SECTION 1 PRELIMINARY INFORMATION

1.1 Introduction

This service manual is divided into three major sections:
A) Circuit Descriptions: The circuit descriptions should be consulted when a problem is suspected in a particular area of the instrument.
B) Trim Procedures: The trim procedures should be used to verify cali-brations or when a component has been changed.
C) Board Test Points: The board test points are a quick reference to verify circuits with suspected problems and should be checked whenever a problem has been identified.

1.2 Specifications

Noise Generator
Noise spectrum types: White and Pink

Voltage Controlled Oscillators
Waveforms: Sawtooth, Square, Pulse, Dynamic Pulse
Frequency range: VCO 1 in low freq. mode, .2 Hz to 20 Hz;
VCO 1 and VCO 2 (audio range), 20Hz to 20 KHz
Warm up drift: 1/30 semitone from turn on max.
Pulse width: 50% to 5%
Pulse width modulation: ADSR, +45%; LFO, +15%
Voltage controlled response: 1V/oct.
Maximum frequency shifts: LFO sine wave, +% oct.; LFO square wave, +1.5 oct.; ADSR +90ct.; S/H +2 oct.

Note: VCO 1 is a low note priority; VCO 2 is high note prtOrtty

Transpose
Positions: Down 2 octaves, normal, up 2 octaves

Pitch Bend
Frequency shift: About + 1 oct. (exactly 1 octave on Odyssey-2)

PPC
Frequency shift: About 5 semitones ±1 semitone.

Portamento .
Maximum speed: About .01 msec./oct.
Minimum speed: About 1.5 seconds/oct.

Ring Modulator
Type: Digital
Input signals: VCO 1 and VCO 2 pulse waves

Voltage Controlled Filter
Type: Low pass
Frequency range: 16 Hz to 16 KHz
Maximum usable Q: 30
Resonance % to self oscillate
Voltage controlled response: 1Vloet.

Voltage Controlled Amplifier
Dynamic Range: 80dS

Sample and Hold
Command sources: Keyboard or LFO trigger
Sampled signals: VCO 1 square wave and sawtooth wave, VCO 2 square wave and pink noise

ADSR Envelope Generator
Attack time: 5 msec. to 5 seconds
Decay time: 10 msec. to 8 seconds
Sustain level: 0 to 100% of peak
Release time: 15 msec. to 10 seconds

AR Envelope Generator
Attack time: 5 msec. to 5 seconds
Release time: 10 msec. to 8 seconds

Audio Outputs
High level: 2.5VPP max.; lOOK impedance
Low level: .25VPP max.; 10K impedance

Interface Jacks
Keyboard CV IN/OUT: lV/oct.
Gate OUT: +10V. key down; OV all keys up
Gate IN: +8V minimum
Trigger OUT: +10V pulse on key depression, 10 microsec. duration
Trigger IN: +8V pulse min., 10 microsec. duration minimum

External Audio
Input: 500 millivolts for full output

CIRCUIT DESCRIPTIONS

2.1 Keyboard Current Source

The keyboard current source supplies constant current through thirty-six 100 ohm resistors connected in series. These resistors are a voltage divider supplying specific voltages for each key on the keyboard. The top end of the resistor chain is connected to J1204-5 and the low end to J1204-6. The current source produces a 3 volt drop across the entire keyboard, 1 volt per octave. The keyboard voltage is fed to the CV memory via the CV bus rod.

Pin 7 of U1202B (high end of the resistor chain) is 0 volts when either no keys or one key is depressed and pin 6 of U1202B (low end of the resistor chain) is +3 volts. When two keys are depressed, the contacts and bus rod short out a section of the resistors in the divider chain which reduces the gain of U1202B thereby raising the voltage on U1202B pin 7. This voltage increase represents the voltage difference between two held keys. When this difference voltage is subsequently added to the control voltage at the control input of VCO 2, high note priority control over the pitch of VCO 2 is produced.

