Oakley Sound Systems

5U Oakley Modular Series

Analogue Synthesiser Voice

PCB set issue 1

Builder's Guide

V1.21

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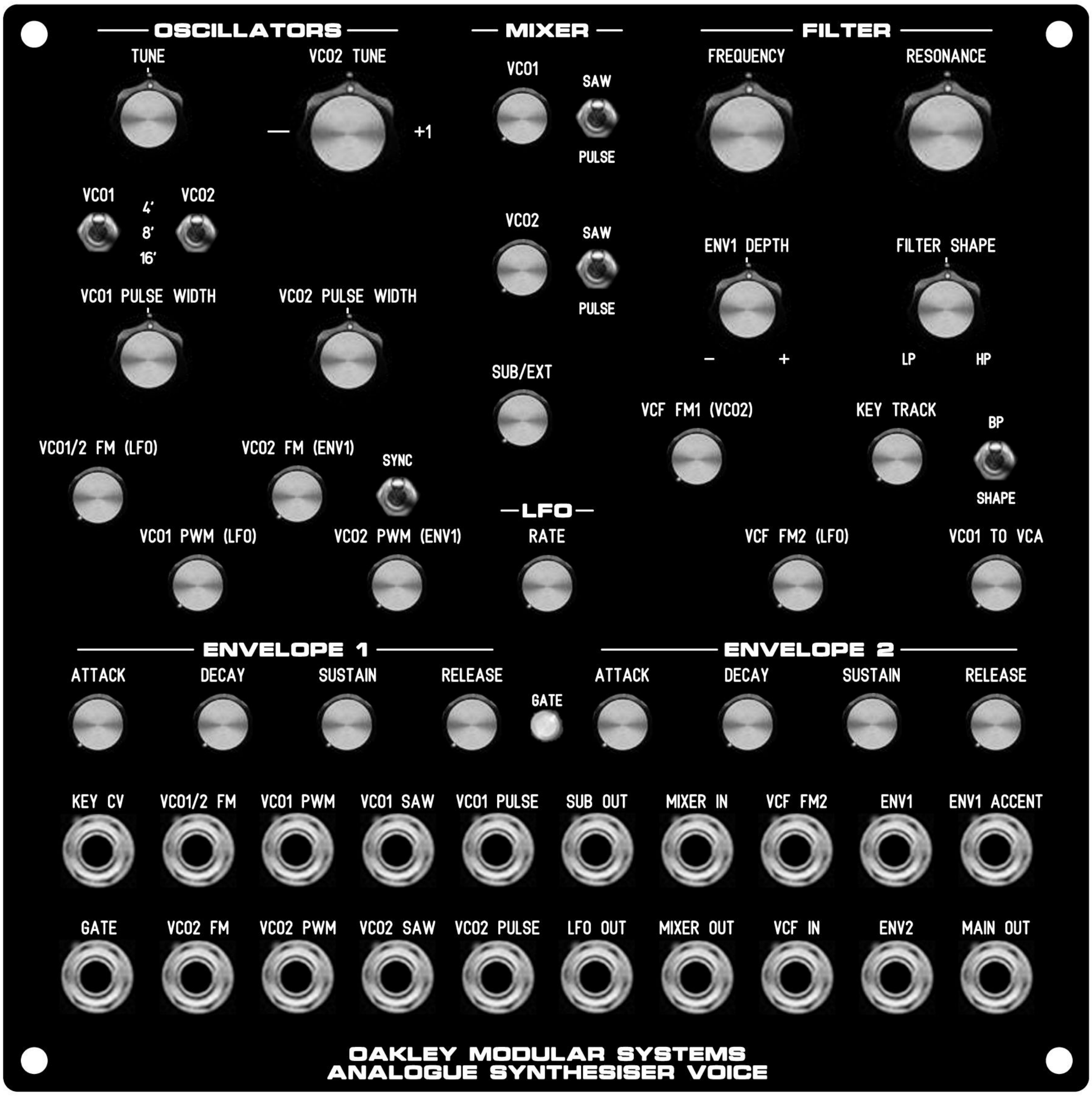


The suggested panel design for the 5U wide MOTM format module.

The suggested panel design for the 4MU wide MU format module.

Introduction

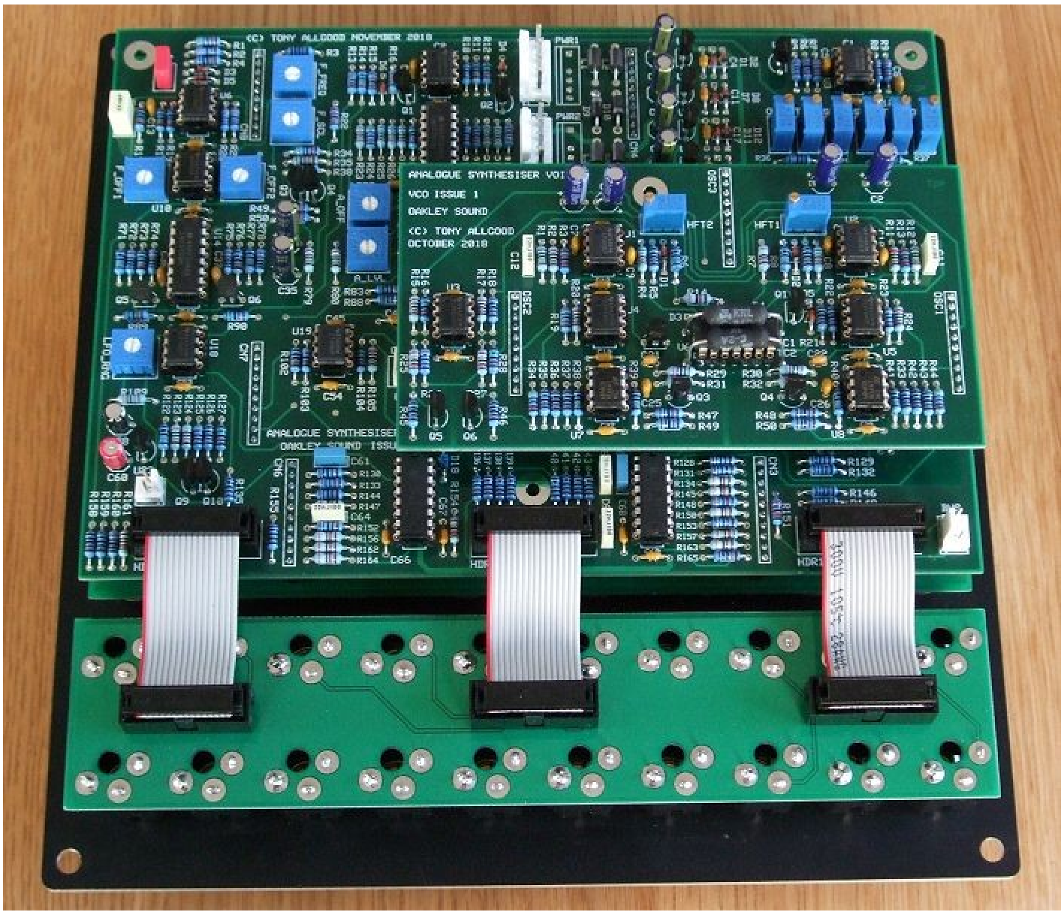
This is the Project Builder's Guide for the issue 1 Analogue Synthesiser Voice (ASV) module from Oakley Sound. This document contains a basic introduction to the board set, a full parts list for the components needed to populate the boards and how to connect the boards together.

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:

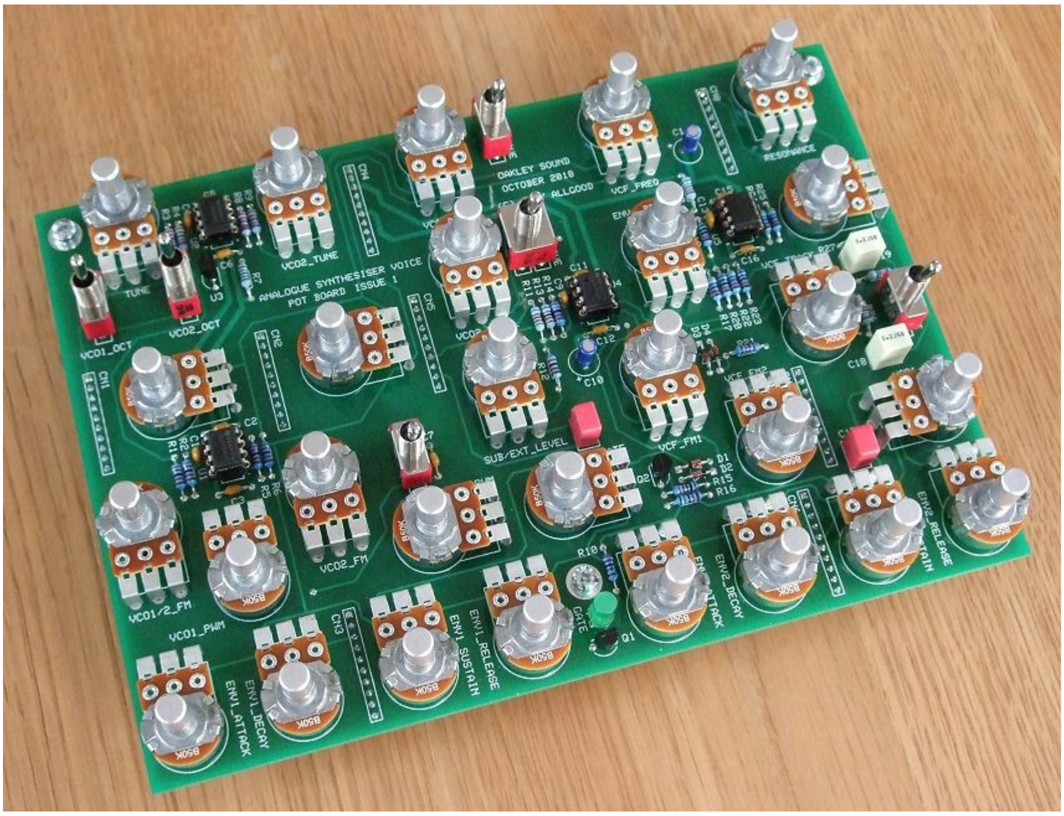
http://www.oakleysound.com/asv.htm

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.

