Oakley Sound Systems

Vintage Flanger

PCB Issue 1 & 1.1

Builder's Guide

V1.4

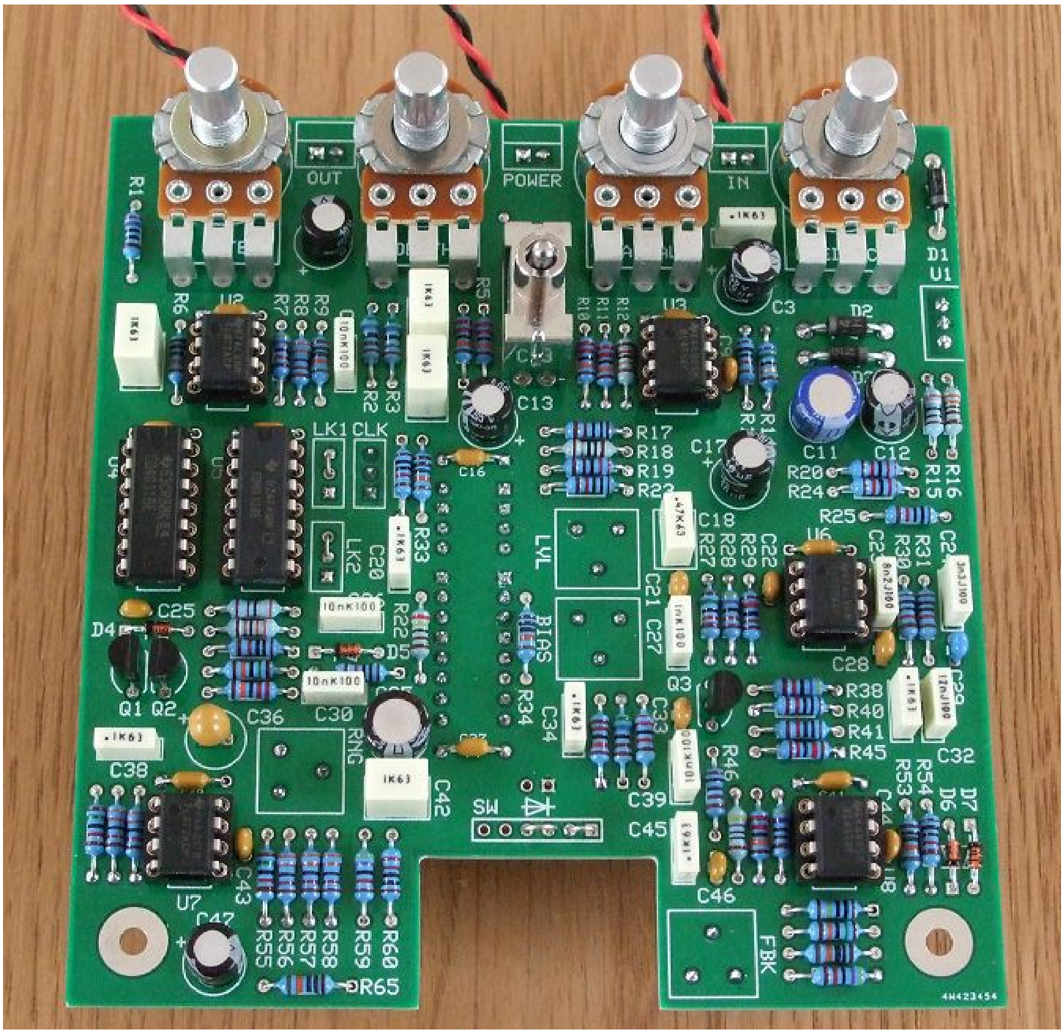
Tony Allgood
Oakley Sound Systems
CARLISLE
United Kingdom

Introduction

This is the Builder's Guide for the Vintage Flanger effects pedal from Oakley Sound. This document contains a basic introduction to the project, a full parts list for all the components needed to populate the board and the calibration routine.

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 fully populated Oakley Vintage Flanger issue 1 PCB. Later issue 1.1 PCBs are similar but have component legending on the underside of the board where appropriate. The BBD chip, the power regulator and four trimmers are mounted on the underside of the board.

