Oakley Sound Systems

5U Oakley Modular Series

Sample/Slew

PCB issue 5 & 5.1

Builder's Guide

V5.4

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Introduction

This is the Project Builder's Guide for the issue 5 and 5.1 Sample/Slew 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 web page at:

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

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.

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 web page or http://www.oakleysound.com/construct.pdf.

Issue 5 changes

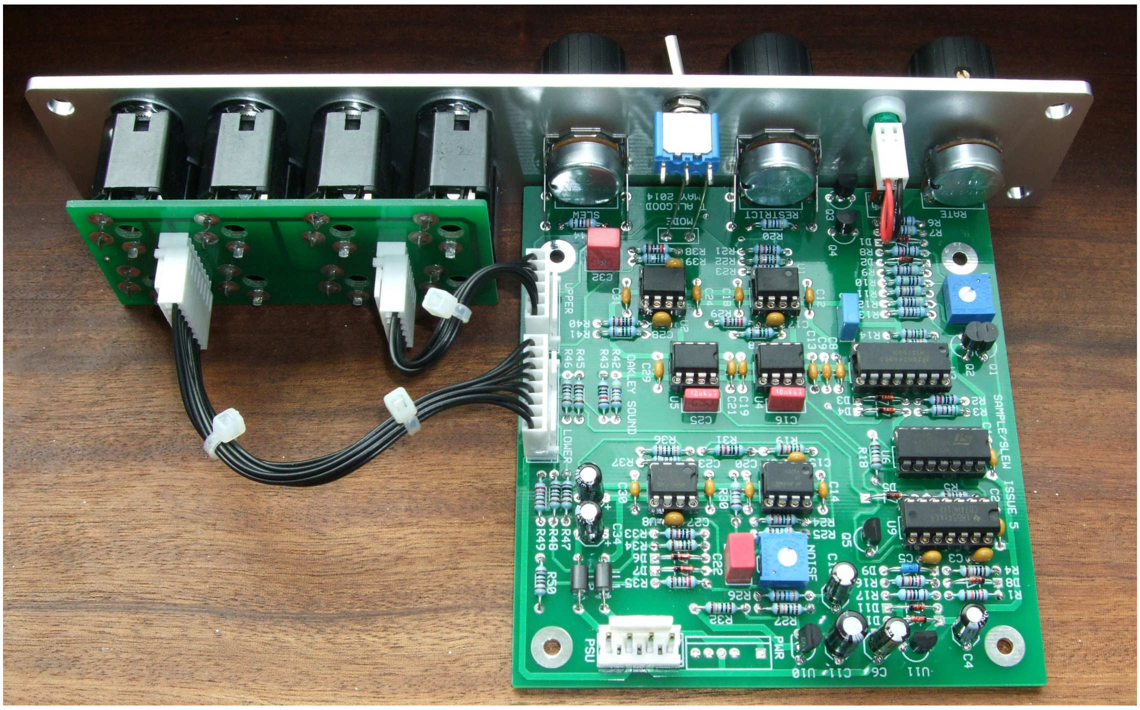
The last produced version of the Sample/Slew PCB was issue 2. Prior to that was issue 1. There was no commercially produced issues 3 and 4.

Issue 5 was a major revision of the design. This version added a voltage controlled clock generator, a white noise source with clipped and unclipped outputs, and improved restriction circuitry featuring a second sample and hold circuit.

The potentiometers are now Alpha/ALPS 16mm PCB mounted and the board can utilise the Oakley Sock8 board for the input/output socket field.

Issue 5.1 was created in November 2018. This was just a small revision to take advantage of a change in PCB manufacturer. The normally unused pin 6 of the MU power header is now connected to the socket ground to separate 0V from the panel. This is only of use if you are using the Oakley MU distribution board and a five way power lead. The only other change affects the 6mm trimmers; the hole size was reduced and the top surface artwork made square to suit the better quality Bourns 3386F types.

