Oakley Sound Systems

5U Oakley Modular Series

Classic VCA

Discrete VCA PCB Issue 1

Builder's Guide

V1.0.1

Tony Allgood
Oakley Sound Systems
CARLISLE
United Kingdom

Introduction

This is the Project Builder's Guide for the issue 1 Classic VCA 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.

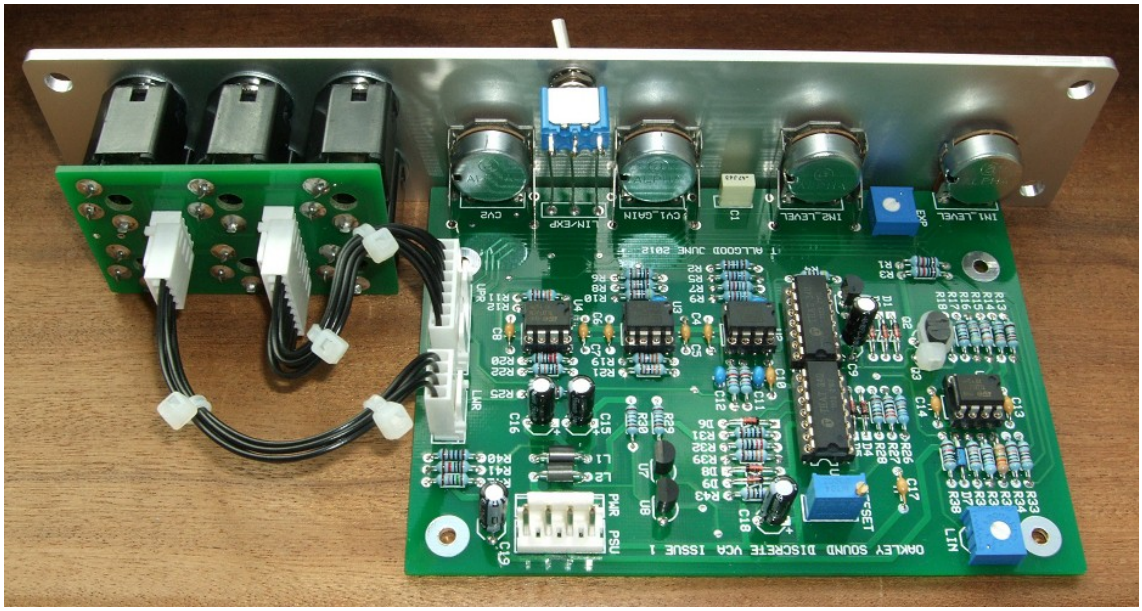
For the User Manual, which contains an overview of the operation of the unit and the calibration procedure, please visit the main project webpage at:

http://www.oakleysound.com/5uvca.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 Discrete VCA PCB



The issue 1 Oakley Classic VCA 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 printed circuit board, called Discrete VCA issue 1, 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 +/-35mA. 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 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 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 89mm (deep) x 126mm (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.

Classic VCA issue 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.

220R	R27, R32
1K	R17, R31, R25, R28, R40, R2, R29, R30
3K3	R14
4K7	R4, R43
6K8	R36
10K	R41, R1, R3, R38
15K	R42
18K	R7
22K	R20
33K	R11, R12, R39, R19, R21
36K	R5, R9
39K	R15
47K	R10
62K	R24, R23
82K	R33
100K	R8, R34, R37, R22, R6
120K	R13
470K	R16
680K	R26
1M	R18
3M3	R35

Capacitors

100nF multi layer axial ceramic	C10, C14, C13, C4, C8, C7, C6, C17, C5
18pF 2.5mm ceramic	C12, C11

33p 2.5mm ceramic	C3, C2
470nF 63V polyester box	C1
2u2, 63V electrolytic	C18, C16, C9, C15, C19

Discrete Semiconductors

1N4148 signal diode	D9, D2, D1, D4, D8, D6, D3, D5
BAT42 Schottky diode	D7
BC550 NPN transistor	Q3
BC560 PNP transistor	Q5, Q2

Integrated Circuits

LM4040DIZ-10.0 10V reference*	U7, U8
OPA2134PA dual audio op-amp	U2, U3
THAT340 NPN/PNP array	U6, U1
TL072 dual FET op-amp	U5, U4

* The LM4040CIZ-10.0 is also suitable.

Trimmers (preset) resistors

100K multiturn cermet	OFFSET
50K 6mm horizontal	LIN, EXP

Potentiometers (Pots)

All pots Alpha 16mm PCB mounted types

47K or 50K linear	IN1_LEVEL, IN2_LEVEL, CV1_GAIN, CV2

Three 16mm pot brackets.

