Oakley Sound Systems

ADSR/VCA
Issue 2

User's Guide

V1.4

Tony Allgood B.Eng
Oakley Sound Systems
PENRITH
CA10 1HR
United Kingdom

e-mail: oakley@techrepairs.freeserve.co.uk

Please note this user guide is for boards marked ADSR/VCA ISSUE 2 only.

Introduction

This is my version of the classic envelope generator module primarily designed for use in modular synthesisers. Its basic design and the use of PCB mounted pots makes this an ideal starter module for beginners to my modular synthesiser projects. It uses standard parts and requires very little setting up.

The envelope generator or EG for short, generates a rising and then falling voltage at it’s output when triggered by a gate signal. The gate is derived from a keyboard, switch or a midi-CV convertor elsewhere in the synthesiser system. The speed of the rise in output voltage is determined by the Attack control. The speed of the fall of the output voltage is determined by the Decay or Release controls. The output of an EG is traditionally patched to the VCA control voltage, to control the volume of the note when the keyboard is pressed, or to the VCF, where it dynamically alters the harmonic structure of the sound throughout the duration of the note played.

Traditionally there are three basic analogue EG types available:

Attack-decay (AD) This is a one shot type of generator. The output will rise and then immediately fall. The A and D pots determine the time taken to rise and fall. Removal of the gate will cause the decay phase to start prematurely on most systems.

Attack-release (AR) Very similar to the AD type, but the voltage is held high once the attack phase is completed until the gate is removed.

Attack-decay-sustain-release (ADSR) This one is controlled by four pots. When the attack phase is initiated by the gate signal, the output will rise to a predetermined level. Then the decay phase starts and the output voltage will then fall to the level set by the sustain pot. The voltage will remain at this level for as long as the gate is high. But as soon as the gate is removed the release stage is initiated. This causes the output to fall at a rate determined by the release pot. The ADSR-EG can perform both AR and AD operations simply by turning the sustain pot full up or down respectively.

Other types of envelope generators are available, especially on digital synthesisers, but the three analogue types still seem to the most musician friendly.

The Oakley ADSR module also incorporates a versatile VCA. This can be used independently as a separate VCA for audio or CV scaling. Or it can be used to modulate the output of the EG itself. For example, a velocity CV from the output of a midi to CV convertor, can automatically scale the ADSR output for touch sensitive control of the VCA or VCF. The suggested layout has the CV input to the VCA permanently connected to the output of the envelope generator circuitry.

Of Pots and Power

There are four main control pots on the PCB. The pots are **Attack**, **Decay**, **Sustain** and **Release**. If you use the specified pots and brackets, the PCB can be held firmly to the panel without any additional mounting procedures. The pot spacing is on a 1.625” grid and is the same as the vertical spacing on the MOTM modular synthesiser. The PCB has four mounting holes, one in each corner should you require additional support which you probably won’t.

The design requires plus and minus 15V supplies. These should be adequately regulated. The current consumption is about 20mA. Power is routed onto the PCB by a four way 0.156” Molex type connector. Provision is made for the two ground system as used on all new Oakley modular projects, and is compatible with the MOTM systems. See later for details. This unit will run from a +/-12V supply with a slight reduction in dynamic range.

Circuit Description

The VCA and ADSR sections are essentially separate circuits that only share the same power supply. Power is applied to them through the **PWR** 4-way Molex connector. L1 and L2, small axial ferrite beads, provide some high frequency resistance, and along with C4, 7, 11, and 12 prevent the board from being effected by any noises on the power rails. They also help keep any noises going the other way too.

The **GATE** input requires a switch type signal that is either at around 0 volts when off, or any positive voltage greater than 2V when on. The Oakley ADSR can easily handle greater voltages without damage. D5 protects Q6 from any negative inputs. When a positive gate arrives, Q6 turns on and pulls its collector down to ground or 0V. R30 provides a little positive feedback to speed up switching times. It also allows slowly increasing CVs applied to the GATE input to trigger the envelope. For example you can use the output of another EG with a slow attack to create gate delay effects.

