Oakley Sound Systems

5U Oakley Modular Series

Deep Equinoxe
Voltage Controlled Phaser

Deep Equinoxe PCB Issue 1 & 1.1

Equinoxe PCB issue 5 and 5.1

Builder's Guide

V5.3

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The 1U wide panel design for the single switch variant of the Deep Equinoxe for MOTM format systems.
The fpd file for this panel can be found on the project webpage.

The 1U wide panel design for the two switch variant of the Deep Equinoxe for MOTM format systems. The fpd file for this panel can be found on the project webpage.

Introduction

This is the Project Builder's Guide for the Deep Equinoxe 5U module from Oakley Sound. This document contains a basic introduction to the boards, a description of the schematics, a full parts list for the components needed to populate the boards, and a list of the various interconnections.

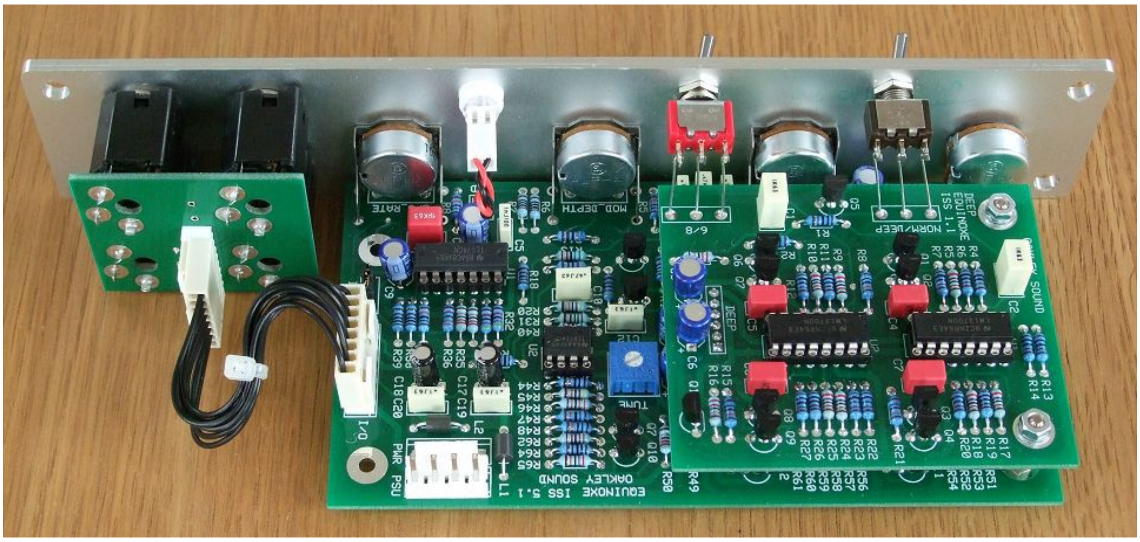
This Builder's Guide contains the instructions for building the whole Deep Equinoxe module, which includes construction of both the Deep Equinoxe daughter board and the Equinoxe main board. Note that the Equinoxe main board has to be issue 5 or above. Earlier issue Equinoxe boards are not able to upgraded with the Deep Equinoxe PCB.

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

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

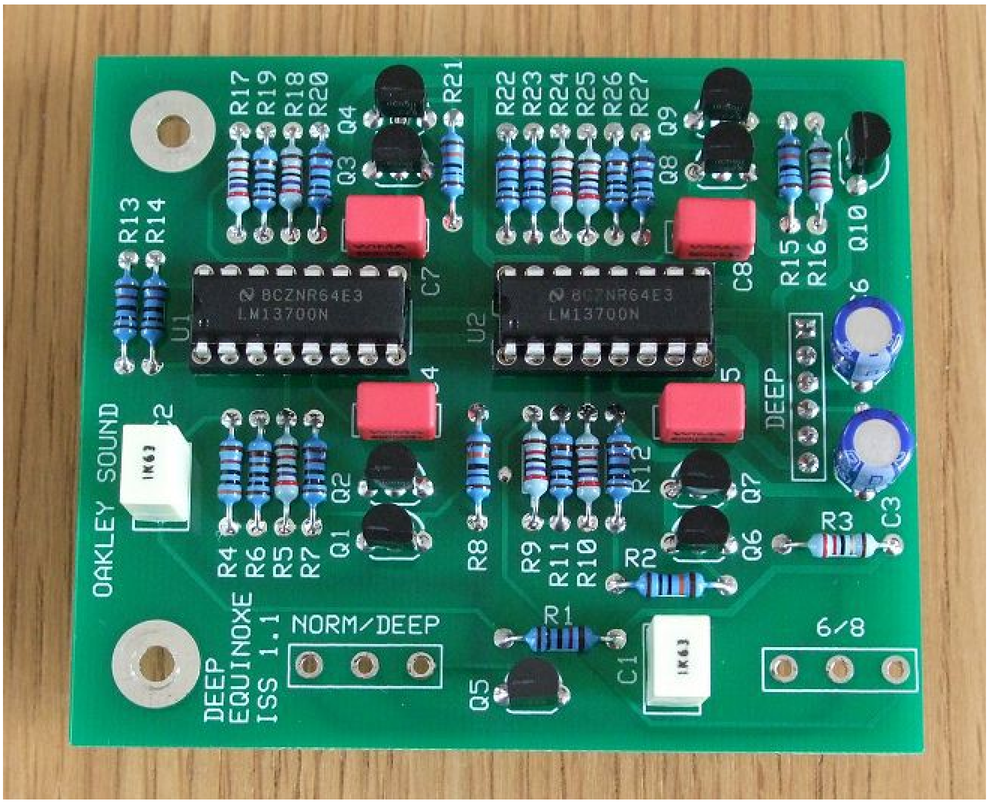
For general information regarding where to get parts and suggested part numbers please see our useful Parts Guide at the project webpage or http://www.oakleysound.com/parts.pdf.

