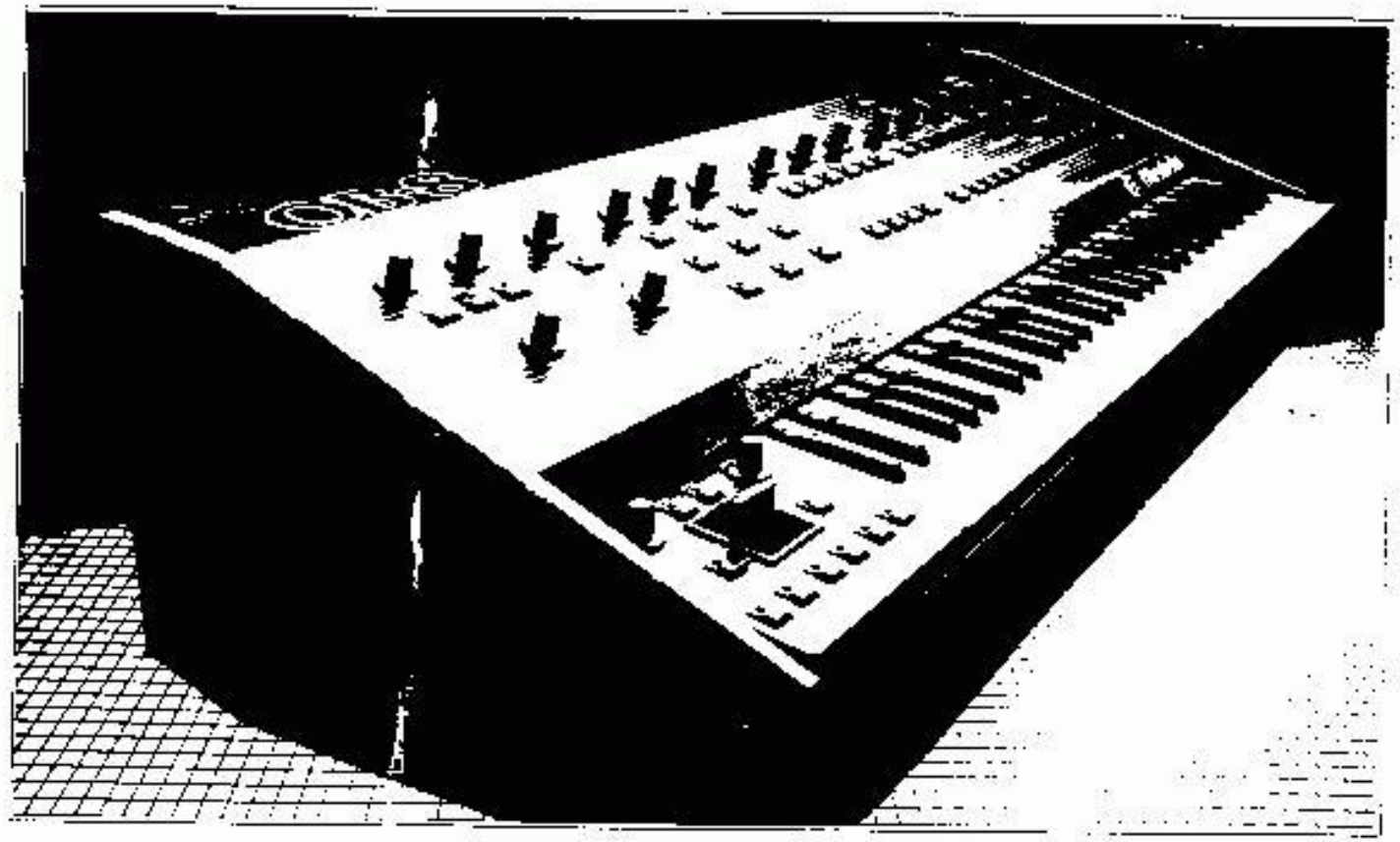
OBERHEIM ELECTRONICS INC.

SERVICE MANUAL

OB-8



OBERHEIM ELECTRONICS, INC.
2250 South Barrington Avenue, Los Angeles, California 90064, (213) 473-6574, Telex 6831071 Oberhm

OB-8

SERVICE MANUAL

First Edition

January 1983

This manual applies to units starting with Serial Number C30101.