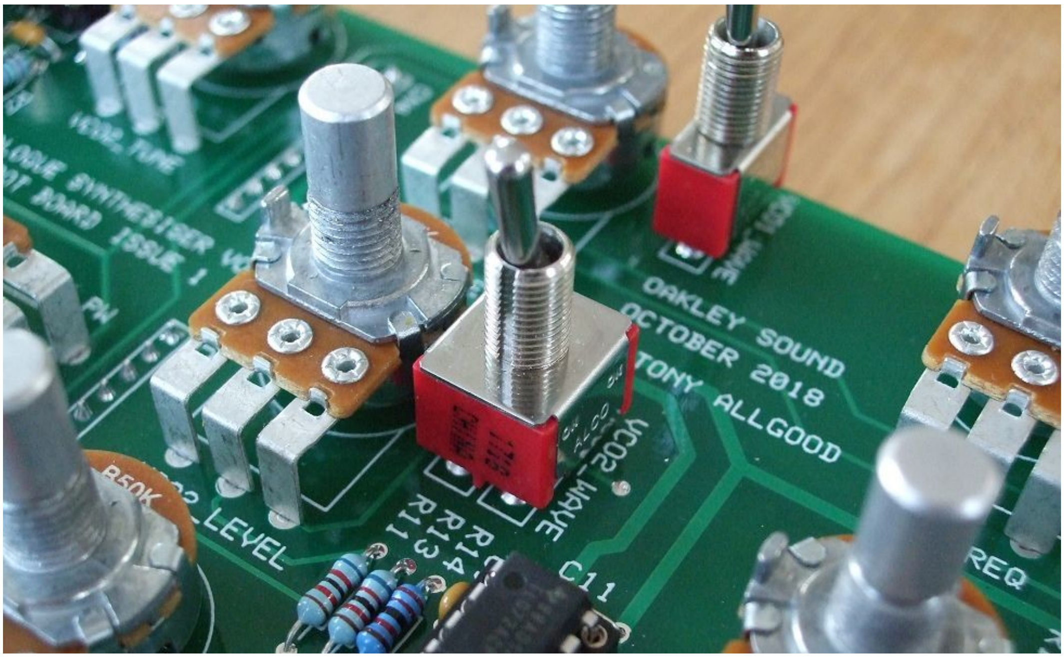
For general information on how to build our modules, including circuit board population, mounting front panel components and making up board interconnects please see our generic Construction Guide at the project webpage or http://www.oakleysound.com/construct.pdf.



The prototype ASV built onto a MOTM format panel with issue 1.1 main board, issue 1 VCO board, issue 1 socket board and issue 1 pot/switch board. Other issue 1 PCBs will be similar.



The original issue 1 Pot/Switch board. Other issues are built in a similar way.



The ASV was the first Oakley module to use vertically mounted pots and switches. This type of construction allows for much shallower modules.

Parts Lists

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

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. 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.

Important Note:

For builders whose ASV board sets include the early issue 1.1 Pot Board then please see the appendix at the back of this document. The appendix has the parts list for the issue 1.1 Pot Board and the appropriate parts list for the issue 1.1 Main Board. If you have an issue 1.1 Pot Board **do not use** the parts list for the Main Board given below, only use the one in the appendix.

ASV Main Board issue 1.1 and 1.2 Parts List

Resistors

1% 0.25W metal film types are recommended for most values. R63, R64, R67 and R68 should be high precision 0.1% or better.

R35 is a positive temperature coefficient resistor with a nominal value of 1K and temp. co. of anywhere between +3000ppm/K and 3900ppm/K. Alternatively, it can be a standard 1K resistor if you don't mind a small amount of temperature dependant drift in the centre frequency of the VCF.

22R	R79, R80
47R	R109
220R	R72, R74, R75, R78, R160
390R	R25, R27, R31, R32, R85, R86
1K	R149, R131, R139, R128, R141, R152, R130, R143, R142, R140, R159, R153, R51, R129, R135, R137, R155, R136, R132, R146, R138, R144, R65
1K +3300ppm/K	R35
2K2	R5, R16
4K7	R103, R125
6K8	R83, R88
10K	R3, R10, R13, R28, R98, R113, R126, R158
11K	R161
12K	R97, R15, R30, R33, R50, R49, R114, R119

15K	R59, R89, R127, R43, R44, R90, R107, R104, R29, R12
20K	R105
22K	R6, R7, R8, R9, R36, R37, R87, R93, R99
27K	R24
30K	R154, R157
33K	R2, R20, R21, R52, R117
36K	R96, R106, R118, R133, R148
39K	R163, R147, R156, R134, R162, R164, R150, R145
47K	R1, R34, R23, R53, R54, R55, R84, R91, R101
68K	R45, R42
75K	R94, R58
100K	R17, R18, R70, R66, R61, R62, R102, R111, R4, R19, R73, R69, R56, R108, R121, R76, R60, R165, R81, R57, R95, R11
100K/0.1%	R63, R64, R67, R68
120K	R112, R115, R116
150K	R38, R82
220K	R22, R151
240K	R110
300K	R123
470K	R124
680K	R26
910K	R48, R39
1M	R41, R46, R77, R120, R14, R71, R122

If you have an issue 1.1 Main Board then do not fit R92 and R100. Leave these two spaces empty.

For use with older Oakley systems

This is to be used if you have already have older Oakley VCOs and want your ASV VCOs to behave identically to the Key CV (1V/octave) input. Anyone with a midiDAC issue 4 and older should also build this version.

150K	R40, R47

For MU/Synthesisers.com or later Oakley formats

This is to be used if you have a predominantly MU system and/or have an issue 5 Oakley midiDAC or compatible interface such as Mutable Instruments Yarns.

220K	R40, R47

Capacitors

100nF axial multi-layer ceramic	C43, C23, C42, C19, C9, C66, C24, C27, C18, C28, C22, C40, C53, C33, C1, C34, C59, C12, C52, C11, C69, C17, C38, C44, C25, C14, C67, C2, C56, C46, C21, C30, C4, C50, C41, C39, C49, C26, C54, C45, C48, C68
10pF C0G ceramic 2.5mm	C13
33pF C0G ceramic 2.5mm	C6, C29, C31
100pF C0G ceramic 2.5mm	C70, C71 (Issue 1.2 Main Boards only)
220pF C0G ceramic 2.5mm	C36, C37
470pF C0G ceramic 2.5mm	C5, C8, C47, C55, C57
10nF polyester film	C62
22nF polyester film	C64, C65
39nF polyester film	C61, C63
330nF polyester film	C7
220nF polyester film	C51
680nF polyester film	C15
1uF, 63V electrolytic	C60
2u2, 63V electrolytic	C3, C10, C16, C20
10uF, 35V electrolytic	C58
47uF, 25V electrolytic	C32, C35

Trimmers

10K multiturn trimmer	SCL1, SCL2
100K multiturn trimmer	TUN1, TUN2
200K multiturn trimmer	OCT1, OCT2
10K 6mm trimmer	F_SCL
50K 6mm trimmer	A_LVL
100K 6mm trimmer	F_OFF1, F_OFF2, A_OFF, F_FREQ, LFO_RNG

Discrete Semiconductors

1N4148 silicon signal diode	D1, D2, D3, D4, D5, D6, D7, D8, D11, D12, D13, D14, D16, D17
BAT42 Schottky signal diode	D15, D18
1N5819 Schottky power diode	D9, D10
BC549 NPN transistor	Q3, Q7, Q8
BC559 PNP transistor	Q1, Q2, Q4, Q9, Q10
J201 FET	Q5, Q6

Integrated Circuits

CD4013 dual D-type flip-flop	U26
CD4093 quad NAND gate	U21
4558 dual op-amp	U10
AS3310 envelope generator	U24, U25
LM13700 dual OTA	U8, U14, U15
LM4040-10 10V reference	U2
LT1013 dual op-amp	U3, U11, U19
OPA2134 dual audio op-amp	U12
TL072CN dual op-amp	U22, U6, U16, U17, U13, U20
TL072ACP dual op-amp	U4, U18
78L12 100mA +12V regulator	U1, U7
79L05 100mA -5V regulator	U23
79L12 100mA -12V regulator	U5, U9

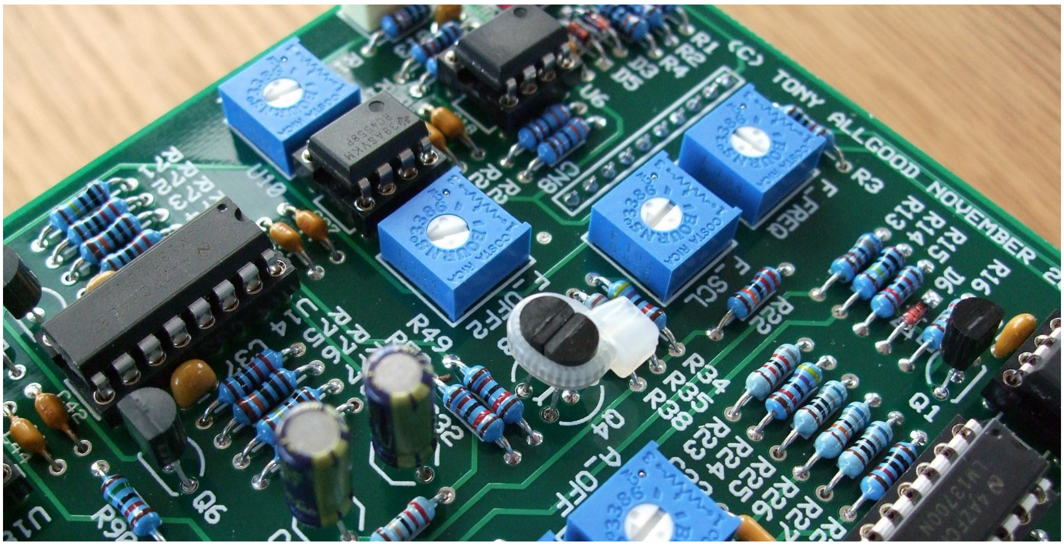
Miscellaneous

Ferrite bead	L1, L2, L3, L4
MTA100 3 way	BUS
MTA100 2 way	OUT
MTA100 6 way	PWR1, PWR2
MTA156 4 way	PSU1, PSU2
2 x 8 way 0.1” boxed header *	HDR1, HDR2, HDR3
10-way SIL 0.1” socket **	CN1, CN2, CN3, CN4, CN5, CN6, CN7, CN8
10-way SIL 0.1” header	OSC1, OSC2, OSC3

