Oakley Sound Systems

5U Oakley Modular Series

Versatile Ramp Generator

VRG PCB Issue 2 & 2.1

Builder's Guide

V2.6

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Introduction

This is the Project Builder's Guide for the issue 2 and 2.1 Versatile Ramp Generator (VRG) 5U module from Oakley Sound. This document contains a basic introduction to the board, a full parts list for the components needed to populate the board or boards, and a list of the various interconnections.

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

http://www.oakleysound.com/vrg.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.

Issue 2 and 2.1 changes

You should note that some of the pictures within this guide show an issue 1 VRG. The two board designs are very similar but are different in the following ways:

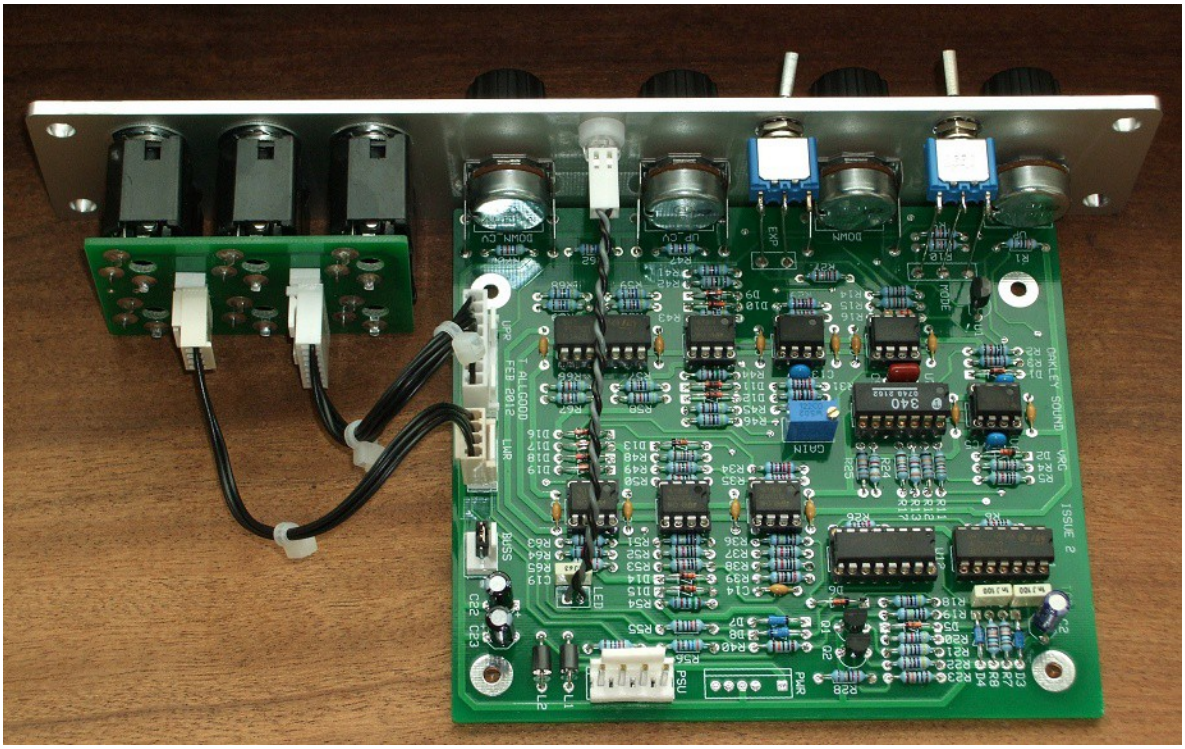
1. The THAT transistor array is now biased differently to allow for increased operating ranges of the up and down times. This small change required the addition of two resistors and the changing of the two of the zener diode voltages. Adding the resistors has changed the resistor numbering – so don't use the issue 1 photographs as a guide to populating the resistors on the board.

2. A three way Oakley Bus header has been added. This creates a normalised gate input to the gate socket. See the User Manual for more details on the Oakley Bus.

3. The mistake in the diode orientation has been corrected.

Issue 2.1 is identical to the earlier issue 2 boards except that the normally unused pin on the MU power connector is now connected to pin 3 of the MOTM power connector. When used with the Oakley MU distribution board and a five way power cable, this will allow the socket ground to be kept separate from module ground to prevent ground loops.

The VRG PCB



The issue 2 Oakley VRG module behind a natural finish 1U wide Schaeffer panel. Note the use of the optional Sock6 socket board to facilitate the wiring up of the six sockets.

