K
Green--100K
Non --120K

to MOTHER BOARD A5, 12, 16, 20

to MOTHER BOARD A7, 11, 15, 19

NOTE: R63 & R154 are "PREMARKS only"

IC 11, 17, 18: BA662 selected (same color)
IC 16: BA662 B
IC 4: TC4069UBF or CD4069UBB

21-2
Differences between PCBs with different suffix:

- No differences in circuit configuration.

C suffix vs D or E suffix: Components which are surface mounted (at foil side) or series-connected outside component holes on C suffix are accommodated in holes on D or E.

D suffix vs E suffix: Only conductor spacings at terminal areas are different.

Holder No.185A
Nylon rivet MRP-345

DL-D6 Cathodes

CLKs (TC4049) Outputs

Moving the A, D or R sliders from bottom to top will increase the frequency by approximately 1000.

Wafer terminal 5045-10A

Wafer terminal 5045-06A

Holder No.184A
Parts attached on foil side:
D2, D3 ---- 1S1588
C3 -------- 22pfd

NOTE:
BA662A can replace BA662B.
Factory selected BA662's (painted) must be a set of the same color.
When a PORTAMENTO TIME is not coincident with other Modules' due to IC replacement,(IC13-IC16), cut and try the capacitor. (C13-016)

CONTROL BOARD G 181-013
(Etch mask 052-336)

View from foil side
All trimmers
CR19R 47KB
KEY ASSIGNER 181-022C (pcb 052-032C)

Serial Numbers 952750-952799
952850-

NOTE: S/N 952800-952849
181-022B

to CONTROL BOARD D
J-4

181-022B and 181-022C
INTERCHANGEABLE
With PORTAMENTO (VR-3)
on CONTROL BOARD D
changed as PCBs change:

181-022B--VM10RB10C
K20 2MA

181-022C--VM10RB10C
K20 50KB

ADJUSTMENT
PORTAMENTO - VR2
C version only

IC13 1R3109
Four circuits on one chip provide synchronous Portamento Times.

IMPROVEMENTS ON 181-022B

Capacitors and Diode for IC11 protection
S/N 861500-
C26, C27 and D4 are connected to IC 4052 as shown in dashed circles
on circuit diagram, facing page, to protect it against breakdown due
to charged voltages.

Connector By-Pass Wirings - for stable CV and VCO voltages -
Compensation for loose-connections
S/N 861500-
Plugs and receptacles on D7 (Key Assigner) and J-4 (Control Board D)
are solder jointed, or leads are directly soldered on conductive
foils at terminal areas. This treatment also eliminates impedent
Portamento effects in PORTAMENTO OFF mode.

S/N 871600-
Besides original wirings through connectors, -15V and Ground for
Key Assigner are fed through additional sole wires from Power
Supply board to D5 pin 3 (-15V), and pin 1 or 2 (GND). Lead ends
are soldered at the foil side.
(Refer to p. 26-1 Power Supply Board.)
POWER SUPPLY BOARD 181-024F
(Etch mask 052-327F)
Serial No. 800600 and higher

DESTINATIONS of CONNECTORS
E1: Mother Board TC30 (Output Mixer)
Control Board D via Module Controller B5(1,2,3)
Module Board C3(2,6,9) VCP, VCA, ENV GEN
E2: Mother Board Module Board C1(1-4)
Key Assigner Dc, Control Board(except D)
Module Controller B3(7,8,9) B4(1,2,3)
E5: Chorus Ensemble Board F1
E5: Power Indicator (LED)

POWER TRANSFORMERS
022-118CH 100V
022-118CC 117V
022-119CD 220/240V

FUSES
AD  F1-F3  F4
100/117V  SMD0002(2A)  SMD0001(1A)
(008-026)  (008-026)
220/240V  GEB T2A  GEB T500mA
(008-070)  (008-065)

181-024C
Right
Serial No. up to 790799
Use 181-024F for replacement

DIFFERENCE BETWEEN
181-024 B and F:
only conductor spacing
REPLACING PCB INVOLVES ADJUSTMENTS

After replacing PCBs, the following adjustments must be performed.