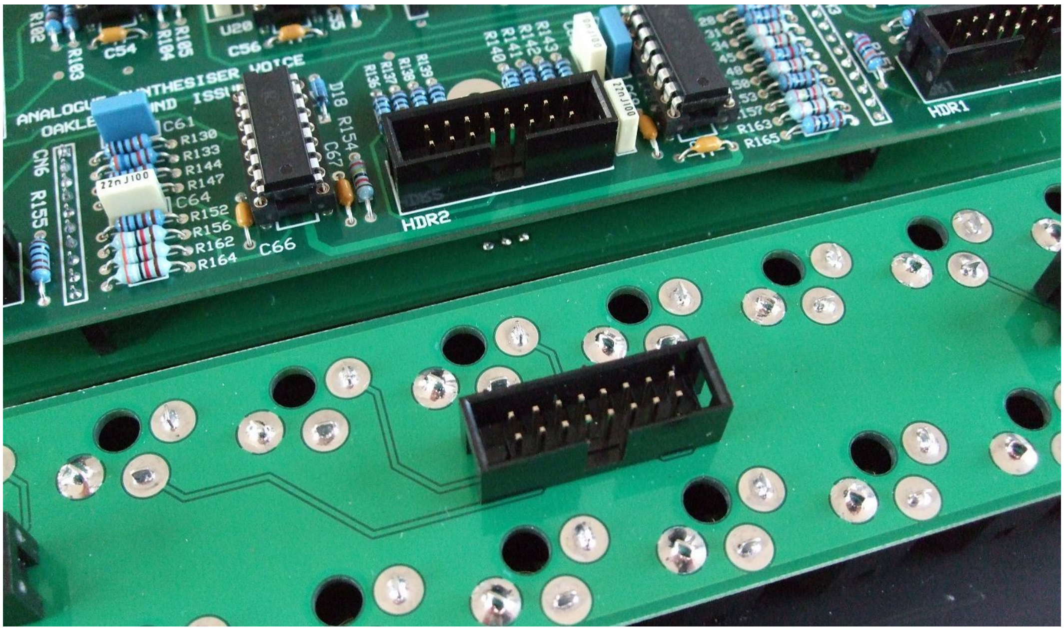
* If you have bought polarised headers for HDR1, HDR2 and HDR3, then they must be aligned correctly. Pin 1 lines up with the square pad on the PCB. Pin 1 is normally depicted by a small triangle on the body of the header.

** CN1 to CN8 mounted on the underside of the board, facing down, and soldered from the top.

IC sockets are optional but recommended for DIY projects. There are thirteen 8-pin, two 14-pin and five 16-pin DIL sockets used on the main board.



The two sets of transistor pairs, Q3 and Q4, and, Q9 and Q10, can be tied together with a cable tie to help keep both devices at a similar temperature. This reduces the amount of drift in the filter's and LFO's operating frequencies.



These boxed IDC headers are polarised as they have a notch taken out of the side to ensure an inserted socket is fitted the correct way around. They are fitted to the topside on the main board and on the underside of the socket board.

ASV Pot & Switch Board issue 1.2 & 1.3 Parts List

Resistors

1% 0.25W metal film types are recommended for most values. R1, R2, R3 and R4 should be high precision 0.1% or better.

220R	R33
2K2	R5, R35
22K	R6, R9, R10, R11, R18, R32, R34
22K/0.1%	R1, R2, R3, R4
47K	R13, R14, R19, R21, R24, R26
62K	R16, R17, R25
100K	R12, R20, R22, R27, R30
180K	R7, R28, R29
470K	R8, R15, R23, R31

Capacitors

100nF axial multi-layer ceramic	C1, C5, C15, C3, C19, C20, C9, C7, C10, C11, C14
33pF C0G ceramic 2.5mm	C8, C12
100pF C0G ceramic 2.5mm	C2, C6, C17, C18
2u2, 50V polyester *	C13, C21, C22, C23
2u2, 63V electrolytic **	C4, C16

* WIMA MKS2B042201F00KSSD are recommended due to their smaller height.

** These should be miniature or low profile types to allow them to fit under the panel. However, ordinary full height parts can be used if they are laid down flat.

Discrete Semiconductors

1N4148 silicon signal diode	D1, D2, D3, D4
BC549 NPN transistor	Q2
BC559 PNP transistor	Q1
LED 5mm green	GATE – solder only when panel is in position

Integrated Circuits

LM4040-10 10V reference	U2
LT1013 dual op-amp	U1
TL072ACP dual op-amp	U3, U4, U5, U6

Potentiometers

50K linear	ENV1_DEPTH, VCF_FREQ, LFO_RATE, ENV1_SUSTAIN, VCO2_LEVEL, SUB/EXT_LEVEL, ENV1_RELEASE, ENV1_DECAY, RESONANCE, ENV2_ATTACK, VCO2_PW, VCO1_PW, ENV2_RELEASE, VCO2_TUNE, VCO2_PWM, VCO1_PWM, VCF_FM1, TUNE, VCF_TRACK, VCO1_LEVEL, VCF_FM2, ENV2_DECAY, ENV1_ATTACK, VCO1_VCA, SHAPE, ENV2_SUSTAIN
50K audio (log)	VCO1/2_FM, VCO2_FM

I recommend additional M7 flat washers for all 28 pots to go between the pot and the inside surface of either the MOTM format panel or the shim panel for MU builds. I recommend using the same thickness of flat washer as those that come with the pots.

Switches

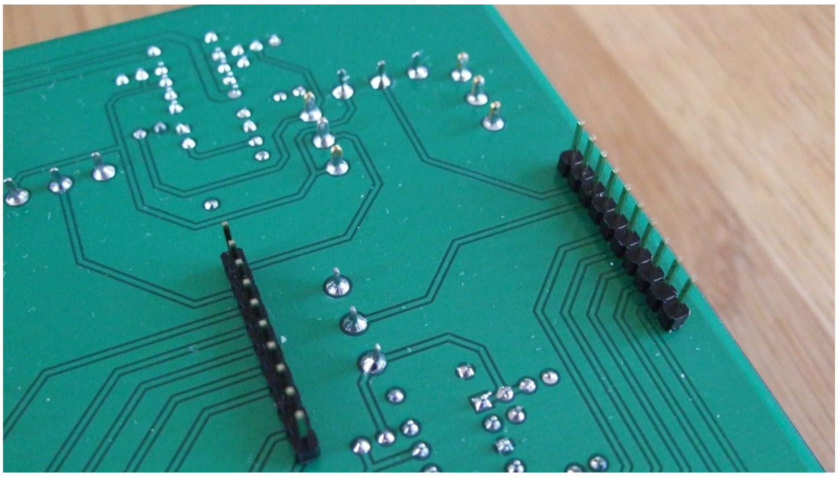
SPDT on-on switch	VCO1_WAVE, SYNC, BP/SHAPE
SDPT on-off-on switch	VCO1_OCT, VCO2_OCT
DPDT on-on switch	VCO2_WAVE

Miscellaneous

10-way SIL header *	CN1, CN2, CN3, CN4, CN5, CN6, CN7, CN8

* SIL headers fitted to the underside of the board and soldered from the top. ie. the pins face down.

IC sockets are optional but recommended for DIY projects. There are five 8-pin DIL sockets used on the issue 1.2 and 1.3 ASV pot/switch boards.



For the Pot/switch board the 10-way SIL headers are best soldered last and fitted to the underside of the board.

ASV Dual VCO Board issue 1 Parts List

Resistors

1% 0.25W metal film types are recommended for all values.

75R	R12, R1
820R	R29, R30
2K	R31, R32
10K	R46, R47, R35, R50, R48, R45, R21, R22, R42, R5, R33, R49, R36, R37, R43, R9
12K	R3, R13
15K	R28, R16
20K	R11, R15, R17, R2, R20, R24
24K	R27, R25
30K	R26, R18, R19, R23
39K	R14, R7
47K	R44, R34
680K	R10, R4
1M	R40, R41, R39, R6, R8, R38
1K +3300 or +3500ppm/K	TC1, TC2 – fit side by side on top surface of U6

Capacitors

100nF axial multi-layer ceramic	C6, C15, C18, C23, C5, C13, C14, C28, C19, C16, C17, C20, C27, C24
47pF C0G ceramic 2.5mm	C7, C10, C25, C26
100pF C0G ceramic 2.5mm	C9, C8
1000pF C0G ceramic 2.5mm	C22, C21
22nF polyester film	C11, C12
2u2, 63V electrolytic	C1, C2, C3, C4

Trimmer

10K multiturn trimmer	HFT1, HFT2

Discrete Semiconductors

1N4148 silicon signal diode	D1, D2, D3, D4, D5
BC549 NPN transistor	Q1, Q5, Q6
J112 FET	Q2, Q3, Q4

Integrated Circuits

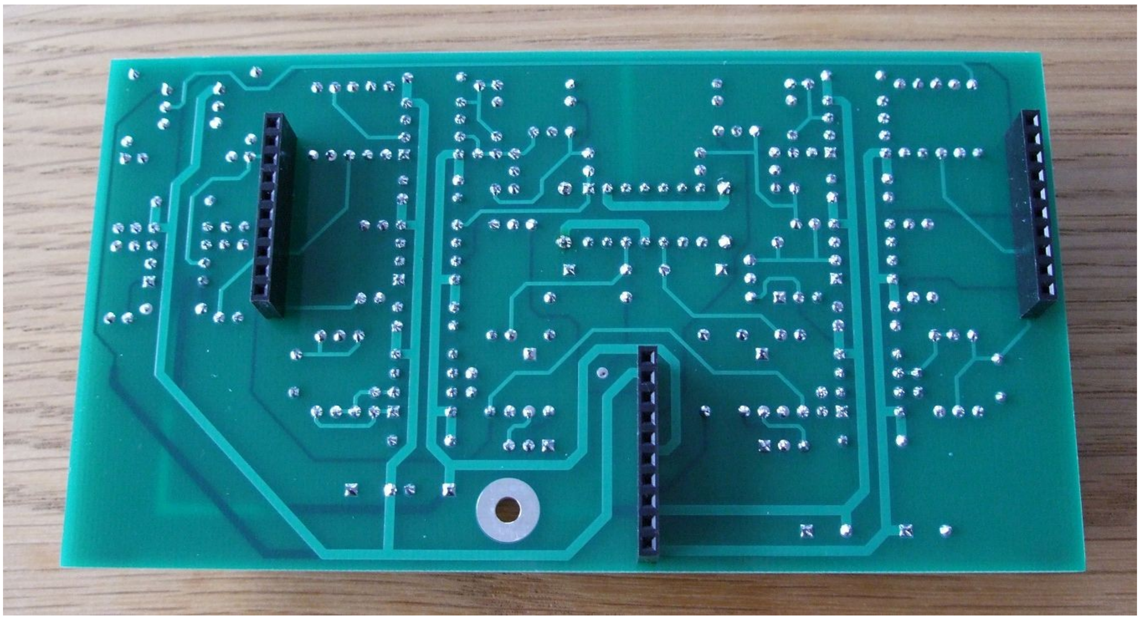
LM393 dual comparator	U7, U8
LT1013 dual op-amp	U1, U2
THAT300 NPN array	U6
TL072ACP dual FET op-amp	U3, U4, U5

Miscellaneous

10-way SIL socket *	OSC1, OSC2, OSC3

* OSC1 to OSC3 are mounted on the underside of the board and soldered from the top.

IC sockets are optional but recommended for DIY projects. There are seven 8-pin and one 14-pin DIL socket used on the VCO board.