The Oakley Vintage Flanger

The guts of a completed Oakley Vintage Flanger. Since this particular unit was built to test both SAD1024 and SAD512D devices both 8-pin and 16-pin IC sockets have been fitted to the underside of the board.

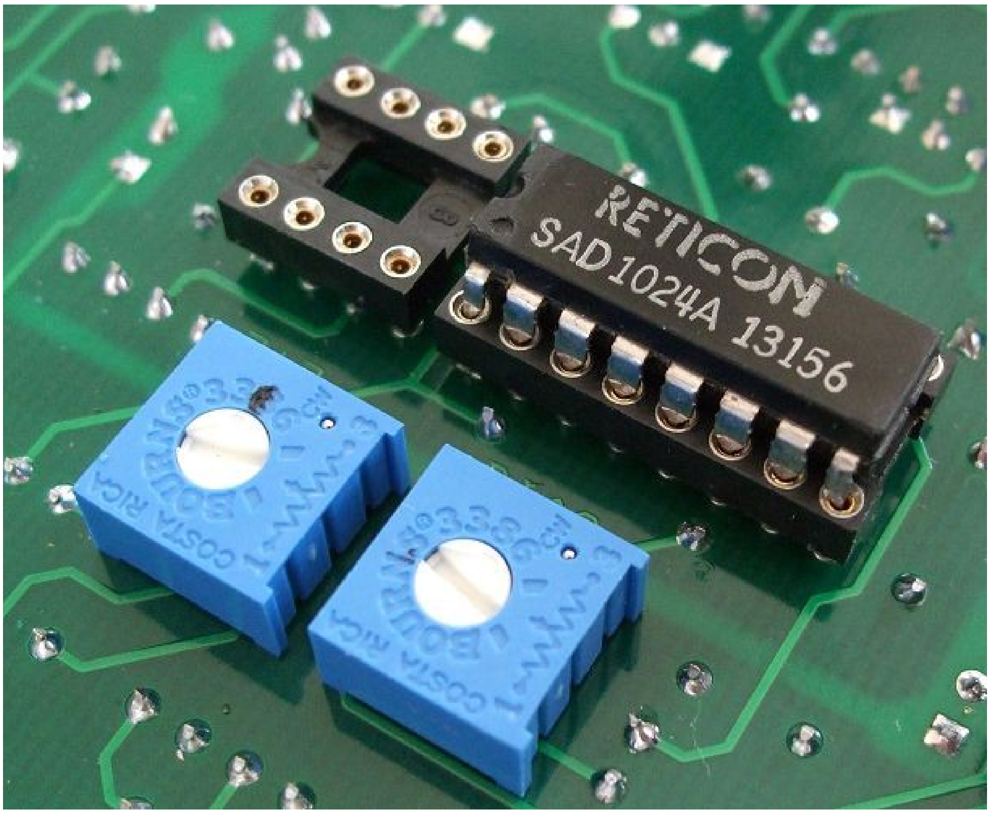
The Oakley Vintage Flanger was originally designed as a test circuit for reclaimed and new old stock (NOS) SAD512D and SAD1024 BBD chips. A flanger makes an ideal test circuit for BBDs since it is easy to hear when something is not quite right. Since I had gone to the effort of making a printed circuit board (PCB) design for the unit it made sense to make the PCB available to others if they too had spare Reticon BBD chips.

The basic design is based upon the classic big box BF-1 flanger from a well known pedal manufacturer beginning with 'B'. I have made some changes including improvements to the power supply, the ability to take a SAD512D or SAD1024, and adding a switch to allow to choose between negative or positive feedback. Other than that the circuit design is a 'warts and all' clone of the original schematic. Unlike the original unit, however, the PCB is a four layer design utilising separate 0V and +V power planes. The two remaining layers being used for signal tracking.

The original BF-1 used a SAD1024 and this is the preferred part for this project if you intend to use your pedal as a flanger and not just as a test circuit for BBDs.

