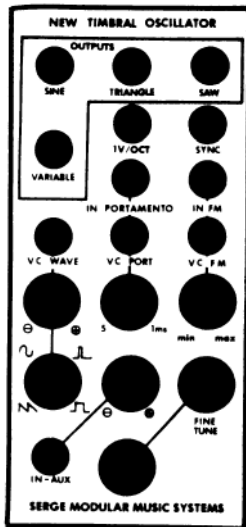


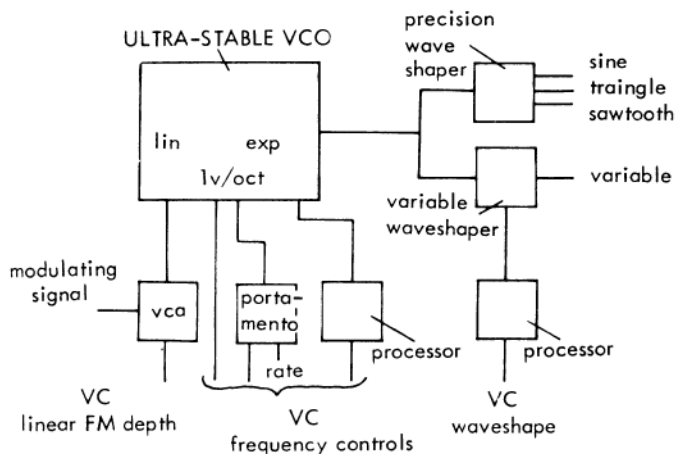
Serge Modular Music Systems

VOLTAGE CONTROLLED OSCILLATORS



- ◆ STATE-OF-THE-ART STABILITY
- ◆ PRECISION TRACKING
- ◆ WIDE-RANGE WAVEFORM CONTROL
- ◆ MULTIPLE WAVEFORMS
- ◆ LINEAR FM WITH DYNAMIC DEPTH VC
- ◆ SYNCING CAPABILITY
- ◆ CALIBRATED INPUTS
- ◆ PROCESSING INPUTS
- ◆ VC PORTAMENTO CONTROL

FUNCTIONAL BLOCK DIAGRAM OF THE NTO



The Serge Modular Systems NEW TIMBRAL OSCILLATOR (NTO) is the state-of-the-art VCO, featuring exceptional range, superb temperature stability, and accurate tracking. Dynamic depth frequency modulation and voltage control of waveform allows unprecedented control over a wide range of sound qualities.

EXPONENTIAL 1 VOLT/OCTAVE RESPONSE

Exponential response parallels the response of human hearing perception as well as musical pitch structure. With multiple oscillators, each must respond exponentially to control voltages to allow transposition from key to key and the exploration of alternative equal tempered tunings such as quarter tones and third tones. In addition, the one volt per octave response assures that the NTO is compatible with most keyboard and computer controllers.

ACCURATE TRACKING

When two or more oscillators are tuned up, it is expected that they will remain in tune throughout their entire range (in other words, that they track). Even two oscillators which track within a fraction of a semitone will be out of tune at the extremities of their range. Therefore, the NTO's have been designed so that any two will track within one cycle/second throughout their entire musical range.

TEMPERATURE STABILITY

Instability of pitch with changes in temperature is the criticism of most synthesizer VCO's. Performers are aware of the disastrous effects of temperature when they must desperately retune oscillators which have drifted during alive performance. The temperature sensitive components of the NTO are kept at an even 120° by a solid state "oven". Thus temperature stability is guaranteed from 50° to 100° F.

WIDE FREQUENCY RANGE

The frequency range of the NTO covers from below 16 Hz to over 16,000 Hz without awkward range switching. With control voltages, the range can be further extended from less than .1 Hz (10 sec/cycle) to greater than 100,000 Hz.

VARIETY OF WAVEFORM OUTPUTS

In addition to three standard waveforms (sine, triangle and sawtooth) of exceptional purity, the NTO offers a variable waveform output providing an amazingly varied range of unique sounds, unavailable on any other synthesizer. This waveform is voltage controllable, allowing dynamic control of sound quality.

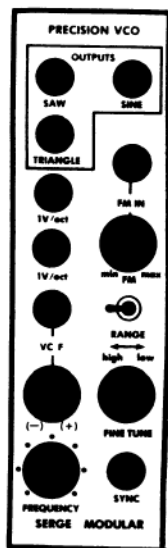
DYNAMIC DEPTH LINEAR FREQUENCY MODULATION

Dynamic depth frequency modulation is now available to the analog synthesist. Frequency modulation (FM), the modulation of one oscillator by another, generates both harmonic overtones (most instrumental sounds) and non-harmonic overtones (bells, gongs, electronic timbres). By varying the amplitude of the modulating oscillator, the richness or complexity of the sound can be varied. However, with conventional FM, an annoying pitch shift occurs. With the NTO, Linear FM avoids this pitch shift, making it possible to maintain accurate pitch control while changing the quality of sound. A built-in VCA assures accuracy and provides dynamic voltage control of Linear FM Depth. Of course, conventional FM is also available on the NTO.

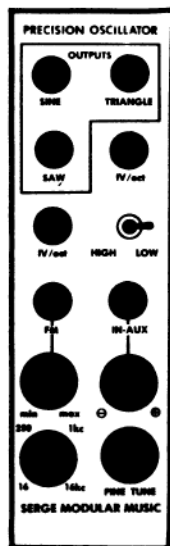
ADDITIONAL FEATURES

The NTO offers two voltage control inputs calibrated to one volt per octave and one variable voltage control input. One of the calibrated inputs incorporates a variable Portamento which allows sliding from pitch at a voltage controllable rate. All of the output levels are "hot", greater than +4 db, to insure maximum signal to noise ratio. A Sync input is provided for locking the NTO to another oscillator's fundamental, harmonic, or subharmonic frequency.

VOLTAGE CONTROLLED OSCILLATORS



STANDARD
VERSION



UPDATE
VERSION

The PRECISION VCO is a versatile, voltage controlled oscillator offering three high quality waveform outputs (sine, triangle and sawtooth) and both linear and conventional frequency modulation capabilities. A front panel switch conveniently extends the range of the PCO from the audio range (16 to 16,000 Hz) to a sub-audio range (.1 to 200 Hz) for Low Frequency Oscillator applications.

EXCELLENT RESPONSE, TRACKING AND STABILITY

Featuring the identical exponential response, exceptional tracking characteristics, and perfect temperature stability as the NTO, the PCO is especially suited for use with the NTO as a modulation source for dynamic depth linear FM.

MANY FEATURES

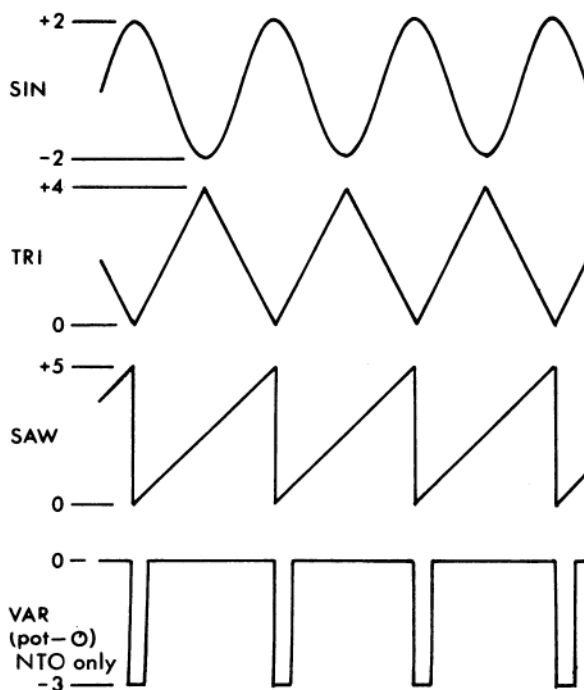
Two calibrated one volt per octave inputs as well as a variable processing input are provided for complex frequency control. FM depth can be varied with the front panel adjustment. All output levels are "hot", greater than +4 db to insure maximum signal to noise ratio when used with subsequent processing. A Sync input is also available for locking the PCO to another oscillator's fundamental, harmonic, or sub-harmonic frequency.

SYSTEM UPGRADE

The PCO is also available for the older 6-hole panels used in early SERGE systems. The addition of this module or the replacement of previous VCO's is a valuable modification of earlier systems. All of the excellent specifications as well as the possibility of linear FM adds new dimensions to existing synthesizer systems.