Part Number 950020

TABLE OF CONTENTS

INTRODUCTION

The OB-8 is the latest development in the evolution of Oberheim synthesizers. The design philosophy behind it was to take all of the features of the OB-Xa, add as many new features as were economically feasable, and redesign all of the circuitry for increased reliability and lower cost. The result is a synthesizer with 90 fewer calibrations and 11 less circuit boards, and with many of the remaining calibrations microprocessor assisted. The circuitry and the trimmers that were eliminated have been replaced with software functions in the microprocessor which simulate the replaced hardware. Some of these functions are explained below.

VCO TRACKING

The volts per octave (scaling) parameters of the 16 oscillators in the OB-8 are adjusted by the microprocessor whenever the AUTO button is pressed. The processor samples 5 different frequencies for each oscillator and calculates the proper correction voltage to bring each oscillator in tune. This voltage changes depending on the final pitch desired from the oscillator. There is a rough trimmer adjustment for each oscillator's volts per octave in order to get the oscillator within the range in which the processor can calibrate it. If this calibration is out of the acceptible range, it may be noticed by either AUTO TUNE failing that oscillator, or excessive beating between it and other oscillators while it is BETWEEN half steps. The reason for this is that the processor compensates for scaling of the oscillators for each half step, requiring that the oscillator be callibrated well enough so that the tracking between half steps is a volt per octave. If this is out of calibration it can also be percived as steps in the LFO modulation, since the oscillator will jump slightly in pitch as the modulation amount reaches each half step.

LFOs

All of the LFOs in the OB-8 are generated in software. What this means is, the voltage necessary at any given time to simulate LFO modulation is output through the DAC to whatever destination is selected. If, for example, the triangle wave of the LFO should be at its peak, then a high voltage will be output to the destination. When the LFO should ramp down, the voltage is decreased. All of the electronic switches and VCAs normally required with a hardware LFO in order to determine its destination and amplitude are eliminated since these functions are now accomplished in software.

PITCH BEND

The pitch bend and vibrato levers are scanned by the microprocessor and their relative positions are calculated to determine the voltage necessary to bend a pitch up or down, or how much vibrato to add. This eliminates all problems associated with matching 100k resistors in order to send equal voltages to all voices, op amp offsets, and scaling trimmers. There are 2 rough trimmers used to bring the levers into range so that the processor can read them. Once they are in range, the processor re-calculates the center dead-zone of each lever each time AUTO is pressed.

4-POLE FILTER

The OB-Xa had seperate 2-pole and 4-pole filters for each voice, each filter utilizing a CEM3320 with different external components to implement the filter functions. In the OB-8, There is one 3320 per voice, and the external components are electronically switched to generate either a 2-pole or a 4-pole slope. This eliminates the need to calibrate the two filters seperately, since they are now the same filter.

OP AMP OFFSETS

Many sample and hold op amps can affect a parameter if their offset is large. To correct for this, the processor uses a software calibration procedure described later to assist in setting the offset to 0 volts. This adjustment is most critical for the envelope time parameters, since the CEM3310 envelope chips require a control voltage range from 0 to 300 millivolts. The software is able to correct for the offsets by outputting a voltage to the sample and holds that will compensate for the offset. If an op amp has +30 millivolts of offset, the processor will output 30 millivolts less than the final voltage required for that sample and hold, effectively canceling the offset.

OB-8 CALIBRATION PROCEDURE

The following calibration instructions are those followed by the technicians at Oberheim Electronics prior to the shipment of an OB-8. The microprocessor assists in many of the necessary calibrations by indicating which direction to turn a trimmer, and indicating when a trimmer is calibrated by using the test LEDs located on the inside of the front panel circuit boards (they are visible when the lid is open). Even though these calibrations seldom need adjustment, it is a good idea to check them whenever servicing an OB-8.

A digital voltmeter with 4 & 1/2 digits is required to perform some of these calibrations. The rest can be done without any test equipment.

