



# R-A-MOOG CO-

TRUMANSBURG, NEW YORK 14886 \* AREA CODE 607 387-9200

## A PROPOSAL

for an

## ELECTRONIC MUSIC COMPOSITION SYSTEM

for the

DEPARTMENT OF MUSIC OF THE UNIVERSITY OF TEXAS

## GENERAL

This proposal describes a system of instruments which are designed specifically for the composition and performance of Electronic Music and Musique Concrete, and for other activities involving the experimental production of sound. In designing the system, we have placed strong emphasis on those features which will allow the musician to produce a wide spectrum of musical sounds in a convenient, efficient, and natural manner. In addition, we have stressed the flexibility of control which the musician will be able to exercise over the detailed structure of the generated sounds.

All instruments are completely transistorized, and are designed to be powered from a single regulated power supply which produces +12V and -6 volts with respect to ground. In addition, all signal input levels, output levels, and output impedances will be compatible with currently-accepted professional audio equipment standards.

The entire system will be manufactured and installed by the R. A. Moog Co. All instruments will be properly adjusted, interconnected, and mounted in a hardwood console-type cabinet. The following instruments will be supplied:



3	Model 901-A	Oscillator Controller
8	Model 901-B	Oscillator
1	Model 901-D	Variable-Waveform Output Stage
3	Model 902	Voltage-Controlled Amplifier
1	Model 903	White Sound Source
1	Model 904	Voltage-Controlled Filter
1	Model 905	Reverberation Unit
1	Model 906	Impulse Generator
1	Model 910	Power Supply
1	Model 950	Five-Octave Keyboard Controller
2	Model 955	Linear Controller
1	Model 984	Four-Channel Mixer
1	Model 907	Fixed Filter Bank
1	Model 1900	Four-Channel Tape Recorder
1	Model 1950	Power Oscillator-Amplifier

In addition, to the above instruments, twenty tablet switches will be provided. These switches will establish commonly-used modes of operation, to be specified by the purchaser before final delivery of the instrument.

#### SPECIFICATIONS OF THE INSTRUMENTS

##### MODEL 901-A OSCILLATOR CONTROLLER

This instrument is designed expressly to control the frequency of the Model 901-B Oscillator, such that the oscillator frequency is exponentially related to the sum of the voltages applied to the inputs of the controller. In the terminology of music, this means that a given change in input voltage will produce a fixed musical interval, regardless of the absolute value of the input voltage.

Number of inputs: 3

Impedance of each input: 100,000 ohms  $\pm 1\%$

Output voltage range: 0-6 volts

Relation between input voltages and output voltages: Output voltage is exponentially related to the sum of the input voltages according to the following relation:

$$E_{\text{OUTPUT}} = 0.1 e^{\sum_{i=1}^3 0.7 E_{i, \text{INPUT}}}$$

##### MODEL 901-B OSCILLATOR

Four output waveforms are simultaneously available from this oscillator. The frequency of oscillation is directly proportional to the magnitude of the voltage which it receives from the Model 901-A Oscillator Controller.

Frequency range: 0.2 cycles per second - 15 kilocycles, in six overlapping ranges.

Output waveforms: Sine, triangular, sawtooth, and square, available simultaneously.

Output amplitudes: All waveforms are fixed at 0.8 volts RMS.

Output impedances: All output impedances are 600 ohms nominal.

#### MODEL 901-D VARIABLE WAVEFORM OUTPUT STAGE

This accessory instrument increases the flexibility of the 901-B Oscillator by deriving waveforms of continuously variable shape and amplitude from the triangular waveform output of an oscillator. Two complementary (push-pull) variable outputs are provided.

Amplitude of each of the complementary outputs: 0-2.5 volts, continuously variable.

Output impedance of each of the complementary outputs: 25,000 ohms maximum.

#### MODEL 902 VOLTAGE-CONTROLLED AMPLIFIER

The gain of this amplifier follows the magnitude of the sum of the voltages applied to the inputs. The amplifier itself is completely balanced and direct-coupled. Signal inputs and signal outputs are both balanced.

