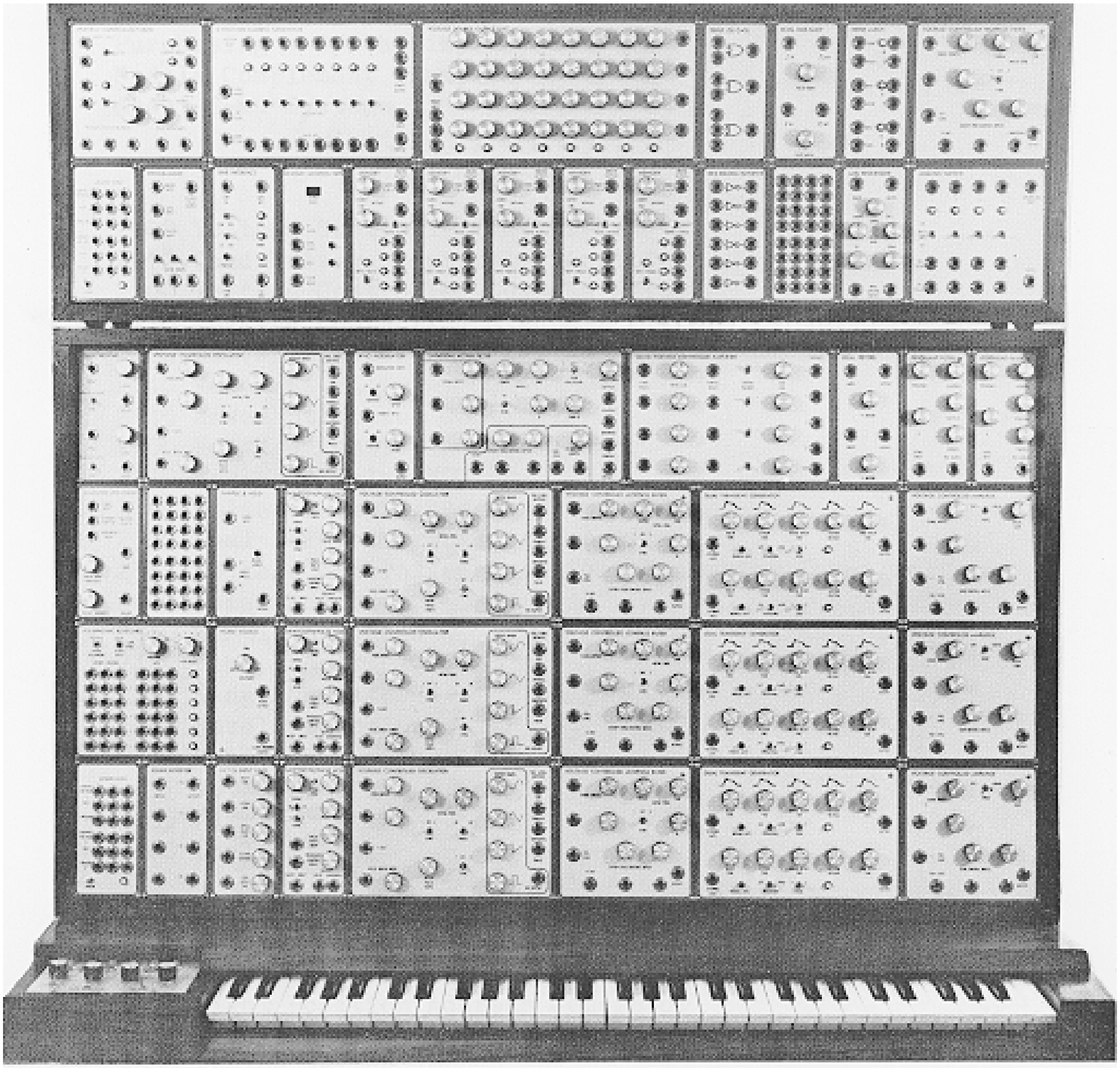
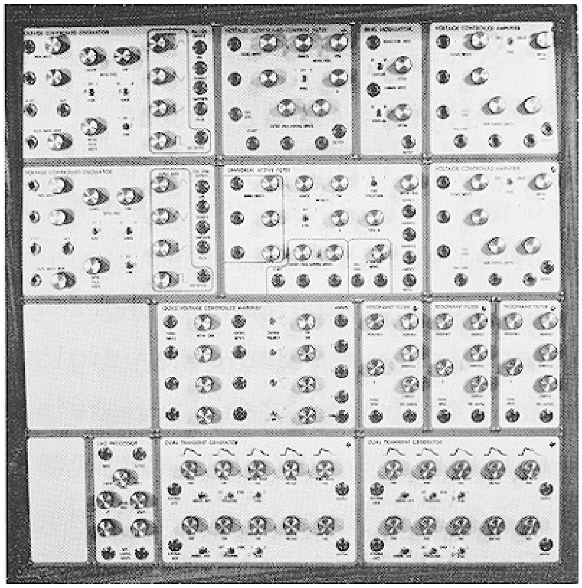


Technical Catalog

December 1978

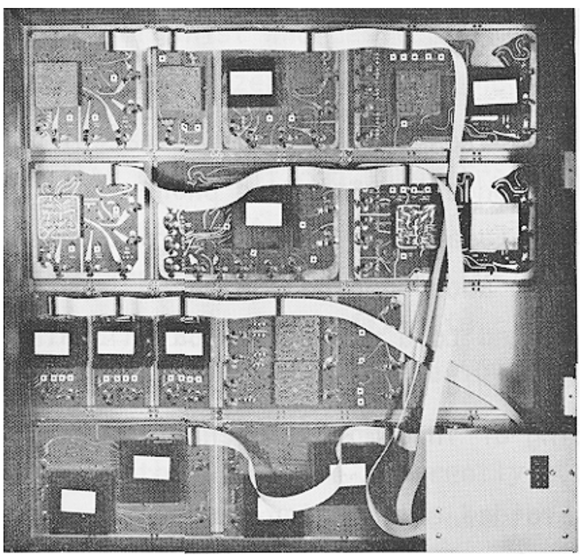
417 Broadway
Santa Cruz, CA 95060
(408) 429-9147

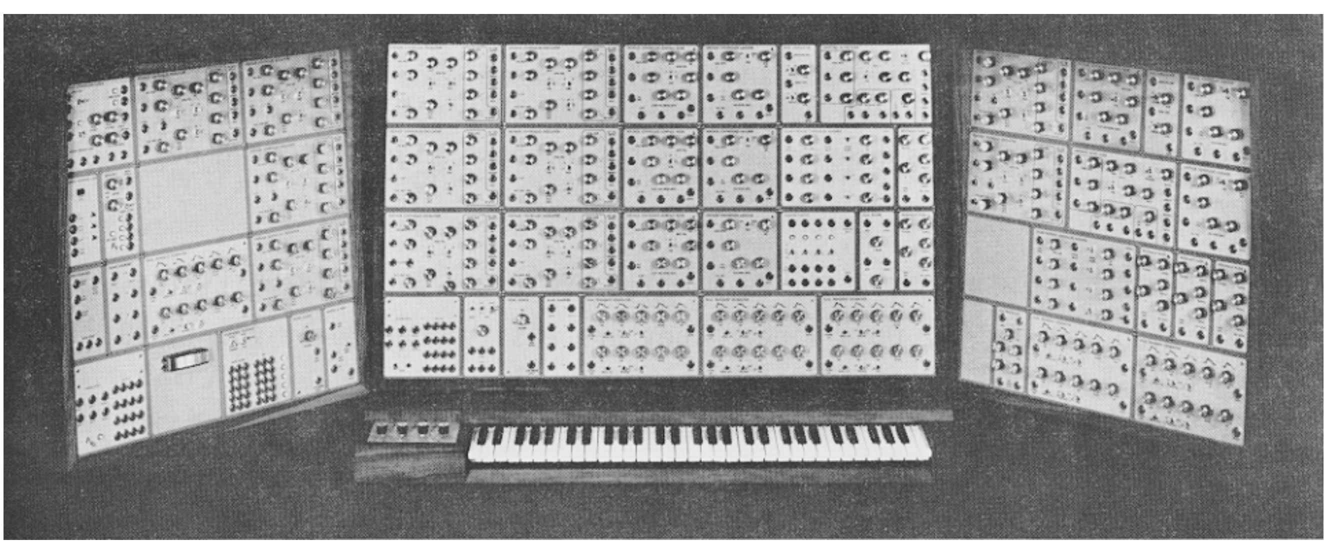
THE Eμ SYNTHESIZER SYSTEM



The Eμ Modular Synthesizer System is based around Eμ submodules, compact solid state building blocks providing highly accurate synthesizer functions. The plug-in submodules are designed for maximum flexibility.

The full system is totally modular. We have endeavored to use the finest panel controls available, compatible with the professional audio market. Pots are conductive plastic, knobs are solid aluminium, switches and jacks are highly reliable. The system's internal construction is clean and neat. All modules are supplied with complete documentation package including schematics and assembly diagrams.





Eμ MODULAR SYSTEM FEATURES

STANDARD SIGNAL LEVELS - All Eμ modules handle ±10 V signals, while output waveforms and control ranges are typically ±5 volts. All frequency controls are exponential at 1V/octave.

STANDARD IMPEDANCES -

INPUT MIXING -

PATCH OVER FIRM-WIRE -

ERASABLE FRONT PANELS -

POWER BUS SIGNAL DISTRIBUTION -

STANDARD MODULE DIMENSIONS -

PURCHASING A SYNTHESIZER SYSTEM

Good synthesizers, as you have no doubt noted, are expensive. Below about $500, it is virtually impossible to get a keyboard synthesizer. Most products in this price range make “flying saucer” sounds or modify other instruments. A few have keyboards, but the oscillators are not of sufficient quality for serious musical work. We would recommend these units only for those who wish to learn the rudiments of voltage control , then discard the product in favor of a good synthesizer should he decide he is seriously interested.

Between $500 and $3000, there are a large number of portable synthesizers. (“Portable” has come to be synonymous with “cheap”: a truly portable synthesizer would use ruggedized, reliable components and be more expensive than a studio system.) Three classes of instrument are found here, with some blending among the classes. There are the instant patched or “preset” units, primarily aimed at the organist who desires some realistic monophonic voices. Switched patched “mini-synthesizers” are designed to give the amateur musician a simple “synthesizer sound”. A few units give patchcord capability, but unless circuit quality is sacrificed, they are at the high end of the price bracket. As audio flexibility is the major advantage of the synthesizer concept, all these units should be carefully scrutinized in this regard. It is best to consider mini-synthesizers as fixed function musical instruments, selecting among them by considering how well the sounds one unit makes match your needs, rather than shopping by comparing advertised features.

Synthesizers are inherently modular in concept, both in the sense that a patch represents the interconnection of certain modular “black boxes”, and in the fact that different synthesizers contain different sets of these similar functional modules. By making the system a set of physically distinct and separate modules, the concept is carried to its logical conclusion. The musician can select the complement of functions that best suits his needs, and can expand his system as his capability grows.

The “entry fee”, or price for a minimal modular system, is about $3000. A big reason for this high price tag is the packaging cost to allow distinct modules, and the expense of stocking a large product line. The necessity of buying power supply, keyboard, and cabinet for even the smallest system adds to this entry fee. However, the inherent long term savings in the modular system becomes apparent when you consider the day the musician requires one more module than is contained in his fixed size portable synthesizer.

MODULE COMPLEMENT EXAMPLES

Our modular approach enables us to supply virtually any module complement a musician might desire, so we do not stock any “standard” systems. We encourage potential customers to think out what system would best suit their musical abilities and tastes (your dealer can help you with this). Nonetheless, many will find the following examples of “well balanced” small systems useful as points of departure.

Minimal Starting System

Qty.	Stk. #	Description
1	2000	Voltage Controlled Amplifier
1	2100	Voltage Controlled Lowpass Filter
1	2200	Voltage Controlled Oscillator
2	2210	Voltage Controlled Oscillator (Sawtooth/Pulse)
1	2350	Dual Transient Generator
1	2400	Noise Source
1	2905	Power Supply
1	4000	Monophonic Keyboard
1	4120	Cabinet
1	2800	
5	2802	Blank Panels

Good Sized Starting System

Qty.	Stk. #	Description
2	2000	Voltage Controlled Amplifiers
1	2100	Voltage Controlled Lowpass Filter
1	2120	Universal Active Filter
2	2200	Voltage Controlled Oscillators
2	2210	Voltage Controlled Oscillators (Sawtooth/Pulse)
2	2350	Dual Transient Generators
1	2400	Noise Source
1	2410	Sample & Hold
1	2430	Ring Modulator
1	2905	Power Supply
1	4000	Monophonic Keyboard
1	4120	Cabinet
1	2802	Blank Panels

ABOUT Eμ SYSTEMS: Eμ (pronounced as the beginning syllables of Electronic Music) Systems is a partnership of Dave Rossum and Scott Wedge, formed in 1972 to produce professional electronic music equipment and components. Our business is and will continue to be a modest venture; quality electronic music systems are not a volume product and cannot alone support a large corporation. We prefer to think of ourselves as craftsmen rather than manufacturers, as each system we build get a good deal of special attention.

Listed below are miscellaneous bits of our policies and philosophy. If you should wish to further discuss them or for that matter any aspect of electronic music, do not hesitate to write us.

DESIGN: The goal of our circuit design is to get the ultimate in performance, compatible with competitive pricing. Of particular significance are the criteria of wide dynamic range, low distortion and noise, flexibility and reliability. The modular system was conceived as an optimum general purpose studio unit, also usable in sophisticated live performance.

ADVERTISING: We are basically opposed to conventional advertising, and prefer to rely upon word of mouth communications. The money we save is spent on a better product. We appreciate our customers spreading their impressions of our products and services.

CATALOG UPDATES: As our product line is continuously expanding, we periodically update our technical catalog. We try to send spec sheets for new products to all active and prospective customers. Keep us informed of your mailing address.

DEALERS: In many areas we are represented by a dealer. He is an expert in the synthesizer field, and has a demonstration system in a studio environment. The dealer can help you find a module complement and layout to suit your needs, and can answer questions regarding any of the system components.

Should you ever be dissatisfied with a dealer (or us, for that matter), don't hesitate to write directly to us.

If you are interested in becoming an Eμ dealer, write to us for details. Keep in mind you must purchase a system suitable for demo, meet our qualifications, and be in a suitable location to fit into our representation net.

FACTORY SALES: We will sell modular systems factory direct to individuals in areas without established dealerships. In these cases the factory is simply acting as its own dealer. Terms for factory direct sales are 50% cash in advance, 50% on delivery.

DELIVERY: Small orders are generally processed in 1-2 weeks. System orders may take from 3 to 8 weeks.

We ship to factory direct customers via UPS whenever possible, otherwise by US Mail. It is our experience that the post office is rough on packages; this should be kept in mind on returns. UPS cannot ship to PO boxes. Large systems are generally shipped air freight.

SUBMODULES: Submodules are not generally considered dealer items, although they may be purchased through dealers.

DISCOUNTS: We offer a 2.5% system discount on orders for modular equipment over $1500, 5% over $3000. We also offer an OEM discount on submodules.

GUARANTEE: Assembled modular systems are guaranteed to be free of defects in workmanship or materials for a period of one year from the date of shipment to the extent of repair or replacement of defective items only, FOB factory. Submodules and other products, and any custom modifications are similarly guaranteed for 30 days. In no case does coverage extend to damage caused by improper connection or use.

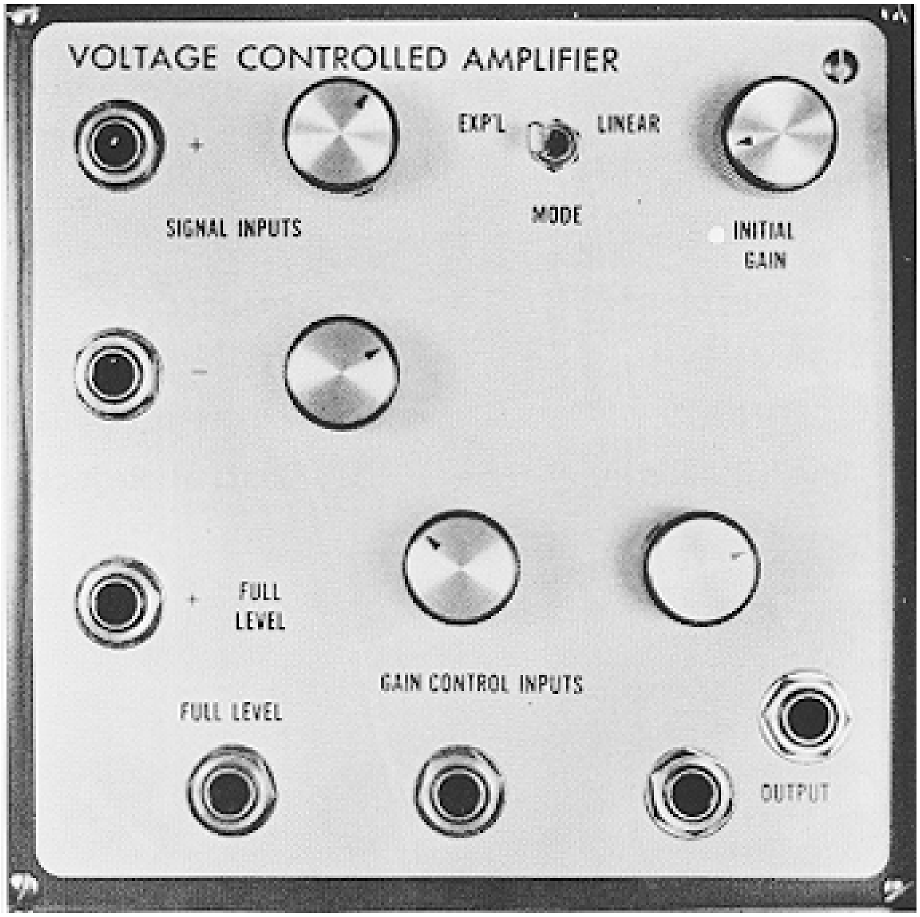
REPAIR: Any failure in a modular system can be quickly remedied by shipping the failed module or plug-in submodule to the factory. We give modular system repairs top priority, and turnaround can generally be effected in 24 hours.

