Oakley Sound Systems

5U Oakley Modular Series

Flanger

PCB Issue 2

Builder's Guide

V2.4

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Introduction

This is the Project Builder's Guide for the issue 2 5U Flanger module from Oakley Sound. This document contains a basic introduction to the board, a full parts list for the components needed to populate the boards and a list of the various interconnections.

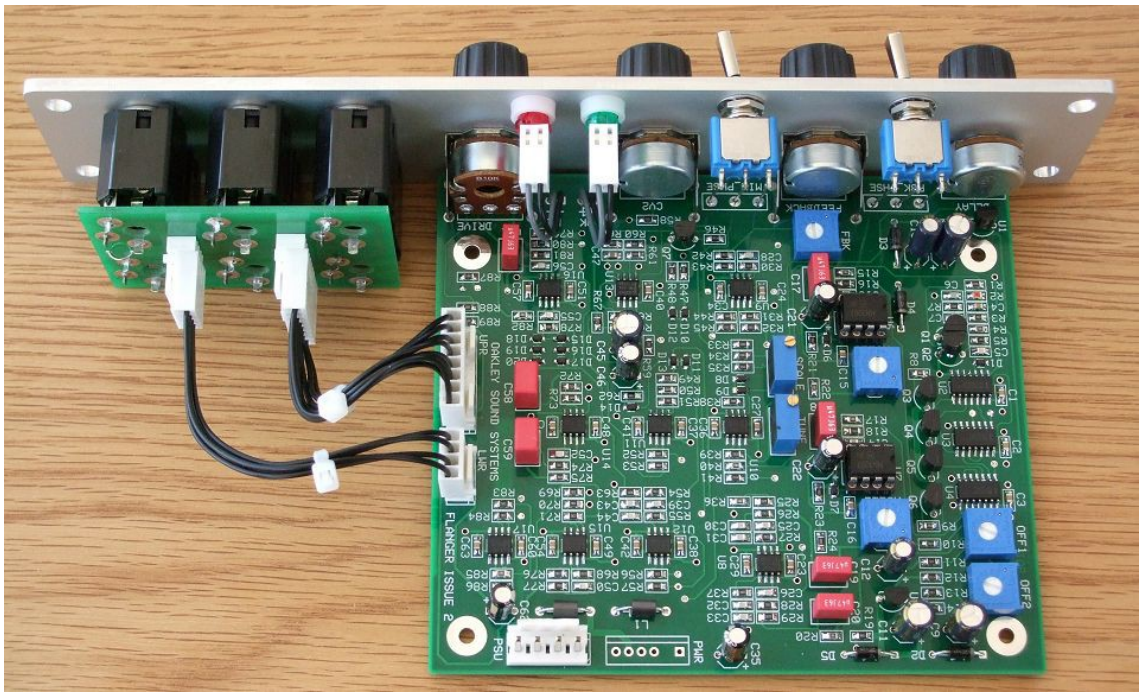
For the User Manual, which contains an overview of the operation of the unit and the calibration procedure, please visit the main project webpage at:

http://www.oakleysound.com/flg.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 Flanger PCB



The issue 2 Oakley Flanger as a single width MOTM format module in a natural finish Schaeffer panel. Note also the use of the optional Sock6 socket board to help keep the wiring to the sockets neat and tidy.

On the 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 some 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 board is a four layer design. This means that the board has layers of copper on top and bottom sides and two internal copper layers. The underside in one solid, with the exception of a few solder pads and vias, copper plane connected to module ground (0V). A well powered soldering iron is required to solder any through hole pins that are connected to this ground plane.

The design requires plus and minus 15V supplies. The power supply should be adequately regulated. The current consumption is around +75mA and -45mA. Power is routed onto the main PCB by either our standard four way 0.156” MTA156 type connector, labelled PSU, or the special five way Synthesizers.com MTA100 header, labelled PWR. The four pins of the header PSU are +15V, 0V or module 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.

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 124mm (high).

Flanger Issue 2 Parts List

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.

