SAN DIEGO: DEPARTMENT OF MUSIC
LA JOLLA, CALIFORNIA

Jan.6,1969

MUSIC 105A- ELECTRONICS IN MUSIC

Instructor- Pauline Oliveros

Reference Books and Magazines:

Musical Acoustics, Charles Culver, The Blakiston Co.
Electronic Music Review, Independent Electronic Music Center Inc. Trumansburg, N.Y.
The Reproduction of Sound, Edgar Vilchur, AR Library
db The Sound Engineering Magazine, Sagamore Publishing Co. INc.
High Fidelity, Billboard publishing Co.
Source, Composer/Performer Edition
Music Educators Journal, Nov. 1968 issue

Materials:
Please use Scotch 201 or 202 Tape.
Carry your own kit of editing mat erials: Single edge razor, Edit-all splicing block, splicing and leader tape, take up reels and at times, patch cords and adaptors.

AXIOM- Is it plugged in? Is it turned on? Bad patch cord?
Study Murphy's Law.(db Magazine, April 1968.)

The purpose of this course is to gain a working knowledge of the Buchla Electronic Music System and the techniques possible with the available sound equipment.
The Buchla Systems are located in rooms 9 and 10 in Q314. Sign-up sheets for these rooms and keys are located in the Music Office.
A minimum of two hours a week lab time is recommended.

Each person must present a tape of his work during class at least once and describe and answer questions about his working process.

Each person will be expected to collect environmental or concrete sound sources for processing through the Buchla System. Sony 800 portable tape recorders are available and maybe checked out.

Each person should contribute questions formulated from his lab work and experience of the acoustic environment for class problem solving sessions.

ASSIGNMENT 1.- Due next meeting.

Discuss in writing what you expect or want from this course.

Make a list of your own available equipment. Include everything concerned with audio, even radios, TVs, etc.

Go to the Music Office, MC407, sign up for your lab time and find out the procedure for checking out keys and equipment.

Find the dimensions of Q307 and rooms 9 and 10 in Q314.

Go to Q314 and draw a diagram of each of the four Buchla Systems. Identify each module. List any other sound equipment in the rooms.

MUSIC 105A * OLIVEROS - QUIZ AND ASSIGNMENT 2.

JAN. 9, 1969

1. Do you think that it would be unfair to lock the door at 10:00 AM in order to eliminate late comers?

2. Draw a diagram of one of the Buchla Electronic Music Systems and list as many of the different modules as you can remember. List all other equipment in room 9 or 10 in Q314.

3. What are the dimensions of Q307 and rooms 9 and 10 in Q314?

4. What is your Lab schedule? Days and times?

5. What is the procedure for checking out keys and equipment from the Music Office?

6. What do you think are fair conditions for the use of equipment and rooms on campus?

7. What question or questions would you like answered about the material presented so far or your assignments? If you don't have any formulate one.

8. Do you have a special project related to this course which has not been covered or you wish to discuss with me?

ASSIGNMENT 2. DUE NEXT MEETING

Study Q307 and list the features of the building, its contents and the inner and outer environment which you think might influence our sound perception. Devise or propose an experiment to prove or disprove the effect of one or more of these features. This experiment should be practical in the sense that we can carry it out in class or you can do the experiment on your own and effectively report and demonstrate the results to the class.

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MUSIC 105A - PREPARATORY EXAMINATION

Instructor - Pauline Oliveros

Use separate paper for your answers to this test. Write your NAME, MAJOR AND STATUS at the top of the paper. Please number your answers and turn them in. Keep the test for future reference.

Define the following terms:

1. Frequency 2. Amplitude 3. Signal 4. Level 5. Intensity

6. Equalization 7. Wave form 8. Modulation (electronic)

9. Voltage Control 10. Plug 11. Jack 12. Impedance 13. Signal to noise ratio 14. Transducer 15. AC 16. DC 17. Potentiometer 18. Attenuate 19. Filter 20. Phase 21. Vibrato

22. Tremolo 23. db 24. Parameter 25. Feedback 26. Gain

27. Trigger 28. Heterodyne 29. Oscillation 30. Attack 31. Decay 32. Envelope 33. Infra-sound 34. Supersonic 35. Hertz

36. Spectrum 37. RMS 38. Sideband 39. Gate 40. Selective synchronization 41. Masking 42. Distortion 43. Insertion loss 44. Ambient noise 45. Clipping 46. Watt 47. Volt

48. Ohm 49. Ampere 50. Transformer 51. Doppler effect 52. Distortion 53. Crossover network 54. Transient 55. Black box

Part Two

1. Name five different type transducers.

2. Name three transducer ratings.

3. What is the purpose of a pre-amplifier?

4. What is the purpose of input selector switches on pre-amplifiers?

5. How is an amplifier rated?

6. How do tone controls work?

7. What constitutes high efficiency in speakers?

8. What factors influence the acoustic environment?

9. How is it possible to detect magnetized tape heads?

MUSIC 105A - PREP. EXAM PAGE 2

10. What is the purpose of a power amplifier?

11. Explain the difference betw een the following wave forms: a) Sine b) Square c) Sawtooth d) Triangular e) Pulse

12. What is the difference between a low level and high level signal?

13. What is a mixer?

14. Name four editing techniques possible with two stereo tape recorders.

15. Name the general components of an electronic music system.

16. What is white noise?

17. What is the range of human hearing?

18. What type input and output jacks are usually found on pre-amplifiers?

19. What cautions should be observed when loading or unloading pre-amplifiers and power amplifiers?

20. What is the difference between zip cord and high impedance microphone cable?

21. Name three methods of signal modification.

22. Why is proper phasing important in the connection of loud speakers?

23. Why should tapes be stored in the 'as played' condition?

24. What is the purpose of the bias oscillator in a tape recorder?

25. What causes tape hiss?

26. What difference can be discerned between original and second, third or fourth generation tapes?

27. At approximately what frequency is the ear most sensitive?

28. What is the difference between linear taper and audio taper in a potentiometer?

29. State Edsel Murphy's law.

30. What effect does temperature have on the speed of sound?

31. Why are equalization circuits built into pre-amplifiers?

32. What is the loudness control on a pre-amp for?

MUSIC 105A - PREP. EXAM PAGE 3

33. Draw a circuit for echo effect using one stereo tape recorder. (Block diagram)

34. How many heads and what are they on a professional quality tape recorder?

35. What are the principle differences between acetate and polyester tape?

36. Explain the non-linearity of the relationship between the physical intensity of a sound and the mental experience, loudness.

37. What is inter-modulation distortion?

38. Name four types of microphone elements.

39. Is any part of a sound ever stationary?

40. For what purpose did Helmholtz use his resonators?

41. Why is it necessary to align tape heads?

42. What should be routine maintenance for a tape recorder?

43. What is a bulk eraser?

44. What are the curves of presbycusis?

45. What are the Fletcher-Munson curves?

46. Draw a circuit showing all necessary components for mixing down a stereo tape to mono. (Block diagram)

47. Name four different directional characteristics of microphones.

48. What is an anechoic chamber?

49. Distinguish between the following: Fundamental, Partial, upper partial, Overtone and harmonic.

50. What is a wave train?

51. State Ohm's Law.

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MUSIC 105A- ELECTRONICS IN MUSIC
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Mid-term Exam:

Describe how you would choose the following components for your own personal sound system on the basis of money available for such a purchase now or in the future: Microphone, Pre-amplifier, Power amplifier, Tape Recorder, Turn Table, Cartridge and Speakers.

Give a detailed account of your criteria for judging the equipment, and explain all compromises.

This paper is due Feb. 7, 1969.

Final Exam:

Demonstrate your knowledge of the techniques possible with the available sound equipment and of each module of the Buchla Systems.

What do you think constitutes a good sound system for Electronic Music? How do you think it might change in the future?

This exam will begin during the last week of class. The paper will be due during exam week, Mar. 18-21.

Your grade for the course will be determined on the basis of class participation as described under the purpose of the course and the two exams.

T.N. Cornsweet The Design of Electric Circuits in the Behavioral Sciences

Prep for Jan 14 Music 105 – chamois for keyboard
So there paper for
tech report.

B. Wong – Schedule and attendance
– Key to 307
– Report needs for equipment etc.

Have the Buchla rooms been in order? &
Presentations of experiments

Architects and engineers for specs.

Announce Exhibit "with Electricity" works dependent on electricity for motion or illumination. Dickson Hall 12-5 PM UCLA to Mar 23

Buchla Demo: continued

Review
Keyboard
MIXER
GATE

Anyone have problem getting sound?

Explain tape recorder – Thursday

current issue of Radio Electronics

Bonnie	Heating + ventilation system on and off low frequency traffic Building creaking ~~Something~~
	Voice is reverberant
	Reflections People absorb sound masking talking
Dave G.	
Keith Carter	Reflection
Ron Watson	moving Blackboard
Mitsi	open all windows
Walker	Ah walking
Zaruccia + Mullen	

Pot is not really at zero on sony

The first consideration of electronic music performance is the space where the performance ~~is~~ occurs. The location of speakers within the space is of prime importance.

