APPENDIX NUMBER ONE

USING EXTERNAL SOUND SOURCES

The Serge Synthesizer can use any sound as an audio signal so long as it has been converted to a varying voltage of the appropriate level. These can be sounds of people talking, instruments playing, airplanes overhead, dogs barking, hummingbirds humming. The Serge can mix, filter, ring modulate, amplitude modulate, and waveshape these sounds. It can also put new envelopes on these sounds or extract envelopes from them to use elsewhere. It can use these signals to frequency modulate oscillators and, with a comparator, check for amplitude peaks to trigger anything from the TKB to envelope generators.

The Serge system has high impedance, line level inputs. This kind of input allows one module to control many other modules without losing accuracy, and is almost impervious to electrical damage. Most Control Voltage inputs are from 50K to 200K ohms. Audio inputs are from 22K to 100K.

Sound sources fall into two broad categories of impedance and voltage level. Line level, high impedance signals, which can be used directly in the Serge and low impedance, low voltage signals which must be pre-amplified before using.

Line level sources include tape recorder outputs, headphone outputs and the Line or Aux output of mixers and pre-amplifiers. There are a few microphones which are also line level, but these are not common.

Low level sources include almost all microphones, instrument pick-ups and record player cartridges. All three of these sound sources must be pre-amplified before they can be used on the Serge.

Available Pre-Amplifiers:

1. The Serge instrument and microphone pre-amplifier.

2. Most portable and studio mixers have microphone and instrument inputs and line level outputs. Often these mixers can also accept line level signals and provide the user with a switch to choose between the inputs.

3. Component stereo systems have pre-amplified outputs and turntable inputs. The line level output may be labelled TAPE OUT, LINE OUT or AUX OUT. This is the most common way to pre-amplify a record.

4. Most tape recorders have a microphone input which will pre-amplify the microphone. The signal can then be taped, and when played back, used directly. Or, the tape recorder can be switched to SOURCE and the input, or source, will appear pre-amplified directly at the output.

5. Small, moderate quality pre-amplifiers can be purchased at electronic stores.

6. Electric guitars and other instruments with pick-ups need to be pre-amplified. Most stage type amplifier "heads" have a LINE OUT which can be used directly to the Serge. Otherwise, small instrument pre-amps are required.

APPENDIX NUMBER TWO

SENDING SERGE SIGNALS OUT

The output levels of all Serge Modules are line level signals and can be sent directly to the LINE, or AUX in of any electronic sound device including pre-amps, amps and mixers. These levels are also appropriate for sending signals to such devices as Reverb units or graphic equalizers. The output impedance of most Serge modules is about 300 ohms.

For tape recording purposes the Serge signal can be sent directly to the Line Inputs of a tape recorder, or to the Line level input of a mixer and then to a tape recorder.

Auxiliary mini-jack inputs and outputs can be found on most Serge mixers and should be used to inter-connect to other equipment to prevent hum, crosstalk and static.

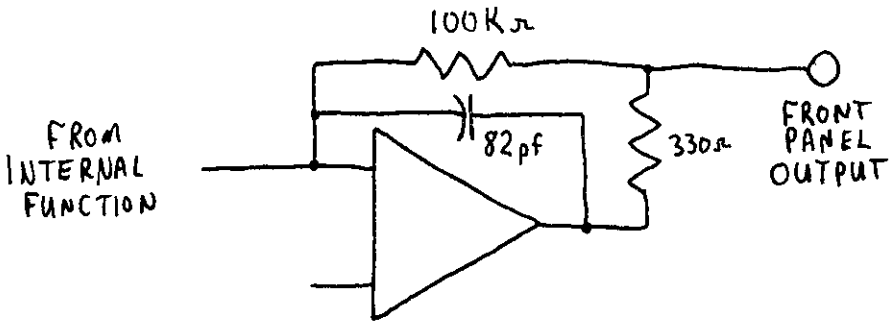
Some inputs and outputs of external devices have "balanced" lines with two signal lines and one ground line. Typically these lines use Cannon Connectors. Many microphones have balanced lines which permit much longer cables to be used before hum becomes noticeable. These lines must be unbalanced before being connected to mini-jacks, unbalanced phone jacks or RCA jacks on the Serge. There are three ways of unbalancing a balanced line.