OBSOLETE CIRCUITS: As changes in the state of the art make it practical to redesign to improve performance or lower cost, we shall update our circuitry. The result will usually be a pin-for-pin improved submodule. This substantially improves the resale value of our equipment, for an older modular system can be fully updated to the latest specifications by replacing outdated submodules at a fraction of the original cost. Naturally replacement parts for obsolete designs will always be available. Should you require an obsoleted circuit for some purpose, we can easily produce it and will be happy to quote a price.

CUSTOM WORK: Our modular system is what we believe to be optimal for general purpose work. Nonetheless, we are happy to quote on custom modifications when needed. Keep in mind that custom work is always much more expensive than standard products.

PROPRIETARY CIRCUITRY: All Eµ designs are proprietary, and purchase of our products does not carry a license to copy them without written permission.

Eμ MODULE 2000 - VOLTAGE CONTROLLED AMPLIFIER



The Eμ 2000 Voltage Controlled Amplifier is an exponentially and/or linearly controlled amplifier for envelope shaping or control functions. It contains an Eμ 1001 VCA submodule.

The top two signal inputs pass through their respective attenuators, and are summed with the full level input. The result appears at the output, amplified by a factor determined by the control inputs. The second signal input is inverting for increased flexibility.

The control inputs are similarly summed with the initial gain control (which effectively varies from -5 to +5 volts) to produce the total input control voltage.

The 3 position mode switch determines the function of the control voltages. In linear mode, the amplifier has zero gain for total control voltages below zero, and the gain increases linearly above zero, passing through unity at +5 volts. In exponential mode, the amplifier again has unity gain at +5 volts, and changes 10 dB per volt around this point.

With the mode switch in the center position, the two leftmost control inputs and the initial gain control behave the same as in linear mode. The rightmost control input, however, acts as a multiplier on the gain, with a sensitivity of 10 dB per volt.

Maximum gain available from the amplifier is approximately +6 dB.

Power Requirements:
±15 V @ 12 mA typical

Firm-wire Patch Connections:

- Inputs Signal (2)
- Control (2)
- Outputs One (3 pins)

Power Bus Connected Inputs:

- None

Adjustments

- Master Gain
- Exponential Gain
- Control Rejection

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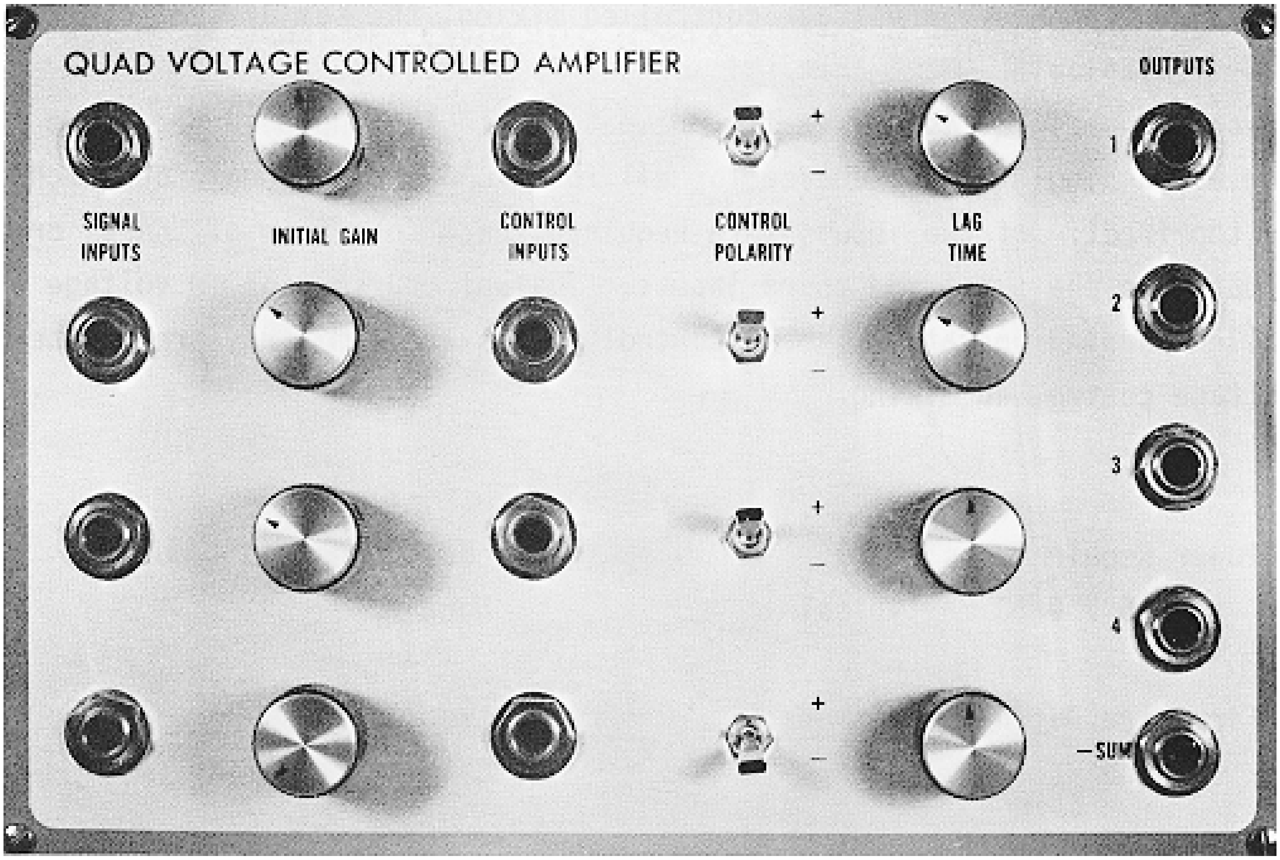
Eμ MODULE 2010 - QUAD VOLTAGE CONTROLLED AMPLIFIER



The Eμ 2010 Quad VCA module is an array of four independent linear two quadrant multipliers, using two Eμ 1010 submodules. It is particularly useful for spatial modulation and voltage controlled mixing.

Each of the four identical VCA sections can function totally independently. The gain at zero control voltage for each VCA is determined by the associated initial gain control. Setting the control left of center always results in zero gain, but as the control is rotated further counterclockwise, more control voltage is required before the VCA begins to pass any signal.

The effective control polarity may be selected by a switch for each VCA. In the + position, the gain is increased for positive control voltages, in the - position it is decreased. Hence a single control voltage applied to two control inputs can turn one channel on and the other off. This is most useful in mixing and panning operations.

The lag control introduces a finite attack and decay into the control path. This is useful when digital signals are used on the control inputs, as it eliminates the pops resulting from sharp attacks. The lag time is variable from a few microseconds to approximately 0.1 second.

As a convenience for voltage controlled mixing, the sum of the four VCA outputs is available. Note that this output is inverting.

Each signal input is internally pre-patched to the input above it, so that to use a single signal source for all four VCA’s it need only be patched to the top input. If two inputs were required, each to a pair of VCA’s, one would patch to the first and third inputs. This of course aids in voltage controlled panning operations. The control inputs are similarly pre-patched for voltage controlled mixing.

Power Requirements:

±15 V @ 30 mA typical

Firm-wire Patch Connections:

None

Power Bus Connected Inputs:

None

Adjustments

Control Rejection (4)

1 January 1976

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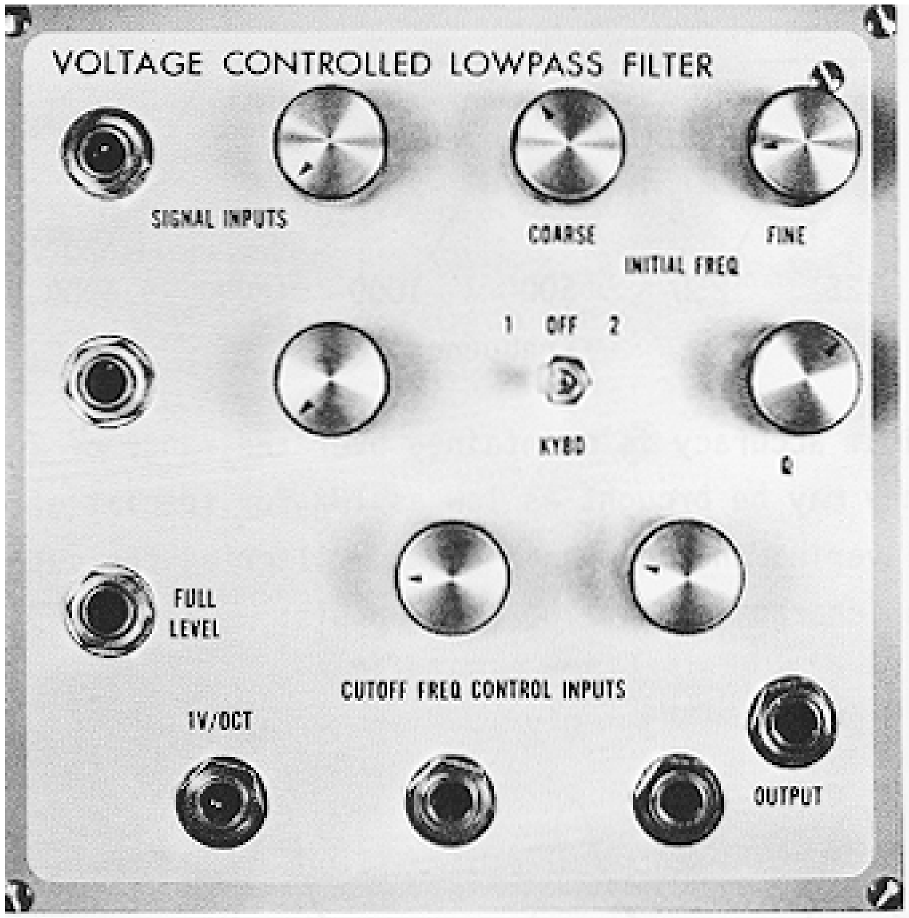
Eμ MODULE 2100 - VOLTAGE CONTROLLED LOWPASS FILTER

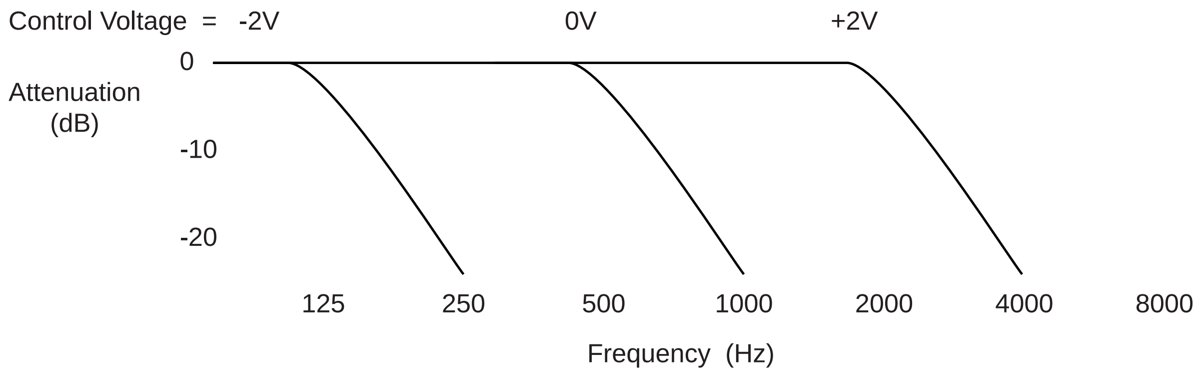


The Eμ 2100 Voltage Controlled Lowpass Filter is an exponentially controlled lowpass filter with variable Q for electronic music applications. It contains an Eμ 1100 VCF submodule.

The top two signal inputs pass through their respective attenuators and are summed with the full level input to form the total signal input. This signal is then lowpass filtered with a cutoff frequency determined by the sum of the initial cutoff frequency controls and the control inputs. The cutoff slope is 24 dB/octave, and the signal path is DC coupled.

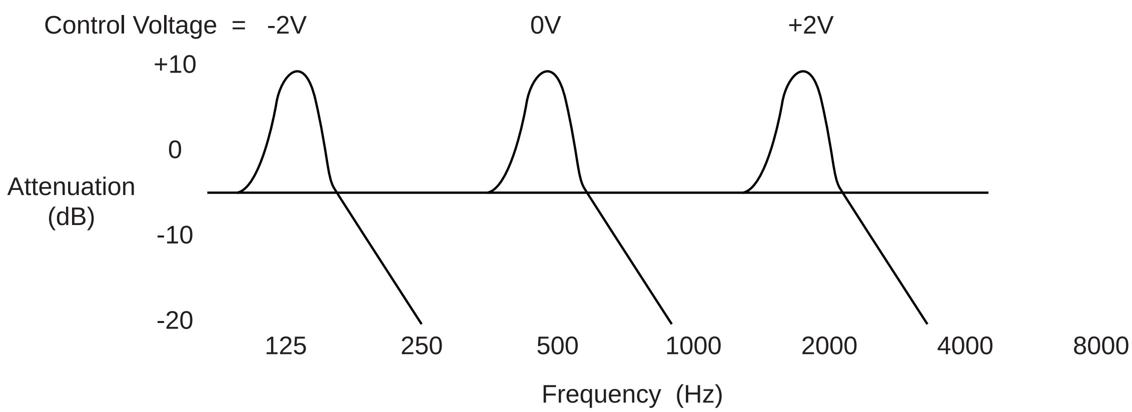
The control inputs are algebraically summed to give a total control input voltage, which will vary the cutoff frequency one octave per volt around the initial cutoff frequency. The keyboard switch allows instant patching of either of two keyboards at precisely one volt per octave. The 1V/octave control input jack is also accurately calibrated.

The filter's operation is best illustrated by the pass characteristic, a plot of attenuation against signal frequency, The first illustration shows typical curves with the initial cutoff frequency controls at midrange (500 Hz) and the Q control fully counterclockwise.



Although maximum accuracy is maintained over the range of 20Hz - 20kHz, the cutoff frequency may be brought as low as 1Hz for special effects.

The Q control varies the resonance of the filter at the cutoff frequency. At high Q, the pass characteristic looks like this:



As the Q approaches maximum setting, the filter breaks into oscillation, producing a pure sine wave. Lowest distortion occurs with the Q control set barely into the oscillation region.

Power Requirements:

±15 V @ 25 mA typical

Firm-wire Patch Connections:

Inputs Signal (2)
Control (2)

Outputs One (3 pins)

Power Bus Connected Inputs:

Keyboard Voices 1 & 2

Adjustments

Volts/Octave

Offset

1 January 1976

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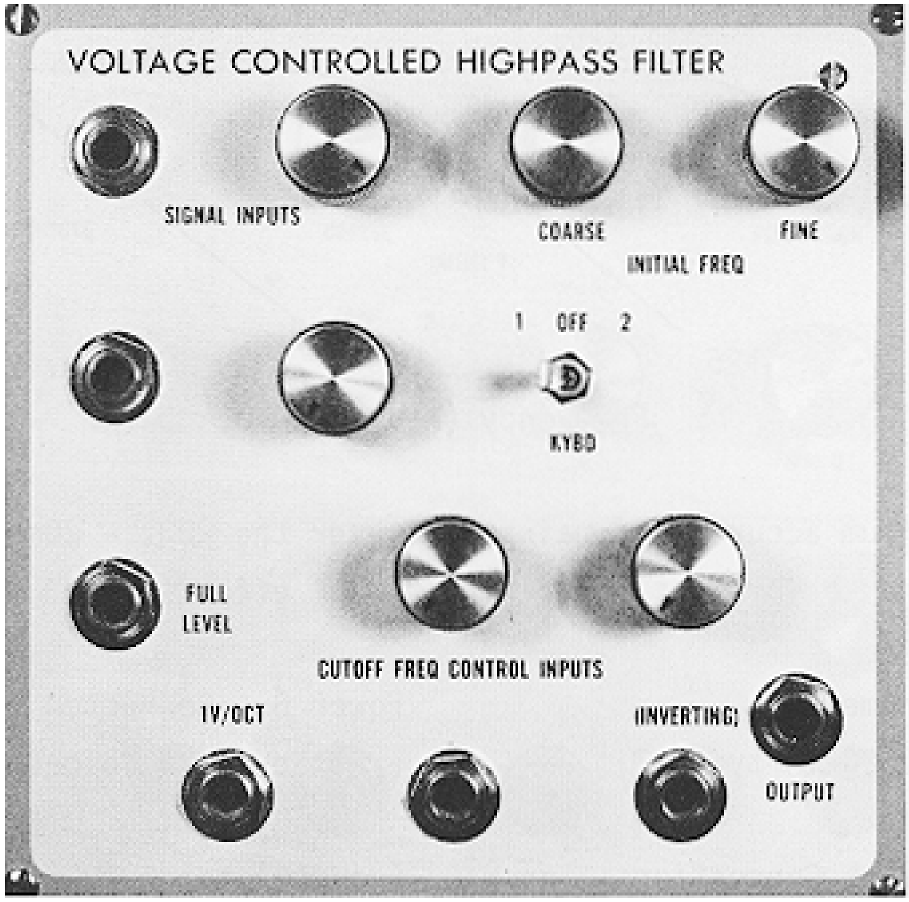
Eμ MODULE 2110 - VOLTAGE CONTROLLED HIGHPASS FILTER

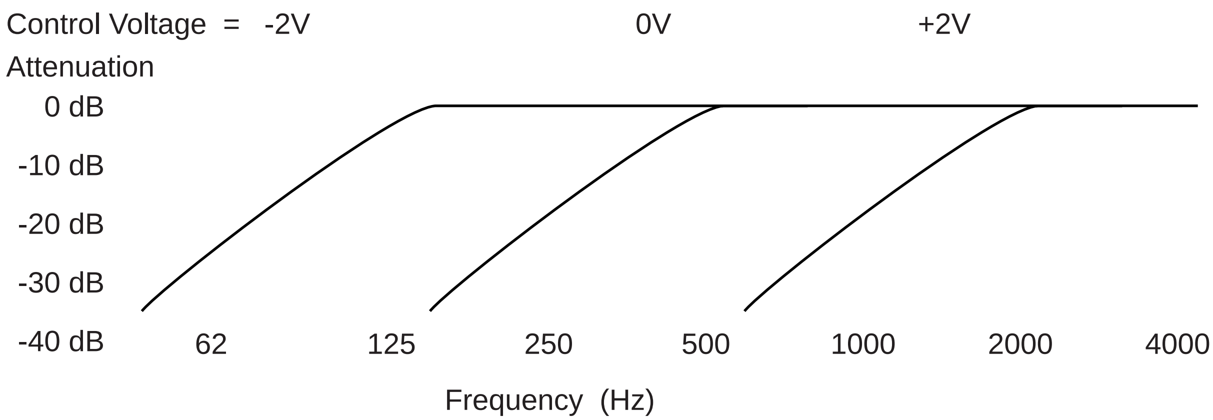


The Eμ 2100 Voltage Controlled Highpass Filter is an exponentially controlled highpass filter based on an Eμ 1101 submodule.