Prep for Jan 16

1. Wong schedule and keys to 314 + 307
   & found the room in disorder - Close doors

Tapes

1 Current Issue Radio Electronics
- Exhibit Dickson Hall UCLA -

Schedule for next week Jan. 21 Panel discussion on Speakers

Assign: Read Erickson's Tube Filters in EMR 6 [Speakers & Space are personal]

105A COLLECTION IN BINDER - CLUSTER I

READ Article on loud speakers

See each person individually to see if you need help on any particular problem

RCA Synthesizer - Olson Jan. 23 I'll be gone

1. 3 recording - comparative systems - N.Y. Times Article
   2 in Music office can be read

[2. Panel Discussion - Terms from text - Each person submit questions from text to panel - Come prepared. Write down to

3. Panel on Buchla box - how to do things turn in

Continue Experiments | Prepare in advance | Architects + Engineers

Keyboard drawing should show connection to box

Demonstrate mixer - [assign lab problem] Assume that you are working on your own.

Block
Diagram notation

1. Small groups 5 of 4
   Divide according
2. Techniques
3. Grading — progress
4.

105A Prep for Jan. 23

1/3 Walker — Recordings Moog Bach Buchla Sabotnick
Book II Babbitt.
Plus article from NY Times

1/3 Panel Discussion — on terms

Each person submit question on terms from Text to panel
Betty Wong
Moderator and recorder

Pete Middleton
Dave Beren
Kent Brodwolf
Eileen Jackson
~~Gerry Walker~~

Record the class!
for my benefit. 7½ IPS

1/5 Buchla Box answers
Gerry Walker

Paper

Ticking

60 ~

Footsteps

Trying to get in

Building creaking from ventilation

Breathing

Foot shuffling

writing

Watch ticking

Car motor

Resonance in ventilator

Paper rattling

sighs

Music 105A - Instructor: Oliveros
TA: Betty Wong

Tues. Feb. 4

Class assignment: Check out all available Sony 800s for the class period. Make small groups for each tape recorder. Take campus environmental sound collection walk. Each person has one 5 inch reel of tape. Each person must edit his own tape and prepare for processing with the Buchla system.

Lab assignment: Using tape as a sound source, submit the material to the following processes:

1. Gating
2. Modulation
3. Filtering
4. Reverberation
5. Addition

The following material is past due: Assignment 1
Assignment 2

If you do not know what these are, ask the TA, Betty Wong, or go to the library and look up the assignments.

THE SYSTEM

The Modular Electronic Music system that was developed at the Tape Music Center is composed of functional *modules*, each designed to generate a particular class of signals or perform a specific type of signal processing. Each module is 7 inches high and 4¼ inches (or an integral multiple thereof) wide. Up to 15 modules sharing a single power supply may be assembled in a single cabinet, and form a *super-module*.

The system employs three varieties of signals, each with a distinctly different function:

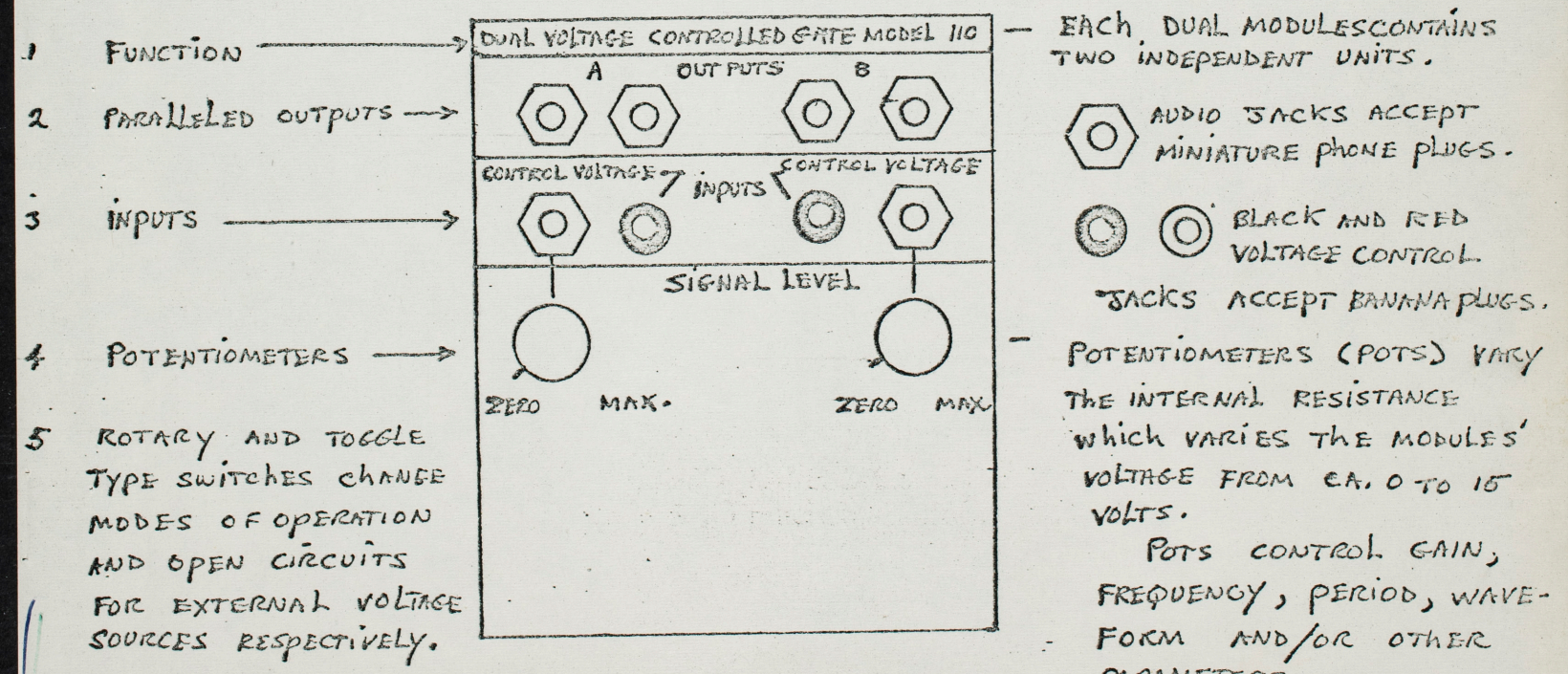
Audio signals, the raw material of electronic music, are formed by various sorts of generators (sine, square, sawtooth, harmonic) or are produced externally (tape loop, radio, microphone). In constructing a piece, they may be filtered, gated, mixed, modulated, or otherwise processed. The patch cords carrying audio signals within the system are grey, shielded cables terminated with miniature phone plugs. A standard level of Odb (ref. 600Ω) is employed for audio signals within the system.

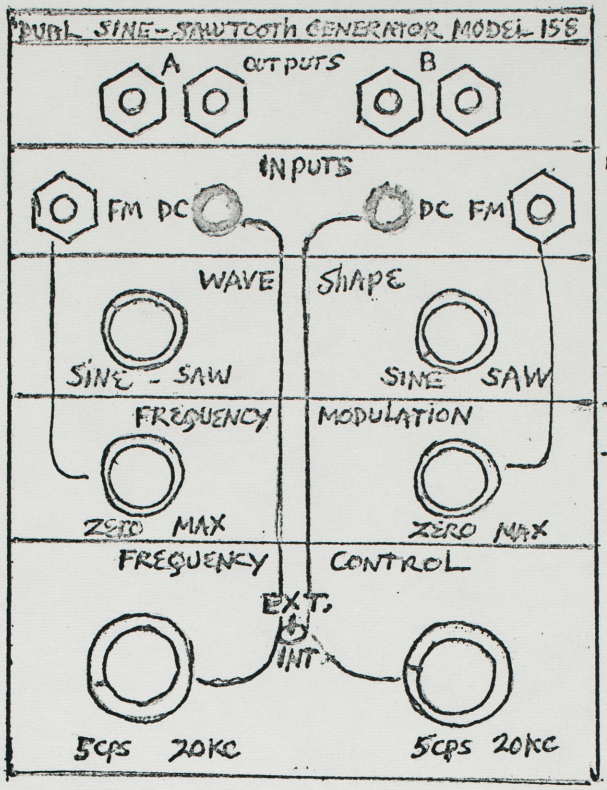
Control voltages, used to determine frequencies, envelope characteristics, amplitudes and other parameters, are generated by keyboards, programmable voltage sources, and format generators. Black banana plug patch cords are used to interconnect control voltages. The standard control voltage range is from .5 to 15 volts.

Timing pulses are originated by keyboards, programmable sequencers, and pulse generators. They are used to trigger notes, open gates, or initiate chains of musical events. Timing pulses are about 10 volts in amplitude and are interconnected with red banana plug patch cords.

The rules for interconnection are straight-forward. Any number of inputs may be connected to a single output. Timing pulse outputs may be paralleled and connected to one input. The system output may be derived from any module; output is of sufficient magnitude to drive line inputs on tape recorders or sensitive inputs on power amplifiers.