The Sample/Slew PCB



The issue 5 Oakley Sample/Slew module behind a natural finish 1U wide Schaeffer panel. Note the use of the optional Sock8 socket board to facilitate the wiring up of the eight sockets.

On the Sample/Slew printed circuit board I have provided space for the three 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 1.625" which is the original Oakley and MOTM spacing. For aesthetic purposes use of 22 to 27mm knobs is recommended.

The design requires plus and minus 15V supplies. The power supply should be adequately regulated. The current consumption is +44mA and -34mA. 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 112mm (deep) x 104mm (high).

The main board has been laid out to accept connection to our Sock8 socket board. This small board speeds up the wiring of the eight sockets and reduces the chances of building mistakes.

Sample/Slew Issue 5 and 5.1 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.

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.

75R	R41, R28, R39, R6
120R	R8, R17
330R	R44
1K	R50, R47, R48
2K2	R12, R38, R49, R29, R35
3K3	R15
3K6	R26, R25
4K7	R7, R20
6K8	R13
10K	R14, R43, R40, R21, R31, R2, R23, R33
22K	R5
30K	R36
51K	R3, R37
100K	R34, R45, R4, R18, R46, R27, R19, R24, R32, R22
220K	R1, R9, R16
270K	R11
470K	R30, R42
1M	R10

Capacitors

100nF axial ceramic	C12, C13, C21, C29, C23, C19, C30, C24, C18, C31, C8, C9, C14, C2, C20, C1
47pF C0G 2.5mm ceramic	C28, C26, C15, C17, C27
220pF C0G 2.5mm ceramic	C3, C5

10nF, 63V polypropylene*	C25, C16
100nF, 63V polyester**	C7
2u2, 50V polyester	C22, C32
2u2, 63V electrolytic	C33, C34, C4
47uF, 35V electrolytic	C6, C10
220uF, 16V electrolytic	C11

* Ideally, C16 and C25 capacitors should be polypropylene or polystyrene types. However, with polypropylene and polystyrene it is hard to find a 10nF with a low enough working voltage so that the device is not too big to fit next to the ICs. The 63V polypropylene from Wima (part number: FKP2C021001G00HSSD) will fit assuming you haven't fitted U4 and U5 in sockets. The advantage of using a better capacitor allows for a more accurate hold voltage but for most purposes within a synthesizer polyester types will work just fine. I used both IC sockets and polyester capacitors in my prototype.

** C7 sets the range of the clock oscillator. Halving the value of C7, to 47nF, will roughly double the rate of the clock. Doubling C7 to 220nF will slow the clock down by a factor of two.

Discrete Semiconductors

1N4148 signal diode	D5, D11, D10, D1, D2
2V7 zener diode	D3, D4
4V7 zener diode	D6, D7
BAT-42 Schottky diode	D8, D9
BC549 NPN small signal transistor	Q3, Q5
BC559 PNP small signal transistor	Q1, Q2, Q4
5mm LED red or green	LED

Q1 and Q2 can be squeezed together and held in place with a cable tie. This ensures both devices are at the same temperature which will minimise frequency drift in the clock oscillator.

Integrated Circuits

4011 CMOS NAND gate	U6
74HC14 Schmitt trigger	U9
78L05 100mA +5V regulator	U11
LF398N sample and hold	U4, U5
LF412 dual FET op-amp	U1, U2, U7
LM13700 dual OTA	U3
TL072 dual FET op-amp	U8
TL431 shunt regulator	U10

IC sockets are to be recommended for all dual in line (DIL) ICs except for U5 and U4. You'll get better performance if the two LF398 devices are soldered to the board direct. You need four 8-pin, two 14-pin and one 16-pin DIL socket.

Trimmers (preset) resistors

10K single turn	NOISE
100K single turn	CLK

* Issue 5 boards use standard horizontal single turn trimmers. Issue 5.1 uses 6mm trimmers such as Bourns 3386F.

Potentiometers (Pots)

All pots 16mm Alpha PCB mounted or equivalent.

