Oakley Sound Systems

Eurorack Modular Series

Classic VCA

6HP version

Builder's Guide

V1.3

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Introduction

This is the Project Builder's Guide for the Classic VCA Eurorack module from Oakley Sound first created in 2019. This document contains a basic introduction to the issue 1 board set, a full parts list for the components needed to populate the boards, some basic help on how to purchase parts and to build the project, a simple test procedure, and calibration.

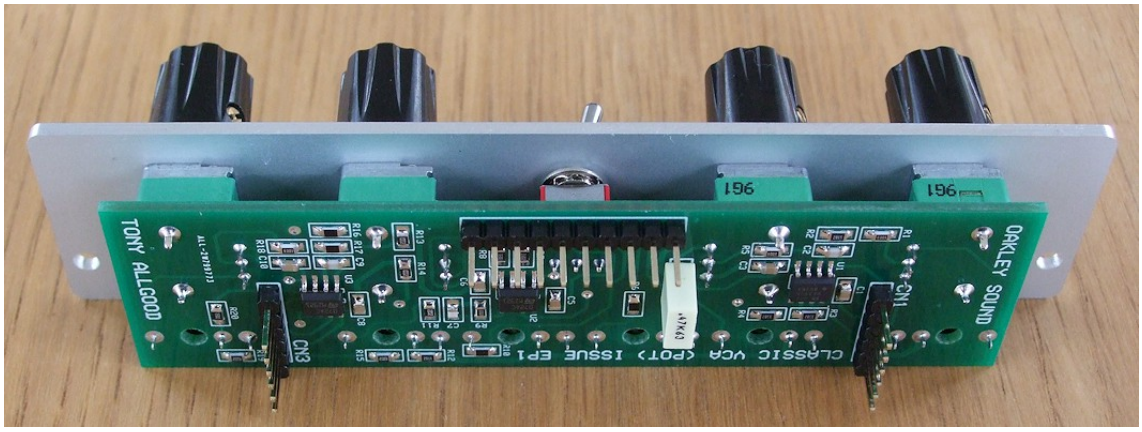
Please note that this Builder's Guide is not applicable for the earlier 8HP wide Classic VCA module which is the one built on a single red coloured board with through hole components.

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, and mounting front panel components please see my generic Construction Guide at the project webpage or http://www.oakleysound.com/construct.pdf.

The Classic VCA PCB Set

The electronics of the Oakley Classic VCA are built on two printed circuit boards (PCBs). The Pot board holds the four pots, single switch, six input and output sockets, and the CV and audio mixing circuitry. All the front panel components are directly soldered to the pot board. The pot board is a double sided design meaning that there are electrically conductive copper tracks on the top and bottom surfaces of the board. The surface mount components are all soldered to the top side of the board while the pots, switch, and sockets are soldered to the underside which faces the inside surface of the front panel.