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 two switch variant of the Oakley Deep Equinoxe module behind a natural finish Schaeffer panel. The Deep Equinoxe daughter board is the smaller one mounted above the standard Equinoxe PCB. Note the use of the optional Sock4 socket board to facilitate the wiring up of the four sockets.

The Deep Equinoxe PCB set



The Deep Equinoxe Daughter board which fits on top of the Equinoxe main board.

The main board size is 143mm (high) x 72mm (deep) and the Deep Equinoxe daughter board is 77mm (high) x 65mm (wide). Both boards are two layer designs which means they have copper tracks on both the upper and lower surfaces. The main board has been laid out to accept connection to our Sock4 socket board. This small board speeds up the wiring of the eight sockets and reduces the chances of mistakes.

If you are building the standard design, with the exception of the two switches and the LED, there are no components mounted off the boards. All components including sockets and pots are soldered directly to the boards. All the socket wiring can be done via the socket board and one eight way MTA100 or Molex KK100 solderless connections.

Some people will wish to use this Oakley design in a non standard format, such as fitting it to another manufacturer's rack or one of their own invention. This is perfectly easy to do. Simply do not use the socket board and wire the main board to the sockets as per usual.

I have provided space for the four control pots on the main PCB. If you use the specified 16mm Alpha pots and matching brackets, the PCB can be held firmly to the panel without any additional mounting procedures. The pot spacing is 1.625" and is the same as the vertical spacing on the MOTM modular synthesiser and many of my other modules.

The issue 5.1 main board 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, however, the top two holes are used to mount the Deep Equinoxe PCB.

Parts Lists

Two PCBs, the Equinoxe and Deep Equinoxe, are needed for this project and a third one, Sock4, is optional.

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.

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.

Issue 5 and 5.1 Equinoxe Parts List

Resistors

1% 0.25W metal film types are recommended.

22R	R34, R35, R49, R50
100R	R2, R6, R7
1K	R18, R24, R29, R39, R38, R41, R53, R60, R64
4K7	R9, R17, R19
6K8	R11
7K5	R31
10K	R10, R42, R1, R25, R43, R57, R56, R54, R61, R30, R16
15K	R3
22K	R4
27K	R28, R59, R23, R58, R14, R51, R27, R52
30K	R22, R15
47K	R32, R33, R36
56K	R40, R13
82K	R62
100K	R44, R63, R47, R48, R55, R8, R5, R37, R26, R21
270K	R65
330K	R46
470K	R45, R12, R20

Capacitors

1nF 5mm polyester film	C5
6n8 5mm polypropylene film	C21, C22, C15, C14
100nF 5mm polyester film	C2, C19, C12, C4, C20
470nF 5mm polyester film	C11, C8, C3, C10
2u2, 63V electrolytic	C17, C18
22uF, 35V low profile electrolytic*	C7, C1, C6, C13, C16, C9

* Low profile, ie. short in height, devices are required to allow an acceptable clearance between the main PCB and the daughter board. For example, Panasonic ECA1HAK220X

Discrete Semiconductors

BC549 NPN small signal transistor	Q1, Q2, Q3, Q5, Q6, Q7, Q8, Q9, Q11, Q12
BC559 PNP small signal transistor	Q4, Q10

Integrated Circuits

LM13700N dual OTA	U3, U4
TL072ACP dual op-amp	U2
TL074CN quad op-amp	U1

IC sockets are recommended. You need two 16-pin, one 8-pin and one 14-pin DIL sockets.

Potentiometers (Pots)

All pots Alpha 16mm PCB mounted types

10K linear	EMPHASIS
50K linear	FREQUENCY, MOD_DEPTH
100K log	LFO_RATE

Three 16mm pot brackets.

Trimmer

500K horizontal*	TUNE

Issue 5 boards require Bourns 3386G-1-504. Issue 5.1 boards require Bourns 3386F-1-504

Miscellaneous

Leaded axial ferrite beads	L1, L2

MTA156 4 way header	PSU (Oakley/MOTM power supply only)
MTA100 6-way header	PWR (Synthesizers.com power supply only)
6-way 0.1” SIL socket*	DEEP

* For example Multicomp part number 2212S-06SG-85

Molex/MTA 0.1” header 8-way	I/O (For connecting to sockets)
Molex/MTA 0.1” housing 8-way	I/O (For connecting to sockets)
3 way 0.1” SIL header*	INV

* For example Multicomp part number 2211S-03G

0.1” jumper	For fitting to INV
Molex/MTA 0.1” housing 2-way	LED (optional connecting technique for the LED)
5mm clear LED lens	LED
5mm LED lens securing ring	LED (if lens is not self securing)

Issue 1 Deep Equinoxe Parts List

Resistors

1% 0.25W metal film types are recommended.

22R	R3, R16
1K	R6, R26, R19, R11
10K	R12, R22, R20, R23, R13, R7, R1, R14, R27
27K	R5, R17, R18, R10, R9, R24, R25
30K	R4
100K	R2, R8, R21, R15

Capacitors

6n8 5mm polypropylene film	C4, C5, C7, C8
1u, 63V 5mm polyester film	C1, C2
22uF, 35V electrolytic	C3, C6

Discrete Semiconductors

BC549 NPN small signal transistor	Q1, Q2, Q3, Q4, Q6, Q7, Q8, Q9
BC559 PNP small signal transistor	Q10
J201 JFET	Q5

Integrated Circuits

LM13700N dual OTA	U1, U2

IC sockets are recommended. You need two 16-pin DIL sockets.