The three ten way SIL sockets on the VCO Board, like the eight sockets on the main board, are mounted on the underside of the board.

ASV Socket Board issue 1.1 Parts List

Miscellaneous

2 x 8 way 0.1” boxed header *	HDR1, HDR2, HDR3
Switchcraft 112APCX 1/4” socket **	SK1 – SK20.

* HDR1, HDR2 and HDR3 are mounted on the underside of the board. They should be fitted first. Pin 1 lines up with the square pad on the PCB. Pin 1 is normally depicted by a small triangle on the body of the header.

** Do read the section on building socket boards in the Oakley Construction Guide.

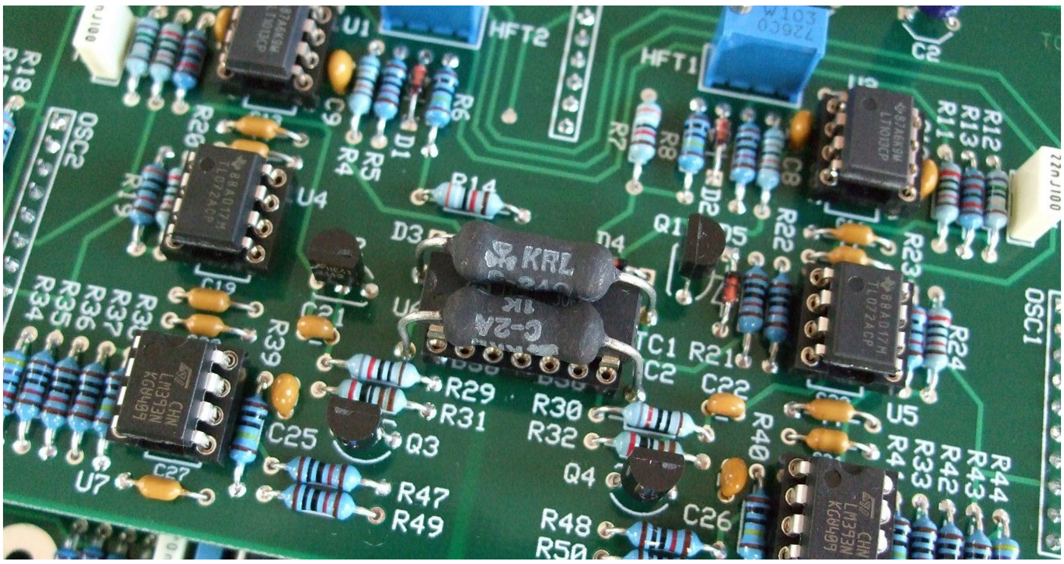
Interconnects

2 x 8 way 0.1” IDC socket	6 off
16 way 0.05” IDC ribbon cable	0.3 metres

Additional Hardware

For securing the main board to the pot/switch board, and the main board to the VCO board, you can use male-female spacers. See assembly section later for more details.

Four off 11mm M3 Male-Female hex spacers.
Eight off M3 toothed washers
Four off M3 6mm screws
Twelve off M3 flat washers
Four M3 nuts



On the VCO board the two temp co resistors straddle the THAT300 NPN array so that all three devices are physically touching each other. A non conductive thermal paste or epoxy can be used to bond them together but I find this is not normally necessary.

Parts Information

For general information regarding where to get parts and suggested manufacturer part numbers please see my useful Parts Guide available from the project webpage or directly from:

http://www.oakleysound.com/parts.pdf

The pots used in this project are Alpha 16mm types designed to fit vertically into a PCB so that the base of the pot lies just above the surface of the board. They are sold by several places and are usually described as 'vertically mounted' or having 'right angled terminals'. The pot shaft is typically 1/4" or 6.25mm in diameter.

I also recommend that you use thin M7 internal flat washers (not toothed washers) between the panel and pot. The thickness of the washer needed will depend on the thickness of the panel used. For both the 3mm thick Schaeffer panel, and the 1.5mm MU panel with shim sub-panel, I recommend using the same thickness of washer as those that come with the pots. These very thin washers are often available from the same places that sell the pots, eg. Banzai and Musikding.

The front panel was designed for three sizes of control knobs – small, medium and large. The large ones are the traditional Moogy style with a diameter of 25mm. The medium ones are 19mm and the small ones are only 13mm. An example of such a trio are shown below and similar knobs can be obtained from online guitar parts and effects retailers.

The above control knobs give the whole panel a standard 5U modular look and it is in this style that

I created the digital artworks for the documentation and website. For my first two prototype models, however, I decided to do something a little different and go with an all black look. For the large control knob I chose Thonk's MXR clones. For the medium sized ones I used original Davies Molding's skirted 'bold small' knobs, also available from Thonk. For the small control knob I used Thonk's Davies 1900H clones. The small 1900H knobs barely cover the pot nut and washer but the overall effect is visually pleasing and the knobs are easy to adjust.

The first prototype unit using a printed Schaeffer panel. The nuts for the switches have not yet been fitted.

The switches used in this project are from the Gemini series from TE Connectivity. Other manufacturers may have equivalents but I have not tried these. The TE part numbers are:

SPDT on-on	A101SYCQ04 or A101SYCB04
SPDT on-off-on	A103SYCQ04 or A103SYCB04
DPDT on-on	A201SYCQ04 or A201SYCB04

You'll notice that each switch type has two different part numbers. The part numbers differ only in the third from last digit. B is a low voltage part while Q is a higher voltage part. For our application either may be used, so simply buy the cheapest available.

The FET, sometimes called JFET, used in the filter on the main board is the somewhat hard to get J201. Mouser sell them as their part 106-J201. I should warn you they aren't terribly cheap compared with other small signal FETs.

The small positive temperature coefficient (PTC) resistor used in the filter is +3300ppm/K, although +3000ppm/K devices will do the job well enough too.

The two PTC resistors used on the VCO board were the classic wirewound 1K +3500ppm/K types made by KRL. Their part number was C-2AQ. Sadly, these are no longer available so the recommended parts are now the Akaneohm 1K +3300ppm/K resistors. The temp co resistor pack that I provide has three such devices, two for the VCO board, and one for the VCF on the main board.

The LM13700 is no longer being made in through hole variants. It is, however, available from many online parts suppliers including most guitar parts stores, such as Banzai and Musikding. The NJM13700 is a perfectly acceptable replacement too.

The AS3310 used on the main board are envelope generators and are made by Alfa in Latvia. The AS3310 is a clone of the much older and now obsolete CEM3310 chip. You can use either the CEM3310 or the AS3310 in the ASV. However, if you use the CEM3310 you should make R154 and R157 both 24K. The CEM3310 has a typical maximum attack peak voltage (Vp) of 5.0V. Early specimens of the AS3310 have a Vp of more than this. I have tested several devices and all were showing a Vp of 5.4V. Because of this I have made R133 and R148 on the main board to be both 36K. This increases the maximum sustain voltage to 5.2V to reduce the small discrepancy with the maximum sustain level and the slighter higher than expected maximum attack voltage. Ideally there should be no discrepancy but 5.2V seems a good compromise between the expected value of 5.0V and the measured value of Vp in some real devices. Alfa's Alex Zaslavski told me in November 2018 that this has now been corrected and Vp will be closer to 5.0V for all new productions of the chip. The AS3310 you purchase, and indeed any CEM3310 you have, may well have a Vp of 5.0V and you can use 39K for R133 and R148. However, using 36K as shown in the parts list will allow perfectly acceptable performance for both versions of the AS3310, and the original CEM3310.

The board interconnects used to connect the main board with the pot board, and the main board with the VCO board, are in two parts, the male header and the female socket or receptacle. All of these interconnects are ten way single in line (SIL) connectors. The ones I have used in my builds are made by Multicomp, although more expensive types are available which may offer increased longevity. These are the Multicomp part numbers for the parts I used:

10 way socket	2212S-10SG-85
10 way header	2211S-10G

With the above headers I found the resistance to movement sufficiently stiff that the whole three board assembly stays together without additional mounting support. However, if you are planning to travel with your ASV then I do suggest using the four suitable M3 hex spacers, nuts and screws to secure the unit together.

For the Multicomp headers above I needed 11mm spacers plus a flat washer to fit the three boards together without stressing them. The 11mm M3 male-female hex spacers are made by Harwin, their part number R30-3001102.

The trimmers used in this project are 6mm and multiturn types. The 6mm ones are Bourns 3386F types, and the multiturn ones are Bourns 3296W. Other manufacturers make similar products but be sure to check the pin spacing will fit the PCBs.

The 1/4” sockets on the socket board are Switchcraft 112APCX. These are excellent parts and will last a long time. However, quality does come at a price and they are not cheap.

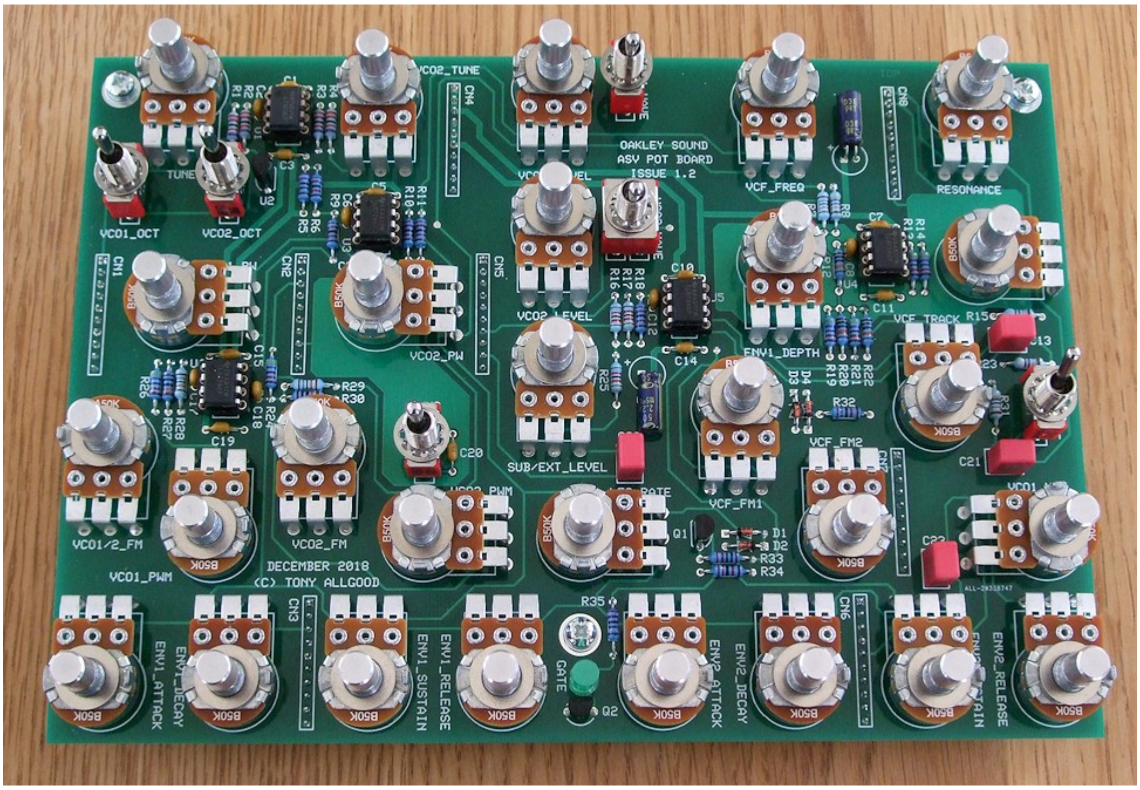
Soldering the Front Panel Components

Soldering the pots and switches on the ASV's Pot Board is relatively straightforward. They are mounted from the top side of the board and soldered from the underside. However, there are a few points worthy of mention.

