Oakley Sound Systems

5U Oakley Modular Series

EFG & EFG-Deluxe
Envelope Follower & Gate Extractor

PCB Issue 6 & 6.1

Builder's Guide

V6.1

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Introduction

This is the Project Builder's Guide for the issue 6 and 6.1 EFG and EFG-Deluxe modules from Oakley Sound.

This document contains a full parts list for the components needed to populate the board and gives details on how to wire up the module in either of its guises.

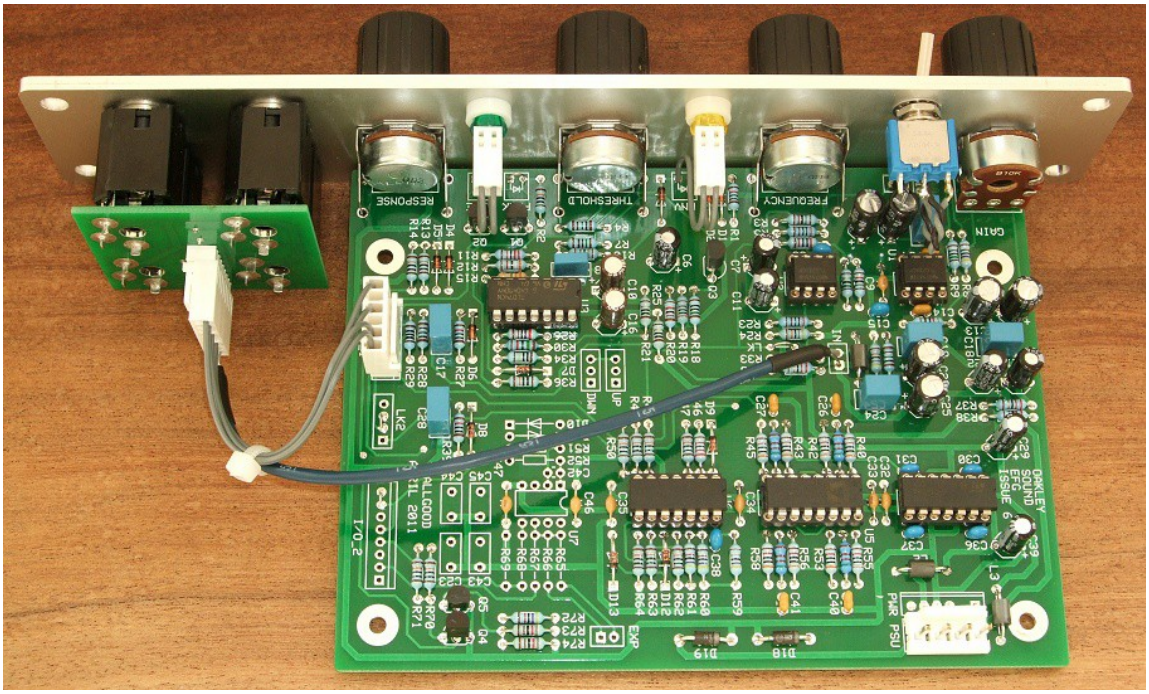
For the User Manual, which contains an overview of the operation of the unit, please visit the main project webpage at:

http://www.oakleysound.com/follower.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 Issue 6 and 6.1 EFG PCB



This is the prototype of the issue 6 standard EFG module behind a natural finish 1U wide Schaeffer panel. Note the use of the optional Sock4 socket board to facilitate the wiring up of the six sockets.

On the EFG 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 the standard MOTM spacing of 1.625”.

The design requires plus and minus 15V supplies. The power supply should be adequately regulated. The current consumption is around +48mA and -38mA for the EFG-Deluxe and slightly less for the EFG. Power is routed onto the main PCB by either a four way 0.156” MTA156 type connector or the special five way Synthesizers.com MTA100 header. You could, of course, wire up the board by soldering on wires directly. 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.

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 107mm (deep) x 143mm (high).

The main board has been laid out to accept connection to our Sock4 socket board. This small board speeds up the wiring of the sockets and reduces the chances of building mistakes. Two such boards are required with the EFG-Deluxe.