Switches

On-On-On (SP3T) toggle switch*	Stage select (single switch option)
On-On (SPDT) toggle switches	NORM/DEEP, 6/8 (Two switch option)

* For example: NKK M2024ES1G01 or M2024ES1W01

Miscellaneous

6-way 0.1" SIL header*	DEEP

* For example Multicomp part number 2212S-06G. This is to be attached to the underside of the board and soldered from the top side.

Other Parts Required

Switchcraft 112APC 1/4" sockets	Four off mounted either on the Sock4 board or on panel

Four knobs

Around 2m of insulated multistrand hook up wire for the LED and socket connections.
About 1m of thin uninsulated tinned solid core wire to connect the switches.

11mm M3 male-female hex spacers	2 off
6mm M3 pan head screws	2 off
M3 nuts	2 off
M3 flat washers	6 off
M3 shake proof washers	4 off

Components required if using optional Sock4 board

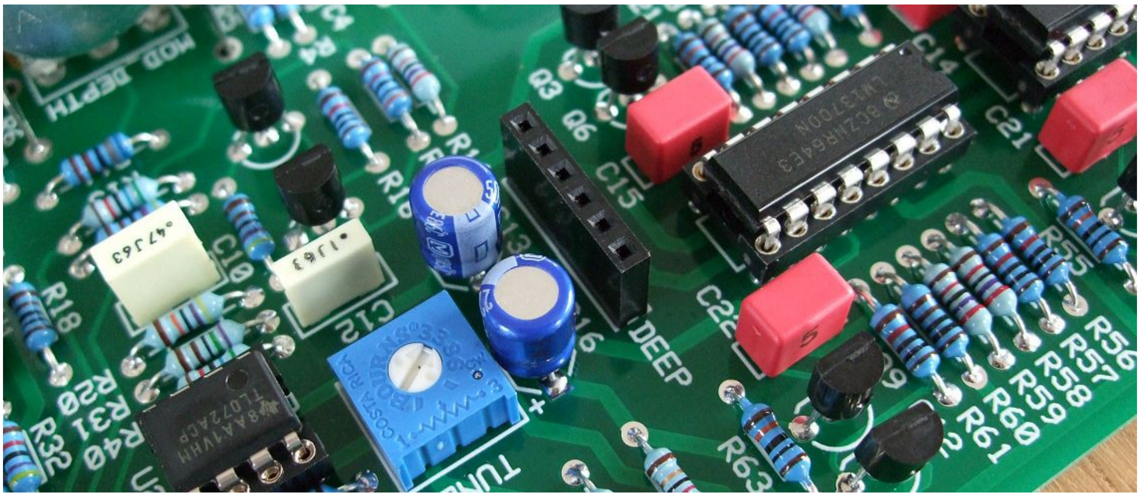
Molex/MTA 0.1" header 8-way	I/O
Molex/MTA 0.1" housing 8-way	I/O

112APC Switchcraft 1/4" socket	SK1, SK2, SK3, SK4

A single wire link is to be fitted to L2 on the Sock4 PCB. L1 is left open.

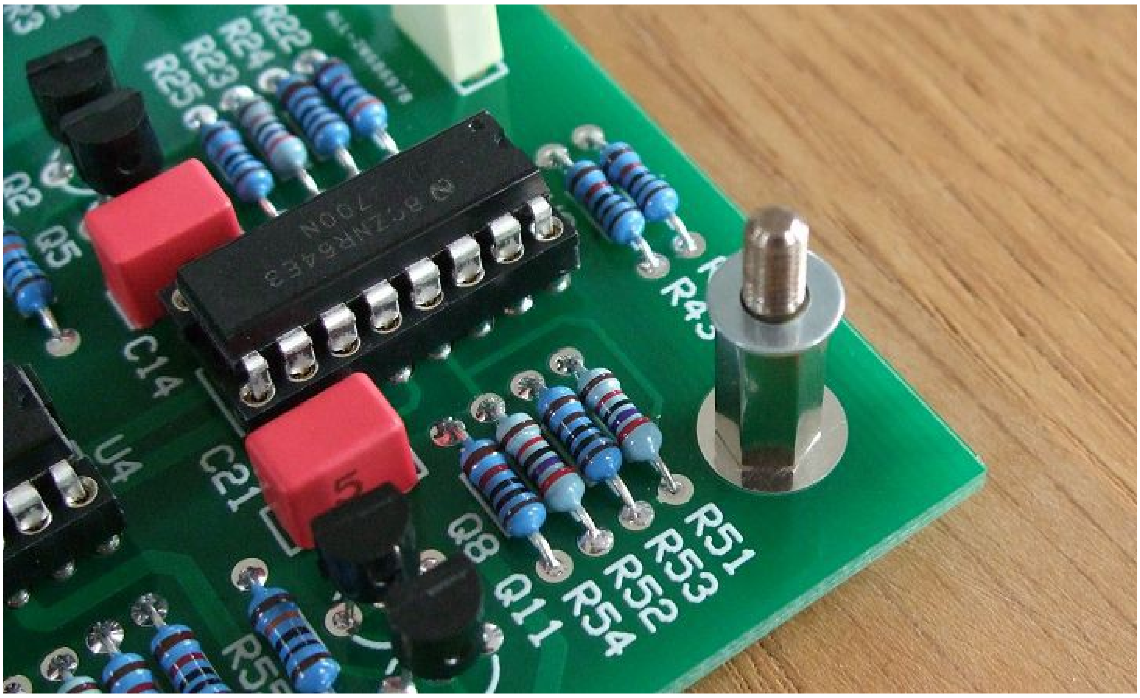
If using Molex KK you'll also need at least 16 crimp terminals.