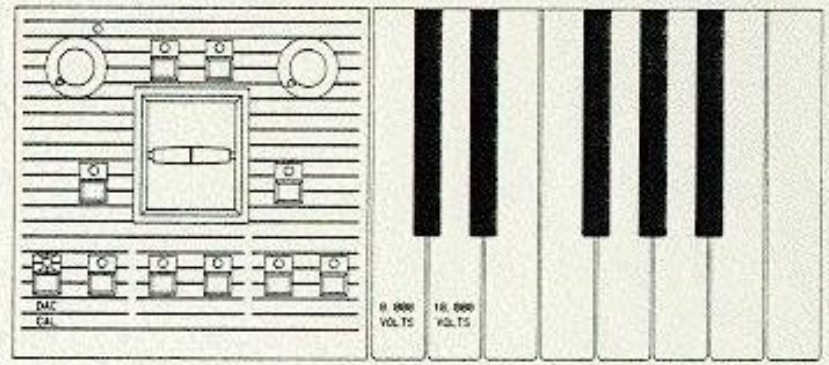
For access to all voices when servicing an OB-8, it is necessary to remove the right wood endbell completely and to remove the top two screws from the left endbell. The four screws holding down the circuit board with the Upper four voices should also be removed, to allow access to the Lower Voices.

The test procedures to follow assume the OB-8 has software version A4 or above. To determine the software version, press the CHORD/PAGE 2 button twice and hold it down the second time (the LED should now be lit), and while holding it, press and hold the SYNC button. The LEDs being displayed in the PROGRAMMER section now show the current version number. If the LEDs light up as version A1 or A2, a few special procedures are required which will be mentioned later in the test descriptions. For software version A3, the only difference is that the output volume offset cannot be calibrated (unless updated to A4 with ECO 410).

First, power the unit on. Verify all voltage sources (+5, -5, +15, and -15) at connectors I and J. Calibrate the +15 supply using T2 to + or -10mv. Calibrate the -5 supply using T1 to + or - 5mv. The +5 and the -15 supplies do not require calibration, but should be verified to be within + or - 5% of their rated value.

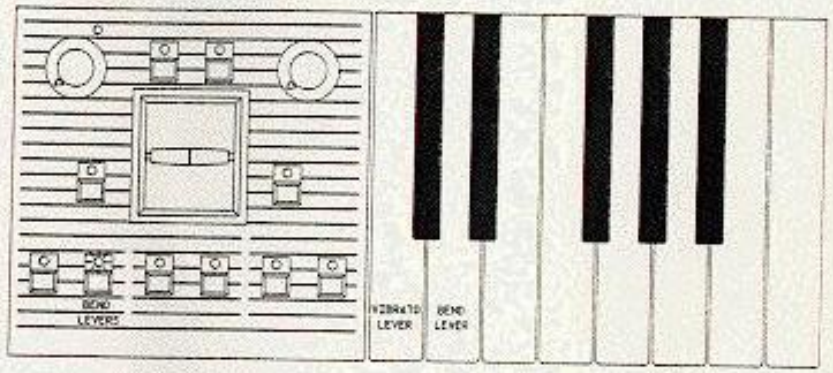
Now, enter the calibration mode by turning the TEST 1 switch on (up). This switch is located inside the synthesizer at the lower left corner of the front panel. All LEDs should now be off except for the OSC 1 MOD LED in the Bend Box. The Bend Box in conjuction with the two leds on the inside of the pot board and the first eight keys of the keyboard can now assist in many of the necessary calibrations. Each button performs a different test or calibration procedure and assists in calibrating 28 of the 56 trimmers in the OB-8.

CALIBRATING THE DAC



Pressing the OSC 1 MOD button in the Bend Box enables the DAC calibration mode. This procedure allows for the DAC offset and scaling to be calibrated, and should be done before any other calibrations (excluding the power supply). Connect a voltmeter to the DAC OUTPUT and AGND test points on the processor board. If there are no test points, the DAC output can be found at pin 20 of U45. Be sure to connect to a ground closest to the DAC. Press C0 on the keyboard. Adjust the DAC OFFSET trimmer (T3) until the meter reads 0.000 volts. Now press D0. Adjust the DAC SCALE trimmer (T4) until the meter reads 10 volts +/- 5mv. Then press C0 again and check that the meter still reads 0.000 volts and recalibrate if necessary. NOTE: The sample/holds to the attack, decay and release controls of the filter and VCA envelopes are enabled during this test so that op-amp offsets may be checked. This is necessary only if version A1 is being used. The procedure is described under SETTING ENVELOPE OFFSETS.