PANEL FORMAT





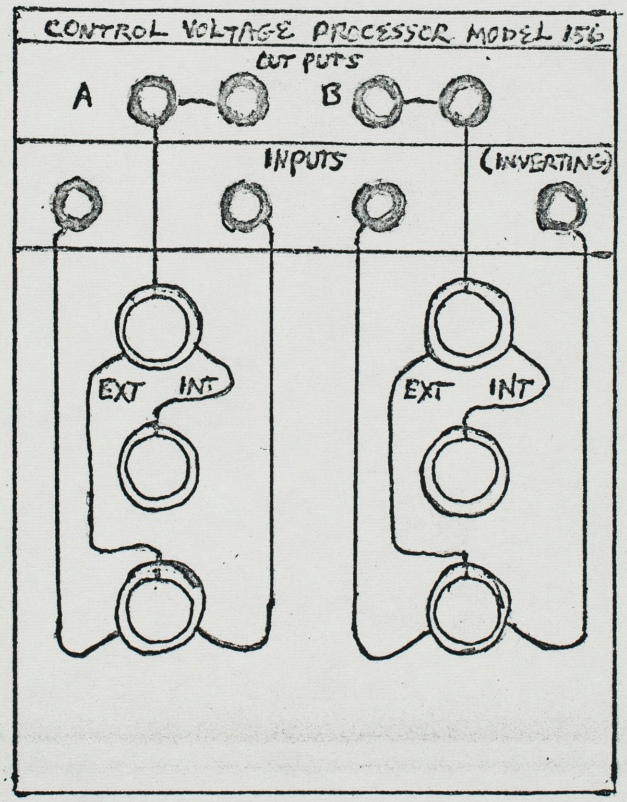
TO GATE OR OTHER AUDIO PROCESSING MODULES OR DIRECTLY TO AMPLIFIER.

FM INPUT: FROM ANOTHER AUDIO SOURCE I.E. OPPOSITE SIDE OF DUAL GENERATOR, WHITE NOISE, OUTPUT OF MIXER OR OTHER PROCESSORS.

DC INPUT: WHEN TOGGLE SWITCH B SET TO EXT., FREQUENCY IS CONTROLLED BY VOLTAGE SOURCES SUCH AS SEQUENCER OR KEY BOARD. THE ASSOCIATED FM POTENTIOMETER CONTROLS THE AMPLITUDE OF THE MODULATING SIGNAL.

WAVE SHAPE POTS ADD HARMONICS CONTINUOUSLY FROM CA. 2% TO 60% (SINE TO SAWTOOTH)

TOGGLE SWITCH MUST BE SET ON EXT. INORDER TO CONTROL FREQUENCY FROM AN EXTERNAL VOLTAGE SOURCE.



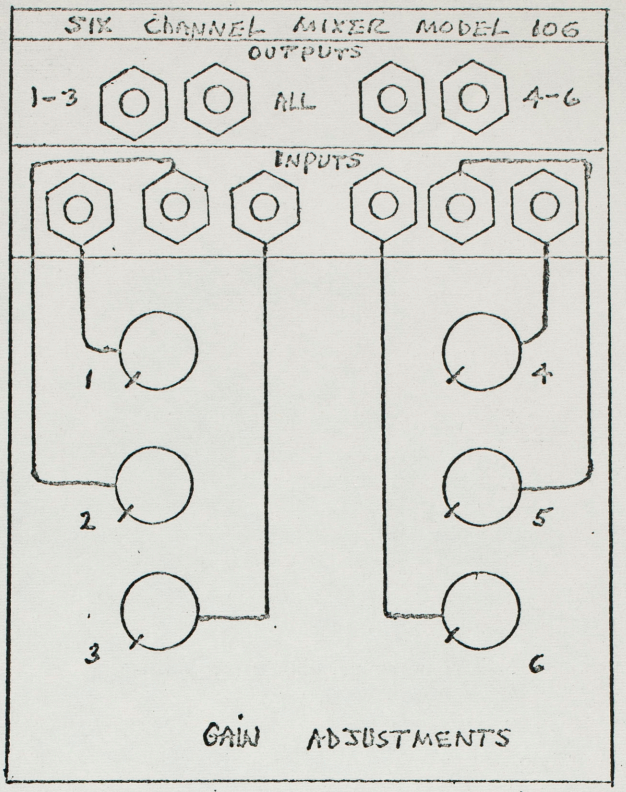
TO DC INPUTS OF GENERATORS OR GATE.

FROM VOLTAGE SOURCES.

- MIXES INTERNAL VOLTAGE WITH EXTERNAL VOLTAGES ALGEBRAICLY IN ASSOCIATION WITH LOWER TWO POTS.
- INTERNAL VOLTAGE POT CA 0-15 VOLTS. WILL HOLD GATE OPEN AT CONSTANT LEVEL WHEN UPPER POT IS AT INT. SETTING.
- CONTROLS AMOUNT OF EXTERNAL VOLTAGES. APPROXIMATELY 50/50 AT 12 O'CLOCK SETTING.

MAY BE OPERATED AS 2 THREE CHANNEL MIXERS ARE 1 SIX CHANNEL MIXER.

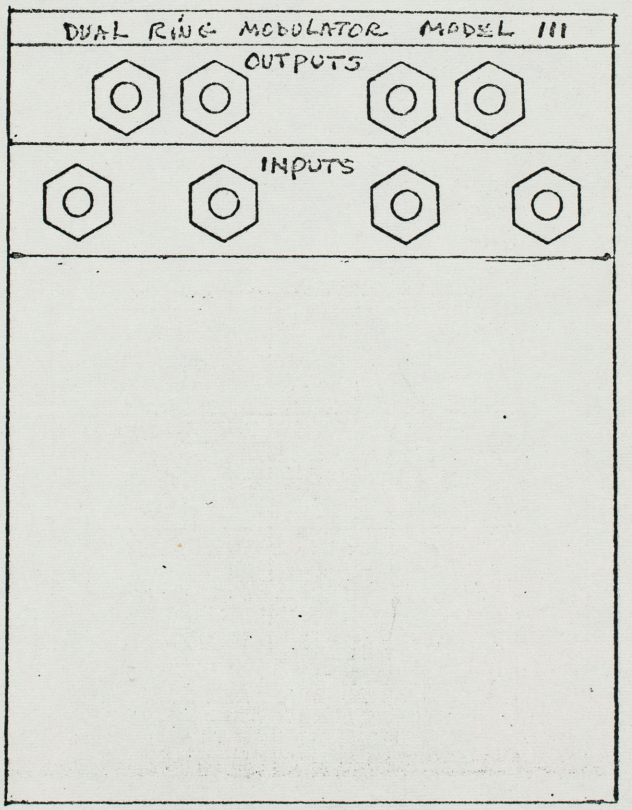
OUTPUT 180° OUT OF PHASE WITH INPUT.



TO GATE OR ANY AUDIO INPUT.

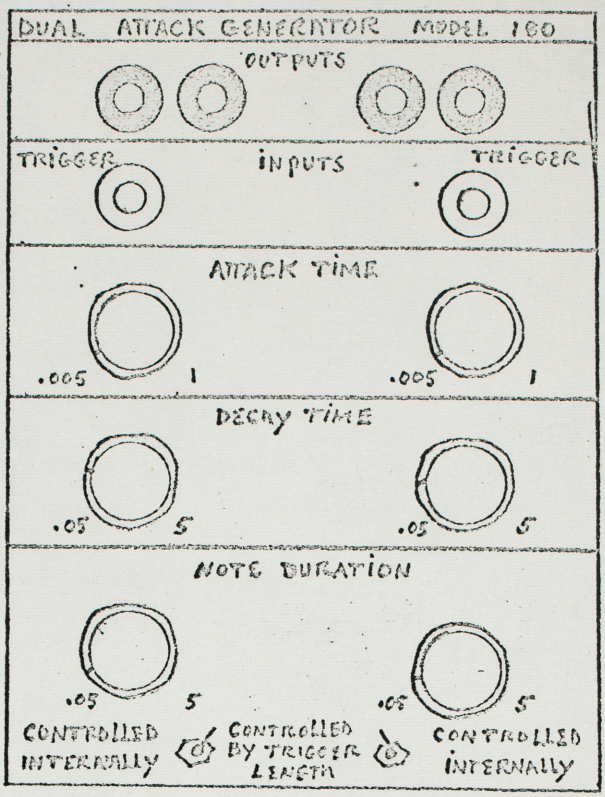
INPUT MAY BE DERIVED FROM ANY AUDIO OUTPUT.

POTS CONTROL GAIN OF EACH INPUT SEPARATELY



RING MODULATOR REQUIRES 2 SEPARATE AUDIO SIGNALS. THE FUNDAMENTALS ARE SUPPRESSED AND THE SUMS AND DIFFERENCES (COMBINATION TONES) ARE AMPLIFIED.

USE OF THE SIX CHANNEL MIXER OR GATE IS RECOMMENDED FOR GAIN BALANCING BETWEED THE TWO AUDIO SIGNALS.

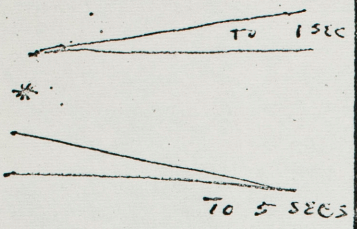


→ USUALLY TO GATE

→ FROM TRIGGER VOLTAGE SOURCE I.E. PULSE GENERATOR, KEY BOARD, SEQUENCER OR ANY 10 VOLT SOURCE.

— CONTINUOUSLY VARIABLE MANUALLY

" " " "



* THESE CAN BE REVERSED BY USING THE INVERTING INPUT OF THE VOLTAGE PROCESSOR.