Attaching the Daughter Board

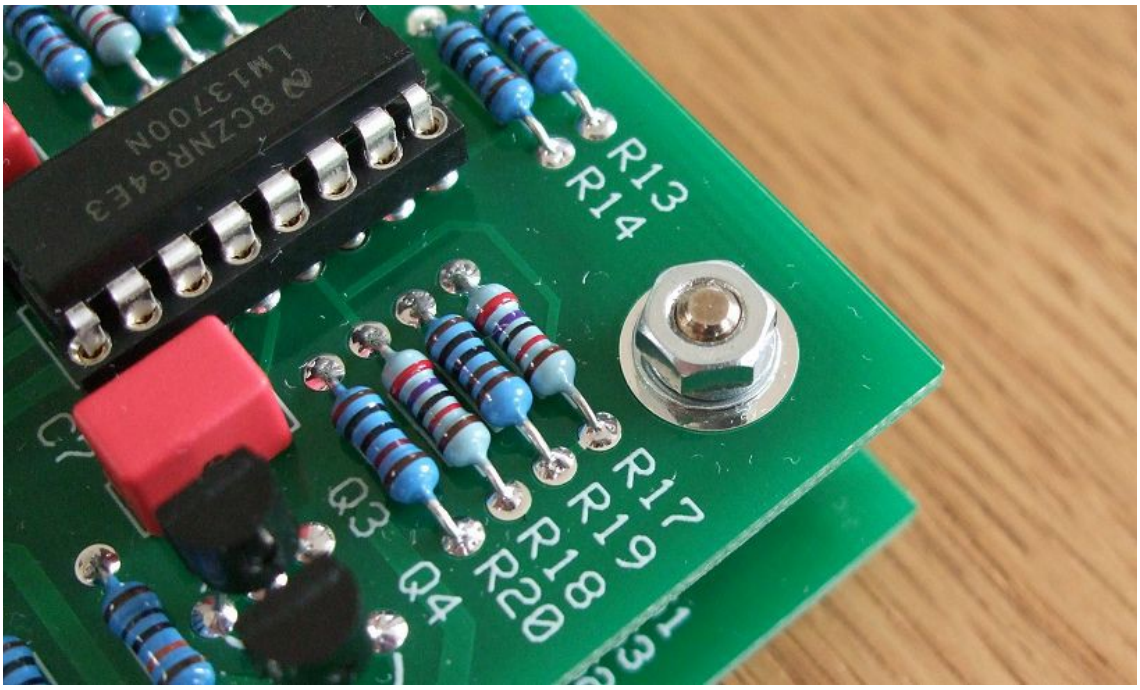


The six way 0.1" SIL socket on the main board.

The two boards are securely mounted together using two 11mm male-female hex spacers, two nuts, four shakeproof washers, six flat washers and two 6mm M3 screws. The hex spacers should be fitted to the main board first. Use the one of the screws, one flat washer and one shakeproof washer to loosely fit the hex spacer to the main board. Do not tighten the screw just yet. Place a flat washer onto the thread on top of the spacer.

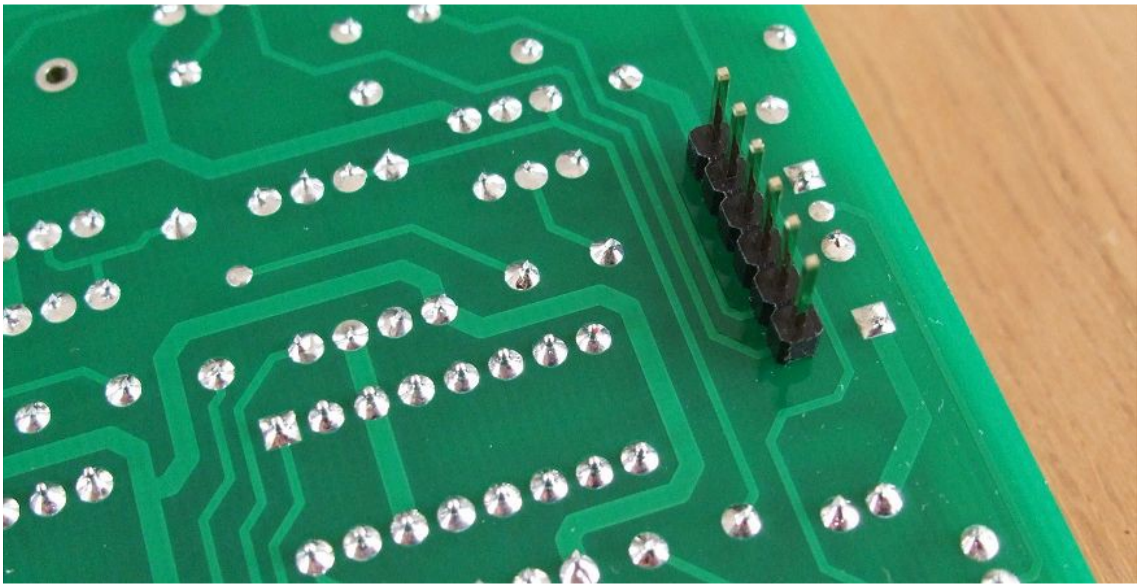


Now slide the Deep Equinoxe board onto the threads of the spacers and carefully make sure the six pins of the Deep Equinoxe's header slide into the socket on the main board. The two screws on the underside of the main board can now be tightened. The Deep Equinoxe board can then be secured by using a flat washer, a shakeproof washer and a nut on each of the exposed threads of the spacers.



Note that if you have earlier issue 5 and issue 1 main and daughter boards you will have three mounting holes. The lower hole need not be used.