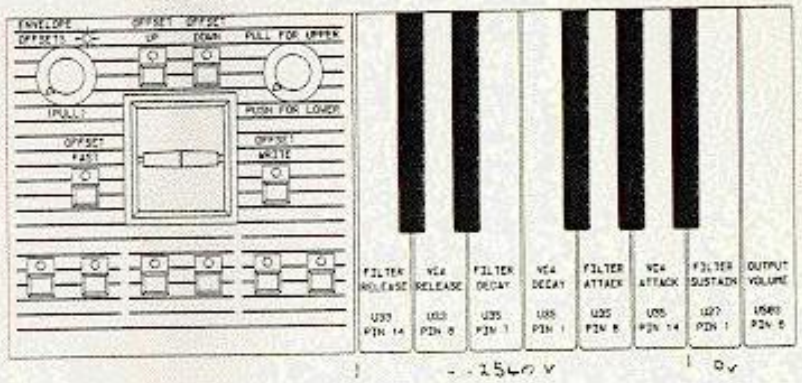
SETTING THE BEND TRIMMERS



When the OSC 2 MOD switch is selected, the Bend Box trimmers can be calibrated. These trimmers are used to roughly center the Pitch Bend and Modulation Levers. First, flick the levers back and forth a little to make sure that they are in their rest position. Press C0. The LOWER LED has come on to indicate that the Modulation Lever trimmer can now be adjusted. Either one or both of the inside Pot Board LEDs (hereafter called test LEDs) will be on. If both LEDs are on, this trimmer is already properly calibrated. If only one LED is on, Adjust the RIGHT trimmer on the Bend Board until both test LEDs are on. Now press D0. The UPPER LED has come on to indicate that the Bend Lever trimmer can now be adjusted. Adjust the LEFT trimmer on the Bend Board until both leds are on. The Bend and Modulation Lever trimmers are now calibrated.

ADJUSTING ENVELOPE OFFSETS

The following procedure should only be done if the envelope parameter times are not matched between the upper and lower four voices. This can by determined by listening for more than a 2 second variation from voice to voice when holding a note with the filter attack set to maximum and the filter sustain and decay set to minimum. This calibration is stored in the memory of the microprocessor and should not have to be reset unless the memory, the battery, or U33, U35, or U27 have been removed or replaced. The purpose of this calibration is to allow the microprocessor to compensate for the offsets of the envelope sample and holds, since these offsets can cause the envelopes to have different time constants. This calibration procedure exists only on software versions A3 and above. For units with A1 or A2 software, envelope matching is done by selecting low offset op amps for use at U33 and U35. The offsets of these op amps can be checked while in the DAC CALIBRATION mode, and should be selected to as close to 0 volts as possible.



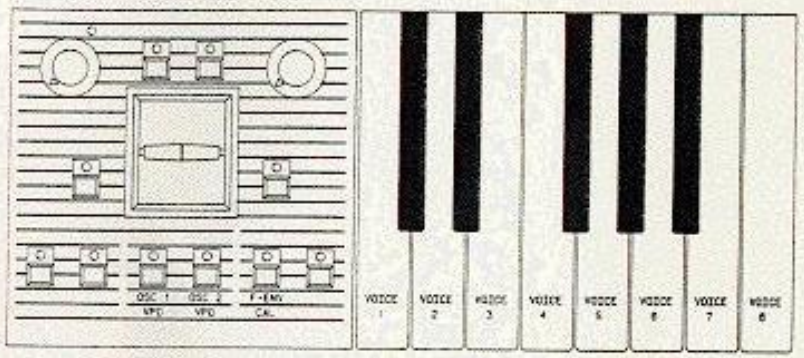
Pull up on the RATE knob. The RATE LED should come on to indicate that the Envelope Offset mode has been selected. Connect the DVM to U33 pin 14 on the Lower Voice Board. Connect the ground of the DVM to a ground near pin U33 (The ground side of one the nearby electrolytic capacitors will do). Be sure that the DEPTH knob is pushed in so that the Lower Voice Board is selected. Press C0. Using the UPPER and LOWER buttons, adjust the offset until the meter reads 0.000 volts, + or - 1 millivolt. To adjust it up or down fast, hold down the MODE button while holding down UPPER or LOWER. When not holding the MODE button, the offset will move up or down slowly. When the offset is set, press the ARPEGGIATE button to write the offset into memory. None of the calibrations set in this mode will be remembered unless each is written into memory. Now attach the DVM to U33 pin 6. Press D0. Adjust for 0.000V offset using the UPPER and LOWER buttons and write it into memory with the ARPEGGIATE button. Using the diagram as a guide, repeat this procedure for the Filter and VCA Decay, and the Filter and VCA Attack by selecting the proper parameter using the first six white keys on the keyboard. Do not adjust the Filter Sustain or the Volume Offset yet.