The top two signal inputs pass through their respective attenuators and are summed with the full level input. The resulting signal is then highpass filtered with a cutoff frequency determined by the settings of the coarse and fine cutoff frequency controls and the control inputs. The cutoff slope is 24 db/octave.

The control inputs are algebraically summed to give a total control input voltage, which will vary the cutoff frequency one octave per volt about the initial cutoff frequency. The 1V/oct input and the switchable keyboard connection are precisely calibrated at 1V/octave; the attenuable inputs have a maximum sensitivity of approximately 1V/octave.

The filter's operation is best illustrated by a pass characteristic plot (attenuation versus frequency) given on the reverse side of this page.



Although maximum accuracy is maintained over the range of 20Hz - 20KHz, the cutoff frequency may be brought lower for special effects.

Power Requirements:
±15 V @ 20 mA typical

Firm-wire Patch Connections:

Inputs	Signal (2)
	Control (2)
Outputs	One (3 pins)

Power Bus Connected Inputs:
Keyboard Voices 1 & 2

Adjustments
1V/octave trim.

1 January 1976

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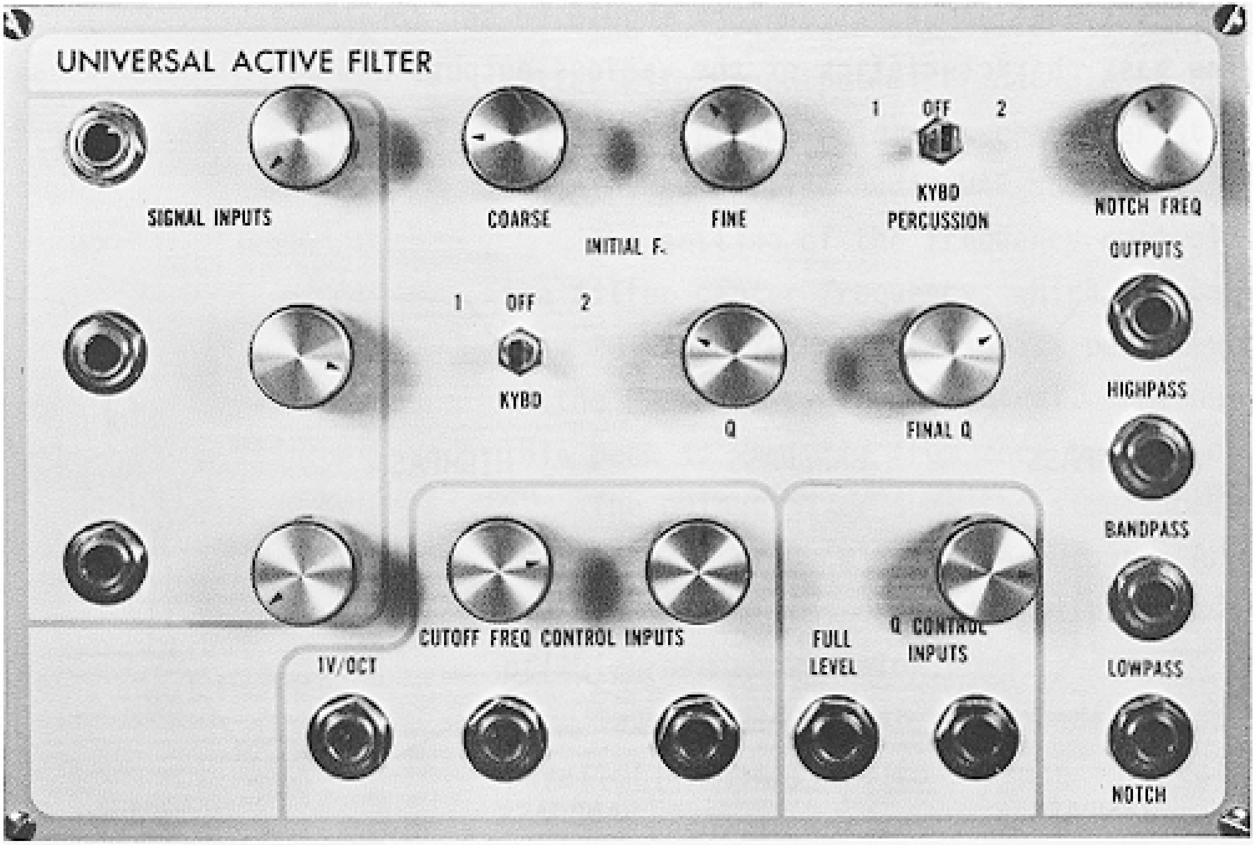
Eμ MODULE 2120 - UNIVERSAL ACTIVE FILTER



The Eμ 2120 Universal Active Filter is a fully voltage controlled filter with simultaneous highpass, bandpass, lowpass, and notch outputs. It contains an Eμ 1120 UAF submodule.

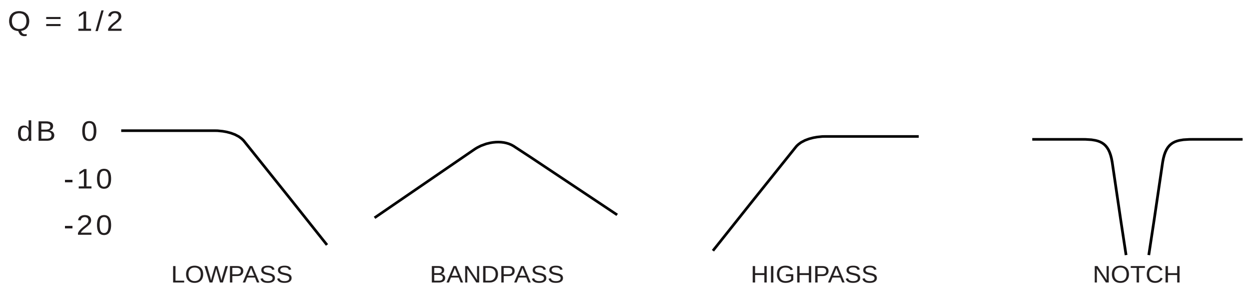
Each of the three signal inputs passes through an attenuator, then the signals are summed and pass through the filter to appear at each of the outputs. The highpass signal is filtered 12 dB/octave below the cutoff frequency, the bandpass 6 dB/octave on both sides of cutoff, and the lowpass 12 dB/octave above cutoff. The notch output is unfiltered except for a 40 dB notch near the cutoff frequency. The Notch Frequency control will vary the ratio of the notch center frequency to the cutoff frequency several semitones to either side.

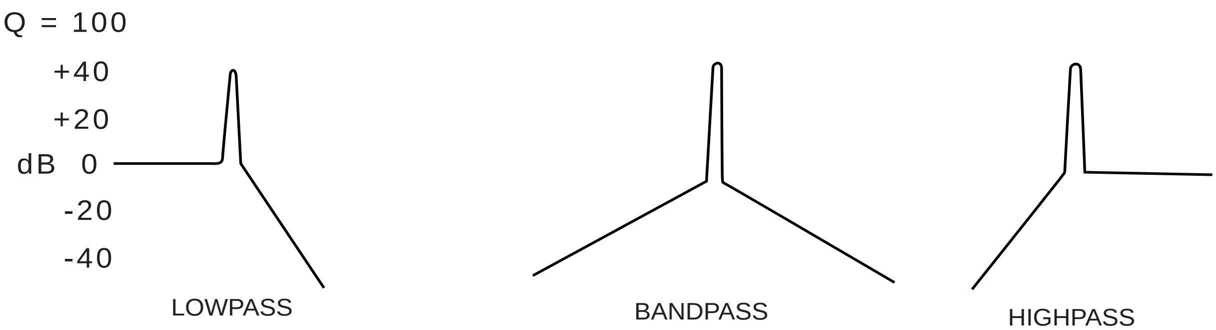
The cutoff frequency is exponentially voltage controlled by the cutoff frequency inputs. The keyboard switch connects either of two keyboards at precisely lV/octave.

The Q of this filter is exponentially voltage controlled over a range from 1/2 to 512, at one volt per factor of two change. The Q is numerically equal to the gain of the filter at the cutoff frequency. As Q is increased, the filter becomes extremely resonant at Fc. Up to 54 dB of gain can be achieved. The notch output is ineffective at high Q.

With such high gains, it is very easy to cause the filter to distort. At high Q, the signal input attenuators should be set for low levels.

The pass characteristics of the various outputs are as follows:





With sufficiently high Q, fast signal transients such as pulse and sawtooth waveforms will cause the filter to “ring” at the cutoff frequency. The keyboard percussion switch patches a keyboard’s gate and trigger signals into the filter to use this effect. On depression of a key, the trigger signal causes the filter to ring with a decay set by the Q control. When the key is released, the filter Q control instead becomes active, allowing a damping effect if desired. The final Q control has no effect with the keyboard percussion switch off.

Power Requirements:

±15 V @ 50 mA typical

Firm-wire Patch Connections:

Inputs Signal (3)
Frequency Control (2)
Q Control (2)

Outputs
Highpass (3 pins)
Bandpass (3 pins)
Lowpass (3 pins)
Notch (3 pins)

Power Bus Connected Inputs:

Keyboard 1 & 2 Voice, Gate & Trigger

Adjustments

V/octave
Highpass Offset
Bandpass Offset
Q Rejection

1 January 1976

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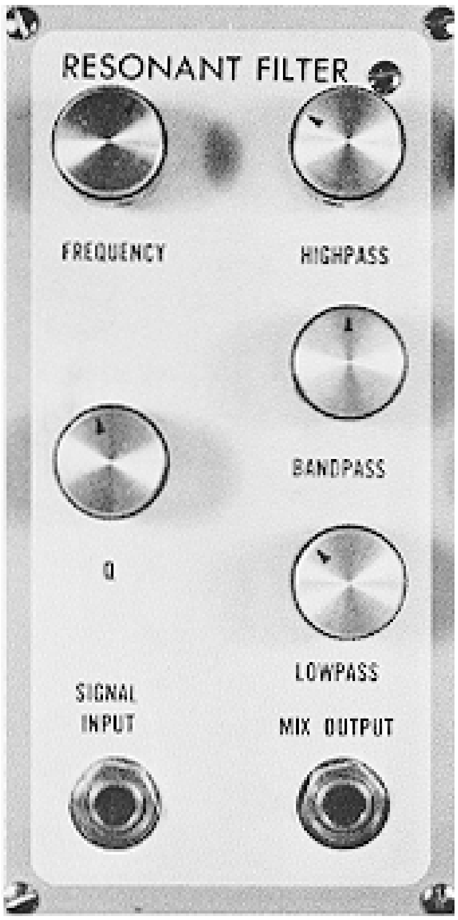
Eμ MODULE 2140 - RESONANT FILTER



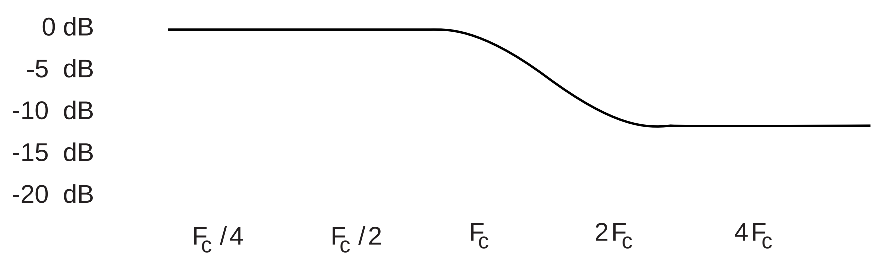
The Eμ 2140 Resonant Filter is an audio filter with an output mixer capable of producing virtually any two pole pass characteristic. It contains an Eμ 1140 Audio UAF submodule.

The setting of the frequency control determines the filter center frequency, which can be varied from 20 Hz to 20kHz. A resonant peak may be added to the response by the Q control. The height of this peak is variable from zero to ≈ +40 dB.

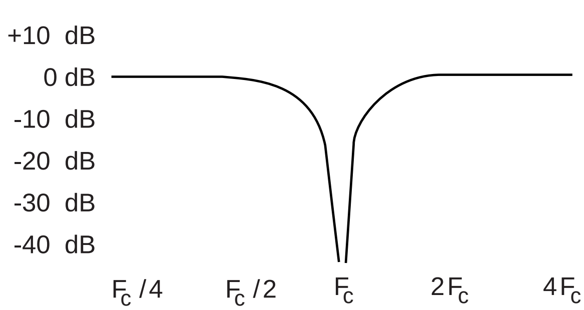
The output mixer sums the simultaneous filter functions to produce a single output. An incredibly wide variety of responses can be produced, a few of which are shown below.

Several 2140's can be cascaded in series/ parallel combinations to produce interesting complex resonant formants. Lower input levels should be used at high Q's to prevent clipping.

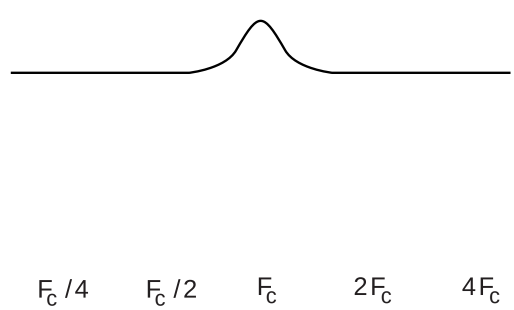
LP = full, BP = 1/2, HP = 1/4, Q = min



LP = HP = full, BP = 0, Q = min



LP = BP = HP = full, Q = +10 dB



Power Requirements:
±15 V @ 20 mA typical

Firm-wire Patch Connections:
- Signal Input
- Output (3 pins)

1V/octave control input

Power Bus Connected Inputs:
- None

Adjustments:
- V/octave
- Highpass Offset
- Bandpass Offset
- Q Rejection

1 January 1976

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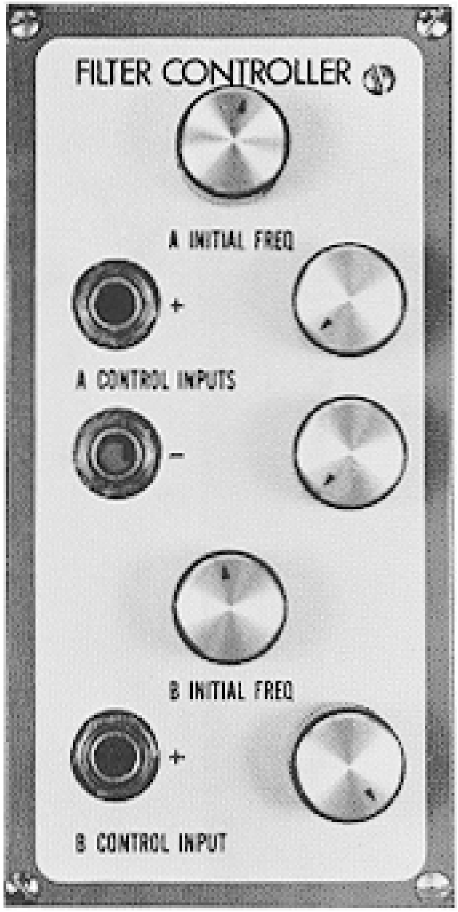
Eμ MODULE 2145 - FILTER CONTROLLER



The Eμ 2145 Filter Controller allows voltage control of the frequency of two banks of Eμ 2140 Resonant Filters. Each bank of filters may contain from one to four 2140 units connected in any series or parallel combination. The bank center frequency will be determined by the 2145 controller while the formant shape will remain unchanged.

The “A” section initial frequency control alters the frequency of the “A” filter bank by +5 octaves. The “A” section “+” control input will shift the frequency of the “A” bank with a maximum sensitivity of 1 volt/octave, depending on the setting of the adjacent attenuator. The “-” control input will similarly shift the “A” bank, but will respond to a positive voltage with a negative frequency shift.

The “B” filter bank is similarly controlled by the “B” section initial frequency control and the “+” control input.

When no external patch is made to the “-” control input in the “A” section, this is pre-patched to the control output for the “B” section. Hence, with the attenuator turned up, rotation of the “B” section initial frequency control, or applying a voltage to the “B” section “+” control input will shift the “B” bank up in frequency while shifting the “A” bank down, an interesting stereo musical effect.

Power Requirements:
±15 V @ 10 mA typical

Power Bus Connected Inputs:
None

Firm-wire Patch Connections:
Inputs +A Control
+B Control
Q Control (2)

Adjustments:
None

Outputs A (4 pins to 2140 control inputs)
B (4 pins to 2140 control inputs)

1 August 1976

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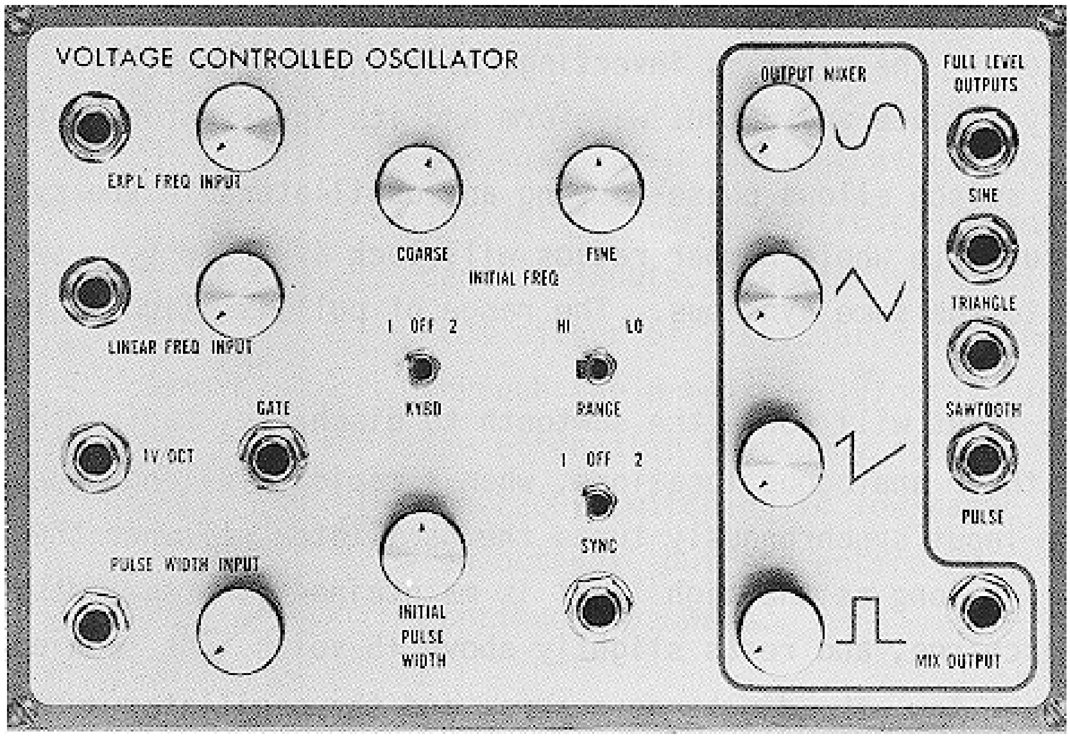
Eµ MODULE 2200 - VOLTAGE CONTROLLED OSCILLATOR



The Eµ 2200 Voltage Controlled Oscillator is a complete, four waveform, exponentially and linearly controlled oscillator with an output mixer. It is exceptionally stable and accurate for use with full size synthesizer keyboards. It contains an Eµ 1201 VCO submodule, and an Eµ 1210 wave converter submodule.