- ◆ STATE-OF-THE-ART STABILITY
- ◆ PRECISION TRACKING
- ◆ MULTIPLE WAVEFORMS
- ◆ LINEAR FM
- ◆ SYNCING CAPABILITY
- ◆ CALIBRATED INPUTS
- ◆ PROCESSING INPUT

WAVEFORM AMPLITUDE AND PHASE RELATIONSHIPS IN THE NTO AND PCO



Serge Modular Music Systems

VOLTAGE CONTROLLED FILTERS

Serge Modular Systems offer a new series of voltage controlled filters (VCF's). Innovations in circuit design have eliminated most of the distortion and noise limitations to provide synthesizer filters which are truly transparent. The following features are incorporated into all Serge Modular VCF's:

- ◆ EXTREMELY QUIET OPERATION
- ◆ PRECISE TRACKING
- ◆ WIDE RANGE: 16 to 16,000 Hz
- ◆ LOW DISTORTION
- ◆ FAST RESPONSE
- ◆ EXCELLENT CONTROL VOLTAGE REJECTION
- ◆ VARIETY OF CHARACTERISTICS
- ◆ ULTRA-STABLE
- ◆ MULTIPLE OUTPUTS

EXCEPTIONALLY LOW NOISE

No annoying "pumping" sounds occur at high resonance settings with low level input signals. This problem is one of the most prevalent in synthesizer VCF's. Clean filter outputs are absolutely essential for wide dynamic ranges.

ACCURATE TRACKING

Calibrated 1 volt/octave inputs allow the VCF's to follow a PCO or NTO when both filter and oscillator are controlled by keyboard, computer, sequencer or other control voltage source. This type of tracking is useful to maintain accurate control over timbre with changing frequencies.

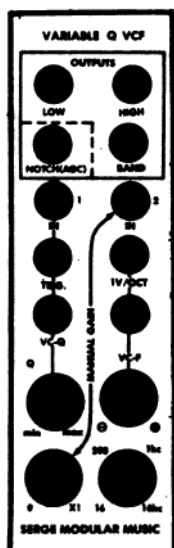
VARIABLE CONTROL VOLTAGE INPUT

Attenuation and inversion of control voltages can be processed with a signal knob.

HIGH STABILITY

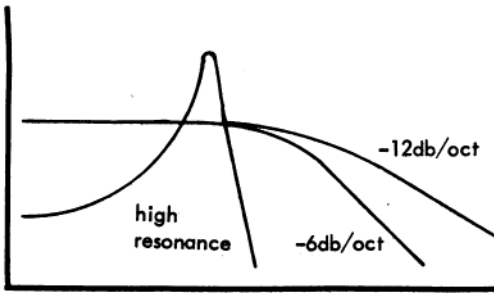
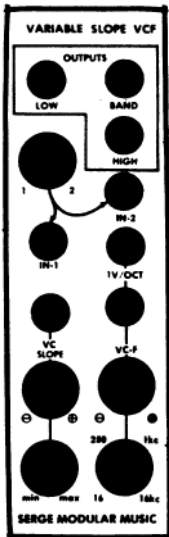
The filters will not overload and go into oscillations under any condition except when they are patch-programmed to oscillate.

Three different types of voltage controlled filters are available, each with unique features. It is suggested that various filters be included in a system to maximize the potential for timbral exploration.

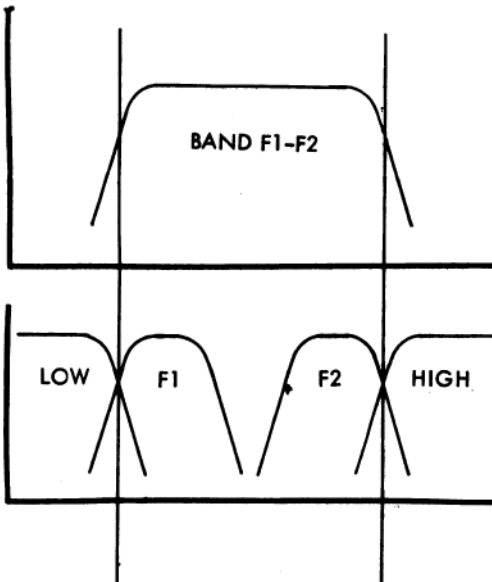
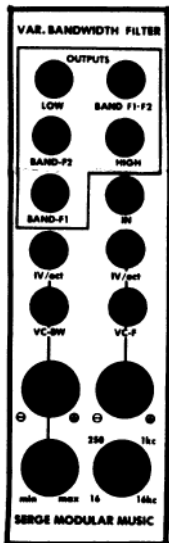


The VARIABLE Q VCF (VCFQ) is an excellent, general purpose VCF offering low-pass, high-pass, band-pass and notch (band-reject) outputs. The resonance (Q) of this filter is dynamically variable by manual or voltage control. The VCFQ has two signal inputs. One incorporates an automatic gain control to assure that the filter will not overload and distort at high Q settings. The second input is attenuated manually so that the percussive effects of overloading the filter can be exploited. When a pulse is applied to the Trigger input, the filter will ring, producing a damped waveform similar to that produced by striking a resonant object. The nature of this ringing is controlled by the Q and the filter frequency. Uniform ringing with identical Q settings occurs, regardless of the filter frequency, so wide range percussive effects from clicks to wood blocks to bell tones can be produced and controlled. This ringing effect can be used in conjunction with signals applied to either of the audio inputs to achieve highly controlled complex tonal qualities.

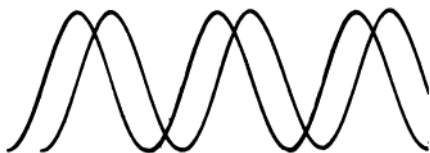
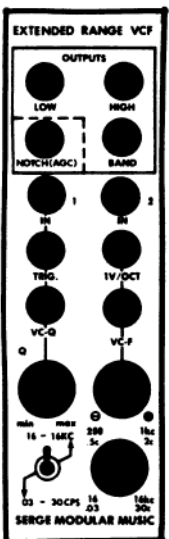
VOLTAGE CONTROLLED FILTERS



The VARIABLE SLOPE VCF (VCF1) offers unique control of sound quality offered by no other synthesizer manufacturer. All VCF's offer voltage control of the cut-off frequency, that is, control of which frequencies the filter lets pass. The VCF1 allows the amount of filtering to be dynamically controlled as well, from barely perceptible filtering to highly resonant sharp cut-offs. With the variable slope control in the center position, the VCF1 acts as a typical flat-response VCF, with high, low, and band-pass outputs. The slope of the cut-off of the outputs is 12 db/octave. As the control is moved toward the minimum position, the slope of the filter is decreased to 6 db/octave so that the filtering becomes less perceptible. As the variable slope control is turned up to the maximum position, the resonance of the filter increases, so that the cut-offs become sharper. Although the VCF1 will not ring like the VCFQ, it will resonate enough at the maximum setting to pick out harmonics from a complex signal input. There are two signal inputs to the VCF1 which are manually mixed by a single pot. This allows cross-fading from one input to the other.



The VARIABLE BANDWIDTH FILTER (VCF2) has a band-pass output which can be varied by manual or voltage control. This is a standard response for synthesizer VCF's used in most studio quality modular systems. In the VCF2, two state variable VCF's are connected in series to produce a total of five outputs. High-pass, low-pass, two fixed bandwidth outputs, and one variable bandwidth output are available. The outputs are all flat-response (no resonance) so the VCF2, similar to a formant filter, is suitable for processing concrete sounds and complex timbres. Under voltage or manual control, cut-off frequency of the high and low-pass outputs are affected, as well as the center frequency of the two band-pass outputs. Both center frequency and bandwidth are independently controllable on the variable bandwidth output (Band F1-F2).



SINE WAVES IN QUADRATURE

In addition to the three standard VCF's, Serge Modular offers an EXTENDED RANGE VCF (VCFX) which is identical to the VCFQ, except it features a second sub-audio range. This low frequency range is useful as a control voltage processor. A standard envelope or pulse applied to the filter in the low range at high Q settings will cause low frequency ringing. This generates complex envelopes and damped vibrato/tremolo effects. The VCFX can be patch programmed to oscillate by patching the band-pass output into the manual input (input 2) to cause the filter to oscillate. The outputs will be in quadrature relationships and are useful for producing rotating sound movement with the Quad Output Mixer.

Serge Modular Music Systems

VOLTAGE CONTROLLED AMPLIFIER FUNCTIONS

- ◆ LOW NOISE
- ◆ WIDE DYNAMIC RANGE
- ◆ LOW DISTORTION
- ◆ LOW CV FEEDTHROUGH
- ◆ EQUAL POWER CONTROL

The Serge Modular Equal Power Series of VCA functions represents the state-of-the-art in voltage controlled amplifier design. The Quad Voltage Controlled Amplifier (QCA), the Universal Equal-Power Audio Processor (UPAP), and the Dual Cross-Fader (FAD) are extremely versatile audio processors. Important features of these modules are:

STUDIO QUALITY SPECIFICATIONS

The VCA's have extremely low noise and exceptionally low distortion for a clean output with no "hiss". Wide dynamic range is included for optimal control of amplitude. Excellent control voltage rejection eliminates annoying thumps and enables clean sounding amplitude modulation.

