Oakley Sound Systems

5U Oakley Modular Series

MOSPhaser
Voltage Controlled Phaser

PCB Issue 1

Builder's Guide

V1.7

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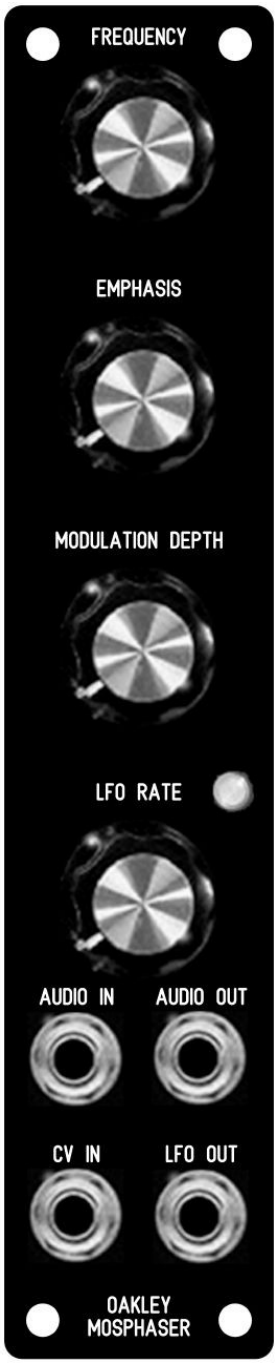


The 1U wide panel design for the MOSPhaser for MOTM format systems. The fpd file for this panel can be found on the project webpage.

Introduction

This is the Project Builder's Guide for the issue 1 MOSPhaser 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 boards, and a list of the various interconnections.

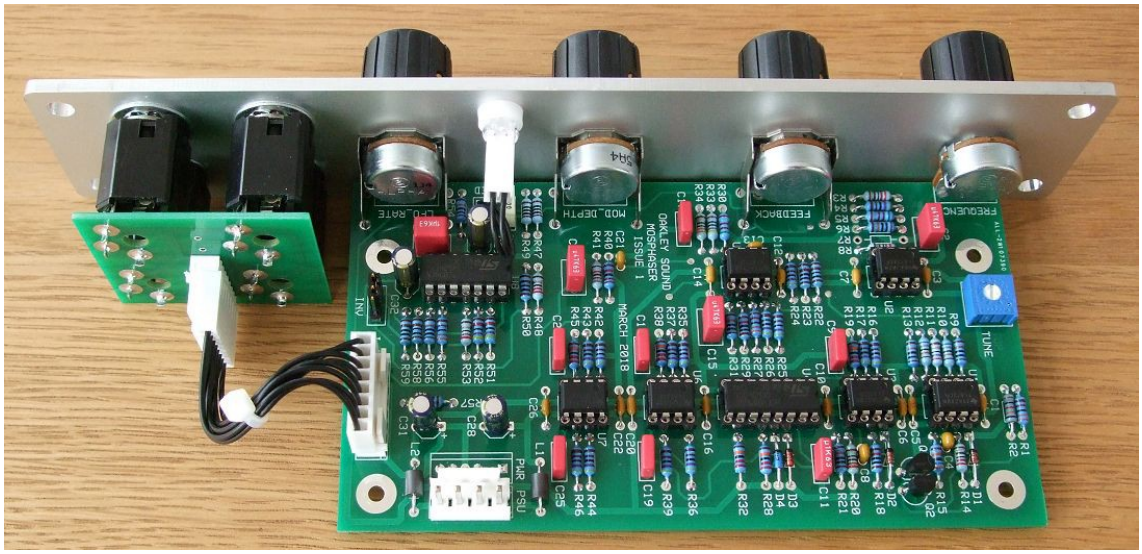
The main project webpage can be found at:

http://www.oakleysound.com/MOSPhaser.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 MOSPhaser PCB



This is the issue 1 Oakley MOSPhaser behind a natural finish Schaeffer panel. Note the use of the optional Sock4 socket board to facilitate the wiring up of the sockets.