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

Many of the parts for this circuit board are surface mount devices but not all of them. Take special care when ordering your parts that you order the correct type of part. This parts list shows the type of part needed whereas the circuit diagram does not.

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

All resistors are surface mount, size 0805 (or metric 2012) 1% 125mW metal film.

22R	R59, R14
47R	R19, R6
75R	R62
120R	R48, R88
470R	R46
1K	R80, R89, R79, R77
1K3	R65
2K2	R66
3K9	R31, R5, R44
4K7	R16, R18, R61
5K6	R64
6K2	R29, R25
8K2	R63
10K	R45, R23, R7, R21, R32, R58
12K	R37, R27, R55
13K	R54, R26, R28
15K	R9, R8
20K	R3
22K	R52, R47, R53, R81, R71, R68, R76
27K	R42
33K	R84, R69, R39, R70, R30, R74, R43, R13, R56, R57, R11, R83
47K	R12, R41, R49, R10, R67, R50, R72, R73, R75
56K	R1
68K	R38

91K	R35
100K	R33, R78, R87, R24, R82, R17, R85, R86, R40, R4, R20, R36, R15, R22
180K	R34
390K	R51
3M3	R60

1K temperature sensor* R2

* Temperature coefficient can be between +3000ppm/K to +3900ppm/K.

Capacitors

The following capacitors are surface mount, size 0805 (or metric 2012) multilayer ceramic, dielectric C0G (or NP0), working voltage 50V (except where stated), tolerance +/-5%.

18pF	C5
47pF	C55, C52
100pF	C50, C28
220pF	C31, C44, C56, C32
1nF	C14, C13
1n5	C43, C30, C33
2n2	C25, C39, C26
4n7	C6
10nF	C47
47nF, 25V	C7

The following capacitors are surface mount, size 0805 (or metric 2012) multilayer ceramic, dielectric X7R, working voltage 50V, tolerance +/-5%.

100nF (0.1uF)	C34, C15, C2, C1, C40, C3, C60, C27, C36, C23, C16, C63, C4, C37, C41, C42, C38, C29, C51, C54, C57, C53, C48, C49, C24

The following capacitors are standard through hole polyester film capacitors with 0.2” (5mm) radial leads.

1uF, 63V	C59, C58
470nF, 63V	C18, C20, C19, C61, C17

The following capacitors are standard through hole electrolytic capacitors with 0.1” (2.54mm) radial leads.

2u2, 63V	C35, C62
4u7, 50V	C12, C10
10uF, 35V	C21, C22, C46

47uF, 35V	C8, C11, C45, C9

Discrete Semiconductors

The following devices are surface mount parts.

BZX384-C5V1 5V1 zener diode	D8, D9
BAT42WS schottky diode	D11, D13
1N4148WS signal diode	D17, D6, D18, D7, D19, D1, D20, D14, D15, D16, D12, D10

The following devices are standard through hole parts.

1N4004 rectifier diode	D2, D3, D4, D5
BC550 NPN small signal transistor	Q2, Q3, Q5
BC560 PNP small signal transistor	Q1, Q4, Q6, Q7

Q1 and Q2 can be secured together with a cable tie for temperature stability.

LEDs

Red 5mm LED	PK
Green 5mm LED	OK (SIG on front panel)

Suitable lenses and mounting clips as required.

Both LEDs are mounted to the panel and are connected to the board using a procedure of your choice. The recommended way is to use two Molex sockets, ie. two sets of 2-way housings and four crimps.

Integrated Circuits

The following devices are standard through hole parts.

78L09 +9V 100mA regulator	U5
79L09 -9V 100mA regulator	U1
V3207 Coolaudio BBD	U6, U7

The Belling BL3207 or Panasonic MN3207 may be used instead of the Coolaudio V3207. Two 8-pin DIL sockets are recommended for the BBDs.

The following parts are all surface mount devices. All are small outline (SOIC) packages.