**POWER SUPPLY BOARD**
(including IC change on this board)

**KEY ASSIGNER BOARD**
Sections 2-3

**MODULE BOARD**
Sections 7-20 except CHORUS

**MODULE CONTROLLER BOARD**
Sections 7-26 except CHORUS

**MOTHER BOARD**
Sections 4-24 except CHORUS

**CHORUS ENSEMBLE BOARD**
Sections 27-28

**DIFFERENT ADJUSTMENT BETWEEN SERIAL NUMBERS & VERSIONS**

Before replacing PCB, refer to pp.12-2, 16-2 for compatibility, modifications involved or PCB combination.

Some adjusting sections and steps are selectively applicable to particular PCB as shown below.

1. Steps are different from for other versions.
2. Sole adjustment to this version.

<table>
<thead>
<tr>
<th>SERIAL NO.</th>
<th>KEY ASSIGNER</th>
<th>MODULE BOARD</th>
<th>CONTROL BOARD A</th>
</tr>
</thead>
<tbody>
<tr>
<td>750100</td>
<td>052-052</td>
<td>052-314</td>
<td>052-330</td>
</tr>
<tr>
<td>750799</td>
<td>A or B</td>
<td>052-314 A or B</td>
<td></td>
</tr>
<tr>
<td>800800</td>
<td>052-032</td>
<td>052-11-12</td>
<td>052-235</td>
</tr>
<tr>
<td>802549</td>
<td>A or B</td>
<td>052-11-12</td>
<td></td>
</tr>
<tr>
<td>852750</td>
<td>052-032</td>
<td>052-314</td>
<td></td>
</tr>
<tr>
<td>852799</td>
<td>052-032</td>
<td>052-11-12</td>
<td></td>
</tr>
<tr>
<td>926800</td>
<td>052-032</td>
<td>052-314</td>
<td></td>
</tr>
<tr>
<td>952849</td>
<td>052-032</td>
<td>052-11-12</td>
<td></td>
</tr>
<tr>
<td>952890</td>
<td>052-032</td>
<td>052-314</td>
<td></td>
</tr>
<tr>
<td>.4100</td>
<td>Section 3</td>
<td>052-11-12</td>
<td></td>
</tr>
</tbody>
</table>

**CAUTION**
- Four Trimmers, CONTROL BOARD G -

Always set these trimmers at midpoint before starting adjustment of V00.

Readjust them for fine tuning the V00s - about an hour after the calibrated and completely reassembled unit is kept power on - to compensate for drifts in temperature surrounding IC uA726 (Module Board).

**UNISON 1**
**UNISON 2**
**POLY 1**
**POLY 2**

<table>
<thead>
<tr>
<th>KEY DESIGNATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0V</td>
</tr>
<tr>
<td>1V</td>
</tr>
<tr>
<td>2V</td>
</tr>
<tr>
<td>3V</td>
</tr>
<tr>
<td>4V</td>
</tr>
</tbody>
</table>
KEY ASSIGN LOGIC

In adjusting JP-4, it is important to know which module is being activated when a given key is pressed.

POLY-1

If one key is depressed repeatedly: Module is changed to the next one in sequence.

After pushing ASSIGN MODE to another mode and back to POLY-1, the key first pressed will be for Module D.

POLY-2

Tapping one key never changes modules. Flural keys must be pressed in the order of number indicated at the left before desired module is triggered(except A).

TO GET AT A TARGET MODULE: Press keys to the number referring to above illustration.

MODULE A ---- press key
MODULE B ---- press and hold 1 and 4, then release 1
MODULE C ---- press and hold 1, 2, and 4, release 1 and 2
MODULE D ---- press and hold 1, 2, and 4, release 1, 2, 3

1. DC VOLTAGE (−15 Volt) POWER SUPPLY BOARD

IMPORTANT

Checking the DC voltages is the must before attempting any adjustment.

