Oakley Sound Systems

Little Lag Processor

Issue 3

User's Guide

V3.00

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Introduction

This is a very simple but useful little module to introduce 'smoothness' to CVs and audio waveforms. It doesn't just have the usual single 'lag time' pot that some simple filters and lag generators possess, but two separate UP and DOWN controls. The UP control will affect the speed at which the output voltage of the module rises. The DOWN control affects the speed at which it falls. You can do a variety of signal processing tasks with this module. For example:

1. Drive the unit with a gate signal and the module becomes an effective AR envelope generator. The UP control is the attack, and the DOWN is the release.

2. Use it also to process the output of an envelope follower to create more natural filter sweeps when used with a VCF. You can use it to simulate 'vactrol' or opto-electronic devices.

A panel design for the Oakley 'Envelope Follower and Gate extractor' (EFG) has incorporated the Little-Lag to create the EFG-Deluxe module. More details about this are found in the EFG User Guide.

An optional switch determines whether the unit creates linear or logarithmic output slopes. The logarithmic output allows for longish times of lag to be set up easily, roughly 8 seconds maximum lag time. The output moves quickly at first then slows to reach the final value. You get a more natural effect when using this mode. However, the disadvantage is that the unit is not sufficiently accurate to use for portamento applications in 'log' mode.

In linear mode, the output rises or falls in a straight line. It is classified in volts per second, as opposed to just time. The amount of time it takes depends on the pots positions AND the voltage change on the input. Generally, for small changes in voltage the linear output will appear to move quicker than its 'log' equivalent. The linear mode is very accurate and can be used to create linear portamento.

Circuit Description

The circuit inspiration came from the development of the Filtrex rack mounted filter. The Filtrex required a **simple** lag generator circuit that smoothed off the bumpy output of the envelope follower. And to save on board space I wanted it to be also used as the core of the internal envelope generator. After all, the OMS/MOTM-820 combination proved that you could successfully marry lag and envelope generators together produce one powerful module.

Most simple lag generators have just one control. This affects the up and down times simultaneously. For use in an envelope generator, we have to have separate up and down times. So this required a new type of circuit. Of course, more complex 'Up-down' lag generators already exist. Examples are the MOTM820, Serge DSG and the E-mu modular.

And the Oakley Little-Lag circuit is really quite simple.

The circuit can be divided down into three lumps. The input stage, the up/down control and the output buffer. The signal flow is generally left to right on the circuit diagram, but the all important job of R3 must not be forgotten. This one part is the key to the 'magic' of this circuit.

In the log mode, the pads S1 and S2 are shorted together. R5 provides a large degree of feedback so the input stage mainly behaves as a standard op-amp follower.

In the linear mode circuit, when S1 and S2 are left open, the input section acts more like a comparator most of the time. It operates in very high gain while the lag capacitors are charging and discharging. R4 provides a little stability for the op-amp.

R1 holds the input low with no connection made to the input socket. R2 provides a little protection for any overvoltages.

Now without R3 the voltage at pin 1 of the op-amp normally reflects exactly what is happening at pin 3 of the op-amp. But with R3, a proportion of the final output signal is fed back into the input stage. This produces larger swings in the output voltage of the op-amp which produce the necessary charging and discharging currents for the next stage.

R3 is important, and essential for the linear output mode. This simple component provides feedback across all three stages of the design. Thus the input stage will respond not only to the main CV input, but also to the Little-Lag module's output. This provides relative DC stability, reduces the drops associated with the two diodes, and controls the shape of the charge and discharge curves.

The output of the first stage is split, each path going through a diode and a control pot. The two paths then coming back together at the four charge holding capacitors, C3, C4, C7 and C8. The diodes point in different directions, so current is either allowed out of the input stage through one path, or back into the input stage though the other. Simply put, the capacitors can be charged up via D1 and the UP pot. And discharged through D2 and DOWN. The resistance of UP and DOWN determine the speed of the charge and discharging process. The fastest speed is limited by the internal resistance of the diode (pretty small) and the output capability of the input stage. The slowest speed is determined by the highest resistance of the UP and DOWN pots, namely 1 megohm.

Longer times may be created by using larger values of capacitors. However, the cost of capacitances greater than 1uF may make this idea uneconomic. The capacitors have to be non-polar, since we cannot be sure of what polarity the input voltage will be. If you can guarantee that the input will be only positive, say from an ADSR module or the EFG's fast output, then you could replace all four capacitors with one larger electrolytic type.