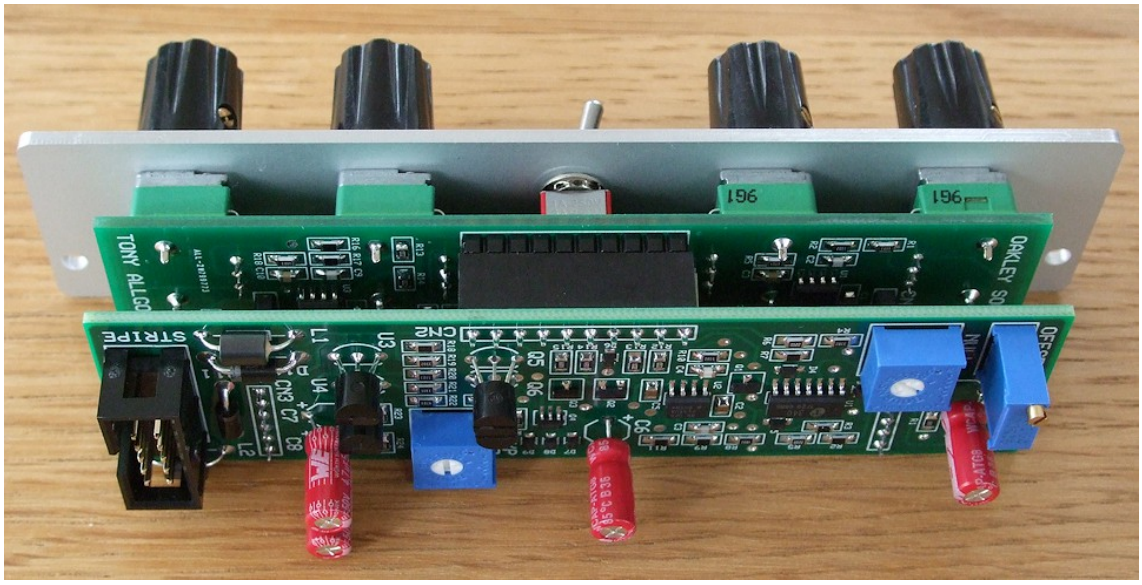
The pot board fitted to the front panel. Note that all the surface mount components are fitted to this side. The pots, switch, and sockets are fitted to the underside of the board.

The second board is called the main board. This holds the discrete VCA core, the linear and exponential control circuitry, the output amplifiers, the power supply conditioning, and the power inlet. The main board is a four layer design. This means that the board has layers of copper on top and bottom sides, as well as two internal copper layers. The top internal layer is solely reserved for the 0V connections – sometimes called module ground – used for the main and top board's electronics.

The components, again a mixture of through hole and surface mount devices, are mostly soldered to the top of the board. The main board's components are all accessible from the rear of the module. Although this means that you need to be a little careful when handling the module, it does mean that fault finding is much easier than it would be if the main board was facing the other way and none of the components would be visible.

The surface mount components are mostly of relatively large geometries to make the build suitable even for beginners in surface mount soldering. The resistors and capacitors are all 0805, and the ICs including the That Corp. NPN/PNP array are narrow body SOIC. The dual transistor array, Q4, is housed in a very small SOT457 package but can soldered easily enough. The larger capacitors, ferrite beads, power diodes, and all the interconnects are through hole parts.

Both circuit boards are the same size, that is, 29 mm (wide) x 107 mm (high). The boards are designed to go behind a panel that is 6HP wide.



The module comprises of two circuit boards connected together with one 10 way 0.1" and two 6 way SIL headers and sockets.

The grip of the three SIL interconnects is strong enough to hold the boards together for most uses. Should you require more rigidity then a **small** blob of silicone (neutrally curing RTV) sealant across the join between the plastic housings of CN1, CN2 and CN3 would hold everything together tightly. However, it is best not to do this until your unit has been thoroughly tested.

The design requires plus and minus 12V supplies. The power supply should be adequately regulated. The current consumption is slightly below +30mA and -30mA at +/-12V.

Classic VCA Parts Lists

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. For electrolytic capacitors the maximum working voltage is normally given with the value, eg. 1uF/63V is a one microfarad capacitor with a working DC voltage of 63V.

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.

Main Board issue 1 Parts List

Resistors

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

220R	R5, R6, R13
560R	R23, R24
1K	R3, R7, R18
3K3	R21
3K6	R1, R16
6K8	R14, R15
10K	R12
18K	R8
33K	R4
36K	R9, R11
39K	R19
51K	R10
120K	R20
470K	R22
680K	R2
1M	R17

Capacitors

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

10pF	C4
33pF	C3

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

100nF/50V	C2, C5

The following capacitors are standard through hole electrolytic capacitors with 0.1" (2.5mm) or 0.2" (5mm) radial leads.

4u7, 63V electrolytic	C1, C6, C7, C8

Discrete Semiconductors

The following devices are surface mount parts.