Now, pull up on the DEPTH knob to select the Upper Voice Board. Connect the meter to the Upper Voice Board and repeat the procedure of the Lower Board. Be sure to write each offset into memory with the ARPEGGIATE button.

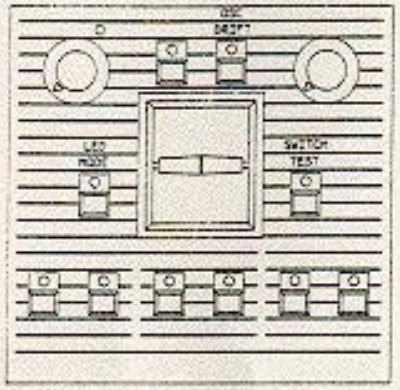
After the Release, Decay, and Attack parameters have been calibrated, the Filter Sustain can be calibrated. This calibration only requires that the Upper and Lower Voice Boards be matched, but it is not necessery for them to be adjusted for 0.000 volts offset. With the DEPTH knob still pulled up, connect the meter to U27 pin 1 on the Upper Voice Board. Press B0. Adjust the offset for zero volts, or as close as it can be adjusted to zero volts. If the offset is not zero volts, remember the offset value. Write the offset into memory with the ARPEGGIATE button. Push down the DEPTH knob and connect the meter to U27 pin 1 on the Lower Voice Board. Press B0. Adjust the offset so that it is the same as the Upper Voice Board. If the offset will not go low enough, set it as low as it can go, store it in memory, and readjust the Upper Board offset to match the Lower Board.

The final offset calibration is the output volume offset. This adjustment is made to insure equal volume between Voice Boards at any volume setting. This calibration only exists in software versions A4 and above. Like the Filter Sustain calibration, the important thing is to match the 2 boards, even if they are not set for 0 offset. Make sure that the MASTER VOLUME and trimmers T501 on each Voice Board are all the way up before making this adjustment. First on the Lower Voice Board, connect the meter to U503 pin 6. This is a high impedence signal so be sure to use a shielded cable on the meter. Press the DEPTH knob into its down position and press C1 on the keyboard . Using the same procedure as for the Filter Sustain, adjust the offset until the meter reads 0.000 volts or is as close to 0 as possible. Write the offset into memory with the ARPEGGIATE button. If the offset is more than 150 millivolts, replace U503 with another 3080 and repeat the procedure. If the offset is below 150 mv but above 0, remember the offset. Repeat the procedure for the Upper Voice Board by pulling up on the DEPTH knob, pressing C1, and connecting the meter to U503 on the Upper Board. Adjust the offset so that it matches the Lower Board. If the offset cannot be adjusted low enough, set it as low as it will go below 150 mv (otherwise it should be replaced), write it into memory with the ARPEGGIATE button and reset the Lower Board so that the offset matches the Upper Board. Write the new offset into memory. After all of the offset calibrations have been completed, press down on the RATE knob.

