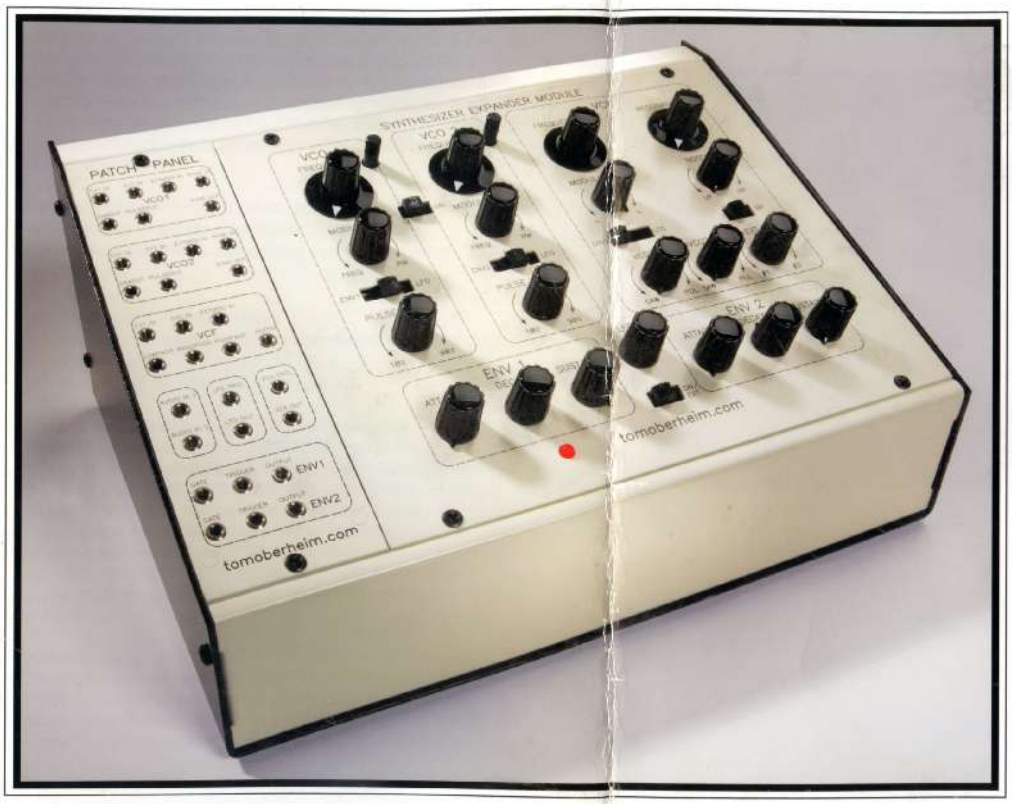


REFERENCE MANUAL

for

tomoberheim

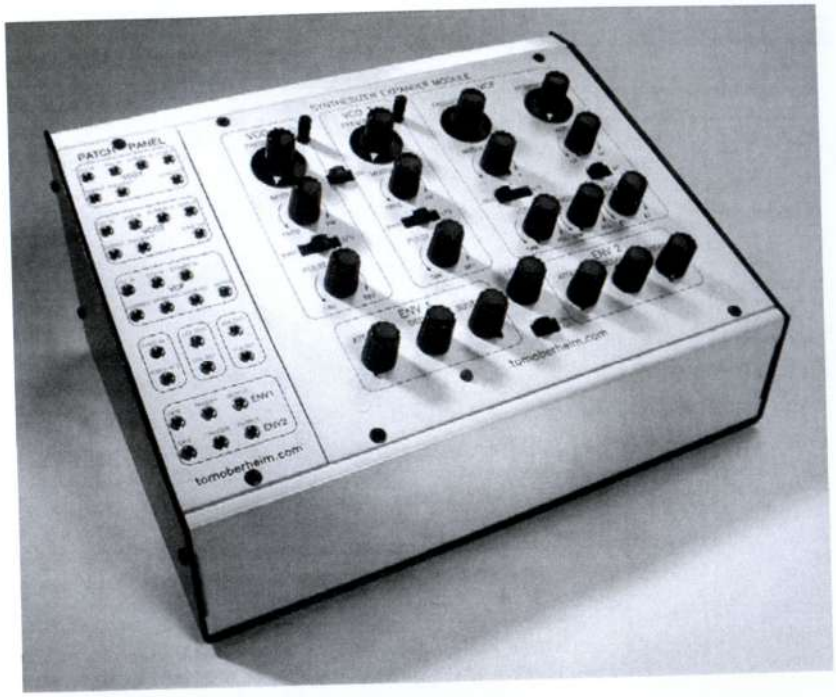
SYNTHESIZER EXPANDER MODULE

"patchpanel" version

Marion Systems Corporation

1480 Moraga Road
Suite i-394
Moraga, CA 94556
(925) 631-9095

www.tomoberheim.com


PATCH PANEL
ENV1
ENV2
tomoberheim.com

Reference Manual

tom oberheim

SYNTHESIZER EXPANDER MODULE

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First Edition
September 2009

MARION SYSTEMS CORPORATION
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INTRODUCTION

The new "tomoberheim" Synthesizer Expander Module (SEM) is a precision electronic music system with a variety of uses. It combines the most often needed circuitry of an electronic music synthesizer in one compact, versatile module. Two voltage controlled oscillators are configured with a four-mode voltage controlled filter, two envelope generators, a low frequency oscillator and a voltage controlled amplifier. The new SEM can be used in the following applications:

- with a keyboard to form a small electronic music synthesizer
- to expand the capability of existing synthesizers at low cost
- with polyphonic keyboards to form multi-voice polyphonic synthesizer systems
- as a precision laboratory signal generation and processing device

The various circuits of the new SEM can be interconnected by potentiometers and switches on the unit's front panel. These interconnections allow many useful synthesizer "patches" to be quickly and easily generated. A multitude of circuit input and output points are available on connectors internal to the unit. Desired patches not possible with front panel controls can often be accomplished by simple wire connections at these internal points. In addition, these internal points can be brought out to external connector jacks and connected to other equipment in a variety of useful ways.

The new SEM can be configured to be compatible with virtually any existing voltage-controlled synthesizer. Normally the unit is constructed at the factory to accept nominal one volt per octave control voltages which is the main industry standard, however other control voltage ranges can be accommodated. The unit has provisions for being easily rewired for most known gate/trigger voltage arrangements by means of internal strapping options.