Issue 6 and 6.1 EFG and EFG-Deluxe Parts Lists

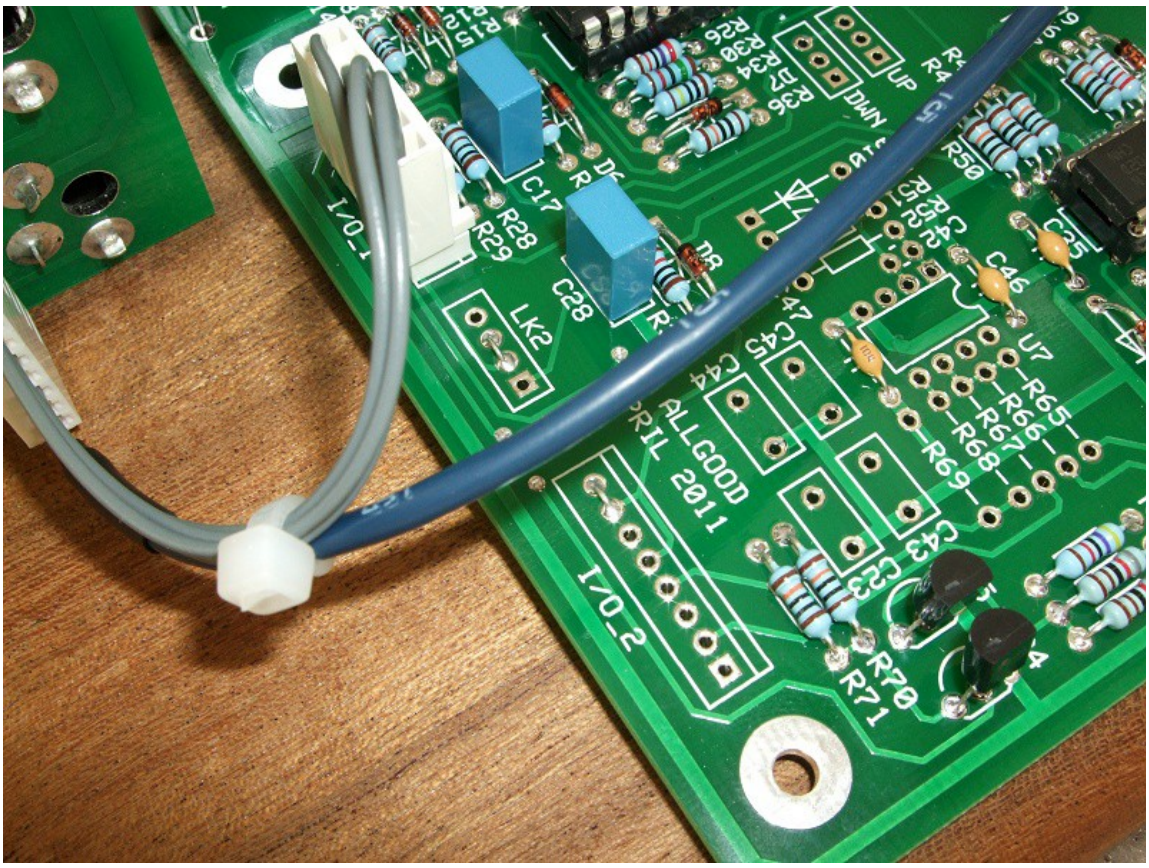
For general information regarding where to get parts and suggested part numbers please see our useful Parts Guide at the project web page or http://www.oakleysound.com/parts.pdf.

The module may be built as one of two variants. There are significant differences between the two builds. To make things easier I have provided two sets of parts lists, one for the EFG and one for the EFG-Deluxe. Take careful note of the various links fitted to the board as not getting this right will lead to much confusion.

In the parts lists the components are grouped into types and then values. The order of the component names, R1, C1, etc. 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.



A close up of the lower part of the EFG standard version showing two of the three links. You can see the links in pins 2 and 3 of LK2, and pins 7 and 8 of I/O_2.

