Oakley Sound Systems

5U Oakley Modular Series

Slim VCO A

SVCO PCB Issue 1 & 1.1

Builder's Guide

V1.1.2

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Introduction

This is the Project Builder's Guide for the issues 1 and 1.1 Slim Voltage Controlled Oscillator variant A (SVCO-A) 5U module from Oakley Sound. This document contains a basic introduction to the board, a full parts list for the components needed to populate the board or boards, and a list of the various interconnections.

For the User Manual, which contains an overview of the operation of the unit and the calibration procedure, please visit the main project webpage at:

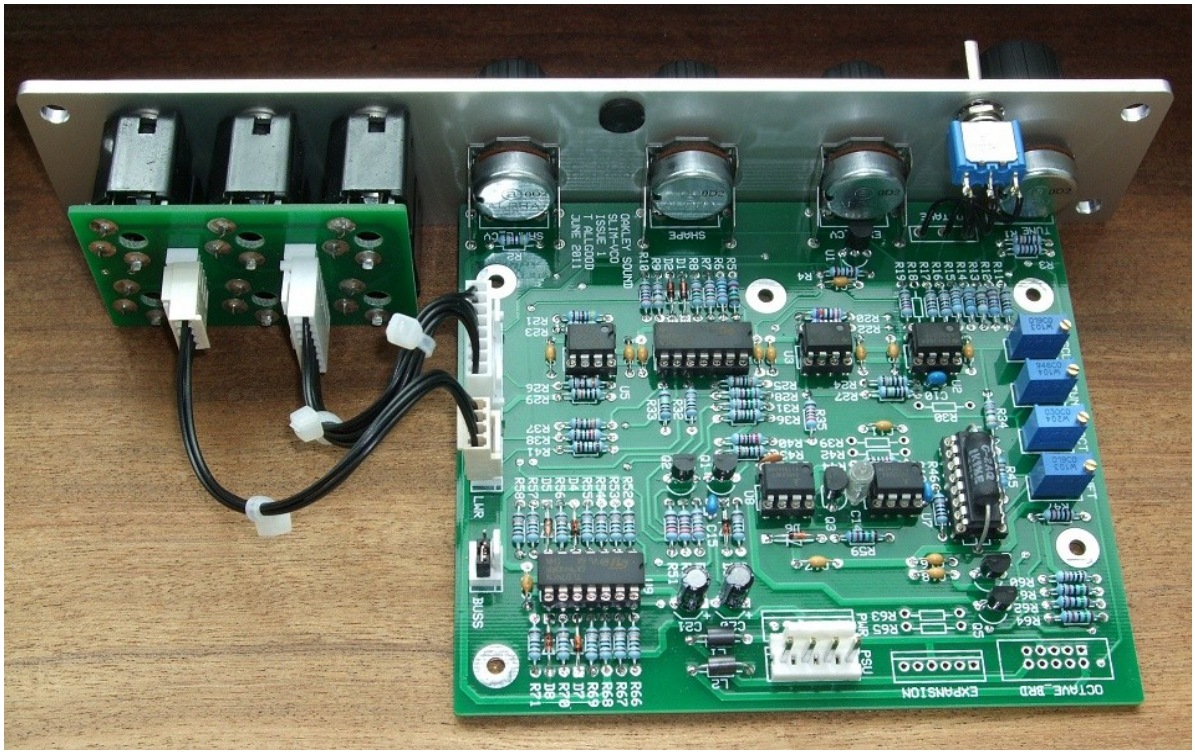
http://www.oakleysound.com/s-vco.htm

Also on the SVCO webpage is all the documentation for the SVCO-B variant. The B version is identical to the A version but with an additional wide range octave electronic switch.

For general information regarding where to get parts and suggested part numbers please see our useful Parts Guide at the project webpage or http://www.oakleysound.com/parts.pdf.

For general information on how to build our modules, including circuit board population, mounting front panel components and making up board interconnects please see our generic Construction Guide at the project webpage or http://www.oakleysound.com/construct.pdf.