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

The design requires plus and minus 15V supplies. The power supply should be adequately regulated. The current consumption is +44mA and -37mA. Power is routed onto the main PCB by either our standard four way 0.156" MTA156 type connector or the special five way Synthesizers.com MTA100 header.

The 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).

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

VRG issue 2 and 2.1 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. R16 can be 5% 0.25W.

22R	R28
75R	R33
220R	R65
1K5	R63
2K2	R55, R61
3K3	R1
3K6	R56
4K7	R21, R22
10K	R37, R38, R50, R5, R2, R53, R6, R52
15K	R64, R54
20K	R32, R39
22K	R35, R30, R31, R26, R34, R29
36K	R41, R45
39K	R24, R13
47K	R43, R57, R69, R59, R47, R60, R18, R68, R46, R58, R20, R66, R67, R70
75K	R44, R42
82K	R49
100K	R7, R23, R10, R9, R40, R8
120K	R3, R15, R11, R14, R27, R48, R17, R4
560K	R62
1M	R36, R51, R19
3M3	R16

1K +3000ppm/K	R12, R25

R12 and R25 are both positive temperature coefficient (temp co) resistors. They may be replaced with ordinary 1K resistors if you are not too bothered about a bit of drift in the UP and DOWN times.

Capacitors

100nF axial ceramic	C1, C7, C8, C10, C11, C12, C14, C15, C16, C17, C18, C20, C21
22pF C0G 2.5mm ceramic	C4, C5
100pF C0G 2.5mm ceramic	C13
1nF, 63V polyester	C3, C6
100nF, 63V polyester	C9, C19
2u2, 63V electrolytic	C22, C23
22uF, 35V electrolytic	C2

Discrete Semiconductors

1N4148 signal diode	D1, D2, D13, D14, D15, D16, D17, D19, D6, D5
6V2 zener diode	D9, D10, D11, D12, D18
BAT-42 Schottky diode	D3, D4, D7, D8
BC549 NPN small signal transistor	Q1, Q2
5mm bi-colour LED (red/green)	LED

Integrated Circuits

4001BE CMOS NOR gate	U11
DG403DJ dual analogue switch	U12
THAT340 NPN/PNP array	U7
LT1013CP	U3, U6
AD712 dual FET op-amp	U2 *
TL072CN dual FET op-amp	U4, U8, U9, U10
TL074CN quad FET op-amp	U5
LM4040DIZ-10.0 10V reference	U1**

* U2 should be a good quality FET if you want the lowest error voltages on your output signal. However, you get quite acceptable results using just a TL072CN.

** The LM4040CIZ-10.0 is also suitable.

IC sockets are to be recommended. You need seven 8-pin, three 14-pin and one 16-pin DIL sockets.

Trimmers (preset) resistors

5K multiturn cermet	GAIN

Potentiometers (Pots)

All pots Alpha 16mm PCB mounted types

47K or 50K linear	UP, DOWN, UP_CV, DOWN_CV

Three 16mm pot brackets.

Switches

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

One single pole ON-OFF toggle switch is required for the LIN/EXP selection.

Both switches are 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 8-way	UPR	– for connecting to sockets
Molex/MTA 0.1” housing 8-way	UPR	– for connecting to sockets
Molex/MTA 0.1” header 4-way	LWR	– for connecting to sockets
Molex/MTA 0.1” housing 4-way	LWR	– for connecting to sockets
Molex/MTA 0.1” header 3-way	BUSS	– for connecting to optional Oakley Bus
Molex/MTA 0.1” housing 2-way	Optional connection method for the LED.	

LED clip and lens

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.