1. EFG Parts List

Resistors

1% 0.25W metal film types are to be recommended simply because they are better quality and lower noise components. However, 5% ones can be substituted in most of the places if you wish. The 3M3 resistors will probably have to be a 5% type since getting hold of a 1% metal film resistor in this value is not trivial nor worthwhile in this case.

10R	R25, R21
22R	R37, R38, R33, R35
75R	R59, R17
100R	R29
150R	R18, R7
510R	R41, R54, R44, R57
820R	R22
1K	R31, R28, R4
1K5	R9
1K8	R10
2K	R5, R23
3K	R19
4K7	R8
7K5	R74, R73
10K	R39, R1, R27
12K	R20
15K	R30
18K	R3, R16
20K	R6
22K	R46
27K	R26
30K	R55, R40, R42, R53, R56, R45, R43, R58
39K	R12
47K	R61, R60, R72
100K	R13, R63, R62, R36, R70, R47, R14, R71, R2, R64, R49, R48, R50
220K	R11
470K	R24, R32
1M	R34
3M3	R15

Capacitors

22pF C0G 2.5mm ceramic	C4, C14
100pF COG 2.5mm ceramic	C5, C38, C15
560pF* C0G 2.5mm ceramic	C40, C26, C41, C27
680pF C0G 2.5mm ceramic	C30, C37, C31, C36
10nF polyester film box	C8

100nF multilayer axial ceramic	C32, C35, C33, C47, C9, C34, C46
680nF polyester film box	C17, C28
1uF polyester film box	C18, C19, C1, C24
2u2, 63V electrolytic	C39, C29
22uF, 35V electrolytic	C21, C22, C10, C11, C16, C6, C7
47uF, 35V electrolytic	C3, C13, C25, C12, C20, C2

* 470pF may be used in place of 560pF.

Potentiometers (Pots)

Pots Alpha 16mm PCB mounted types:

47K or 50K linear	FREQUENCY, THRESHOLD, RESPONSE
10K dual (stereo) linear	GAIN

Three 16mm pot brackets.

LEDs

5mm red round LED	PEAK
5mm orange round LED	ENV
5mm green round LED	GATE

Three LED clips for front panel and three LED securing rings if required.

If using my suggested way of wiring up the LEDs you will also need three two way 0.1" Molex style housings and six crimps.

Discrete Semiconductors

1N4148 signal diode	D1, D2, D3, D4, D5, D6, D7, D8, D9, D12, D13
1N5819 Schottky power diode	D18, D19
BC549 NPN small signal transistor	Q1, Q2, Q4, Q5
BC559 PNP small signal transistor	Q3

Integrated Circuits

OP275* dual audio op-amp	U1, U2
SSM2164 or V2164 quad VCA	U5
TL074 quad FET op-amp	U3, U4, U6

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

* For the pre-amplifier any good dual op-amp can be used, eg. OPA2134. Decent enough performance can be had even with a TL072 or LF412.

Switches

SPST or SPDT toggle switch	X10

Miscellaneous

Leaded axial ferrite beads	L1, L2, L3	
MTA156 4 way header	PSU	– Oakley/MOTM power supply
MTA100 6-way header	PWR	– Synthesizers.com power supply
Molex/MTA 0.1” header 6-way	I/O_1	– for connecting to sockets
Molex/MTA 0.1” housing 6-way	I/O_1	– for connecting to sockets

Wire Links

These are made either from resistor lead clippings or thin solid core wire.

1. LK is linked. LK is found between R24 and R33.

2. On LK2 use a single link to connect pins 2 and 3 together. Pins 1 and 4 have nothing inserted.

3. On I/O_2 pins 7 and 8 are linked.

Components required if using the optional Sock4 board

Molex/MTA 0.1” header 8-way	I/O on Sock4
Molex/MTA 0.1” housing 8-way	I/O on Sock 4
112APC Switchcraft 1/4” socket	SK1, SK2, SK3, SK4 on Sock 4

L1 and L2 are left open and no links are fitted to the Sock4 PCB.

If using Molex KK you'll also need at least 32 crimp terminals.

Suitable lengths of wire to make up one single 100mm interconnect. 180mm of thin screened audio cable. A single cable tie may be needed. See later for details.