I have provided space for the four main control pots on the PCB. If you use the specified 16mm Alpha pots and matching brackets, the PCB can be held firmly to the panel without any additional mounting procedures. The pot spacing is 1.625” and is the same as the vertical spacing on the MOTM modular synthesiser and most of our other modules.

The design requires plus and minus 15V supplies. The power supply should be adequately regulated. The current consumption is about 35mA for each rail. Power is routed onto the PCB by a four way 0.156” MTA156 type connector or the special five way Synthesizers.com MTA100 header. You could, of course, wire up the board by soldering on wires directly. 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 PCB has four mounting holes for M3 bolts, one near each corner. These are not required if you are using the three 16mm pot brackets.

The board size is 143mm (high) x 77mm (deep).

The board has been laid out to accept connection to our Sock4 socket board. This small board speeds up the wiring of the eight sockets and reduces the chances of mistakes.

Issue 1 MOSPhaser Parts List

For general information regarding where to get parts and suggested 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.

Resistors

1% 0.25W metal film types are recommended.

22R	R53, R48
100R	R47, R49
220R	R20
470R	R33
510R	R5, R30
1K	R22, R23, R57, R58, R50, R59
1K +3000ppm/K	R2
2K2	R3, R14, R8
3K3	R34
4K7	R36, R39, R4, R42, R46, R43, R26, R44, R17, R24, R25, R37, R35, R16
10K	R18, R29
22K	R40
33K	R1, R27, R55
47K	R51, R52
82K	R41
100K	R31, R54, R13, R9, R6, R21, R56
220K	R32, R19, R38, R45, R28
270K	R11
360K	R15
680K	R10, R12

R7 is not fitted and the space is left empty.

R2 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 phaser.

Trimmer

100K trimmer (eg. Bourns 3386F)	TUNE

Potentiometers

All pots Alpha 16mm PCB mounted types.

10K linear or reverse log	FEEDBACK
50K linear	FREQUENCY, MOD_DEPTH
50K log	LFO_RATE

Three 16mm pot brackets.

Capacitors

100nF axial multilayer ceramic	C20, C7, C3, C16, C22, C12, C14, C10, C6, C5, C1, C26
100pF 2.5mm C0G ceramic	C21
470pF 2.5mm C0G ceramic	C13, C8, C4
1nF, 100V polyester	C27
47nF, 63V polyester	C18, C17, C9, C25, C19, C24
100nF, 63V polyester	C11
470nF, 63V polyester	C2, C15
1uF, 50V polyester	C23, C30
2u2, 63V electrolytic	C28, C31
22uF, 35V electrolytic	C32, C29

Discrete Semiconductors

1N4148 signal diode	D1, D2
5V1 zener diode	D3
BAT42 Schottky diode	D4
BC549C NPN transistor	Q1, Q2
Bi-colour 5mm LED	LED – not fitted directly to board

Integrated Circuits

CD4009UBE* CMOS hex inverter	U4
TL072CP	U1, U2, U3, U5, U6, U7
TL074CN	U8

* The HCF4009UBE may also be used.

The 4009UBE is easily damaged with static discharge. Take special care when handling this device. IC sockets are not necessary but I would advise using a 16-pin DIL socket for U4.

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	I/O	– for connecting to sockets
Molex/MTA 0.1” housing 8-way	I/O	– for connecting to sockets
3 way 0.1” header	INV	
0.1” jumper	For fitting to INV	
Molex/MTA 0.1” housing 2-way	LED (optional connecting technique for the LED)	
5mm clear LED lens	LED	
5mm LED lens securing ring	LED (if lens is not self securing)	
Switchcraft 112APC 1/4” sockets	Four off mounted either on the Sock4 board or on panel	

Four knobs

Around 2m of insulated multistrand hook up wire.

Components required if using optional Sock4 board

Molex/MTA 0.1” header 8-way	I/O (mounted on reverse side of PCB)
Molex/MTA 0.1” housing 8-way	I/O
112APC Switchcraft 1/4” socket	SK1, SK2, SK3, SK4

A single wire link is to be fitted to L2 on the Sock4 PCB. L1 is left open.