Allow five minutes warm up for circuits stabilization

Connect Digital Voltmeter to TP-1.

1. Adjust Trimmer 1 for −25.000 ±10mV.

The remaining voltages should be:

+5.000±50mV
+15.000±50mV

2. KEY ASSIGNER (CV and WIDTH) KEY ASSIGNER BOARD

IMPORTANT!

ASSIGN MODE ---- UNISON-1
PORTAMENTO ---- OFF

Connect digital voltmeter to TP-2 or Q16 source (A or B version).

1. Press C0 key and set TUNING on front panel for 0.000V.
2. Press C4 key. Set Trimmer 2 for 4.000±20mV.
3. Confirm:
   C1 ---- 1V
   C2 ---- 2V
   C3 ---- 3V

BASIC CONTROLS SETTINGS

*Trimmer 31(P. IVK) of Module Board 052-5348 (later version, 4/30 44100-)
All midpoint.

These settings allow each adjustment step to be made with minimum reset.
3. PORTAMENTO

Applicable to Serial Numbers 952750-952799
or PCB 052-032 C

IMPORTANT! Replacement of 052-032 A or B with C necessitates change of VR 5
3MA on Control Board D to 50K to retain the time constant by
compensating for difference between circuit configurations.
See p. 12-2.

4. LFO WAVEFORM

Connect oscilloscope to TP-4.
1. Adjust trimmer 11 for straightness.

5. LFO RATE

NOURHER BOARD

Connect scope to TP-4 on NOURHER BOARD.
1. Set trimpot 12 (Mother Bd) for
5Hz or 200ms sawtooth waveform.

6. LFO OFFSET

CONTROL BOARD A

Applicable to S/N up to 790799

Test point: TP-4 (NOURHER BOARD)
1. Set trimpot 13 on CONTROL, BD A
(052-235) so that NOUR-WIDE
switching produces no frequency change.

TRIMPOT LOCATIONS ON MODULE BOARDS OF DIFFERENT VERSIONS

Although trimmer potentiometers on every module are arranged in the same order
(except 31 on later B version), spacings are different.
This difference will help when distinguishing versions.

052-314 A or B (S/N up to 790799)

052-314 D (S/N 800800-942749)

052-314 K (S/N 952750-xx4099)

052-314 K (S/N xx4100 and above)

JP-4

FEB. 23. 1981
7. VCA LEVEL  MOTHER BOARD

For TP-3 Location, see illustration above Section 18.

8. VCA BALANCE  MOTHER BOARD

PUSH BUTTON: POLY-2, MANUAL
TEST POINT: TP-3 (MOTHER BOARD)

Use above key pressing order.
Minimize click noise from individual Module Board (A,B,C,D) in the following way.
While holding down key(s), tap key repeatedly and turn trim pot.

9. VCO WAVEFORM (Pulse width 50%)  MODULE BOARD

PUSH BUTTON: POLY-2, MANUAL
TEST POINT: TP-3 (MOTHER BOARD)

With key pressing order used in Section 7, set trimmer 7 for duty 50%.

10. VCO FREQUENCY and WIDTH  MODULE BOARD

PUSH BUTTONS: POLY-2, MANUAL

VCO can be calibrated in different manners: scope, tuning meter, Linar/sine, zero beat, etc. Below is an example using scope for coarse adjustment and zero beat for fine tune.

Set up instruments as shown in Fig. 2.
Set four trimmers of Control Board 0 to midpoint.
Use key arrangement shown in Section 7, reading the key designation as a one suitable for adjusting step.

1. While playing two keys alternately, set trimmers of Module Board A for a step in between, result is jolting or jittering output since control voltage jumps up and down between these two steps.
2. Repeat trimmings and finish with zero beat method.
3. In the same way, calibrate the remaining Modules B, C and D.