The four layer PCB is 109 mm x 114 mm and will fit into a standard Hammond 1590XX die cast enclosure of size 145 mm x 121 mm x 39 mm. There is a cut out in the PCB to allow for a standard 3PDT foot switch which provides true bypass when off and also illuminates an LED when on.

The power required for the pedal is 15V to 18V DC with a current consumption of around 50mA and is reverse polarity protected. Internally, the core circuitry of the Vintage Flanger runs from a regulated +12V and +6V. I do not recommend this pedal be powered from anything over 18V, eg. 24V, as the pedal's internal 12V regulator will run too hot.



Both SAD1024 and SAD512D devices are supported but the Flanger sounds best when used with the SAD1024. The calibration settings will be significantly different between the SAD1024 and SAD512D.

Parts List

For general information regarding where to get parts and suggested part numbers please see our useful Parts Guide at the project webpage or directly from http://www.oakleysound.com/parts.pdf.

The components are grouped into values, the order of the component names is of no particular consequence. Component values given in this list supersede those shown on the schematic.

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 4,700 ohm resistor, 6n8 is a 6.8 nF capacitor.

Resistors

1% metal film 1/4W types are recommended.

10R	R18
75R	R14
220R	R60
270R	R1
390R	R15
470R	R50
1K	R46, R17
2K2	R19
2K4	R22
2K7	R43
3K3	R16
3K9	R26
4K7	R52, R59
5K6	R2, R3
10K	R21, R25, R54, R31, R30, R13, R37, R40, R23, R41, R44, R35
12K	R42, R45, R29
15K	R55, R27, R47
22K	R20, R24
33K	R49, R48, R58, R57, R56, R8
47K	R7, R64, R28, R38
100K	R53, R63, R33, R34, R65, R9, R6
120K	R12
150K	R36, R62
220K	R11, R51, R39, R5, R4, R10
330K	R32
1M	R61

Capacitors

100nF axial multilayer	C37, C4, C19, C40, C14, C5, C41, C15, C16
15pF C0G ceramic 2.5mm	C25
100pF C0G ceramic 2.5mm	C46, C43
150pF C0G ceramic 2.5mm	C33, C9, C22, C44
220pF C0G ceramic 2.5mm	C21
330pF C0G ceramic 2.5mm	C28
560pF C0G ceramic 2.5mm	C29
1nF polyester	C27
3n3 polyester	C24
8n2 polyester	C23
10nF polyester	C8, C39
12nF polyester	C32
47nF polyester	C26, C30
100nF polyester	C45, C20, C1, C34, C31, C38
470nF polyester	C18
1uF polyester	C7, C10, C6, C42
22uF, 16V tantalum	C36
10uF/50V low profile elect	C12, C17, C47, C13, C3
47uF/35V low profile elect	C11
100uF/25V low profile elect	C35
220u/10V low profile elect	C2

Electrolytic and polyester capacitors must not be of a height that is greater than 11mm.

All electrolytic capacitors have a lead spacing of 2.5mm or 2.54mm (0.1”).

Trimmers

All trimmers are mounted on the underside of the board and are 3/8" square vertically adjusted types, eg. Bourns 3386F

5K 3/8" trimmer	BIAS
10K 3/8" trimmer	LVL
100K 3/8" trimmer	FBK
200K 3/8" trimmer	RNG

Discrete Semiconductors

1N4001 diode	D3, D2, D1
1N4148 signal diode	D5, D7, D6, D4
5mm green LED	LED
BC549 NPN transistor	Q2, Q3
BC559 PNP transistor	Q1

Integrated Circuits

4011 quad NAND gate	U4
4013 dual d-type	U5
4558 dual op-amp	U8, U3
TL072ACP dual op-amp	U2, U6, U7
LM317 linear regulator	U1*

* U1 is mounted on the underside of the board sticking directly downwards and its leads pushed as far into the board as they will go. The metal tab should be facing inward and away from the nearest edge of the board. Care should be taken so that the tab does not touch any part of the metal case including the lid when the case is closed.

SAD1024 **or** SAD512D

The bucket brigade delay (BBD) IC is also mounted on the underside of the board. Either the SAD1024 or SAD512D need to be fitted, not both.