OSCILLATOR VOLTS PER OCTAVE ADJUSTMENTS



To calibrate the volts per octave of oscillator 1 of each voice, press the OSC 2 ONLY button. The voice to be calibrated is selected using the first 8 white keys on the keyboard (C0-C1). The gate LED will be lit on the voice that is currently selected. Select voice 1 by pressing C0 on the keyboard. If both test LEDs are on, this oscillator is in calibration. If only one LED is on, adjust the volts per octave trimmer (T101) until both test LEDs are on. If both test LEDs are off or seem to be flashing randomly, then this oscillator is not functioning properly and should be repaired or replaced. Select D0 now to calibrate voice 2 and repeat the procedure stated above for voices 2 through 8 using trimmers T201, T301, T401, etc. After calibrating all 8 voices, both test LEDs should be on whenever pressing any of the first 8 white keys. To calibrate oscillator 2 of each voice, press the BEND AMOUNT button. Follow the procedure for calibrating oscilator 1 using the first 8 white keys to select which voice is being calibrated. Adjust oscillator 2's volts per octave trimmers (T103, T203, T303, etc.) until all 8 voices are calibrated. To calibrate the amount of filter envelope modulation into oscillator 2, press the DOWN TRANSPOSE button and select a voice using the first 8 white keys. Adjust the F-ENV trimmer for each voice (T102, T202, etc.) until both test LEDs are on. Again, if both test LEDs are off or flashing randomly, oscillator 2 of the selected voice is not functioning correctly. NOTE: The volts per octave for Osc 2 and the envelope offsets must be calibrated before this adjustment is made. Also, on software version A1 and A2, the F-ENV calibration may not be able to be calibrated so that both LEDs are always on. This is due to the tempature instability and the nonlinearity of the CEM3360 VCA on each voice (U109). If this is a problem, it can be rectified by implimenting ECOs 405 and 406 and replacing the eproms (U21-U24) with the most recent version of software. This change requires many cuts and jumpers as well as component value changes and should only be attempted if absolutely necessary.



LED TEST

To test all of the LEDs, press the MODE button. This test will turn on all of the LEDs on the front panel and in the Bend Box except for the CASSETTE LED which must be turned on with the Cassette Enable switch. Any LEDs that do not light are not functioning properly. To leave this mode, select another test.

SWITCH TEST

Enter the switch test mode by pressing the ARPEGGIATE button. When in the switch test mode, each switch on the front panel will light its respective LED when pressed. The AUTO switch will light the detune LED. This test, in conjunction with the LED test, can be used to determine whether a switch or a LED is not functioning. To leave this mode, select another test.

OSCILLATOR DRIFT TEST

This test is used to determine if any of the oscillators drift an unreasonable amount over a given time and temperature. To enter this mode, press the UPPER button in the Bend Box. The UPPER LED will flash and the processor will wait 10 minutes to allow the internal temperature to stabilize, afterwhich it will autotune all of the voices. The UPPER LED will continue to flash as the processor waits another 10 minutes, and then autotunes the oscillators again, comparing them to the last tuning. After the second tuning, the UPPER LED will stay on to indicate that the test is over, and if any of the oscillators have drifted more than + or - 10 cents (hundredths of a semitone), the processor will light a corresponding LED for the drifting oscillator(s). The bottom row of LEDs in the programmer section of the front panel except for the MANUAL LED will show which oscillator(s) drifted out of range. The SPLIT LED is for voice 1 oscillator 1, the DOUBLE LED is for voice 1 oscillator 2, LOWER is for voice 2 osc 1, UPPER is voice 2 osc 2, GROUP A is voice 3 osc 1, GROUP B is voice 3 osc 2, GROUP C is voice 4 osc 1, GROUP D is voice 4 osc 2, and PROGRAM 1-8 are for voices 5-8. If any of these LEDs came on, the test should be performed again to verify that the lit oscillator is bad, since this test requires that the temperature remains stable to determine accuracy, and could fail an oscillator due to room temperature changes. If the oscillator fails the test twice, it should be replaced and recalibrated, and the test should be performed again, to insure that the new oscillator is within stability range.

This test is accomplished by tuning each oscillator at A-Sharp 3 (466.16 Hz), waiting 10 minutes, tuning again at A-Sharp 3 and comparing the amount of correction necessary to tune. If the difference between the 2 tunings is more than plus or minus a half a cycle, the oscillator is displayed. It is important to note that this test can only check for long term drift, and not short term stability since the tuning is done only twice within the 10 minute interval. If it is desired to interrupt this test while it is in process, press any of the other test switches to enter a new test.

REMAINING BEND SWITCHES

The remaining Bend Box switches (LOWER, UP TRANSPOSE) do not currently have any test function and will be ignored when pressed. These switches have been left for possible future test procedures.