LM2903D dual comparator	U13
TL072ACD dual FET op-amp	U11, U12, U16, U10, U9, U15, U14, U17, U8

CD4011BM quad NAND gate	U3
CD4013BM dual flip flop	U4
CD4069UBM hex inverter	U2

Trimmers (preset) resistors

5K 6mm	NULL2, NULL1
22K 6mm	FBK
50K 6mm	OFF1, OFF2
20K multiturn	SCALE
100K multiturn	TUNE

The 6mm single turn trimmers are Bourns 3386F or similar.

The multiturn trimmers are Bourns 3296W, Vishay T93YA or similar.

Potentiometers (Pots)

All pots Alpha 16mm PCB mounted types.

47KB (or 50KB) linear	DELAY, FEEDBACK, CV2
10KB (or 50KB) dual/stereo linear	DRIVE

Three 16mm pot brackets.

Switch

Two 'single pole double throw' SPDT toggle switches are required for MIX and FBK.

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 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	

Other Parts Required

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

Four 20mm knobs.

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

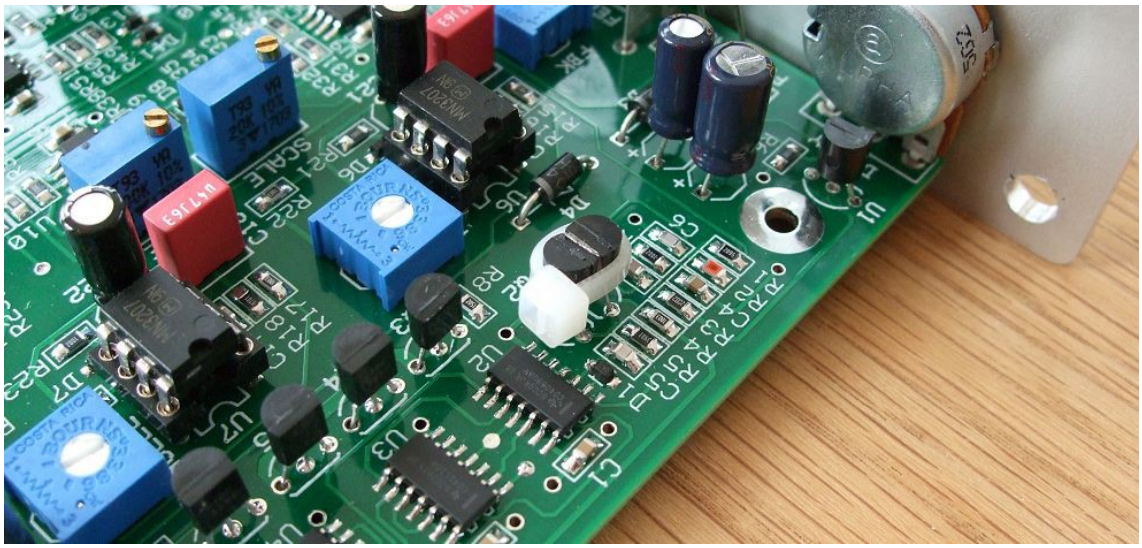
Components required if using optional Sock6 board

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

A wire link, L1 on the Sock6 PCB, is to be fitted. Simply solder a wire hoop made from a resistor lead clipping to join the two pads of L1 together.

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.



Q1 and Q2 can be secured together with a cable tie as shown to reduce the amount of clock frequency drift with temperature. A very thin layer of heat sink paste between them improves the thermal bonding.

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 ground (0V)	2
Socket ground	3
-15V	4

Pin 1 on the LWR header is connected to pin 3 of the PSU header and has been provided to allow the ground tags of the jack sockets to be 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.

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.