EQUAL POWER CONTROL OF PANNING AND CROSS-FADING

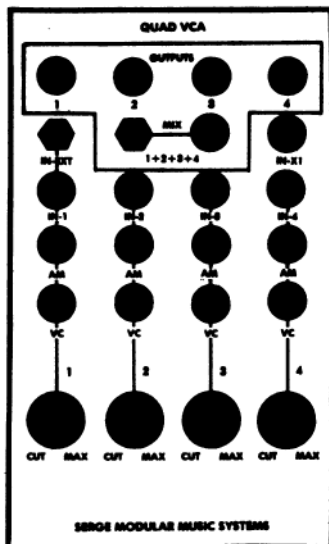
Equal power control assures that the overall amplitude of the VCA's will remain constant throughout spatial location and cross-fading signals.

LINEAR RESPONSE OF PANNING AND CROSS-FADING

Linear response assures that panning and percentage cross-fade behave predictably in response to a control voltage, eliminating signal level changes as well as annoying slow and fast areas.

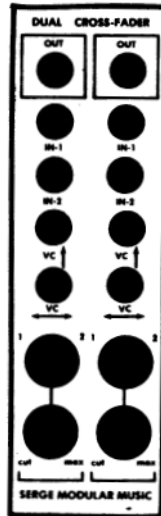
MULTI-FUNCTIONAL GAIN CONTROLS

The gain control pots are important multi-purpose controls. This single knob allows the user to perform a number of functions. In the normal center position, the VCA operates as a typical VCA with a dynamic range of 100 db with a 0 to +5 volt control voltage. As the knob is turned down, the output signal is increasingly attenuated, even though a control voltage is being applied. At the minimum "cut" setting, the input is fully attenuated, regardless of the control voltage. To the left of center position, the pot can control the gain manually to unity gain (output level = input level), or, when used with control voltages, gain through the VCA can be achieved. Since the gain can be controlled in this manner, different channels can be adjusted to provide the desired mix at the module outputs while the voltage controlled amplitude and panning functions are occurring. This eliminates the need for additional mixers to get a balanced final mix.

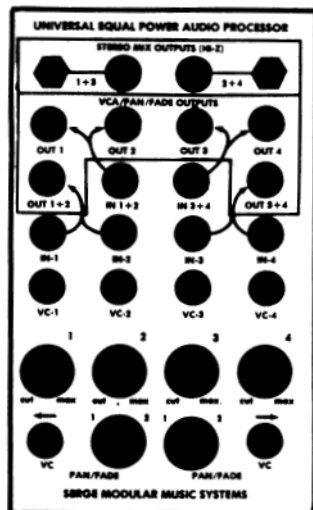
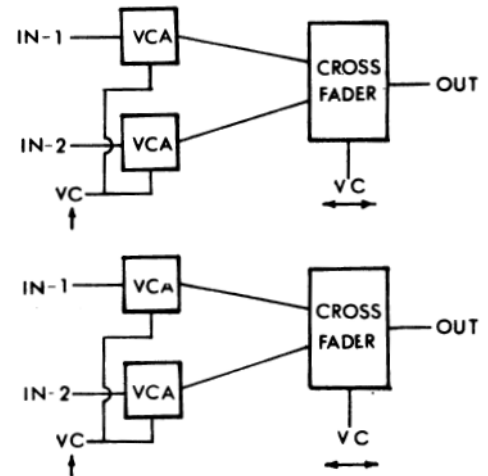
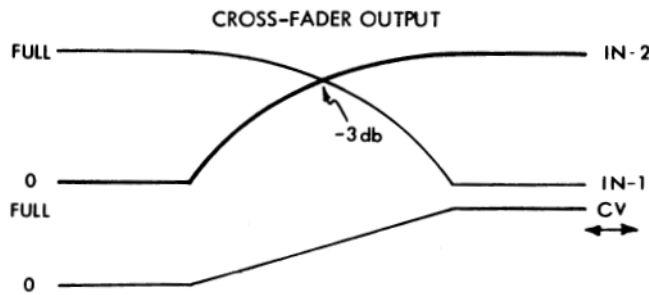


The QUAD VOLTAGE CONTROLLED AMPLIFIER (QCA) employs four high quality VCA's. Each VCA has one input suitable for DC control voltages to control the overall amplitude of the audio input signal. Envelope generators or sequencers are normally patched to this input. A second control voltage input is ideal for amplitude modulating signals. This input has less dynamic range than the other input and normally oscillators or other control voltages are patched to this input for simultaneous modulation and gating functions. A mixed output of all four VCA's is also included, so that the QCA can be used as a four-in/one-out voltage controlled mixer with independent level control for each input. A unity gain input is used to bus other QCA's together to form mixers of eight, twelve or more input channels.

VOLTAGE CONTROLLED AMPLIFIER FUNCTIONS

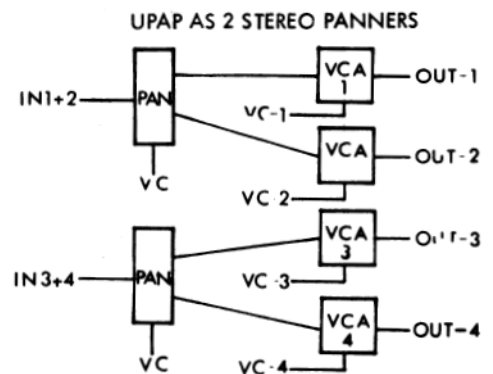
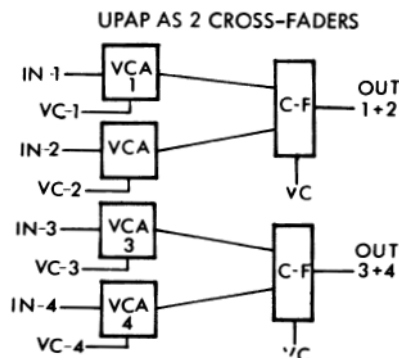
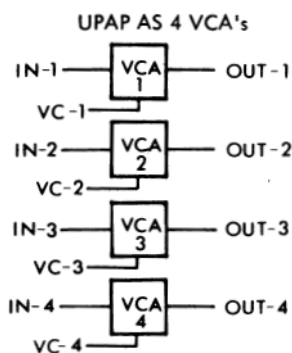


The DUAL CROSS-FADER (FAD) consists of two independent equal-power voltage controlled cross-faders. Each cross-fader has two signal inputs. As one signal increases in level under manual or voltage control, the other signal decreases. This effect is used to accurately fade one sound out while fading in another. Cross-fading with voltage control permits a smooth or sudden transformation between two different timbral sources. If a sound and its reverberated image are sent through a cross-fader, the reverb mix (proportion of the reverb image to the original "dry" sound) can be voltage controlled. This effect is used to modify the spatial characteristics of a sound event, from immediate presence to distant ambience. In addition to the cross-fade function, a VCA controls the output amplitude of each section.



The UNIVERSAL EQUAL-POWER AUDIO PROCESSOR (UPAP) is the ideal VCA module for small Serge systems because it can function in the following ways:

1. Four independent VCA's with separate signal and control inputs.
2. Two voltage controlled stereo panners. Each panner has one input which is routed to two outputs, in a proportion which is voltage controlled. The panners can be used for signal routing within a system or for the positioning of sounds in a stereo field. A VCA controls the overall amplitude of the input signal.
3. Two voltage controlled cross-faders. Each cross-fader has two inputs. As one input signal increases in amplitude, the other decreases.
4. Four input stereo mixer, utilizing both panning and cross-fading. Miniphone jacks allow the mixer to be connected to external audio equipment, such as tape recorders and monitor amplifiers.



Serge Modular Music Systems

VOLTAGE CONTROLLED OUTPUT MIXERS

- ◆ LOW NOISE
- ◆ WIDE DYNAMIC RANGE
- ◆ LOW DISTORTION
- ◆ LOW CV FEEDTHROUGH
- ◆ EQUAL POWER CONTROL

The Serge Modular Equal Power Series of voltage controlled output mixers represents the state-of-the-art in voltage controlled mixer and panner designs. A voltage controlled panner has an input which is routed to two, four, or more outputs in a proportion which is voltage or manually controlled. In these output modules, panning can be utilized to dynamically position sounds in stereophonic, quadrasonic, or three-dimensional sound space. All Serge Modular mixers are studio quality in order that they may be interfaced to external audio systems. Important features of these modules are:

STUDIO QUALITY SPECIFICATIONS

The VCA's in all of the Serge output modules have extremely low noise and low distortion for clean outputs with no "hiss". Wide dynamic ranges permit optimal control of amplitude. High control voltage rejection eliminates annoying "thumps" and enables clean amplitude modulation and noise-free spatial modulation.