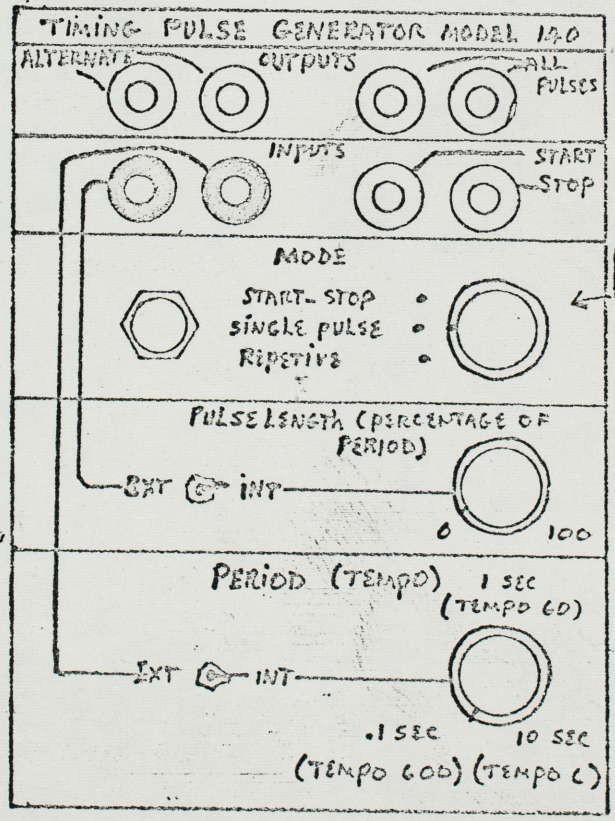
DURATIONS CAN BE CONTROLLED BY ANY TRIGGER SOURCE, AS INDICATED ABOVE WHEN TOGGLE SWITCH IS SET TO TRIGGER LENGTH CONTROL. OTHERWISE DURATION IS CONTINUOUSLY VARIABLE MANUALLY.

ALTERNATE pulses DIVIDES REPETITION RATE BY 2 AND PRESENTS ALTERNATE pulses AT EACH OUTPUT.

MOMENTARY CONTACT SWITCH: OPERATED MANUALLY IN SINGLE PULSE MODE. USUALLY FOR TUNING SEQUENCER OR SETTING OTHER PARAMETERS

TOGGLE SWITCH: pulse LENGTH CAN BE CONTROLLED FROM EXTERNAL VOLTAGE SOURCE I.E KEYBOARD, SEQUENCER OR RANDOM VOLTAGE GENERATOR.

PERIOD CAN BE CONTROLLED BY ANY EXTERNAL VOLTAGE SOURCE.

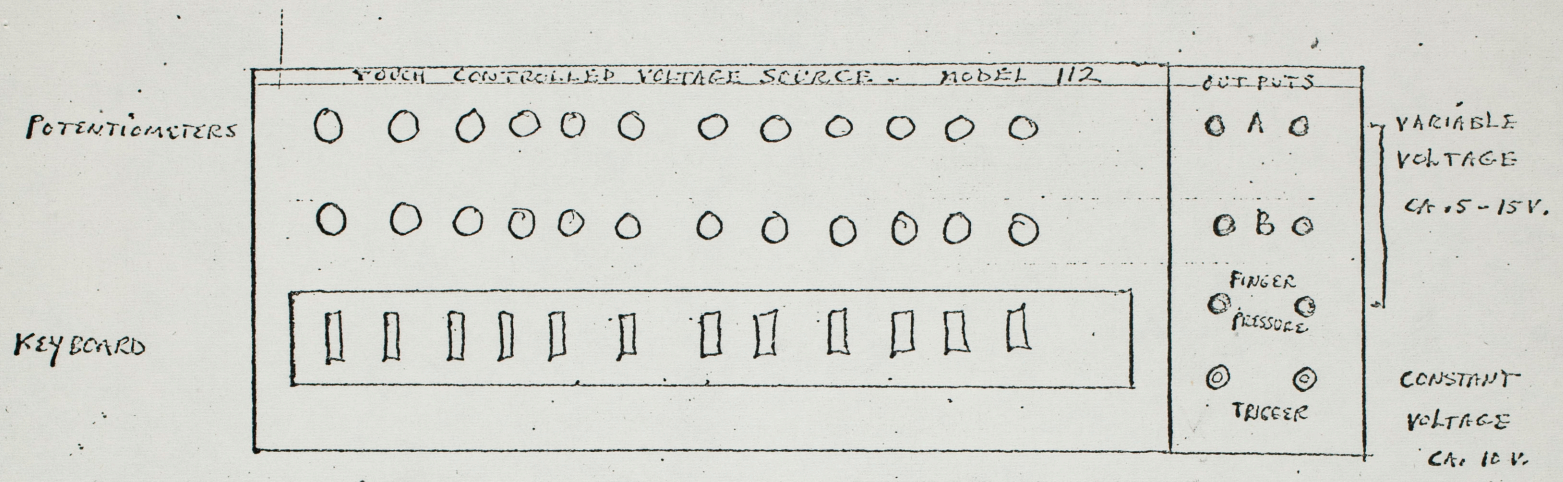


TO OTHER FREQ TRIGGER INPUTS I.E. ATTACK GENERATOR, SEQUENCER OR GATE (GATE CONTROL VOLTAGE INPUT IS BLACK)

IN START-STOP MODE, START AND STOP INPUTS MAY BE TRIGGERED FROM ANY EXTERNAL SOURCE, I.E. KEYBOARD OR SEQUENCER.

REPETITIVE MODE: pulse REPEATS CONTINUOUSLY ACCORDING TO SETINGS OF pulse LENGTH AND PERIOD POTENTIOMETERS.

ALTERNATE pulse OUTPUT DIVIDES PERIOD IN HALF.



PARALLELED OUTPUTS A AND B HAVE 12 CORRESPONDING POTENTIOMETERS FOR SETTING THE VOLTAGE OF EACH INCREMENT OF THE KEYBOARD. THESE VOLTAGES CAN BE SENT TO ANY VOLTAGE CONTROLLED MODULE IN THE SYSTEM.

THE FINGER PRESSURE OUTPUTS VARY ACCORDINGLY.

TRIGGER OUTPUTS CAN OPEN THE GATE, TRIGGER THE ATTACK GENERATOR, RANDOM VOLTAGE GENERATOR AND ETC.

THE KEYS WILL ACTIVATE SUCCESSIVELY BUT NOT SIMULTANEOUSLY.

GLOSSARY OF ELECTRONIC TERMS

This glossary of electronic terms was designed to be used in conjunction with the articles in this issue. Definitions were prepared with the assistance of Milton Babbitt, Composer, and James Seawright, Technical Supervisor, the Electronics Music Center of Columbia and Princeton Universities, and H. Emerson Meyers, Professor of Music and Director of the Electronic Music Laboratory, The Catholic University of America, Washington, D.C. Recommended source book for electronic terminology: *The Audio Cyclopedia* by Howard M. Tremaine. Indianapolis, Indiana: Howard W. Sams, 1959. Distributed by Bobbs-Merrill, Indianapolis.—Ed.

acoustics. The study of production, transmission, and reception of sounds. Psychoacoustics deals with the effects of sound on humans.

amplifier. A device used to increase the power, voltage, or current of a signal.

amplitude. Usually equated with loudness; it refers to the maximum value of a power, voltage, or current during a single cycle of a wave.

amplitude modulation. The periodic variation of amplitude, or the process by which this is achieved. It refers to the alteration of signal amplitude to affect loudness, usually, in electronic music, in the nature of a tremolo whose periodicity and amplitude alternations are exactly controllable by studio equipment.

analog computer. A computer in which computation is effected by measuring and processing physical priorities such as voltages, whereas in digital computers, numbers or numerical representations are manipulated to effect computation. The analog computer deals with continuously variable information rather than with digital information.

analog tape. A magnetic tape on which information is stored in continuous form as magnetic densities. The common tape used in a tape recorder is an analog tape.

attack. Those amplitude characteristics having to do with the beginning of a sound or signal (sometimes called growth).

audio generator. Strictly speaking, an electronic device that produces complex (that is, nonsinusoidal) signals at frequencies between 20 and 20,000 Hz. The terms oscillator and generator are frequently used interchangeably, but correct usage is that oscillator refers to a generator of sine waves, whereas generator refers to a device that produces other than sine waves.

audio oscillator. A device that produces sinusoidal signals at frequencies between 20 and 20,000 Hz, normally for purposes of sound synthesis or testing.

audio spectrum. The entire range of oscillations that can be heard by the human ear. The extreme limits of human hearing are about 20-20,000 Hz.

band-elimination (reject) filter. A filter that attenuates a particular band of frequencies, while permitting other frequencies to pass and be heard. (See, filter.)

binary input language. A two-character language used to convey instruction to electronic equipment. A convenient language to use since the two characters may be represented by the two states of a switch (on or off), the presence or absence of a hole in a paper tape, and so on.

contact microphone. A microphone that must be placed in physical contact with a vibrating body (violin, guitar, cymbal, and the like), thereby transforming vibrations into electrical signals.

conversion. The process by which digitally stored information is transformed into analog information or vice versa.

decay. Those amplitude characteristics having to do with the ending of a sound or signal.

digital tape. Magnetic tape on which information is stored in discrete, numerical form (as differentiated from analog tape).

drift. Any gradual, unintentional shifting away from a desired value due to equipment shortcomings. In electronic music, reference is generally to oscillator frequency drift.

echo. The discernible replication of sounds usually at a lower amplitude. (See, reverberation.)