The inverse version of the applied gate signal at the collector of Q7 is sent to three destinations. Referring to the schematic, we see that the middle destination is another transistor, Q7. This is configured as another inverter. Thus the output of Q7 produces a copy of the gate signal that swings from 0 when off to +15V when on. It is passed on to a CR network that acts as a differentiator. This circuit produces a positive voltage spike when the gate goes high. The duration of the spike is determined principally by the values of C3 and R5. D1 prevents a negative spike being produced when the gate goes low. The positive spike triggers an RS flip-flop circuit based around two NOR gates, U1.

A flip-flop is a sort of a one bit memory, or latch. Once triggered by a positive going pulse at pin 1, it stays latched. You can only reset it by removing the power or a reset pulse at its other input, pin 6. When the flip-flop is latched, pin 4 goes high and pin 3 goes low. This switches on U2 at pin 5.

U2 is a 4066 CMOS switch or analogue transmission gate. This, quite simply, behaves like an electrically controlled switch. For example, when pin 5 goes high, pins 3 and 4 are shorted together. With U2 (3,4,5) switched on C8, the main timing capacitor, begins to charge up through the Attack pot. The speed of the charging is determined by the resistance of the Attack pot.

U4 (5,6,7) acts as a voltage follower or buffer. This device ‘sniffs’ the voltage on its input and reproduces it at its own output. The voltage across C8 is therefore perfectly replicated by U4 and this then can be used as our final output. Furthermore, by buffering the capacitor’s voltage this way, the capacitor is unaffected by output loads.

Monitoring the voltage at the output is a comparator based around U3 (1,2,3) and Q5. When the voltage exceeds 9V or so, the comparator’s output goes from 0V to +15V. This tells the flip-flop that the attack phase is over and the **decay** phase is about to start. The latch is thus reset; pin 4 goes low and pin 3 goes high. The capacitor is no longer charging up.

In some other EG circuits, the level at which the attack phase stops is set by the CMOS logic gate’s threshold voltage. In other words, the buffered capacitor voltage is fed directly to the flip-flop. This, in my opinion, is not very good for two reasons. One, the slowly rising voltage at the input to CMOS logic is not a good idea since it produces a large heat dissipation is the device. Secondly, it can lead to false triggering. The benefit in having a reasonably precise comparator is that you can set the end of the attack phase to suit your own purposes. The timing capacitor is being charged from a +15V source through a resistor. This leads to the exponential rise in voltage over time. I prefer the attack phase to be nearly linear for a more punchy sound. By setting the maximum attack peak to a little below 5V, we get a moderate approximation to a straight line. However, it does limit the maximum attack time to below 5 seconds using 1M resistors and 10uF timing capacitor. By using a 14V peak, we can get really long maximum attack times, but a very exponential response, and in my opinion very unrealistic sounds. By using a value of 9V, we get a nice compromise between punchy attack and long maximum attack times. Feel free to adjust the value of R2 which controls the peak and the maximum sustain value and do some experimenting yourself.

In the decay phase, the capacitor is discharged to the level set by the **Sustain** pot. The rate of discharge is set by the Decay pot. In some designs the sustain pot supplies or drains the current to the timing capacitor directly. Thus the resistance of the sustain pot will effect the minimum decay time. There are two solutions: One use a very low value sustain pot, say 1K, and cope with a large current drain from the power supply. Or, do what I have done, and use another voltage follower, U3 (5,6,7) to sniff the sustain pot’s voltage and provide the current.