If using Molex KK you'll also need at least 16 crimp terminals.

Suitable lengths of wire to make up the single 100mm interconnect and two cable ties.

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 power 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.

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.

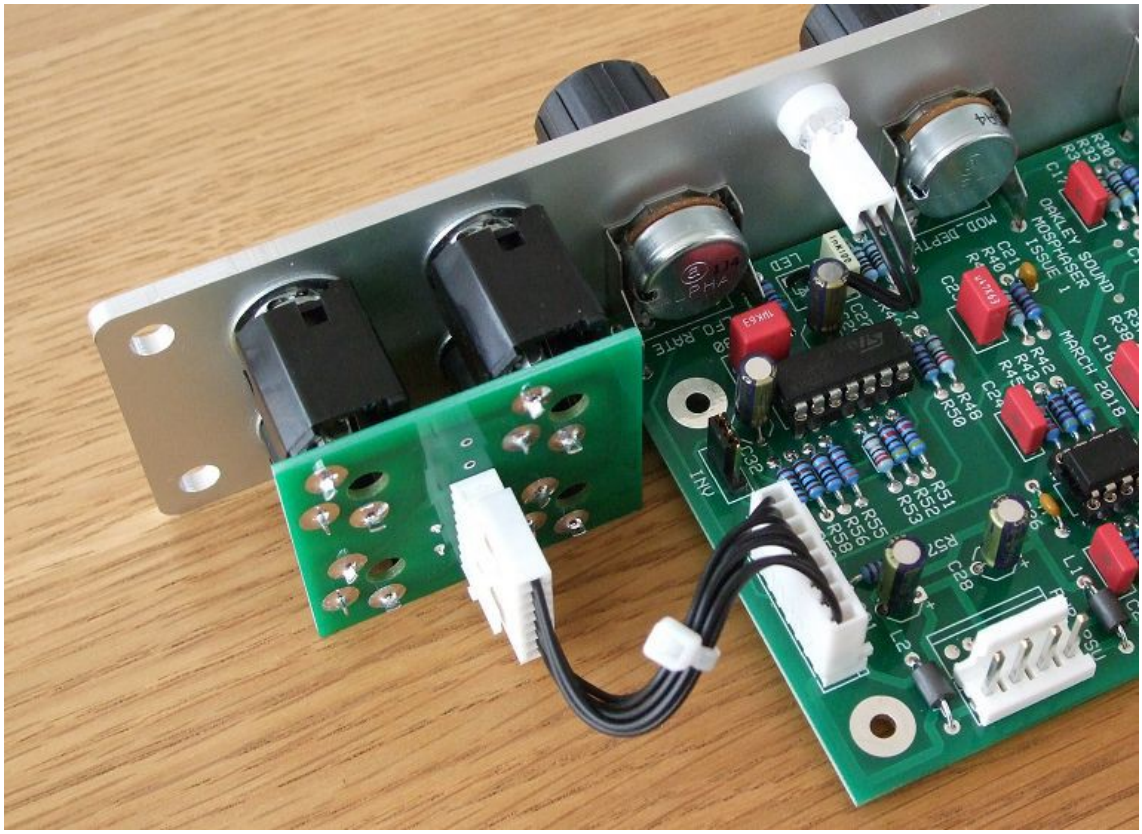
If fitting the PWR header, you will also need to link out pins 2 and 3 of PSU. This connects the panel ground with the module ground. Simply solder a solid wire hoop made from a resistor lead clipping to join the middle two pads of PSU together.

Building the MOSPhaser module using the Sock4 board

This is the simplest way of connecting all the sockets to the main board. The Sock4 board should be populated in the way described in our construction guide found on the project webpage. There is only one eight way header and it is to be fitted to the bottom side of the board.

Do not forget to solder in the wire link L2. Link L1 is left open.

You need to make up only one eight way interconnect. It should be made so that it is 100mm long.