By using four 1uF capacitances in parallel, we have a total of 4uF.

The voltage stored on the capacitors is fed directly to another op-amp based buffer, the third and final stage of the design. This circuit sniffs the voltage without affecting it, and its output is a copy of the voltage on the capacitors. The use of a compensated buffer circuit allows you to draw reasonable levels of current from the output without affecting the voltage. In other words, there is no 1K output resistance to worry about.

The action of this type of compensated buffer circuit is actually very complex. A good, but mathematical, description of its behaviour can be had in AN-257 from the Analog Devices webpage.

Components

Most of the parts, but not all, are easily available from your local parts stockist. I use Rapid Electronics, RS Components, Farnell and Maplin, here in the UK. In North America, companies called Mouser, Newark and Digikey are very popular. In Germany, try Reichelt, and in Scandinavia you can use Elfa.

The PCB is laid out for a certain type of pot and its matching pot bracket. The pot brackets make mounting the board to the front panel very easy. They hold the board at the correct angle to the panel, and can provide all the support the board needs in normal usage. The pots suggested are Alpha or ALPS 16mm carbon types. These are very much an industry standard part and are used in all sorts of gear, including most of the Doepfer and Analogue Systems gear.

You could use any pot type you want, but not all pots have the same pin spacing so may not fit on the PCB. Of course, the pin spacing will not be a problem if you are not fitting the pots into the board and are hand wiring them to the front panel.

Now this is where it gets complicated. Even if you buy 16mm Alpha or ALPS pots you still need to make sure you have the correct pot shaft. It is the shaft that the knob will fit onto. They come in three basic types; splined, round, and D-shaft. The knobs you will need to buy should then fit onto the shaft you have chosen. The D-shaft types are probably not going to be easy to find although they are the most common in commercial applications. The most likely one you will see from the parts suppliers is the 6mm diameter splined shaft which work with low cost push fit knobs. Round types have perfectly smooth cylindrical sold shafts and tend to be found on the genuine ALPS pots you can buy. You will need solid shafted ones if you want to use grub screw knobs like the usual Oakley modular knobs.

Now just to make things really annoying, the shaft length also varies with vendor. In most cases a longer shaft can be simply cut down with a hack saw to the smaller lengths. It is a good idea to use a file to round off any sharp edges though.

In the UK, Rapid sell the Alpha pots we need at a very good price. However, the Rapid pots have long splined shafts that need to be cut down if you want to use their excellent 'soft touch' knobs for splined shafts. RS and Maplin sell the 1M log pots with solid round shafts, but again these will need to be cut down if you want to use them with the Oakley modular standard 27mm K series knobs.

Banzai are in Germany, but deliver worldwide, also sell Alpha pots. These come with a nice short shaft, so they don't need cutting down. However, they don't sell 1M log pot we need for this project. I actually wrote to Banzai requesting that they should think about selling these, but they politely told me they had no plans to introduce this part to their stock. Futurelec also sell these type of pots, but again they don't have the 1M log as a stock item.

The pot brackets are available from Oakley Modular as part of the pot bracket kit.

For the resistors 5% 0.25W carbon types may be used for all values. But I would go for 1% 0.25W metal film resistors throughout since they are very cheap these days, and are more useful for any other Oakley projects you may want to build. However, the 3M3, although sometimes available in 1%, it will be generally cheaper to buy these as a 5% type.

All the electrolytic capacitors should be 25V or 35V, and radially mounted. Don't chose too high a working voltage like 63V. The higher the working voltage the larger the size of the capacitor. A 220V capacitor will be too big to fit on the board.

The pitch spacing of the 100nF and 1uF polyester capacitors is 5mm (0.2"). These common types come in little plastic boxes with legs that stick out of the bottom. They come in a variety of styles and names, but they should be described as metalised polyester types. For either value try to get those with an operating voltage of 63V or at the most 100V. Higher operating voltages can be used but will probably be too large to fit on the PCB. Farnell do sell 1.5uF, 50V polyester caps which could be used for the four big lag caps.

I have seen compact 2.2uF types, and it would be worthwhile getting these if you can afford them. If you are likely to be using the linear mode for portamento a lot, then the bigger capacitance you have the more useful the slide effect will become.

The ceramic capacitor should be a 'low-K' ceramic plate. The lead spacing is 0.2" or 5mm. Do not chose cheap and nasty ceramic types, usually 'high-K', obtainable from some surplus places.