The decay phase is controlled by the flip-flop output on pin 3. Pin 3 goes high when, as we have discussed; the attack peak has been reached. But it also goes high when the gate signal is removed. This is the signal that tells us that the **release** phase has started. C9, R25 and D4 form a differentiator which apply a pulse when the gate goes low. This is combined with the attack peak detected signal to reset the flip-flop. U1 (12,13,11 & 8,9,10) acts as the OR gate which combines the signals. To distinguish between the decay phase and the release phase, U2 (6,8,9) is used. This only allows the output of the flip-flop to enable the decay phase when the gate is high. Essentially it acts as a switch, only allowing the gate output to control the decay switch when the flip-flop output is high. If the flip-flop is reset due to the gate falling, then decay phase is not initiated.

The timing capacitor will remain charged to the sustain level for as long as the gate is high. Technically speaking the decay and sustain phase are one of the same thing. The sustain period merely being the final level of the decay process.

When the gate drops, the envelope generator will start the release phase. This can happen at any point in the ADSR cycle. The output of Q6, the inverted gate signal will go high. This turns on U2 (1,2,13) and the timing capacitor is discharged to ground through the Release pot and R4. The flip-flop will be reset, as we have already discussed, to prevent the attack and decay pots from affecting the timing capacitor. With no gate present, the envelope generator is continually in release mode thus keeping the capacitor always discharged.

The output of the envelope generator is available at pin 7 of U4. As is custom in modulars, the output goes through a 1K resistor before reaching the output socket. This is normally used to prevent mispatching damaging the op-amp's output, but it also prevent high frequency oscillations due to unwanted cable capacitance.

In the suggested panel layout, I have hardwired the ADSR output, marked as **ENV** on the board, straight to the VCA control input, CV.

The VCA is based on one dug up by Chris Crosskey in the Modulus Synth E-zine. I am sure that it originally surfaced in a Babani Paperback on audio projects, but its original designer is unnamed. However, what is clear that it is a type of Gilbert Multiplier. Now at first site it may seem to be more complex than the usual OTA based VCA. But the cost of the parts is less than a single 3080, and 3046 arrays are easier to come by than the OTA. I don't think it has any real benefits over the OTA approach, but it is more unusual and it does offer excellent performance.

I have changed a few things to the original Modulus circuit. The first is a trim pot that adjusts the balance of current injected into the two current nodes, pin 2 and 6 of U5. This should be able to counteract any imbalance between the two transistors in the long tailed pair. Jorgen Bergfors also did this in his version. The benefit of this is to reduce CV breakthrough into the audio path. CV breakthrough is where the output is found to vary with control voltage even when there is no input signal. In this particular application, fast attack and decays would be heard as a thumping sound if CV breakthrough is not nulled correctly.

I added D12 as a precaution to avoid any excessive negative control voltages. Negative values of CV end up superimposed on the output, and are best avoided. This will not occur if you build the suggested layout, since the CV input is derived from the positive only ADSR output.

I added an inverter to the VCA's output, since the original circuit actually inverts the signal. However, we can use this inverted signal as an inverted ADSR output in the suggested panel layout.

Operation of this VCA is twofold. The main Gilbert multiplier is based around U6 (1,2,3,4,5) a matched transistor pair within the 3046 array. With no signal present at the IN input, the current through both transistors will be roughly the same. U5 (5,6,7) acts as a loop controller, it will try and maintain its pin 6 at zero volts. So whatever current is coming down R71 due to the CV input, it will match with an opposite current through the left hand transistor of the pair. It does this by driving the bottom of the pair, the tail, with R16. As both transistors are matched, both transistors have the same current flowing through them. The VCA's output will not be affected by any change in current through R16, since the same current is travelling through R14 from the CV input and canceled out by the current in the right hand transistor.

Now, lets upset the perfect balance we have. By adding a small positive signal to the base of the left hand transistor, we alter the amount of current distribution in the pair. The left hand will take more. The loop controller will still try and maintain zero volts at pin 6, but it now has to push less current through the pair. Since the right hand side of the pair cannot 'see' what is happening at the base of the other transistor, this decreasing current leads to an imbalance at pin 2 of U5. This op-amp will then have to lower its output voltage to try and maintain the balance through the feedback resistors, R13 and **Level**. It is this output voltage that is our required signal, the multiplication of CV and audio signal.