2. EFG-Deluxe Parts List

Resistors

1% 0.25W metal film types are to be recommended simply because they are better quality and lower noise components. However, 5% ones can be substituted in most of the places if you wish. The 3M3 resistors will probably have to be a 5% type since getting hold of a 1% metal film resistor in this value is not trivial nor worthwhile in this case.

10R	R25, R21
22R	R37, R38, R33, R35
75R	R52, R59, R17
100R	R29
150R	R18, R7
510R	R41, R54, R44, R57
820R	R22
1K	R31, R28, R4
1K5	R9
1K8	R10
2K	R5, R23
3K	R19
4K7	R67, R68, R8
7K5	R74, R73
10K	R51, R39, R1, R27
12K	R20
15K	R30
18K	R3, R16
20K	R6
22K	R65, R46
27K	R26
30K	R55, R40, R42, R53, R56, R45, R43, R58
39K	R12
47K	R61, R60, R72
100K	R13, R63, R62, R36, R70, R69, R47, R14, R71, R2, R64, R49, R48, R50
220K	R11
470K	R24, R32
1M	R34
3M3	R66, R15

Capacitors

22pF C0G 2.5mm ceramic	C4, C14, C42
100pF COG 2.5mm ceramic	C5, C38, C15
560pF* C0G 2.5mm ceramic	C40, C26, C41, C27
680pF C0G 2.5mm ceramic	C30, C37, C31, C36
10nF polyester film box	C8

100nF multilayer axial ceramic	C32, C35, C33, C47, C9, C34, C46
680nF polyester film box	C17, C28
1uF polyester film box	C18, C19, C1, C24
2u2 polyester film box**	C43, C45
2u2, 63V electrolytic	C39, C29
22uF, 35V electrolytic	C21, C22, C10, C11, C16, C6, C7
47uF, 35V electrolytic	C3, C13, C25, C12, C20, C2

* 470pF may be used in place of 560pF.

** C23 and C44 are normally left empty when using 2.2uF capacitors in positions C43 and C45. However, 2.2uF is quite a large value and you may not be able to obtain it from your supplier. In this case simply use four 1uF polyester film caps in positions C23, C43, C44, C45.

Should you wish to achieve longer lag times you may wish to populate all four positions with 2u2 polyester box capacitors. This will double the rise and fall times of the lag generator in both the minimum and maximum positions of the up and down pots.

Potentiometers (Pots)

Pots Alpha 16mm PCB mounted types:

47K or 50K linear	FREQUENCY, THRESHOLD, RESPONSE
10K dual (stereo) linear	GAIN

Pots Alpha 16mm PCB or chassis mounting types:

1M log	UP, DOWN – both mounted off board via flying wires.

Three 16mm pot brackets.

LEDs

5mm red round LED	PEAK
5mm orange round LED	ENV
5mm green round LED	GATE

Three LED clips for front panel and three LED securing rings if required.

If using my suggested way of wiring up the LEDs you will also need three two way 0.1" Molex style housings and six crimps.

Discrete Semiconductors

1N4148 signal diode	D1, D2, D3, D4, D5, D6, D7, D8, D9, D12, D13
1N5819 Schottky power diode	D18, D19

BAT42 small signal Schottky diode	D10, D11
BC549 NPN small signal transistor	Q1, Q2, Q4, Q5
BC559 PNP small signal transistor	Q3

Integrated Circuits

LF412 dual FET op-amp	U7
OP275* dual audio op-amp	U1, U2
SSM2164 or V2164 quad VCA	U5
TL074 quad FET op-amp	U3, U4, U6

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

* For the pre-amplifier any good dual op-amp can be used, eg. OPA2134. Decent enough performance can be had even with a TL072 or LF412.