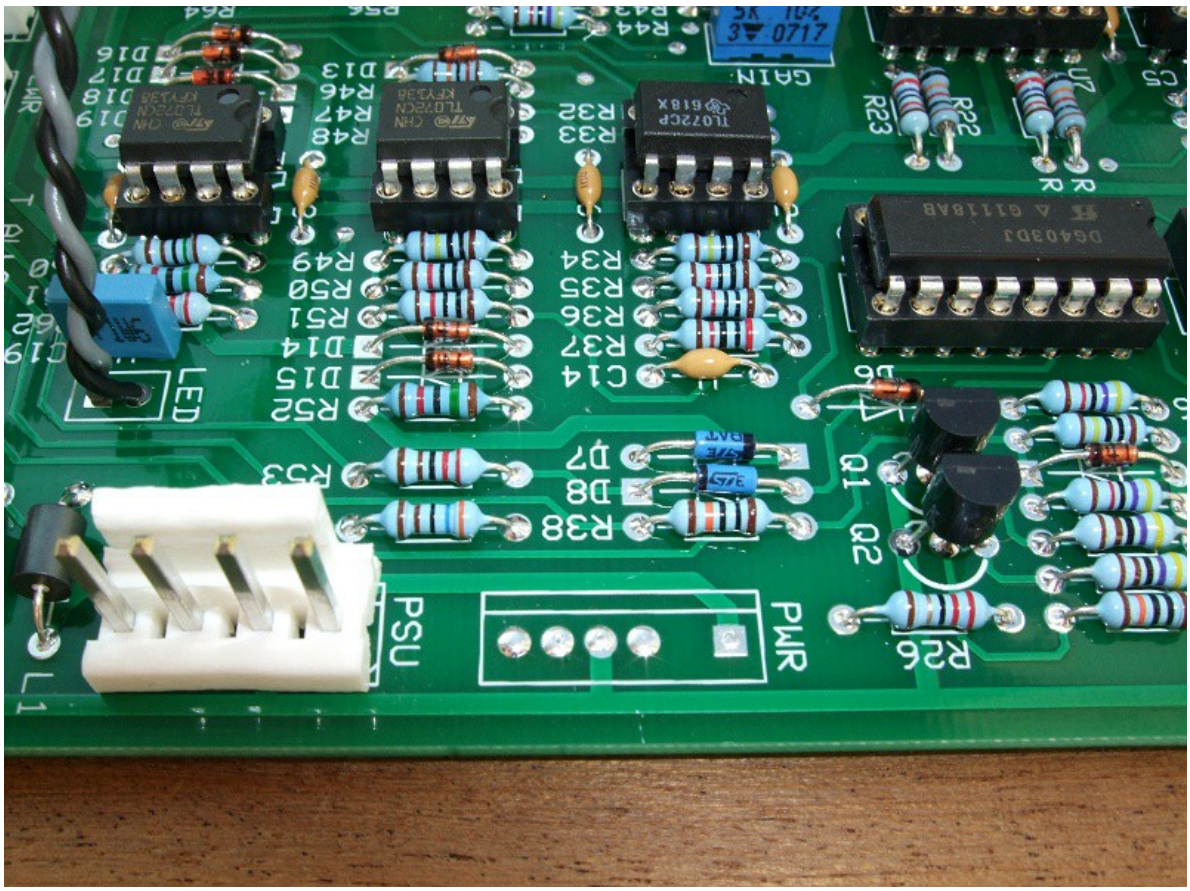
Components required if using optional Sock6 board

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

L1 on the Sock6 PCB is not to be fitted.

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

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



You should fill any unused solder pads with solder. In the VRG this means the unused power supply header location and all the little via holes.

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 I/O 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 3 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
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.