The Issue 1 SVCO PCB



This is the prototype issue 1 Oakley SVCO-A module behind a natural finish 1U wide Schaeffer panel. Note the use of the optional Sock6 socket board to facilitate the wiring up of the six sockets. Ignore the black blanking plug to the left of the shape pot.

On the SVCO printed circuit board I have provided space for the four main control pots. If you use the specified 16mm Alpha pots and matching brackets, the PCB can be held very firmly to the panel without any additional mounting procedures. The pot spacing on this board is different to many of our other 5U modules, instead of 1.625” it is 1.375”. Used in conjunction with smaller 20mm diameter knobs this still allows for an attractive module design and finger friendly tweaking.

The design requires plus and minus 15V supplies. The power supply should be adequately regulated. The current consumption is about +40mA and -35mA. Power is routed onto the main PCB by either our standard four way 0.156” MTA156 type connector or the special five way Synthesizers.com MTA100 header. The four pins are +15V, ground, earth/panel ground, -15V. The earth/panel connection allows you to connect the metal front panel to the power supply’s ground without it sharing the modules’ ground line. More about this later.

The main PCB has four mounting holes for M3 bolts, one near each corner. These are not required for panel mounting if you are using the three 16mm pot brackets. The board size is 109mm (deep) x 123mm (high).

The main board has been laid out to accept connection to our Sock6 socket board. This small board speeds up the wiring of the six sockets and reduces the chances of building mistakes.

SVCO-A issue 1 and 1.1 Parts List

For general information regarding where to get parts and suggested part numbers please see our useful Parts Guide at the project web page or http://www.oakleysound.com/parts.pdf.

Note that this is the parts list for the SVCO-A and not the SVCO-B. The B version has its own Builder's Guide and this should be used if you are building the B version.

The components are grouped into values, the order of the component names is of no particular consequence.

A quick note on European part descriptions. R is shorthand for ohm. K is shorthand for kilo-ohm. R is shorthand for ohm. So 22R is 22 ohm, 1K5 is 1,500 ohms or 1.5 kilohms. For capacitors: 1uF = one microfarad = 1000nF = one thousand nanofarad.

To prevent loss of the small '.' as the decimal point, a convention of inserting the unit in its place is used. eg. 4R7 is a 4.7 ohm, 4K7 is a 4700 ohm resistor, 6n8 is a 6.8 nF capacitor.

Resistors

1% 0.25W or 0.4W metal film resistors are recommended. R20 and R22 should be 0.1% 0.25W metal film.

Not all resistor spaces are filled up. These are for use with the expansion port. For the standard SVCO-A module R18, R30, R39, R42, R63 and R65 should be left empty.

On issue 1.1 PCBs there is also a position R0. However, this too should be left empty as it is only used when building the SVCO-B variant.

1K	R41, R4
2K2	R38
3K6	R37
4K7	R44
7K5	R6
9K1	R3
10K	R32, R60, R46, R47
15K	R5, R64, R62, R59, R61
22K	R19, R35, R40, R50, R51
22K/0.1%	R22, R20
27K	R10
30K	R7
39K	R26, R9, R34
47K	R2, R21, R23, R43
68K	R15
75K	R8, R31, R28
100K	R71, R16, R68, R29, R48, R24, R57, R69, R55, R67, R66, R58, R54, R52, R53, R56, R70, R17, R1, R11

150K	R36
220K	R49
300K	R25
680K	R14
910K	R13
1M	R27, R33, R45

Oakley/MOTM systems:

120K	R12

Synthesizers.com systems:

180K	R12

1K 1% KRL temp co	PTC (mounted on top and in contact with U6)

Capacitors

100nF axial ceramic	C16, C4, C6, C1, C8, C7, C5, C18, C3, C11, C19, C9, C17, C2
4p7 C0G 2.5mm ceramic	C12
100pF C0G 2.5mm ceramic	C15
150pF C0G 2.5mm ceramic	C13
470pF C0G 2.5mm ceramic	C10
1nF C0G 2.5mm ceramic	C14*
4u7, 35V electrolytic	C20, C21

* Alternatively 50V or 63V radial polystyrene can be used but these tend to be much larger devices so do check that it will fit.