Figure A shows Linar/sine figure for reference. When using this method, change the set-up in figure B as follows: standard 500Hz into sine wave, scope EXT TRIG to HBR VARI (External Sweep, X-Y),
Fine tune by ear, listening to zero beat.

EFFECTS OF DIGITAL VOLTAGE ON ADJUSTMENTS

Moving of slider on the panel delivers control voltage in series of steps to the subsequent stage which in turn varies its parameter in digital steps. When the slider is set midway between steps, result is jolting or jittering output since control voltage jumps up and down between these two steps.
Significant effects may be seen on adjustment sections are: VCF, VIBRATIONS FRQ., WIDTH, MODULATION DEPTH, etc. In which slider is to be set midway travel range. In such a case, set knob at a point where waveform jolts positively.
Some divergences from the value specified by adjustment steps may be negligible or may be compensated for by other manners.

Fig. A
Fig. B
11. VCF RESONANCE

APPLICABLE SUBSECTIONS
11-A S/N up to 790799 or PCB 052-314 A/B/C
11-B S/N 800800 and above or PCB 052-314 D/E

PUSH BUTTONS: POLY-2, MANUAL
TEST POINT: TP-3 (MOTHER BOARD) or Output jack

CAUTION
Proceed Sections 11 thru 14 in the order numbered.
The purpose of this adjustment is to have the four modules begin resonating
at a point and produce equal amount.

NOTES:
1. Panel setting and test point are common to all versions.
2. Use key pressing arrangement shown in KEY ASSIGN LOGIC or Section 7.

IMPORTANT
1. Before starting actual adjustment, read through the steps in a subsection
to have the conception of an adjustment.
2. Since this is a relative adjustment, first try to coarse, then fine tune.
3. Amplitude in resonance depends greatly on RHE knob position. Resetting of the
knob is sometimes required to keep VCF resonating and delivering output
within a range 200-300mVp-p at which accurate adjustment can be established.
4. If waveform fitter seen on a scope, shift corresponding knob slightly referring
to "EFFECTS OF DIGITAL---" on the preceding page.

11-A. Serial Number up to 790799 or PCB 052-314 A/B/C

Unlike D or B version, this adjustment is to
divide constant current source into four to
duplicate circuit condition. Turning one
trimmer out of balance will increase or
decrease current flowing into other three
modules. These trimmings are touchy and would
have to be repeated quite a few times for
accurate setting.

1. Check each module and determine which voice is highest amplitude.
2. With trimmer 18, lower the highest. This will increase other modules' level,
then lower the new highest, then to next until four modules are equal in
amplitude. Keep amplitudes close 200mVp-p with RHE knob; if one module mis-
resonates, up the knob a little. Repeat trimmings until none is outised.
3. Make sure that all modules begin resonating simultaneously when RHE
is raised to 7-8.

11-B. Serial Number with 800800 or PCB 052-314 D or E

1. With trimmer 18, find a module least accessible to 200mVp-p. Set other
modules for that value with trimmer 18.
2. Set RHE for 200mVp-p. Check all modules for nip-resonance, is any, readjust
trimmer 18 of missing module for resonance. If this module won't resonate,
slightly up RHE to 200mVp-p (can be read as 500mV if convenient) then
readjust other modules to 200m or 300mVp-p.
3. Make sure that all modules begin to resonate at the same RHE position and
show equal output in amplitude.

12. VCF FREQUENCY AND WIDTH

TEST POINT:
same as for Section 11 but RHE knob at "10"

INITIAL SETTING:
used for different methods. Below describes

NOTES:
1. Use key pressing arrangement shown in KEY ASSIGN LOGIC or Section 7.
2. Panel setting and test point are common to all versions.
3. Use reference sine wave of 880Hz to scope V-In and
adjust time base (B) for 2 cycles across graticule. Disconnect reference note from, and connect TP-3 or
JP-4 output jack to V-In.