47K or 50K linear	RATE, RESTRICT
1M log	SLEW

Two 16mm pot brackets.

Switch

One single pole ON-OFF toggle switch is required for the mode selection.

The switch is mounted on the 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 6-way	UPR	– for connecting to sockets
Molex/MTA 0.1" header 8-way	LWR	– for connecting to sockets
Molex/MTA 0.1" housing 6-way	UPR	– for connecting to sockets
Molex/MTA 0.1" housing 8-way	LWR	– for connecting to sockets
Molex/MTA 0.1" housing 2-way	LED	– optional connecting technique for the LED.
5mm red or green LED lens & clip	LED	
Switchcraft 112APC 1/4" sockets	Eight off mounted either on the Sock8 board or on panel	

Three knobs

Power lead MTA to MTA connector

Additional components required if using optional Sock8 board

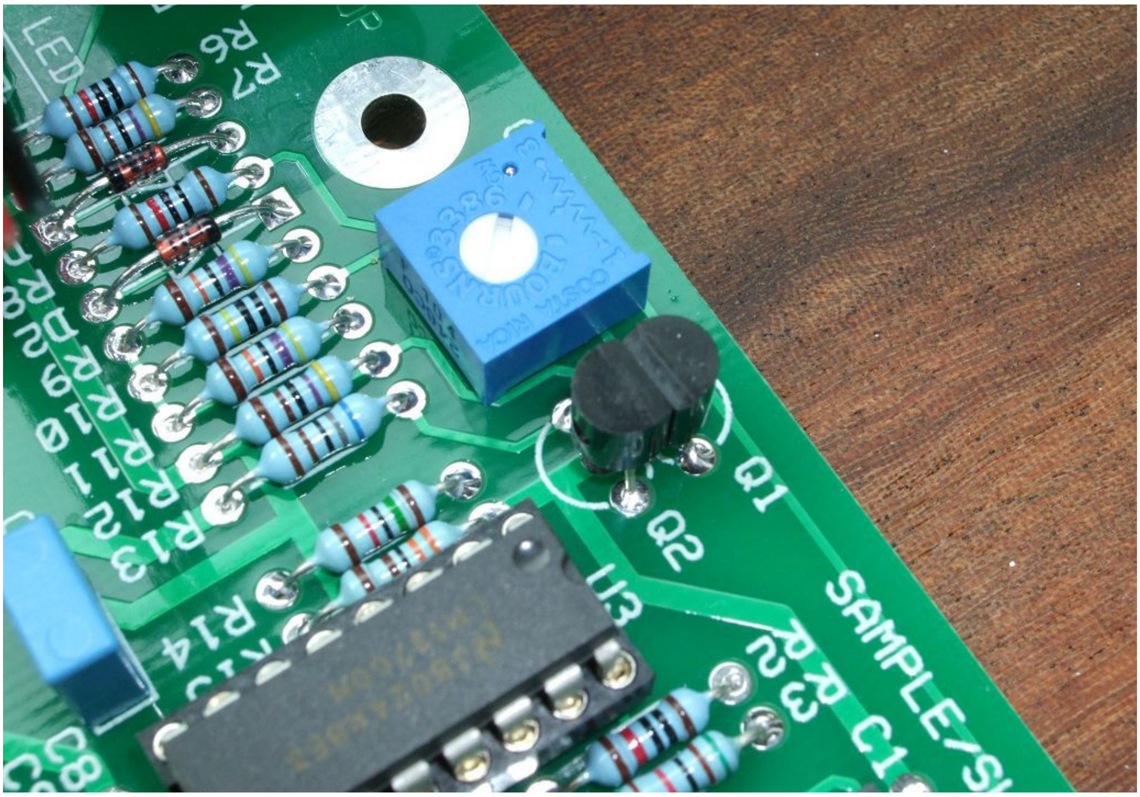
Molex/MTA 0.1” header 6-way	UPR
Molex/MTA 0.1” header 8-way	LWR
Molex/MTA 0.1” housing 6-way	UPR
Molex/MTA 0.1” housing 8-way	LWR

112APC Switchcraft 1/4” socket	SK1, SK2, SK3, SK4, SK5, SK6, SK7, SK8

Do not fit link L1 on the Sock8 board.