LINEAR EQUAL POWER CONTROL

Equal power control assures that a sound has the same amplitude wherever it is positioned in space. Linear response is necessary for accurate panning with control voltages too avoid fast or slow spots.

A VCA FOR EACH CHANNEL

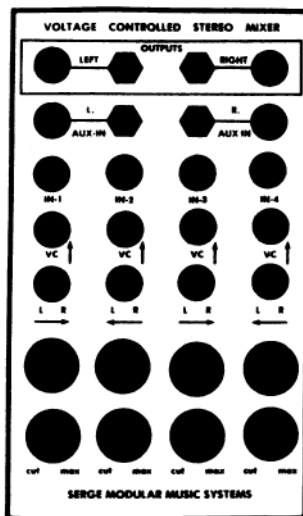
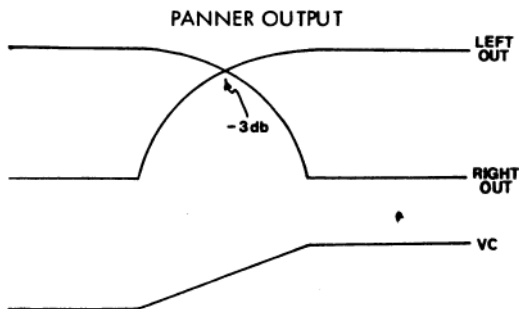
Thus, voltage control of the output level of each panner is possible without the need for more VCA's. Each channel of a panner may be used as a VCA with or without the panning function.

MULTI-FUNCTIONAL GAIN CONTROLS

The gain control pots are versatile multi-purpose controls. This single knob allows the user to perform a number of functions. In the normal center position, the channel VCA operates as a typical VCA with a dynamic range of 100 db with a 0 to +5 volt control voltage. As the knob is turned down, the output signal is increasingly attenuated, even though a control voltage is being applied. At the minimum "cut" setting, the input is fully attenuated, regardless of the control voltage. To the left of the center position, the pot can open the VCA up to unity gain, or when used with control voltages, gain can be achieved. Since the gain of each of the channels can be controlled in this fashion, the levels of the various channels can be adjusted for the optimum desired balance. This gain function is independent of panning functions.

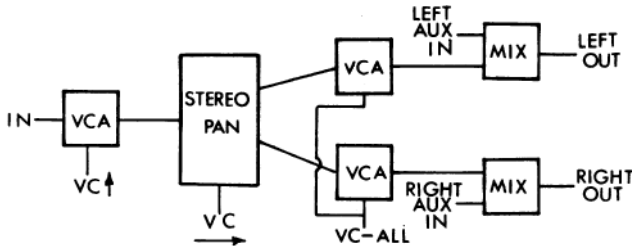
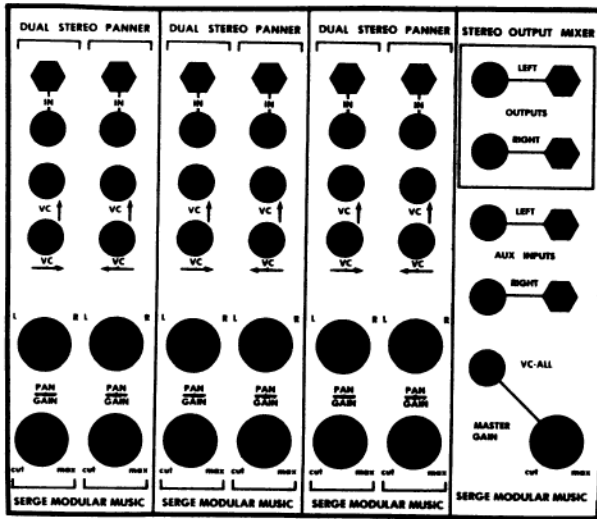
EASILY INTERFACED TO OTHER EQUIPMENT

Mini-phone jacks on auxiliary high impedance inputs as well as on all channel outputs are provided for direct hook-up with external audio equipment such as tape recorders and monitor amplifiers.



The QUAD INPUT VOLTAGE CONTROLLED STEREO MIXER (QVM) is an excellent low noise mixer for small to medium size Serge systems, since it incorporates an equal power stereo panner as well as a voltage controlled amplifier for each of four inputs. Both signal level and spatial location can be controlled manually or by voltage control. The QVM is also well-suited for external computer control and for automated mix-downs with voltage programmable spatial positioning. Two or more QVM's can be connected together conveniently to form voltage controlled mixers of eight, twelve, or more inputs by connecting the outputs of one to the auxiliary inputs of another. Outputs and Auxiliary inputs are provided with mini-jacks in addition to banana jacks to facilitate hook-up to external audio equipment.

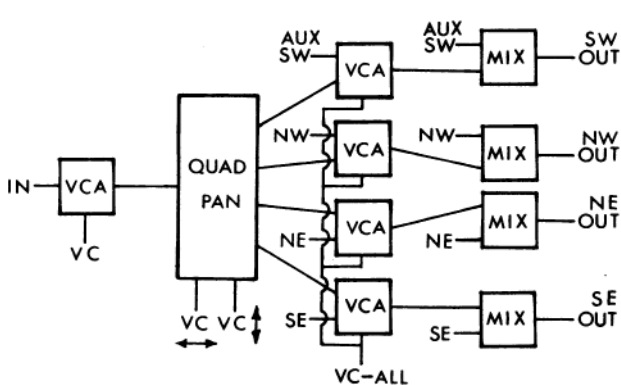
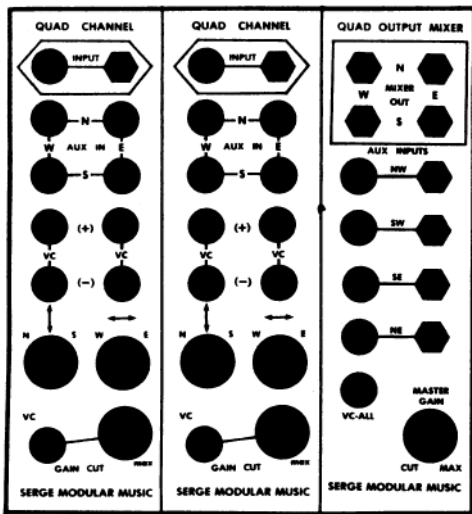
VOLTAGE CONTROLLED OUTPUT MIXERS



The MULTI-CHANNEL STEREO MIXER (SMX) is an expandable studio quality output mixer for medium to large Serge systems. From a minimum of six input channels, it is expandable up to 14 channels on one panel. The SMX is an indispensable aid for live electronic music performance or can be used with appropriate computer control for automated stereo mix-downs in the studio.

The SMX consists of three or more Dual Channel Stereo Panners wired to a single Stereo Output Mixer. Each DUAL CHANNEL STEREO PANNER (PAN) contains two equal power voltage controlled stereo panners. Each panner is used to position the input signal in a stereophonic sound field with manual or voltage control. A VCA allows the overall amplitude of the channel to be voltage controlled. Each panner has an input fitted with both a banana jack and a mini-jack for use with signals from within the system and for hookup to external sources such as tape recorders. Due to the fast response, low noise and excellent control voltage rejection, location modulation can be achieved up to supersonic frequencies with virtually no noise.

The Stereo Output Mixer sums the stereo signal from each panner. An important feature of this output section is a master gain VCA which controls the overall sound level of the two stereo output signals. Thus, the entire output level can be faded in, faded out, or adjusted with a single knob or control voltage. Auxiliary inputs allow non gain controlled inputs to be added directly to the final mix. Mini-phone jacks are included on the outputs to connect directly to other equipment.



The MULTI-CHANNEL QUADRAPHONIC MIXER (QMX) is the top-of-the-line studio quality output mixer for four channel applications. From a minimum of two inputs, it is expandable up to seven independent inputs. Like the other Serge output mixers, this module is an especially important control module for live performance, for computer control of amplitude and location, and for automated mixes in the studio.

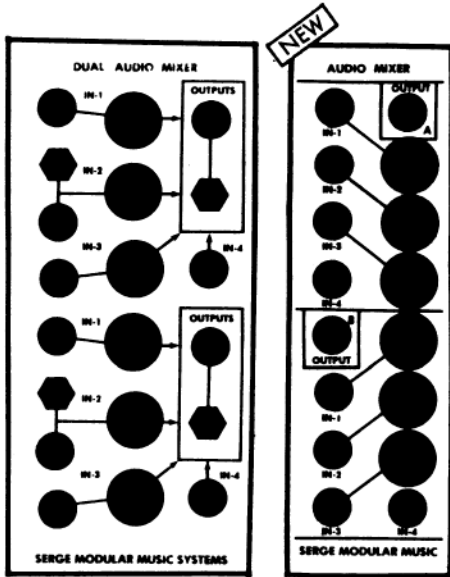
The QMX consists of two or more input sections with a single Quad Output Mixer. An equal-power QUAD PANNER CHANNEL (QPC) is used to position the sound image in quadraphonic space. The amplitude of each channel is controlled by a VCA, so that both gain control and spatial location can be realized simultaneously in each Quad Channel. An input is available for mini-phone hook-up to external audio sources. Due to fast response, low distortion and excellent control voltage rejection, location modulation can be effected up to supersonic frequencies with virtually no noise.