1. Connecting one of the hot lines to ground.

2. Using a balanced-in, grounded-out transformer.

3. Using a mixer that balances and unblances signals.

To send Serge or Line level signals any distance it is a good idea to use shielded wire. To send low level signals long distances it is advisable to use balanced line. Because it is possible to send low impedance signals extremely far (say 1000 feet) without hum building up, it is often wise when sending line level signals such distances, to use a transformer to convert it to a low impedance balanced signal, with a second transformer at the far end of the line reconverting it back to an unbalanced signal.



TYPICAL OUTPUT BUFFER ON SERGE MODULES

APPENDIX NUMBER THREE

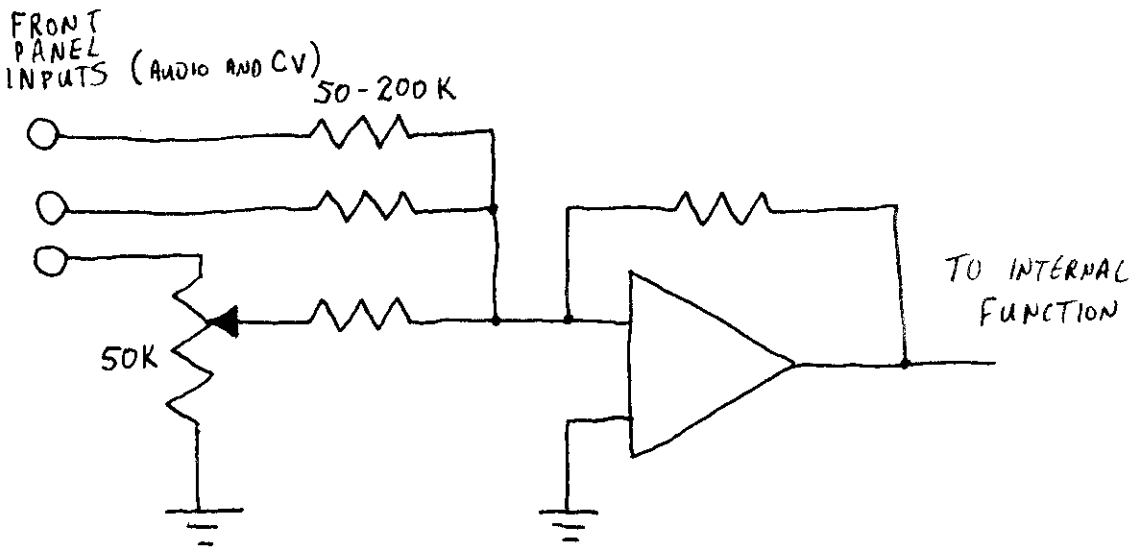
EXTERNAL CONTROL VOLTAGES

Almost all control voltage sources on the Serge such as the envelope generators, the TKB, the Random Control Voltage sources and the non-Sine wave oscillator outputs have a voltage range of about 0 to 5 volts. Using the Processor Module or Processing Inputs this range can be effectly increased to -10 to +10 volts. The great majority of Serge VC inputs respond to voltages in this range, though some only respond to positive voltages. These VC inputs can accept voltages in this range from ANY source including other synthesizers, home built circuits, foot pedals and/or voltage-out keyboard units. In fact, because of the extremely high impedance of the inputs on the Serge, DC voltages greater than 12 volts (up to 25 volts) can be used without damage to the Serge, though this will generally drive the module out of its effective range.