If using Molex KK you'll also need at least 28 crimp terminals.

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



Q1 and Q2 can be thermally coupled with a cable tie, heat sink paste, or glued together with a bit of epoxy resin as they are here.

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.

MU and 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 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.

Power	*Location number*	*Schematic Pin number*
+15V	1	1
Missing Pin	2	
+5V	3	2
Module ground (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 PWR header, and using it with a standard MU power distribution system, 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.

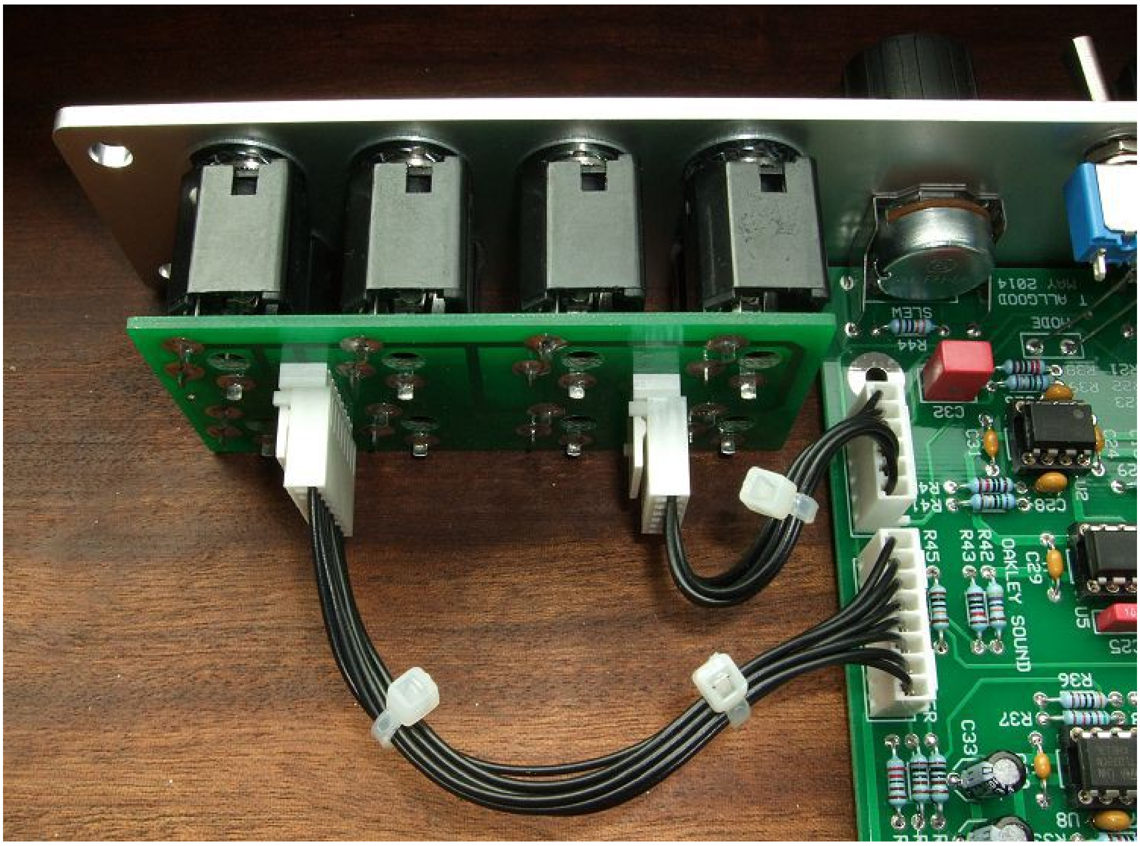
* Issue 5.1 boards now connect the unused pin 6 of the MU connector to socket ground. With the wire hoop as described above not fitted, and using an Oakley MU distribution board with a five way power cable, will allow the socket ground to be kept separate from module ground to prevent ground loops.