1N4148WS signal diode	D1, D2, D3, D4, D5, D7, D8, D9
BAT42WS Schottky diode	D6
BC850 NPN transistor	Q1, Q2
BC860 PNP transistor	Q3
BCM857DS dual PNP transistor	Q4

The following devices are standard through hole parts.

1N5819 Schottky diode	D10, D11
BC549C NPN transistor	Q6
BC559C PNP transistor	Q5

Q5 and Q6 should be fitted to the board so that the flat parts of the packages are pressed against one another. They can either be glued together with a bit of thin film of epoxy, or simply held in place with a cable tie.

Integrated Circuits

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

THAT 340S14-U NPN/PNP array	U1
OPA2134UA dual op-amp	U2

The following parts are through hole devices.

LM4040-10 10V reference diode	U3, U4

Trimmer (Preset) Resistors

100K multiturn (eg. Bourns 3296W)	OFFSET
50K 3/8" trimmer (eg. Bourns 3386F)	NULL, EXP

Miscellaneous

Axial ferrite bead	L1, L2
2 x 5 0.1" boxed header	STRIPE
6-way SIL 0.1" socket	CN1, CN3
10-way SIL 0.1" socket	CN2

CN1 to CN 4 are mounted on the underside of the board. Special care must to be taken to ensure that connectors CN1 to CN3 are mounted perpendicular to the board surface.

Pot Board issue 1 Parts List

Resistors

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

1K	R6, R10
10K	R13, R14, R15, R19
11K	R12
15K	R20
22K	R11
33K	R3, R4, R7, R8
51K	R2
82K	R16, R17
100K	R1, R5, R9, R18

Capacitors

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

33p	C2, C9
100p	C7

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

100nF	C1, C3, C5, C6, C8, C10

The following capacitor is a through hole component.

470nF, 63V polyester	C4

Integrated Circuits

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

OPA2134UA dual op-amp	U1
TL072ACD dual op-amp	U2, U3

Potentiometers

All pots are Alpha 9mm vertical pots with 6.35mm round shafts.

50K linear	IN1_LVL, IN2_LVL, CV1_LVL, CV2_LVL

The pots are to be fitted to the underside of the board and their pins soldered from the topside.

Four knobs to suit. Davies 1900H or clones thereof are to be recommended.

Miscellaneous

SPDT on-on switch (eg. Thonk DW1)	LIN/EXP
3.5mm 'Thonkiconn' socket	IN1, IN2, CV1, CV2, OP_A, OP_B

The switch and two 3.5mm sockets are to be fitted to the underside of the board and their pins soldered from the topside. See later for more details.

6-way SIL 0.1” header	CN1, CN3
10-way SIL 0.1” header	CN2

Special care must to be taken to ensure that connectors CN1 to CN3 are mounted perpendicular to the board surface.

Part Sourcing

For general information regarding where to get parts and suggested part numbers for Oakley projects please see my Parts Guide at the project webpage or direct from www.oakleysound.com/parts.pdf.

The front panel is obtained either from Schaeffer in Germany, or Front Panel Express (FPE) in the US. The database for the panel is provided on the project webpage and this file can be opened, edited and ordered using the Frontplatten Designer program available free from Schaeffer or FPE. The cost of the 6HP wide panel was around 27 Euros at the time of writing. The panel is 2.5mm thick and has a natural silvery finish. The black text is printed, although it is possible to edit the database to have the text engraved.

The four pots are Alpha 9mm vertical pots as sold by Thonk and others. I use Thonk's standard ones with 6.35mm (0.25”) round shafts. Other shaft types are available, like splined or D-type, and you should purchase those that are compatible with your choice of control knob. I prefer the round shafts as they require control knobs that have a fixing screw. Although these knobs take more time to place and secure, the height at which the knob sits on the pot shaft is under your control. Push fit knobs can sometimes not sit at the right height which is unsightly if they are too high, or graunch against the pot's securing nut and washer if they are too low.