The new SEM is packaged in a rugged metal case and is self-powered. Oscillator stability is unsurpassed. Due to the unique "piggy-back" printed circuit board construction technique used, the unit is virtually wire free which enhances reliability and serviceability.

FEATURES

- Two voltage controlled oscillators (VCOs) with sawtooth and pulse outputs
- VCO frequency and pulse width can be modulated by either an envelope generator, the low frequency oscillator or from an external source
- VCOs can be phase synchronized
- One two-pole voltage controlled filter (VCF) with lowpass, bandpass, highpass and notch response
- VCF frequency can be modulated in either the positive or negative direction by either an envelope generator, the low frequency oscillator or from an external source
- VCF has an integral three-input mixer allowing combinations of signals from VCO1, VCO2 or either to two external sources
- Two envelope generators with adjustable attack, decay and sustain
- One low frequency oscillator
- All internal circuit inputs and outputs are brought out to jacks on the Patchpanel for interconnection to other equipment
- Can be configured to be compatible with virtually any voltage controlled synthesizer
- Unique packaging technique enhances reliablilty and makes servicing and modifications easy
- Two cascaded regulated power supplies makes unit immune to power line variations
- Operates from any common AC power source: 100 thru 240 volts AC, 50-60Hz

FRONT PANEL CONTROLS

VCO 1 & VCO 2 CONTROLS:

FREQUENCY	Controls initial frequency setting of oscillator; covers about a four octave range
MODULATION	When turned to the left, the selected modulation source modulates the frequency of the oscillator; when turned to the right, the selected modulation source modulates the pulse width of the pulse waveform
ENV-EXT-LFO	Selects modulation source for the MODULATION pot from either an envelope generator, an external source, of the low frequency oscillator
PULSE WIDTH	Controls initial pulse width of the pulse waveform, from 10% to 90% duty cycle
SYNC	When switched 'on', causes VCO 2 to be "hard-sync's to VCO 1