However, without the actions of other transistors in the 3046 array, this VCA has a major fault. To work properly without audible distortion the input signal must be very small, in the order of tens of millivolts. However, this is not much use to us in a modular that uses signals exceeding 10V p-p. The other transistors in the array work as pre-distortion elements. They distort the signal in exactly the opposite way to that of the Gilbert pair. In essence the two systems working together cancel each other's non-linearities. U6 (6,7,8) and U6 (9,10,11) actually perform the pre-distortion, with U6 (12,13,14) providing the temperature stabilised biasing.

Also included is an AC coupled input. This is not used on the suggested panel, but you can use this if you specifically want the VCA to be used to control the volume of an audio signal.

The little two resistor network at the bottom of the schematic creates a +5V signal that is added to the VCA's signal path when no jack plug is inserted into the CV input. This allows the ADSR output to be always available with a fixed attack peak of +5V even with no modulation input. Thus the envelope generator can be used as if the VCA were not present.

Components

Most of the parts are easily available form your local parts stockist. I use Rapid Electronics, RS Components, Maplin and Farnell, here in the UK. The ADSR/VCA module was designed to be built solely from parts obtainable from Rapid Electronics and myself only. Rapid's telephone number is 01206 751166. They offer a traditional 'paper' catalogue as well as an on-line ordering service at www.rapidelectronics.co.uk.

In North America, companies called Mouser, Newark and Digikey are very popular. In Germany, try Reichelt, and in Scandinavia you can use Elfa. All companies have websites with their name in the URL. In the Netherlands try using www.telec.com.

The pots are Omeg Eco types with matching brackets. You could use any type you want, but not all pots have the same pin spacing. Not a problem, of course, if you are not fitting them to the board. In the UK, Maplin, CPC and Rapid sell the Omeg pots at a very good price. But note that Maplin and Rapid do not have the pot brackets. The pot kit that I supply contains all four pots and the pot brackets.

The resistors are generally ordinary types, but I would go for 1% 0.25W metal film resistors throughout, since these are very cheap nowadays. For the UK builders, then Rapid offer 100 1% metal film resistors for less than 2p each! For R8, which is a 3M3 resistor, you better go with a 5% type since high values of resistance are harder to obtain in metal film.

All the electrolytic capacitors should be over 25V, except where stated, and radially mounted. However, don't chose too higher voltage either. The higher the working voltage the larger in size the capacitor. A 220V capacitor will be too big to fit on the board. 25V or 35V is a good value to go for.

Earlier editions of this User Guide recommended that C8 be a tantalum capacitor. I chose this type of capacitor because if its closer tolerance. However, comments on the Synth-DIY mailing list have suggested that surge currents, which are present at fast attack and decay times, may shorten the life of this component. Electrolytic capacitors are more rugged in this respect and are now recommended for C8. I personally have found no evidence that tantalum capacitors do have this problem, but I bow down to the knowledgeable fellows on their list and take their advice very seriously.

The pitch spacing of all the non-polar capacitors is now 5mm (0.2”). This may differ from some of the older Oakley modular boards you have built. For values between 1nF and 470nF, I use metalised polyester film types. These come in little plastic boxes. Try to get ones with operating voltages of 63V or 100V.

The ceramic capacitor, C5 should be a ‘low-K’ ceramic plate. These are sometimes called C0G types. The lead spacing is 0.2” or 5mm. Do not chose cheap and nasty ceramic types, usually ‘high-K’, obtainable from some surplus places. These can lead to a noisy audio output.

L1 and L2 are leaded ferrite beads. These are little axial components that look like little blackened resistors. They are available from most of the mail order suppliers. Find them in the EMC or Inductor section of the catalogues. Farnell sell them as part number: 108-267.