The issue 1.1 and 1.2 ASV Pot Boards are large boards with a lot of copper on their underside. During manufacture this creates a small amount of warp in the board's shape, that is, it bows slightly upward in the middle. This is nothing to be concerned about as the board is flexible and will straighten once it is placed against the flat front panel. The later issue 1.3 boards have been designed so that the amount of copper on both sides of the board is similar. As such issue 1.3 boards should not have any appreciable warp and be flat.

The bottom of the metal case of each pot should not sit against the top surface of the PCB. Each should be fitted so that the bottom of the pot lies just above the board surface and be parallel to it. If one places a pot into the board and then solders all three pins, the pot will naturally sit at an angle and make it difficult to fit the pot's thread through the front panel. It is best, therefore, to first solder the pot's middle pin only, then gently bend the pot slightly to its correct position so that the bottom of the pot is parallel and above the board's top surface. Now one can solder the two outer pins which will hold it in place quite firmly.

The switches are perhaps best soldered after the panel is fitted and the pots already secured into place. You can fit the switches before the panel is in place, as I did with my two prototypes, but great care must be taken to ensure that each switch is sitting at right angles to the board surface during soldering. For now, I would put the switches aside and keep them safe alongside the otherwise completed ASV Pot Board.



A completed issue 1.2 Pot Board.

Ribbon Cable Connections

The main board and socket board are connected together with three identical 16-way ribbon cables. These cables are terminated in sockets that are called insulation displacement connectors (IDC). They are called this because they make connection with the cable by piercing the plastic insulation that surrounds the wire inside the cable. The piercing action is created by pushing the connector's top section down onto the cable and forcing the spikes in the lower section through the cable. There is no soldering involved in making the cable assembly and the connection made is both reliable and strong.

Special tools are available for neatly squeezing the two sections of the connector together. However, for a 16-way cable it can easily be done in a bench vice. Some connectors have additional strain relief bars that clamp the cable onto the top of the connector, however, these are not needed for such a short length of cable and can actually make construction of the assembly more difficult. If your connectors have come with such a clamp you can simply not fit it.

The red line on the cable lines up with pin 1 on the connector. Pin 1 is usually depicted by a little triangle shape on the connector near where the cable will be eventually seated. Note that both connectors are mounted onto the cable so that they face the same way. That is, pin 1 of each connector is on the same side.

Each connector has two rows of eight contacts. The gap between each individual contact is 0.1” or 2.54mm. This means that the ribbon cable's conductors are spaced apart by 0.05” or 1.27mm.

All three cable assemblies are to be made the same total length of 48mm.

If you haven't made such cables before I strongly advise you to buy some extra sockets and cable so you can practice first. Once the cable is squashed onto the connector it is not easy to get them apart again without damaging the connector. Also, the part of the cable that has been pierced cannot be used again.

Mechanical Assembly

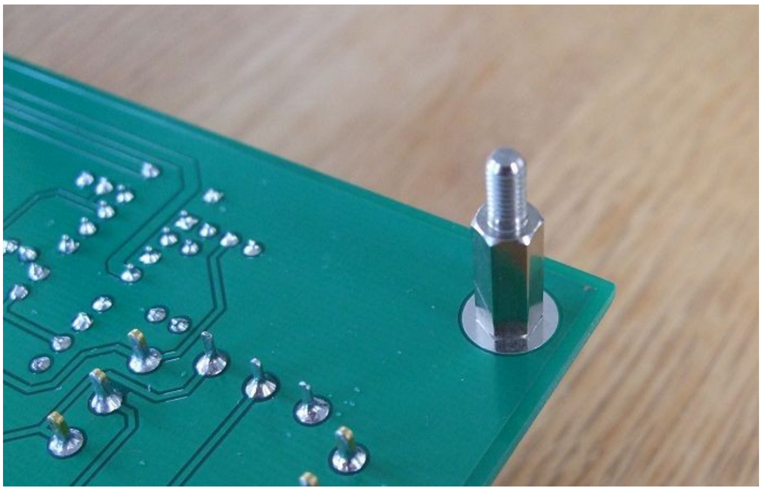
The Oakley ASV has been designed with ease of construction in mind. That said, it is a complex project with four circuit boards and over three hundred individual parts. It is also designed with the circuit boards parallel to the front panel. While this does create a shallow module it does make construction somewhat more difficult than a single board mounted at right angles to the panel.

The pot/switch board is held onto the front panel solely by the pots, and possibly the switches. This actually turns out to be very rugged since there are twenty eight pots and six switches. The main board is secured onto the pot/switch board with three M3 11mm male-female threaded spacers and associated hardware, and the VCO board onto the main board with one 11mm spacer and its associated hardware. The multiple SIL connectors also hold the boards together quite well and you will need to quite careful that you don't bend the boards when prising them apart.

It is imperative that you check that the SIL headers are all correctly aligned before applying power to the module. For this reason alone I recommend that you fit the spacers as these will help in ensuring the boards are fitted together properly.

Before we fit the Pot/Switch Board to the panel it is necessary to fit the hex spacers to the board as this is tricky to do once the panel is in place. The spacers recommended are male-female (M-F) hex spacers, with the actual spacer part being 11mm long. These have a threaded stud at one end and a threaded hole at the other. The threaded hole will take an M3 screw and the threaded stud takes an M3 nut and washers. Use a 6mm M3 screw to secure the spacer to the bottom of the board, with a toothed washer and flat washer in between the screw head and the top surface of the circuit board.

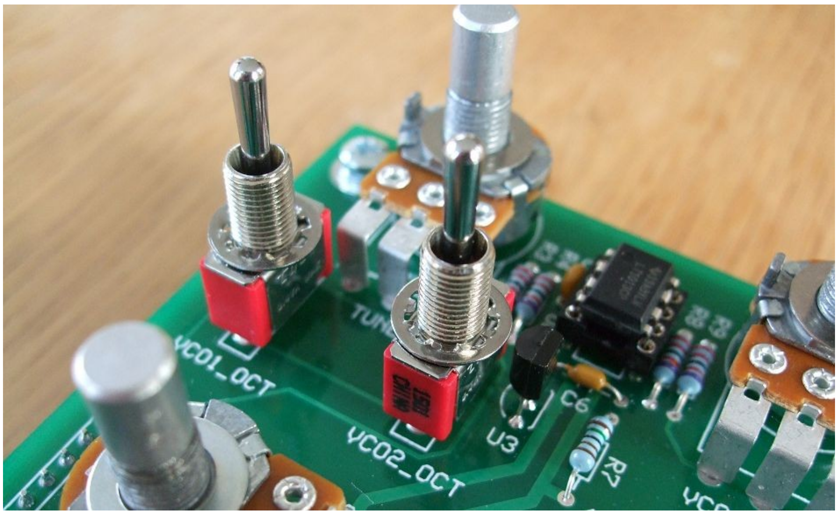
It is worth checking at this point that the Main Board will fit onto the Pot/Switch board. The threaded studs of the spacers should poke through the three big holes of the main board. If not, then loosen the screw holding the spacer to allow some movement and re-tighten once the spacer is correctly placed. Gently pull the two boards apart and put the main board aside for now.



An 11mm Harwin M-F threaded spacer fitted to the pot/switch board. It is secured on the top side of the board with one M3 screw, one M3 internal toothed washer and a M3 flat washer.

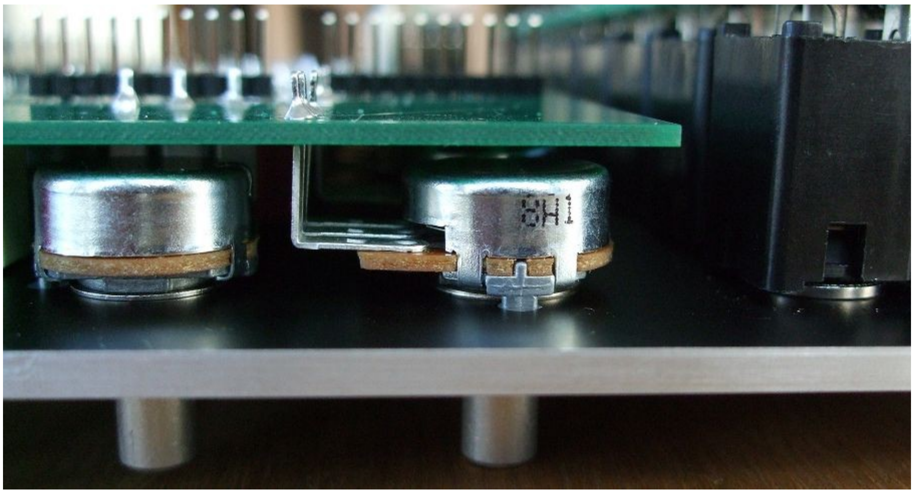
Now it is time to fit the Pot/Switch board to the front panel. This is best done with the pots facing upwards and the board sitting on the three spacers. Slide the LED into its holes on the PCB making sure that the cathode and anode are correctly placed. Do not solder the LED's leads yet. If you haven't fitted the switches yet, you must now push them into their correct locations on the Pot/Switch board but do not solder them just yet. Move every switch's toggle to its middle position, even the ones that don't naturally have a middle position.

Whether you have chosen to use the MOTM format Schaeffer panel or the MU panel with its shim plate, each pot will need to be fitted with an additional thin M7 flat washer, and each switch with its toothed washer. You will not be needing to use the thicker washer or the second nut that is provided with the switches.