Switch

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

IC sockets should be used: you need four 8-pin DIL sockets and two 14-pin DIL sockets.

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.

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 powers 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.

It's worth filling the empty holes of the PWR pads with solder.

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 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.

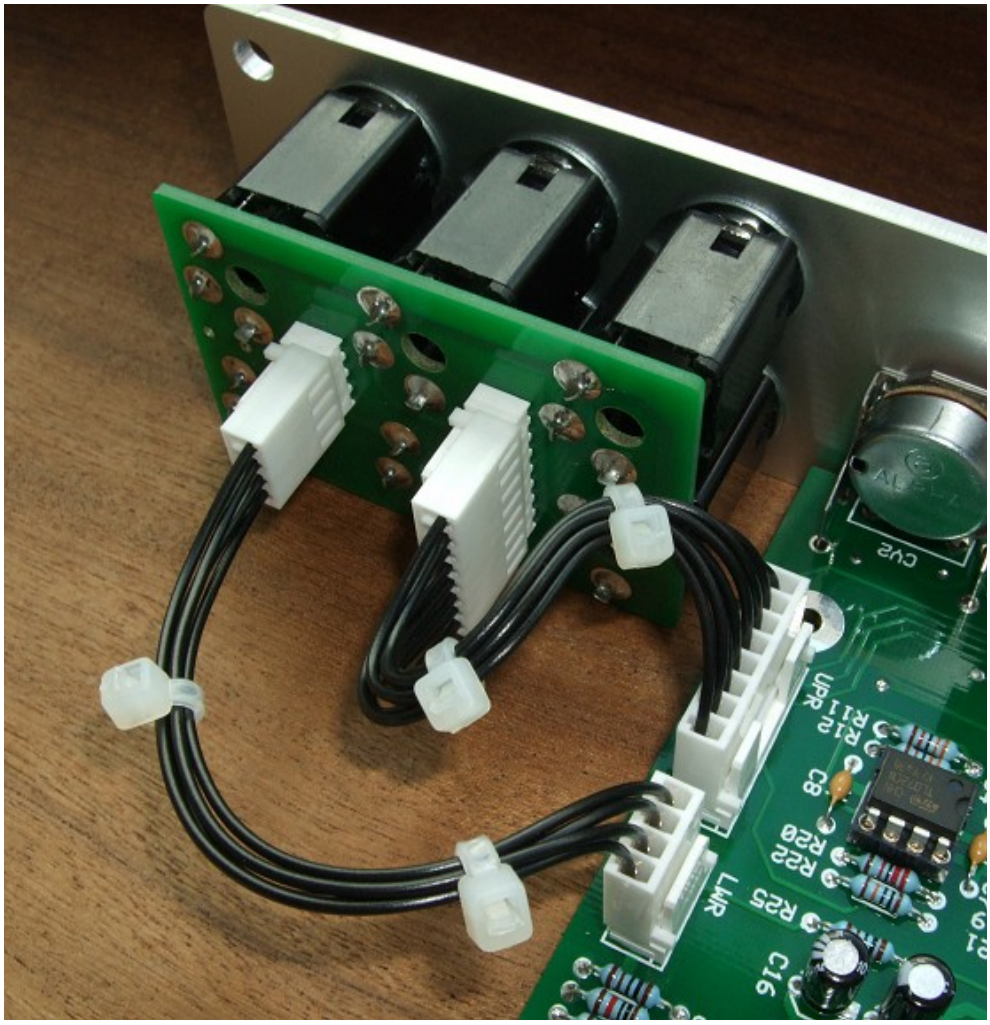
If fitting the PWR header, you will also need to link out pins 2 and 3 of PSU. This connects the panel ground with the module ground. Simply solder a solid wire hoop made from a resistor lead clipping to join the middle two pads of PSU together.