Discrete Semiconductors

1N4148 signal diode	D3, D4, D5, D6, D7, D8
5V6 zener diode	D1, D2
2SK30A-GR Japanese JFET	Q3
BC550 NPN small signal transistor	Q1, Q2, Q4
BC560 PNP small signal transistor	Q5

Integrated Circuits

CA3083 NPN array	U6
CA3130EZ single MOSFET op-amp	U7, U8
TL072CN dual FET op-amp	U5
TL074CN quad FET op-amp	U4, U9
LM4040DIZ-10.0 10V reference	U1*

LT1013CP dual precision op-amp U2, U3

* The LM4040CIZ-10.0 is also suitable.

IC sockets are to be recommended. You need five 8-pin, two 14-pin and one 16-pin DIL socket.

Trimmers (preset) resistors

All are multiturn cermet types.

10K	HFT, SCL
100K	TUN
200K	OCT

Potentiometers (Pots)

All pots Alpha 16mm PCB mounted types

47K or 50K linear	TUNE, EXPO_CV, SHAPE, SAHPE_CV

Three 16mm pot brackets.

Switch

One single pole ON-OFF-ON toggle switch is required for the octave selection. Mounted on panel and wired to the board with fly wires – see later for details.

Miscellaneous

Leaded axial ferrite beads	L1, L2	
MTA156 4 way header	PSU	– Oakley/MOTM power supply
MTA100 6-way header	PWR	– Synthesizers.com power supply
Molex/MTA 0.1” header 3-way	BUSS	– for connecting to Oakley CV/gate buss
Molex/MTA 0.1” header 8-way	UPR	– for connecting to sockets
Molex/MTA 0.1” housing 8-way	UPR	– for connecting to sockets
Molex/MTA 0.1” header 4-way	LWR	– for connecting to sockets
Molex/MTA 0.1” housing 4-way	LWR	– for connecting to sockets

If not connecting to the Oakley Buss then you will also need a 0.1” jumper to short out pins 1 and 2 on the BUSS header. If you are going to be using the Oakley Buss you will need the

usual 3-way KK/MTA housings for your connecting cable. See section on the Oakley Buss in the User Manual for the SVCO.

Other Parts Required

Switchcraft 112APC 1/4” sockets Six off mounted either on the Sock6 board or on panel

One 27mm knobs and three 20mm knobs.

A small amount of thermally conducting paste can be useful to help bond the PTC and U6 together.

Around 2m of insulated multistrand hook up wire for the switch and socket connections.