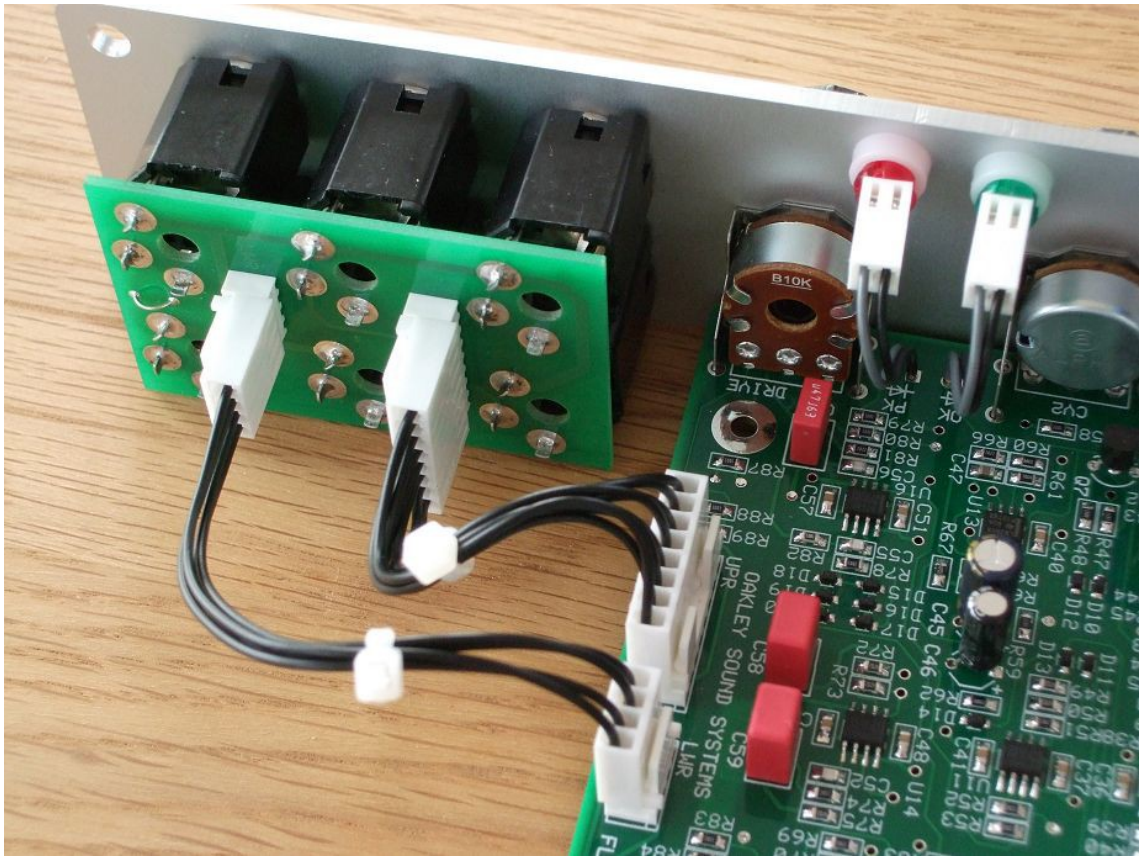
If fitting the PWR header, you will also need to link out pins 2 and 3 of PSU. This connects the panel ground with the module ground. Simply solder a solid wire hoop made from a resistor lead clipping to join the middle two pads of PSU together.

Building the Flanger 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 be fitted to the Sock6 board. Simply solder a wire hoop made from a resistor lead clipping to join the two pads of L1 together.

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 Sock6 board makes it much easier to build the module. Here I have used Molex 0.1" KK headers and housings. This is a 'strip and crimp' system that is cheap but very reliable.

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 the 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	Not Used		
Pin 2	DELAY_OUT	DLY OUT	Signal
Pin 3	Not Used		
Pin 4	MIX_OUT	MIX OUT	Signal
Pin 5	FBK_OUT	FBK IN	NC
Pin 6	FBK_IN	FBK IN	Signal
Pin 7	Module ground	INPUT	NC
Pin 8	AUDIO_IN	INPUT	Signal