Building the Classic VCA 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 Classic VCA 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	IN2	NC
Pin 2	IN2	IN2	Signal
Pin 3	Module ground	CV2	NC
Pin 4	CV2	CV2	Signal
Pin 5	CV1_NC	CV1	NC
Pin 6	CV1	CV1	Signal
Pin 7	Module ground	IN1	NC
Pin 8	IN1	IN1	Signal

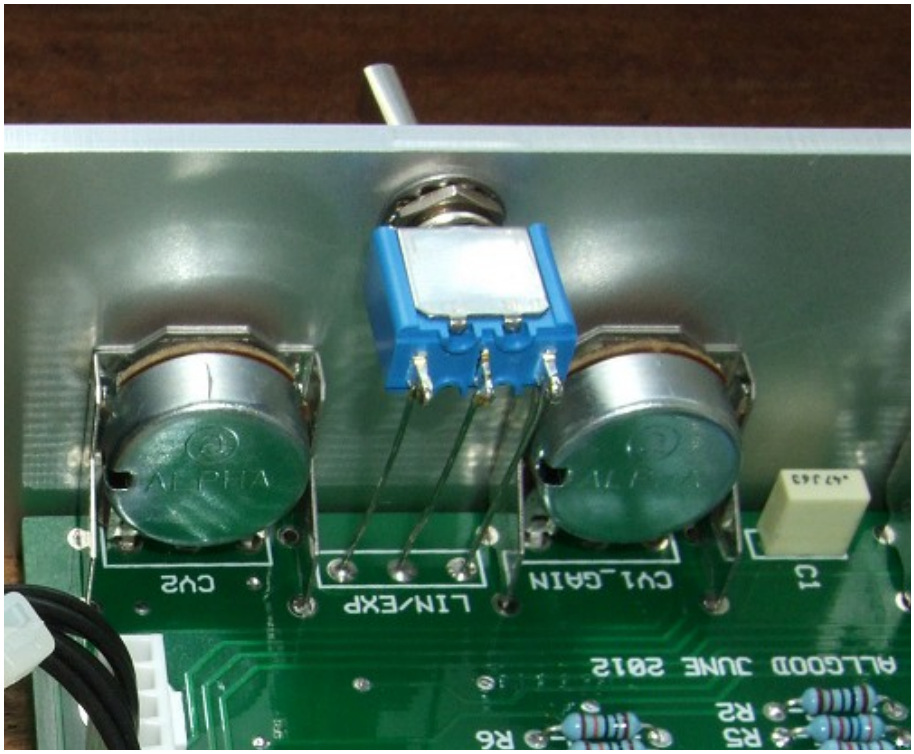
LWR

Pin	*Pad name*	*Socket*	*Lug Type*
Pin 1	Panel ground	Connects to all sockets	Ground lugs
Pin 2	ALT_OUT	OUT B	Signal
Pin 3	Not used		
Pin 4	VCA_OUT	OUT A	Signal

Wiring the Switch

The Classic VCA uses a standard ON-ON SPDT (single pole double throw) switch.

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

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

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.

Assuming everything is OK so far, it is time to apply an audio input. Use a signal like a triangle output from a VCO. Middle A, 440Hz is a good note to use. Turn down all the pots to their minimum setting and insert your triangle wave signal into IN 1 (DC). Listen to the output signal from the OUT A socket. For the moment you should hear nothing.

Turn up the IN 1 LEVEL pot to full. Again, you shouldn't hear anything. Now slowly turn up the CV1/GAIN pot. If all is well this should behave like a volume control, increasing the level of the triangle wave as it is turned up.

Ensure that altering the IN 2 LEVEL pot should have no effect on the sound, but that IN 1 LEVEL behaves also like a volume control. It should seem that both IN 1 LEVEL and GAIN do the same thing. They do not of course, since IN1 LEVEL is altering the signal level going into the VCA circuit, and GAIN is adjusting the amplification within the VCA's core.

Now listen to the output signal at OUT B. You should hear the signal at its loudest when GAIN is at its minimum. Turning up GAIN will decrease the signal so OUT B seems to do the opposite of OUT A. At maximum gain it is unlikely the signal will decrease to nothing. This will be part of the calibration process although it should be noted that the OUT B signal can only achieve around 50dB of attenuation even when perfectly calibrated.

Swap the input signal over to the IN2 (AC) input and listen once again to OUT A. It should be quiet again. Turning up the IN 2 LEVEL pot should bring back the signal.