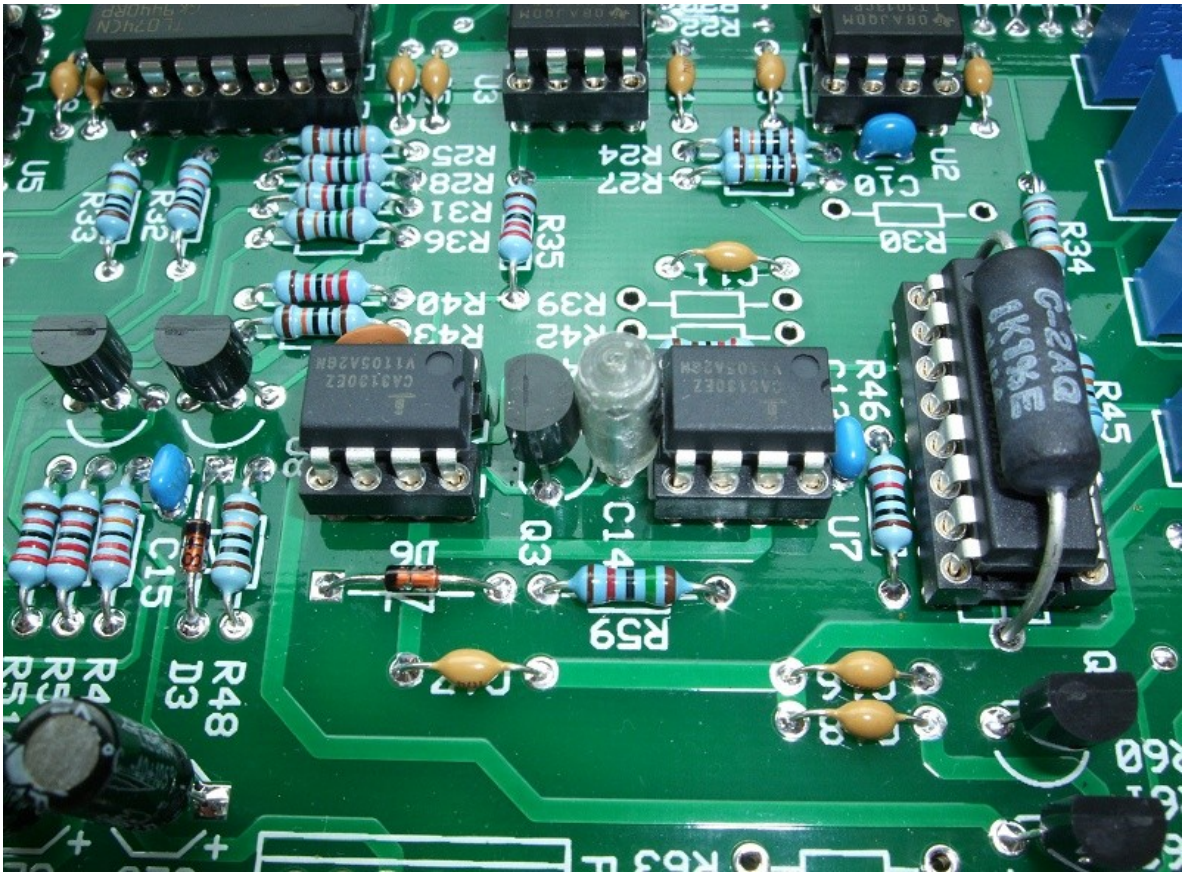
Components required if using optional Sock6 board

Molex/MTA 0.1” header 8-way	UPR
Molex/MTA 0.1” housing 8-way	UPR
Molex/MTA 0.1” header 4-way	LWR
Molex/MTA 0.1” housing 4-way	LWR
112APC Switchcraft 1/4” socket	SK1, SK2, SK3, SK4, SK5, SK6

L1 on the Sock6 PCB is not to be fitted.

If using Molex KK you'll also need at least 24 crimp terminals.

Suitable lengths of wire to make up the two interconnects and four cable ties.



A close up of the VCO core in the SVCO. Note the positioning of the positive temperature coefficient (PTC) resistor. The PTC straddles U6 and a small amount of thermal paste can be used to keep them both at the same temperature.

Note also C14. In this prototype I have used a radial polystyrene capacitor. Although this one fits just fine a much smaller C0G ceramic capacitor would have been neater.

Connections

Power connections – MOTM and Oakley

The PSU power socket is 0.156” Molex/MTA 4-way header. Friction lock types are recommended. This system is compatible with MOTM systems.

Power	***Pin number***
+15V	1
Module GND	2
Earth/PAN	3
-15V	4

Pin 1 on the I/O header has been provided to allow the ground tags of the jack sockets to be connected to the powers supply ground without using the module’s 0V supply. Earth loops cannot occur through patch leads this way, although screening is maintained. Of course, this can only work if all your modules follow this principle.

It's worth filling the empty holes of the PWR pads with solder.

Power connections – Synthesizers.com

The PWR power socket is to be fitted if you are using the module with a Synthesizers.com system. In this case you should not fit the PSU header. The PWR header is a six way 0.1” MTA, but with the pin that is in location 2 removed. In this way location 3 is actually pin 2 on my schematic, location 4 is actually pin 5 and so on.

Power	***Location number***	***Schematic Pin number***
+15V	1	1
Missing Pin	2	
+5V	3	2
Module GND	4	3
-15V	5	4
Not connected	6	5

+5V is not used on this module, so location 3 (pin 2) is not actually connected to anything on the PCB.