The upper three inputs are for frequency control. The uppermost is attenuable from 1 volt per octave with exponential response; the center has AC coupled linear response with a maximum sensitivity of 20% per volt. The lowest input responds exponentially at precisely lV/octave. The keyboard switch will instantly connect either of two keyboards at exactly lV/octave.

The oscillator’s initial frequency can be adjusted by the coarse control over more than ten octaves, while the fine adjustment with its four semitone range allows precise tuning. The range switch shifts the oscillator initial frequency down ten octaves. The frequency can be swept, however, over the entire twenty octave range from 0.03Hz to 30kHz.

The pulse width control and the pulse width modulation input vary the duty cycle of the pulse waveform from 0% to 100%. Maximum sensitivity is 10%/volt.

The four upper output jacks give each of the waveforms at full level (lOV peak-to-peak for sine, triangle, and pulse, 0 to +5V for sawtooth). The waveforms are phased as shown on the panel; the falling edge of the pulse waveform is varied by the pulse width voltage.

The output mixer enables the creation of waveforms with infinitely variable harmonic content. The mixer is inverting, allowing the oscillator to simultaneously produce any output waveform and its inverse for control purposes.

The sync switch allows phase-locking any oscillators in the system. Oscillators tuned to whole number ratios will lock if their sync switches connect them to the same sync bus. The range of pull is slightly less than a semi tone.

The sync input will force the sawtooth to discharge, taking the other waveforms to their analogous locations, when a rapidly falling edge is applied.

The gate input synchronously turns the oscillator off when the input exceeds about +2.5V. As long as the high level is maintained, the sawtooth is not allowed to discharge, and rests slightly above +5 volts. As soon as the gate input is brought low, the discharge occurs, and the oscillator runs again. The gating and sync input features are not only useful in control oscillators at subaudio frequencies, but also produce interesting timbres when both the controlling and sync'd or gated oscillators are run at audio rates.

Power Requirements:

±15 V @ 50 mA typical

+5 V @ 10 mA typical

Firm-wire Patch Connections:

Inputs:

- Frequency Control (2)
- Pulse Width Modulation

Outputs:

- Sine (3 pins)
- Sine (3 pins)
- Triangle (3 pins)
- Sawtooth (3 pins)
- Pulse (3 pins)
- Mixer (3 pins)

Power Bus Connected Inputs:

- Keyboard CV's 1 & 2
- Sync Busses 1 & 2

Adjustments:

- V/octave sensitivity
- Sine Distortion
- Sine Offset
- Sine Gain
- Triangle Symmetry
- Triangle Offset
- Triangle Gain

1 May 1977

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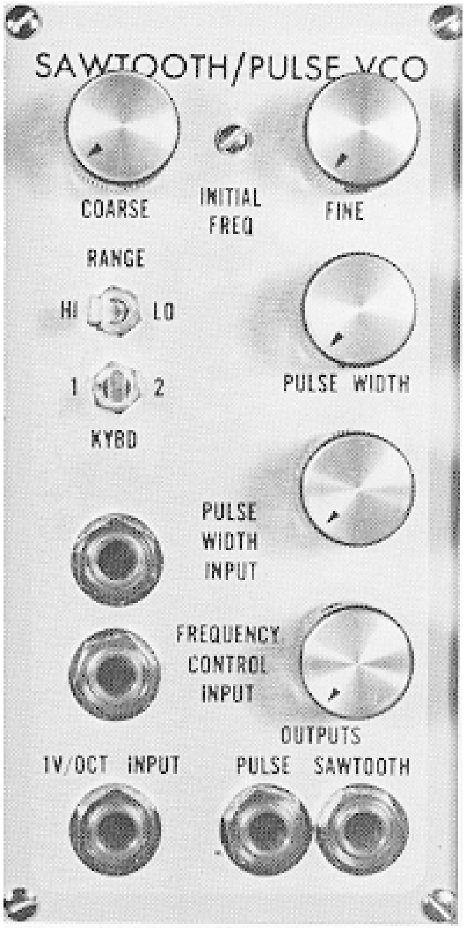
Santa Cruz, CA 95060
(408) 429-9147

Eμ MODULE 2210 - SAWTOOTH/PULSE VCO



The Eμ 2210 Sawtooth/Pulse VCO is a two waveform exponentially voltage controlled oscillator with many of the features of our 2200 VCO. It contains the stable and accurate 1201 VCO submodule.

The oscillator's frequency is determined by the sum of the settings of the coarse and fine initial frequency controls and any frequency control inputs. Control voltages may be applied from either of 2 keyboards via the keyboard switch, through the precision lV/octave input, or through the attenuated frequency control input. As with the 2200, switching to low range lowers the frequency ten octaves, but the entire 20 octave range may be continuously swept.

The pulse width control and the pulse width modulation input are summed and vary the duty cycle of the pulse waveform from 0% to 100%, with a maximum sensitivity of 10%/volt. The phase relationship between sawtooth and pulse is the same as in the 2200: the pulse rises as the sawtooth falls, and the pulse falling edge location is controlled by pulse width modulation.

Power Requirements:
±15 V @ 30 mA typical
+5 V @ 60 mA typical

Firm-wire Patch Connections:
Inputs:
- Frequency Control (2)
- Pulse Width Modulation

Outputs:
- Sawtooth (3 pins)
- Pulse (3 pins)

Power Bus Connected Inputs:
- Keyboard CV's 1 & 2

Adjustments:
- V/octave sensitivity

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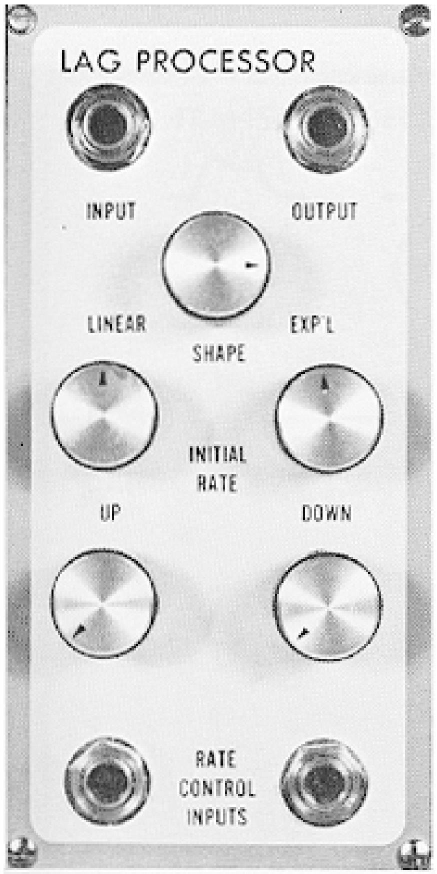
Eμ MODULE 2340 - VOLTAGE CONTROLLED LAG PROCESSOR



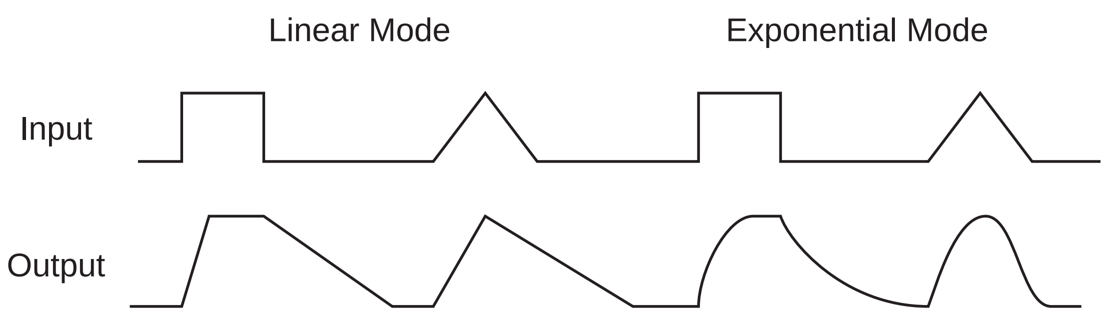
The Eμ 2340 Voltage Controlled Lag Processor is a control voltage processing module using an Eμ 1340 submodule.

With the shape control set to “linear”, the module acts as a slew limiter. Whenever the input level changes at a rate faster than the appropriate rate control setting, the output slew rate is limited to that maximum slew rate. Highest accuracy is achieved in this mode, sufficient to use this module for voltage controlled keyboard portamento.

In the exponential mode, the module acts as a filter with time constant determined by the rate control settings. In this mode it can act as an attack/release transient generator with voltage controlled time constants.

The up and down rates are independently exponentially voltage controllable from 0.3 to 3000 Volts/second. The initial rate controls set the center rates; the control inputs are attenuable and vary the rates at a maximum sensitivity of 2V/decade.

TYPICAL FUNCTION (Fast up rate, slow down rate):



Power Requirements:

±15 V @ 20 mA typical

Power Bus Connected Inputs:

None

Firm-wire Patch Connections:

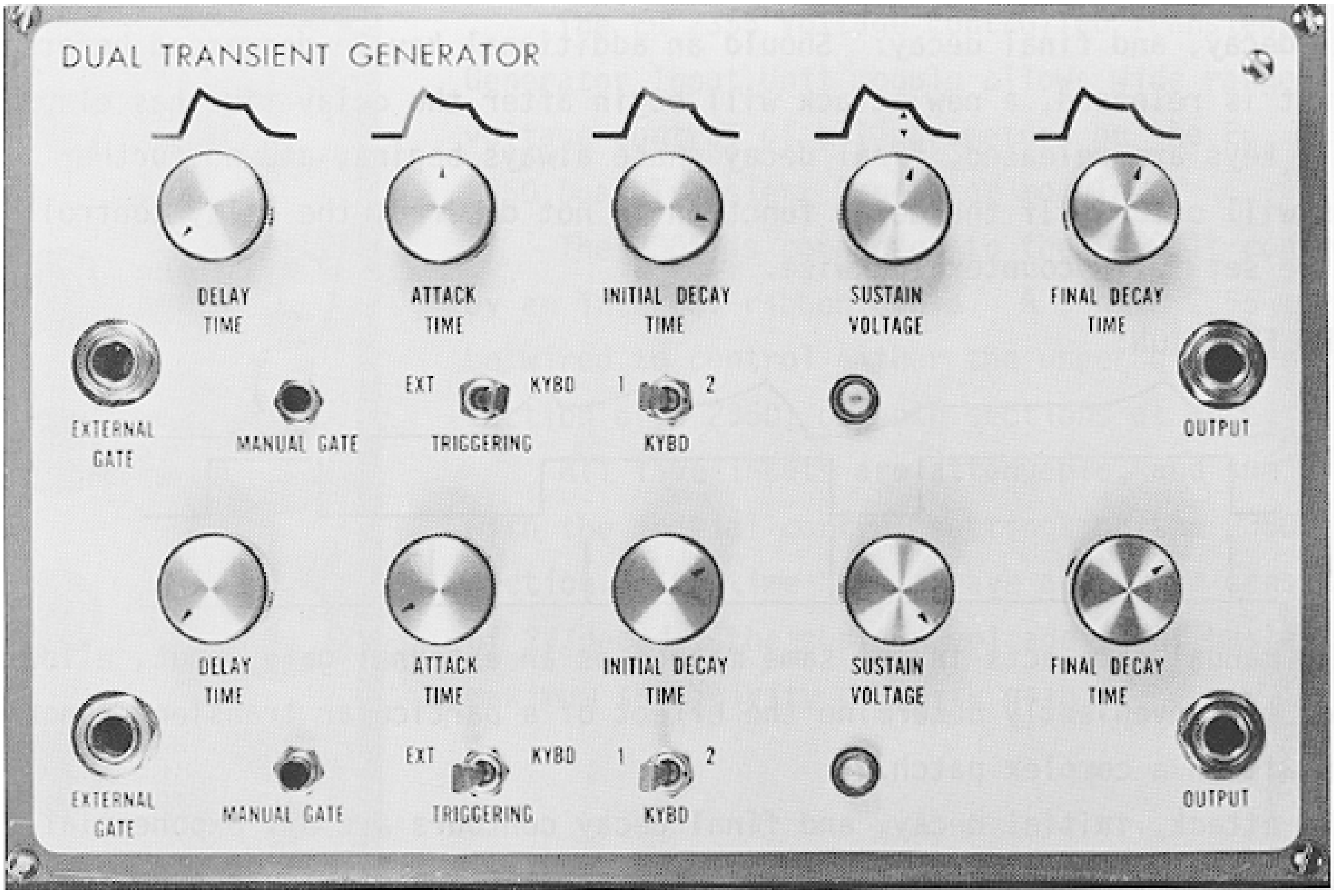
Inputs:

- Signal Input
- Rate Inputs (2)
- Output (3 pins)

Adjustments:

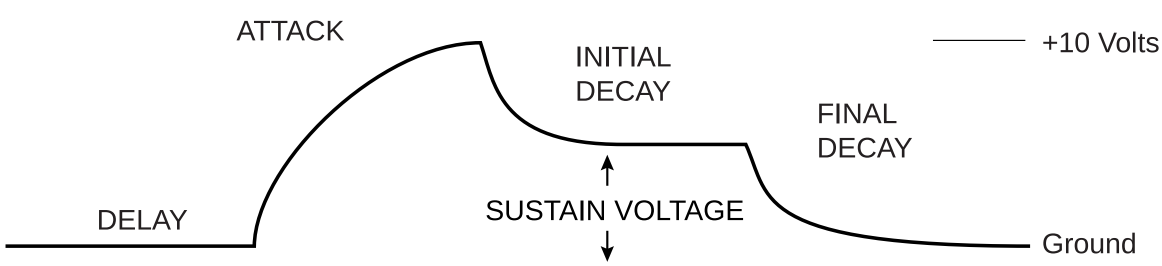
- Up Offset
- Down Offset

Eμ MODULE 2350 - DUAL DELAYED TRANSIENT GENERATOR



The Eμ 2350 Dual Delayed Transient Generator module contains two independent four-phase electronic music transient generators in a single module. It is based on two Eμ 1350 submodules.

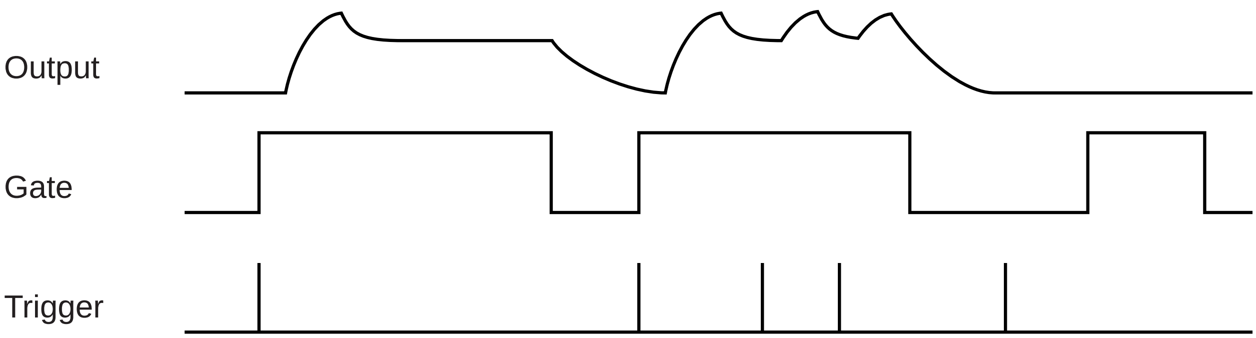
With the triggering switch in the external position, the module will produce a four-phase transient when triggered by an external gate:



The time constants for the four independent phases, and the sustain voltage, are determined by the settings of the appropriate controls.

In the keyboard mode, the module will similarly respond to the depression of a key (producing simultaneous gate and trigger) with a delay, attack, initial decay, and final decay. Should an additional key be depressed before the first is released, a new attack will begin after the delay time has elapsed. When all keys are released, final decay phase always begins, and no further attacks will occur. If the delay function is not desired, the delay control should be set fully counterclockwise.

KEYBOARD FUNCTION:



The manual gate acts in the same manner as an external gate input, allowing the user to conveniently determine the effect of a particular transient generator section within a complex patch.

The attack, initial decay, and final decay contours are all exponential functions in time, whose time constants are variable over a wide range. The controls vary the time constants exponentially, resulting in remarkably smooth and accurate control over the entire range. The standard control range for the time constants is 1 millisecond to 10 seconds (3 msec to 3 seconds on delay), but the range can be expanded or reduced on request.

The gate lamp indicates the presence of a high level (logic “l”) on the gate input.