For control knobs I use Davies 1900H clones available from Thonk and others.

The toggle switch is a standard sub-miniature type that is designed to fit directly into a PCB. The on-on switches are available from Thonk as their DW1 sub-miniature switch. They are made by Dailywell and offer good performance for their price.

The six 3.5mm sockets are available from Thonk known either by their Thonkiconn moniker or as part number PJ398SM.

The fixed 2.54mm (0.1”) interconnects are in two parts, the male header, and the female socket or receptacle. I use one 10-way and two 6-way single in line (SIL) connectors in this project. The ones I use are made by Multicomp, although more expensive types are available which may offer increased longevity. These are the Multicomp part numbers for the parts I used:

6 way socket	2212S-06SG-85
6 way header	2211S-06G
10 way socket	2212S-10SG-85
10 way header	2211S-10G

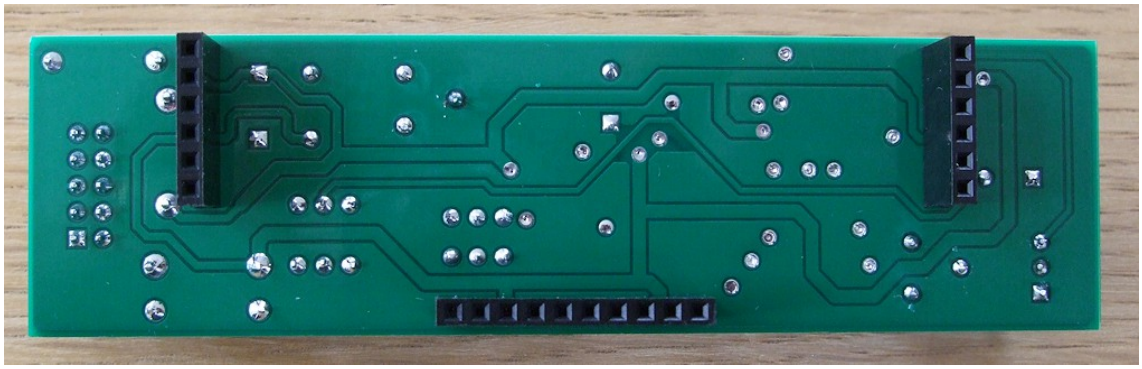
Populating the Circuit Boards

For general information on how to build Oakley modules, including circuit board population, mounting front panel components and making up board interconnects please see my generic Construction Guide at the project webpage or http://www.oakleysound.com/construct.pdf.

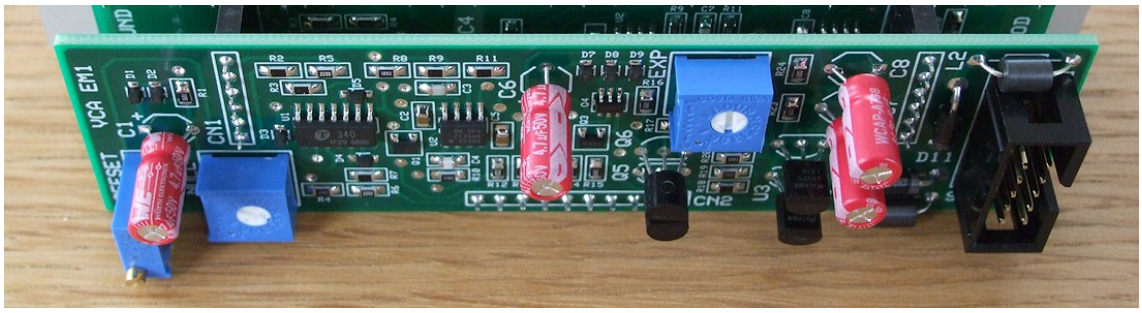
Main Board Construction

All the surface mount components should be soldered first. Take care to treat all transistors, diodes and ICs as static sensitive devices. I usually solder the resistors first, then the capacitors, then the discrete semiconductors, and then the ICs.