Switches

SPST or SPDT toggle switch	X10, EXP

Miscellaneous

Leaded axial ferrite beads	L1, L2, L3	
MTA156 4 way header	PSU	– Oakley/MOTM power supply
MTA100 6-way header	PWR	– Synthesizers.com power supply
Molex/MTA 0.1” header 6-way	I/O_1	– for connecting to sockets
Molex/MTA 0.1” housing 6-way	I/O_1	– for connecting to sockets
Molex/MTA 0.1” header 8-way	I/O_2	– for connecting to sockets
Molex/MTA 0.1” housing 8-way	I/O_2	– for connecting to sockets

Wire Links

These are made either from resistor lead clippings or thin solid core wire.

On LK2 use two links to connect pins 1 and 2 together, and pins 3 and 4 together.

LK is left open and no links are fitted.

Components required if using optional Sock4 boards

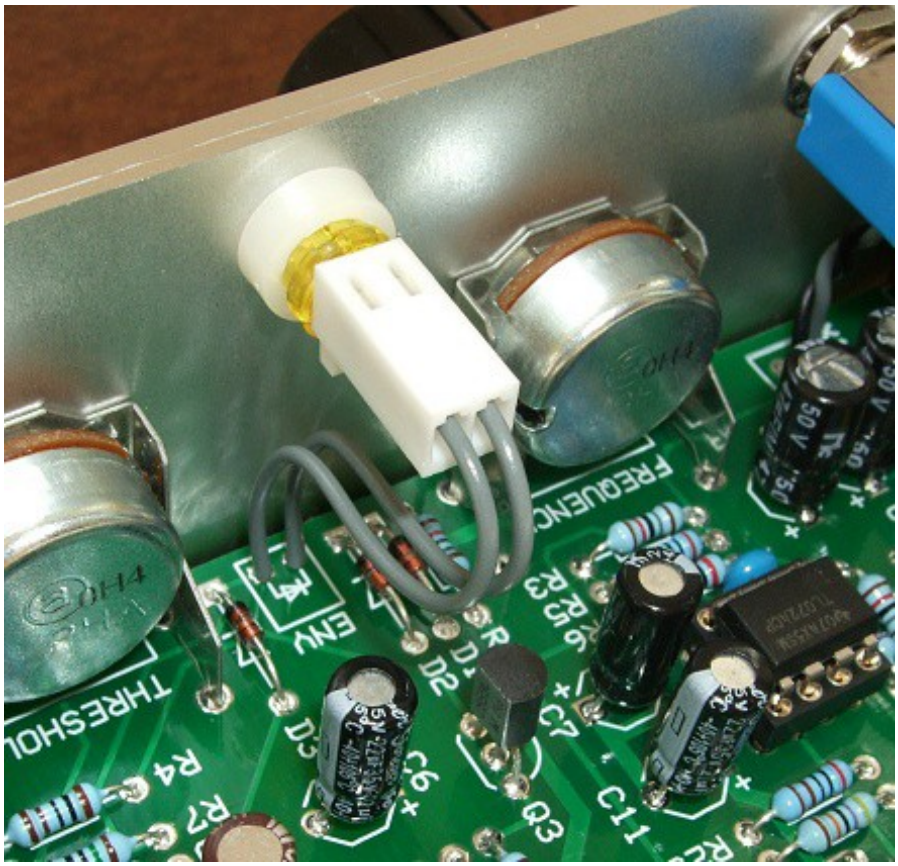
Molex/MTA 0.1” header 8-way	I/O on left hand Sock4
Molex/MTA 0.1” housing 8-way	I/O on left hand Sock 4
Molex/MTA 0.1” header 8-way	I/O on right hand Sock4
Molex/MTA 0.1” housing 8-way	I/O on right hand Sock 4
112APC Switchcraft 1/4” socket	SK1, SK2, SK3, SK4 on left hand Sock 4
112APC Switchcraft 1/4” socket	SK1, SK2, SK3, SK4 on right hand Sock 4

A single wire link is to be fitted to L1 on both Sock4 PCBs.

L2 is left open on both Sock4 PCBs

If using Molex KK you'll also need at least 32 crimp terminals.

Suitable lengths of wire to make up one single 100mm interconnect and one 140mm interconnect. Three or four cable ties. 180mm of thin screened audio cable. See later for details.



All three LEDs can be wired in by using Molex KK 0.1” housings and solderless crimps. The LED clips used here are the low profile types with white securing rings.