All of the microprocessor assisted calibrations and tests have now been done. Return the synthesizer to its normal operating mode by turning the TEST 1 switch inside the front panel to its off position before performing the following calibrations.

FILTER CALIBRATION

There are three more calibrations necessary per voice before the voices are calibrated, and these are for the filter. This calibration procedure can be done by ear, or with a strobe tuner. First, put the front panel into manual mode, and turn off all of the switches except TRACK in the filter section. Turn the RESONANCE, VOLUME ENVELOPE SUSTAIN, and PROGRAM VOL/BAL knobs all the way up, center the MASTER TUNE control, and turn everything else all the way down. Set the master volume to a desired listening level. Go into page 2 by pressing the CHORD/PAGE 2 button twice, and turn off all of the voices except the one to be calibrated by using the program 1-8 buttons. Play a note on the keyboard and adjust the resonance trimmer (T1D4 for voice 1) up until sound can be heard. While playing alternate octaves on the keyboard, adjust the volts per octave trimmer (T1D6) until the interval is one octave. Verify this adjustment by playing notes 2 or 3 octaves apart and determining that the octaves are in tune. Next, adjust the resonance trimmer (T1D4) down while holding down a key until just after the filter stops oscillating. To adjust the filter initial frequency (T1D5), Turn on oscillator 1 and adjust the trimmer for maximum volume. This sets the filter to the same frequency as the oscillator. Repeat this procedure for all 8 voices by enabling the voice to be calibrated and following the steps stated above. After all 8 voices have been calibrated, turn all 8 voices back on and verify that all 8 voices sound the same.

OUTPUT VCA VOLUME ADJUSTMENT

The only two remaining adjustments are the final volume trimmers (T5D1) on each Voice Board). While listening in MONO, turn both trimmers to maximum volume (clockwise). Turn the MASTER VOLUME and the PROGRAM VOL/BAL knobs to maximum, and check for even volume between the two Voice Boards by playing through the voices and seeing if four voices are louder than the other four. If uneven, adjust the trimmer on the board that is louder to match the other. While still in mono, turn the Master volume half way up. Check for about the same volume between Voice Boards. If the difference is very noticable, the output volume offsets may need to be calibrated. This procedure was mentioned under ADJUSTING ENVELOPE OFFSETS. If the software version is A1, A2, or A3, replace U5D3 on the louder board with a 3080 with low offset and recalibrate T5D1.

FREERUNNING THE DB-8 PROCESSOR BOARD

By removing the jumper plug at location U25 on the DB-8 Processor Board the Z80 will be placed in a freerun mode. To do this turn off AC power, remove the jumper and reapply AC power.

Theory:

In cases when the uP locks up, troubleshooting can be a nightmare. Because the uP bus forms a complex feedback loop, failure here causes many components to behave abnormally or vice-versa. The answer is to break the feedback path. By removing the jumper plug, the data bus is isolated from the system. The pull-down resistors cause the uP to see only NOP instructions (00H for a Z80 CPU). Therefore on power up the first instruction fetch is a NOP. This instruction increments the program counter and causes a fetch of the next instruction (another NOP in this case). This technique forces the processor to address the entire memory-address space despite failures in the bus, address decoder or ROM.

Troubleshooting Technique:

The test set-up used is relative to the "Instruction Op-Code Fetch" cycle (refer to any Z80 data book). With the uP freerunning attach the EXT. trigger of an oscilloscope to the RD* signal (pin 21 on the Z80), trigger on the falling edge.

An acending binary count can now be observed on address lines A00 through A15. Address decoding can be verified by checking all logical outputs for any type of transistion.

If the uP is not stepping through the address field (no movement on the address pins of the Z80) then a failure is likely in one of the following:

The Z80.
The system clock.
The BUSRQ* is stuck low.
The power supply.
The RESET input is stuck low.