The Quad Output Mixer sums the quad signals from each Quad Panner Channel. An important feature of this output section is the master gain VCA, which controls the overall level of the quadraphonic outputs. Thus, the entire output level can be conveniently faded in, faded out, or adjusted with a single knob or control voltage.

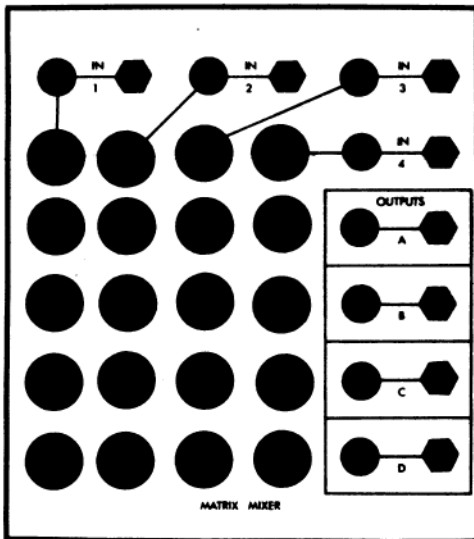
There are four auxiliary inputs, one to each speaker, for mixing other signals into the output mixer. There are also auxiliary inputs on the Quad Panner Channels which are voltage controlled in such a way that spatial cross-fading can be achieved. The sound from one speaker can be faded out while a different sound at another speaker can be faded in.

Serge Modular Music Systems

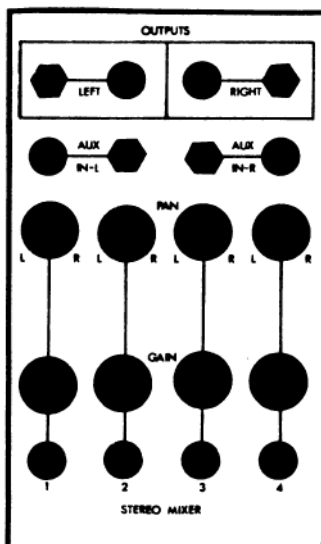
AUDIO MIXERS



The Serge MIXER (MIX) is two independent mixers. Each section is a four-in/one-out manual mixer. Three inputs have level control potentiometers and one input is a unity gain (non-attenuated) input. The main output of one section can be connected to the unity gain input of the other section to create larger mixing units. This module can be used as two audio mixers with three variable inputs, or as one mixer with six variable inputs. This module can also be used in combination with other mixers, VCA modules and output modules to provide various mixing functions. A two-inch version of the Mixer is available for high density systems.

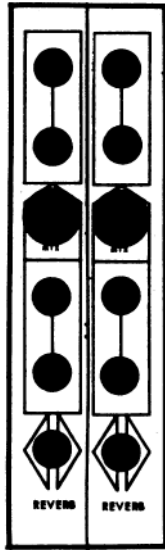


The MATRIX MIXER (MAX) is a four-in/four-out mixer. Each input has four pots which separately control the level of that input at each of the four outputs. This operation requires 16 pots arranged in a four-by-four matrix. Four additional pots are included to control the total output level of the four outputs. This arrangement allows the user to set four independent mixes with a separate output level control. Thus, each of the four mixes can be adjusted for the proper output level without affecting the balance of the four input signals.

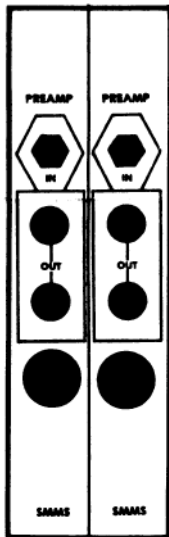


The STEREO MIXER/PANNER (MXP) has a manual level control and a manual pan pot for each of its four inputs. Each panner has one input which is routed to the two outputs in a proportion determined by the manual pot. Panning can be used for routing signals within a system or for positioning sounds in a stereo field. By connecting the outputs of one mixer to the corresponding auxiliary inputs of another, larger mixers of eight, twelve, or more inputs can be formed. Outputs are provided with mini-jacks for hook-up to external audio equipment.

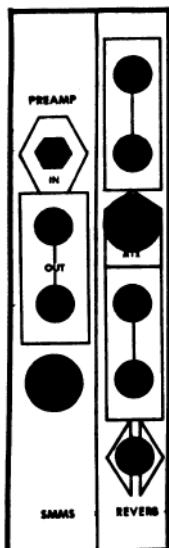
AUDIO PROCESSORS



The DUAL CHANNEL REVERB (REV) utilizes two spring type reverb units to process audio signals. This type of signal conditioning is useful in synthesizing complex spatial qualities, for timbre refinements and for the simulation of acoustical ambience. Two outputs are provided: one is pure reverberated image of the input signal; the other is a manually variable mix of the input signal and its reverberation.



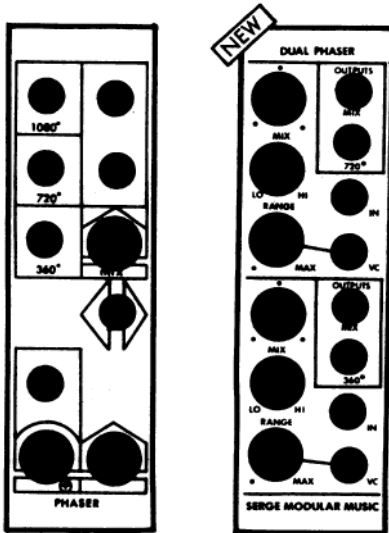
The DUAL MICROPHONE PREAMP (PRE) is two independent channels of pre-amplification suitable for use with low impedance microphones. Gain is 60 db, and the wide dynamic range and low noise of this unit makes it useful for boosting low signal levels for further processing within the system.



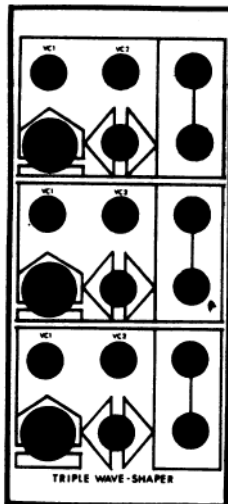
The REVERB/PREAMP (PREV) module consists of one microphone preamp and one channel of reverberation as described above.

Serge Modular Music Systems

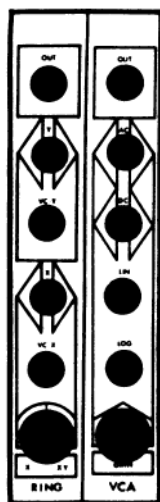
AUDIO PROCESSORS



The VC PHASER (PHA) is perhaps the lowest noise and lowest distortion phase shifter available today. As an aid to recreating some of the subtle properties of phase delay in acoustic sounds, three separate outputs are provided with 360°, 720°, and 1080° of voltage controllable phase shift. A Mix output combines the 1080° phase shift with the input signal to produce the multiple notch filter effect that is usually associated with phase shifters. The VC Phaser's log-conforming characteristics and the manual and voltage controls enable ultra-smooth, precisely centered sweeps of phase shift for both spatial effects and timbral modification. For large, high-density systems, a 2" Dual Phaser is available.

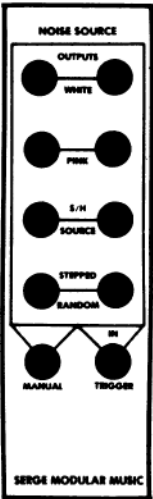


The TRIPLE WAVESHAPER (TWS) is a non-linear wave modifier which can transform a sawtooth wave into a sine wave. This module incorporates three independent waveshapers which are useful for modifying synthesizer waveforms or for processing signals from preamped instruments. This module has been found to be an excellent modifier of flute sounds and other audio signals which are low in harmonic content.