The two horizontal preset or trimmer resistors are just ordinary carbon types. No need to buy the expensive cermet types. Carbon sealed units have more resistance to dust. Piher and Spectrol make suitable types. Pin spacing is 0.2” at the base, with the wiper 0.4” away from the base line.

The BC549 transistors can be pretty much any NPN transistor that corresponds to the same pin out. For example: BC550, BC548 etc. I have used BC549B throughout in my prototypes.

All ICs are dual in line (DIL or DIP) packages. These are generally, but not always, suffixed with a CP or a CN in their part numbers. For example; TL072CP. Do not use SMD, SM or surface mount packages. You may also use LF412CN types for the dual op-amps. I have found that using a faster lower offset op-amp in U5 results in marginally less CV break through. The 3046 can be either CA3046 from Harris or LM3046 from National. Again they may have additional suffixes, but make sure you getting the 14-pin DIL or DIP version.

The two logic ICs are standard 4000 series CMOS. Typical part numbers are CD4001BE or HCF4066BE. I found that one batch of 4066 chips I bought from Farnell, made by ‘Fairchild’ and labelled CD4066BCN exhibited strange behaviour with minimum attack and release settings. This behaviour resulted in the ADSR output latching up and staying high for an indefinite period. The reasons for this are not fully understood, but I believe them to be related to current flow within the analogue switch's channel. A large current flow causes the input gate of the switch to emit a high level pulse which confuses the control logic either in the rest of the ADSR circuit or within the 4066 gate control circuitry. This fault was simply solved by making R4 a 330R resistor. Earlier editions of this User Guide and the current schematic have R4 as a 47R resistor.

The increase in value of R4 reduces the flow of current and prevents the ‘latch up’ condition from ever happening in the first place. However, it does have the knock on effect of increasing the minimum release time a bit, but this slight increase is negligible.

U2 may also be replaced by a 4016. This actually works perfectly well even with R4 as 47R, but because of the increased channel on resistance all the minimum times are lengthened slightly.

You may use a 47R for R4 only if you have 4066 not made by Fairchild. Which is probably most of you anyway.

Finally, if you make a circuit change that makes the circuit better, do tell me so I can pass it on to others.

Parts List

The components are grouped into values, the order of the component names is of no particular consequence. Please read the above section for more details about the parts used in this module.

A quick note on European part descriptions. 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.

Resistors

Resistors 1/4W, 5% or better.

47R	R3
330R	R4
1K	R32,18,17,33
4K7	R26,27
5K1	R29
6K8	R2
10K	R9,10,28
22K	R16
33K	R13
47K	R31,1,7,15,14,19

100K	R11,12,34,21,5,22,25,23,20,24
220K	R6
1M	R30
3M3	R8

Capacitors

22uF, 25V electrolytic	C2,11,12
10uF, 25V electrolytic	C8
1nF, 100V polyester film	C3,9
100nF, 63V polyester film	C1,4,6,7
33p Ceramic low-K	C5
470nF, 63V polyester film	C10 (optional for audio input to VCA)

Semiconductors

1N4148 small signal diode	D1-6
BC549B NPN transistor	Q5,6,7
TL072 dual bi-fet op-amp	U3,4,5
CA3046 NPN array	U6
4001 quad NOR gate	U1
4066 quad analogue switch	U2

Other

4-way 0.156” Molex/MTA connector	PWR
10K linear single gang variable resistor	SUSTAIN
1M log single gang variable resistor	ATTACK, DECAY, RELEASE
Four pot brackets to suit	
1K carbon trimmer (horizontal)	CV-TRIM
22K carbon trimmer (horizontal)	LEVEL
Leaded or taped ferrite beads	L1, L2
1m of multistrand hook up wire	
Four knobs	
Four decent quality jack sockets, eg. Switchcraft 112	

You may well want to use sockets for the ICs. I would recommend low profile turned pin types as these are the most reliable. You need three 14 pin and three 8 pin DIL sockets.