electronic switch. A device used to produce a periodic interruption of a signal.

electrosonics. A term covering the whole field of electronically produced sounds, whether they represent sonic experiments, sound effects, or music.

envelope. Those characteristics of amplitude that determine the growth and decay of a signal. The contours of a sound or sounds include such variables as rate of attack time, attack height, frequency, timbre, sustain level, rate of initial decay, and also the rate of final decay.

equalizer. A device for increasing or decreasing signal strength in selected portions of the audible spectrum. Certain frequencies may be strengthened in amplitude while others may be diminished. (See, Fletcher-Munson curve.)

erase head. The leadoff head of a tape recorder that erases previously recorded material on the tape prior to its passing the record head.

event. A single, perceptually separable musical entity in all of its dimensions; that is, pitch, duration, loud-

either reinforcement (positive feedback) or reduction (negative feedback) of the original input. The term, as commonly used in electronic music, refers to the practice of sending a portion of the playback signal from a tape recorder back around to the input while the machine is running in the second mode. The playback signal is re-recorded and again played back, and so on, but often at an interval of time corresponding to the distance between the record and playback heads, and the speed of the tape. The effect is that of a series of echoes of the original sound, either dying away or increasing to an avalanche of sound, depending on the loop gain of the feedback system.

filter. A device that permits the selective transmission of certain frequencies of the input signal by the attenuation of undesired frequencies. (See, band-pass filter, band-elimination filter.)

Fletcher-Munson curve. A diagram of equal contours that displays the relationship between intensity and loudness (perceived intensity) at varying (sinusoidal) frequencies. A group of sensitivity curves made of the human ear showing its characteristic for different intensity levels between the threshold of hearing and the threshold of feeling.

four-track tape. Recording tape on which four separate sound paths can be utilized at the same time for recording and playback. (See, quarter-track recorder.)

frequency. Vibrations per second of a signal. The frequency of a signal usually determines its pitch.

frequency counter. A device that measures the frequency of a signal by literally counting the individual oscillations that occur during a precisely determined time interval.

frequency modulation. The periodic variation of signal frequency affecting pitch. (See, amplitude modulation.)

frequency shift. A change in frequency of an input signal accomplished by a multiplier-type modulator or frequency shifter *(Klangumwandler).*

gain. A quantity expressing the degree of amplification of an amplifier or device. Gain may be positive or negative, although negative gain is usually referred to as loss.

gate. A device for controlling the amplitude (loudness) of a signal path. Voltage-controlled amplifiers are sometimes called gates.

half-track recorder. A tape recorder that records and plays on half of a one-fourth-inch magnetic tape. Two-track or stereo recorders are sometimes referred to as "half-track" if the width of each channel is actually one-half of the tape width. Generally, however, half-track recorders are monaural.

half-track heads. The heads on a half-track tape recorder.

harmonic. An overtone, or frequency component present in complex sounds. The frequency of a harmonic is an integral multiple of the fundamental frequency, which is the lowest frequency partial present in a given sound. All harmonics are necessarily partials.

Hertz. A term used internationally in place of "cycles per second." Hertz (Hz) derives from the name of the German scientist Heinrich Rudolph Hertz, who was first to detect, create, and measure electromagnetic waves.

input. A signal fed into a circuit or device.

input language. The code employed to convey instructions when programing an electronic device. An encoding language such as Fortran or Cobol.

jack. A plug-in type terminal such as is found on telephone switchboards. A socket-type connector to which temporary connections may be made with patch cords.

key punch. A device for punching information on computer data cards.

Klangfarbenmeldie. A succession of musical events usually having different instrumental timbres associated with each event. The use of timbre as the primary compositional material; timbre used thematically.

Klangumwandler. A ring modulation-like device (see below) in which one set of resultant frequencies is suppressed.

linear controller. A device for continuously varying properties of sound. As manufactured by the R. A. Moog Company, fingertips are moved along gold contact wires to vary electrical current.

magnetic tape. Iron-oxide-coated plastic tape used in magnetic recordings. Standard widths are one-quarter, one-half, and one inch.

mixer. A device for combining several input signals by algebraically summing their instantaneous amplitudes.

modulation. The process in which a characteristic of a waveform is (usually periodically) varied. (See, amplitude modulation; also, frequency modulation.)

monitor. A device used for checking audio signals, usually during the recording process.

musique concrète. Music that is constructed from recorded sound sources, other than purely electronic.

mutation. The transformation of sound by radical change.

noise. Undesired sound. (See, white noise.)

oscillator. (See, audio oscillator; also, audio generator.)

oscilloscope. An instrument that reproduces on the screen of a cathode-ray tube a graphical representation of signals as voltages with respect to time. Used to determine amplitude, frequency, and other waveform characteristics.

output. The signal that comes out of a circuit or device.

parameter. A variable quantity that can be measured.

partial. A frequency component, not necessarily harmonically related to other components.

patch cord. A cord with a plug at both ends used to establish a temporary connection between two jacks, usually between an output and an input.

peak. The maximum value of amplitude, or a momentary value considerably higher than the average.

permutation. The alteration or changing of variables in sounds or structures.

pitch succession. The consecutive sounding of two or more tones.

potentiometer. A device used for the precise measurement of voltages by comparison of an unknown voltage with a reference voltage. Often commonly used to denote a volume control on audio equipment (abbreviated "pot").

programing. The directions for the sequential behavior of an electronic system, particularly a computer.

punched paper tape programer. An instrument that stores information by means of coded holes in a paper tape.

quarter-track recorder. A tape recorder that uses one-quarter (rather than one-half, or all) the width of the tape for each recording. Stereo recording requires simultaneous recording on two of the four tracks. Many "four-track" recorders should properly be called quarter-track, as a four-track machine must be capable of simultaneous use of all four tracks on the tape.

recording head. An electromagnetic transducer used to implant magnetized patterns on recording tape.

The playback head "reads" the results of such arrangements.

reverberation. Repetitions of sound that are so closely spaced in time that they cannot be distinguished individually. The effect produced by multiple overlapping echoes in a room or concert hall. (See, echo.)

reverberation unit. A device that artificially produces the effect of reverberation upon signals passed through it.

ring modulator. An analog multiplier circuit used to combine signals in such a way that the output consists of sums and differences of all the input frequency components.

sawtooth wave. A signal consisting of a fundamental frequency and all harmonics, with the intensities of the harmonics inversely related to frequency. (See, waveform.)

Sel-sync. In a normal, three-head, multi-track tape recorder, the signal played back during monitoring is delayed by an interval of time corresponding to the distance between the recording and playback heads, and the speed of the tape. If it is desired to record a signal on a second track while listening to the first track as a guide for synchronization it will be found that the time delay error is about one-tenth of a second (at 15 ips.) and the second track will be out of synchronism by that amount. In order to avoid this, circuits have been developed to allow the playback from the first track (or any track) to be made from the recording head, by using it as a playback head. The sound heard will then be synchronous with the recording of another signal on another track, as the record heads are all in line vertically with each other. Of course there are problems in so using the second head as a playback head; only in the finest machines is the signal quality usable at all for other than the crudest guide to synchronization. The term Sel-sync* refers to such a system.

sequencer. A device that is used to produce a preset voltage sequence for the purpose of controlling a series of events with voltage-controlled equipment.

signal. Electrical analog of sound.

signal generator. The source of sound; an oscillator or, even a tape recorder in a very general sense.

sine wave. The waveform corresponding to a single frequency oscillation.

sound. Pressure waves of a frequency audible by the human ear. The properties of sound are frequency, amplitude, duration, and timbre or waveform. When frequency of vibration is regular or stable, pitch results; when unstable, noise results.

sound-on-sound. A method of recording a second signal on top of a previously recorded track of a tape. The erase head of the tape recorder must be disconnected or disabled to prevent erasure of the first signal during the process of recording the second. The results are usually quite poor in terms of signal quality.

sound wave. The periodic compression and rarefaction of the atmosphere at frequencies discernible to the human ear.

source. The entity that supplies signals.

spectrum. A frequency representation of the (audio) signal which plots amplitude against frequency; the conversion from the waveform to the spectrum representation is achieved mathematically by a Fourien transformation.

splice. The connection of two segments of magnetic tape, usually with the help of special splicing tape that is adhered to the glossy back surface.

square wave. A signal consisting of a fundamental frequency and all odd-numbered harmonics with the intensities of the harmonics inversely related to frequency.

steady-state. That portion of a sound or signal that lacks significant perceived variations.

synchronization. Coordinating with regard to time one set of events with another.

synthesizer. A system of electronic instruments for the production and control of sound.

tape deck. The tape transport and heads portion of a tape recorder. Sometimes preamplifiers are included, but not power amplifiers and speakers usually present in portable machines.

tempophone. A device used in tape recording to increase or decrease performance speed without altering pitch. The reverse operation is also possible and pitch may be altered without altering speed.

timbre. Tone-color. Timbre is the complex function of the relative amplitudes and frequencies of the frequency components.

timbre modulation. The alteration of the amplitudes and frequencies of frequency components to affect perceived tone-color.

transient overtones. Overtones (harmonics) momentarily present, usually during the attack of a sound. (See, steady-state.)

transistor. A device made from semiconductor materials that can act as an electrical insulator or conductor, depending on the electrical charges placed upon it. Transistors are used in amplification and oscillation as a substitute for vacuum tubes.

variable speed unit. A device used to control the speed of a tape recorder motor. Professional tape recorders are driven by a synchronous motor whose speed is dependent on the frequency of the AC power to it. Most variable speed units consist of an oscillator that furnishes a frequency between, roughly, 30 and 40 Hz, and a power amplifier that amplifies this signal to a level of 117 volts at a power sufficient to drive the motor. Variation of the oscillator within this frequency range will affect the speed of the motor over a three to one range, usually without ill effects.

variac. A variable AC transformer, sometimes used to control the speed of a tape recorder motor by reducing the 117-volt line voltage. This method will usually shorten the life of the motor.

vocoder. Developed in the early 1950's to break down complex vocal sounds into digital bits of information for transmission over narrow bandwidths by wire or by radio. Used as a mutation device in electronic music composition.

voltage-controlled amplifier. An amplifier whose gain may be varied by means of a change in a control voltage.