The prototype unit showing the detail of the board to board interconnect. Here I have used the Molex KK 0.1" system to connect the Sock4 to the main PCB.

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.

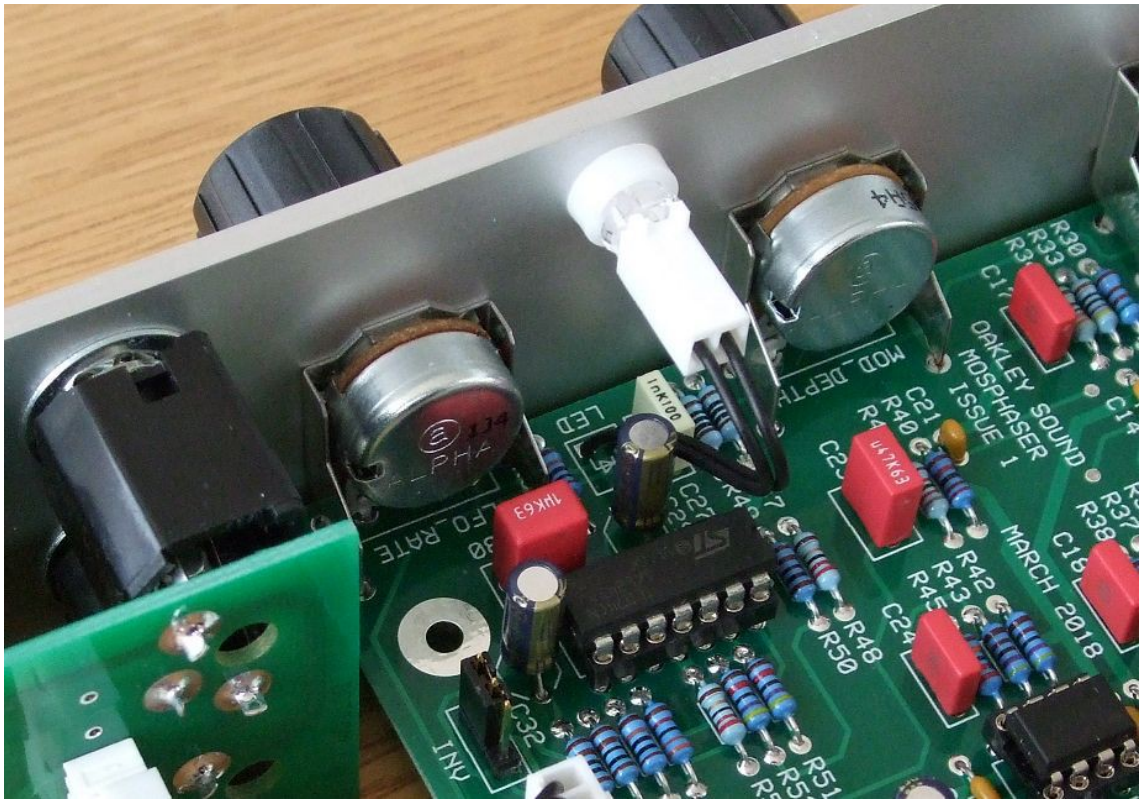
Once fitted to the front panel the ground tags of each socket can be all connected together with solid wire. I use 0.91mm diameter tinned copper wire for this job. It is nice and stiff, so retains its shape. A single piece of insulated wire can then be used to connect those connected earth tags to pin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

Pin	*Pad name*	*Socket Connection*	*Lug Type*
Pin 1	PANEL_GND	Connect to all sockets	Earth lugs
Pin 2	LFO_OUT	Connect to LFO OUT	Signal lug
Pin 3	NC	No connection	
Pin 4	AUDIO_OUT	Connect to AUDIO OUT	Signal lug
Pin 5	NC_LFO	Connect to CV IN	NC lug
Pin 6	CV_IN	Connect to CV IN	Signal lug
Pin 7	GND	Connect to AUDIO IN	NC lug
Pin 8	AUDIO_IN	Connect to AUDIO IN	Signal lug

Wiring the LED

The Oakley MOSPhaser has one LED which is held in place on the panel with a LED lens and clip. These are wired to the main board in similar fashion to other Oakley 5U modules.