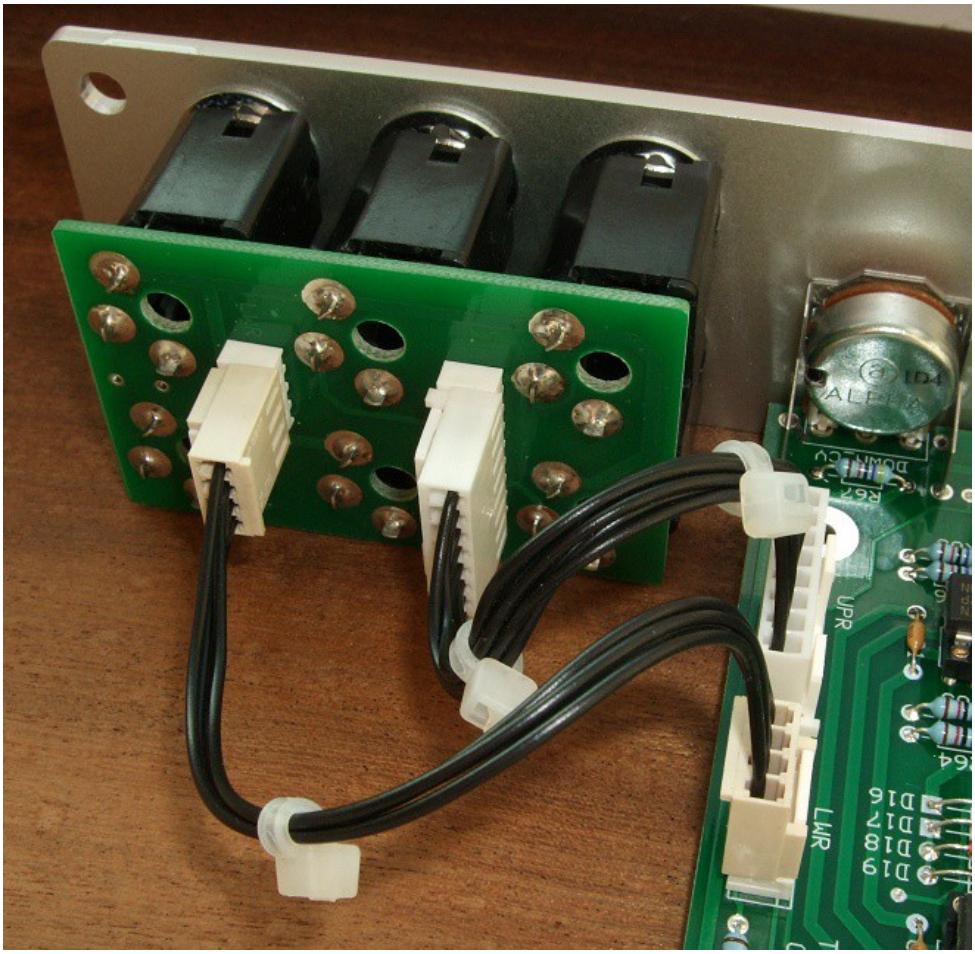
* Issue 2.1 boards now connect the unused pin 6 of the MU connector to socket ground. With the wire hoop as described above not fitted, and using an Oakley MU distribution board with a five way power cable, will allow the socket ground to be kept separate from module ground to prevent ground loops.

Building the VRG module using the Sock6 board

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

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

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



The VRG 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.

Hand wiring the sockets

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

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

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

UPR

Pin	*Pad name*	*Socket*	*Lug Type*
Pin 1	Module ground	GATE IN	NC
Pin 2	GATE_IN	GATE IN	Signal
Pin 3	UPCV_IN	DOWN CV	NC
Pin 4	DOWNCV_IN	DOWN CV	Signal
Pin 5	Module ground	UP CV	NC
Pin 6	UPCV_IN	UP CV	Signal
Pin 7	SLEW_NC	SLEW IN	NC
Pin 8	SLEW_IN	SLEW IN	Signal