2.2 Control Voltage Memory

Control voltages supplied from the keyboard CV bus are buffered by a unity gain amplifier, U1201A. This voltage is then supplied to the memory capacitor C1201 through the portamento slider (P1202) and the gating FET (Q1201). Q1201 is turned on by the gate generator circuit only while a key is depressed. Q1202 and U1201B are a FET follower with high input impedance to buffer the voltage on capacitor C1201. J1201-1 and J1201-2 are connected to the portamento footswitch so that the portamento slider can be bypassed while the footswitch is plugged in.

2.3 Pitch Bend

The Pitch Bend control supplies an offset voltage to U1202A to be summed with the control voltage from U1204A (CV memory). D1203 and D1204 create a `dead' zone when the control is centred and P1203 calibrates the output to exactly plus and minus 1 volt.

2.4 PPC

The PPC circuit contains three resistive carbon strips, three conductive rubber strips and various summing resistors. Each end of the carbon strip is connected to a designated voltage source, while each end of the conductive rubber is making contact with the summing resistors. As the PPC button is depressed, the conductive rubber makes contact at various points on the carbon strip which, in turn, provides various degrees of control voltage to the summing resistors. The conductive rubber is tapered so that maximum sensitivity is achieved at the top of the button.

2.5 Transpose Switch

The transpose switch also supplies an offset voltage to U1202A to be summed with the control voltages from U1204A. P1201 calibrates the output to exactly plus and minus 2 volts.

2.6 Summing Circuit.

The output of U1202A is +3 volts when high `C' is depressed and 0 volts when low `C' is depressed. This control voltage is summed with the offset voltages from the transpose and pitch bend circuits on the input of U1202A. U1202A is unity gain inverter whose output will be 0 volts with low `C' depressed (transpose and pitch bend in their normal positions) and +3 volts with high `C' depressed. This voltage is supplied to the VCOs and VCF.

2.7 Gate Generator

Each gate contact on the keyboard is connected to a 2.2K ohm resistor to ground. When a key is depressed the gate bus voltage drops from +15 volts to about +10 volts which turns on Q1. Q1 supplies two gate signals:

SIGNAL:	Key up	Key down	Location
CV Memory	-15V	+15V	Q1 collector
Gate out	0V	+10V	J4-3

2.8 Trigger Generator

When a key is depressed, the gate bus voltage drops from +15 volts to about +10 volts. Additional key depressions will drop this voltage still further. These voltage transitions are coupled through capacitor C1203 and R1220 to Q1206. Capacitor C1204 is charged to +15 volts by Q1206 when a key is depressed. U1203C and U1203D are CMOS NAND gates (threshold is +7.5 volts). As C1204 charges up, U1203D pin 11 will produce a 10 millisecond pulse (the pulse width is determined by C1204) which is applied to Q1206. Q1206 will conduct during the falling edge of the pulse from U1203D to produce a +10 volt trigger pulse (20 millisecond duration). Trigger pulses from external sources are coupled through C1207, U1203A and U1203B to Q1208. U1203A and U1203B are connected in parallel to increase drive.

2.9 Noise Generator

The noise generator circuit produces 10VPP white and pink noise signals which are supplied to the VCF audio input and the S/H mixer. The noise is obtained by amplifying a reversed biased transistor junction (Q401) in avalanche break down. Q401 is a transistor selected for optimum avalanche characteristics and therefore has good noise producing capability. Q402 is a buffer and U401A amplifies and clips the noise signal.
U402A filters the noise to provide pink noise to the VCF and S/H.

2.10 Sample & Hold (S/H)

The sample and hold circuit provides a DC voltage output by sampling and storing the instantaneous voltage level of signals on its input each time a trigger pulse is provided. This stored voltage is held until the next trigger pulse occurs. Signals which are to be sampled are applied to U701A_3. U70lA amplifies and buffers the signal and supplies it to Q701. When a trigger from either the LFO or the keyboard is received through C702, Q70l conducts just long enough for the memory capacitor (C70l) to assume the new voltage level. Then Q70l turns off until another trigger is supplied. Q702 and U702A are a FET op amp follower which buffers the voltage on C70l and provides it to the lag circuit (P703 and C703) and the output buffer (U702B).