The IC is a dual in line (DIL or DIP) packages. These are generally, but not always, suffixed with a CP or a N in their part numbers. For example; LF412N. You can use a standard TL072 in place of the LF412 if you wish. The benefit of the LF412 is that is more accurate than the cheaper TL072 part. Do not use SMD, SM or surface mount packages.

Input and output sockets are not board mounted. You can choose whichever type of sockets you wish. I use the excellent Switchcraft 112 as used on the Moog and MOTM modulars. All of the sockets must have normalising lugs if you are building the suggested layout. The Switchcraft 112 types have normalising lugs as standard.

I am now able to supply four way MTA power leads at either 40cm or 60cm lengths.

The optional switch is a normal SPDT toggle type. I use ones with a flat toggle to match with the MOTM modules. Apem and C&K make good ones. Farnell part number: 147-772. There will be more detail on how to wire the switch to the board later on in this document.

Finally, if you make a change that makes the circuit better, do tell the 'Oakley-synths' mailing list or myself directly. Any updates are added to the current user guide as quick as possible.

Parts List

The components are grouped into values, the order of the component names is of no particular consequence.

Resistors: all 5% carbon or better. For example 1%, metal film

22R	R7, R8
75R	R6
4K7	R2, R3
10K	R9
22K	R5
100K	R1
3M3	R4

Capacitors

22uF, 25V elect	C1, C2
1000nF, 63V polyester film	C3, C4, C7, C8
100nF, 63V polyester film	C5, C6
22pF ceramic low-K	C9

Discrete Semiconductors

BAT-42 Schottky diode	D1, D2

Integrated Circuits

LF412N or TL072CN dual FET op-amp

Miscellaneous

4-way 0.156” header	PSU
Pot bracket for 16mm pots	(2 off)
1M log 16mm ALPS pot	Up, Down
1/4” sockets	Input, Output

Multistrand wire for connections
Solid core (0.9mm) copper wire for earthing socket lugs

You may well want to use an 8-pin socket for the IC. I would recommend low profile turned pin types as these are the most reliable.

Building the Little-Lag Module

Warning:

Oakley Modular PCBs are now supplied with the RoHS compliant Ni/Au finish. This is a high quality finish but does possess slightly different soldering characteristics to the traditional lead based HASL finish. Handle the boards with care, and avoid touching the Ni/Au that can cause premature tarnishing of the finish. Shelf life is hard to predict but we recommend soldering in all the components less than one year from when you receive your board.

We are not responsible for any accidents caused whilst working on these boards. It is up to you to use your board responsibly and sensibly.

Occasionally people have not been able to get their Oakley projects to work first time. Some times the boards will end up back with me so that I can get them to work. The most common error with most of these was parts inserted into the wrong holes. Please double check every part before you solder any part into place. Desoldering parts on a double sided board is a skill that takes a while to master properly.

If you have put a component in the wrong place, then the best thing to do is to snip the component's lead off at the board surface. Then using the soldering iron and a small screwdriver prize the remaining bit of the leg out of the hole. Use wick or a good solder pump to remove the solder from the hole. Filling the hole with fresh solder will actually make the hole easier to suck clean!

Sometimes people like to substitute parts in place of my own recommendations. Feel free to do this, but remember that there is normally a good reason why I have selected that particular part. If you do find that, say changing an op-amp with another one, makes an improvement, please do let me know either via the Oakley-Synths list or directly to me.

All resistors should be flat against the board surface before soldering. It is a good idea to use a 'lead bender' to preform the leads before putting them into their places. I use my fingers to do this job, but there are special tools available too. Once the part is in its holes, bend the leads that stick out the bottom outwards to hold the part in place. This is called 'cinching'. Solder from the bottom of the board, applying the solder so that the hole is filled with enough to spare to make a small cone around the wire lead. Don't put too much solder on, and don't put too little on either. Clip the leads off with a pair of side cutters, trim level with the top of the little cone of solder.

Once all the resistors have been soldered, check them ALL again. Make sure they are all soldered and make sure the right values are in the right place.

The diodes can be treated much like resistors. However, they must go in the right way. The cathode is marked with a band on the body of the device. This must align with the vertical band on the board. In other words the point of the triangular bit points *towards* the cathode of the diode. The two diodes used in this project are BAT-42s. They look like small cylinders made from a blue glass. The band which denotes the cathode is painted on the surface of the device usually in black or white ink.

An IC socket is to be recommended, especially if this is your first electronics project. Make sure, if you need to wash your board, that you get water in and around these sockets.