It is worth checking that the tops of the two electrolytic capacitors, C13 and C16, directly under the bottom edge of the Deep Equinoxe daughter board are not touching any part of the daughter board. If they are they will need to be resoldered so that they are sitting closer to the main board's top surface.



The 6-way 0.1" header on the underside of the Deep Equinoxe daughter board.

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 3 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 connect together the middle two pads of the PSU header on the main board. This link connects the socket and panel ground with the module ground. Simply solder a solid wire hoop made from a resistor lead clipping, or bit of solid core wire, to join to the two middle pads of PSU.

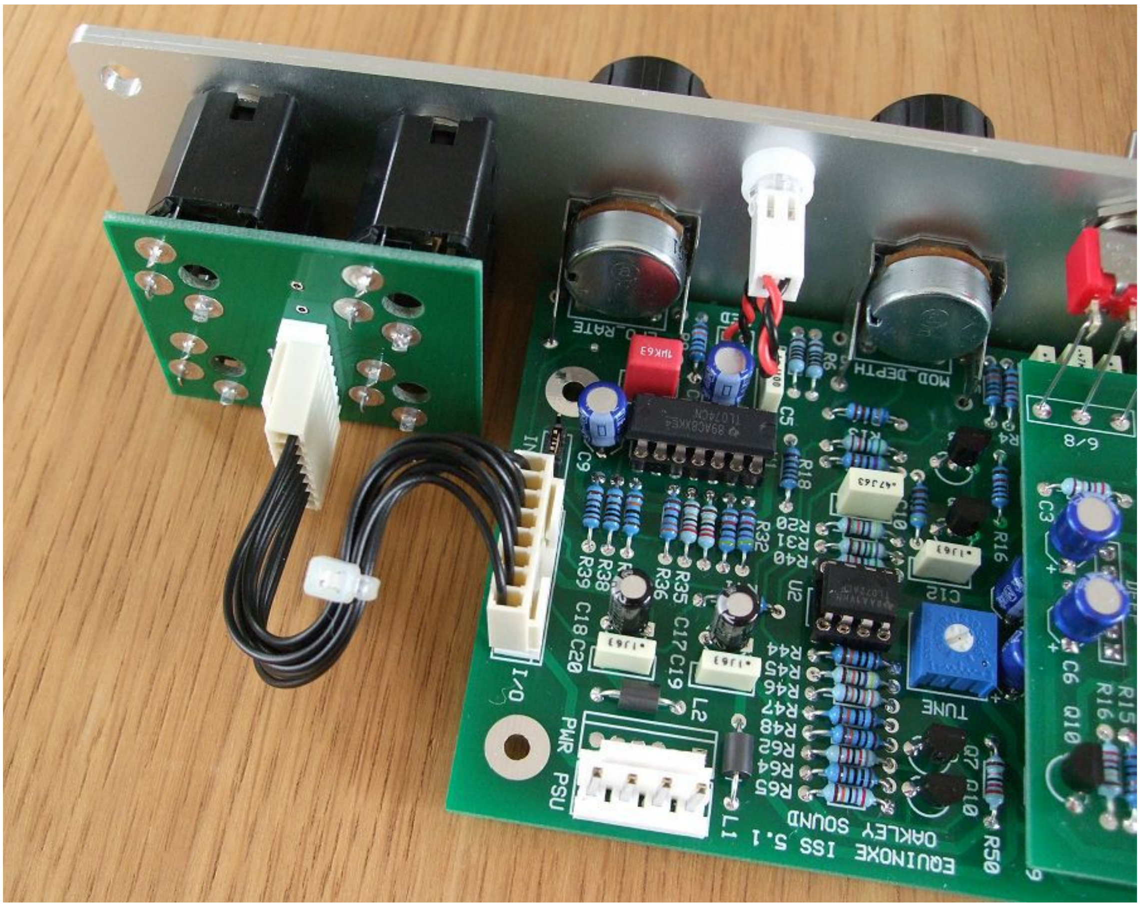
* The issue 5.1 Equinoxe boards connect the normally unused pin 6 of the MU connector to socket ground. With the link on PSU not fitted, and using an Oakley MU Dizzy distribution board with a five way power cable, will allow the socket ground to be kept separate from module ground to prevent ground loops.

Building the Deep Equinoxe module using the Sock4 board

This is the simplest way of connecting all the sockets to the main board. The Sock4 board should be populated in the way described in our construction guide found on the project webpage. There is only one eight way header and it is to be fitted to the bottom side of the board.

Do not forget to solder in the wire link L2. Link L1 is left open.

You need to make up only one eight way interconnect. It should be made so that it is 100mm long.



Here I have used the Molex KK 0.1" system to connect the Sock4 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 I/O. 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:

Pin	*Pad name*	*Socket Connection*	*Lug Type*
Pin 1	PANEL_GND	Connect to all sockets	Earth lugs
Pin 2	LFO_OUT	Connect to LFO OUT	Signal lug
Pin 3	NC	No connection	
Pin 4	AUDIO_OUT	Connect to AUDIO OUT	Signal lug
Pin 5	NC_LFO	Connect to CV IN	NC lug
Pin 6	CV_IN	Connect to CV IN	Signal lug
Pin 7	GND	Connect to AUDIO IN	NC lug
Pin 8	AUDIO_IN	Connect to AUDIO IN	Signal lug

Wiring the Bi-colour LED and Switches

Bi-colour LEDs have just two leads and each one should connect to the solder pad directly beneath it when it is mounted into the panel. I normally wire it up so that the LED goes red when the output is positive. In my builds I use a two way 0.1” Molex KK housing and crimps to connect to the LED's leads. I normally twist the wires together to keep things neat and avoid any unnecessary emissions of LED switching noise.