VCF CONTROLS:

FREQUENCY	Controls initial frequency setting of the filter
RESONANCE	When turned to the right, cause peaking action in the filter
MODULATION	When turned to the left, the selected modulation source modulates the frequency of the filter in the negative direction; when turned to the right, the selected modulation source modulates the frequency of the filter in the positive direction
ENV2-EXT-LFO	Selects modulation source for the MODULATION pot from either envelope generator No. 2, an external source, or the low frequency oscillator
LP-NOTCH-HP-BP	When turned all the way to the left selects LOW-PASS filter response; when set at the 12 o'clock position, selects NOTCH filter response; when turned al the way to the right, selects HIGH-PASS filter response

BP	When switched 'on' selects BANDPASS filter response
VCO 1	Filter input mixer pot No. 1; when turned to the left, selects sawtooth waveform from VCO 1; when turned to the right selects pulse waveform from VCO1; when set at the center detent position, turns off VCO 1 as an input to the VCF
VCO 2	Filter input mixer pot No.2; when turned to the left, selects sawtooth waveform from VCO 2; when turned to the right, selects pulse waveform from VCO 2; when set at the center detent position, turns off VCO 2 as an input to the VCF
EXT	Filter input mixer pot No 3; when turned to the left, selects external audio input No. 1; when turned to the right, selects external audio input No 2; when set at the center detent position, turns off the external inputs as inputs to the VCF

ENV 1 & ENV 2 CONTROLS:

ATTACH	When turned to the right, increases attack time of the envelope generator
DECAY	When turned to the right, increases decay time of the envelope generator
SUSTAIN	When turned to the right, increases sustain level of the envelope generator

LFO CONTROLS:

LFO	When turned to the right, increases frequency of the oscillation of the low frequency oscillator

VCA CONTROL:

VCA ON/EXT	When switched 'on', envelope generator control of the VCA is overridden, forcing the VCA to the full amplification state, unless an external VCA Control Input is applied, in which case that signal controls the VCA

INPUT-OUTPUT CONNECTIONS

CONN PIN	FUNCTION	DIRECTION
A1	VCO1 External Modulation	Input
A2	VCO1 Sawtooth Waveform	Output
A3	VCO1 Pulse Waveform	Output
B1	VCO1 Control Voltage #1	Input
B2	Ground	
B3	VCO1 Control Voltage #2	Input
C1	VCO1 SyncOutput	Output
C2	Ground	
C3	VCO1 SyncInput	Input
D1	VCO2 Control Voltage #1	Input
D2	Ground	
D3	VCO2 Control Voltage #2	Input
E1	VCO2 External Modulation	Input
E2	VCO2 Sawtooth Waveform	Output
E3	VCO2 Pulse Waveform	Output
F1	VCO2 Sync Output	Output
F2	VCA Control Input	Input
F3	VCO2 Sync Input	Input
G1	LFO Trigger	Input
G2	Ground	
G3	LFO Waveform	Output
H1	VCF Control Voltage #1	Input
H2	VCF Control Voltage# 2	Input
H3	VCF External Modulation	Input
I1	VCA Output	Output
I2	Ground	
J1	VCF Hi Pass Signal	Output
J2	Ground	
J3	VCF Bandpass Signal	Output

K1	Selected VCF Response	Output
K2	Ground	
K3	VCF Low Pass Signal	Output
L1	External Audio Input #1	Input
L2	Ground	
M1	External Audio Input #2	Input
M2	Ground	
X1	ENV1 Output	Output
X2	ENV1 Gate	Input
X3	ENV1 Trigger	Input
Y1	ENV2 Output	Output
Y2	ENV2 Gate	Input
Y3	ENV2 Trigger	Input

CALIBRATION PROCEDURES

Important: Let the SEM warm up for at least 10 minutes before attemping calibration.