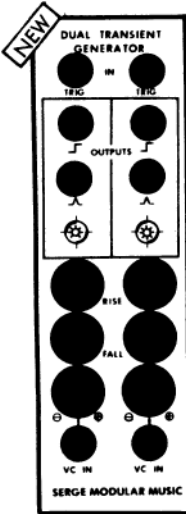
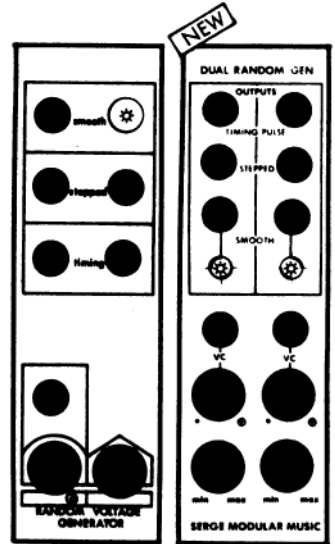
The RING MODULATOR/GATE (MOD) is an AC or DC coupled Ring Modulator and VCA featuring superior audio processing capabilities. The Ring Modulator offers two VC inputs in addition to the two signal inputs which may be used to perform voltage controlled transitions between full ring modulation and amplitude modulation. The VCA can be used as a standard voltage controlled amplifier with either log or linear control voltage characteristics. The DC coupled input is useful for using the VCA as a DC multiplier or gate.

CONTROL MODULES



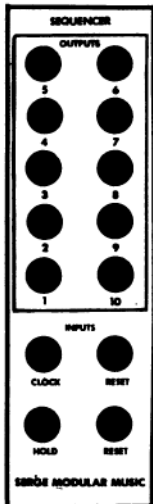
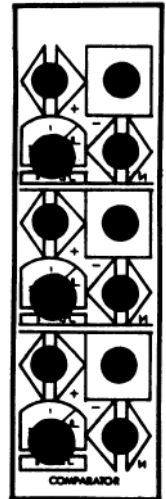
The NOISE SOURCE (NOI) generates both white and pink noise waveforms. The S/H Source provides the necessary input for a sample and hold function to produce equi-probable random voltages. Additionally, the Noise Source features as a random voltage output which can be activated by pulses or from a pushbutton on the front panel.

The RANDOM VOLTAGE GENERATOR (RVG) produces random voltages which vary smoothly or in a step-wise manner. Random timing pulses are also available. Rate of change of all outputs is voltage controllable over a wide temporal range. **IMPORTANT NOTE:** The Random Voltage Generator must be internally connected to the Noise Source, and therefore must be placed on the same panel as the Noise Source. Up to seven Random Voltage Generators may be used with one Noise Source. The Random Voltage Generator is now available as a 2" Dual unit for large, high-density systems.



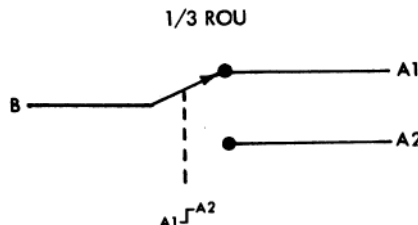
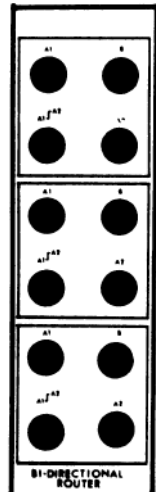
The DUAL TRANSIENT GENERATOR (DTG) provides two independent outputs with voltage controllable rise and fall times. The transients may be actuated with external pulses or can be recycled by patching the end pulse into the input trigger jack.

The TRIPLE COMPARATOR (COM) consists of three independent functions which are useful in the production of square waves and variable pulse waves. The Comparator reference level can be a time-varying control voltage, a complex audio signal, or a fixed preset voltage. Additionally, the comparators are useful for level detection and for logic decisions based on amplitude.

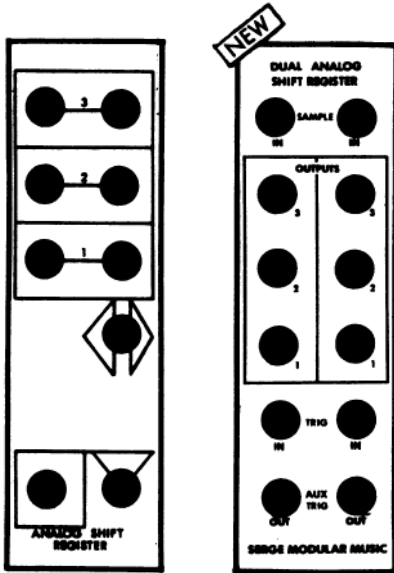


The SEQUENCER (SEQ) is a pulse output ten-stage sequencer. Use of Clock, Reset, and Hold inputs allows a variety of sequencing operations.

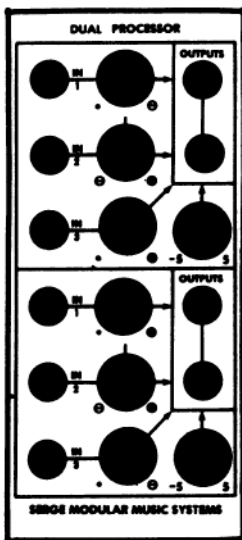
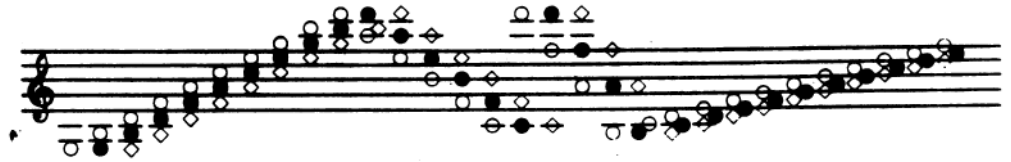
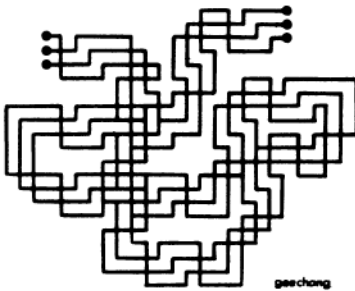
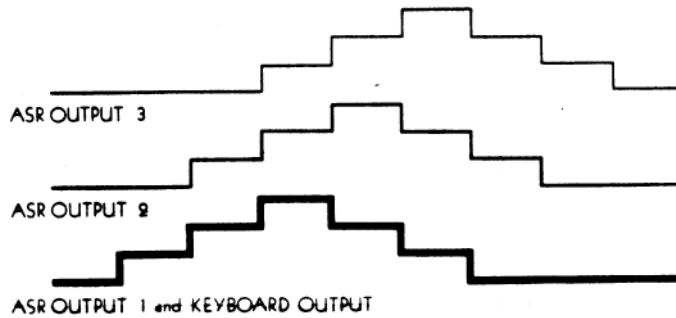
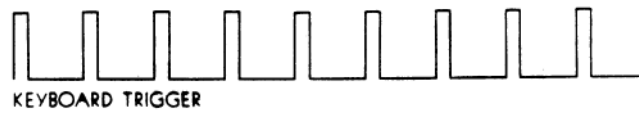
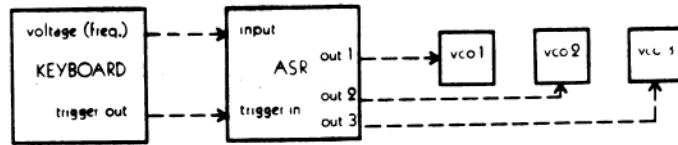
The TRIPLE BI-DIRECTIONAL ROUTER (ROU) is three switches which route one input to either of two outputs or either of two inputs to one output according to a pulse or control voltage level.



CONTROL MODULES

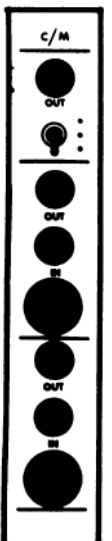


The ANALOG SHIFT REGISTER (ASR) is a sequential sample and hold module for producing arabesque-like forms in musical space. Whenever pulsed, the previously held voltage is sent down the line of three outputs, yielding the electrical equivalent of a canonic musical structure. A pulse output permits linking two or more ASR's together to form longer patterns. This is available as a dual unit for high-density systems.



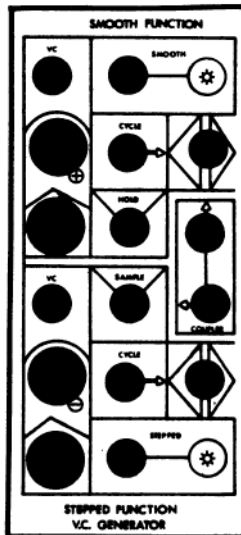
The DUAL PROCESSOR (PRC) is two independent circuits for adding and inverting control voltages. Full processing control of level and polarity of three input voltages is provided. A manual offset voltage is available as an additional voltage level which is summed to the other three inputs.

The CONTROL MODULE (C/M) is provided for economic utilization of extra panel space. This module has two level controllers and a manual pulse source.