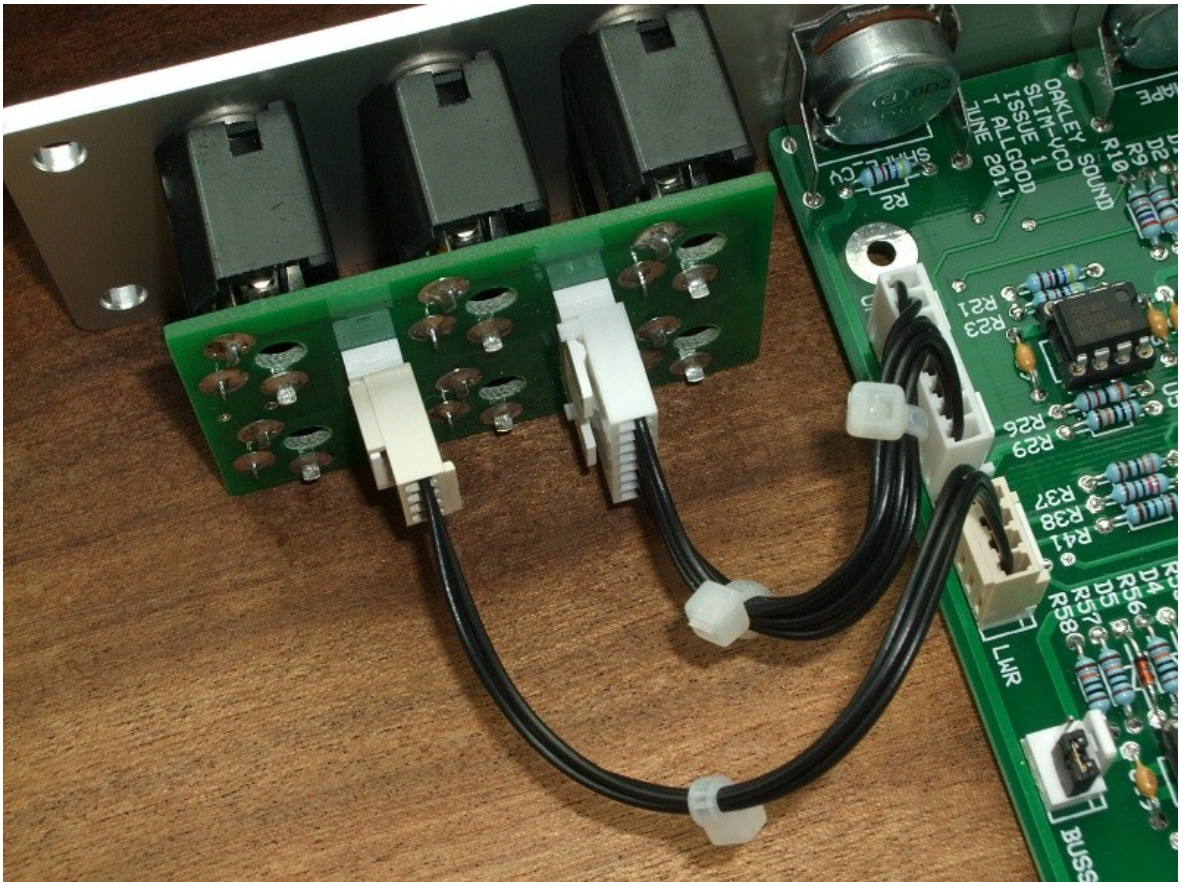
If fitting the PWR header, you will also need to link out pins 2 and 3 of PSU. This connects the panel ground with the module ground. Simply solder a solid wire hoop made from a resistor lead clipping to join the middle two pads of PSU together.

Building the SVCO-A module using the Sock6 board

This is the simplest way of connecting all the sockets to the main board. The Sock6 board should be populated in the way described in our construction guide found on the project webpage. There are only two headers, UPR (for upper) which is eight way, and LWR (for lower) which is four way. Both headers are fitted to the bottom side of the board.

The wire link L1 should not be fitted to the Sock6 board.

You need to make up two interconnects. The eight way one should be made so that it is 95mm long. The four way should be made to be 110mm.



The SVCO-A prototype module showing the detail of the board to board interconnect. Here I have used the Molex KK 0.1" system to connect the Sock6 to the main PCB.