2.11 Low Frequency Oscillator (LFO)

The LFO produces a triangle and a square wave output in a frequency range from about 0.1Hz to 25Hz. U301A and C301 are an integrator which charges from current passing through R311. U301B is a hysteretic switch whose output switches from -15 volts to +15 volts when the output of U301A reaches +5 volts. This change in output polarity then reverses the direction of current through R311 and the rate control (P301) and thus the direction of integration of the output of U301A. When the output of U301A reaches -5 volts, the output of U301B switches back to -15 volts and the cycle repeats. An LFO reset pulse is supplied from Q1205 every time a key is depressed. Q301 is turned on momentarily by the LFO reset pulse and discharges the integrating capacitor (C301) thus reinitializing the LFO output to zero.

2.12 Voltage Controlled Oscillator (VCO 1)

Control voltages from the keyboard, initial frequency and fine tune sliders, the sample and hold circuit, LFO square wave and sine wave, and the ADSR are summed on the base of Q1001. Q1001 and Q1002 are a linear voltage to exponential current generator; for every volt applied to the control input of the VCO from the keyboard, Q1001 will conduct twice as much current. Cl003 is the integrating

capacitor; it is initially charged to +15 volts and discharges through R1017 and Q1002 towards ground. Q1002 determines the discharge current of the capacitor and therefore the period of oscillation. Q1004 buffers the voltage on Cl003 and supplies it to a comparator, U1001B and U1001A. U1001A_4 is fixed at about +7.5 volts. When the voltage on U1001A_2 decreases to below +7.5 volts, U1001A turns on Ql005 which supplies +15 volts to the gate of Q1003. Q1003 then charges capacitor Cl003 back to +15 volts to start the cycle over again.

R1013, Cl001 and R1012 supply current to Q1002 as the frequency of the oscillator is increased to prevent the oscillator from going flat due to the recovery time of the circuit. Q1007 is a phase splitter which takes the sawtooth from U1001A_3 and supplies it to the oscillator output and the pulse converter. The wave-form on the emitter of Q1007 is 7.5VPP negative going (+7.5 volts offset), and the collector is about 5VPP positive going (zero referenced).

Sawtooth To Pulse Converter: U1001C and U1001B form a comparator with R1034 and R1035 setting the switch point at +7.5 volts. The sawtooth wave from the oscillator is supplied to the comparator through R1029 and C1004. U1001D supplies an offset current to raise or lower the DC level of the sawtooth wave to change the point at which the comparator switches. When the pulse width pot on the front panel is at minimum, the comparator will switch exactly in the middle of the sawtooth slope, producing a square wave (50% duty cycle). The output of the comparator (U1001B_8) is processed through U601B which inverts the shapes of the pulse output.

2.13 Voltage Controlled Oscillator (VCO 2)
Control voltages from the keyboard, initial frequency and fine tune sliders, the sample and hold circuit, LFO square wave and sine wave, and the ADSR are summed on the base of Q1101. Q1101 and Q1102 are a linear voltage to exponential current generator; for every volt applied to the control input of the VCO from the keyboard, Q1101 will conduct twice as much current. Cll03 is the integrating capacitor; it is initially charged to +15 volts and discharges through R1117 and Q1102 towards ground. Q1102 determines the discharge current of the capacitor and therefore the period of oscillation. Q1104 buffers the voltage on Cll03 and supplies it to a comparator, U1101B and u1101A. U1101A_4 is fixed at about +7.5 volts. When the voltage on U1101A_2 decreases to below +7.5 volts, U1101A turns on Qll05 which supplies +15 volts to the gate of Q1103. Q1103 then charges capacitor Cll03 back to +15 volts to start the cycle over again.

R1113, Cl101 and R1112 supply current to Q1102 as the frequency of the oscillator is increased to prevent the oscillator from going flat due to the recovery time of the circuit. Q1107 is a phase splitter which takes the sawtooth from U1101A_3 and supplies it to the oscillator output and the pulse converter. The wave-form on the emitter of Q1107 is 7.5VPP negative going (+7.5 volts offset), and the collector is about 5VPP positive going (zero referenced).