Serge Modular Music Systems

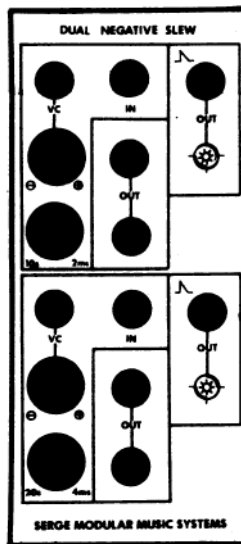
CONTROL MODULES



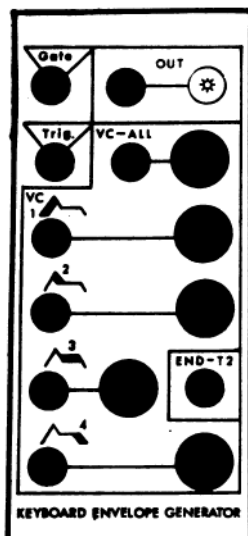
The SMOOTH & STEPPED GENERATOR (SSG) is a complex multifunctional module which can be patch-programmed to provide various slew and sample functions. The Smooth section will place a positive and negative slew on input voltage transitions for lag effects, voltage controlled portamento, and for low frequency filter applications. With the Cycle jack patched to the input, the unit will oscillate yielding a voltage controlled triangle wave LFO. A high level into the Hold input will enable the Smooth Function to be used as a track-and-hold circuit with voltage controlled slew rate.

The Stepped Function can be used as a sample-and-hold with voltage controlled slew rate limiting. With the Cycle jack patched to the input and a pulse applied to the Sample input, complex staircase waveforms are generated for control voltage applications and for use as audio signals.

The Coupler is an internal comparator which compares the output levels of the Smooth and the Stepped Generators. This output is useful for generating complex control voltages and for the production of random voltages.

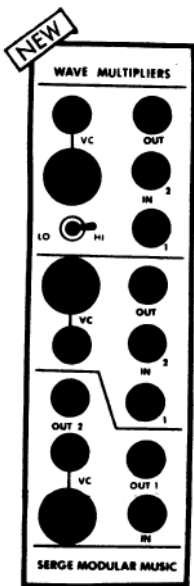


The DUAL NEGATIVE SLEW (NEG) is one of the unique multi-functional patch-programmable modules in the Serge system. The module features two independent sections with wide range voltage controllable slew rates. The slew is active in the negative direction only and can be patched to perform a number of synthesizer functions. With the Pulse output applied to the input, the module will regenerate for use as a voltage controlled sawtooth oscillator or pulse generator. An audio signal applied to the input will be envelope detected, and the complex envelope will be available at the output. If a pulse is applied to the input, the unit will function as an envelope generator with a fast rise time and a voltage controlled fall time.



The KEYBOARD ENVELOPE GENERATOR (KEG) is specifically designed to interface with existing keyboard type synthesizers. This module provides the useful ADSR type of envelope with full voltage control over the Attack, Decay, Sustain, and Release. The pre-scaled VC inputs are calibrated at 1 volt per octave.

Wave Multipliers



For generating and modifying sound, the typical synthesizer patch is that of the VCO-VCF-VCA linked in that order. The VCO provides control of frequency, the VCF is able to dynamically vary timbre, and the VCA controls the amplitude of the final sound. The Serge Modular WAVE MULTIPLIERS (VCM) provide a new link in this chain, representing an advance in synthesizer technology. In this typical patch, the Wave Multiplier could be placed just before the VCF. Like the VCF, the Wave Multipliers affect the timbre. Unlike the VCF's, whose action is a subtractive process of attenuating (filtering) frequencies in an input waveform, the Wave Multipliers are able to dynamically multiply the input waveforms to add new harmonically related frequencies. This multiplying function is highly non-linear, and should not be confused with ring modulation which is a linear multiplicative form of modulation. Just as it is really impossible to describe what a VCF sounds like, it is difficult to convey the action of the Wave Multipliers. The nearest we can come to describing the unique qualities of this new module is to say that the Wave Multipliers function as timbre modifiers in exciting new ways, and which offer alternative forms of signal processing which are unique in the Serge Modular Music Systems.

There are actually three entirely separate and different types of wave multipliers in this module. These provide an enormously varied palette of effects, since they can be used together in a multitude of ways.

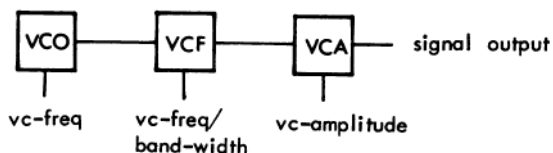
The uppermost Wave Multiplier is the simplest of the three multipliers. Like many of our modules, it is multi-purpose. With its switch set at "HI", the module functions to "square" up an input signal. The audible result of this function is similar to overdriving a tube-type amplifier, except with full manual and voltage control of this process. With the switch in the "LO" position, the module is a linear gain controlled VCA. This VCA is useful for various functions such as amplitude modulation, and for gating signals into the other wave multipliers.

The middle Wave Multiplier provides a sweep of the odd harmonics (1, 3, 5, 7, 9, 11, 13) when a triangle wave is applied to its input and the knob is turned up or a control voltage is swept from minimum to maximum. The effect is very similar to overblowing a wind pipe closed at one end, and thus the module can be used to give the effect of various wind instruments. Different input waveforms will result in widely different combinations of harmonics. Audio signals can be applied to the VC inputs or the second input to develop new types of modulation. This module can be used to explore effects beyond ring modulation because there are more varied harmonics formed than simple sum and different tones.

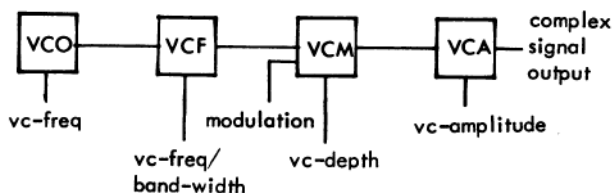
The bottom Wave Multiplier performs non-linear waveshaping known as full-wave rectification. Actually, the process involves three full-wave rectifiers which are assembled in a very refined and controllable format. Each section doubles the frequency of a sine or triangle wave applied to its input. Thus, sweeping the VC input of this module over its range provides a smooth transition between even harmonics (2, 4 and 8). Many other partials are present in the basic sound, however, and the sonorities are very rich and varied. A notable feature of this multiplier is that the full-wave rectification process is not accompanied by a reduction in the output amplitude. There is no alteration of the essential level of the sound. Another feature is that internal time constants are incorporated which add interesting dynamic effects, depending upon the rate of the VC control. There are two inputs which produce various types of modulation effects, but quite different from those generated from the other two multipliers in this module. A second output is provided which is a "squared up" version of the main output. The signal here resembles voltage controlled pulse width modulation.

The Wave Multipliers are among the most powerful timbral modifiers available on any analog music synthesizer. The rich varieties of inter-patch possibilities is nearly inexhaustible, and is useful to the individual who is willing to experiment with entirely new sounds. As a class of modules, the Wave Multipliers provide what has too often been lacking in electric music: a means of generating sounds as complex and dynamically variable as those found in acoustic sound sources. Yet these are also precision modules which respond accurately to control voltage, so they may be used to give repeatable results in the most exacting analog or digital applications.

TYPICAL SYNTHESIZER PATCH

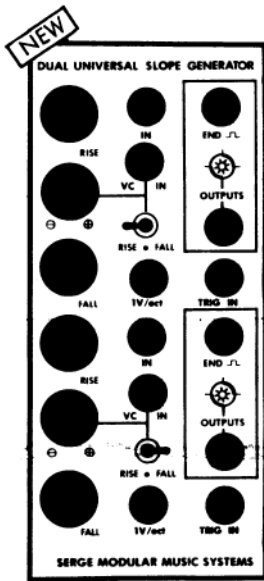


TYPICAL PATCH USING WAVE MULTIPLIER FOR TIMBRAL MODIFICATION/MODULATION



Serge Modular Music Systems

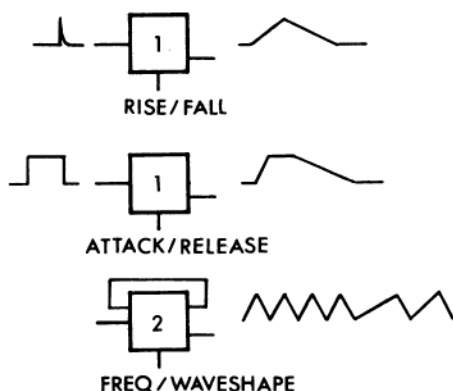
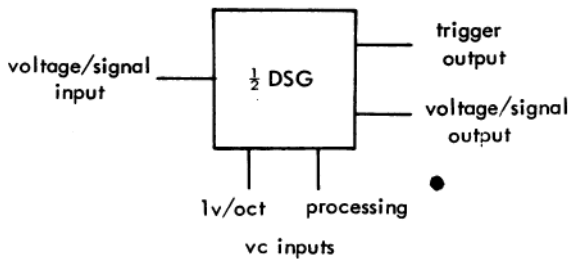
Dual Universal Slope Generator