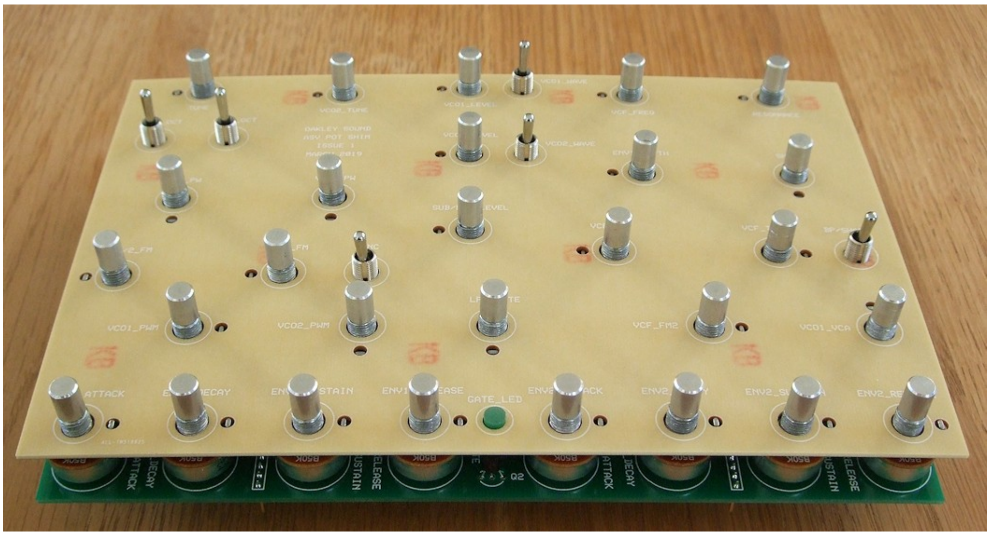
A close up of the top left of the pot/switch board showing the toothed washers in place on the switches and the slim washers on the pots prior to the panel or sub-panel being fitted on top.

The Schaeffer panel is 3mm thick and includes 2.1mm deep blind holes on the reverse side of the panel. These are used by the locating lugs on the vertically mounted 16mm pots. The lugs prevent the pots from turning while their securing nuts are tightened.



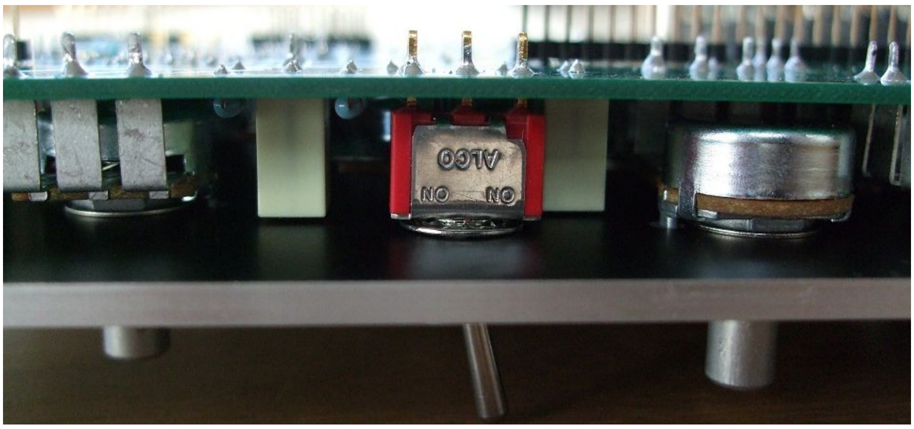
A view of the VCO1 to VCA pot (left) and ENV2's Release pot (right) on a MOTM format build using a 3mm thick Schaeffer panel. Note the locating lugs of the pots fitting snugly into the blind holes in the panel. Note also the slim M7 washer between the inside surface of the panel and the pot.

The MU panel is only 1.5mm thick so does not have the depth to incorporate suitably deep blind holes for the locating lugs of the pots. Holes could be drilled through the panel but this would make the holes and lugs visible to the user on those pots that use the smaller control knobs. The solution was to make a sub-panel or shim plate. This is a specially constructed thick sheet made from SRBP (synthetic resin bonded paper) which has holes drilled to accommodate all the front panel parts and the locating lugs. The pot lugs fit into small holes in the sheet without having to go through the main panel. This sub-panel or shim plate is provided when you purchase the MU panel from Oakley Sound Systems. You'll notice that the shim plate may have a slight bow to it, this is not a problem as it will straighten out once squashed up against the aluminium panel.



The shim plate sitting atop the Pot Board. Note how each of the pot's locating lugs are sitting inside the small holes in the shim plate.

Carefully place the Schaeffer panel, or the shim plate, onto the pot/switch board easing in the eight ADSR pots first and then the others working your way up the front panel from the bottom. If there are any parts not wanting to go through then either take the panel off and realign the part, or try to gently coax the part through its mounting hole with a long screwdriver from the side. Do not force the panel into place if there are parts not aligned. For the MU build, once the shim plate is in place you can now fit the front panel. Remember to remove the protective plastic film from both sides of the panel.



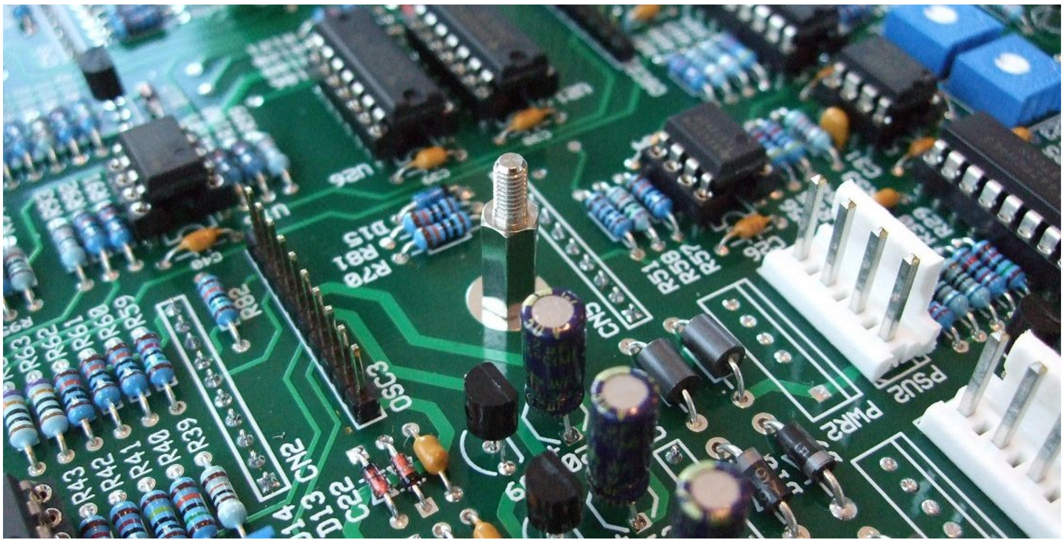
The filter mode switch showing the toothed washer sitting between the panel and switch body.

Fit a flat washer and nut to a few pots to gently hold the PCB to the panel. Check carefully that all pots are pushed through their holes properly. Simply wiggling each one in turn will make sure that it is seated correctly, and you need to take particular care to ensure that each of the pot's locating lugs haven't slipped out of their holes. Gently tighten each pot nut making sure you do not over tighten or scratch the panel's front surface. Now fit and tighten the switch nuts. If you chose not to solder the switches before fitting the panel, once the switches are secured with their nut, you can now solder their leads.

With the pot/switch board in place you can solder the LED's two leads. For my builds I used a flat topped LED and soldered it so that the flat top was aligned with the top surface of the panel. If using a flat topped LED you can use a bit of sticky tape to hold the LED flush with the surface while you solder.

Now attach the socket board making sure it is the right way up. The board is mounted so SK1 and SK11, fit into the panel holes for Key CV and Gate respectively. Fit a dress washer and nut for each socket on the outer surface of the panel.

Now we need to fit another M3 spacer, this time it's on the main board which will eventually secure the VCO board. Like the pot/switch board this spacer will be sticking away from the panel but this time it's fitted to the top side of the board. It is secured on the underside by a 6mm M3 screw, M3 toothed washer, and M3 flat washer. Again, it's worth checking that the VCO Board will fit comfortably into place. If it does then take off the VCO board and put it aside for now. It's time to fit the main board to the pot/switch board properly.

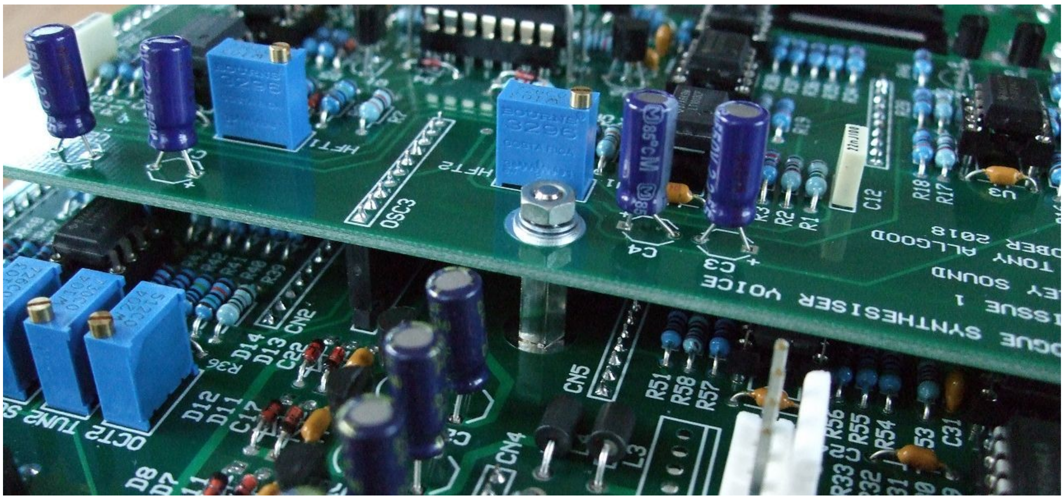


The single M3 spacer needed to secure the VCO board in place.

With the module face down fit an M3 flat washer onto each of the threaded studs on the spaced secured to the pot board. This prevents the boards from being pulled closer together than the SIL headers would like – a 12mm spacer is a little too big, but 11mm with a flat washer is perfect.

Now fit the main board to the pot/switch board. Make sure that all the SIL headers and sockets are aligning correctly and no pins are out of place. Secure the two boards with a flat washer, an internal toothed washer and an M3 nut on each threaded stud.

The VCO Board can now be fitted and secured in the usual manner.



Each of the four 11mm M-F spacers use a 6mm screw, an M3 nut, three flat washers and two toothed washers.

The final thing to do is fit the three ribbon cables making sure that any polarising lugs are aligned correctly. Pin 1, the red stripe on the cable, is to the left when looking at the module from the rear.

Power Connections

The ASV main PCB has four power headers, two MOTM/Oakley and two MU. Whether you choose MOTM/Oakley or MU, both headers of the same type must be connected back to your power supply or power supply distribution system. That is, both MOTM/Oakley or both MU. It is best not to mix types, so using one MOTM/Oakley and one MU is not recommended.