It is recommended that IC sockets be used for this project. You will need two 14-pin DIL sockets, five 8-pin DIL sockets. On the underside of the board fit either an 8-pin DIL socket if you are using a SAD512D, or fit a 16-pin DIL socket if you are using a SAD1024. U1 should not be mounted in a socket.

Potentiometers

Alpha 16mm right angle type.

50K linear	MANUAL, DEPTH
50K log	RATE
100K reverse log	FEEDBACK

So as to make the pots align with the top of the suggested switch you need also to purchase eight additional pot washers (two extra for each pot) that will sit on the pot's mounting bush between the inside surface of the panel and the pot to act as a spacer. Pot washers are usually available from the same parts supplier you got the pots from. They are thinner than standard M7 washers. You will generally get one pot washer per pot when you purchase the pot and this one is to be fitted between the nut and the front panel.

Miscellaneous

If fitting SAD1024 then solder two wire links, one between pin 2 and pin 3 (the round solder pads) of LK1 and another between pin 2 and pin 3 (the round solder pads) of LK2. CLK is not used.

If fitting SAD512D then fit a wire link between pin 2 and pin 3 (the round solder pads) of CLK. LK1 and LK2 are not used.

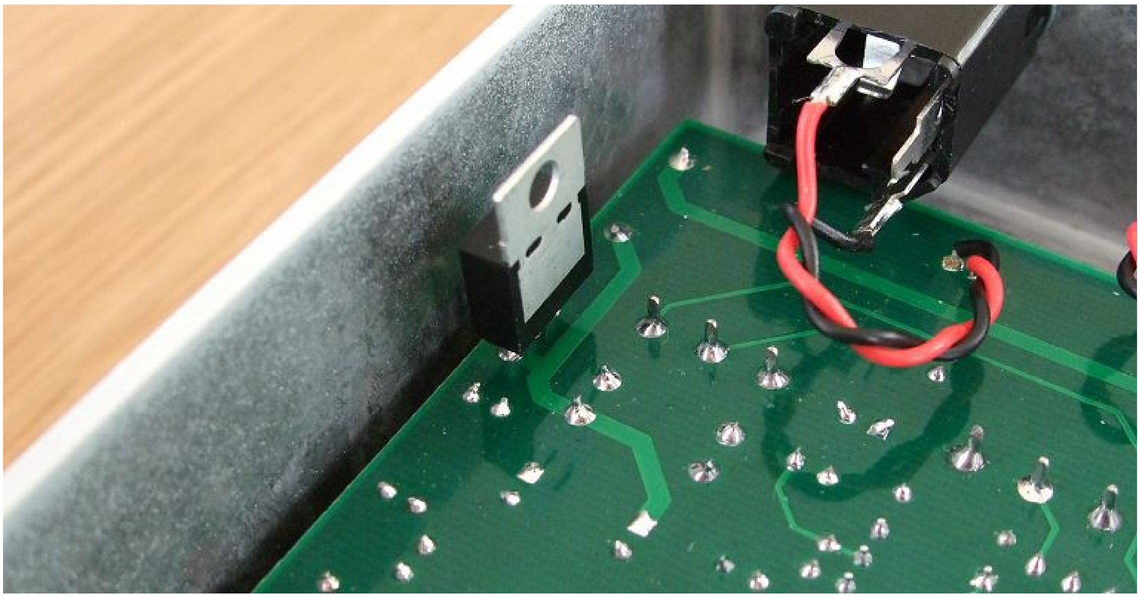
SPDT switch, eg. Multicomp 1MS1T2B4VS2RES MODE

Enclosed 1/4” socket, eg. Switchcraft 112A or equivalent 2 off for input & output

Suitable power socket, eg. 2.1mm barrel type.