1. Press A2 key. Adjust trimmer 14 of Module A for
figure right. If waveform is jolly because of
reason explained on the preceding page below
Section 10, slightly move CUTOFF knob for stable figure. Adjust trimmer 14
for exact 880Hz.
2. Set JP-4 FILLow switch to 3. The frequency will shift high. Lower CUTOFF for
880Hz. Avoid waveform from joggling, fine tune with TUNING knob.
3. While playing A3 and A1 keys alternately, adjust trimmers 14 and 15 respectively for fig. right.

NOTE:
Trimmers corresponding to two keys are completely reversal between version groups.
S/N up to 942749 or
PCB 052-314 B/C/D
S/N 852750 and up or
PCB 052-314 E

4. Repeat step 5 for the remaining modules using A module's as a reference.

Note that the filters will never track as well as the oscillators. Best notes counting up to 10/second are considered within tolerance. As for the beats in excess of 10, they can be reduced by fine tuning trimmer 14 of those pbs.

13. VCF ENVELOPE BALANCE

TEST POINT:
same as for Section 11. NOTE: POLARITY - NORM

INITIAL SETTING:
used for different methods. Below describes

To let your left hand free from key play,

1. While pressing A2 key for module A,
push HOLD into OR.
2. While moving ENVELOPE MOD slider 0
to/from 10, adjust trimmer 16 of A
module for no frequency change.
3. Release HOLD to OFF.
4. Duplicate steps 1-3 for other three
modules.

JP-4
FEB. 23, 1981
14. VCF ENVELOPE MODULATION DEPTH

Module Board

TEST POINT: TP-3 (MOTHER BOARD)  FUSE BUTTONS: POLY-2, MANUAL

1. Press A2 key, set trimmer 17 of Module board A for 500Hz.
2. Adjust remaining modules B, C and D to 500Hz using module A's output as a reference signal. This can be done by displaying two waveforms at a time in the following key plays:

- Module B: Press and hold G2 key, then A2 key.
- Module C: Press and hold keys in this order; F2, G2, A2, release G2 only.
- Module D: Press and hold; E2, F2, G2, A2, release F2, G2.

These frequencies may not have to be at exact 500Hz, but as close to each other as possible.

15. VCA ENVELOPE ATTACK

Module Control Board

PUSH BUTTONS: RELEASE & HOLD - OFF,  POLY-2 & MANUAL - ON

Adjustment can be done either by observing screen on scope connected to TP-3 (MOTHER BOARD) or by listening to one note through speaker. Use stopwatch for timing.

In the following key pressing order, find the shortest Attack time. Note that key(s) once pressed should be kept held down until 4th module is measured.

- Press and hold A1 key for Module A.
- Press and hold B1 key for Module B.
- Press and hold G2 key for Module C.
- Press and hold D2 key for Module D.

Adjust trimmer 19 so that the shortest attack time becomes 3 seconds. The same key for that module may be pressed any number of times provided key(s) for preceding module(s) is being held down.

Check remaining modules for attack time. Acceptable variations 0 to +40%.

16. VCA ENVELOPE DECAY

Module Control Board

(Four seconds in Sections 16 & 17 means the time required for the envelope to decrease in amplitude 1/10 of its maximum value.)

Change panel setting in Section 15: ATTACK to 0; DECAY to 10.

Use the same procedure as in Section 15 VCA ATTACK, but adjust trimmer 20 so that shortest decay time is 4s. Acceptable variations: 0 to +40%.

17. VCA ENVELOPE RELEASE

Module Control Board

Change panel setting in Section 15: ATTACK to 0; SUSTAIN, RELEASE to 10.

Use the same procedure as in Section 15, but adjust trimmer 21 to set the shortest release time for 4 seconds. Acceptable variations: 0 to +40%.