Other Connections

Using the Sock8 board

This is the simplest way of connecting all the sockets to the main board. The Sock8 board should be populated in the way described in our construction guide found on the project web page. There are only two headers, UPR (for upper) which is six way, and LWR (for lower) which is eight way. Both headers are fitted to the bottom side of the board. L1, the optional wire link, on the Sock8 board is not fitted.

You need to make up two interconnects. The six way one should be made so that it is 90mm long. The eight way should be made to be 140mm.



The Sample/Slew issue 5 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.

Wiring the sockets manually

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:

<u>UPR</u>

Pin	*Pad name*	*Socket Connection*	*Lug Type*
Pin 1	SLEW_OUT	Connect to SLEW OUT	Signal lug
Pin 2	Not connected		
Pin 3	Not connected		
Pin 4	SAMPLE_OUT	Connect to SAMPLE OUT	Signal lug
Pin 5	module ground	Connect to SAMPLE IN	NC lug
Pin 6	SAMPLE_IN	Connect to SAMPLE IN	Signal lug

<u>LWR</u>

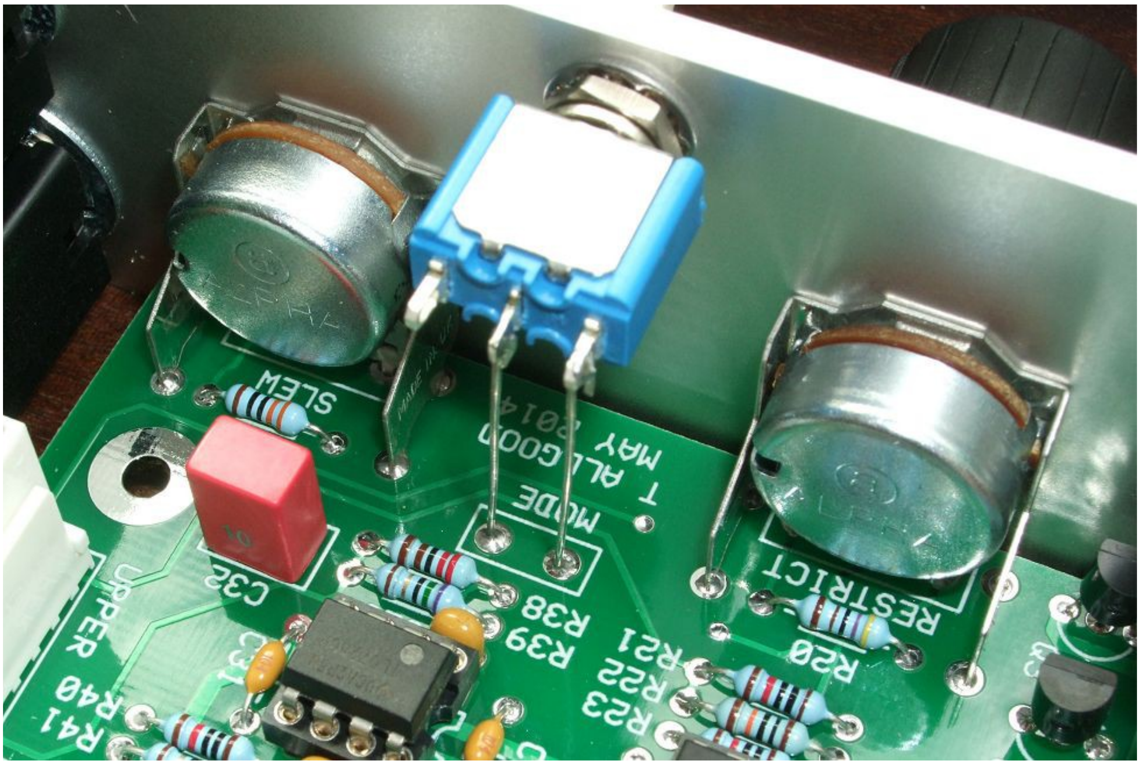
Pin	*Pad name*	*Socket Connection*	*Lug Type*
Pin 1	Panel ground	Connects to all sockets	Ground lugs
Pin 2	NOISE_CLIP	Connect to CLIPPED OUT	Signal lug
Pin 3	NOISE	Connect to NOISE OUT	Signal lug
Pin 4	CLK_OUT	Connect to CLOCK OUT	Signal lug
Pin 5	SAMPLE_OUT	Connect to SLEW IN	NC lug
Pin 6	SLEW_IN	Connect to SLEW IN	Signal lug
Pin 7	CLKIN_NC	Connect to CLOCK IN	NC lug
Pin 8	CLKIN	Connect to CLOCK IN	Signal lug