Power Requirements:
±15 V @ 30 mA typical
+5 V @ 20 mA typical

Firm-wire Patch Connections:
- External Gate Inputs (2)
- Outputs (2-3 pins each)

Power Bus Connected Inputs:
- Keyboards 1 & 2 Gate & Trigger

Adjustments:
- None

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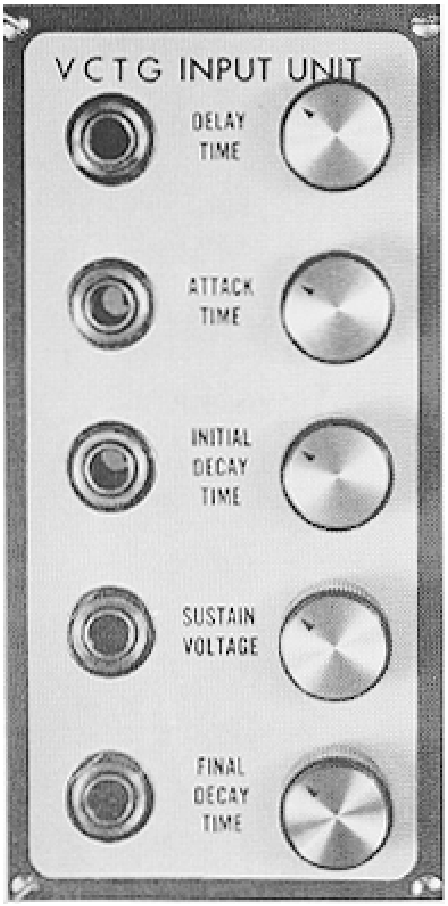
Eμ MODULE 2355 - VOLTAGE CONTROLLED TRANSIENT GENERATOR INPUT UNIT



The Eμ 2355 Voltage Controlled Transient Generator Input Unit module allows wide range voltage control of all parameters on the Eμ 2350 Dual Transient Generator module.

The 2355 is connected to the 2350 it controls by an internal ribbon cable. A single 2355 may be wired to control either the upper or lower section of a 2350, or both sections at once.

All five inputs are attenuable, and sum with the initial control settings on the 2350 section. The time inputs have a maximum sensitivity of 2V/decade; the sustain voltage input has a maximum sensitivity of unity gain.

Power Requirements:
None

Firm-wire Patch Connections:
5 Inputs

Power Bus Connected Inputs:
None

Adjustments:
None

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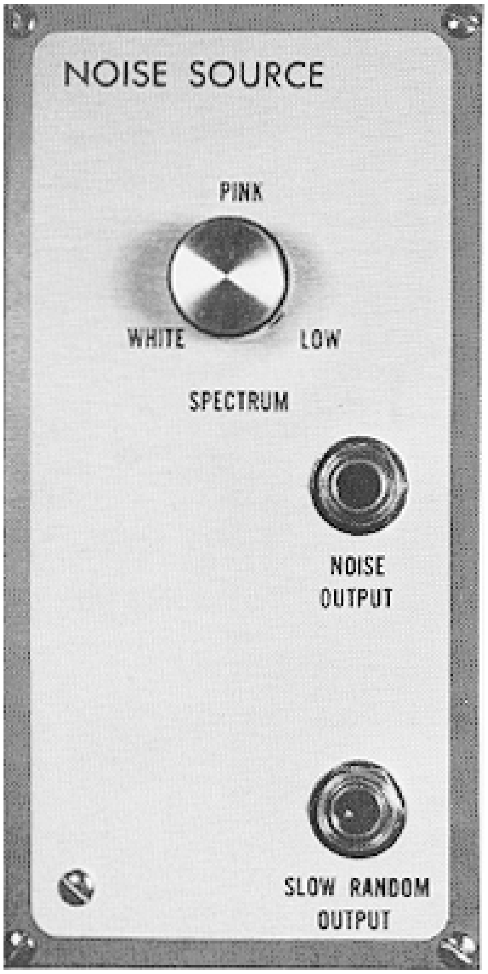
Eμ MODULE 2400 - NOISE SOURCE



The Eμ 2400 Noise Source produces random audio and control signals for use in electronic music. It contains an Eμ 1400 noise source submodule.

The spectrum control varies the energy distribution of the audio output from white through pink to low filtered noise, by increasing the filtering on the original white noise signal from zero to 6 dB per octave.

The slow random output gives a slowly varying control signal , whose energy is maximized in the range from 1 to 10 Hz. Due to the very low frequencies processed by this output, it will not become totally random for several seconds after power is applied.

Power Requirements:
±15 V @ 10 mA typical

Firm-wire Patch Connections:

Inputs -	None
Outputs -	Noise (3 pins)
	Slow Random (3 pins)

Power Bus Connected Inputs:
None

Adjustments:
None

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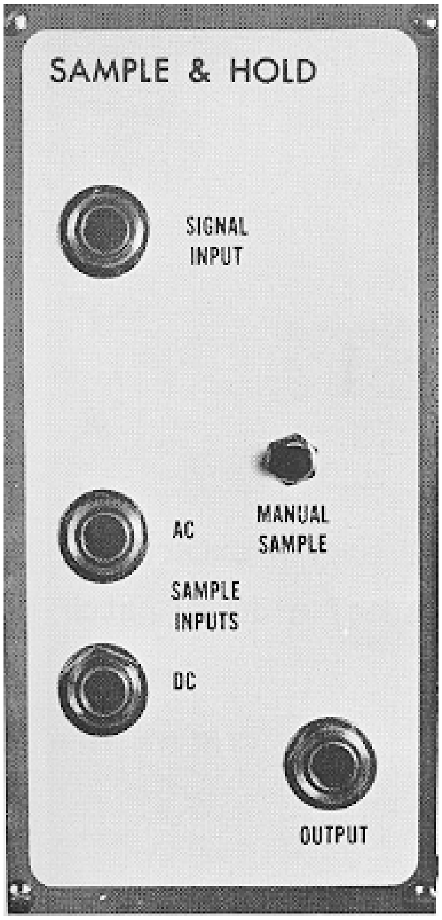
Eμ MODULE 2410 - SAMPLE AND HOLD



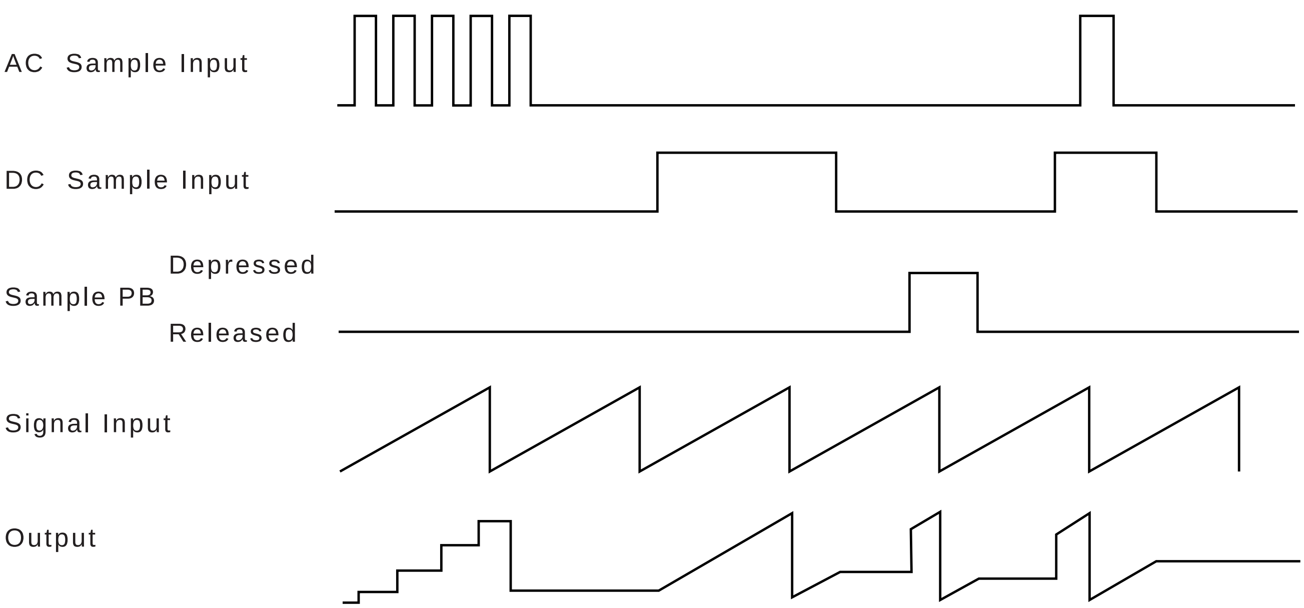
The Eμ 2410 Sample & Hold module acts as an analog memory for synthesizer signals. It contains an Eμ 1410 sample and hold submodule.

On application of a fast rising edge (such as a pulse waveform) to the AC sample input, the output of the module will instantly slew to the voltage present at the signal input, and remain at that voltage until another sample command is applied.

On application of a positive voltage (>2.5V) to the DC sample input, the output will assume the voltage at the signal input, and track that voltage while the DC sample input remains high. When the sample input goes low, the output will remain at the signal voltage present at that time.

The sample pushbutton on the panel behaves as a DC sample input, causing the output to track the input when depressed, and hold when released.

TYPICAL FUNCTION:



Power Requirements:
±15 V @ 15 mA typical

Firm-wire Patch Connections:
Inputs - Signal
AC Sample
Outputs - One (3 pins)

Power Bus Connected Inputs:
None

Adjustments:
None

Note: Use of the AC Sample firmwire patch input may interfere with external patches using the DC sample only. This can be remedied by the use of a dummy patch cord in the AC Sample input.

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Eμ MODULE 2420 - DUAL PREAMP

The Eμ 2420 Dual Preamp is a dual variable gain preamplifier for use in interfacing external signals to the modular synthesizer system. It is not intended to replace studio preamps for other purposes. The two amplifiers are completely independent.

The gain range is selected by the gain switch, and the desired level accurately adjusted by the attenuator. The gain switch calibrations refer to the amplification factor with the attenuator fully clockwise.

The module uses an Eμ 1420 High Gain Amplifier submodule.

Power Requirements:
±15 V @ 20 mA typical

Firm-wire Patch Connections:
Outputs (3 pins each)

Power Bus Connected Inputs:
None

Adjustments:
None

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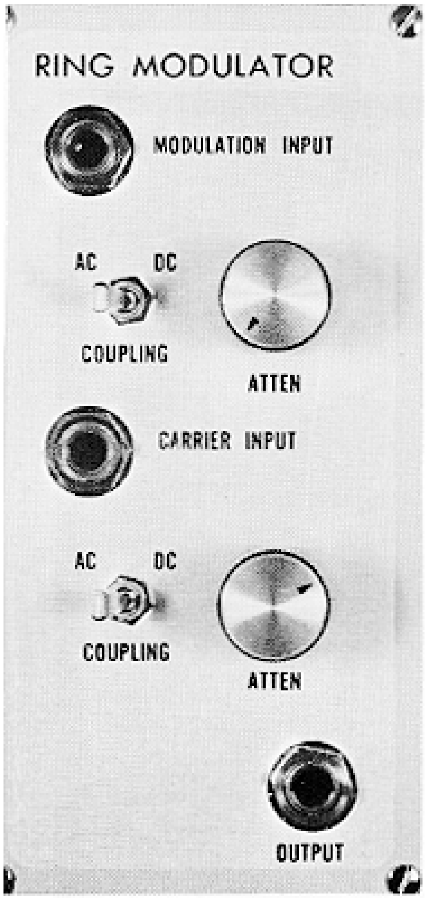
Eμ MODULE 2430 - RING MODULATOR



The Eμ 2430 Ring Modulator is a balanced modulator for electronic music. It contains an Eμ 1430 ring modulator submodule.

The module has two inputs, modulation and carrier, which are identical for high signal levels. The output is the algebraic product of the input voltages:

$$V_{out} = V_{mod} \times V_{car} \div 5$$

when the input attenuators are fully clockwise and the coupling switches are in the DC position.

AC coupling will level-shift the corresponding input so it effectively centers around zero volts. This can have a striking effect on the output signal, due to the inherent non-linearity of balanced modulation.

The Eμ 2430 was designed for high carrier rejection in the absence of a modulation signal, typically in excess of 80dB. The reverse rejection, that of modulation feedthrough with no carrier, is only 40dB.

Power Requirements:
±15 V @ 10 mA typical

Firm-wire Patch Connections:

Inputs -	Modulation
	Carrier
Outputs	One (3 pins)

Power Bus Connected Inputs:
None

Adjustments:
- Gain
- Modulation Rej'n - Mod positive
- Modulation Rej'n - Mod negative

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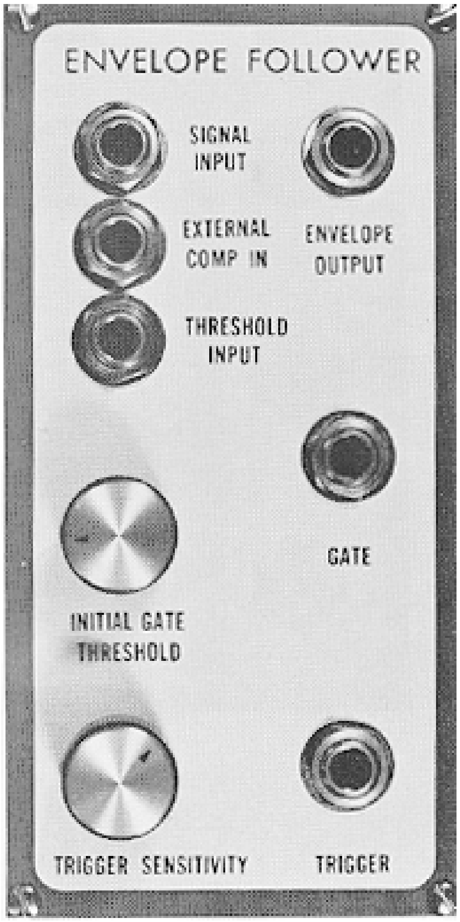
Eμ MODULE 2440 - ENVELOPE FOLLOWER



The Eμ 2440 Envelope Follower module is a conventional envelope detection circuit with slope and level comparators to derive trigger and gate signals. It contains an Eμ 1440 submodule.

The input signal is AC coupled and its envelope subsequently detected. The envelope output is filtered such that signal frequencies as low as 50 Hz can be followed without serious ripple.

The comparator input is internally pre-wired to the envelope output. At each rapid rise on its input, the trigger section of the comparator will produce a narrow pulse at the trigger output. The slope required to produce a trigger is adjusted by the trigger sensitivity control. When fully counterclockwise, triggering is inhibited.

Whenever the DC comparator input level exceeds the sum of the gate threshold control (range O-lOV) and the external threshold input, the gate output rises to +5 volts.

The comparator section of the 2440 may be used independently of the envelope follower section by patching the signal to be compared into the external comparator input. Functions such as external pulse generation and modulation, and cyclic transient triggering may be accomplished in this manner.

Power Requirements:
±15 V @ 25 mA typical

Firm-wire Patch Connections:
- Signal Input
- Envelope Output (3 pins)
- Gate Output (3 pins)
- Trigger Output (3 pins)

Power Bus Connected Inputs:
None

Adjustments:
None

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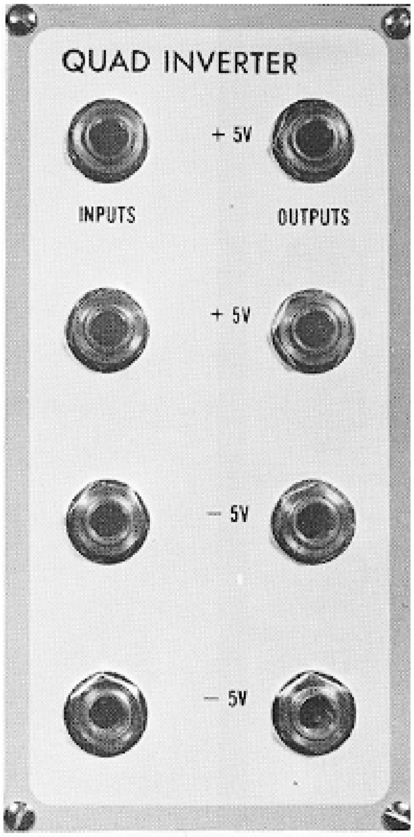
Eμ MODULE 2450 - QUAD INVERTER



The Eμ 2450 Quad Inverter is an array of four independent analog signal inverters. The output of the inverter is the inverse about 0 volts of the input signal. Thus a voltage V at the input gives -V out, and sine waves are put 180° out of phase.

The inverters are pre-patched to the power supplies to serve as voltage sources when other inputs are not patched. The voltage next to each output jack is the voltage that will appear there when no patch cord is applied to the corresponding input.

Power Requirements:
±15 V @ 15 mA typical

Firm-wire Patch Connections:
None

Power Bus Connected Inputs:
None

Adjustments:
None

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Eμ MODULE 2451 - POTPOURRI

The Eμ 2451 Potpourri Module is a multipurpose module designed to add a variety of useful functions to small or medium sized modular systems.

The output voltage of the Summing Amp is precisely the sum of the upper input voltage as attenuated by the adjacent control, plus the voltages at the second and third input jacks.

The Digital Inverter produces a logic “O” (low impedance to ground) if the input voltage is greater than 3.5 volts, and produces a logic “1” (l.OKΩ to +5 volts) if the input is less than 1.5 volts. Thus the output is the logical inversion of the input.

The output voltage of the Inverter section is the negative (+1 volt in gives -l volt out) of the input, as attenuated by the adjacent control.

The LFO is a low frequency oscillator giving triangle and square wave outputs with amplitudes adjustable by the adjacent controls. The oscillation frequency is adjustable from 0.02 to 50 Hz.

The Comparator produces a digital output that will be a logic “1” if the input voltage is greater than 0.25 volts, and a logic “0” for inputs below 0.1 volts. Some hysteresis is provided to prevent oscillation even on very slowly changing inputs.

The +lOV and -lOV jacks give these voltages with an impedance of l.OKΩ.

Power Requirements:
±15 V @ 40 mA typical
+5 V @ 11 mA typical

Firm-wire Patch Connections:

Inputs -	Summing Amp Atten'd
	Summing Amp Unatten'd
Outputs -	Summing Amp (3 pins)
	LFO Triangle (3 pins)
	LFO Square (3 pins)

Power Bus Connected Inputs:
None

Adjustments:
None

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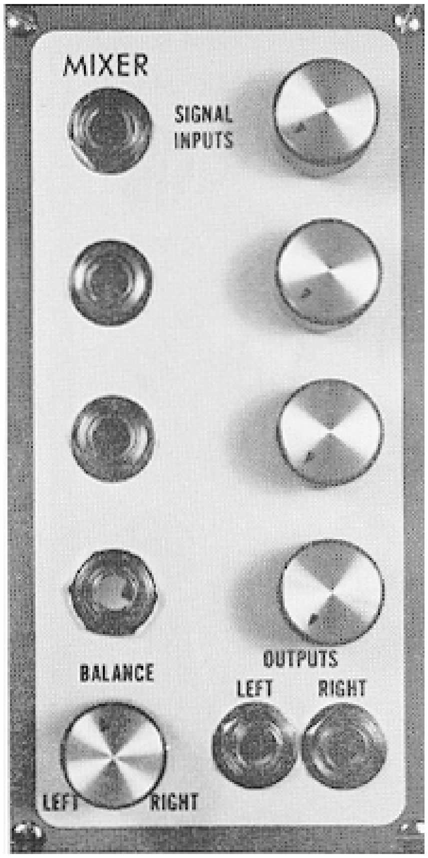
Eμ MODULE 2455 - MIXER



The Eμ 2455 Mixer is a four input, stereo output mixer with pan for use within the Eμ modular system. While a mixer is seldom needed in the system as most modules provide input mixing (multiple inputs with attenuators) and output mixing (patching several outputs together in a multiple gives an even mix of the outputs), a dedicated mixer module may prove useful in special situations.