Note also the black jumper on pins 1 and 2 of the BUSS connector. This shorts out the 1V/octave input to ground when no jack plug is inserted thus reducing unwanted noise pick up.

Hand wiring the sockets

If you have bought Switchcraft 112A sockets you will see that they have three connections. One is the earth or ground tag. One is the signal tag which will be connected to the tip of the jack plug when it is inserted. The third tag is the normalised tag, or NC (normally closed) tag. The NC tag is internally connected to the signal tag when a jack is not connected. This connection is automatically broken when you insert a jack.

Once fitted to the front panel the ground tags of each socket can be all connected together with solid wire. I use 0.91mm diameter tinned copper wire for this job. It is nice and stiff, so retains its shape. A single piece of insulated wire can then be used to connect those connected earth tags to pin 1 of LWR. Pin 1 is the square solder pad.

All the other connections are connected to the signal or NC lugs of the sockets. The tables below show the connections you need to make:

UPR

Pin	*Pad name*	*Socket*	*Lug Type*
Pin 1	Module ground	CV IN	NC
Pin 2	CV1_IN	CV IN	Signal
Pin 3	Module ground	SHAPE CV	NC
Pin 4	SHAPE_CV	SHAPE CV	Signal
Pin 5	Module ground	SYNC	NC
Pin 6	SYNC_IN	SYNC	Signal
Pin 7	BUSS-CV	1V/OCT	NC
Pin 8	KEY CV	1V/OCT	Signal

LWR

Pin	*Pad name*	*Socket*	*Lug Type*
Pin 1	Panel ground	Connects to all sockets	Ground lugs
Pin 2	RAMP_OUT	SAW/TRI	Signal
Pin 3	Not used		
Pin 4	PULSE_OUT	PULSE	Signal