If you are building the older two switch design the switches are simply wired to the Deep Equinoxe board with stiff solid core wire although you can use multistrand hook up wire if you like. The solid core wire is looped around each switch lug and soldered to the pad directly below it. I recommend that the wire has some slack to allow the boards to flex a little.

I normally make sure the switch is in its place and tightened before soldering the leads. I always tighten from the back thus reducing the chance of scratching the front panel. I usually put the shakeproof washer on the inside of the module as they look unsightly on the front panel.

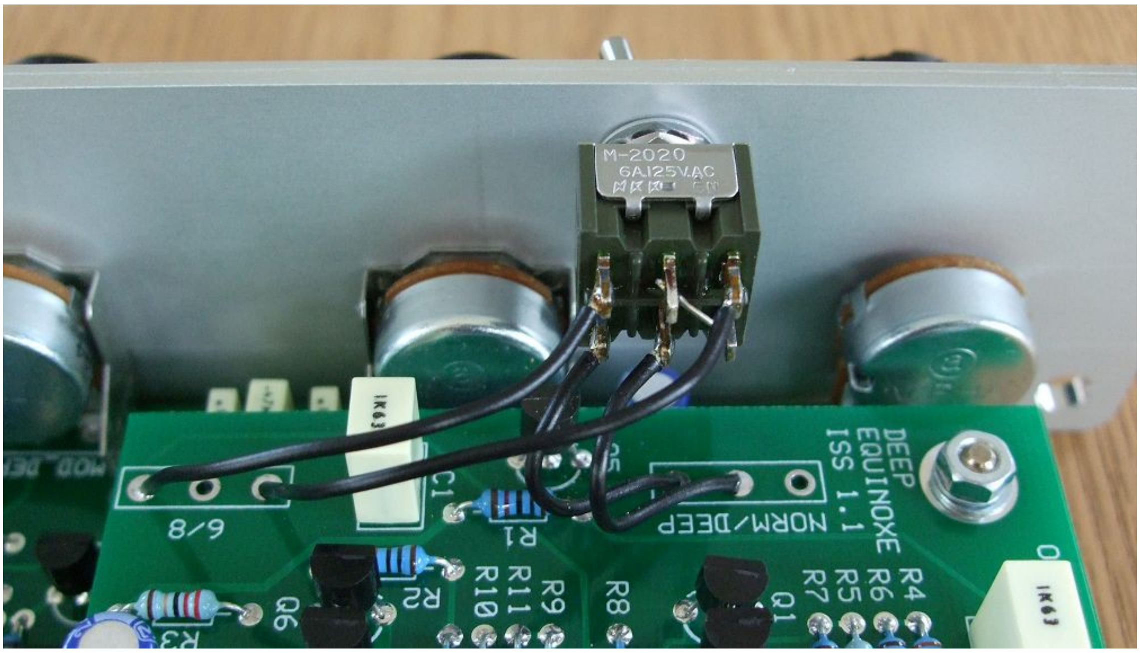
For the single switch design you need a special on-on-on SP3T switch. These look like DPDT switches but are wired very differently internally.

Before you mount the switch to the panel you must join two of the switch's terminals to one another. Hold the switch in your hand and have the toggle pointing away from you and the terminals facing you. If needed, rotate the switch so that the terminals are lined up as two horizontal rows of three. That is, when switched the toggle would move in the horizontal plane, left to right and vice versa. Connect with a thin bit of solid core wire, for example, a resistor lead clipping, the middle pin of the top row to the right most pin on the bottom row.

Now mount the switch to the panel. Remember to fit the shakeproof washer so that it makes contact with the inside surface of the panel. Now place the module down onto your work surface so that the PCB is lying flat with the components facing upwards and the front of the module is facing away from you.

With appropriate short lengths of multistrand hook up cable connect the remaining switch terminals to the Deep Equinoxe daughter board. The two free terminals on the bottom row of the switch should be connected to the NORM/DEEP solder pads. The middle terminal should connect to the middle solder pad. The left terminal should connect to the left solder pad. The right most solder pad of NORM/DEEP is left unconnected.

The top row of terminals should connect to the 6/8 solder pads. The right hand terminal needs to be wired to the right hand solder pad. The left hand terminal needs to be connected to the left hand solder pad. The middle pad of 6/8 is left unconnected.



Circuit Description

The Oakley Deep Equinoxe phaser is based around phase shift network built from operational transconductance amplifiers or OTAs. This type of shifter is not that common compared to the more numerous designs based on FETs and light sensitive devices. Other units that use the OTA are the Moog 12-stage phase shifter, DOD FX-20C and the Electro Harmonix Smallstone. It is the latter that Jean Michel Jarre used on the Equinoxe album, and the reason behind the Oakley device's name. Jarre had his unit modified by Michel Geiss, and the exact modifications are not known and have become subject to much speculation.

I wanted to create a phaser that was similar in tone to that used on the Jarre albums, but with more compatibility to modern modular synthesisers. The Deep Equinoxe uses either four, six or eight all pass stages to achieve its sound. Each all pass stage is identical. Four of the stages reside on the main board and the other four are on the Deep Equinoxe daughter board. The core of each stage is half an LM13700 OTA acting as current controlled resistor and inverter in one. This 'resistor' acts in combination with the 6.8nF capacitor to produce an all pass filter whose amplitude response is flat across the audio spectrum, but importantly, but one with a uneven phase response. At a certain frequency, determined by the current driving the OTA, the phase shift will be exactly 90 degrees.

You can think of a phase shift as being like a little time delay but for a specific input frequency only. Here's another way of looking at phase. Consider a child on a swing and then consider another child, next to her on the same length swing. He will move at the same frequency as she does, but it is unlikely that he will have started at the same time in the swing. So as he goes up, the other swing may be coming down. The two swings are out of phase, but moving at the same frequency. Only if they started at exactly the same time will they be in phase, or if he started his swing at a matching point in both their travels.