Building the ADSR/VCA module

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. To date this has happened only four times across the whole range of Oakley PCBs. The most common error with three 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! Hang on a minute you say. This will waste a component. Yes, it will. But better to waste one component than to trash the PCB.

Paul Schreiber of SynthTech has won me over to water washable flux in solder. The quality of results is remarkable. In Europe, Farnell sell Multicore's Hydro-X, a very good value water based product. You must wash the PCB at least once an hour while building. Wash the board in warm water on both sides, and use a soft nail brush or washing up brush to make sure all of the flux is removed. Make sure the board is dry before you continue to work on it or power it up. It sounds like a bit of a hassle, but the end result is worth it. You will end up with bright sparkling PCBs with no mess, and no fear of moisture build up which afflicts rosin based flux. Most components can be washed in water, but do not wash a board with any trimmers, switches or pots on it. These can be soldered in after the final wash with conventional solder or the new type of 'no-clean' solder.

I have recently found that if you are using a very hot soldering iron it is possible to run your iron so hot as to boil the flux in the 'water washable flux' solder. This is not a good idea as it can create bubbles in the solder. If you prefer to have a fixed temperature iron, then it is best to get a 18W one for this purpose. I use an ordinary Antex 25W iron with a Variac power supply running at 205V. This seems to work well for 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. When all the diodes are in place, double check all are pointing the right way.

The polyester film 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.

Ceramic capacitors are strange flat plates made from pot. Be careful with this one and make sure you have bought the ones with 0.2" lead spacing. Forcing the smaller 0.1" ones into these larger pads will break them. Another thing to watch out for is the identification markings on these capacitors. It should just say 33p, but it may say just 33.

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.

IC sockets are 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. And that any water is thoroughly dried out before you power up. Sockets harbour little pools of water in their pins which can lead to some very odd effects. Several sharp taps face down onto a towel will loosen off any remaining globules of liquid.

The transistors can be soldered into the board without sockets. Match the flat side of the device with that shown on the PCB legend. Push the transistor into place but don’t push too far. Leave about 0.2” (5mm) of the leads visible underneath the body of transistor. Turn the board over and cinch the two outer leads on the flip side, you can leave the middle one alone. Now solder the middle pin first, then the other two once the middle one has cooled solid.

Sometimes transistors come with the middle leg preformed away from the other two. This is all right, the part will still fit into the board. However, if I get these parts, I tend to ‘straighten’ the legs out by squashing gently all the three of them flat with a pair of pliers. The flat surface of the pliers parallel to the flat side of the transistor.

I would make the board in the following order: resistors, IC sockets, small non-polar capacitors, transistors, electrolytic capacitors. Then the final water wash. You can now fit the trimmers to the board with no-clean or ordinary ‘ersin’ flux solder. 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 Eco 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.** Now remove all the nuts and washers from the pots and fit the board up to your front panel. Refit the washers and tighten the nuts, but not too tight. Now carefully position the PCB at right angles to the panel.

The pot's own pins will hold the PCB 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 Omeg pots are labelled A, B or C. For example: 47KB or 100KA. Omeg uses the European convention of A = Linear, B = logarithmic and C = Reverse logarithmic. So a 1MB is a 1 megohm log pot.

The pots shafts may be cut down with a good pair of pliers, or a junior hack saw. Try not to bend or rotate the shaft as you are cutting.

The pots are 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.

Connections

This module is very easy to connect up. There are just four sockets in the suggested layout. I have internally hardwired the ENV output to the CV input. This means the envelope generator is always connected to the VCA. This is simply achieved by linking the CV and ENV pads on the PCB together with a small piece of wire.