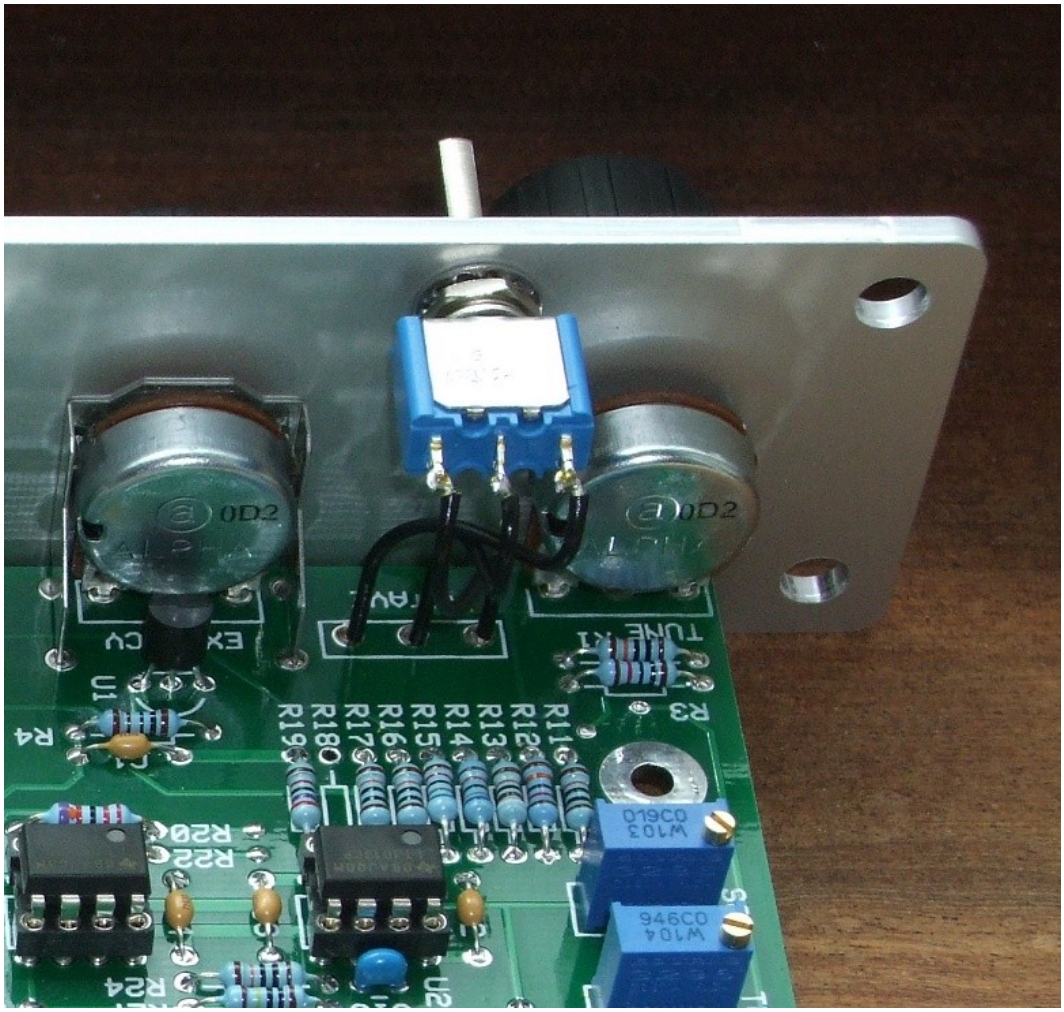
Wiring the Switch

The SVCO-A panel design features a single on-off-on switch mounted just below the tune pot. All three lugs on the switch need to be connected to the SVCO PCB.

Depending on which issue PCB you have the method of wiring the switch will be different.

Issue 1 PCBs only:

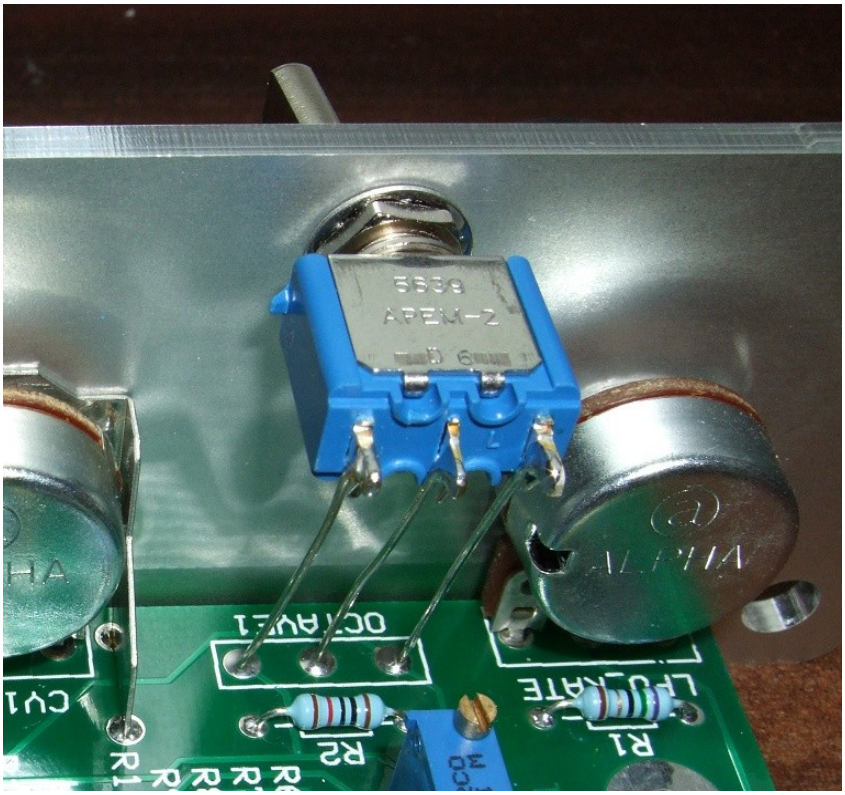
Put the module down on your bench as indicated in the picture above. The module's rear side will be facing you and the circuit board should be sitting flat on your bench. You must wire the switch so that the left hand switch lug goes to the right hand hole on the PCB, the right hand lug goes to the left hand hole, and the middle lug goes to the middle hole. In other words the two end wires must cross each other on their way from the switch to the PCB. You have probably guessed that I laid out the switch connections upside down.