Input impedance of signal inputs: 10,000 ohms

Output impedance of signal outputs: 600 ohms

Input impedance of control inputs: 100,000 ohms  $\pm$  1%

Number of control inputs: 3

Relationship between sum of control voltages and amplifier gain: Either linear or exponential, selectable by a front panel switch.

Rejection of control voltage change at signal output: greater than 35 db.

Maximum gain: 2

Gain Range: Greater than 80 db.

Harmonic distortion at unity gain and 0.8 volts signal output: Less than 2%

Maximum output noise at unity gain: 0.2 millivolt.

#### MODEL 903 WHITE SOUND SOURCE

This white sound source produces a uniform distribution of frequencies throughout the audio frequency range. In conjunction with filters, the white sound source enables the composer to generate sounds containing continuous frequency distributions.

RMS Amplitude of output: 0.5 volts

Output Impedance: 600 ohms

Uniformity of output per unit bandwidth:  $\pm$  2db from 10 cps to 20 Kc.

#### MODEL 904 VOLTAGE CONTROLLED FILTER

## MODEL 904 VOLTAGE CONTROLLED FILTER

This active filter operates in either low-pass or resonant (band-pass) mode. The cutoff frequency (lowpass mode) or the center frequency (resonant mode) is proportional to the exponential of the sum of the control voltages.

Slope of low-pass mode cutoff: 12 db/octave  
 Effective "Q" of band-pass mode: Greater than 10  
 Relationship between the sum of the control voltages and the characteristic frequency of the filter: Characteristic frequency doubles for every volt increase in the sum of the control voltages.

Accuracy of the control voltage-frequency relationship:  
 $\pm 10\%$  over a 30:1 frequency range

Frequency Ranges:	500 - 20,000 cps
(Selectable by a	250 - 10,000 cps
panel switch)	120 - 5,000 cps
	60 - 2,500 cps

Input Voltage: 2.0 volts maximum  
 Input Impedance: 10,000 ohms  
 Output Voltage 2.0 volts maximum  
 Output Impedance: 600 ohms  
 Number of Control Inputs: 3  
 Impedance of control inputs: 100,000 ohms  $\pm 1\%$

## MODEL 905 REVERBERATION UNIT

The basis of the unit is a mechanical spring-type reverberator, which will produce echo effects. Input and output amplifier couple this unit to the rest of the system.

Maximum Input Voltage: 2.0 volts  
 Input Impedance : 600 ohms  
 Maximum Output Voltage: 2.0 volts  
 Average voltage gain: Unity

## MODEL 906 IMPULSE GENERATOR

An impulse generator is a specialized oscillator that will produce a single waveform in response to a triggering signal. In the Model 906, the available "one-shot" waveforms include sine, damped sine, triangular, and sawtooth. The impulse period is continuously variable, and extends to greater than 10 seconds, thus making the output of the Model 906 useful for controlling any of the voltage-controlled instruments.

Maximum Output Voltage: 5 volts absolute  
 Output Impedance: 10,000 ohms  
 Range of impulse period: .01 second, - 10 second, variable by front panel controls.

## MODEL 907 FIXED FILTER BANK

In this instrument, eight active-network bandpass filters are simultaneously available. Each filter is equipped with an input attenuator and a control for the sharpness of the filtering. A wide range of formants can be simulated or synthesized with the Model 907.

Maximum Input Voltage: 2.0 volts  
Maximum Output Voltage: 2.0 volts  
Input impedance: 10,000 ohms  
Output impedance: 600 ohms

## MODEL 910 POWER SUPPLY

This power supply is precisely regulated and completely transistorized, and it is capable of powering up to thirty modular instruments of the type listed in this proposal.

Output voltages: + 12 volts and -6 volts with respect to common ground.  
Input voltage: 105-130 volts 60 cps.  
Maximum output current: 2 amperes  
Line regulation: Better than  $\pm 0.1\%$  for line variations of 105-130 volts.  
Load regulation: Better than  $\pm 0.2\%$  for load current variations of 0.1-2.0 amperes.  
Temperature stability: Better than 0.05%/degree C.