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

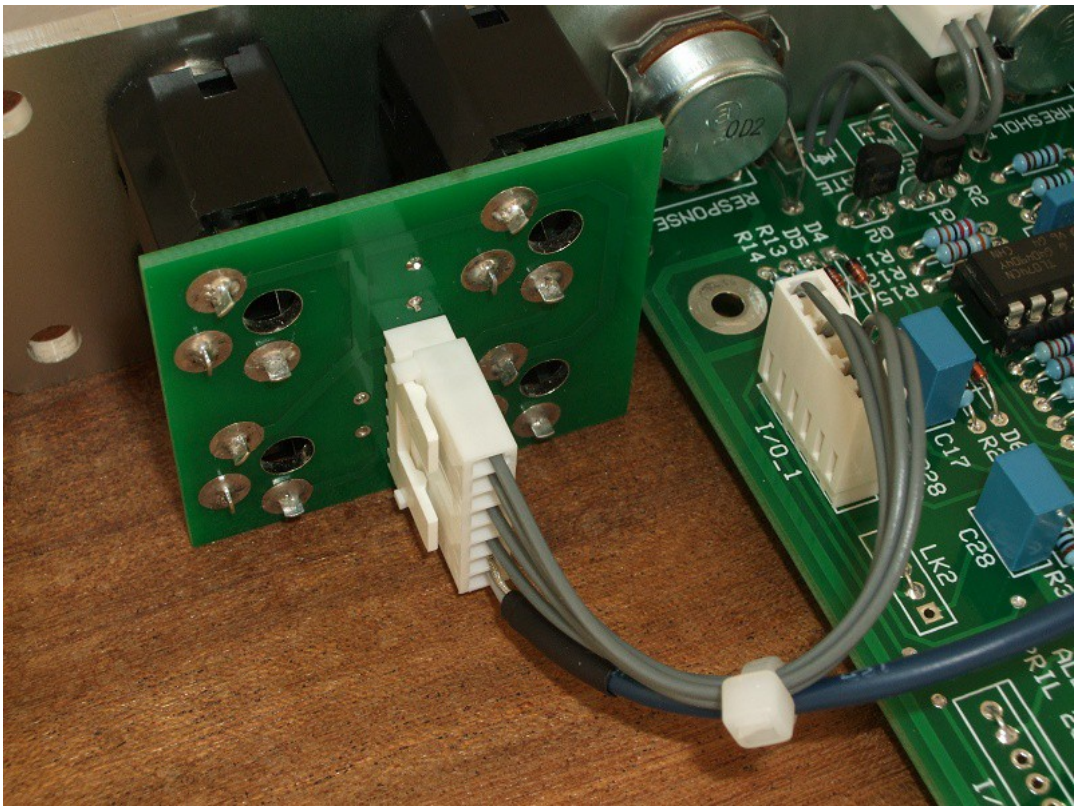
The PWR power socket is to be fitted if you are using the module with a Synthesizers.com system. In this case you should not fit the PSU header. The PWR header is a six way 0.1” MTA, but with the pin that is in location 2 removed. In this way location 3 is actually pin 2 on my schematic, location 4 is actually pin 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
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 EFG module using the Sock4 board



This shows the Sock4 connection on a standard EFG. Here I have used Molex KK 0.1" connectors. These are solderless crimp fixings that make a low cost but effective connection. Pin 7 and 8 of the interconnect are connected via a screen cable (also crimped into the Sock4's Molex housing) and go on to the pre-amp input, IN, on the main board.

Using the optional Sock4 boards is the simplest way of connecting all four, or eight, sockets to the main board. The Sock4 board, or boards, should be populated in the way described in our general construction guide found on the project webpage.