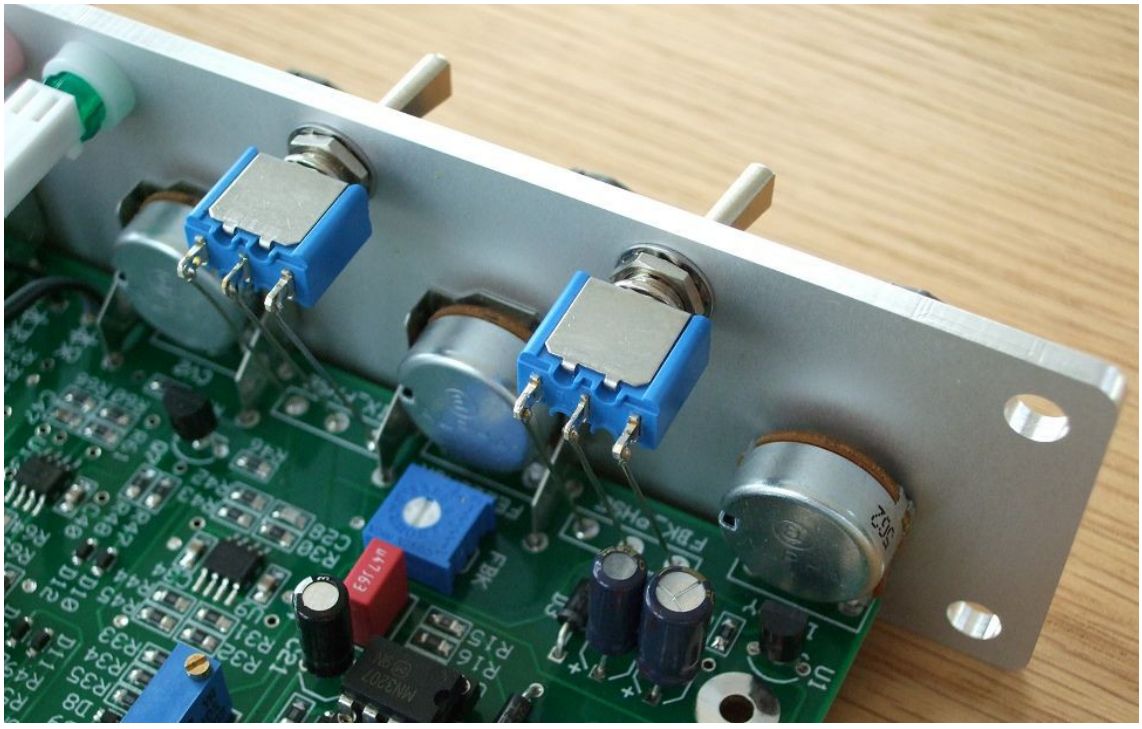
LWR

Pin	*Pad name*	*Socket*	*Lug Type*
Pin 1	Panel ground	Connects to all sockets	Ground lugs
Pin 2	CV2	CV2	Signal
Pin 3	Module ground	CV1 & CV2	NC
Pin 4	CV1	CV1	Signal

Wiring the Switches

The Oakley Flanger features two of the same type of switch. They are two position ON-ON switches.

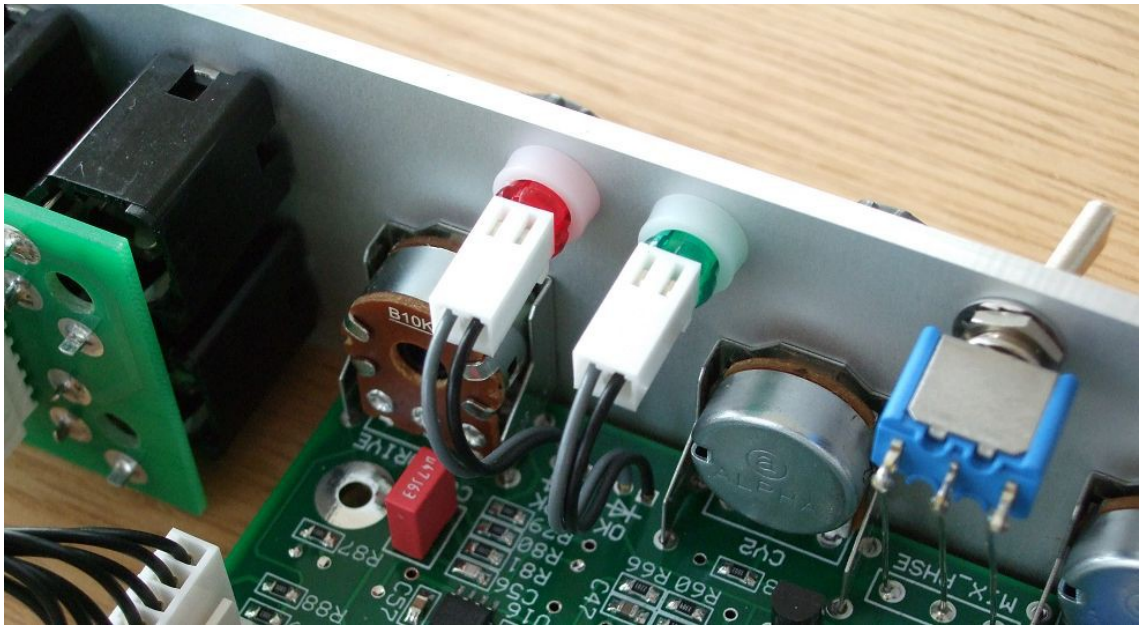
You should wire each switch as you would other Oakley modules. I typically use thin solid core wire rather than insulated multi-strand wire. This keeps the connection firmly in place and very neat. I normally bend the wire at one end into a hook and place the straight end into the PCB pad's hole. I then 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.