## MODEL 950 KEYBOARD CONTROLLER

A standard five-octave keyboard is used to produce control voltages that determine the pitch and amplitude contours of a sound. Three independent control voltages are produced: one oscillator control voltage and two amplifier control voltages.

Characteristics of oscillator control voltage: The oscillator control voltage varies from zero to 5 volts, depending on the key which is depressed. The voltage difference between keys is precisely set to be constant across the keyboard.

Characteristics of amplifier control voltages: The amplifier control voltage rises sharply and decays gradually whenever a key is depressed. The height and speed of both the rise and decay are controllable by a series of knobs at the controller.

## MODEL 955 LINEAR CONTROLLER

A taut gold-plated band is positioned over a special resistance ribbon. The composer determines the magnitude of the control voltage output by placing his finger on the gold band. Either discrete or continuous variations in control voltage can be made in this manner.

Range of Control Voltage: 0-5 volts  
Length of active portion of gold band: 18 inches

## MODEL 984 4-CHANNEL MIXER

This mixer enables the composer to combine and route sound signals that are generated or modified by other instruments. In addition to input and master level controls, one bass and one treble control per channel are provided.

Number of inputs: 4

Arrangement of input attenuators: Four per channel

Maximum amount of boost or cut by tone controls:  $\pm$  10 db  
from flat response.

Signal-to-noise ratio: Better than 80 db.

Maximum output voltage: 2 volts

## MODEL 1900 Four Channel Tape Recorder

This tape recorder will use the basic Viking Model 230 tape transport mechanism, adapted to the special requirements of electronic music composition. The following features will be present:

1. Four-channel in-line recording and playback heads.
2. Dual Speed (7-1/2 and 15 ips capstan speed) hysteresis synchronous drive motor.
3. Provision for reversing the direction of tape playback motion.
4. Four recording and four independent playback channels.
5. Electrical Specifications as follows:
  - Frequency Response: 20-25,000 cps record-playback
  - Signal-to-noise ratio: 55 db.
  - Flutter and Wow: Less than 0.2%

## MODEL 1950 POWER OSCILLATOR-AMPLIFIER

The Model 1950 produces a continuously-variable alternating voltage, or accepts an alternating voltage from an external oscillator, and amplifies it to a power level such that it can drive the synchronous motor of any commercial tape recorder. This allows the composer to precisely and continuously control the tape speed of any recorded material.

Maximum output voltage: 150 volts RMS

Maximum output power: 150 watts

Mode of regulation: Constant current

Frequency response: 20 cps - 400 cps.

LIST OF PRICES (ON NEXT PAGE)

## LIST OF PRICES

QUANTITY	MODEL NUMBER AND DESCRIPTION	UNIT PRICE	TOTAL PRICE
3	901-A Oscillator Controller	\$80	\$240
8	901-B Oscillator	\$125	\$1,000
1	901-D Variable Waveform Output Stage	\$75	\$ 75
3	902 Voltage-Controlled Amp.	\$150	\$ 450
1	903 White Sound Source	\$ 60	\$ 60
1	904 Voltage Controlled Filter	\$250	\$ 250
1	905 Reverberation Unit	\$ 85	\$ 85
1	906 Impulse Generator	\$220	\$ 220
1	907 Fixed Filter Bank	\$160	\$ 160
1	910 Power Supply	\$180	\$ 180
1	950 Five Octave Keyboard	\$325	\$ 325
2	955 Linear Controller	\$75	\$ 150
1	984 Four-Channel Mixer	\$200	\$ 200
1	1900 Four-Channel Tape Recorder	\$1500	\$1,500
1	1950 Power Oscillator Amplifier	\$250	\$ 250

TOTAL SYSTEM PRICE - - - - \$5,145.

As noted in the first section of this proposal, the total system price includes all necessary enclosures and interconnections, as well as twenty tablet switches to establish specified modes of operation. Shipping and installation costs (if any) are not included in the above price.

Submitted May 10, 1965  
R. A. MOOG CO.

*Robert A. Moog*