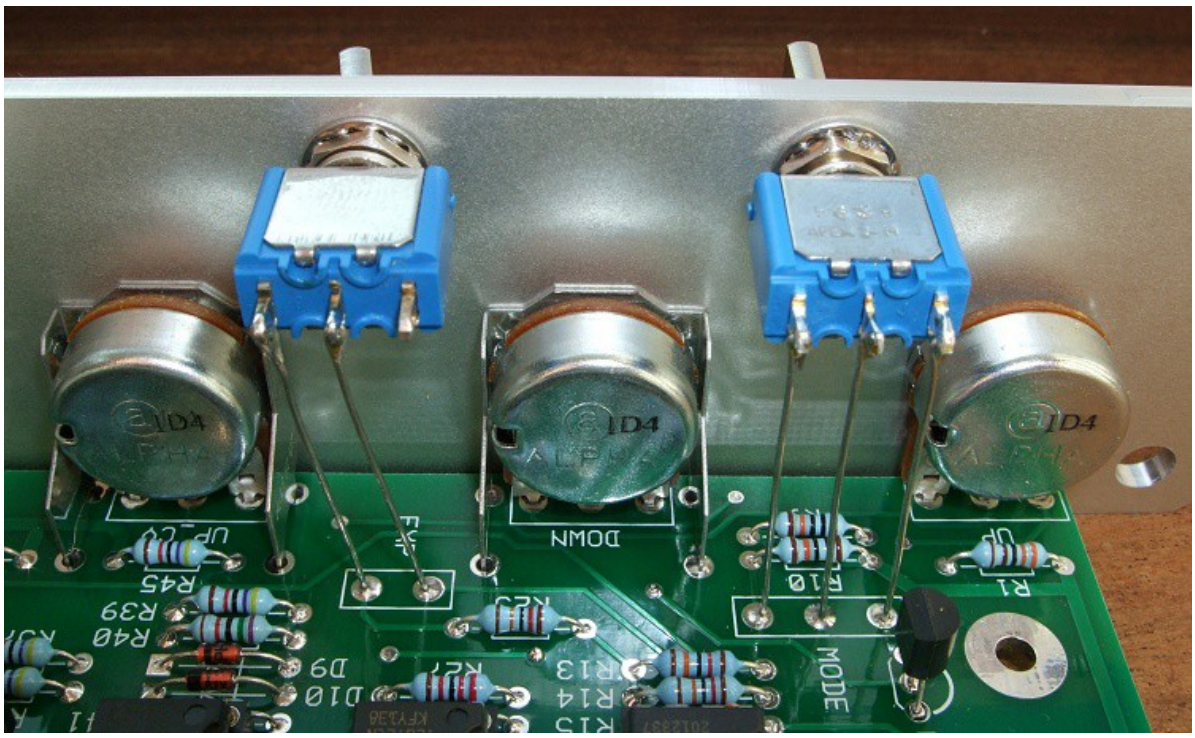
LWR

Pin	*Pad name*	*Socket*	*Lug Type*
Pin 1	Panel ground	Connects to all sockets	Ground lugs
Pin 2	NEG_OUT	NEG OUT	Signal
Pin 3	Not used		
Pin 4	SLEW_OUT	OUTPUT	Signal

Wiring the Switches

The VRG features two different types of switch. The three position ON-OFF-ON switch should go to the top of the module, while the ordinary two position ON-OFF switch should go to the middle hole in the panel. The ON-OFF-ON switch has all three tangs connected to the board and the ON-OFF one has just the two lower ones connected.

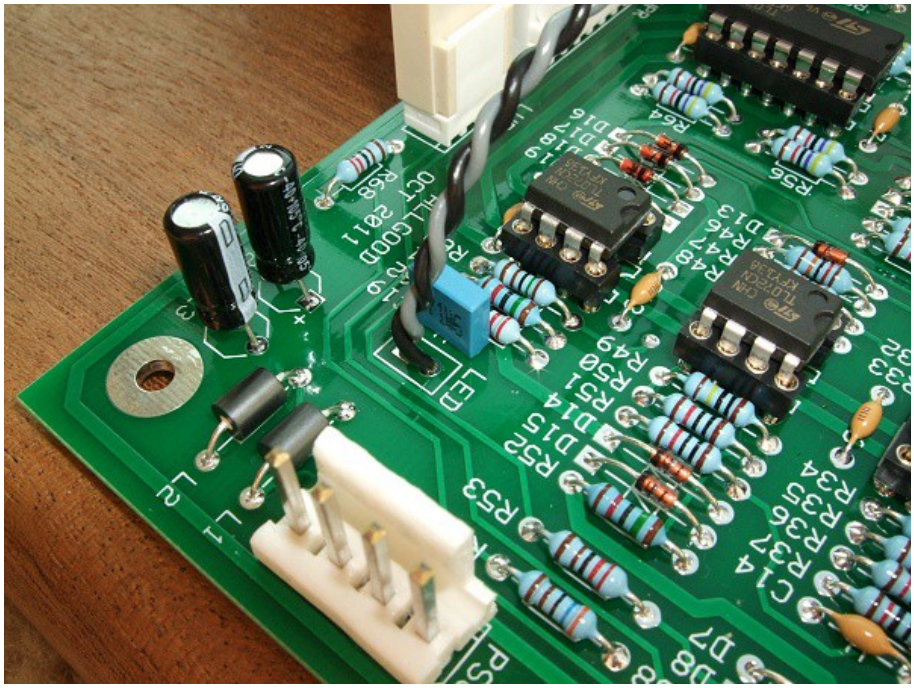
You should wire each switch as you would other Oakley modules. I typically use thin solid core wire rather than insulated multi-strand wire. This keeps the connection firmly in place and very neat. I normally bend the wire at one end into a hook and place the straight end into the PCB pad's hole. I then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