These are Apem SPDT (on-on) toggle switches. Note that the switches' washers are on the inside of the panel.

Wiring the LEDs

The Oakley Flanger features two LEDs which are held in place on the panel with LED lenses and clips. These are wired to the main board in similar fashion to other Oakley 5U modules.



Here I have used a Molex 0.1" KK header and crimps to attach each LED to the PCB. The LED is thus not soldered to the wiring allowing the board to be easily removed from the front panel.

Testing, testing, 1, 2, 3...

Turn the Feedback and Drive pots to their minimum value. Turn the Delay and CV 2 pots to their mid points. Set both offset adjustment trimmers, OFF1 and OFF2, to their middle positions. 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, and the direction of the ICs in their sockets and the polarity of the electrolytic capacitors. Neither LED should be on although they may flash briefly on power up.

Assuming everything is OK so far, it is time to apply an audio input. Use a bright signal like a sawtooth output from a VCO and connect this to the socket INPUT. The A below middle C, 220Hz, is a good note to use.

Connect your amplifier or mixing desk input to the DLY OUT socket. You should be able to hear the sawtooth signal. It will be about 9dB lower in volume than the signal going in. You may, if you have good ears, notice that the sound is slightly less bright as the higher frequency parts of the sawtooth are being filtered by the anti-aliasing filters of the Flanger.

Turn up the Drive pot and you should find that the green LED will light as the pot is taken past the 9 o'clock mark. As you increase it still further you will probably notice that the sound changes a little and may even get distorted. As the Drive pot is taken past mid way the red LED should light and the sound, even if it were clean before, will now sound reedy and may have lost some power. If all this happens the input and output stages, and LED driver circuitry, are working. Move the Drive pot back its minimum position again.

Now move the Delay pot. If you move it very slowly you'll notice only a slight change in the sound. Move it fast, and the pitch will shift noticeably and somewhat drunkenly. At its highest settings the volume of the output will be slightly lower. This is because the BBDs can't transfer the audio input through to their outputs efficiently when clocked at a very high speed. If at the lowest settings you start to hear a high pitched whistle and other strange noises, do not worry as this will be removed when we calibrate the module. If all is well then the BBDs, the high frequency clock circuitry and CV control are probably working.

Listening to the delayed output with the sawtooth input still connected, patch a triangle wave or sine wave LFO to the CV2 input. You should start to hear, as you move CV2 away from its mid point, an increasing amount of pitch modulation. Using a triangle wave will produce a more 'dee-dah' pitch change, while a sine wave will be more gentle.

Now try the CV1 input. This should have the same affect as the CV2 input but you'll not be able control the depth of the modulation. The pitch shifting, thanks to the sensitive 1V/octave relationship, will be dramatic.