Voltages that are too low can be amplified slightly by using a Processor module and sending the voltage to all three inputs. (This technique also works with audio voltages using either a processor or mixer).

All Frequency dependent modules have VC inputs which operate on a 1 volt to 1 octave ratio. Other voltages that are not of this range can be scaled using Processor Modules or the processing inputs on the modules and then "tuned" by ear.

There are some synthesizers on the market that have exponential control voltages with linearly responding modules. The Serge, and most synthesizers, operate in the opposite fashion. Because of these differences, control voltage generators such as keyboards and sequencers from these other synthesizers cannot be used with the Serge in a meaningful manner.



TYPICAL INPUT NETWORK ON SERGE MODULES

APPENDIX NUMBER FOUR

COMPUTER INTERFACING

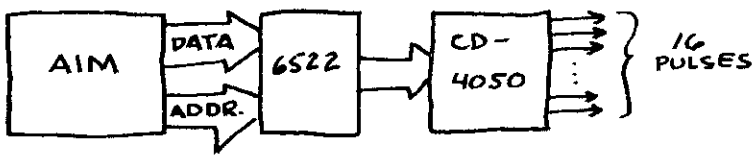
Connecting the Serge system to a small computer requires suitable buffers to prevent the higher voltages of the synthesizer from being applied directly to the computer or its associated circuitry. Most micro-computers have a single +5 volt power supply, and if negative voltages or voltages greater than +5 are received, permanent damage to the computer might result. It is therefore advisable that you be fairly confident of your technical abilities before attemping such an interface. A wide variety of books and magazines is available on computer/synthesizer interface which provide detailed schematics and procedures (see bibliography). There are commercially available interface boards and cards which incorporate these safeguards.

An inexpensive home computer such as the AIM, APPLE, KIM, SYM, RADIO SHACK or OSI is a perfect complement to the Serge System, expanding the possibilities of both. The following list of possible interfaces gives an overview of the most common applications of small computers with the Serge synthesizer.

TRIGGER GENERATOR:

Triggers for the Serge are easy to generate with a computer since they are voltages of only two levels: HI (+5 volts) and LOW (0 volts). These are the values used to represent "1" and "0" on almost all computer hardware. A HI voltage is able to open a VCA fully and sustain any sustainable function on the Serge.

The following schematic is of a simple circuit that will provide up to eight programmable pulses to the Serge. It uses a 6522 Programmable Interface Adaptor which can be used with all 6502 microprocessor-based systems such as the APPLE, KIM, SYM and AIM (and is in fact included on the board of many of these systems.) Note that this circuit uses a CD4050 buffer to protect the 6522 and 6502 from any inadvertent damage from the higher voltages of the synthesizer.



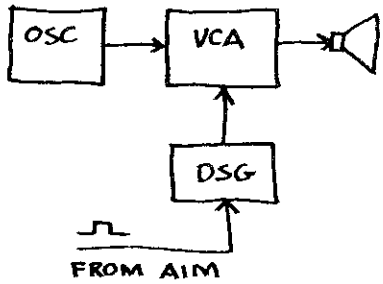
To turn on one output you can use the following 6502 Assembly Language routine:

```
LDA MASK
ORA PORT
STA PORT
```

where PORT is the address of the 6522 port; MASK is an 8-bit word which has one of its bits set to a digital "1" or high value and the rest set to "0". To turn the same output off:

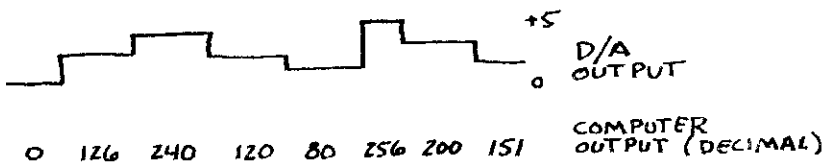
```
LDA MASK
EOR $FF
AND PORT
STA PORT
```

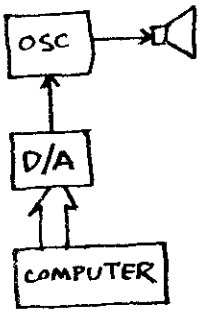
For one of these pulse outs to trigger a Serge device it must rise from a LO level to a HI level (since the Serge is rising-edge-triggered). To trigger an envelope generator repeatedly, the pulse out must return to a "0" level first.