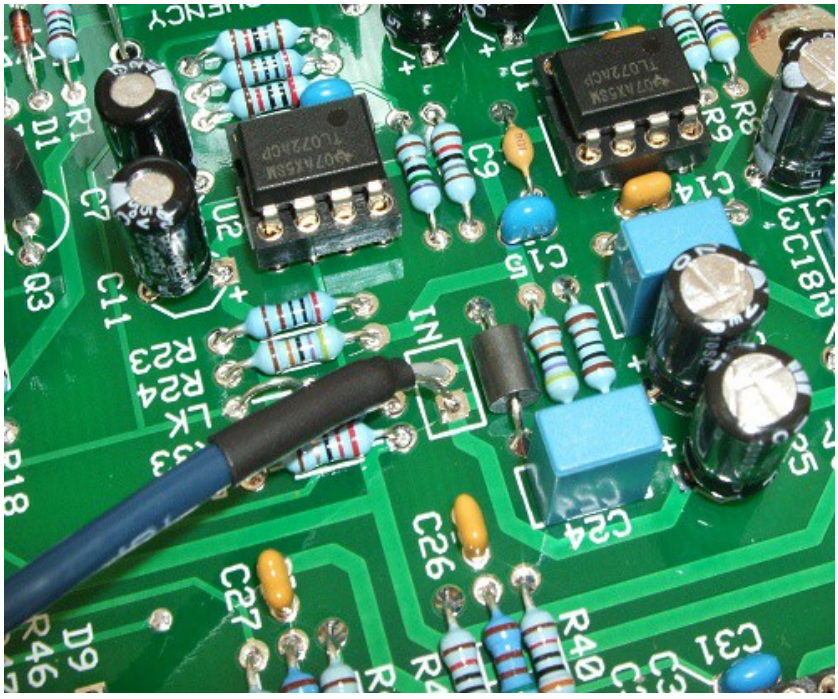
Neither wire link on the Sock4 is fitted when you are building the standard EFG module, but L1 is fitted on both Sock4 boards when you are building the EFG-Deluxe.

For the standard EFG, and left hand Sock4 on the EFG-Deluxe, you now need to make up a special interconnect and it's a little different than the usual eight way Sock4 interconnection you may have done on other Oakley modules. The Sock4 features an eight way header but not all eight connections are going back to the main board, and not all of those are going to the same place on the main board. Pin 8 is carrying the pre-amp input and as such needs to travel within a screened cable. The screen of that cable being connected to pin 7 of the Sock4 header. The other six connections of the Sock4's header can be connected to the I/O_1 header on the main board but in truth only four (for the EFG) or five (for the EFG-Deluxe) of these are actually used so we can save a bit of wire and only fit those.

Let's put those connections into a simple table to make it a little clearer:

Sock4 header	Main board destination
Pin 1	I/O_1 pin 1
Pin 2	I/O_1 pin 2
Pin 3	No connection
Pin 4	I/O_1 pin 4
Pin 5	I/O_1 pin 5 (not needed on standard EFG)
Pin 6	I/O_1 pin 6
Pin 7	Screened cable screen connects to IN pin 1
Pin 8	Screened cable core connects to IN pin 2

Remember that pin 1 is the square solder pad for any connector on an Oakley PCB. The insulated wire needs to be around 100mm long and the screened cable around 180mm long.



The top end of the screened cable. The screen being connected to pin 1 and the core of the cable connected to pin 2. Here I have used a bit of black heatshrink to keep things neat and tidy.

For the EFG-Deluxe you have two Sock4 boards. For the right hand board you simply need to connect it to the main board's I/O_2 header with the usual eight way interconnect. Make this interconnect from standard insulated multistrand wire. Its length should be around 140mm.

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_1 and/or I/O_2. 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:

1. Standard EFG

There are two headers that connect to the sockets, I/O_1 and IN. The IN header is near the top of the board and carries the pre-amp input signal.

I/O_1	***Pad name***	***Socket***	***Lug Type***
Pin 1	PAN_GND	Connect to all sockets	Earth lugs
Pin 2	GATE	GATE	Signal lug
Pin 3	No connection		
Pin 4	FLWOUT	CV OUT	Signal lug
Pin 5	No Connection		
Pin 6	PRE_OUT	PRE OUT	Signal lug

IN	***Pad name***	***Socket***	***Lug Type***
Pin 1	GND	PRE IN	NC lug
Pin 2	IN	PRE IN	Signal lug

Use screened cable for connection from IN to PRE IN socket. Screen should connect to pin 1 and NC lug of PRE IN socket.