Initial Settings:

- **VCO FREQUENCY** pots fully CCW - **FINETUNE** pots centered
- **SYNC** off
- **VCF FREQUENCY** pot fully CW - **RESONANCE** fully CCW
- **VCF** in **LP** mode - **BP** off
- All **MODULATION** pots in off (center detent) position
- All **MODULATION** switches in **EXT** (center) position
- Both **PULSE WIDTH** pots in center (12 o'clock) position
- All **MIXER** pots in off (center detent) position
- **LFO** pot in center (12 o'clock) position
- **ENV** - CCW, center, CW
- **ENV** - CCW, center, CCW

Pulsewidth Adjustment:

- **VCA** switch on
- **VCO1 MIXER** pot fully on - **PUL**
- Adjust T4 trimmer for minimum overtones
- **VCO2 MIXER** pot fully on - **PUL** (VCO1 MIXER pot off)
- Adjust T8 trimmer for minimum overtones
- **VCA** switch off

VCO1 Initial Frequency and Volts/Octave Adjustments:

- Apply +3.000 volt control voltage to VCO1 Volts/Octave input
- Observe VCO1 frequency and adjust T1 trimmer for 261.6 Hz
- Apply 0.000 volt control voltage and adjust T2 trimmer for 32.7 Hz
- Repeat two or three times as necessary

VCO2 Initial Frequency and Volts/Octave Adjustments:

- Apply +3.000 volt control voltage to VCO2 Volts/Octave input
- Observe VCO2 frequency and adjust T5 trimmer for 261.6 Hz
- Apply 0.000 volt control voltage and adjust T6 trimmer for 32.7 Hz
- Repeat two or three times as necessary

VCF Adjustments:

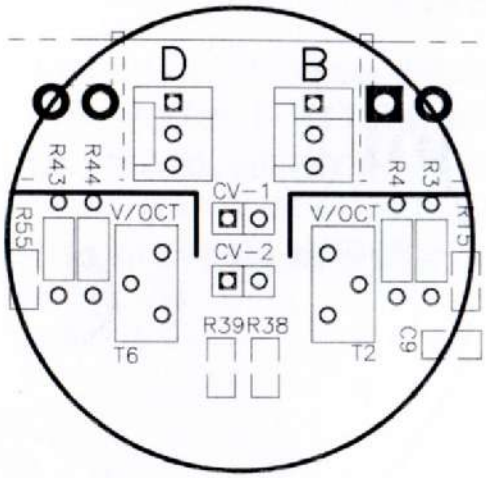
- All **MIXER** pots in off (center detent) position
- Observe connector pin Q5 and adjust T9 trimmer for zero volts
- Observe connector pin Q2 and adjust T10 trimmer for zero volts
- **VCO1 FREQUENCY** and **VCF FREQUENCY** pot fully CCW - **RESONANCE** pot fully CW
- **VCO1 SAW MIXER** pot on
- Jumper keyboard control voltage Volts/Octave to H1
- Apply +1.000 volt control voltage
- Adjust T11 to maximize the fundamental of the input sawtooth wave

VCA Adjustment:

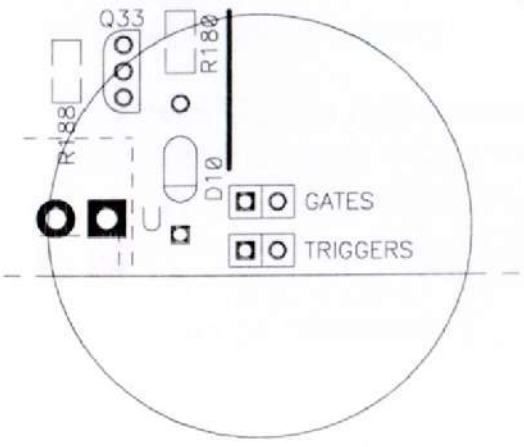
- All **MIXER** pots in off (center detent) position
- Observe output IA1
- Apply gate signal and adjust T13 for minimum offset due to gating

STRAPPING OPTIONS

There are separate Volts per Octave inputs to both VCOs but for convenience these inputs can be connected together using small shorting bars. Applying a shorting bar to the "CV-1" connector connects together the VCO 1 and VCO 2 Control Voltage #1, and applying a shorting bar to the "CV-2" connector connects together the VCO 1 and VCO 2 Control Voltage #2.