The next items to be soldered are the single in line (SIL) sockets. These are to be fitted to the underside of the board and soldered from the top side.



Special care should be taken to ensure that each SIL socket sits at right angles to the board surface. One way to do this is to temporarily fit the SIL headers into the SIL sockets and fit the Main board and Pot board together with the headers and sockets in between. Then solder the headers to the main board. Pulling the two boards apart should reveal all the sockets neatly in place and at the correct angle.

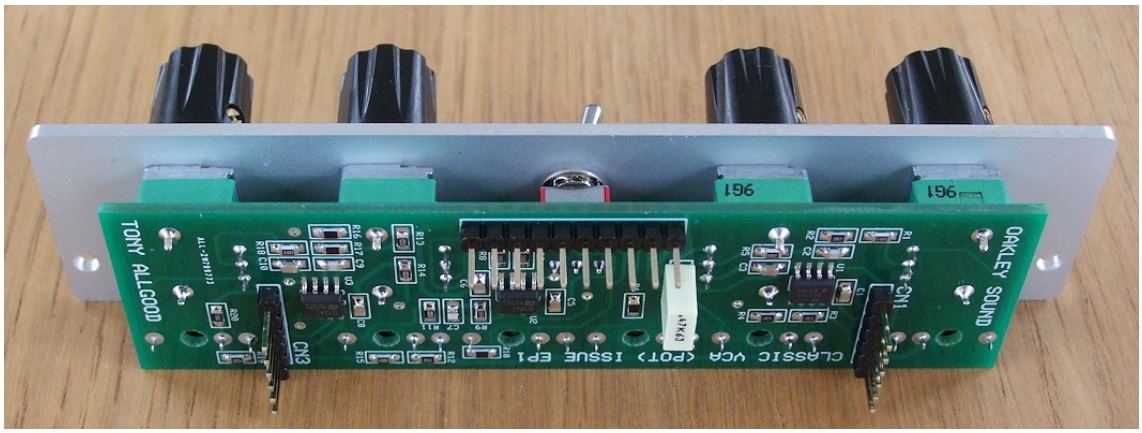


The next items to be soldered will be the through hole components. Remember that diodes and electrolytic capacitors are polarised so they need to be fitted the right way around. You should especially make sure that the boxed header is correctly orientated. Pin 1 is normally designated with a little arrow shape on the plastic housing of the header and this should align with the square pad on the board. Also, the hole in the housing should correspond to the little box shape on the board's printed legend.

Pot Board Construction

Except for the pots, switch, and sockets all the parts are to be fitted to the topside of the board. The surface mount parts should again be soldered first.

Now fit the SIL headers into place and solder from the underside of the board. It may be worth temporarily fitting the Pot board to the Main Board so as to hold the headers exactly at right angles while you solder.



The remaining parts are the front panel components and these will be fitted to the underside of the board and soldered from the top of the board. There are no legends on the underside of the board to indicate where the parts will go but using the front panel it should be clear where they need to be fitted. To ensure the correct alignment of these parts before soldering you should have your front panel ready. The panel will be used as a jig to hold the parts in the correct place while you solder. Failure to use the panel as a jig prior to soldering could mean that the panel will not slide onto the components.

The first parts to place, but not solder, will be the pots. The pots should be fitted so that the three pot pins go into the board first, then ease in the two lugs into their holes and push in firmly so that the pot clicks into place. The pot will sit securely in the board even without soldering.

Now fit the six sockets and switch into their places on the board but again do not solder yet. Place a toothed washer that came with the switch onto the switch's mounting bush..

Now ease the panel down onto the pots, switch and sockets making sure that all their threads are sitting snugly in their holes. Place a washer and a nut on each of the pots and sockets, but not the switch. Tighten the nuts but not too tightly. Turn the module over to reveal the topside of the circuit board. Now solder all the pots and sockets, but not the switch yet.