Failure to connect one or the other connector will not result in damage to the ASV or your power supply. However, the ASV will not work correctly. The lower headers, PWR2 and PSU2, power the LFO and VCO2. The upper headers, PWR1 and PSU1, power the rest of the ASV. Sharing the power over two leads reduces the chances of unwanted interaction between the two VCOs and helps provide a good solid 0V connection.

Current consumption with both connectors attached is approximately +/-180mA at +/-15V. +/-12V operation is not possible.

MOTM and Oakley

The PSU1 and PSU2 power sockets are 0.156” Molex/MTA 4-way headers. Friction lock types are recommended. This system is compatible with MOTM systems.

PSU1	***Pin number***
+15V	1
Module ground (0V)	2
Module ground (0V)	3
-15V	4

PSU2	***Pin number***
+15V	1
Module ground 2 (0V)	2
Socket ground	3
-15V	4

Pin 3 of the PSU2 header is connected via the main board's internal tracking and interconnects to the 1/4” sockets' ground lugs on the socket board. Thus the ground tags of all the jack sockets are connected to the power supply ground without using the module’s 0V supply. Earth loops cannot occur through patch leads this way, although screening is maintained.

MU and Synthesizers.com

The PWR1 and PWR2 power headers are to be fitted if you are using the module with an MU or Synthesizers.com system. In this case you should not fit the PSU1 and PSU2 headers. The PWR1 and PWR2 header is a six way 0.1” MTA, but the pin in location 2 is removed. In this way location 3 is actually pin 2 on my schematic, location 4 is actually pin 5 and so on.

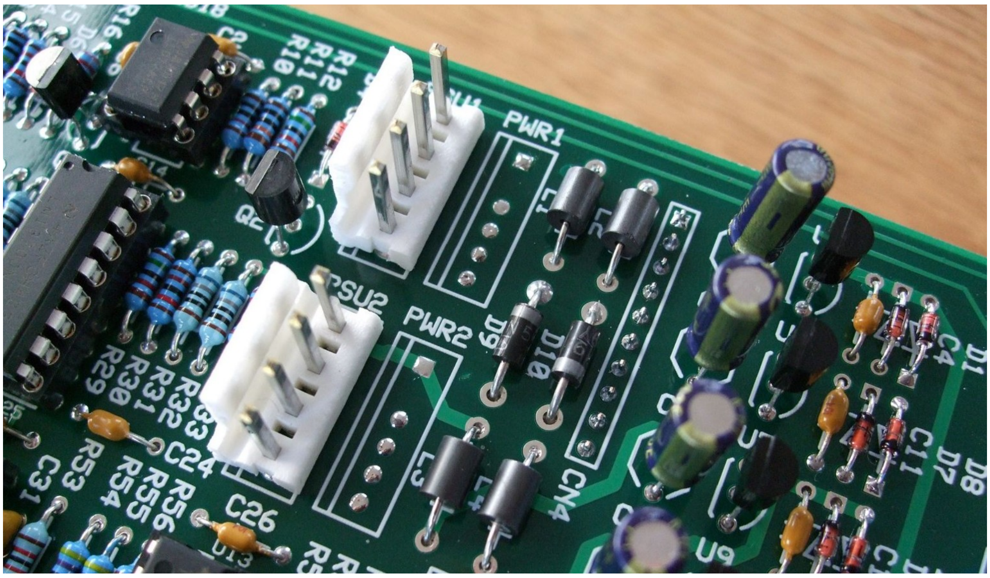
PWR1	***Location number***	***Schematic Pin number***
+15V	1	1
Missing Pin	2	
+5V	3	2
Module ground (0V)	4	3
-15V	5	4
Module ground (0V)	6	5

PWR1	***Location number***	***Schematic Pin number***
+15V	1	1
Missing Pin	2	
+5V	3	2
Module ground 2 (0V)	4	3
-15V	5	4
Socket Ground *	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 PWR1 and PWR2 headers and using them with a standard MU power distribution system, you will also need to connect together the middle two pads of PSU2. This link connects the socket and panel ground with the module ground. Simply solder a solid wire hoop made from a resistor lead clipping, or bit of solid core wire, to join the middle two pads of PSU2 together. The middle two pads of PSU1 are left alone.

* Newer Oakley boards now connect the unused pin 6 of their MU connector to socket ground. With the link not fitted, and using an Oakley MU distribution board with a five way power cable, will allow the socket ground to be kept separate from module ground to prevent ground loops.



The two MOTM/Oakley headers fitted. Note that the solder pads for the unused PWR headers can be filled with solder.

Testing Procedure

Apply power to the unit making sure you have connected the power leads correctly. Both power leads should be fitted. 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, and the direction of all the ICs in their sockets and the polarity of the electrolytic capacitors.

The unit should take around 180 mA from the +15V and the -15V power rails. If the ASV is taking significantly more than this there is something wrong. The LED should be lit constantly.

Connect a short patch cable between LFO OUT and GATE. The LED should now flash at a speed determined by the LFO Rate control. The range of the rate control will be adjusted during the calibration process.

Remove the patch lead and turn the ENV1 Decay pot to its minimum value. Measure the output voltage on the ENV1 socket. With no jack inserted into the Gate input both envelopes will be in sustain mode. Check that rotating the Sustain pot on ENV1 from its minimum to maximum makes the output voltage go from 0V to around 5V. Repeat this process for ENV2.

Plug in your 1V/octave keyboard or midi to CV convertor into the ASV. The pitch control voltage should be inserted into the Key CV socket and the gate into the gate socket. Pressing a note on your keyboard should light the little LED.

Listen one by one, or monitor on an oscilloscope, to the two VCO sawtooth outputs. Make sure that the pitch of both VCOs changes with the note pressed. It will not be in tune but going up the keyboard should increase the pitch heard. Check that the pitch of each VCO can be changed with its three position octave switch. Check that VCO2's pitch changes significantly with the VCO2 Tune control. Check too that the Sync switch locks the pitch of VCO2 so that the VCO2 Tune control changes only the volume and timbre of the note heard and not the pitch.

Now listen to the pulse wave outputs of each VCO. Check that both pulse wave outputs produce a square wave sound with their respective Pulse Width controls at their centre point. Square waves sound more hollow than non square pulse waves.

If you have an oscilloscope you should ensure that all the VCO outputs, both sawtooth and pulse, are approximately 10V peak to peak. Note that the pulse wave's output will change with respect to 0V; when the pulse is thin the waveform shifts towards +10V, and when the pulse is fat the shift is towards -10V. However, the peak to peak value of the pulse output is still always 10V.

Listen to the output of the mixer via the Mixer Out socket. You should be able to use the front panel's Mixer control to add the chosen outputs of VCO1 and VCO2 together. You should hear nothing with all three levels at their minimums. Both VCO1 and VCO2 level controls have a waveform switch next to them. Make sure that the two switches are doing their job properly.
Turn up the Sub/Ext level pot and make sure you can hear the sub-octave output. It should be a triangle wave although there will be a little extra buzz to it because it is not a pure triangle wave. If you have a 'scope then you may see little glitches in the waveform near the peaks. Note that the signal level at the Mixer Out is considerably quieter than the main VCO outputs. With just one channel turned up full the signal here will be around 3.3V peak to peak, ie. around -10dB lower.

Now pull out the gate connection to the ASV. The unit will be in drone mode once again. Turn

Sustain pot of ENV2 to its maximum. Turn the three Mixer pots, and the four small pots in the filter section to their minimums. Listen to the main output. It should be silent. Now turn up the VCO1 to VCA pot, and you should hear a triangle wave at the same pitch as VCO1. Turn the Sustain pot of ENV2 down and the volume of the triangle wave should also go down.

Turn the Sustain pot back up and the VCO1 to VCA pot down. Turn the filter mode switch to Shape and the Shape control to LP (Low Pass). Now turn up the level control of VCO1 on the mixer and select sawtooth. The signal you hear now will be the one going through the filter. Check that the Frequency and Resonance controls do their usual thing. Turn the Shape control and listen to sound change. It should become a fizzy high pass sound at the HP end and a phaser like sound in the middle. Flip the mode switch into BP and the filter will be in band pass mode. This should accentuate only one narrow band of frequencies and create sounds reminiscent of a wah-wah pedal when the ASV's resonance is turned up.

Turn the VCF FM2 control up and you should hear the LFO modulating the filter's centre frequency. The LFO's waveform is a sine wave. Turn VCF FM2 down and now turn up VCF FM1. This allows VCO2 to modulate the filter and it'll probably just produce burbling out of tune noises at the moment. Turning up the filter's resonance control will accentuate the burbling.

Now insert the gate connection to the Gate input again. Check that the ASV's output is now controlled by your keyboard. Make sure that the envelope controls of ENV2 are behaving correctly.

Turn the ENV1 Depth control to its maximum and now check that ENV1 is behaving correctly. If you have access to velocity CV from your midi-CV convertor or keyboard then connect this to the ENV1 Accent socket. Check that playing harder on your keyboard sweeps the filter more strongly when the ENV1 Depth control is not at its central position.

If all is well then it is time to calibrate your ASV. Please see the User Manual for details on the calibration process.

Final Comments

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

If you can't get your project to work and you are in the UK, 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 directly with questions about sourcing components or general fault finding. Honestly, I would love to help but I 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 SynthDIY and Analogue Heaven mailing lists, and those at Muffwiggler.com.

Tony Allgood at Oakley Sound

Cumbria, UK

Appendix

Introduction

This appendix is only for builders that have ASV board sets that include the early issue 1.1 Pot/Switch Boards. It contains the appropriate parts lists for the issue 1.1 Pot Board and the Issue 1.1 Main Board. The Dual VCO Board and the Socket Board should be built as described in the main part of this document.

An error in the copper tracking of the issue 1.1 ASV Pot Board results in a small amount of bleedthrough from VCO1's reset pulse to the wiper of the PWM pot of VCO2. This manifests itself as a slight instability in VCO2's pulse width when the wiper of PWM pot is set away from either of its ends. The problem was corrected in issue 1.2 Pot Boards by actively summing the pulse width signals on the pot board before sending them to the main board.

Thankfully, even for these early issue boards the problem can be corrected by slightly restricting the frequency response of the amplifier that sums together the control voltages from the pulse width pot and the PWM pot on the main board. This requires a simple modification to the main board of which the details are given later in this appendix.

ASV Main Board issue 1.1 Parts List

Resistors

1% 0.25W metal film types are recommended for most values. R63, R64, R67 and R68 should be high precision 0.1% or better.

R35 is a positive temperature coefficient resistor with a nominal value of 1K and temp. co. of anywhere between +3000ppm/K and 3900ppm/K. Alternatively, it can be a standard 1K resistor if you don't mind a small amount of temperature dependant drift in the centre frequency of the VCF.