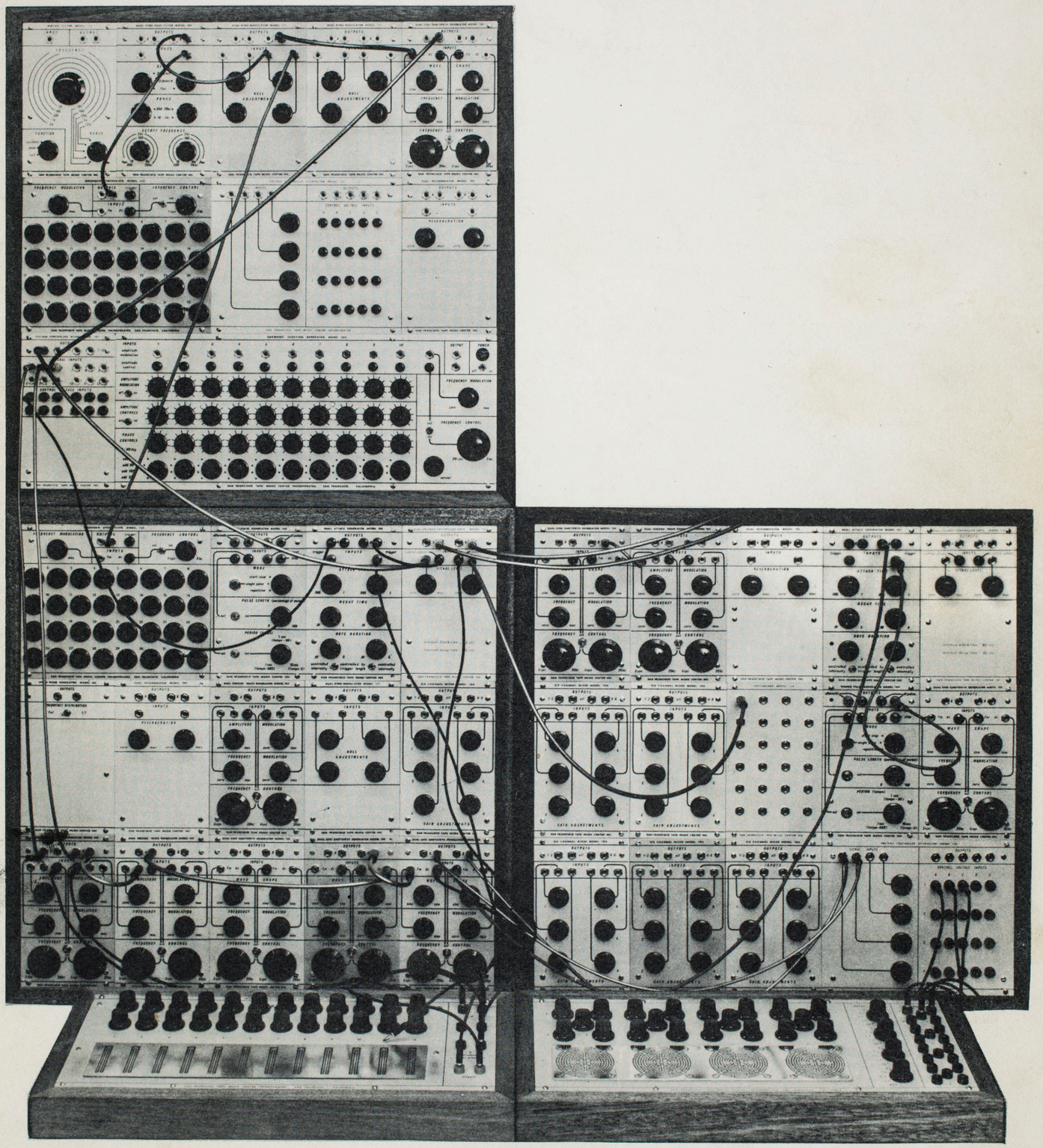
waveform. The shape of a wave in the sense of a graphical representation showing variations in amplitude versus time.

white noise. By analogy with light, a signal that may be considered to contain all audible frequencies, with amplitudes randomly distributed. Colored noise, analogously, is noise in which a band (or bands) of frequencies is suppressed. The audible effect of white noise is like that of escaping steam.

wye (Y) connector. A device having the appearance of the letter "Y"; at the arms and bottom of the stem are three connectors, all connected in parallel at the intersection. Should not be used for mixing signals, but for dividing a signal to send it to more than one place.

* Trademark, Ampex Corporation

THE MODULAR ELECTRONIC MUSIC SYSTEM



SOME HISTORY

In the past decade electronic music has developed into a form that assumes all the roles of music in our culture, from concert pieces to film music and rock-and-roll. Studios specializing in electronically generated music have been built in Europe and America and, while still few in number, have exerted considerable impact on the cultural activity of our time. An increasing number of composers are active in the field, and within a few years electronic music may well be part of the curriculum at every college and university music department.

The offspring of a technology which is itself but half a century old, electronic music is in its infancy. Instruments specifically designed for its production have been crude and generally unavailable. The San Francisco Tape Music Center approached the instrumentation problem in the traditional manner: ingenious application of surplus equipment that saw service in World War II bombers; occasional acquisition of new (and expensive) instruments designed for the physics laboratory; construction of innumerable pieces of electronic gadgetry from circuits provided by trade publications, hobby manuals, and friendly engineers.

As the number of member-composers grew, the limitations of the Tape Music Center's facilities became increasingly apparent. Maintenance and overhead costs were high, studio time was wasted in setup and tape splicing, and instruction in the intricacies of impedance matching and ground loops was necessary.

Last year the Tape Music Center received Rockefeller Foundation support which enabled the Center to initiate the development of a line of improved studio equipment. Basic objectives were:

1) The achievement of direct, immediate control of musical parameters. Instruments should be played in real time, eliminating such note-forming routines as: set frequency—start recorder—stop recorder—measure—cut—splice—repeat, etc.

2) Compatability of all equipment. Rules for interconnecting equipment to be straight-forward and consistent. Interfacing with external equipment (recorders, tuners, microphones, etc.) should be readily accomplished.

3) Fully transistorized circuitry, employing conservative design and high quality components. Reliable operation with minimal maintenance must be realized.

4) A special requirement of the Tape Center was that the equipment be lightweight and portable, thus making feasible its use in the composer's home, the concert hall, and on tour.

5) Without compromising other design objectives, cost should be low. Power supplies and cabinetry should be common to several units, and modular construction should be employed to permit economical system expansion.

Equipment that meets the above criteria has been designed and installed in the Center's studio. Results have exceeded all expectations. The new instrumentation can accommodate twice as many member-composers, and the time required to put a composition on tape has been reduced substantially. The range of sounds and formats far exceeds that previously available. The instrument has been played on stage in several concerts in the Bay Area. (Live, on-line, real-time performance of electronic music without tape buffering is, to our knowledge, unprecedented.)

Model No.	Panel Units	Description	Price
100	0	Cabinet	$ 70.
106	1	Mixer	75.
107	2	Voltage-Controlled Mixer	250.
110	1	Dual Voltage-Controlled Gate	100.
111	1	Dual Ring Modulator	95.
112	0	Touch-Controlled Voltage Source	210.
113	0	Touch-Controlled Voltage Source	300.
114	0	Touch-Controlled Voltage Source	220.
115	0	Power Supply	100.
120	2	Voltage-Controlled Distributor	235.
123	2	Sequential Voltage Source	210.
124	1	Patch Board	35.
130	1	Dual Envelope Detector	135.
140	1	Timing Pulse Generator	90.
144	1	Dual Square Wave Generator	165.
146	4	Sequential Voltage Source	370.
156	1	Dual Control Voltage Processor	95.
157	1	Control Voltage Inverter	95.
158	1	Dual Sine-sawtooth Generator	175.
160	1	White Noise Generator	75.
165	1	Random Voltage Source	140.
170	1	Dual Microphone Preamplifier	125.
175	1	Dual Equalizer - Line Driver	165.
180	1	Dual Attack Generator	100.
190	1	Dual Reverberation Unit	160.
191	2	Sharp Cutoff Filter	360.
194	1	Bandpass Filter	135.
196	1	Phase Shifter	140.
311	2	SCR Driver	250.
320	1	Dual Projector Controller	160.
321	1	Cross Fader	145.
350	0	Flash Source	600.
		Patch Cord Set	65.
		Complete System No. 1	2210.
		Complete System No. 2	4430.
		Complete System No. 3	6700.