Sawtooth To Pulse Converter: U1101C and U1101B form a comparator with R1134 and R1135 setting the switch point at +7.5 volts. The sawtooth wave from the oscillator is supplied to the comparator through R1129 and C1104. U1101D supplies an offset current to raise or lower the DC level of the sawtooth wave to change the point at which the comparator switches. When the pulse width pot on the front panel is at minimum, the comparator will switch exactly in the middle of the sawtooth slope, producing a square wave (50% duty cycle). The output of the comparator (U1101B_8) is processed through U601C which inverts the shapes of the pulse output.

2.14 Ring Modulator
The ring modulator utilizes two CMOS NAND gates (U601A and U601D) and Q601 in an 'exclusive or' function. Square waves from VCO 1 and VCO 2 are supplied to pin 2 and pin 12 of U601 and the output is taken from the emitter of Q601.

2.15 Voltage Controlled Filter (VCF)

Audio signals from both VCOs, the ring modulator, and the noise generator are applied to the audio input of the voltage controlled filter (VCF-AUDIO) through C902. Control voltages from S/H, LFO, KYBD CV, and the envelope generators (ADSR and AR) are summed and inverted by U90l. The control input of the VCF accepts negative going control voltages; as the voltage on VCF-CONTROL is decreased, the filter cutoff increases. Signals on the output of the VCF (TP-C2) are fed back to the resonance input (4035-2) via the resonance pot (R914).

2.16 Voltage Controlled Amplifier (VCA)

Audio signals 'from the VCF are processed by the high pass filter (C801, R801 and P801) and connected to the non-inverting input of U801. U801 is an operational transconductance amplifier (OTA) whose gain is a function of the current supplied to pin 5. Control voltages from the two envelope generators and the VCA gain slider are connected to Q80l which supplies current to the OTA. P802, the control reject trimmer, balances the inputs of the OTA to minimize the effect of control voltages on the audio output of the VCA.

2.17 AR Envelope Generator

The Attack-Release envelope generator produces a control voltage with variable rise and fall times. It is used to control the VCF or the VCA.

When a gate voltage is supplied by the keyboard or the LFO through S201, Q201 turns on, which charges capacitor C202 through P201, R206 and D201. The position of P201 (attack knob) determines the time C202 takes to charge up. When the gate voltage is removed, Q201 turns off which allows Q202 to turn on. The voltage on C202 then discharges through D202, RR205, P202, and Q202. P202 (release knob) sets the release time. Q203 and Q204 buffer the voltage on C202 and supply it to the VCA and VCF.

2.18 ADSR Envelope Generator

The Attack-Decay-Sustain-Release envelope generator produces a control voltage with variable rise and fall times. It is used to control the VCF or the VCA. A gate and trigger signal must be supplied from the key-board or LFO to start the ADSR voltage rising.

Attack: When a gate signal (+10 volts) is supplied through S101, Q101, Q102 and Ql05 turns on which then allows Q106 to turn off. With Q106 off, a trigger applied through C103 and R118 will momentarily turn on Q107 and Q104. Q104 then supplies +15 volts through D1009, D110, D111 and R111 to hold Q107 on. Q107 and Q104 (the attack latch) now supplies +15 volts through the attack knob (P104), R109 and D105, and charges up the integrating capacitor, C101.

Q108, Q109 and Q110 buffer the voltage on C101 and provides it to the VCA and VCF. Q111 is the peak detector which monitors the output of the ADSR. When the ADSR voltage reaches its maximum, (about +10 volts), Q111 will turn on and provide this voltage to the base of Q106 through D115. Q106 then grounds out the voltage on the base of Q107 to unlatch Q107 and Q104 and end the attack portion of the ADSR cycle.

Decay & Sustain: When the attack portion of the ADSR cycle has completed, the voltage on C101 is allowed to discharge through D104, R108 and the decay knob (p103) to the emitter of Ql03. The sustain knob (P102) sets the voltage level on the base of Ql03. When the voltage level on the emitter of Ql03 falls below the level on the base, Ql03 turns off and prevents the voltage on Q101 from discharging further.