Similarly, there are separate Gate and Trigger inputs to both envelope generators but for convenience these inputs can be connected together again using small shorting bars. Applying a shorting bar to the "GATES" connector connects together the Gate signal to both envelope generators and applying a shorting bar to the "TRIGGERS" connector connects together the Trigger signal to both envelope generators.



HISTORY OF THE SEM

By the fall of 1971 I was set up as an ARP dealer in a store front in Santa Monica where I was building Maestro Phase Shifters. With my first ARP 2600 in hand, I set out to learn about analog synthesis. I systematically began learning every part of the 2600, and after a few weeks knew it backwards and forwards. It was one of the best times of my technical life as a completely new area of electronics was opened up to me. Things like the basic patch, a big, fat three-oscillators drone that sounded like a fleet of B-29s, filter sweeps, keyboard control voltage reversal, sample and hold tricks with noise and different oscillator mixes, on and on. The 2600 was such a great design that I still admire Alan Pearlman's handiwork to this day.

As my experience with the ARP 2600 increased, I became interested in building my own sequencer. I was familiar with the power of sequencers from seeing them in action at Paul Beaver's studio and also at the UCLA electronic music lab. Those sequencers were the classic modular Moog and Buchla totally analog types, but I started thinking about how digital circuitry could be incorporated. I was aware at the time of the growing field of semiconductor memory, so I decided to design a more practical system that combined digital logic with one of these new memory chips.

The result was the DS-2 Digital Sequencer that interfaced to either an ARP 2600 or Odyssey, or a MiniMoog, and allowed the user to load the sequence, both notes and timing, by simply playing the sequence on the synthesizer keyboard. The first version, called the DS-2, had one Intel 2102 memory chip, which contained 1024 bits (not bytes) and cost about $25! Later the cost of this chip came down to about $15 and I added a second chip which doubled the number of notes, and I changed the name to DS-2A. The first units were delivered in August of 1973. The device was in the Oberheim product line for three or four years and I think about 200 units were eventually sold.

The DS-2 sequencer was an interesting and useful device, but it created a perplexing problem. After the sequencer was loaded with a sequence and the sequence played back, the synthesizer

player was left with no synthesizer to play! (At this time, most synth players had only one synthesizer) This predicament gave me the idea to design a minimal synthesizer module that the DS-2 could play while the synthesizer musician is playing the main synthesizer. I was selling the ARP Odyssey at that time so I was very familiar with the concept of a minimal synthesizer. So in late 1973 I used my knowledge of the Odyssey and of my MiniMoog and conceived what I thought would be the absolute minimum synthesizer voice.

The design concept for the module, soon to be called the Synthesizer Expander Module (SEM-1), included:

- basic circuits for a true analog synthesizer voice
- low cost
- small size
- patchable (to some extent)
- two-pole, multi-mode filter to complement the standard four-pole filter
- simple but flexible user interface

At the time, my thoughts were that getting seriously into the synthesizer business, even in 1973/1974, was a major undertaking. But by starting out making just the SEM-1, without all the other complications that are part of making a complete keyboard synthesizer, the process was made easier. The plan was simply that the SEM-1 would be an accessory product to be used with a synthesizer made by some other company (ARP, Moog, etc.) And, to that end, I purposely built the voice around a two-pole, multi-mode filter as a complement to the standard four-pole filter.

The overall design of the SEM-1 was done by Jim Cooper (of JLCooper fame) and myself. I came up with the feature set and user interface, and Jim designed much of the circuitry. In addition, Dave Rossum of E-Mu systems helped with the VCO design and Dennis Colin of ARP designed the multimode filter.

Little did I realize at the time how critical the SEM-1 would be to the later success of Oberheim when in 1975 I utilized the SEM-1 to create the Oberheim 2-Voice and 4-Voice synthesizers.