Flip the module over again and fit a single nut, and if you have one, a flat dress washer, to the exposed thread of the switch. You can ignore the other nut that came with the switch, as well as any washers that have locating lugs. Gently tighten the nut taking care not to scratch the panel. The switch will be pulled towards the panel and slightly off the board's top surface when you tighten the nut. The module can be turned over and the switch's three leads soldered.

Initial Testing

It is prudent to test the main board on its own before fitting it to the pot board and panel. If you have a bench power supply that allows you to select the current limit then set both the +12V and -12V supplies to a current limit of 50mA. This should prevent any serious meltdowns if there is a problem with the build.

Power up the main board on its own. If you can measure power supply current then it should be around -15mA from the negative rail and +15mA from the positive rail. Anything significantly more than this, like 30mA, will indicate a problem. If you can't measure current then check that no devices are getting warm.

If all is well, then the main board can be powered down. Wait a minute and then attach the main board to the pot board. Be very careful to ensure all the SIL connections are correctly in place.

Set the switch to Linear and power up the module and, if you can, check the current draw of the module. It should be around +30mA and -30mA. Anything significantly different to this, say over 45mA, will indicate a problem.

Turn the Input (DC), Input (AC) and CV2 pots to their minimum settings. Turn the CV1 pot to its maximum. Connect a 10V peak to peak 440Hz (the A above middle C) triangle wave to the Input (DC) socket. Listen to the output from the Out A socket. As you turn the Input (DC) level control up you should hear the triangle wave. Turn the CV1 pot back towards its middle position and the output level should fall. You should hear nothing from the Out A socket with the CV1 pot in its middle position. Leave CV1 in the middle and now turn up CV2. You should again hear your 440Hz triangle wave with CV2's Level pot acting like a volume control.

Swap the input signal to the Input (AC) socket. This should behave identically to the other input although this time it is the Input (AC) level control that affects the signal. There is no need to check the Exponential mode or the Out B socket as we need to calibrate the module before these parts can be tested properly.

Calibration

The module must be calibrated in the order given here. That is, OFFSET, NULL and then EXP.

OFFSET

This is a multiturn trimmer and is used to minimise the offset voltage when the VCA is turned on. The offset voltage is an unwanted steady state voltage that appears at the output of the VCA. If not set correctly a small proportion of the control voltage will be added to the output signal.

Turn the Input (DC), Input (AC), and CV2 pots to their minimum. Turn CV1 up to maximum. Set the switch to Linear.

Measure the voltage with respect to 0V at the Out A socket. Adjust the OFFSET trimmer until the voltage is 0.000V.

NULL

This is a single turn trimmer and it is used to adjust the overall gain of the VCA. It is called NULL because it is used to null, or minimise, the breakthrough of the signal from Out B.

Turn the Input (AC) and CV2 pots to their minimum. Turn the Input (DC) pot to its middle position, and the CV1 pot up to its maximum. Set the switch to Linear.

Connect a 10V peak to peak 440Hz (the A above middle C) triangle wave to the Input (DC) socket. Listen to the output signal from the Out B socket. Adjust NULL so that the audible signal heard from Out B is minimised. You will not be able to silence the signal but the idea is to get the signal heard to be as small as possible.

EXP

This is a single turn trimmer and it is used to adjust the offset voltage applied to the module's exponential convertor. It is called EXP because it is used to null, or minimise, the breakthrough of the signal from Out B when the switch is set to Exponential.

The module should be set as it was for the NULL calibration except that the switch is now set to Exponential.

Using the same 10V peak to peak 440Hz triangle wave to the Input (DC) socket, again listen to the output signal from the Out B socket. Adjust EXP so that the signal heard from Out B is minimised. As before you will not be able to silence the signal but, once again, the idea is to get the signal heard to be as small as possible.

Final Comments

If you have any problems with building 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 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 the great people on the Synth-diy and Analogue Heaven mailing lists and those at Muffwiggler.com.

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