Using a two way Molex KK housing to connect the bi-colour LED to the circuit board. The LED is held onto the panel with a clear Cliplite lens, or equivalent.

Bi-colour LEDs have just two legs and each one should go to the solder pad directly beneath it when it is mounted into the panel. I normally wire it up so that the LED goes red when the non inverted output is positive.

You can either solder your connecting wires to the LED's legs or use a MTA or Molex connector to make the connection.

Testing

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.

The unit should take no more than around 35mA from the +15V and the -15V power rails. The LED should be lighting up and moving from red to green continuously. If it doesn't turn off, and check all the parts again thoroughly. If your LED is OK, and there is no smoke rising from the board, then try the LFO Rate control. It should control the LED's flashing. From around one cycle every 70 seconds to around 8 cycles a second.

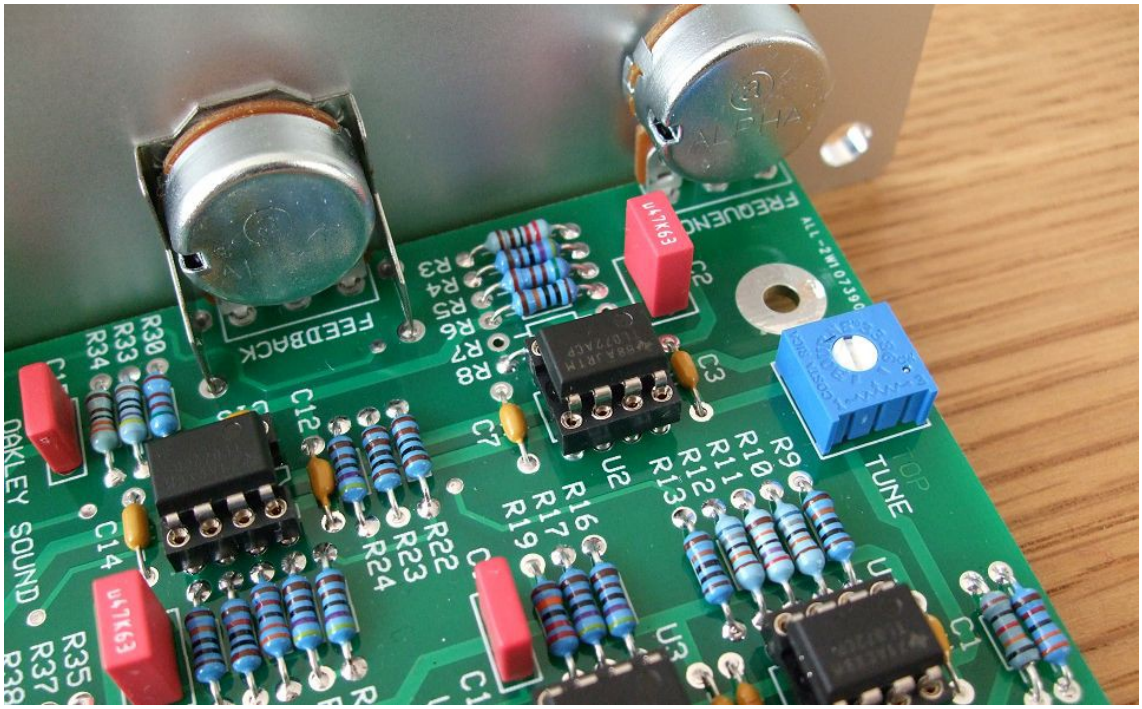
Now input an audio signal of some sort, any will do, but a simple sawtooth wave at around 220Hz is quite sufficient. Listen to the audio output, and play with the controls. With all controls to the minimum setting, sweep the FREQUENCY pot. Do you hear the characteristic phase sweep? If not, you have got a problem. If yes, now turn up the EMPHASIS. Using the frequency pot again, does the sweep have a more metallic ring to it.