The polyester capacitors are like little blue or red boxes. Push the part into place up to the board's surface. Little lugs on the underside of the capacitor will leave enough of an air gap for the water wash to work. Cinch and solder the leads as you would resistors.

The smaller electrolytic capacitors are very often supplied with 0.1" lead spacing. My hole spacing is 0.2". This means that the underside of these radial capacitors will not go flat onto the board. This is deliberate, so don't force the part in too hard. The capacitors will be happy at around 0.2" above the board, with the legs slightly splayed. Sometimes you will get electrolytic capacitors supplied with their legs preformed for 0.2" (5mm) insertion. This is fine, just push them in until they stop. Cinch and solder as before. Make sure you get them in the right way. Electrolytic capacitors are polarised, and may explode if put in the wrong way. No joke. Oddly, the PCB legend marks the positive side with a '+', although most capacitors have the '-' marked with a stripe. Obviously, the side marked with a '-' must go in the opposite hole to the one marked with the '+' sign. Most capacitors usually have a long lead to depict the positive end as well.

I would make the board in the following order: resistors, diodes, IC socket, small non-polar capacitors, electrolytic capacitors. Then the final water wash. Do not fit the pots at this stage. The mounting of the pots requires special attention. See the next section for more details.

Mounting the Pots

If you are using the recommended Alpha pots, then they can support the PCB with specially manufactured pot brackets. You will not normally need any further support for the board. When constructing the board, fit the pot brackets to the pots by the nuts and washers supplied with the pots. Now fit them into the appropriate holes in the PCB. But only solder the three pins that connect to the pot. **Do not** solder the pot bracket at this stage. When you have soldered all the pots you can fit the board to your front panel. Position the PCB at right angles to the panel, the pot's own pins will hold it fairly rigid for now. Then you can solder each of the brackets. This will give you a very strong support and not stress the pot connections.

The Alpha pots are labelled with an A or B suffix. For example: 50KB or 1MA. Alpha and ALPS do the opposite to our European convention and use A = log and B = linear. So a 1MA is a 1 megohm log pot.

Pots are often lubricated with a thick clear grease. This sometimes is visible along the screw thread of the pot body. Try not to touch the grease as it consequently gets onto your panel and PCB. It can be difficult to get off, although it can be removed with a little isopropyl alcohol on cotton wool bud. If I do see any grease near the top of the bush, I tend to wipe it clean with a bit of kitchen paper before I mount the pot.

Connections

The power socket is 0.156” 4-way header in common with rest of the Oakley, Blacet and MOTM modules. Friction lock types are recommended.

Power	***Pin number***
+15V	1
Module 0V	2
Earth/Screen	3
-15V	4

The PAN pad on the PCB has been provided to allow the ground tags of the jack sockets to be connected to the power supply ground without using the modules 0V supply. Earth loops cannot occur through patch leads this way, although screening is maintained. Of course, this can only work if all your modules follow this principle.

If you have used Switchcraft 112 sockets you will see that they have three connections. One is the earth tag on the bevelled edge. 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. In the Little-Lag we will not be using either socket’s NC lug.

You should use multicore hook-up wire to connect the sockets to the board. For the input socket, connect the signal lug to the pad on the board marked IN.

For the output socket, connect the signal lug to the OUT pad.

The ground tags of each socket can be connected together with solid piece of wire. I use 0.9mm diameter tinned copper wire. A single piece of insulated wire can then be used to connect both the tags to the PAN pad on the PCB. Do not connect the ground tags to any other ground.

S1 and S2 are the switch connections. If you are not fitting a switch, then you need to decide which option you are wanting to use. The linear option is selected simply be leaving the S1 and S2 pads unconnected. For the log version, you need to link S1 and S2 together.

If you would like to use a switch to allow mode switching on the fly, then simply connect your switch to the S1 and S2 pads. You should be using a SPDT or SPST switch. Connect your switch so that the two pads are shorted by the switch contacts when the switch is in the LOG position. Remember that for a toggle switch, when the switch is in the ‘up’ position, the lower two contacts are shorted.

Keep the wires short but not taut. Colour coding the wires makes it easy to connect, and gives an attractive finish.

At the rear of this user guide I have included a 1:1 drawing of a suggested front panel layout for a 1U Little-Lag panel.

Another option, already mentioned, is to make the Little-Lag project as part of the EFG module. This is the so called EFG-Deluxe. This 2U panel will give access to all the EFG's outputs and also have room for the Little-Lag complete with LIN-LOG switch. The input of the Little-Lag is normalised to the 'LAG' output on the EFG circuit board. But this can be overridden by inserting a jack into the Lag input socket.

