Oakley Sound Systems

5U Oakley Modular Series

Dual Voltage Controlled Amplifier
&
Quad Voltage Controlled Amplifier

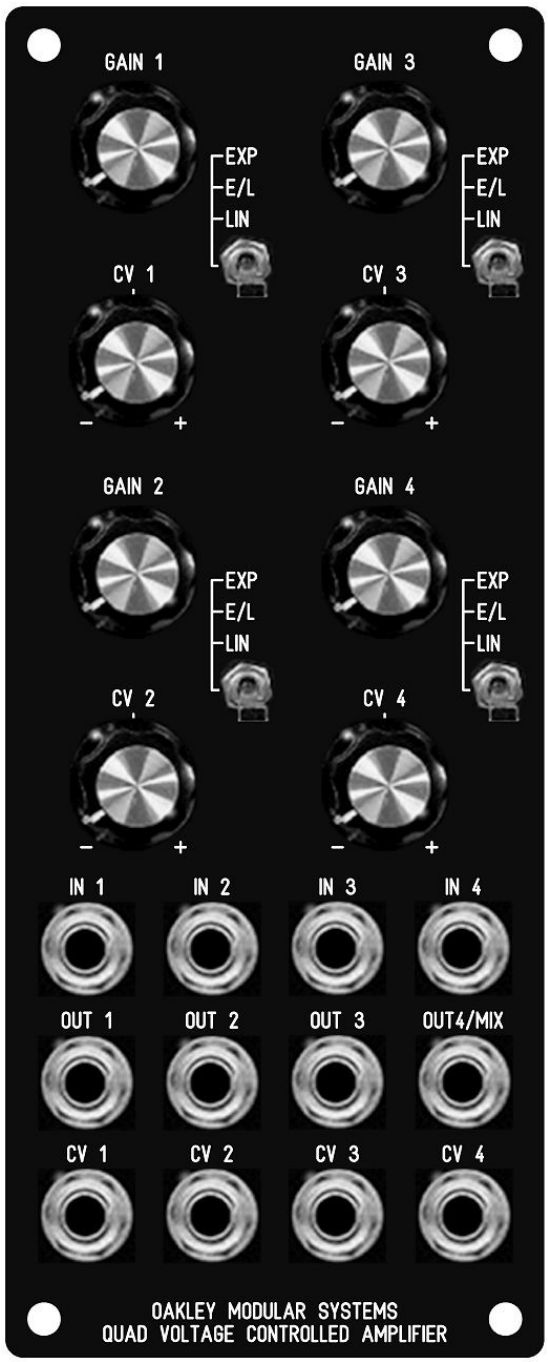
Dual VCA-X PCB issue 1

User Manual

V1.0

Tony Allgood
Oakley Sound Systems
CARLISLE
United Kingdom

The suggested panel layout for the single width MOTM format module.



The suggested panel layout for the dual width MOTM format module.

Introduction

This is the User Manual for the Dual and Quad Voltage Controlled Amplifier 5U modules that use the issue 1 Dual VCA-X printed circuit boards from Oakley Sound. This document contains an overview of the operation of the units and the calibration procedure.

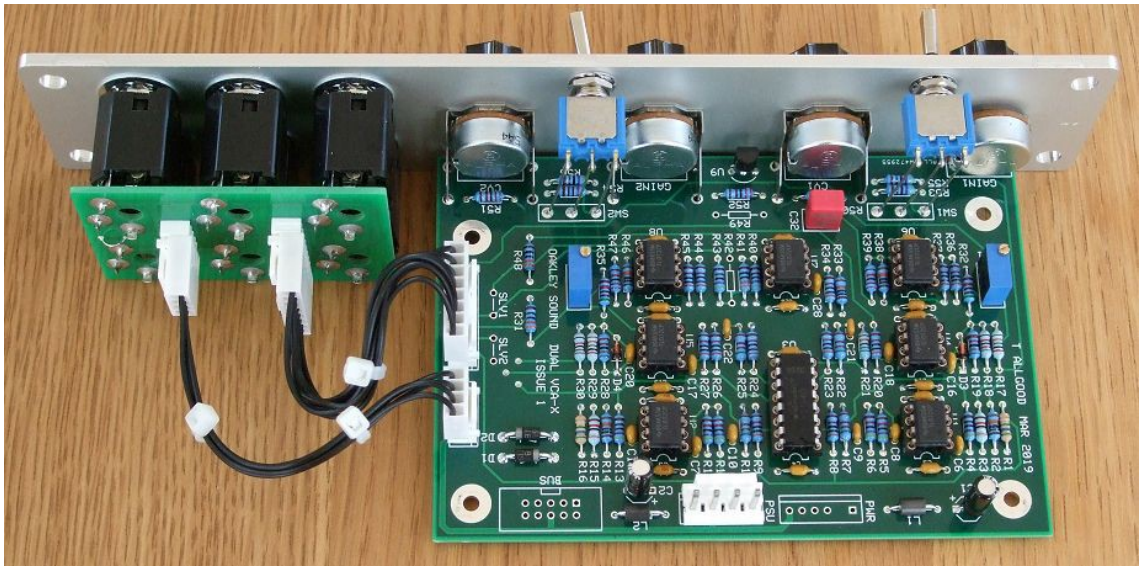
For the Builder's Guide, which contains a basic introduction to the board, a full parts list for the components needed to populate the boards, and a list of the various interconnections, please visit the main project webpage at:

http://www.oakleysound.com/VCA-X.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 Oakley Dual and Quad Voltage Controlled Amplifiers



This is the Oakley Dual VCA module built with the issue 1 Dual VCA-X PCB behind a natural finish 1U wide Schaeffer panel.