Please note that some resistors are different depending on whether you are building your ASV in a MU or MOTM based format.

22R	R79, R80
47R	R109
220R	R72, R74, R75, R78, R160
390R	R25, R27, R31, R32, R85, R86
1K	R149, R131, R139, R128, R141, R152, R130, R143, R142, R140, R159, R153, R51, R129, R135, R137, R155, R136, R132, R146, R138, R144, R65
1K +3300ppm/K	R35
2K2	R5, R16
4K7	R103, R125
6K8	R83, R88
10K	R3, R10, R13, R28, R98, R113, R126, R158
11K	R161

12K	R97, R15, R30, R33, R114, R119, R50, R49
15K	R59, R89, R127, R43, R44, R90, R107, R104, R29, R12
20K	R105
22K	R6, R7, R8, R9, R36, R37, R87
27K	R24
30K	R154, R157
33K	R2, R20, R21, R52, R117
36K	R96, R106, R118, R133, R148
39K	R163, R147, R156, R134, R162, R164, R150, R145
47K	R1, R34, R23, R53, R54, R55, R84
68K	R45, R42
75K	R94, R58
100K	R17, R18, R70, R66, R61, R62, R102, R111, R4, R19, R73, R69, R56, R108, R121, R76, R60, R165, R81, R57, R95, R11, R91, R92, R100, R101
100K/0.1%	R63, R64, R67, R68
120K	R112, R115, R116
150K	R38, R82
180K	R93, R99
220K	R22, R151
240K	R110
300K	R123
470K	R124
680K	R26
910K	R48, R39
1M	R41, R46, R77, R120, R14, R71, R122

For older MOTM/Oakley format

This is to be used if you have already have older Oakley VCOs and want your ASV VCOs to behave identically to the Key CV input. Anyone with a midiDAC issue 4 and older should also build this version.

150K	R40, R47

For MU/Synthesisers.com or later Oakley formats

This is to be used if you have a predominantly MU system and/or have an issue 5 Oakley midiDAC.

220K	R40, R47

Capacitors

100nF axial multi-layer ceramic	C43, C23, C42, C19, C9, C66, C24, C27, C18, C28, C22, C40, C53, C33, C1, C34, C59, C12, C52, C11, C69, C17, C38, C44, C25, C14, C67, C2, C56, C46, C21, C30, C4, C50, C41, C39, C49, C26, C54, C45, C48, C68
10pF C0G ceramic 2.5mm	C13
33pF C0G ceramic 2.5mm	C6, C29, C31
220pF C0G ceramic 2.5mm	C36, C37, Cx*
470pF C0G ceramic 2.5mm	C5, C8, C47, C55, C57
10nF polyester film	C62
22nF polyester film	C64, C65
39nF polyester film	C61, C63
330nF polyester film	C7
220nF polyester film	C51
680nF polyester film	C15
1uF, 63V electrolytic	C60
2u2, 63V electrolytic	C3, C10, C16, C20
10uF, 35V electrolytic	C58
47uF, 25V electrolytic	C32, C35

* Cx is fitted to the underside of the board between pins 1 and 2 of U16. See later for details.

Trimmers

10K multiturn trimmer	SCL1, SCL2
100K multiturn trimmer	TUN1, TUN2
200K multiturn trimmer	OCT1, OCT2
10K 6mm trimmer	F_SCL
50K 6mm trimmer	A_LVL
100K 6mm trimmer	F_OFF1, F_OFF2, A_OFF, F_FREQ, LFO_RNG

Discrete Semiconductors

1N4148 silicon signal diode	D1, D2, D3, D4, D5, D6, D7, D8, D11, D12, D13, D14, D16, D17
BAT42 Schottky signal diode	D15, D18
1N5819 Schottky power diode	D9, D10
BC549 NPN transistor	Q3, Q7, Q8
BC559 PNP transistor	Q1, Q2, Q4, Q9, Q10
J201 FET	Q5, Q6

Integrated Circuits

CD4013 dual D-type flip-flop	U26
CD4093 quad NAND gate	U21
4558 dual op-amp	U10
AS3310 envelope generator	U24, U25
LM13700 dual OTA	U8, U14, U15
LM4040-10 10V reference	U2
LT1013 dual op-amp	U3, U11, U19
OPA2134 dual audio op-amp	U12
TL072CN dual op-amp	U22, U6, U16, U17, U13, U20
TL072ACP dual op-amp	U4, U18
78L12 100mA +12V regulator	U1, U7
79L05 100mA -5V regulator	U23
79L12 100mA -12V regulator	U5, U9

Miscellaneous

Ferrite bead	L1, L2, L3, L4
MTA100 3 way	BUS
MTA100 2 way	OUT
MTA100 6 way	PWR1, PWR2
MTA156 4 way	PSU1, PSU2
2 x 8 way 0.1" boxed header *	HDR1, HDR2, HDR3
10-way SIL 0.1" socket **	CN1, CN2, CN3, CN4, CN5, CN6, CN7, CN8
10-way SIL 0.1" header	OSC1, OSC2, OSC3

* If you have bought polarised headers for HDR1, HDR2 and HDR3, then they must be aligned correctly. Pin 1 lines up with the square pad on the PCB. Pin 1 is normally depicted by a small triangle on the body of the header.

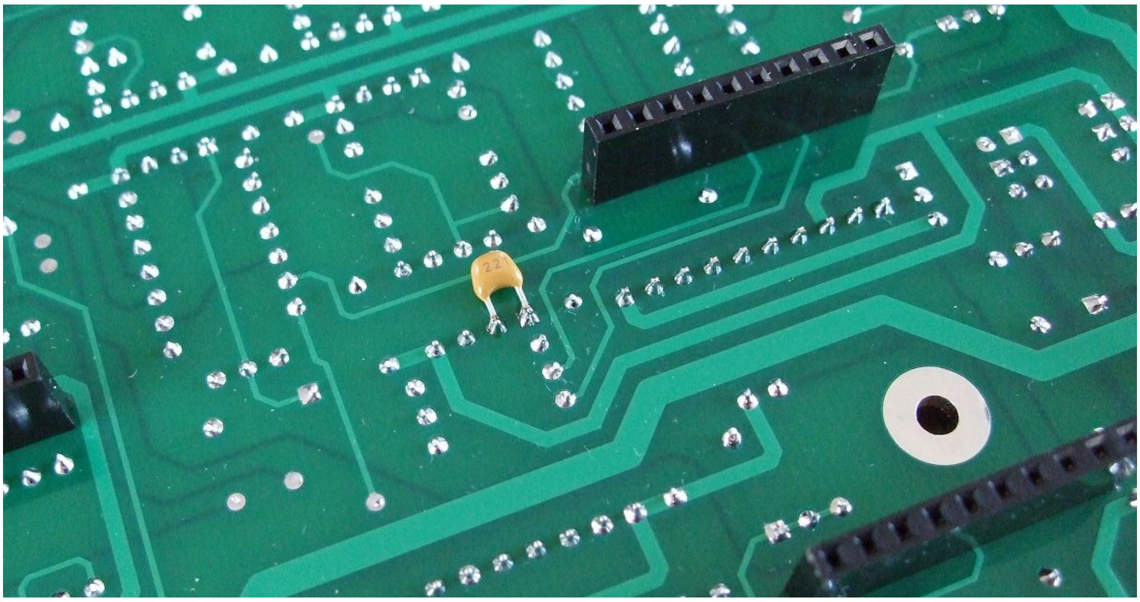
** CN1 to CN8 mounted on the underside of the board, facing down, and soldered from the top.

IC sockets are optional but recommended for DIY projects. There are thirteen 8-pin, two 14-pin and five 16-pin DIL sockets used on the main board.

The Modification to issue 1.1 Main Board

A 220pF 2.5mm C0G/NP0 ceramic capacitor should be placed between pins 1 and 2 of U16 on the underside of the issue 1.1 ASV **Main** board.

This modification is not required when the Main Board is used with issue 1.2 or 1.3 Pot Boards.



ASV Pot & Switch Board issue 1.1 Parts List

Resistors

1% 0.25W metal film types are recommended for most values. R1, R2, R3 and R4 should be high precision 0.1% or better.

220R	R27
2K2	R5, R29
22K	R21, R22, R23, R24, R14, R26, R28
22K/0.1%	R1, R2, R3, R4
47K	R9, R10, R15, R17
62K	R12, R13, R20
100K	R8, R16, R18
180K	R6
470K	R7, R11, R19, R25

Capacitors

100nF axial multi-layer ceramic	C1, C7, C8, C5, C15, C3, C12, C16, C11
33pF C0G ceramic 2.5mm	C6, C9
100pF C0G ceramic 2.5mm	C2, C14
2u2, 50V polyester *	C10, C17, C18, C19
2u2, 63V electrolytic **	C4, C13

* WIMA MKS2B042201F00KSSD are recommended due to their smaller height.

** These should be miniature or low profile types to allow them to fit under the panel. However, ordinary full height parts can be used if they are laid down flat.

Discrete Semiconductors

1N4148 silicon signal diode	D1, D2, D3, D4
BC549 NPN transistor	Q1
BC559 PNP transistor	Q2
LED 5mm green	GATE – solder only when panel is in position

Integrated Circuits

LM4040-10 10V reference	U3
LT1013 dual op-amp	U2
TL072ACP dual op-amp	U1, U4, U5

Potentiometers

50K linear	ENV1_DEPTH, VCF_FREQ, LFO_RATE, ENV1_SUSTAIN, VCO2_LEVEL, SUB/EXT_LEVEL, ENV1_RELEASE, ENV1_DECAY, RESONANCE, ENV2_ATTACK, VCO2_PW, VCO1_PW, ENV2_RELEASE, VCO2_TUNE, VCO2_PWM, VCO1_PWM, VCF_FM1, TUNE, VCF_TRACK, VCO1_LEVEL, VCF_FM2, ENV2_DECAY, ENV1_ATTACK, VCO1_VCA, SHAPE, ENV2_SUSTAIN
50K audio (log)	VCO1/2_FM, VCO2_FM

I recommend additional M7 flat washers for all 28 pots to go between the pot and the inside surface of either the MOTM format panel or the shim panel for MU builds. I recommend using the same thickness of flat washer as those that come with the pots.

Switches

SPDT on-on switch	VCO1_WAVE, SYNC, BP/SHAPE
SDPT on-off-on switch	VCO1_OCT, VCO2_OCT
DPDT on-on switch	VCO2_WAVE

Miscellaneous

10-way SIL header *	CN1, CN2, CN3, CN4, CN5, CN6, CN7, CN8

* SIL headers fitted to the underside of the board and soldered from the top. ie. the pins face down.

IC sockets are optional but recommended for DIY projects. There are four 8-pin DIL sockets used on the ASV pot/switch board.