In practice it's highly unlikely that any two swings will go at the same frequency. Even with the same length of rope, there are other factors at work to make things more complicated.

A 90 degree phase shift is equivalent to one swing reaching the top, as the other one flies past the middle point. Or vice versa.

And a 180 degree phase shift is when one swing is at the top at one end, while the other swing reaches the top at the other end. Note that the phase shift remains constant so long as both swings are still moving at the same frequency. Thus the phase shift is still 180 degrees when the swings are at any point in their travels. For example, when the two swings pass each other in the middle but going different directions. So the phase shift doesn't just describe one point in time, but the whole relationship between two oscillating bodies.

Now, an all pass filter will create a 90 degree phase shift at one frequency only. All other frequencies will be affected, but to a lesser or greater extent. 90 degrees is important, because if we cascade two **identical** all pass networks together we get 180 phase shift at one frequency. And 180 degrees is exactly half a cycle of oscillation.

Now let us take our two all pass networks and listen to the output. Well, the output doesn't sound that different. But, let us now mix the output with the input. The overall impact is the signal gets louder. However, at just one frequency, something special happens. This is the frequency at which you have 180 degrees of phase difference between the input and the output. So as the input wave at that one frequency is going up, the output wave is going down. When the two are added together, they cancel each other out. And in theory, completely. So by mixing the 'out of phase' and the 'in phase signal' we can annihilate the signal.

So if we were to look at output response over the whole audio range we would find it pretty flat but for a very large notch taken out at just one frequency. So a two stage phaser will create one notch. By cascading more stages we can create more notches. Four stages, like we have in the standard Equinoxe, means we have two notches.

By using an OTA will can vary the frequency of these two notches. All the OTAs work together, hopefully producing the same phase response. (Like the swing example, no two OTAs will behave identically, and there are other things to complicate our simple analysis, but that's the wonder of analogue electronics for you)

Each OTA network is followed by a simple Darlington follower. This two transistor circuit behaves as buffer. The voltage at the emitter of the second transistor follows the voltage on the base of the first. The nice thing is that no current is stolen by the base, and the OTA can go about its business with no fear from the outside world pinching its output.

As we have heard the all pass filters are cascaded together to form a chain. The chain can be either four, six or eight stages long. The length of which is determined by the two switches on the front panel. The input signal enters the chain through C11 and leaves the main board via the SEND pad which is pin 1 on the DEEP header. The chain continues to the Deep Equinoxe board and returns by the aptly named RETURN pad, pin 2. The two switches that control the length of the chain are connected to the daughter board and reference should be made to the Deep Equinoxe schematic to understand how they are connected.

The Deep Equinoxe board simply copies the first four stages exactly. The only additional circuitry is a simple FET buffer or voltage follower circuit based around Q5. This allows the signal to be fed into the four other stages without any stealing any additional current from the output of the fourth phase shifter.

On returning to the main board the phase shifted signal is passed on to R14 and R15 which provide the necessary mixing effect at their junction for the notches to be created. U2a (pins 1, 2, 3) acts as a buffer circuit and also amplifies the mixed signal, via C10 and R20, up to the high levels associated with modulars.

The main input signal enters the Equinoxe by means of a resistive attenuator, also called a pad. This reduces the input level so as not to cause distortion in the input stage and the rest of the circuit. R13 and R11 set the 'gain' of the pad.

Q1 and Q4 form a discrete input circuit which buffers the padded input signal. It also provides the means for some additional mixing from the EMPHASIS pot. The emphasis pot provides a resonant type effect to be heard, by creating a positive feedback path within the phaser. So not only do we get the notches we also now get peaks in the response when the output signal reinforces the input signal. The more positive feedback the more 'peaky' the response. Too much positive feedback, and the system gets carried away and oscillates wildly. Getting this right is too complex for me to analyse by mathematics alone... so I just let my ears do the work. I played around with various feedback paths and listened to the sound created. In the end I went for the network of resistors and capacitors you see here. A simple solution in the end, and I think a very effective one.

It should be noted that the overall gain of the Deep Equinoxe is less than unity or 0dB, in fact, it is closer to -6dB. This is deliberate although you may find it less than convenient in some situations where you have a small input signal. The input level is expected to be the typical modular signal of 5V peak, or 10V peak to peak. With the emphasis turned up high it is possible to create large resonant peaks at some frequencies. If the through path gain of the Equinoxe was left at 0dB then these peaks would exceed the maximum allowed output level and cause distortion. If you are not going to use a 5V peak input, ie. you are connecting your module to a line level input, then you can increase the gain of the final stage [based around U2a], and decrease the padding on the input. Lowering R31 will increase the gain of the final stage, and increasing R11 will decrease the attenuation on the input pad.

The OTAs are all controlled from one current source. This is clever current source though. Based around Q7 and Q10, it is actually a simple exponential convertor. In other words a steady increase in base voltage produces a exponential rise in collector current. For every 18mV increase in Q7's base voltage we double the current sourced by Q10. The voltage on the base of Q10 is also passed onto the Deep Equinoxe's own exponential convertor device, also called Q10. Thus all eight OTA stages should be more or less track together.

The current source is driven from a simple one op-amp inverting summer. Its inputs derived from either the FREQUENCY pot, the TUNE trimmer and the external CV input

The LFO circuit is quite simple and is based around half of one quad op-amp, U1.

One quarter of the TL074 op-amp, U1b (pins 5, 6, 7) forms part of the integrator. Any positive voltage applied to the right of R8 will cause the voltage to fall at the output of the op-amp. The speed at which the voltage falls is controlled by C8 and the size of the voltage applied to R8. If the applied voltage is negative the op-amp's output will rise. It is the integrator's output that will be used as the source for the triangle wave output.