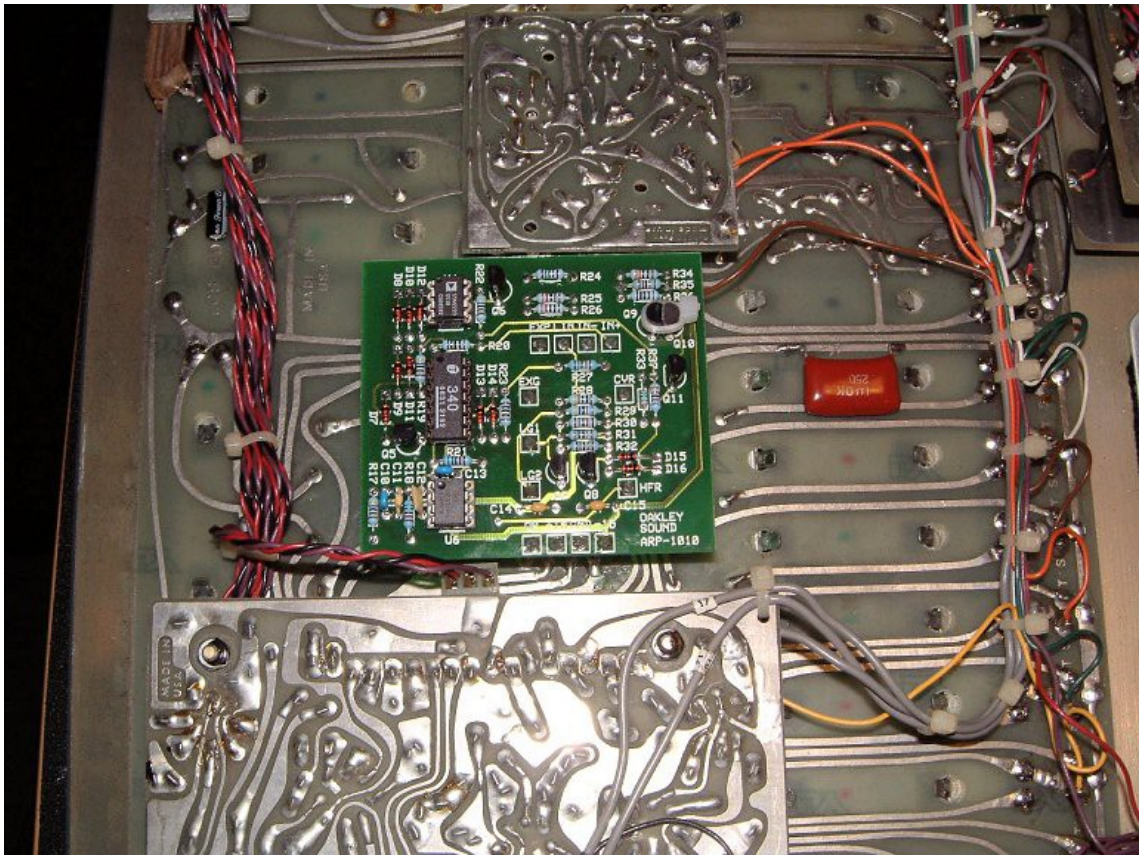
There is a very good chance your circuit is working correctly if you have got this far with no problems. However, we still need to check a few other things and you'll need another signal source to do this. Connect a LFO or VC-LFO to the CV2 input. Use a sine or triangle wave signal at a lowish frequency, say 1Hz or so.

Turn the GAIN down to about 50%, set the switch to LIN (in the upwards position) and the turn CV2 up. Listen to the resultant sound. It should be the triangle wave you can hear again, but it will pulsate evenly up and down with LFO signal. You should hear it go up and down in volume once for every cycle of the LFO. When the CV2 pot is in the middle position you should have the smallest amount of modulation.

Now click the switch down to the EXP mode. You should hear the same sort of pulsating sound as you had in the LIN mode. However, it should be slightly different, spending more time loud than quiet. It may be on average louder or softer than when in linear mode but that is probably fine as this is part of the calibration process.

Your module will now need calibrating and this is detailed in the User Manual.

The Prototype



This is very first version of the Oakley Classic VCA, built in 2008 and fitted to a real ARP2600C. This one off clone was built to replace a dead 'all epoxy' 4019 which itself had replaced an older 4010. Note the pin out placement to accommodate the smaller 4010 module.

I later compared this 2600C to an early 2600P fitted with a standard 4019 module and the differences were negligible in all but the increased frequency response in the clone.

The large red polypropylene capacitor fitted to the underside of the main circuit board is a modification done to provide DC blocking to the VCA on one of its inputs. The ARP2600 is predominantly DC coupled, but this tends to unbalance the VCA since many of the VCO waveforms are unipolar, ie. all positive. This positive bias of the VCA signal input leads to thumping at fast attack and release settings. The capacitor removes the bias and allows for fast thump free sounds. The action of the red capacitor is much the same as the IN 2 (AC) input on this module.

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, 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 or Paul Darlow directly with questions about sourcing components or general fault finding. Honestly, we would love to help but we 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 at Muffwiggler.com.

Tony Allgood at Oakley Sound

Cumbria, UK