The four signal inputs pass through their respective attenuators and are summed to give the mixer output signal. This is then routed into the left and right outputs in a ratio determined by the setting of the balance control. With the balance control fully counterclockwise, the output signal appears unattenuated at the left output jack and no signal appears at the right jack; with the control clockwise, the entire signal is routed instead to the right output jack. At intermediate settings, an appropriate signal level is sent to each jack to simulate spatial positioning, with the total power from the two jacks remaining constant. The balance control could thus be used as a master volume control if only one output were used.

Power Requirements:
±15 V @ 10 mA typical

Firm-wire Patch Connections:
- Inputs - Signal (4)
- Outputs - Left & Right (3 pins each)

Power Bus Connected Inputs:
None

Adjustments:
None

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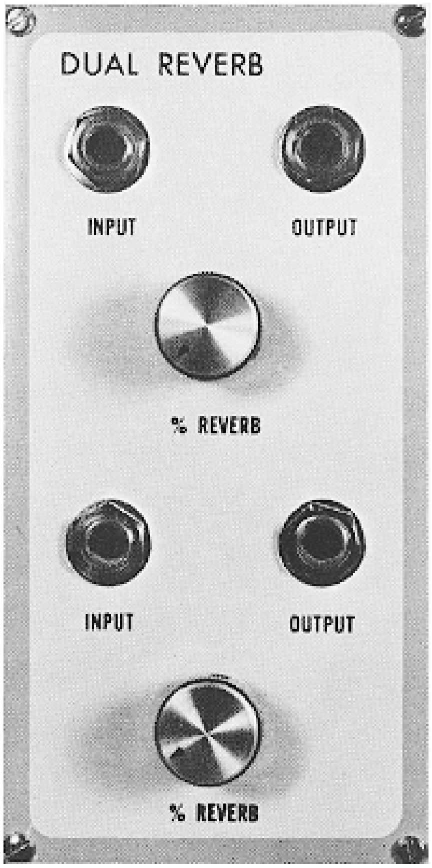
Eμ MODULE 2460 - DUAL REVERB



The Eμ 2460 Dual Reverb module is a dual spring type reverberation unit, using an Eμ 1420 submodule. The two channels are completely independent.

The input signal to a channel is AC coupled and sent to the reverb spring. The return signal is amplified, and then mixed with the original AC coupled signal, according to the setting of the "% Reverb" control, to produce the final output.

The reverb elements are physically separate from the module, and it is recommended that they be placed remote to the synthesizer cabinet to minimize the effects of vibration and hum. If these precautions are taken, the noise and hum are virtually inaudable in normal use.

Power Requirements:
±15 V @ 25 mA typical

Firm-wire Patch Connections:
- Inputs (2)
- Outputs (3 pins each)

Power Bus Connected Inputs:
- None

Adjustments:
- None

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THE Eµ MODULAR SEQUENCER

Previously, the only commercially available sequencers have been single function units. By following a modular concept in sequencer design, Eµ Systems has expanded sequencer capabilities in the same way the modular synthesizer surpassed conventional musical instruments.

A sequencer is conventionally composed of a clock or time base, a counter, and some sort of voltage selecting and generating device. In the modular system, each of these distinct functions is a separate module, which can be interconnected with the others in a variety of ways. The addition of logic function modules further expands the possibilities.

Certain common features of the sequencer modules are described below:

LOGIC LEVELS - The threshold voltage for logic inputs is nominally 2.5 volts Voltages above 3.5 volts should be considered logical ones, while those below 1.5 volts are logical zeros

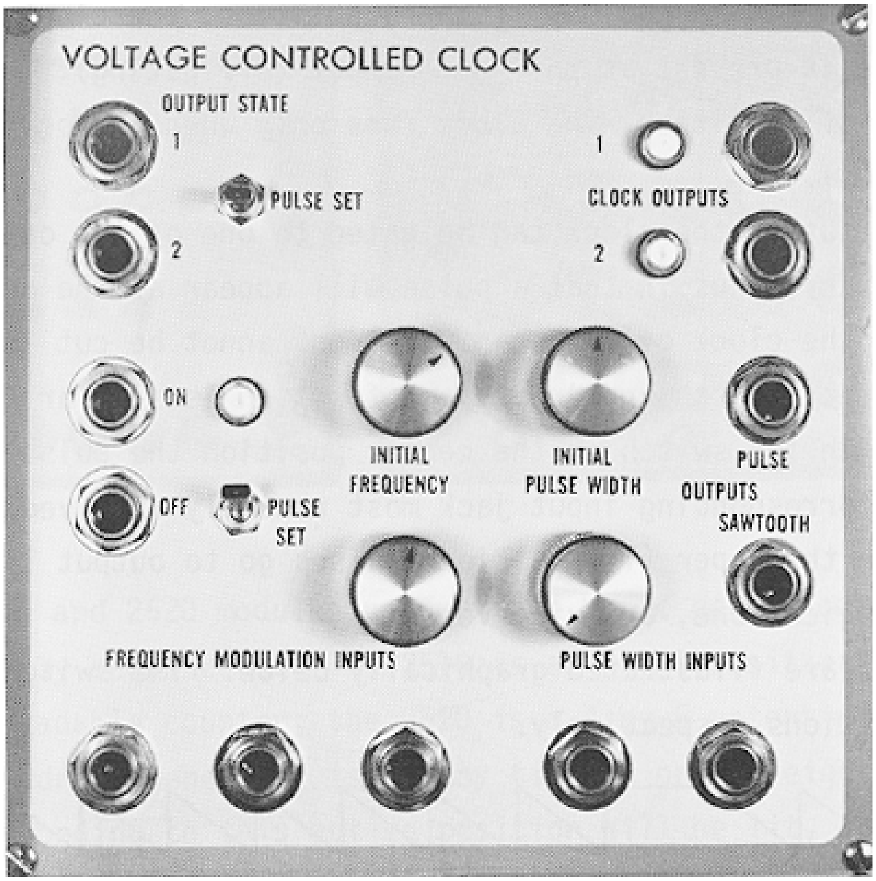
CLOCK INPUTS - All edge sensitive inputs are independent of risetime, and can consequently be properly driven by any synthesizer waveform.

EXTERNAL COMPATIBILITY - Input impedance on all logic inputs is lOOK~. Inputs may be directly driven by CMOS logic, or TTL logic with 4.7KΩ pull-ups. Naturally, inputs are fully protected from any voltages within the synthesizer.

Outputs are directly TTL and CMOS compatible, and short-circuit protected.

LOGIC OUTPUTS - Logic one output voltage is +5 volts; logic zero is approximately +0.1 volt. Outputs shorted together through a multiple will “wire-and”, meaning that the result will be high only if both signals are high.

Eμ MODULE 2500 - VOLTAGE CONTROLLED CLOCK



The Eμ 2500 Voltage Controlled Clock module is a low frequency sawtooth/ pulse VCO with special gating capabilities, based on the Eμ 1500 submodule.

The initial frequency control varies the clock rate from approximately 0.001 Hz (1 cycle/ 18 min.) to 500 Hz; the two leftmost frequency modulation inputs vary this center frequency with approximately 1 volt/octave sensitivity. The third FM input has sensitivity adjustable from zero through 1V/octave.

The pulse width control varies the pulse duty cycle from virtually zero to virtually 100%. However, a pulse will always be issued each cycle for correct clocking. The pulse width modulation inputs have a maximum sensitivity of 10%/volt. Pulse width modulation is such that only one rising edge can be generated each cycle.

The clock may be synchronously gated on or off. When the oscillator is turned off, it will finish the current timing cycle and then stop. When gated back on, a pulse rising edge will immediately be generated.

The switch below the lamp determines the function of the on and off input jacks. In the “pulse set” (center) position, a logical one at the “on” input turns the clock on; it may be turned off by a logical one at the “off” input. The “on” lamp is lit when the clock is running.

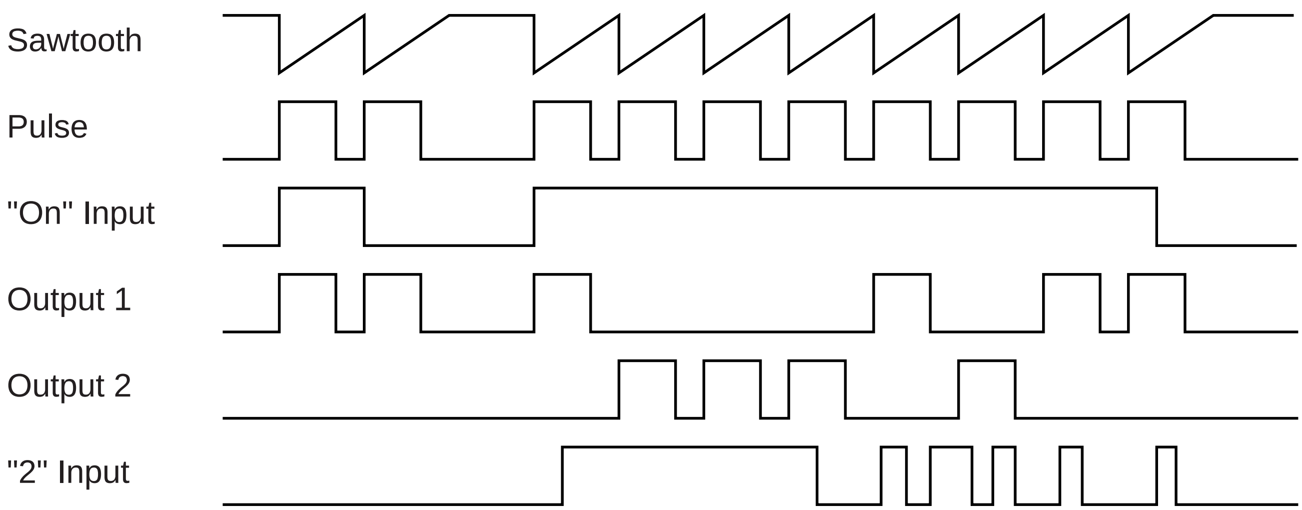
With a logical zero at both inputs, the oscillator stays on or off as set by the most recent pulse.

With the switch set in the “on” (upper) position, the clock runs except when a logical one is present at the “off” input (off gating). Similarly, with the switch in the off position, the clock runs only when the on input receives a logical one signal.

The pulse output of the clock can be gated to one of two outputs. This gating is also synchronous in that a pulse will appear at the output which was selected when the clock cycle began. Pulses cannot be cut in half.

The output state switch and input jack function is similar to the on/off gating scheme: with the switch in the center position the pulse is sent to the output whose corresponding input jack most recently received a one pulse; with the switch in the upper (1) position, pulses go to output 1 except when input two has a logical one, and vice versa.

The functions are illustrated graphically below. The switches are in the “off” and “1” positions respectively.



Power Requirements:
±15 V @ 10 mA typical
+5 V @ 50 mA typical

Firm-wire Patch Connections:
- Frequency Modulation Input
- Pulse Width Input
- Outputs (Four, 3 pins each)

Power Bus Connected Inputs:
None

Adjustments:
None

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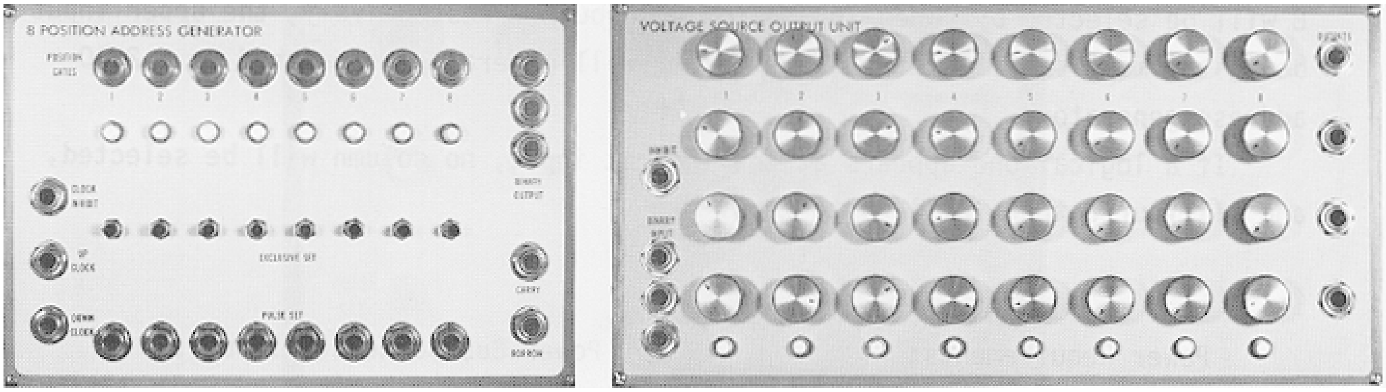
Eμ MODULE 2510 - 8 POSITION ADDRESS GENERATOR
MODULE 2520 - VOLTAGE SOURCE OUTPUT UNIT



The Eμ 2510 and 2520 modules perform the basic potentiometer matrix functions of early sequencers. The 2510 is an eight position (3 bit) up/down presetable, cascadable counter; the 2520 is a 4 by 8 potentiometer matrix.

The 2510 Address generator is at any time in one of eight position states. The lamp corresponding to this active position will be lit, and the associated position gate output will present a logical one. The binary equivalent of this position (coded 0-7 for positions 1-8) will appear at the binary outputs, the upper being the most significant bit. The binary outputs are usually patched to a 2520 voltage source.

A rising edge on the up clock input causes the active state to move right one position, while a pulse on the down clock input will result in a leftward shift. Both clock inputs will be ignored if a logical one is applied to the clock inhibit input. If the position is clocked up from position eight to position one, a pulse will be issued from the carry output. Similarly, clocking down from 1 to 8 will produce a borrow pulse. The carry and borrow outputs could be connected to the up and down clocks of a second 2510 for cascading.

Depressing one of the exclusive set pushbuttons will result in shifting the active position to that location regardless of other conditions. Applying a logical one to the appropriate pulse set input will similarly result in exclusively setting that position.

The 2520 Voltage Source Output Unit contains four parallel rows of potentiometers. When one of the eight columns is activated (indicated by the corresponding lamp), each of the four outputs will maintain the voltage set by the potentiometer at the row/column intersection. The range of each potentiometer is zero to +10 volts.

The selected column is determined by the binary inputs. Columns 1 through 8 will be selected by coded inputs for 0 through 7 respectively, the upper input being the most significant. These inputs will generally be patched to a 2510 address generator.

If a logical one appears at the inhibit input, no column will be selected, and all four outputs will go to zero.

Power Requirements:

2510 - +5 V @ 100 mA typical

2520 - +5 V @ 25 mA typical

±15 V @ 25 mA typical

Firm-wire Patch Connections:

2510 - Up and Down Clock Inputs

Binary Outputs (3 pins each)

Borrow and Carry Outputs (3 pins each)

2520 - Binary Inputs

Outputs (Four, 3 pins each)

Power Bus Connected Inputs:

None

Adjustments:

None

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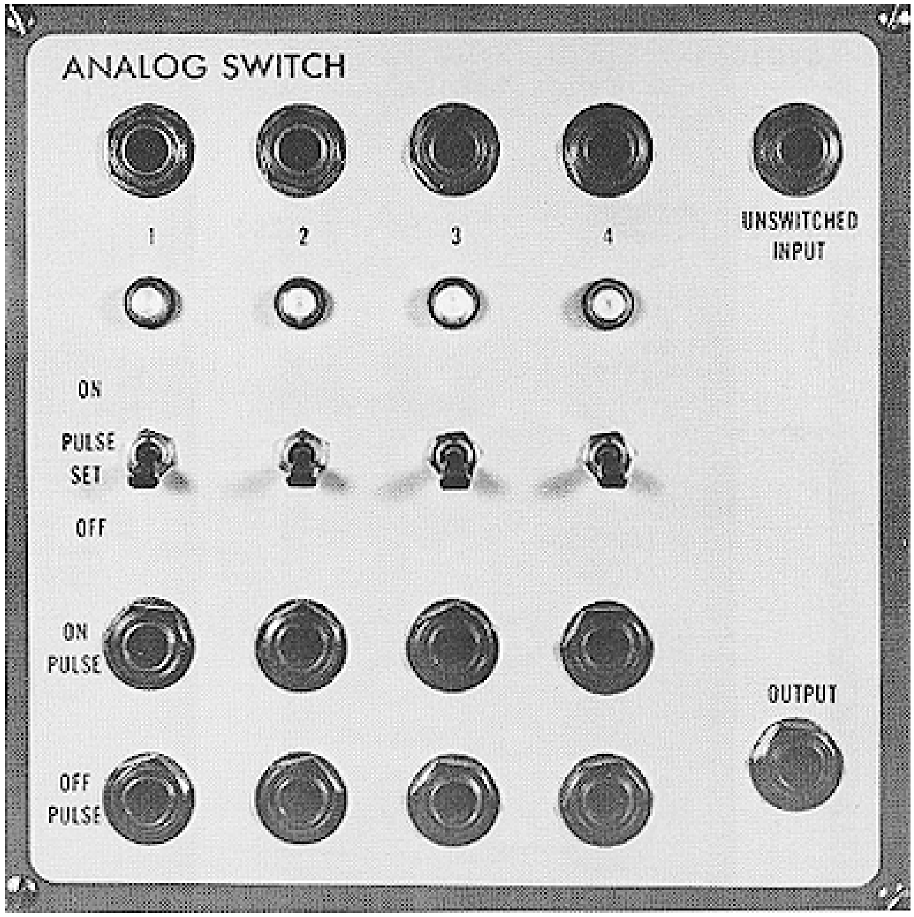
Eμ MODULE 2530 - ANALOG SWITCH



The Eμ 2530 Analog Switch is a four channel digitally controlled summing buffer with an additional uncontrolled input for cascading switch sections. The output is the algebraic sum of the voltages appearing at the inputs to activated channels plus the voltage at the unswitched input. Signals at the off inputs are rejected at better than 80 dB. Whenever an input channel is “on”, the corresponding lamp is lit.