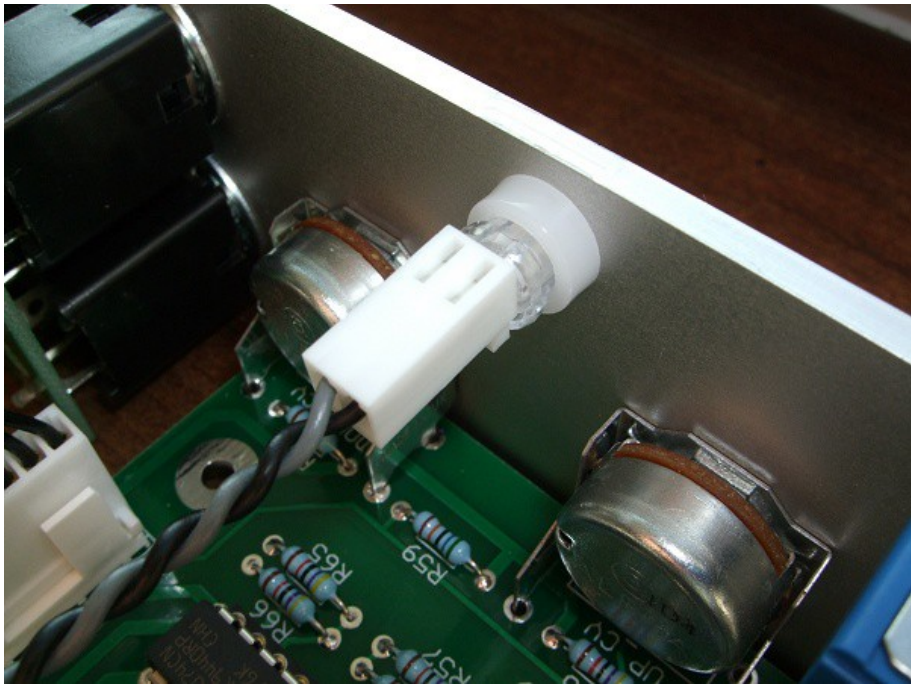
The prototype unit showing the solid core wire connections between the toggle switches and the PCB.

Wiring the LED

The VRG features a bi-colour LED and this is wired in similar fashion to other Oakley 5U modules. I recommend that you use a twisted wire pair to connect the LED to the board.



The twisted pair's end is stripped back and soldered into the board.



A clear 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 VRG

Apply power to the unit making sure you are applying the power correctly. Check that no device is running hot. Any sign of smoke or strange smells turn off the power immediately and recheck the polarity of the power supply, the two transistors Q1 and Q2, the direction of the ICs in their sockets and the polarity of the electrolytic capacitors.

Select the LFO mode using the three way switch. You should notice the LED start to glow or flash. Check that turning the UP and DOWN controls affect the speed of the flash. Start with both controls fully counter clockwise and then turn up the down control. At first the LED should be a blur of red and green. Only at lower speeds will you notice the separate colours. With the down pot at it's maximum setting the LED should take a long time to change colour and intensity. Now check that with the down pot at its lowest setting (ie. fast) changing the up control has a similar effect on the speed of the pulsating.

You can verify the LFO's behaviour by plugging it into another module in your system. Try modulating the frequency of an audio VCO or a self-oscillating filter. Note that flicking between the LIN and EXP modes changes the sound somewhat as well as the frequency of the modulation. The LIN mode should produce a faster modulation from the VRG.

If you require a brighter light from the LED then you can reduce the value of R60. I don't recommend that you go below 1K though as this will draw excessive current from your power supply.

Now select ONE SHOT. The VRG should now stop oscillating. Connect a short patch lead between the NEG OUT and the GATE input. The VRG should start oscillating again but this time the LED should only be one colour as the VRG's output is now only going from +0.6V to around +5V. I normally wire my bi-colour LEDs to go red with a positive output voltage so here I would expect to see a red pulsating light. Again flicking between LIN and EXP should reveal that the LIN mode produces faster pulses.

Remove the patch lead from NEG OUT. Select TRAD AD on the VRG and use a gate signal from your modular to trigger the VRG's attack-decay envelope generator (EG). Use the VRG's output to modulate a VCA or filter. Check that the up and down controls behave in the same way as attack and decay would on a normal ADSR. Listen to the difference between the LIN and EXP modes. Notice how the LIN mode gives rise to sharper sounds while the EXP is more natural in the way it opens and closes the VCA or filter.

Still using the VRG as a traditional attack-decay EG verify the operation of the CV input sockets and controls. Remember that the controls are reversible attenuators and the minimum setting is in the middle of the rotation.

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

Final Comments

If you have any problems with the module, an excellent source of support is the Oakley Sound Forum at Muffwiggler.com. 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.

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