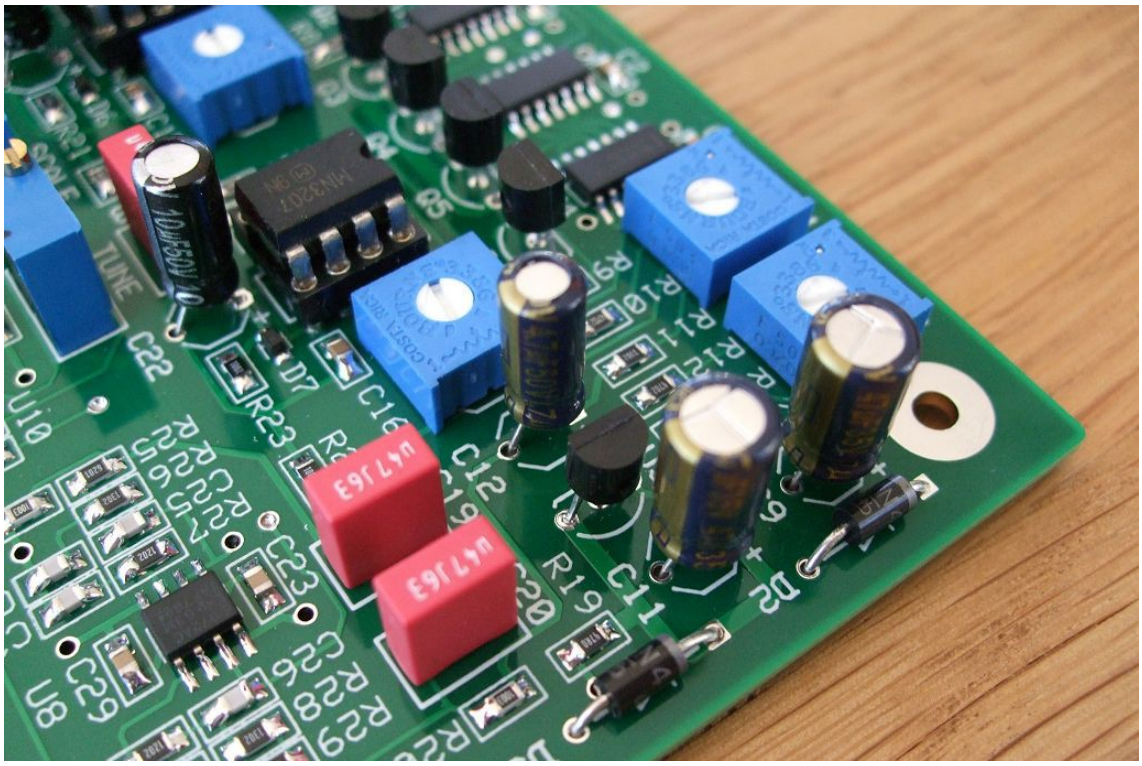
Remove the LFO and plug your amplifier or mixer into the MIX OUT. The mix output is simply the mix of the of the delayed signal and the input signal. Set the MIX switch to POS. Listen to the sound as you sweep the Delay pot. It should sound similar to two nearly matched VCOs. With the Delay pot stationary the effect should stop.

Now change the MIX switch to NEG. When the Delay time is swept you should get a similar sound to changing the pulse width on a VCO. There will be a few points in the travel of the delay pot where the sound will thin out completely as the now inverted delayed sawtooth cancels out the original sawtooth input.

Now change the MIX switch back to POS and ensure that the FBK switch is set to POS also. Turn up the Feedback pot carefully. We have not yet set the feedback gain in the calibration process so it is possible to get uncontrolled oscillation which may startle you. Sweeping the delay pot with the feedback pot turned up will create the classic flanged sound. If it doesn't sound that obvious, or it is howling like a wolf, playing with the FBK trimmer will adjust the maximum level of the feedback signal.

Clicking both switches to the NEG position should change the sound, but still obviously a flanging effect, to become more woody and reedy.

If all this happens, the chances are that you have a working module and the unit is ready for full calibration. The calibration details can be found in the User Manual.



These single turn trimmers are Bourns 3386F.

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 and you are in the EU, 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 Synth-diy and Analogue Heaven mailing lists and those at Muffwiggler.com.

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