The numbers in the "Panel Units" column indicate the relative space occupied in the cabinet by the corresponding modules. Total the number of panel units desired in a system and order one power supply (115) and cabinet (100) for each 15 (or portion thereof) panel units.

The following are representative of several modular instruments devised for controlling visual aspect of "total theater" compositions. All are mechanically and electrically compatible with the Modual Electronic Music System.

Model 311 SCR Driver.

Ten channel unit transforms control voltages to 120 c.p.s. pulses for phase control of silicon controlled rectifiers. Each channel can control up to ten 2 kilowatt SCR units. Diagrams of suggested SCR circuits are provided; complete control units of various sorts are available.

Model 320 Dual Projector Controller.

Enables control voltages to regulate the intensity of 35 mm. slide projectors. Slide changing (forward and backward) is accomplished with switches or externally applied timing pulses. Appropriately modified slide projectors (Kodak AV-900) are available.

Model 321 Cross Fader.

Provides control voltages and pulses to a Model 320 Dual Projector Controller for "dissolving" one slide into another. Change may be initiated manually, through applied timing pulses, or automatically at a preset rate. Fade rate is variable from .1 to 10 seconds and may be voltage controlled. Display time (in the automatic mode) is variable from 1 to 10 seconds.

Model 350 Flash Source.

A compact, powerful strobe unit with a variety of applications. Flash rate may be controlled internally, remotely, or through the application of a control voltage or timing pulse. Energy input to the xenon-filled tube is 30 watt seconds at low rates, diminishing to 10 watt seconds at the maximum rate of 15 flashes per second. Horizontal light distribution is 90°; vertical is 40°. Dimensions are 8" high x $14\frac{1}{2}$" wide x $10\frac{1}{2}$" deep; weight is 35 pounds. Remote control box and 50' connecting cable are provided.

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SAN FRAN CISCO TAPE MUSIC CENTER MODULAR ELECTRONIC MUSIC

SIGNAL GENERATORS

Model 158 Dual Sine-sawtooth Oscillator.

Two independent oscillators in one unit. Frequencies are continuously variable from 5 cps to 20 kc and may be controlled internally or with externally applied voltages. Wave shape may be adjusted from sine (1% harmonic content) to sawtooth (60% harmonic content). The oscillators may be wide-band frequency modulated over five octaves.

Model 144 Dual Square Wave Oscillator.

Two independent oscillators in one unit. Frequencies are continuously variable from 5 cps to 10 kc and may be controlled internally or with externally applied voltages. There is provision for up to 100% amplitude modulation and up to five octaves of wide-band frequency modulation.

Model 132 Waveform Synthesizer.

Used to generate complex, repetitive waveforms. The desired waveform is approximated by setting the instantaneous amplitude of each of 32 increments. Aural feedback, random knob-twiddling, and (desirably) an accessory oscilloscope contribute to achieving the desired sound. Frequency is continuously variable from 1 cps to 2 kc and may be controlled internally or with an externally applied voltage. The instrument may be frequency modulated and a synchronizing trigger is provided to facilitate oscilloscope monitoring.

Model 160 White Noise Generator.

Produces white noise with a flat frequency distribution from 5 cps to 20 kc and weighted noise with a constant power per octave distribution. When used as a frequency modulation source for oscillators, the resultant sound is similar to filtered white noise. The purity of this "pink noise" is inversely proportional to the amplitude of frequency modulation.

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SAN FRAN CISCO TAPE MUSIC CENTER MODULAR ELECTRONIC MUSIC

SIGNAL PROCESSORS

Model 111 Dual Ring Modulator.

Two independent, linear, ring modulators in one unit. Ring modulators are a variety of balanced modulators in which the output consists of the sum and difference frequencies of two input signals. The original signals are suppressed about 30 db.

Model 190 Dual Reverberation Unit.

Two spring-type reverberators. Amount of reverberation is adjustable. Reverberation is used to add brilliance to original material, to achieve a stereophonic effect from a monophonic source, or to simulate the natural reverberation of a large room or cavern.

Model 170 Dual Microphone Preamplifier.

Two high-gain mike preamplifiers in one unit. Input connectors are 3-pin XLR. Input impedences are selected by a panel-mounted switch.

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SAN FRAN CISCO TAPE MUSIC CENTER MODULAR ELECTRONIC MUSIC

CONTROL VOLTAGE AND TIMING PULSE SOURCES

Model 112 Touch-Controlled Voltage Source.

Two voltages are controlled by 12 keys. When a key is touched, the resultant output voltages are determined by the setting of potentiometers adjacent to that key. These voltages may be used to control oscillator frequencies, in which case 12 preselected notes can be instantly obtained by touching appropriate keys.

A third output voltage is proportional to finger pressure, and, when used to control a gate (Model 110), enables direct control of the signal amplitude.

A pulse output appears when a key is activated and is useful for triggering an attack voltage generator (Model 180) for shaping the attack and decay characteristics of a note.

Model 113 Touch-Controlled Voltage Source.

A touch-sensitive keyboard consisting of four circles, each of which is divided into five segments (1 central and 4 peripheral). Touching a segment causes an increase in voltage at a corresponding output. Switch-selected time constants provide extended attack and decay times. 20 potentiometers control the output voltages independently of or in conjunction with the keyboard.

Used with the Model 120 distributor, the Model 113 enables a performer to manipulate the origin of sounds within a room. Used with Model 310 lamp drivers, spatial control of room lighting may be realized.

Model 114 Touch-Controlled Voltage Source.

A 10 key touch-controlled keyboard with a control voltage output and a pulse output corresponding to each key. The voltage outputs are normally used to control gates (110) or mixers (107), and the pulse outputs for initiating attack waveforms (180) or other events. The time constant associated with each key is independently and continuously variable.

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Model 123 Sequential Voltage Source.

Produces a sequence of two to eight preselected voltages at each of three outputs. Switching from one voltage to the next is accomplished by applying a pulse. Indicator lamps show which of the 24 potentiometers are in control. Eight pulse outputs are energized as corresponding segments are switched.

Used in conjunction with a timing pulse generator (140), the Model 123 can produce two programmed sequences of voltages with any desired timing. (The third output voltage controls the period.)

Model 146 Sequential Voltage Source.

Produces a sequence of 2 to 16 preselected voltages at each of three outputs. Otherwise identical to Model 123.

Model 180 Dual Attack Generator.

Two independent units on one panel produce envelope control voltages initiated by pulses. Attack time is variable from .005 to 1 second; decay time from .05 to 5 seconds; and duration from .05 to 5 seconds. Duration may optionally be controlled by trigger pulse length.

Normally used with Model 110 gate for note shaping.

Model 140 Timing Pulse Generator.

A source of timing pulses for establishing a rhythmic element. The period may be varied from .1 to 10 seconds, and the pulse length from 1% to 99% of the period. Both parameters may be controlled internally or by externally applied voltages.

The Model 140 may be used to trigger the Model 180 attack generator, Model 123 voltage sequencer, and/or the Model 165 random voltage source.

Model 165 Random Voltage Source.

Produces two uncorrelated, random output voltages, each of which is changed by applying a trigger pulse. Used to randomize frequencies, amplitudes and timing.

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Model 106 Mixer.

Two 3-channel mixers with both separate and common outputs and level controls for each input. Maximum gain is 5 db.

Model 107 Voltage-Controlled Mixer.

Two 5-channel mixers with separate and common outputs. Input levels are controlled by externally applied voltages normally derived from a Model 114 touch-controlled voltage source. Maximum gain is 5 db.

Model 110 Dual Voltage-Controlled Gate.

Dual fast-response gate. Gain is determined by control voltages such as those derived from a Model 180 attack generator. Maximum gain is 5 db.

Model 120 Distributor.

A cross mixer with four inputs and five outputs. Any input may be connected to any output by applying a voltage at the appropriate point in the control matrix.

The Model 120 may be used in conjunction with the Model 113 voltage source for directing the origin of sounds within a room.

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Model 100 Cabinet.

Specially designed mahagony cabinet accommodates power supply and 15 panel units. (Most modules are $4\frac{1}{4}$" x 7" and occupy one panel unit, but some are $8\frac{1}{2}$" or 17" wide and take up 2 or 4 panel units.) Over-all dimensions are 23" x 23" x 8".

Model 115 Power Supply.

Regulated supply for powering a cabinet full of modules plus one or two keyboards. Normally installed in Model 100 cabinet, unit occupies no panel space.

Model 124 Patch Board.

Consists of 24 miniature phone jacks mounted on a panel and connected to a rear-mounted terminal strip. Used in studio installations to terminate lines from external sources or to tape recorders and other auxiliary equipment.

Model 156 Dual Control Voltage Processor.

Serves to mix, compress, and invert control voltages. Each channel has one normal input, one inverting input, and one internal voltage source. Particularly useful for obtaining fine pitch control and for compressing the range of the Model 165 random voltage source.

Patch Cord Set.

Consists of sufficient patch cords to program one super-module and one or two keyboards.