Wiring the Switch

The Sample/Slew module has one toggle switch to allow the module to be used in either track/hold or sample/hold mode.

You should wire the 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.

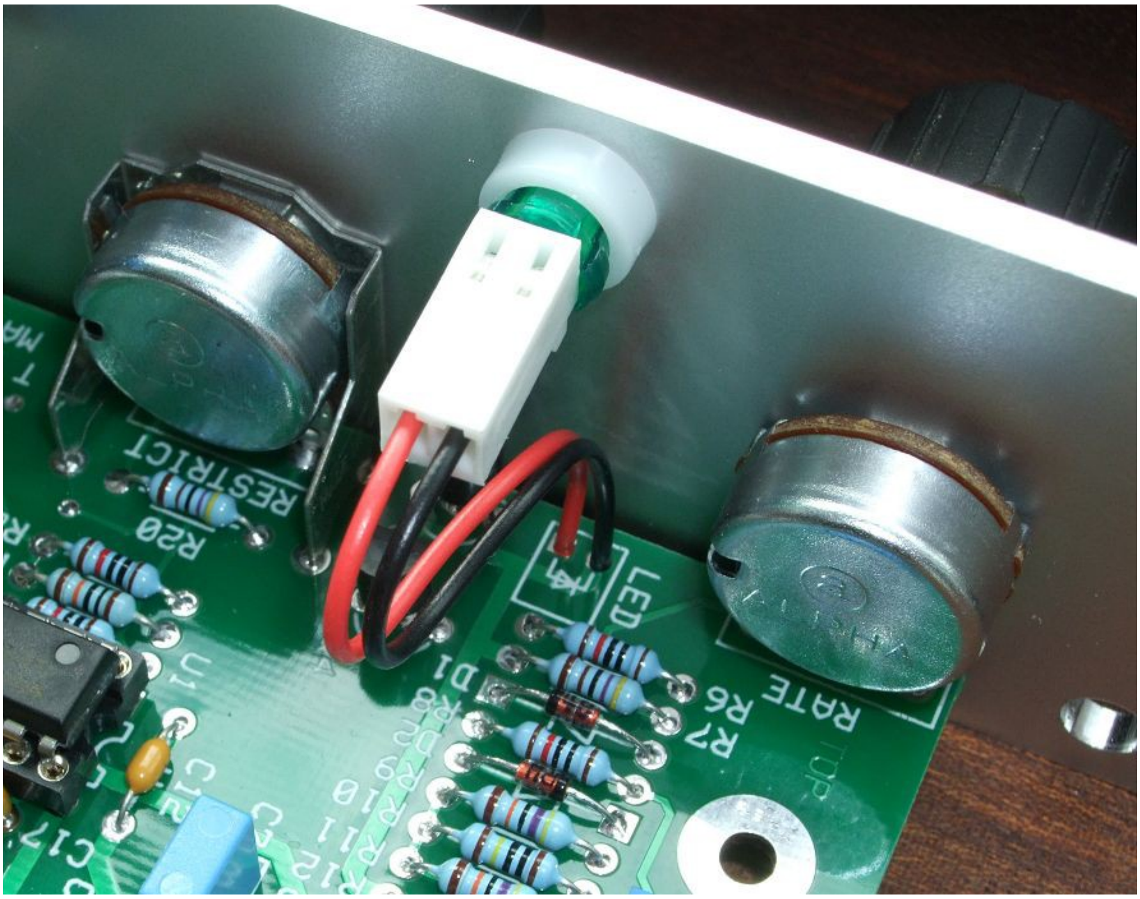
The switch will probably have three solder tags. Only the top two tags need to be connected to the board, each tag simply connecting to the solder pad directly below it.