Release: When the gate is removed, the remaining voltage on C101 is discharged to ground through D103, R105 and the release knob (P101).

SECTION 3 TRIM PROCEDURES

3.1 Power Supply Trim Procedure
NOTE: Always execute Power Supply trims first.

Reference	Trimmer	Trim Procedure
	+15 VOLT SET	• Monitor the power supply’s +15 volt output with a digital multimeter • Adjust for exactly +15.00 volts
	-15 VOLT SET	• Monitor the power supply’s -15 volt output with a digital multimeter • Adjust for exactly -15.00 volts

3.2

Reference	Trimmer	Trim Procedure
T2	VCO 1 50% PULSE	• Put the TRANSPOSE switch in the normal position • Depress a key in the middle of the keyboard • Monitor TP-5 with an oscilloscope • Adjust VCO1 COARSE FREQUENCY to display one complete cycle • Adjust the 50% PULSE WIDTH trimmer until the duty-cycle is 50%
T5	VCO 2 50% PULSE	• Put the TRANSPOSE switch in the normal position • Depress a key in the middle of the keyboard • Monitor TP-5 with an oscilloscope • Adjust VCO1 COARSE FREQUENCY to display one complete cycle • Adjust the 50% PULSE WIDTH trimmer until the duty-cycle is 50%
T3	VCO 1 CALIBRATE	• Monitor TP-5 with either an oscilloscope or frequency counter • Set the COARSE FREQUENCY to minimum • Set the FINE FREQUENCY to it’s exact centre point • Press low `C` on the keyboard • Adjust VCO CAL for a 50mSec period or 20Hz.
T6	VCO 2 CALIBRATE	• Monitor TP-5 with either an oscilloscope or frequency counter • Set the COARSE FREQUENCY to minimum • Set the FINE FREQUENCY to it’s exact centre point • Press low `C` on the keyboard • Adjust VCO CAL for a 50mSec period or 20Hz.
T1	VCO 1 V/OCT	1. Set the VCO Range switch to KYBD ON 2. Monitor TP-5 with a frequency counter 3. Press low `C’ on the keyboard 4. Adjust VCO1 COARSE FREQUENCY for exactly 100Hz 5. Press high `C’ on the keyboard 6. Adjust VCO1 V/OCT trimmer for exactly 800Hz 7. Repeat steps 3 to 6 until the frequency is correct on low `C’ and high `C’
T4	VCO 2 V/OCT	1. Set the VCO Range switch to KYBD ON 2. Monitor TP-5 with a frequency counter 3. Press low `C’ on the keyboard 4. Adjust VCO1 COARSE FREQUENCY for exactly 100Hz 5. Press high `C’ on the keyboard 6. Adjust VCO2 V/OCT trimmer for exactly 800Hz 7. Repeat steps 3 to 6 until the frequency is correct on low `C’ and high `C’
T7	2ND VOICE V/OCT	Press low `C’ on the keyboard