CONTROL VOLTAGES:

A Digital-to-Analog converter is a device that takes a digital number, and converts that number into a voltage level. A sequence of numbers from the computer to a D/A will result in a series of voltages.

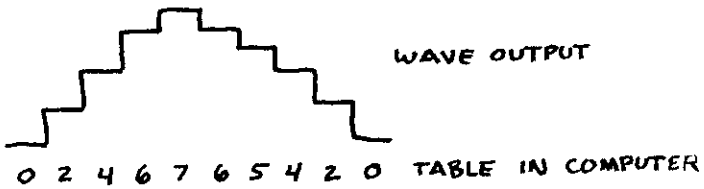




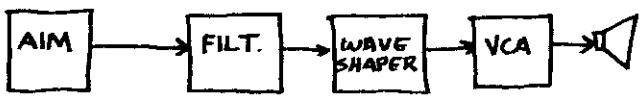
A D/A that can convert numbers from 0 to 255 into a voltage is fairly inexpensive. Such a D-to-A is perfect for creating presets and doing some kinds of voltage control. A D/A that can accurately control the frequency of an oscillator generally requires greater precision and is somewhat more costly. In "computer time" most of the control voltages that a synthesizer sequencer or envelope generator might produce are very slow, thus a computer, with the appropriate hardware, can handle many channels of control voltages.

AUDIO VOLTAGES:

It is possible for a computer, using a D/A converter to output actual waveforms. Usually such a waveform is stored in a table and "read" out to the D/A. The computer can manipulate these waveforms in certain interesting ways, but in general, the programmer/synthesist will be up against the speed of the computer. With 8-bit computers it is still fairly hard to duplicate the timbral possiblities of the filters, waveshapers, and modulators of the synthesizer, especially if these are to change in fast, musically useful ways.



It is fairly easy to produce square waves using a one-bit output of the computer and to control its frequency accurately. This pulse wave can then be "timbre" modified by the synthesizer. The Serge system makes a perfect companion for such digital waveform generation. These waveforms almost invariably need filtering and can be further modulated using Wave-Multipliers and VCAs. These constructed waves can be mixed with analog waves.

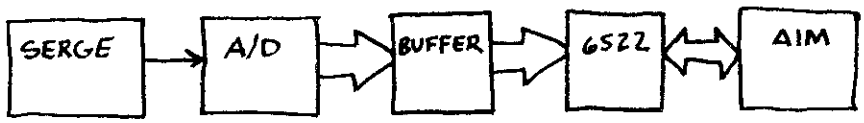


PULSE CONTROL OF COMPUTER:

In much the same way that the computer sends a pulse to the synthesizer, the synthesizer can send a pulse to the computer. This pulse can tell the computer that some effect has commenced or that one is over. Knowing this, the computer can then respond in some appropriate way. The computer can "see" the pulse in one of two ways: The pulse can interrupt the computer, sending it to a new program; or, the computer can continually "poll" the bit , acting only when it finds a pulse there.

ANALOG TO DIGITAL CONVERSION:

The functional opposite of a Digital to Analog converter is an Analog to Digital converter which inputs an analog voltage and outputs a series of numbers that corresponds to the input voltage.



Using an A/D converter any control voltage can be converted into a series of numbers and stored in the computer. This table then can be altered and read back out to the Serge. If the A/D converter is fast enough it is possible to "read" audio waveforms which can then be manipulated and sent back to the Serge using a D/A converter.