Another quarter of the TL074 op-amp (pins 9, 10, 8) is used as a Schmitt trigger. It's output is either high at +13V, or low at -13V. If the output of the Schmitt is initially low, it requires +6V at the output of the integrator to make it go high. The integrator will need to produce an output of -6V to make the Schmitt go low again.

To make any oscillator you normally require an output to be fed back into the input. This is positive feedback again. In a standard LFO like this one, the integrator is fed by the output of the schmitt trigger. Thus, a low at the output of the schmitt causes the integrator to rise. When the integrator's output reaches a certain point, the schmitt switches state and the integrator's output falls. The schmitt trigger changes state once again, and the process repeats itself...

The LFO_RATE pot allows only a controlled proportional of the Schmitt's output voltage to reach the integrator. If the proportion is large, the voltage on R8 is large, and the integrator sweeps fast. If the proportion is small, the integrator sweeps slowly. R6 sets the minimum speed. You can change the value of C8 to get different range of sweep speeds. Setting C8 at 470nF, we can go through the very slow at one cycle per minute to around 10Hz.

The output of the LFO is then split up to do several duties. One branch through R38 goes to drive the phaser core via the NC (normally closed) lug on the CV input socket. Another branch goes to pin 1 of the INV header and its little 2-way jumper so, if selected, to feed the LFO OUT socket via R39.

A third branch of the LFO output goes to a simple inverting amplifier based around U1d (pins 12, 13, 14). This simple circuit creates an oppositely going signal at its output, ie. when its input is +1V, the output is -1V. This inverted output goes to pin 3 of the INV header, which when the jumper is fitted to short out pins 2 and 3, the inverted output ends up at the LFO OUT socket.

The fourth branch of the LFO output is sent to the LED driver, based around U1a (pins 1, 2, 3). The bi-colour LED is in the feedback of this op-amp, so whatever current is drawn by R18, is also put through the LED. If one were to connect the LED and resistor straight across the LFO output and ground, the LED would be off when the voltage was less than its ‘turn-on’ voltage. This is normally around 2V which is a fair proportion of the 5V output signal. The old issue one boards did this, and although the LED did give an indication of LED speed, it would go out for some time. This special driver circuit makes the current through the LED proportional to the input voltage. So even at small LFO output levels, the LED is still giving out some light.

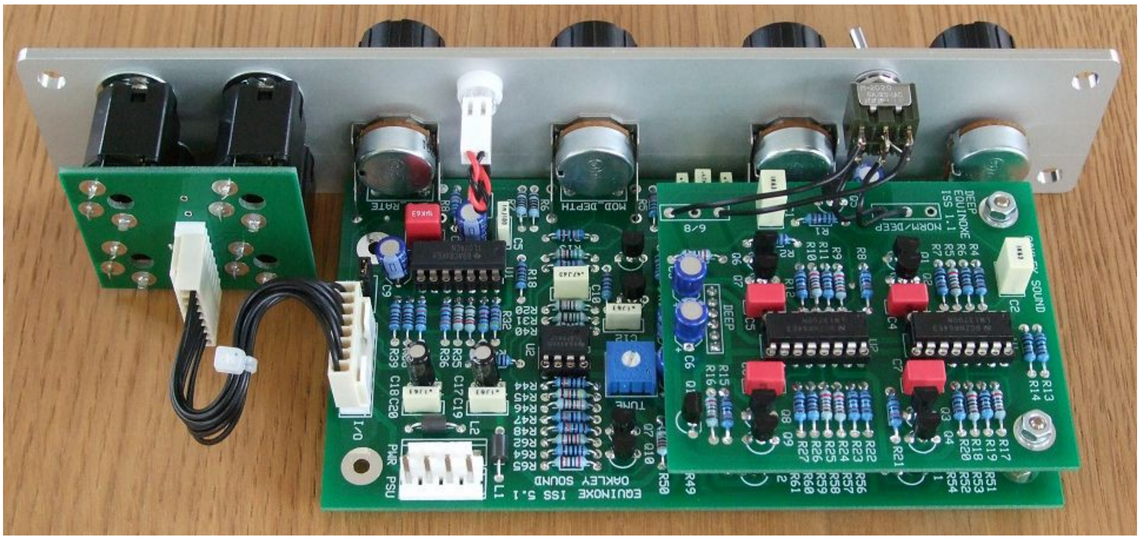
Testing

Apply power to the unit making sure you are applying the power correctly. The LED should throb between red and green. If it doesn’t turn off, and check all the parts again thoroughly. If your LED is OK, and there is no smoke rising from the board, then try the LFO rate. It should control the LED’s flashing. From around one cycle every 30 seconds to around 10 cycles a second.

Click the top switch into NORM. This will test the first four stages of the phase shifter. Now connect up an audio signal of some sort, any will do, but a simple sawtooth wave is quite sufficient. Listen to the audio output, and play with the controls. With all controls to the minimum setting, sweep the FREQUENCY pot. Do you hear the characteristic phase sweep? If not, you have got a problem. If yes, now turn up the EMPHASIS. Using the frequency pot again, does the sweep have a more metallic ring to it. It’ll probably be a bit louder too.

Click the top switch into DEEP. Rotate the frequency pot and you should again hear the characteristic phase sweep. Make sure that you get a similar effect in both SIX and EIGHT modes. However, the effect should be stronger in eight stage phasing.

Now set the FREQ and EMPHASIS pots to their middle position. Turn up the MOD DEPTH. The LFO should now be modulating the phaser. Check that the RATE affects the speed of the modulation.



The single switch variant of the Deep Equinoxe.

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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