18. VCF ENVELOPE ATTACK

Module Control Board

PUSH BUTTONS: RELEASE & HOLD - OFF  POLY-2 & MANUAL - ON

Use the key pressing arrangement given in Section 15 VCA ATTACK but the last key pressed should always be G2. Note the attack time for 4 VCFs. Attack time is defined as the time from pressing the key to the time when the increasing frequency drops suddenly.

Using the same key pressing method, adjust trimmer 22 so that the shortest attack time noted becomes 3 seconds.

Check that the remaining attack times are within 3 seconds + 40%.

19. VCF ENVELOPE DECAY

Module Control Board

Change panel setting in Section 18: ATTACK to 0; DECAY to 10.

Use the same procedure as in Section 16.

Determine Decay time for each module in the following manner.

While tapping G2 key, adjust scope sweep and sync controls to display ten cycles on the screen, depress the key; measure the time required for the waveform to become one cycle.

Adjust trimmer 24 so that the shortest decay time noted becomes 4 seconds.

Check that the remaining decay times are within 4 seconds +40%.

20. VCF ENVELOPE RELEASE

Module Control Board

Change panel setting in Section 18: ATTACK to 0; SUSTAIN, RELEASE to 10.

Use the same procedure as in Section 18.

Determine release time for each module in the following manner.

While pressing G2 key, adjust scope sweep and sync controls to display ten cycles on the screen, release the key, measure the time required for the waveform to become one cycle. It will be necessary to increase LEVEL as VCF output decreases.

Adjust trimmer 24 so that the shortest release time becomes 4 seconds.

Check that the remaining release times are within 4 seconds +40%.
21. LFO VCO MODULATION

Module Control Board

Test Point: TP-10
Scope: V. IN - AC coupling
ground - GROUND 3 (Mother Board)

Set trimmer 25 for:

Earlier models: 150mVp-p
Decrease to 130mVp-p if any VCO is modulated
by LFO in this setting.

22. LFO VCF MODULATION

Module Control Board

Panel setting: same as above but
VCF MOD to 5
Test Point: TP-11
Scope: same as above

Set trimmer 26 for:
S/N up to 750kHz - 300mVp-p±10%
S/N 750kHz and up - 100mVp-p±10%

23. LFO VCA MODULATION

Module Control Board

Press C2 key, turn BENDER lever to
extreme right.
Set trimmer 27 for 100% modulation.

24. HPF CUTOFF FREQUENCY

Module Control Board

Push Button: MANUAL, HOLD, POLY-2 ON
Test Point: TP-3 (Mother Board)

Low HPF CUTOFF FREQUENCY
High

With HPF CUTOFF FREQUENCY set at HIGH, press C4 (highest key)
and adjust trimmer 28 so that trailing edges terminate
on the horizontal line. The waveform must be restored
to rectangular when the knob is turned to LOW. If not,
slightly reverse the trimmer.

25. VCF INV

Applicable to S/N xx 4100 and higher or PCB 052-314 E
w/trimmer 31 (VR11 on circuit diagram)

Module Board

Just change above panel setting by pushing VOICE in.

This adjustment should be made only after finish of all other VCF adjustments
and should follow immediately Section 24 with VOICE button pushed in.

Observe every module board's waveform on the screen, adjust trimmer 31 for uniformity in
shape and in level.

26. NOISE LEVEL

Module Control Board

Test Point: TP-9 (R94)
Connect scope ground to GROUND 3 on Mother board.

Set trimmer 29 for: 3 Vpp
27. CHORUS

Although circuit configuration and PCB layout are different between 052-236 and 022-236, they can be adjusted in the same manner.

GROUND-4

FUSE SETTINGS: POST-2, MANUAL

GROUND-4

FUSE SETTINGS: POST-2, MANUAL

VOICE OUTPUTS A & POINT B (10-pin)

---

28. OUTPUT LEVEL

CHORUS VOLUME BOARD

PULL RESISTOR: FUSE-2, BUILT-IN, MANUAL

TEST POINT: TP-6