The prototype unit showing the solid core wire connections between the toggle switch and the PCB.

Wiring the LED

The Sample/Slew module uses one LED and this is wired in similar fashion to other Oakley 5U modules. Since the distance to the board from the LED is relatively short there is no need to use a twisted wire pair to connect the LED to the board as you may have done on other modules.



A green LED lens and matching clip holds the LED into the panel. The Molex KK housing and crimps make a reliable solderless connection to the LED's leads.

Testing the Sample/Slew module

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 direction of all the ICs and the polarity of the electrolytic capacitors.

If you can monitor current, check that it doesn’t exceed 45mA or so from each rail. If you can’t check current directly, check with your finger that none of the op-amps are getting warm.

The first thing to check is that the clock oscillator is working. The LED should flash on and off at a speed determined by the rate pot. At its lowest settings you may find the LED stays on or off for a very long time. We will need to perform a simple calibration later to set the minimum clock speed.

Connect the clock output to your audio monitoring system. Be careful, the clock output will be around +/-5V which is louder than normal line signals. Check that the rate control can drive the clock into audio frequencies. If you have a scope check that the output waveform is approximately +/-5V and that the waveform is a square wave at audio rates. It will deviate from a proper square wave at very low frequencies due to the LM13700's simple buffer circuitry. If the output is drastically different from +/-5V then altering the value of R3 can set things right. An increase in the value of R3 will lower the output amplitude.

Connect the clock output to the slew in socket and set the rate to produce a bass frequency audio tone. Listen to the audio output from the slew out socket. Adjusting the slew pot you should notice the sound getting quickly duller and quieter as you turn the pot clockwise. This should sound like simple filtering, which is exactly what it is.

Hook up your mixer or amplifier to listen to the output of your modular's VCO which should be producing a constant tone. Connect the slew output to a CV input of a VCO. Set the rate pot to produce a 1Hz clock signal. You should find that the VCO’s pitch will change in time with the clock. At low settings of the slew pot, the pitch changes should be fast, giving rise to a two tone siren effect. As you turn the slew pot upwards the effect should become more slurred and less deep.

Now connect your audio monitoring system to the noise output socket. You should hear the familiar rush and hiss of white noise. It's not proper white noise since it does lack some high frequency content of true white noise. However, it should be even sounding and not contain any unwanted clicks or pops. There is a trimmer on the PCB, called noise, to set the output level. Check the clipped output. This should be louder but will mostly have the same tonality as the ordinary noise. If you have a scope, you'll be able to see that the output waveform is restricted so as not to go over +/-5V or so.

If all is well so far we can now progress to test the sample and hold section.

Set the restrict pot to its minimum value and the mode switch to hold. Connect with a patch lead the clipped noise output to the sample in socket. Listen again to the VCO and connect the sample output socket to a suitable CV input on the VCO. Set the rate pot to around 1Hz and you should hear the VCO produce random pitch changes once a second or so. Increase the restrict pot and you will hear the pitch changes appear to get less. The actual maximum and minimum pitch deviation will be the same over time, but the changes between each step will be less than before.

Set the restrict pot back to its minimum value. Click the switch into track mode and listen to the sample output. You should hear white noise being gated by the clock rate. That is, the noise should be heard as a series of bursts determined by the rate pot. When the clk LED is lit then you should be hearing the noise.

Now click the switch back into hold mode. Listen to the sample out as you play with the rate pot. Atari game console sounds abound!

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

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