Metal case Hammond 1590XXLG (145 mm x 121 mm x 39 mm)

12mm hex M3 male-female spacer	2 off for securing the board to the case
M3 6mm screw	2 off for securing the board to the case
M3 shakeproof washer	2 off for securing the board to the case
M3 nut	2 off for securing the board to the case



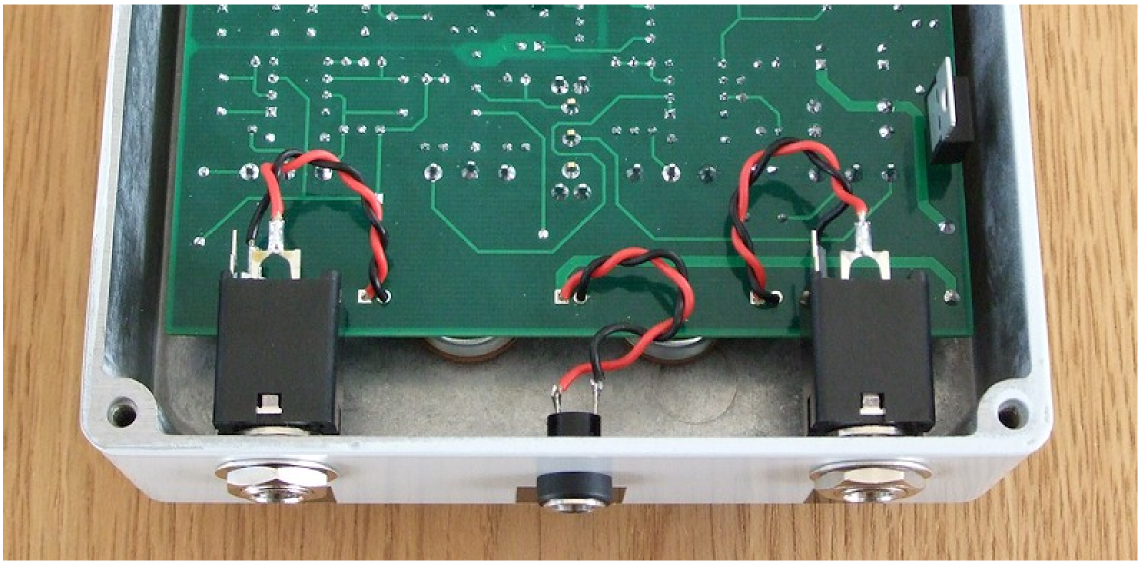
U1, the LM317, is mounted on the underside of the board and mounted so that the metal tab faces away from the metal side of the enclosure.

Audio Input and Output Connections

The 1/4" sockets I recommend are Switchcraft 112A. The PCB mounting 112APCX are the ones I have used in my prototype, but the ones with solder tags are to be preferred. The 112A sockets have three terminals, one connects to the tip of the inserted jack plug, another connects to the sleeve or 'ground' of the inserted jack plug and the other is the normally closed, or NC, terminal that connects to the tip terminal but only when there is no jack inserted. We will not be using the NC terminal for either the input or output socket.

The input and output signals pass from the PCB via two 2-way Molex style 0.1" headers. Pin 1 of the header is a square solder pad, and pin 2 a round solder pad. Rather than use headers and matching sockets I simply soldered the wires from the 1/4" sockets to the board.

For both sockets, pin 1, the square pad, goes to the tip (T) terminal of the socket, and pin 2 goes to the sleeve (S) terminal. I used black and red wires twisted together to use as interconnects between the board and the sockets. The red lead carries the signal to the tip, and the black lead is 0V and connects to the sleeve.



The rear of the unit from the underside. The sockets, from left to right, are audio output, power in, and audio input.

Power Inlet

I used a standard chassis mounted 2.1mm barrel connector. The tip of the socket normally being used for the positive voltage of the supply. I usually recommend that the connector be isolated from the chassis, that is, the socket's housing is made from plastic and is not electrically connected to either of the socket's two terminals. If you do use a socket with a metal bush then please ensure that the metal bush will be connected to the negative side of the incoming power source.

The power enters the circuit board by a two way 0.1" header in the middle of the board, which can be soldered to directly. Pin 1, the square solder pad, is the positive voltage input. Pin 2, the round solder pad, is connected to 0V (the module's local ground).