In the suggested panel you will not be using the pad marked AUD. This is designed for an audio input only and will remove any DC that is superimposed on the audio signal. It is really to be used by those of you who want to use the VCA part of this module for audio VCA purposes only. The IN pad can also be used with audio, as well as CVs.

If you have used Switchcraft 112 sockets you will see that they have three connections. One is the earth 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.

Connect, with four pieces of insulated wire, each signal tag to the respective pad on the PCB. The pads that are going to be connected are OUT, INV, GATE and IN. I have used slightly different names for the front panel sockets. The table below shows which is connected to which:

PCB	**Front Panel**
GATE	GATE
OUT	OUT+
INV	OUT-
IN	IN

Leave the NC tags unconnected on the GATE, OUT+ and OUT- sockets. Now with another piece of insulated wire connect the NC tag on the IN socket to the NORM pad on the PCB. This will allow the ADSR outputs to function even without any CV input.

The 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 GND	2
Earth/PNL	3
-15V	4

The PNL pad on the PCB has been provided to allow the ground tags of the jack sockets to be connected to the powers supply ground without using the module’s 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. For a suitable power distribution board you may want to consider the Oakley ‘Dizzy’ PCB.

The ground tags of each socket can be all connected together with solid wire. A piece of insulated wire can then be used to connect the tags to the PNL pad. Do not connect the ground tags to any other ground.

At the rear of this user guide I have included a 1:1 drawing of the suggested front panel layout. Actual panels can be obtained from Schaeffer-Apparatebau of Berlin, Germany. The cost is about £25 per panel. All you need to do is e-mail the fpd file that is found on the MultiLadder 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 3mm thick anodised aluminium. The fpd panel can be edited with the Frontplatten Designer program available on the Schaeffer web site.

Setting Up

There are just two trimmers to be set before you are finished. The LEVEL trimmer allows you to trim the output of the VCA to the desired gain. In the suggested layout, with no CV input, the ADSR output is trimmed to give +5V peak attack and sustain levels. Connect a positive gate signal to the Gate input. Set A, D, and R to their minimum positions, and set S to the maximum. Adjust LEVEL until you get +5V from the ‘OUT+’ output. Just to check you should get -5V from the ‘OUT-’ output.

Apply a 100Hz or so, square wave to the gate input. Now connect a zero volt signal to the CV input. You can easily get this by hooking up a non-oscillating filter’s output to the CV input. Now attach the ADSR output to your final mixer or amplifier. With the volume quite low, adjust CV-TRIM until any audible 100Hz buzz is minimised. Turn the amplifier up to fine tune the control. You won't get it absolutely silent, but it will be near enough.

That's it you're ready to go.

Final Comments

I hope you enjoy building and using the Oakley *ADSR/VCA Module*. Please feel free to ask any further questions about construction or setting up. If you cannot get your project to work, do get in touch with me, and I will see what I can do. Sometimes, it can be the simplest things that can lay out a project. I do offer a get-you-working service. Send your completed non-working module back to me with £10 and I will fix it for you. You will also have to pay for the postage both ways, and for any replacement parts needed. Make sure you wrap it carefully and include a full description of the fault.

Occasionally, there may be an error in the parts list. I have checked the documentation again and again, but experience has taught me to expect some little error to creep past. The schematic is always the correct version, since the parts list is taken from the schematic. So if there is any problem, use the schematic as the guide. If you do notice any error, please get in touch.

Please further any comments and questions back to me, your suggestions really do count. If you have any suggestions for new projects, feel free to contact me. You can e-mail, write or telephone me. If you telephone then it is best to do this on Monday to Friday, between 9 am and 6 pm, British time.

Last but not least, can I say a big thank you to all of you who helped and inspired me. For this module in particular, I would like to thank Chris Crosskey, Paul Maddox and Jorgen Bergfors. Thanks especially to all those nice people on the Oakley-synths, Synth-diy and MOTM mailing lists.

Tony Allgood. July 2002

Version. 1.4

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