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SAN FRAN CISCO TAPE MUSIC CENTER MODULAR ELECTRONIC MUSIC

COMPLETE SYSTEMS

The following systems are presented as examples of complete, well-balanced Modular Electronic Music Systems:

Modular Electronic Music System No. 1

A single super-module consisting of the following components:

1 Model 100 Cabinet
2 Model 106 Mixers
1 Model 110B Dual Voltage-Controlled Gate
1 Model 111A Dual Ring Modulator
1 Model 112 Touch-Controlled Voltage Source
1 Model 115 Power Supply
1 Model 123 Sequential Voltage Source
1 Model 140 Timing Pulse Generator
1 Model 156 Dual Control Voltage Processor
3 Model 158 Dual Sine-sawtooth Oscillators
1 Model 160 White Noise Generator
1 Model 180 Dual Attack Generator
1 Model 144 Square Wave Oscillator
1 Model 190 Dual Reverberation Unit
1 Patch Cord Set

Modular Electronic Music System No. 2

Two super-modules consisting of the following components:

2 Model 100 Cabinets
3 Model 106 Mixers
1 Model 107 Voltage-Controlled Mixer
2 Model 110B Dual Voltage-Controlled Gates
1 Model 111A Dual Ring Modulator
2 Model 112 Touch-Controlled Voltage Sources
1 Model 114 Touch-Controlled Voltage Sources
2 Model 115 Power Supplies
1 Model 123 Sequential Voltage Source
1 Model 124 Patch Board
2 Model 140 Timing Pulse Generators
1 Model 144 Square Wave Oscillator
1 Model 146 Sequential Voltage Source
2 Model 156 Dual Control Voltage Processors
4 Model 158 Dual Sine-sawtooth Oscillators
1 Model 160 White Noise Generator
1 Model 165 Random Voltage Source
1 Model 170 Dual Microphone Preamplifier
2 Model 180 Dual Attack Generators
1 Model 190 Dual Reverberation Unit
2 Patch Cord Sets

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SAN FRAN CISCO TAPE MUSIC CENTER MODULAR ELECTRONIC MUSIC

PRICE INFORMATION

Model No.	Panel Units	Description	Price
100	0	Cabinet	$ 70.
106	1	Mixer	55.
107	2	Voltage-Controlled Mixer	160.
110B	1	Dual Voltage-Controlled Gate	75.
111A	1	Dual Ring Modulator	95.
112	0	Touch-Controlled Voltage Source	130.
113	0	Touch-Controlled Voltage Source	210.
114	0	Touch-Controlled Voltage Source	140.
115	0	Power Supply	60.
120	2	Voltage-Controlled Distributor	235.
123	2	Sequential Voltage Source	180.
124	1	Patch Board	35.
132	2	Waveform Synthesizer	190.
140	1	Timing Pulse Generator	70.
144	1	Dual Square Wave Generator	110.
146	4	Sequential Voltage Source	290.
156	1	Dual Control Voltage Processor	95.
158	1	Dual Sine-sawtooth Generator	130.
160	1	White Noise Generator	75.
165	1	Random Voltage Source	140.
170	1	Dual Microphone Preamplifier	125.
180	1	Dual Attack Generator	80.
190	1	Dual Reverberation Unit	135.
		Patch Cord Set	45.
		Complete System No. 1	1720.
		Complete System No. 2	3420.

The numbers in the "panel units" column indicate the relative space occupied in the cabinet by the corresponding modules. Total the number of panel units desired in a system and order one power supply (115) and cabinet (100) for each 15 (or portion thereof) panel units.

660408

THE SYSTEM

The Modular Electronic Music system that was developed at the Tape Music Center is composed of functional *modules*, each designed to generate a particular class of signals or perform a specific type of signal processing. Each module is 7 inches high and 4¼ inches (or an integral multiple thereof) wide. Up to 15 modules sharing a single power supply may be assembled in a single cabinet, and form a *super-module*.

The system employs three varieties of signals, each with a distinctly different function:

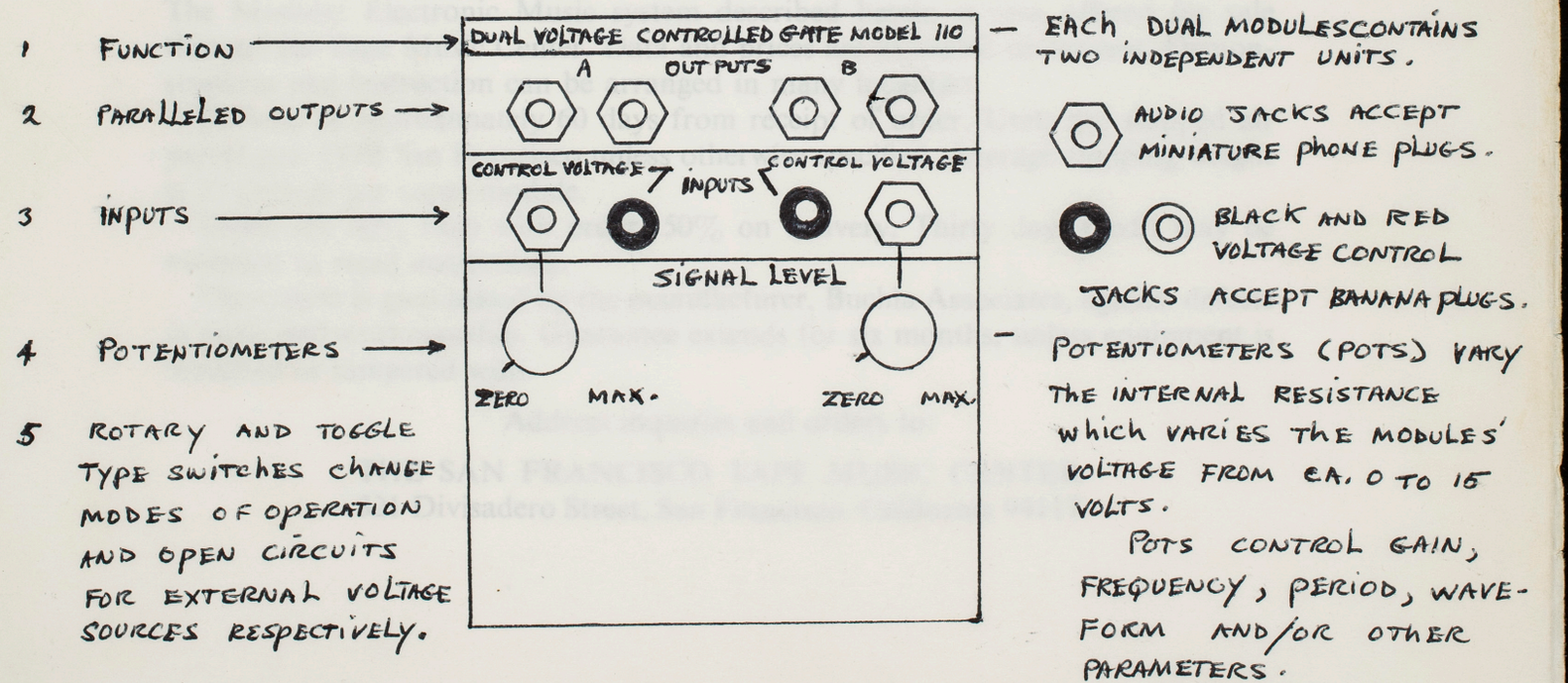
Audio signals, the raw material of electronic music, are formed by various sorts of generators (sine, square, sawtooth, harmonic) or are produced externally (tape loop, radio, microphone). In constructing a piece, they may be filtered, gated, mixed, modulated, or otherwise processed. The patch cords carrying audio signals within the system are grey, shielded cables terminated with miniature phone plugs. A standard level of Odb (ref. 600Ω) is employed for audio signals within the system.

Control voltages, used to determine frequencies, envelope characteristics, amplitudes and other parameters, are generated by keyboards, programmable voltage sources, and format generators. Black banana plug patch cords are used to interconnect control voltages. The standard control voltage range is from .5 to 15 volts.

Timing pulses are originated by keyboards, programmable sequencers, and pulse generators. They are used to trigger notes, open gates, or initiate chains of musical events. Timing pulses are about 10 volts in amplitude and are interconnected with red banana plug patch cords.

The rules for interconnection are straight-forward. Any number of inputs may be connected to a single output. Timing pulse outputs may be paralleled and connected to one input. The system output may be derived from any module; output is of sufficient magnitude to drive line inputs on tape recorders or sensitive inputs on power amplifiers.

PANEL FORMAT



THE MODULAR ELECTRONIC MUSIC SYSTEM

Now offered for sale by the
SAN FRANCISCO TAPE MUSIC CENTER

An exciting new instrument for generating and processing electronic material.

An imaginatively flexible studio instrument capable of producing an enormous range of sounds and formats.

Direct immediate control of musical parameters enabling live real-time performance of electronic music without tape buffering.

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Comment

"The instrument is the answer for composers who wish to work with electronic materials but care nothing for electronics, and teachers will find it student-proof."

Robert Erickson,
Composer
Teacher, San Francisco Conservatory of Music

"Aside from creating an imaginatively flexible studio instrument, Mr. Buchla has made it practical for a composer to have a complete electronic music studio in his own home."

Mort Subotnick,
Composer

". . . a keyboard connected to an enormous range of the sounds of our time. Every composer should come to see, hear, and possibly play the thing, just to know what resources Buchla has made available."

Lou Gotlieb,
San Francisco Chronicle

"It could be the precursor of fascinating developments in the field of electronic music."

Carl Cunningham,
San Francisco Chronicle

"A most remarkable instrument for manipulating sound. As useful in the concert hall as it is in the studio."

David Tudor,
Musician