CONNECTOR D
Computer Interface
(Rear Panel)

1	-	HRD*
2	-	GROUND
3	-	GROUND
4	-	GROUND
5	-	GROUND
6	-	GROUND
7	-	OSC MUX
8	-	HD 4
9	-	HD 5
10	-	HD 6
11	-	HD 7
12	-	HA 0
13	-	HA 2
14	-	HA 4
15	-	HA 6
16	-	HA 15
17	-	HA 14
18	-	HA 13
19	-	HA 12
20	-	HNRD*
21	-	HWR*
22	-	HINT*
23	-	BUSAKA*
24	-	BUSRQ*
25	-	HRV*
26	-	HD 3
27	-	HD 2
28	-	HD 1
29	-	HD 0
30	-	HA 1
31	-	HA 3
32	-	HA 5
33	-	HA 7
34	-	HA 8
35	-	HA 9
36	-	HA 10
37	-	HA 11

CONNECTOR E
Bend Box Connector
(On Processor Board)

E1	-	+15
E2	-	-15
E3	-	+15
E4	-	DGND
E5	-	+5
E6	-	DGND
E7	-	AR1
E8	-	+5
E9	-	AR0
E10	-	AGND
E11	-	PDT3*
E12	-	AGND
E13	-	ANLGIN
E14	-	AGND
E15	-	BSWD*
E16	-	V18
E17	-	BLED0*
E18	-	BLED1*
E19	-	BSW1*
E20	-	D1A
E21	-	D5A
E22	-	D0A
E23	-	D3A
E24	-	D4A
E25	-	D2A
E26	-	BSWEN*

CONNECTOR G
Pot Board Connector
(on Processor Board)

G1	-	AGND
G2	-	ANLGIN
G3	-	AGND
G4	-	-15
G5	-	VDLP
G6	-	+15
G7	-	SWENF*
G8	-	PDT1*
G9	-	AR3*
G10	-	DGND
G11	-	+5
G12	-	AR0
G13	-	LCD0
G14	-	AR1
G15	-	LCD2
G16	-	AR2
G17	-	LCD1
G18	-	PDT2*
G19	-	CEN*
G20	-	PDT0*
G21	-	SWD7*
G22	-	SWD0*
G23	-	LRD7
G24	-	SWD1*
G25	-	LRD6
G26	-	SWD4*
G27	-	LRD5
G28	-	SWD2*
G29	-	SWD6*
G30	-	SWD5*
G31	-	LRD4
G32	-	SWD3*
G33	-	LRD3
G34	-	LRD2

CONNECTOR H
Voice Board Connector
(on Processor Board)

H1	-	NOISE
H2	-	VCFP
H3	-	AGND
H4	-	AGND
H5	-	ANLGOUT
H6	-	AGND
H7	-	AGND
H8	-	AGND
H9	-	AGND
H10	-	VOLPOT
H11	-	CASSIN
H12	-	OSCMUX
H13	-	VOICE3*
H14	-	CASSIN
H15	-	VOICE4*
H16	-	D3A
H17	-	VOICE2*
H18	-	D7A
H19	-	VOICE1*
H20	-	D2A
H21	-	A3
H22	-	D6A
H23	-	A2
H24	-	D1A
H25	-	A1
H26	-	D5A
H27	-	CLR*
H28	-	D0A
H29	-	A4
H30	-	D4A
H31	-	A5
H32	-	DGND
H33	-	A6
H34	-	DGND

POT BOARD INTERCONNECTIONS

NOTE:
These connectors are not labeled. The connectors are described from top to bottom with the unit opened up.

POT BOARD 1		POT BOARD 2
A1	SWD7*	A1
A2	LEDR5	A2
A3	SWD5*	A3
A4	SWENC*	A4
A5	LEDR3	A5
A6	SWD6*	A6
A7	SWEN9*	A7
A8	SWD3*	A8
B1	LEDR1	B1
B2	LEDC0	B2
B3	LEDC7	B3
B4	SWD1*	B4
B5	SWD0*	B5
B6	N.C.	B6
B7	SWD4*	B7
B8	LEDR2	B8
C1	SWD2*	C1
C2	SWENA*	C2
C3	LEDC1	C3
C4	LEDC3	C4
C5	LEDRD	C5
C6	LEDR4	C6
C7	+15	C7
C8	+5.6	C8
D1	AGND	D1
D2	AGND	D2
D3	MOD 1	D3
D4	MOD 2	D4
D5	RATE	D5
D6	PORT	D6
D7	DETUNE	D7
D8	TUNE	D8
D9	BALANCE	D9
D10	VOLPOT	D10