Actual panels can be obtained from Schaeffer-Apparatebau of Berlin, Germany. The cost is about £15 per panel. All you need to do is e-mail the fpd file that is found on the Little-Lag web page on my site to Schaeffer, and they do the rest. The panel is black with white engraved legending. The panel itself is made from 3 mm thick anodised aluminium. The fpd panel can be edited with the Frontplatten Designer program available on the Schaeffer web site.

Testing the Little-Lag

There's not much to this module so it should be very easy to test. Firstly power the unit up, making sure you have the power connected correctly. The unit should not smoke...

Once you have passed the smoke test, make sure no component is getting warm. Gently, but quickly, place your finger on each component to make sure everything is running cool.

The method of testing depends on your hardware. However, let us assume you have a standard VCO, VCF, VCA modular synth in front of you. Set it up so that you have the standard or classic synth patch which plays a note when you use your controller keyboard. Connect a mult'ed version of the gate output of your keyboard into the IN of the Lag module. Now the output of the Lag can go to the VCF's control voltage input. Pressing a note should make the filter's cut-off frequency rise. The UP control on the Lag module should control the speed at which it rises. Fully counter clockwise should make it jump upwards immediately. Fully clockwise should make it sweep up slowly. It should take about 8 seconds to get there if you have built the standard 'log' version. The DOWN pot should control the downward sweep once you remove your finger of the keyboard. Make sure that the VCA stays open to allow you to hear this. The Little-Lag should be behaving as a standard AR envelope generator.

If all is well, you have a working Little-Lag module. Try using audio as an input and see what affect the Up and Down pots have on the sound. If both pots are moved together you have a simple one pole low pass filter.

Final Comments

If you have any problems with the module, an excellent source of support is the Oakley-Synths Group that can be found at http://launch.groups.yahoo.com/group/oakley-synths/

If you can't get your project to work, then Oakley Sound Systems are able to offer a 'get you working' service. If you wish to take up this service please e-mail me, Tony Allgood, at my contact e-mail address found on the website. I can service either fully populated PCBs or whole modules. You will be charged for all postage costs, any parts used and my time at 20GBP per hour. Most faults can be found and fixed within one hour. The minimum charge is 20GBP plus return postage costs.

Your comments and questions are important to both Oakley Sound and Oakley Modular. In the first instance, please use the Oakley Synths Group where a wealth of experience resides! Please do not contact me or Oakley Modular directly with questions about sourcing components or general fault finding. Both Ceri and I are on the Oakley-Synths list and this is the best way to get help from us.

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, Oakley-Synths and Analogue Heaven mailing lists.

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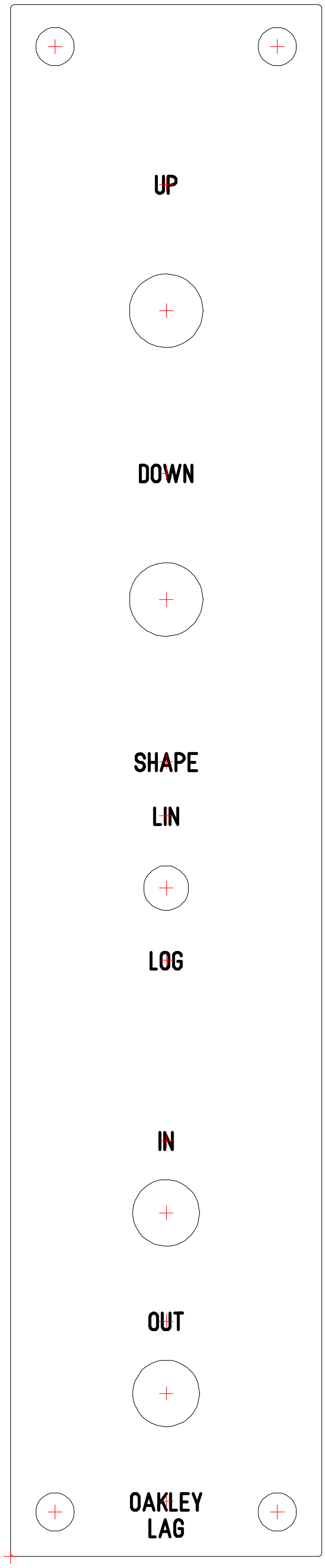
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