The earlier issue 1 SVCO-A using an APEM single pole 'on-off-on' switch. Make sure the switch and PCB are secured to the panel before soldering the three wires. Issue 1.1 PCBs have been laid out differently to allow each of the switch tangs to be connected to the solder pad directly below it.

Issue 1.1 PCBs only:

You should wire the switch as you would other Oakley modules. I typically use solid core wire rather than insulated multi-strand wire. This keeps the connection firmly in place and very neat. I normally bend the wire at one end into a hook and place the straight end into the PCB pad's hole. I then loop the hooked end around the switch tang and squash the hook into place before soldering it. The solder pad on the board can then be soldered from the underside and the excess wire on snipped off.



This is the switch on a VCO Controller module. The issue 1.1 SVCO PCBs should be wired similarly with the each tang connected to the solder pad directly below it.

Testing the SVCO-A

Apply power to the unit making sure you are applying the power correctly. Check that no device is running hot. Any sign of smoke or strange smells turn off the power immediately and recheck the polarity of the power supply, the two transistors Q4 and Q5, the direction of the ICs in their sockets and the polarity of the electrolytic capacitors.

Now you need to check the outputs of the VCO are working. The module has two outputs, a pulse wave and a sawtooth wave. The pulse wave output should generate rectangular wave shapes that move between approximately -5V and +5V. Check that, with the waveshape pot at its lowest setting, the pulse output is around -5V. Now move the waveshape pot to its maximum setting, the pulse output should now be around +5V.

Now connect the pulse output to your monitoring system. If you haven't built a modular VCO before you should note that the output level is much higher than ordinary audio signals. Turn the waveshape pot to its middle position. You may hear a tone but you may just hear a series of clicks. Make sure that the tune pot controls the pitch of the tone or the repetition rate of the clicks.

Insert a CV from your midi-CV convertor or sequencer. Check that a rising control voltage increases the pitch of the SVCO. It will probably not play in tune yet since it will need proper calibration to do that.

Flick the octave switch into the +1 position. You should hear a sudden increase in frequency. Again it won't be a perfect octave jump but it should be close. Now set the switch to its -1 position. This time the pitch should drop accordingly.

Now unplug the note CV input and plug it into the CV IN socket. Check that the pitch increases when you turn up the CV in pot.

Now listen to the output of the saw/tri output with the note CV connected back into the 1V/OCT again. If you have an oscilloscope then it's worth having a look at the output waveform here. Watch what happens as you turn the waveshape pot from 0% to 100%. The output should move from a rising ramp waveform to a falling sawtooth via a triangle wave in the middle. The sawtooth and ramp waves should go from approximately -5V to +5V and the triangle only -2.5V to +2.5V. As you turn the waveshape pot the sound should change from bright and brassy at either end to a quieter and smoother sound in the middle. Both the saw and ramp waves actually sound the same even though one is actually the mirror image of the other.

If all this happens, the chances are that you have a working module and it is now time to calibrate. The User Manual gives full details on how to calibrate your module.

Final Comments

If you have any problems with the module, an excellent source of support is the Oakley Sound Forum at Muffwiggler.com. Paul Darlow and I are on this group, as well as many other users and builders of Oakley modules.

If you can't get your project to work, then Oakley Sound Systems are able to offer a 'get you working' service. If you wish to take up this service please e-mail me, Tony Allgood, at my contact e-mail address found on the website. I can service either fully populated PCBs or whole modules. You will be charged for all postage costs, any parts used and my time at 25GBP per hour. Most faults can be found and fixed within one hour, and I normally return modules within a week. The minimum charge is 25GBP plus return postage costs.

If you have a comment about this builder's guide, or have a found a mistake in it, then please do let me know. But please do not contact me or Paul Darlow directly with questions about sourcing components or general fault finding. Honestly, we would love to help but we do not have the time to help everyone individually by e-mail.

Last but not least, can I say a big thank you to all of you who helped and inspired me. Thanks especially to all those nice people on the Synth-diy and Analogue Heaven mailing lists and those at Muffwiggler.com.

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