An input channel may be turned on and off in different ways depending on the setting of the three position switch. With the switch in the center (pulse set) position, the channel can be turned on by a logical one pulse at the corresponding “on pulse” input, and turned off by a similar pulse at the “off pulse” input. If both inputs remain at logical zero, the channel stays in the state most recently pulsed.

With the switch in the “on” position, the channel will normally be on, and can be gated off by a logical one at the off pulse input. Similarly, with the switch in the off position, a logical one at the “on pulse” input will gate the channel on.

Power Requirements:
±15 V @ 10 mA typical
+5 V @ 50 mA typical

Firm-wire Patch Connections:
- Inputs (4)
- Output (3 pins)

Power Bus Connected Inputs:
- None

Adjustments:
- None

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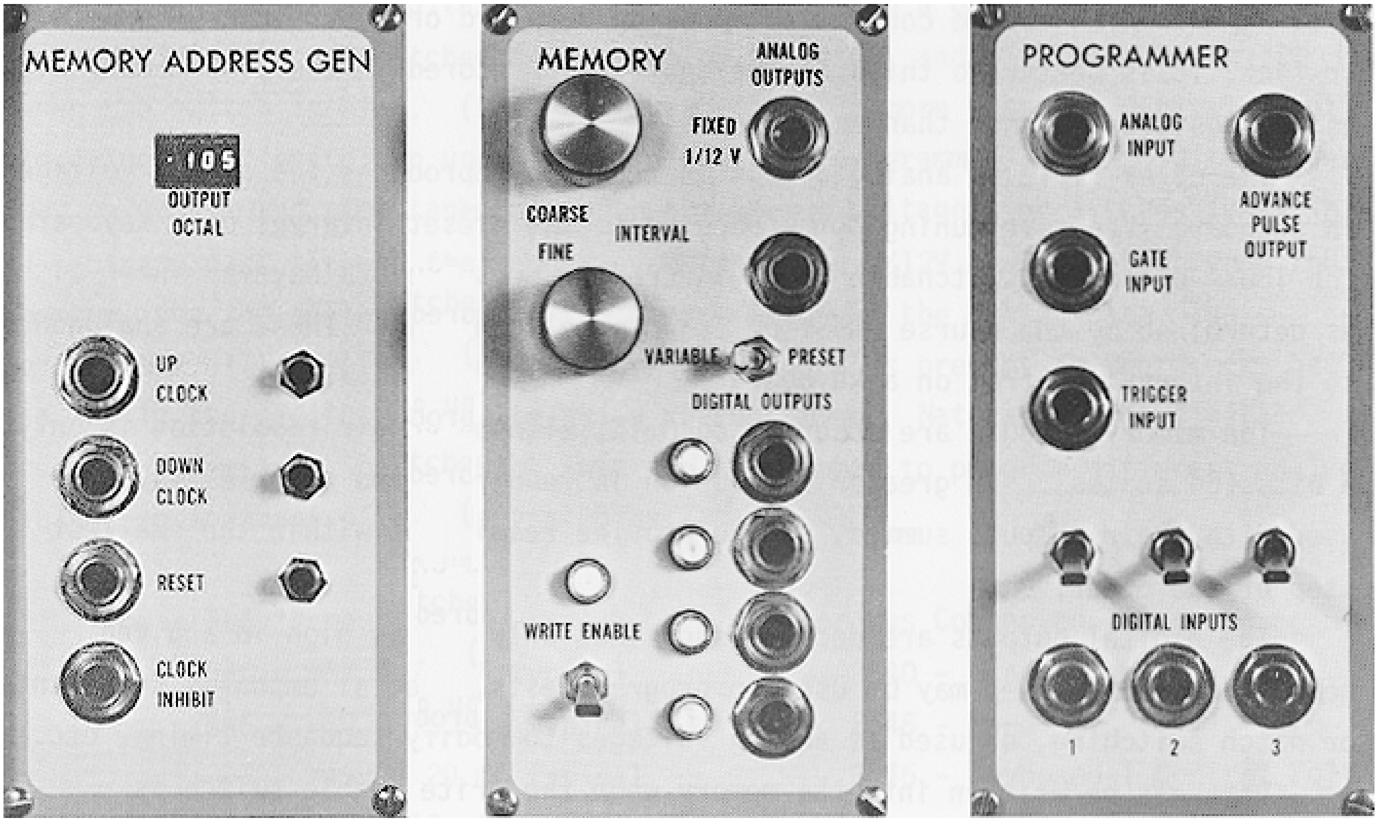
Santa Cruz, CA 95060
(408) 429-9147

Eμ 2540 SERIES - MEMORY SEQUENCER MODULES



The Eμ 2540 Memory Address Generator, 2545 Memory, and 2546 Programmer modules are designed for use together in producing long voltage sequences. The 2540 contains an Eμ 1540 submodule, the 2545 contains a 1545 submodule.

The 2540 Memory Address Generator is a 256 (512 optional) position counter. A positive going pulse at the up clock input advances the counter one position; a similar pulse on the down clock input lowers the count. Both inputs are ignored if a logical one is presented to the clock inhibit input. A logical one on the reset input forces the counter to position zero regardless of the status of the other inputs.

The up clock pushbutton acts as a fast-forward if held down, but a quick depression will advance the position a single step. The down pushbutton behaves similarly. The reset pushbutton resets the count to zero.

The numeric display shows the address position in octal (base 8) notation, which proves particularly useful for conventional music tempos. The count ranges from 000 to 377 octal in the normal version, and to 777 in the extended range unit.

Any number of 2545 memories (up to approx. 50) can be driven by a single 2540. For each address position the memory can record an analog voltage and one of four digital codes. The memories are programmed by a common 2546 programmer, which can be controlled by an Eμ keyboard or other voltage source. In fact, it is better to think of the analog data stored in the 2545 memory as key positions rather than as voltages.

The upper (1/12 V) analog output on the 2545 reproduces the analog voltage in standard lV/octave tuning, corresponding to the preset interval on a keyboard. The lower output is switchable to be internally preset or to have an interval as determined by the course and fine front panel controls. These are analogous to the interval control on a keyboard.

The memory outputs are accurate to 0.1%, although their resolution is only 6 bits (64 states). If greater resolution is required, two memories may be used with their outputs summed, one to provide resolution within the smallest step of the other.

The digital outputs are decoded such that only one is high in a given memory location. They may be used to program rests, special emphasis transients, or patch switching, or used as analog voltages to modify sequence timing, etc.

Data can be written into the memory when the write enable switch is on (up). A lamp is lit to warn of this condition.

By the use of multiple memories and the 2530 Analog Switch module, arbitrarily long sequences can be obtained.

The 2546 Programmer can program up to 50 sets of memories through their 2540 address generators. No more than one programmer per address generator may be used.

When a rising edge is received by the trigger input, whatever analog voltage is present at the analog input is converted to the nearest keyboard voltage, and stored at the associated address generator position in all write enabled memories. At the same time, whichever digital input is in a logical one state will be written into the digital portion of the memories. If all three inputs are at logical zero, the fourth digital code will be written.

When a falling edge appears at the gate input, a 10 msec positive pulse is issued from the advance pulse output.

The analog input is internally pre-wired to the keyboard 1 control voltage, and the gate input is pre-wired to the keyboard 1 gate output. The trigger input is pre-wired to the gate input (and hence to the keyboard 1 gate when no external gate input is applied). When the advance pulse is patched to a memory address generator up clock, sequential key depressions will cause sequential locations in an enabled memory to be written with the appropriate voltages.

The digital codes may be programmed by patching any source of digital information, such as another sequencer module or the low octave gates from a keyboard, into the digital input jacks. When such a patch is not made, the digital input is pre-patched to the switch above it, and will be a logic “1” when the switch is high. (Beware programming with more than one digital input in a logic “1” state; an unexpected code may be programmed.) The digital codes may be programmed simultaneously with the analog voltages, or alternatively in a separate pass through the memory by feeding the l/l2V analog output from the memory into the analog input of the programmer. In the latter case, the programmer will simply write whatever analog data is present in the memory back in, while the digital codes are being reprogrammed. Naturally, the digital codes may similarly be fed back into the programmer to program different analog values independent of the digital bits.

Power Requirements:

2540 - +5 V @ 75 mA typical

2545 - +5 V @ 100 mA typical
±15 V @ 20 mA typical

2546 - +5 V @ 10 mA typical
±15 V @ 25 mA typical

Firm-wire Patch Connections:

None

Power Bus Connected Inputs:

2540 - None

2545 - None

2546 - Keyboard 1 Control Voltage
Keyboard 1 Gate

Adjustments:

2540 - None

2545 - 1/12V interval
Variable interval
(Coarse & Fine)

2546 - Interval

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417 Broadway
Santa Cruz, CA 95060
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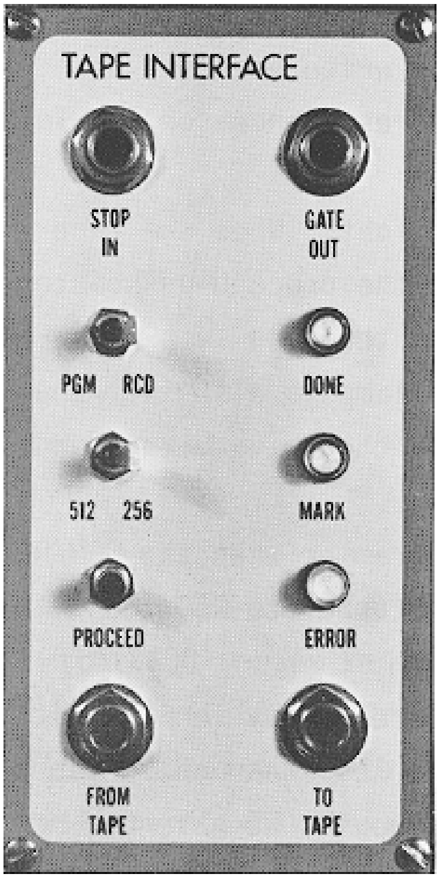
Eμ MODULE 2547 - TAPE INTERFACE



The Eμ 2547 Tape Interface module is a special purpose device providing permanent non-volatile storage for the contents of Eμ 2545 memory modules on audio recording tape. To record data from a memory onto tape, the memory's l/12V output should be patched to the programmer's analog input, and the memory's digital outputs 1, 2, & 3 should be patched to the corresponding programmer inputs. The tape interface gate output should be patched to the programmer gate input, and the programmer advance pulse output should be connected to the memory address generator up clock. The "TO TAPE" output should go to the line input for the tape recorder, and the "FROM TAPE" input can be patched to the recorder line output.

If less than a full memory is to be recorded, a digital output that goes high on the last address to be sent should be patched to the "STOP" input.

If a full memory is used, the 256/512 switch should be set to 256 unless specially modified 512 word memories (consult factory) are to be used. To record data on the tape, set the PGM/RCD switch to RCD, reset the address generator, start the tape, and wait a few seconds for the tape speed to settle. Pressing the "PROCEED" pushbutton initiates data transfer; the contents of a 256 word memory takes 10 seconds. When data transfer is complete, the done lamp will light and the tape can be stopped.

If a 3-head tape machine is used, the signal from the playback head may be patched to the "FROM TAPE" input during record mode. In this case, lighting of the "ERROR" lamp indicates a tape flaw has prevented proper recording of data. If the signal at "from tape" was not the playback signal, the error lamp has no meaning. In all cases, errors can be checked by testing the tape in the program mode.

To program a memory from tape, the tape interface gate output should be connected to the address generator up clock (patching the gate output to the programmer gate input and the programmer advance pulse output to the up clock will also work). The memory to be programmed should be write enabled, and the PGM/RCD switch should be the PGM position. The address generator should be reset before programming.

When the tape is started, the "MARK" lamp should light. When the tape speed has settled, and the mark lamp does not flicker, the proceed pushbutton should be pressed. After the data stream has finished, the done lamp will light and the memory will be programmed. If the error lamp is also lit, one or more words in the memory may be misprogrammed. When they have been found and corrected a new tape should be made.

The 2547 disables the normal operation of the programmer when the PGM/RCD switch is in PGM, hence this switch should always be returned to RCD for normal system use.

The specifications required of the tape recorder are fairly lenient; it is only necessary that the long term speed variation be less than ≈5%. The recording tape should be selected primarily for low dropout. We have had good results using TDK tape on an ordinary cassette machine.

Power Requirements:

±15 V @ 30 mA typical

+5 V @ 60 mA typical

Firm-wire Patch Connections:

None

Power Bus Connected Inputs:

None

Adjustments:

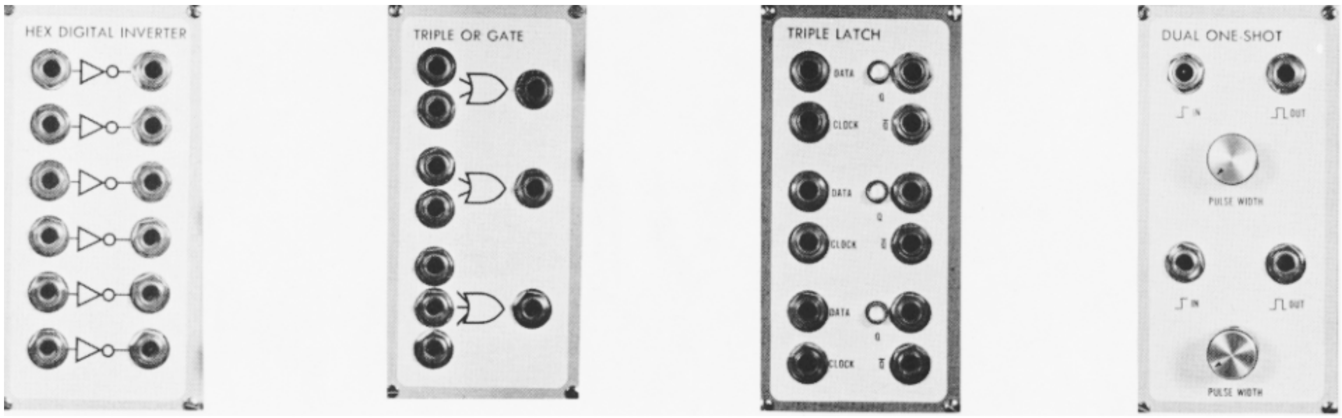
Mark Frequency

Space Frequency

PLL Center Frequency

Clock Frequency

Eμ 2550 SERIES - LOGIC MODULES



The Eμ 2550 Series Logic Modules perform elementary logic functions for use with 2500 series sequencer modules.

The 2550 Hex Digital Inverter module has six identical logically inverting stages. If a logical zero is present at the input of an inverter, its output will be at +5 volts, while a logical one at the input will take the output near ground (+0.1 volt).

The 2551 Triple Or Gate module performs the logical “or” function on two or three inputs. In each section the output will be a logical one if any of the corresponding inputs are at a logical one.

The 2552 Triple Latch module contains three identical digital “sample and hold” circuits. When the clock input changes from logical zero to logical one, whatever digital value was at the data input during the transition will appear at the Q output, and its complement will appear at Q. The data input is internally prewired to the Q output, so that if no data input patch is present, the stage acts as a divide-by-two circuit when a square wave is applied to the clock input.

The 2553 Dual One-Shot module contains two pulse-forming circuits. When a rising edge appears at the input, a pulse of duration as set by the pulse width control (10 msec - 10 sec.) will occur at the output. The circuit is nonretriggerable, and is particularly useful in transforming audio signals into digital clock pulses.

Power Requirements:

2550 - +5 V @ 40 mA typical

2551 - +5 V @ 20 mA typical

2552 - +5 V @ 50 mA typical

2553 - +5 V @ 25 mA typical

1 January 1976

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Santa Cruz, CA 95060
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Eμ 2800 SERIES - BLANK PANELS

For filling unused spaces in Eμ modular systems, or for producing panels for home designed modules, the solution is an Eμ blank panel. These panels are made from brushed aluminium, with the standard Eμ blue border and corner mounting holes, but with no other features. They are available in three sizes.

We are also initiating a “recycling” service on blank panels used as space fillers. We will repurchase used panels in good condition for $1 less than the purchase price and pass them on to users at this same discount. To order used panels, include the suffix -R. We will refund the difference the difference between the new panel price if any recycled panels are available.

2800	3” x 6” Blank Panel
2801	6” x 6” Blank Panel
2802	9” x 6” Blank Panel

1 January 1976

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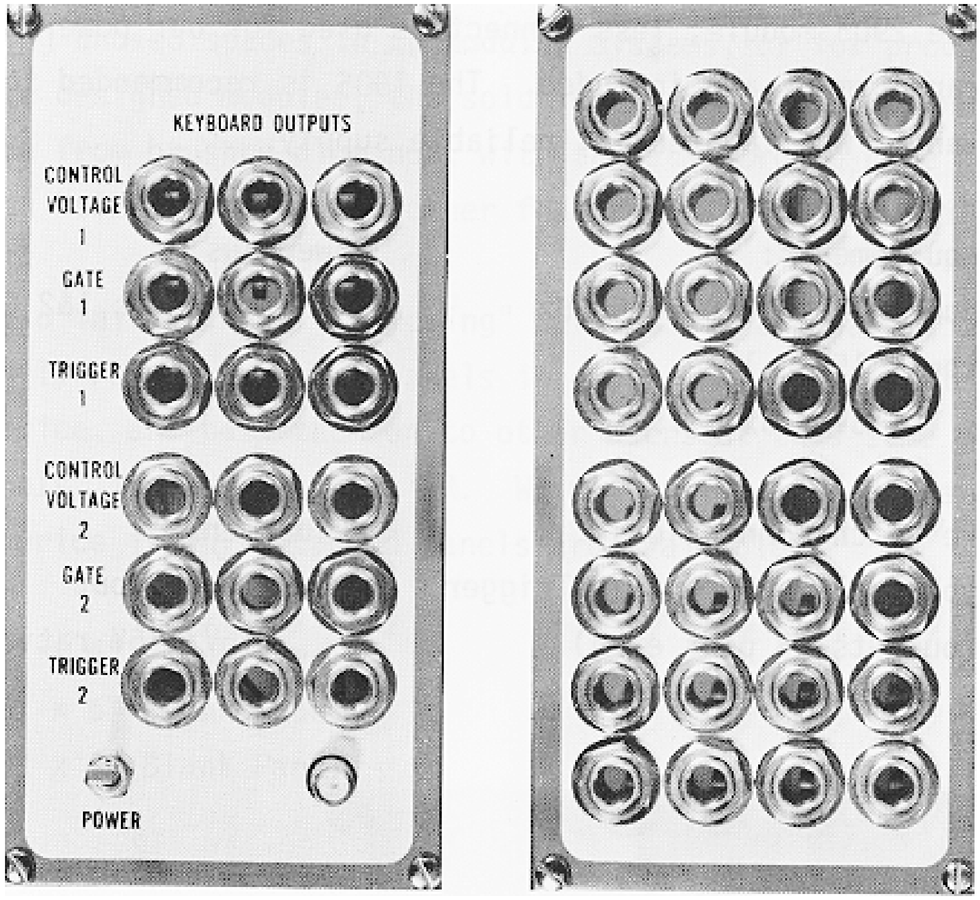
Eμ 2905 SERIES - POWER SUPPLIES



The Eμ 2905 Power Supply Modules are complete power systems for Eμ modular synthesizers. The 2905's front panel contains the power switch and pilot lamp, plus multiple outputs for two keyboards. When a keyboard is not connected, the associated system busses can be used for routing any signal by applying via these power supply panel jacks.