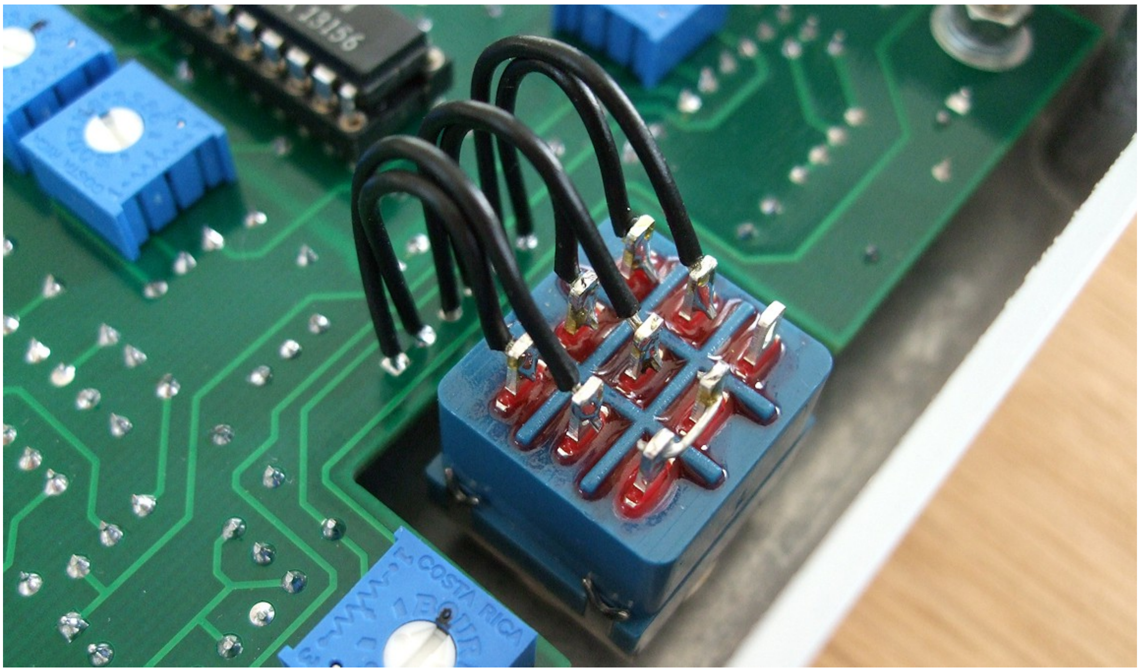
D1, a 1N4001 diode, prevents any damage being done to the module should the input power's polarity be reversed.

The input voltage should be between 15V to 18V. Current consumption is no more than 50mA.

Note the module is powered up as soon as power is applied. Putting the module into bypass with the foot pedal does not turn the unit off.

Bypass Switch

The unit uses a foot operated push switch to either pass audio direct from the input to output sockets, or via the electronics of the pedal. This is called true bypass, and it allows the audio signal to run through the pedal even when the pedal has no power. The switch is a three pole, change over type, usually called 3PDT (three pole, double throw) switch. Two of the poles direct the audio through the pedal, and the remaining pole simply lights an LED to indicate the effect is active. The switch is not mounted to the PCB.



Six small lengths of wire are required to connect the switch to the circuit board. Further to these is a small wire link that connects two of the switch's terminals together. This wire link can be seen on the photograph connecting the lower left hand and lower middle terminals together. This should be soldered first.

The switch is connected to the PCB with six wires going to six solder pads spaced 0.1" apart from each other. Pin 1 is the square pad, and next to it is pin 2, then pin 3, etc. The switch is connected so that its three terminals nearest the board are connected to pins 2, 4, and 6 of the six pads. The switch's middle row of pins are then connected to pins 1, 3, and 5.

Note that one of the switch's nine terminals is not soldered to anything.

Calibration

There are four trimmers, RNG, BIAS, LVL, and FBK, that need to be set to allow the unit to function at its best. They should be adjusted in the order given. It should be noted that all BBD chips will need to trimmed differently, so using different specimens of SAD1024, or SAD512D, will result in slightly different trimmer positions. The difference in trimmer positions between the SAD1024 and SAD512D is significant. However, the trimmers in the Vintage Flanger have been given suitably large ranges to hopefully cope with any devices you may have.