The DUAL UNIVERSAL SLOPE GENERATOR (DSG) is the ultimate patch programmable control voltage generator in the Serge system. People familiar with our previous series of modules know that we have produced a wide variety of "slewing" modules, each performing specific functions for control voltage generation and processing. These have, for the most part, been replaced by the DSG. Among the modules which have been superseded are the VC Slew Generator, the VC Envelope Generator, the Positive Slew and the Negative Slew. The Universal Slope Generators are slew limited unity gain voltage followers whose positive and negative slewing rates are voltage controllable in an exponential manner. The range is very wide, covering sub-sonic to high audio frequency rates. Trigger inputs and pulse outputs are included to extend the use of the slewing amps for use as low frequency oscillators, transient (envelope) generators, and VC variable pulse delay monostable functions. Two VC inputs are provided, one is calibrated at 1 volt per octave ($\pm 3\%$), and the other is fully adjustable in the negative and positive direction. This input can be switched to control either the positive or the negative slope or both. The linearity and accuracy of the slewing amplifiers allows them to be used in the most exacting applications, such as portamento functions. Among the functions which one Slope Generator can be patch-programmed to perform are the following:

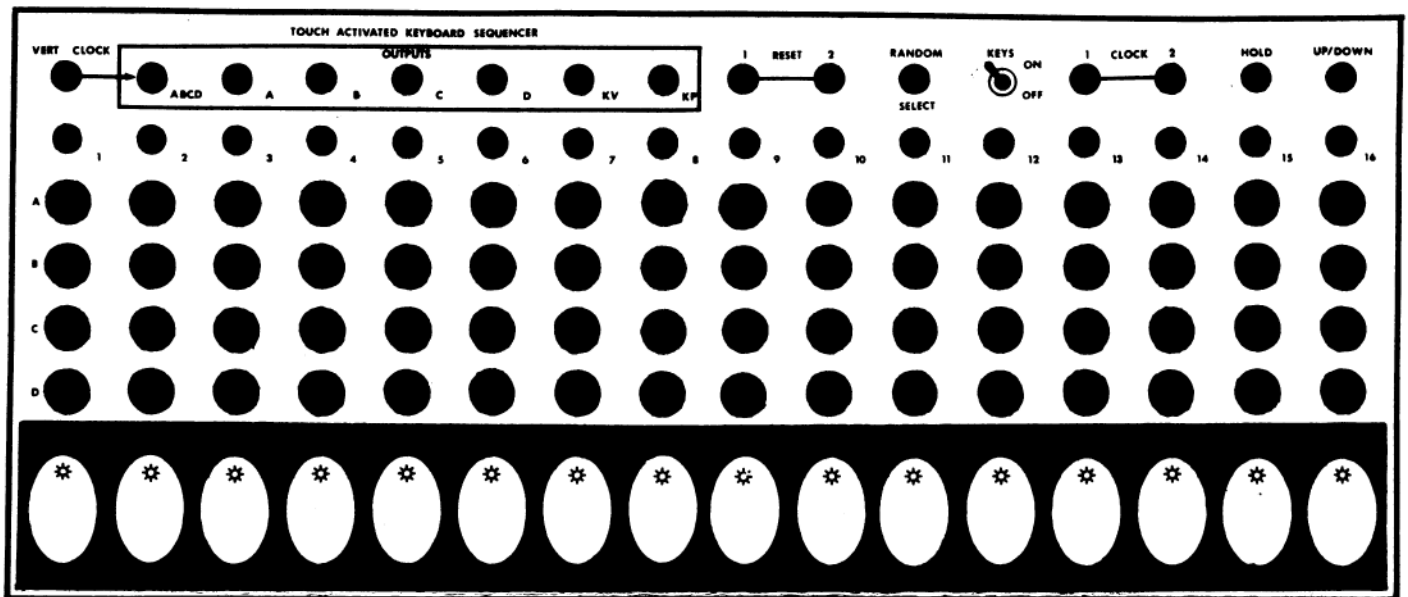
1. VC Transient Envelope Generator. The transient may be simply started with a trigger, or with a gate input, a sustain level can be achieved.
2. VC LFO. The waveform is voltage controllable from saw to triangle.
3. VC Timing Pulse Generator.
4. VC Portamento device. The accuracy of the slew amps makes this portamento function useful for keyboard use and for generating control voltages of arbitrary shapes and times with Digital-to-Analog computer control. This latter use is an extremely economical computer application, since only two voltages are needed to generate any segmented envelope sequence.
5. Envelope Follower (Detector). The decay rate is voltage controllable with the unique function that under voltage control the response may be moved from positive peak to negative peak detection.
6. VC Pulse Delay (Monostable).
7. Sub-Harmonic Series Generator. A trapezoidal waveshape is generated for sonorous, smooth sounds.
8. Audio Generator. The range reaches 4000 Hz and the waveform has variable symmetry (saw to triangle).
9. Non-Linear Low-Pass Filter. The slew limiting is voltage controllable. A sawtooth input will progressively transform to a triangle wave, to full attenuation. Thus a Slope Generator can be used as a low-fidelity VCF.

Block Diagram Representation of $\frac{1}{2}$ Dual Universal Slope Generator



Serge Modular Music Systems

Touch Activated Keyboard Sequencer



The TOUCH ACTIVATED KEYBOARD SEQUENCER (TKB) is an extremely versatile controller, combining the functions of a touch keyboard, a voltage programmer, and a sequencer. As a keyboard-programmer it permits the performer to access up to 16 separate stages of 4 voltage presets and trigger pulses. The touch programmer would be used to change characteristics of a sound or to initiate events instantly in live performance and in the studio. Additionally the keyboard produces a scale of equal-interval voltage "notes" and a common trigger pulse which duplicates the function of a traditional synthesizer keyboard.

As a sequencer this module permits a wide variety of sequencer effects, since the 16 stages can be programmed to go forward and backwards, can be set to provide any desired sequence length (from 2 to 16 stages), and can be triggered to skip among stages in a semi-random pattern. These sequencer functions can be further enhanced using the touch keyboard to interact with the sequencer's actions, so that the sequence length and stage access can be programmed at a touch in real time. In addition, a second four-stage sequencer function is incorporated which sequences vertically through the four rows, making it possible to switch from one sequence row to another and to realise sequences of up to 64 stages.

Specific features include light-emitting diodes on each stage for immediate visual indication of sequence and programmer activity, dual RESET and CLOCK inputs for a wide variety of rhythmic and sequence length effects, a HOLD function which disables sequencing whenever pulsed "high", 6 separate voltage outputs including an output for each row (A,B,C,D), a key actuated voltage (KV), and the vertically sequenced output (ABCD), a key actuated trigger which occurs whenever a key is touched (KP), and sequence activated triggers for each stage. A unique function is the RANDOM SELECT pulse input which randomly selects a stage whenever it receives a reset pulse. A KEYS switch is included to partially disconnect the keyboard function from the sequencer, allowing the keyboard to be used independently.

Serge Modular Music Systems

The POWER SUPPLY (POW) for the Serge synthesizer is a high quality multiple output supply delivering +12, -12, and +6 volts . It is recommended for most uses that the POWER SUPPLY IN CHASSIS BOX (PWB) be ordered. The PWB comes completely assembled with AC line cord, fuse, switch, and terminal block for easy connection to the Panel/Rack power cables. For systems larger than six panels (and for some exceptionally dense systems) a SUPER POWER SUPPLY is needed for the proper power requirements. This supply comes assembled in a chassis box with line cord, fuse, switch and terminal block.

The Panel/Rack (PA) is a two part package consisting of a pre-punched front panel for accomodating all of the Serge modules, and a Rack assembly which holds the printed circuit cards behind the front panel. The P/R includes all hardware, protective Mylar covering, wire, and connectors needed to assemble the finished system. Once completed, the Panel and Rack fasten together to form a sturdy package which can conveniently be mounted into a variety of cases, wood frames, equipment racks, or Chassis Boxes.

The CHASSIS BOX (BOX) provides a compact and extremely rugged means of packaging a Panel/Rack. Boxes are recommended for most systems since they provide protection for the printed circuit modules and offer shielding for sensitive circuitry. Many find that no other case is needed, since the Panels in Chassis Boxes can be quickly plugged into the power supply . Thus, the system can be easily disassembled, and packed into traveling cases for transportation or storage, then quickly re-assembled when needed. Boxes are easily mounted into custom metal or wood cabinets, and the RACK MOUNTABLE CHASSIS BOX (ROX) is available for installation into standard 19" equipment racks.

The PATCHCORD KIT (PAK) consists of 10 banana patch cords of various lengths and color-codes. Extremely flexible, high quality thermoplastic insulated wire is used for reliable, light-weight patchcords. Banana plugs are stackable, eliminating the need for "multiple" connectors.