The interface panel (on cabinet rear) holds the power cord connector, fuse, and connectors for the two keyboards. In addition, four general purpose 24 pin connectors are provided. These can be used for custom functions, multi-voiced keyboard connections, or inter-cabinet firm-wiring.

The power supplies are current limited, overvoltage and reverse voltage protected, and factory calibrated. One 2905 module is required per cabinet.

The Eμ 2906 multiple panel consists of eight four-wide multiples.

The Eμ 1905 Power Supply submodule consists of the power supply circuit board for the 2905 module, less connectors used for our power distribution system. Transformers are included.

The 1905 is recommended for submodule users who want a well protected, reliable supply.

Power Requirements:

Input 100-140 VAC 50-60 Hz

Output ±15V @ 1.5A

+5V ±5% @ 1.0A

Firm-wire Patch Connections:

Keyboard 1 & 2 CV, Gate & Trigger

(6 outputs, 3 pins each)

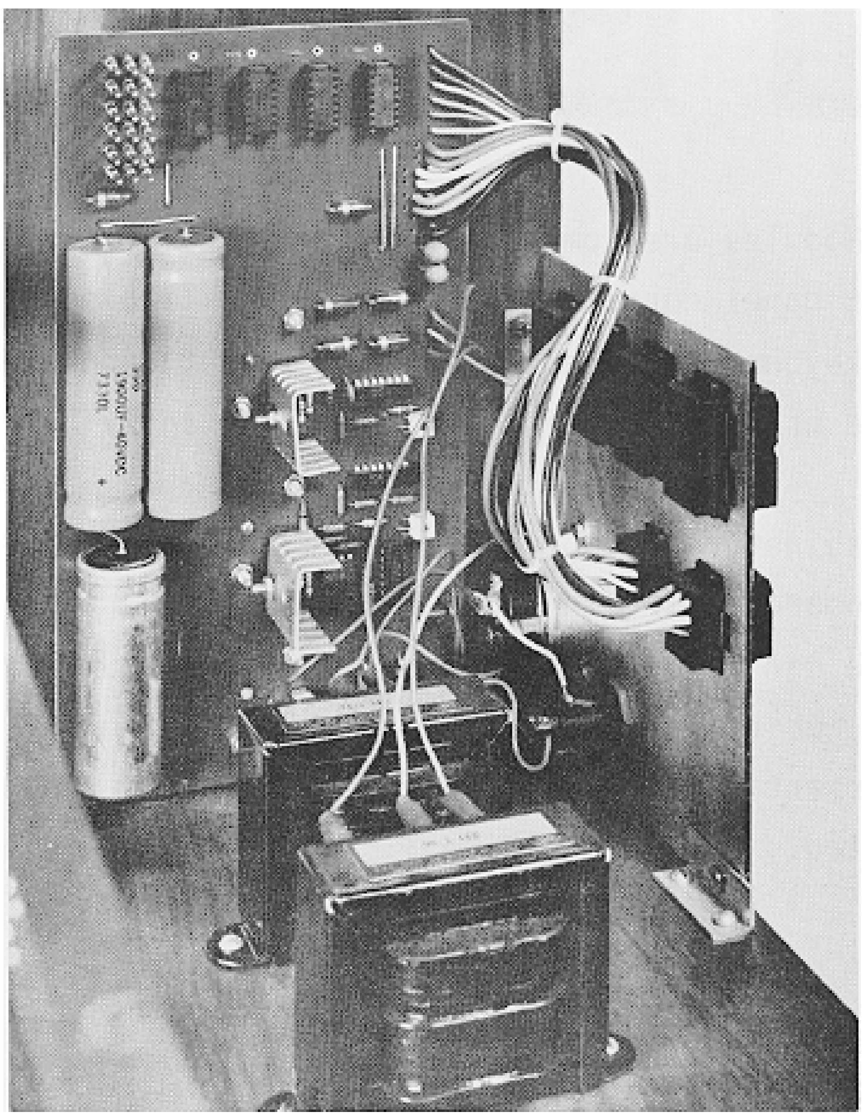
Power Bus Connected Inputs:

Keyboards 1 & 2 CV, Gate & Trigger

Adjustments:

+15V output

-15V/+15V ratio



1 January 1976

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417 Broadway
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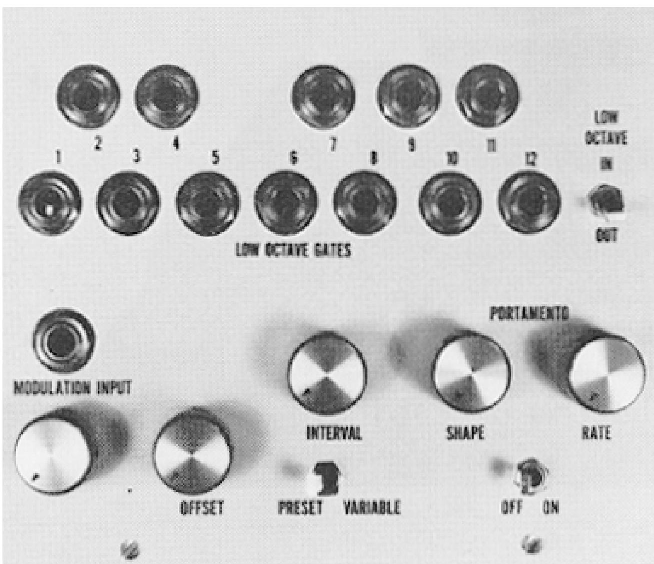
Eμ 4000 SERIES - MONOPHONIC KEYBOARDS



The Eμ 4000 series keyboards represent a major advance in synthesizer technology. Unreliable spring-type contacts have been replaced by J-wires, and finicky analog circuits have been superceded by a stable digital design. The result is an accurate voice output, timing signals that give attacks at the right times, and the addition of several new features.

The voice output is a voltage proportional to the lowest key pressed, or the last key to be depressed when all are released. It is totally drift-free, and accurate to 1/24 semitone. The constant of proportionality (interval) is linearly variable from zero to over two volts per octave, and can be instantly preset to lV/octave.

The gate output is high whenever any key is depressed. The trigger output, a 100 ~sec pulse which initiates new attacks on transient generators, fires whenever the gate rises, or when the voice changes notes. Internal circuitry totally eliminates the effects of contact bounce on all outputs.

The portamento circuit produces a glide between notes, whose shape is variable from linear (control fully counterclockwise) to exponential. The rate control varies the initial glide slope from lV/10 msec to lV/sec. With the portamento switch off, the slew rate is in excess of a volt per microsecond.

The low octave gates are a set of twelve signals, each of which is high when the corresponding key in the low octave is depressed, and low when it is released. The low octave may be switched off so these gates can be used without affecting the voice or timing signals.

The offset control adds or subtracts 0.2 volts (about 2 semitones) from the control voltage output of the keyboard.

A voltage applied to the modulation input is added to the keyboard output voltage before processing by the portamento circuit. The gain is determined by the attenuator below the input, and can be varied from zero to O.lV/V.

POWER CONNECTOR PIN ASSIGNMENTS:

Pin 1 - +15V	Pin 4 - -15V	Pin 7 - Cnt'l V	Pin 10 - NC
Pin 2 - GND	Pin 5 - +5V	Pin 8 - Gate	Pin 11 - NC
Pin 3 - GND	Pin 6 - +5V	Pin 9 - Trigger	Pin 12 - NC

POWER REQUIREMENTS:

±15 V @ 25 mA typical

+5 V @ 75 mA typical

ADJUSTMENTS:

V/octave (adjustable through hole in bottom of cabinet)

ORDERING INFORMATION:

4000 - Monophonic Keyboard in walnut cabinet

4003 - Monophonic Keyboard Circuit Board, exclusive of panel controls and keyboard manual, fully tested.

1 August 1976

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Eμ 4010 FOOTPEDAL CONTROLLER

The Eμ 4010 Footpedal controller is a standard Morley footpedal mechanism modified to produce a control voltage varying from 0 to 10 volts. The pedal travel is sensed photo-electrically; hence there is no potentiometer or gear train to wear out. Maximum control voltage is obtained when the toe end of the pedal is fully depressed.

The unit contains its own power supply; it requires 100V AC power, and gives its output on a standard 1/4” phone jack.

1 August 1976

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The Eμ 4060 series Polyphonic Keyboard and Sequencer is a microprocessor controlled 16 channel synthesizer controller. The unit is housed in a standard Eμ keyboard cabinet, and requires a 6” x 12” (4 module unit) space in the system cabinet for the output panel.

The 4060 itself includes the keyboard and electronics to produce up to 16 polyphonic channel outputs of control voltage and and gate. The sequencer in the 4060 is capable of storing about 60 key depressions; each 4065 16K RAM board added (up to 3) adds 2000 notes of storage capability. The 4060 output panel contains the control voltage and gate output jacks (3 each) and the gate indicator lamps.

The 4060 control panel, located at the left end of the keyboard, holds the following controls:

OFFSET - varies all control voltage outputs +/- 200 mV (total range about 5 semitones).

SLIDE - varies the slide rate for those outputs whose slide is ON. Clockwise is fastest rate.

RESET - depression is the same as turning power off, then on. All sequences are erased and the keyboard is brought to its power-on state.

ERROR/BATTERY - If this lamp flashes intermittently when power is applied, the battery needs replacement. (Call factory for instructions; this happens about once in seven years.) The lamp will blink or stay on in response to certain commands described below.

CLOCK RATE - Controls the rate of the internal sequencer clock oscillator. During sequence storage, a low rate will reduce timing resolution; a high rate will increase it. During sequence recall, the setting will determine sequence rate.

EXTERNAL CLOCK - If an external signal is required for the sequence clock it should be input here. The threshold is nominally 2.5 V, usable with any synthesizer digital or pulse waveform.

TO TAPE - connects to the tape recorder input for storage of sequencer data on tape.

FROM TAPE - connects to the tape recorder output for retrieval or error checking of sequencer data on tape.

The 4060 control panel also holds the 16 key touch pad which is used in conjunction with the keyboard manual itself in defining the 4060's operating modes. The touch pad is similar to a "touch-tone" telephone dial, containing the characters 0-9, *, and #, but adding the letters A-H.

In the following descriptions of 4060 functions, the sequence of depressions that activate the function are shown symbolically.

□ represents the touch pad key with the symbol shown. $\boxed{D}$ (also L and M) represent any number from 1-9. note represents any note on the keyboard manual. Mkey (also Nkey) represents one of the 16 numbered low white keys on the keyboard manual. The functions are summarized in the table at the end of the section. To execute a function, press the key sequence indicated for the command.

LOWER SLIDE ON/OFF $\boxed{1}$ Turns on and off the slide (portamento) function for the lower section (see SPLIT KEYBOARD below). The slide rate is set by the SLIDE control. This and certain other functions are toggle types: the first depression turns the slide ON, the second back OFF.

UPPER SLIDE ON/OFF $\boxed{2}$ Same as above for upper section.

LOWER UNISON ON/OFF $\boxed{4}$ Toggles the lower section in and out of UNISON mode, which forces all channels in a section to identical outputs, which will be the control voltage and gate for the most recently depressed key. Unison is especially useful for tuning purposes.

UPPER UNISON ON/OFF 5 Same as above for upper section.

LOWER HOLD ON/OFF 7 Toggles the lower section in and out of HOLD mode, which causes any gates in the section to remain high once they are activated by a key depression. Exiting HOLD mode returns the gates to their normal states.

UPPER HOLD ON/OFF 8 Same as above for upper section.

TRANSPOSE SEQUENCE 3 note Transposes the sequence being recalled by an interval equal to the distance from low C to the note depressed. i.e. 3 low C# would transpose the sequence up 1/2 step.

CIRCULAR ASSIGNMENT OFF/ON 6 Toggles the circular assignment mode. Normally , the notes played cause channel assignment in a rotating or "next available in order" basis. Pressing 6 toggles the channel assignment to a "lowest available" basis.

CHORUS MODE OFF/ON 9 Normally, repeated depression of a note will cause successive channels to be activated by the note. With chorus mode OFF, the processor will first see if the note is already assigned to the channel, and if it is, will activate the gate on that channel rather than assign a second channel to the note. The effect of chorus mode, then, is to allow one note to decay on several channels at once, giving an audible chorus effect 9 toggles chorus mode OFF, then ON.

HOME A This function returns the keyboard to a known state. SLIDE, UNISON, and HOLD are turned OFF; CHORUS and CIRCULAR ASSIGNMENT are turned ON. The sequencer is immediately halted, producing and immediate normal ending to any sequence being stored. Tape actions are unaffected.

STORE SEQUENCE # N Erases sequence number N and begins storage of a new sequence with that number, starting with the next note played. The sequencer remembers the control voltage, gate, glide, glide state, and channel assignment for each not played. Transpositions and HOLD mode are stored exactly as these are heard during STORE. The analog controls - offset and slide rate - are not stored. The error lamp will blink while storage is in progress, and will stay on if memory capacity is exceeded. Storage is terminated by HOME, RECALL, STOP, or any TAPE command.

STOP SEQUENCE 0 When pressed during STORE, 0 stops storage and puts the end of the sequence at the instant the stop key is depressed. During RECALL, the STOP command will cause the recall to terminate the next time the end of the sequence is reached.

RECALL SEQUENCE * N Recalls sequence N, beginning immediately when N is pressed. The sequence will repeat, recycling at the end of the sequence. If a RECALL command is given during recall, the new sequence will begin at the end of the old. STOP will terminate recall at the next end of sequence; HOME will terminate it immediately.

RECALL DURING STORE $\boxed{\#}\boxed{N}\boxed{*}\boxed{M}$ Starts storage of sequence N at the instant $\boxed{M}$ is pressed, adding what is played from the keyboard to the contents of sequence M. STOP terminates both recall and store at the end of the sequence being recalled; HOME ends recall and storage immediately. In this mode, RECALL L will recall sequence L for storage at the end of the current sequence being recalled. By changing the channels assigned to the keyboard in between RECALL DURING STORE passes, the musician can exercise tremendous control over the voicing of the final composite sequence.

SETUP LOWER $\boxed{D}\boxed{1}$ Mkey Nkey Sets the lower section to be channels M through N; makes it one channel if M = N.

SETUP UPPER $\boxed{D}\boxed{2}$ Mkey Nkey Same as above for upper section.

TRANSPOSE LOWER $\boxed{D}\boxed{4}$ note Transposes the lower section upward by the interval between low C and the note i.e. $\boxed{D}\boxed{4}$ note C2 would transpose the lower section up one octave.

TRANSPOSE UPPER $\boxed{D}\boxed{5}$ note Same as above for upper section.

SPLIT KEYBOARD $\boxed{D}\boxed{3}$ note Defines the upper and lower sections of the keyboard. The note is the top note of the lower section; the next higher note is the bottom of the upper section. The upper section is automatically transposed to the lowest note within it; this transposition may be changed up or down by a TRANSPOSE UPPER command.

STORE ON TAPE $\boxed{D}\boxed{\#}$ Initiates transfer of sequencer data to tape and begins error checking routines. A tape recorder using good quality audio tape should be recording at 0 dB level from the TO TAPE output before the command is given. If a 3-head tape machine is used, data integrity can be checked during storage by connecting the tape recorder output to the FROM TAPE input. Actually any data may be checked during STORE ON TAPE, so any previously recorded tape can be checked by applying the signal to FROM TAPE during STORE ON TAPE. When the command is given, the error lamp will blink. If an error is detected, the error lamp will stay on; if the data is successfully checked, the lamp will go off. Transmission will be aborted by a STOP TAPE, STORE SEQUENCE, or RECALL SEQUENCE command.

STOP TAPE $\boxed{D}\boxed{0}$ Restores the 4060 to a coherent state by terminating all tape action - STORE ON TAPE and RECALL FROM TAPE.

RECALL FROM TAPE $\boxed{D}\boxed{*}$ Loads the sequencer memory with data from tape. The command is best issued when the tape is rolling, but before data begins on the playback line patched to the FROM TAPE input. When the command is issued, the error lamp will blink. If the tape contains a data error, the lamp will stay on; if it goes out, the sequencer memory was filled without error. If no data is presented after the command, the sequencer memory will remain intact, but if any data arrives at the FROM TAPE input, the old sequences will be erased.

NO PREFIX:

1 LOWER SLIDE ON/OFF	2 UPPER SLIDE ON/OFF	3 TRANSPOSE SEQUENCE	A HOME
4 LOWER UNISON ON/OFF	5 UPPER UNISON ON/OFF	6 CIRCULAR ASSIGN ON/OFF	B IGNORE
7 LOWER HOLD ON/OFF	8 UPPER HOLD ON/OFF	9 CHORUS MODE ON/OFF	C IGNORE
* RECALL SEQUENCE [N]	0 STOP SEQUENCE	# STORE SEQUENCE	D TO D PREFIX

D PREFIX:

1 LOWER SETUP Nkey Mkey	2 UPPER SETUP Nkey Mkey	3 SPLIT KEYBOARD note	A HOME
4 LOWER TRANSPOSE note	5 UPPER TRANSPOSE note	6 CANCEL D	B IGNORE
7 CANCEL D	8 CANCEL D	9 CANCEL D	C IGNORE
* FROM TAPE	0 STOP TAPE	# TO TAPE	D IGNORE