Sadly as the SAD512D and SAD1024 age they become less efficient at passing audio. They become noisier and crucially the audio signal at the output becomes smaller. If you find that after a time, your flanger becomes less resonant at high feedback settings, it is likely that your BBD chip is nearing the end of its useful life.

RNG, or range, adjusts the operating range of the high frequency oscillator that controls, or clocks, the BBD. The BBD's delay is shortest when the oscillator's frequency is high, around 2MHz.

Set all the unit's front panel potentiometers to their minimum values. The high frequency oscillator will now be running at its slowest. Adjust RNG so that the frequency seen on pin 8 of the SAD1024, or pin 1 of the SAD512D is roughly 40kHz (time period 25us).

BIAS, adjusts the DC offset applied to the audio signal at the input of the BBD. It should be set so that the audio signal will lie in the region where the BBD does not distort. The boundaries of this region change with the clocking frequency so there is no ideal position for BIAS that covers all the delay times used in the flanger. However, a good compromise position is obtained when the unit is adjusted for minimum distortion at the highest clocking frequency.

Set all the front panel pots to their minimum positions except for Manual which should be set to its maximum value. This sets the high frequency oscillator to its maximum frequency. Connect a 2V peak to peak triangle wave signal at approximately 440Hz to the input of the module. Move the BIAS trimmer to its furthest clockwise position. Listen to the audio output. Now slowly back off the BIAS trimmer, in an anti-clockwise direction. You'll first hear the pure tone of the input signal. Then you will hear a slight distortion, this will increase as you slowly turn the trimmer. Then the tone will become clear again. At this point stop. The ideal position of BIAS will be at that point when you hear a distortion free sound and slightly off the distorted sound.

If you have an oscilloscope then you can monitor the signal at the middle pin of the feedback mode switch. You will see only the BBD's delayed audio signal at this point. The ideal position of BIAS will be at that point when the top of the waveform has just become unclipped, that is, no flattening of the upper portion of the wave shape.

LVL, or level, adjusts the delayed audio signal level leaving the BBD. It should be adjusted so that the delayed signal level is the same as the non-delayed signal level just prior to where they are mixed together to form the flanger's output.

Set all pots to their minimum value. Connect a 1V peak to peak 440Hz triangle or sine wave to the input of the module. Listen to the output. Adjust the Manual pot to a point near its middle position so that the volume of the audio output is minimised. It won't become silent but there will be several positions of the Manual control that reduce the output level significantly. Now adjust the LVL trimmer, without moving the Manual pot on the front, so that the audio output is reduced still further. The ideal position of LVL will be when the output is at its quietest.

FBK, or feedback, adjusts the sensitivity of the Feedback (Resonance in the original BF-1) control. This can be set to taste, as many people like the ability of a flanger to self-oscillate when the feedback control is turned up to its maximum value. The BF-1 was originally designed not to self-oscillate so if you wish to not have any self-oscillation then the FBK trimmer can be set as follows. All the pots should be set to their minimum value except for Feedback (or Resonance) which should be set to its maximum. Listen to the output of the flanger. Adjust the FBK trimmer so that the unit is not quite oscillating. Any oscillation will be heard as a loud howling sound. The ideal position of FBK will be that narrow point between self-oscillation and stability. Check that the unit does not oscillate at all positions of the Manual control. If it does then gently back off FBK until it stops.

The unit will come to no harm in self-oscillation, but self-oscillating flangers are unpredictable and wild things, and output levels can get very loud.

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.

I'd love to hear about what you have done with your module. Please do post pictures of your finished module at the Oakley Sound forum on Muffwiggler.

If you are in the UK and 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 at my contact e-mail address found on the website. I can service either fully populated PCBs or whole pedals. 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 user 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. The forum is the best place to ask these sorts of questions.

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 Muff's Forum and the SynthDIY and Analogue Heaven mailing lists.

Tony Allgood at Oakley Sound

Cumbria, UK