3.3

Reference	Trimmer	Trim Procedure
R23	TRANSPOSE	• Set the following knobs at maximum: Mixer VCO 1, VCF FREQUENCY, and VCA GAIN. • Set all other pots to minimum. • Put the TRANSPOSE switch to NORMAL. • Press low `C' on the keyboard. • Connect a frequency counter to the HIGH OUTPUT of the Odysseus. • Adjust the VCO 1 COARSE FREQUENCY and FUNE TUNE knobs to 100Hz. • Put the TRANSPOSE switch in to the UP 2 OCT position. • Adjust the TRANSPOSE trimmer Pxx for exactly 400Hz
R26	PITCH BEND	• Set the following knobs at maximum: Mixer VCO 1, VCF FREQUENCY, and VCA GAIN. • Set all other pots to minimum. • Put the TRANSPOSE switch to NORMAL. • Put the PITCH BEND knob to its CENTRE position. • Press low `C' on the keyboard. • Adjust the VCO 1 COARSE FREQUENCY and FUNE TUNE knobs to 100Hz. • Turn the PITCH BEND knob fully CLOCKWISE. • Adjust the PITCH BEND trimmer Pxx for exactly 200Hz
R67	VCF BAL	• Put the following knobs at maximum: VCA GAIN and LFO FREQUENCY • Put the ADSR `DECAY' knob at the ¼ position. • Put the switches UP • Monitor the HIGH OUTPUT of the Odysseus with an oscilloscope set to about 500mV per division. Adjust the VCF BAL trimmer for the minimum amplitude signal
R71	VCF CUTOFF	• Turn the VCF RESONANCE knob to maximum. • Turn all other knobs to minimum. • Monitor… with on oscilloscope or frequency counter. • Adjust the VCF CUTOFF trimmer for a 62.5mS period or 16Hz.
R68	VCF V/OCT	Turn the following knobs to maximum: VCF RESONANCE, VCA GAIN and VCF KYBD CV. 1. Turn all other knobs to minimum. 2. Monitor the HIGH OUTPUT with a frequency counter. 3. Press low `C' on the keyboard. 4. Adjust the VCF FREQUENCY for 100Hz. 5. Press high `C' on the keyboard 6. Adjust the VCF V/OCT trimmer for 800Hz 7. Repeat steps 3 through 7 until the frequency of the VCF is correct on low `C' and high `C'.
R69	VCA GAIN	
R70	VCA CVR	

4.4 Test Points

Test Point	Function	Set Up	Specification
ATP-1	CURRENT SOURCE & 2nd VOICE CV GENERATOR	No keys depressed	0V
		Both low `C' and high `C' held	+3V
ATP-2	CV BUFFER	Depress and hold low `C'	+3V
		Depress and hold high `C'	0V
ATP-3	CV MEMORY	Depress and release low `C'	+3V (should not change more than 20 millivolts in one minute)
		Depress and release high `C'	0V (should not change more than 20 millivolts in one minute)
ATP-4	CV OUTPUT	Depress and release low `C'	0V
		Depress and release high `C'	+3V
ATP-5	GATE BUS	All keys up	+15V
		Depress any key	+10V
ATP-6	MEMORY GATE	All keys up	-13V
		Depress any key	+15V
ATP-7	GATE OUT	All keys up	0V
		Depress any key	+12V
ATP-8	TRIGGER OUT	Depress any key	
ATP-9	WHITE NOISE	Put NOISE switch to the WHITE position	
ATP-10	PINK NOISE	Put NOISE switch to the PINK position	
BTP-1	SAWTOOTH	INITIAL FREQUENCY mid-position. All other knobs to minimum	
BTP-2	SAWTOOTH	INITIAL FREQUENCY mid-position. All other knobs to minimum	
BTP-3	RESET PULSE	INITIAL FREQUENCY mid-position.	
BTP-4	SAWTOOTH TO PULSE	INITIAL FREQUENCY mid-position. All other knobs to minimum	
BTP-5	SQUARE WAVE OUTPUT	INITIAL FREQUENCY mid-position.	
BTP-6	SAWTOOTH OUTPUT	INITIAL FREQUENCY mid-position. All other knobs to minimum	
BTP-7	LFO TRIANGLE OUTPUT	LFO FREQUENCY knob to maximum	
BTP-8	LFO SQAURE WAVE OUTPUT	LFO FREQUENCY knob to maximum	
BTP-9	S/H OUTPUT	S/H NOISE knob to maximum LFO/KYBD switch to LFO LFO FREQUENCY knob to maximum	
BTP-10	ADSR INVERTER	Put all ADSR knobs at mid-position Depress any key	
BTP-11	TRIGGER PROCESSOR	Depress any key	
CTP-1	CV INVERTER		
CTP-2	VCF OUTPUT		
CTP-3	VCA OUTPUT		
CTP-4	GATE BUFFER		
CTP-5	AR OUTPUT		
CTP-6	ADSR OUTPUT		