2. EFG-Deluxe

There are three headers that connect to the sockets, I/O_1, I/O_2 and IN. The IN header is near the top of the board and carries the pre-amp input signal.

I/O_1	***Pad name***	***Socket***	***Lug Type***
Pin 1	PAN_GND	Connect to upper sockets	Earth lugs
Pin 2	GATE	GATE	Signal Lug
Pin 3	No connection		
Pin 4	FLWIN	FOLLOW IN	Signal lug
Pin 5	PRE_OUT	FOLLOW IN	NC lug
Pin 6	PRE_OUT	PRE OUT	Signal lug

IN	***Pad name***	***Socket***	***Lug Type***
Pin 1	GND	PRE IN	NC lug
Pin 2	IN	PRE IN	Signal lug

Use screened cable for connection from IN to PRE IN socket. Screen should connect to pin 1 and NC lug of PRE IN socket.

I/O_2	***Pad name***	***Socket***	***Lug Type***
Pin 1	PAN_GND	Connect to lower sockets	Earth lugs
Pin 2	LAG_OUT	LAG OUT	Signal Lug
Pin 3	No connection		
Pin 4	LAG_IN	LAG IN	Signal lug
Pin 5	ABS_OUT	LAG IN	NC lug
Pin 6	FLW/SLEW_OUT	SLEW OUT	Signal lug
Pin 7	ABS_OUT	SLEW IN	NC lug
Pin 8	SLEW_IN	SLEW IN	Signal lug

Wiring the switches

The standard EFG uses one panel mounted switch and the EFG-Deluxe uses two. Both are wired in the same way, that is, with a twisted wire pair. This is simply made by twisting two pieces of insulated multistrand wire together to form a simple cable. You can use two different colours but you don't have to.

Now it does not matter which of those two wires connects to which lug on the switch. However, to make the switches' behaviour match the front panel's legending it is important to connect the wires to the right pair of lugs on the switch. For the x10 switch you need to ensure the two wires connect to the top pair of lugs of the switch. This means that when the toggle of the switch is down the contacts are closed and the pre-amp is switched to its high gain mode.

The standard EFG's 'x10' switch. Note that the twisted pair connects to the top pair of lugs on the switch.

With the EFG-Deluxe you have an additional switch. Just to make things slightly awkward you need to connect your switch so that the twisted wire pair connects to the bottom two lugs on the LIN/EXP switch. Thus the contacts should be closed when the toggle is in the up position. In other words it behaves in opposite fashion to the x10 switch.

Wiring the off board pots

The standard EFG has all of its pots mounted on the board. However, the EFG-Deluxe uses two off board pots. These need to be connected to the main board with 'flying wires' much like the switches. For my prototype I used twisted wire pairs again. This keeps most of the unwanted stray noise from getting into the lag circuitry. However, the main board does allow the use of twin cored screened cable for additional noise immunity if you wish to use that.

Each pot is wired identically with just two wires needed to make the connection. The pots are used as variable resistors so we don't need to use all three of the pot's solder lugs. If you are using twisted wire pairs you need to connect each pot as follows:

Pin 1 – the square pad	Wiper of the pot
Pin 3 – the round pad	CCW of the pot

The wiper of the pot is the middle pin. The CCW (counter clockwise) pin is the right hand pin when the pot has it's pins facing down and you are looking from the rear. Remember the lag circuitry produces its fastest times when the pot resistance is at its minimum value.

If you wish to use screened cable you need to ensure that the cable you are using has two cores. This is sometimes called twin screened cable. Pin 2 of each of the pot's connecting pads is connected to ground or 0V. Thus, for each length of screened cable, you can connect the screen to pin 2. However, you must remember not to connect the screen at the other end of the cable, the pot end, to anything. Just snip it off and use a bit of heatshrink to prevent the frayed ends from shorting to anything they shouldn't.

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 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 those nice people on the Synth-DIY and Analogue Heaven mailing lists and those at Muffwiggler.com.

Tony Allgood at Oakley Sound

Cumbria, UK