Now set the frequency and emphasis pots to their middle position. Turn up the MODULATION DEPTH. The LFO should now be modulating the phaser. Check that the LFO RATE control affects the speed of the modulation.

Calibration

Apply power to module and allow to warm up for a few minutes. Turn the Frequency and modulation controls to their minimum positions.

Measure the voltage across zener diode D3 – which is to the right of U4, the 4009UBE. Adjust the trimmer labelled TUNE so that the voltage across D3 reads 0.75V.



There is one trimmer on the MOSPhaser board. This is a Bourns 3386F.

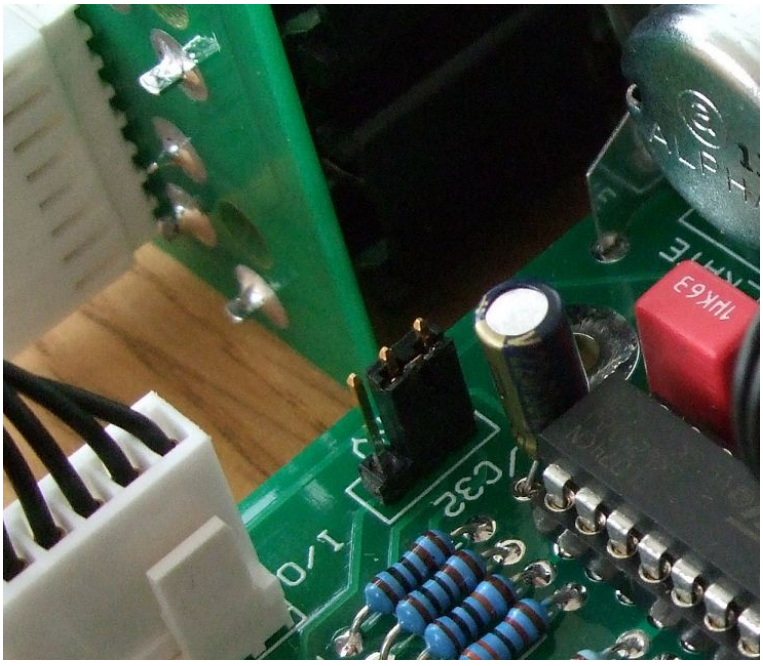
The Low Frequency Oscillator Output

The internal LFO circuit produces a triangle wave output of approximately +/-5V which is also available from a dedicated front panel socket. This allows you to use the MOSPhaser's internal LFO for other modulation purposes. The LFO's output signal is automatically routed to the modulation depth pot when no jack is inserted in the CV input.

The LFO OUT socket can be configured as normal or inverted. In normal mode the LFO output is in phase and is simply a copy of the signal being sent to the phaser circuitry. That is the voltage output from the LFO OUT socket rises as the phaser frequency moves upwards. In inverted mode the LFO output is an inverted signal. Thus when the phaser is being swept upwards, the LFO OUT signal is going downwards. The mode is selected by the position of a movable jumper found at the lower edge of the circuit board. The position of the jumper does not affect the polarity of any CV IN signal.

When the jumper is fitted across the two pins nearest the front panel the output from LFO OUT is inverted. When the jumper is fitted across the two pins furthest from the front panel the signal from LFO OUT is in phase with the internal modulation. If no jumper is fitted the LFO OUT socket will not produce any signal.

By having two MOSPhaser modules you can use one to modulate the other. Simply connect the LFO OUT of one (the master) to the CV IN of the other (the slave). You can now modulate both phasers with the master's LFO. If the LFO mode is set to non inverting this will allow for true stereo phasing, whereby both channels are treated equally. With mode set to invert then you will create a form of stereo phase panning, where each phaser moves in an opposite direction to give a wide stereo effect.



Here we can see the three pin header and two way jumper that selects the LFO mode. In the position shown in the photograph the LFO OUT will produce an inverted signal.

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 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 Synth-diy and Analogue Heaven mailing lists and those at Muffwiggler.com.

Tony Allgood at Oakley Sound

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