This is a high quality low noise VCA module built around the popular 2164 integrated circuit. The VCA core circuitry is based on the work of Mike Irwin, Philip Gallo and David Dixon. The module is built either as a single width two channel VCA or a double width four channel VCA. Each VCA stage is identical and each features a high quality linear or exponential response analogue VCA with very low noise and low CV breakthrough. Each VCA is direct coupled and can therefore process CVs and audio signals.

If the output socket of any VCA channel is unused then that signal will be mixed with the output of the final channel. That is, in the four channel version this module can be used as a four channel voltage controlled mixer. However, any VCA channel can simply be taken out of the mixing process by inserting a jack lead into its respective output socket.

Each VCA has two controls. Firstly, there is GAIN, a fixed bias to set the initial gain of the VCA, it can also be used a volume control. Secondly, the CV pot allows you to alter the sensitivity of the external CV that controls the VCA's gain. This pot is a 'reversible attenuator', so you are able to control not only the depth of the modulation but also the polarity. With the CV pot set straight up no CV signal reaches the VCA. With it fully right the CV is applied so that positive CVs increase the gain of the VCA. With the pot fully left then increasing positive CVs reduce the gain of the VCA.

Each VCA can be set, with its three way front panel switch, to respond either as a standard linear VCA, an exponential VCA, or with the switch in the middle position as a mixture of the two responses.

With the gain control fully clockwise, and with no additional CV applied, the gain of the VCA is 0dB, or unity gain, in either linear or exponential modes. With the gain control at zero, the CV Depth at full, an applied CV of +5V will also produce unity gain. In linear mode a 10V

applied CV will produce a gain of two (+6dB). In exponential mode the gain will rise rapidly with input CVs exceeding 5V with the maximum gain available being limited to around six (+15dB).

Current consumption is approximately +/-35mA.

What is a VCA?

The VCA (Voltage controlled Amplifier) is a device used to control the level of one signal by the application of another. Traditionally, the controlled input to the VCA is called the **input**, whilst the controller input is called the **CV**, or **control voltage**. A typical usage will have the input as the audio output from a filter or oscillator, and the CV from an envelope generator. As the envelope generator's output voltage rises and falls, so the output of the VCA becomes louder and softer.

It should be noted that the CV input can also be an audio input, and that the input can be a control voltage. It is up to you what you put into the module. The nomenclature refers only to the original and common usage of the input sockets on a VCA module.

The term amplifier may be different to the one you normally use too. A VCA doesn't always amplify in so far as it doesn't always make the input signal bigger. The amplification, or gain, actually varies from zero, ie. when the VCA is closed or off, to about one, or 0dB, when the input CV is +5V. When the gain is one then the output voltage is the same as the input voltage.

Linear and Exponential Responses

Each VCA can be used in either linear, exponential, or a mixture of the two. These modes affect the way the VCA responds to both the gain control pot and the input CV.

In linear mode doubling the CV will double the output signal level. It also means that when the gain pot is half way around, the VCA will produce half the signal level it would as when the gain pot was fully clockwise. In general the linear response is the most useful response for general VCA duties irrespective of whether you are controlling CVs or audio. You may hear that exponential VCAs are for audio and linear VCAs are for CVs but this is incorrect. You can use whichever you want that gets the job done, but in general linear VCAs are the ones you will use most of the time.

With the gain control at zero, the CV Depth at full, an applied CV of +5V will produce unity gain (0dB). While with a CV of +10V the VCA will produce a gain of two (+6dB). The gain control pot on its own will control the gain from zero to one (approximately -100dB to 0dB). The applied CV and gain pot add together, so a +5V CV input with the CV depth pot set fully clockwise, and the gain pot also turned fully clockwise, will produce a gain of two (+6dB). Likewise, a +5V CV input with the CV depth pot now set fully anti-clockwise, and the gain pot still turned fully clockwise, will produce no output as both controls have cancelled each other out.

The 2164 integrated circuit that forms the heart of the Dual VCA-X board is actually four exponential VCAs in one chip. The linear function is obtained by using two of these exponential VCAs together, one to be the VCA and the other to linearise the exponential response of that VCA. This linearisation process is not completely perfect. It goes slightly awry when the gain is very low, that is, when the VCA is almost off. It's almost undetectable but the linearised VCA has a slight bump in its response meaning that as it turns on, it does so a little quicker than it should. Likewise, it turns off a little quicker than it should. However, because this happens at exceptionally low gains this is not a problem in practice.

The exponential response means that a rising CV will produce a proportional change in gain where the gain is measured in decibels (dB). Indeed, the response of the VCA-X module is approximately 50mV per dB of gain. Thus a 5V change in input voltage gives us a change in signal level of around 100dB. For ease of use the linear and exponential responses are set to be effectively the same at both 0V and +5V. A +5V CV input giving us a gain of one (0dB) in both linear and exponential modes. And a 0V CV input effectively turning the VCA off.

In practice the exponential mode produces a VCA that initially only very gently increases the signal level as the CV rises from 0V to +5V. Only when it is near to +5V does it seem to do much to the signal level.

The Oakley Dual VCA-X circuit also incorporates an E/L mode. This is a half way house between the linear and exponential responses. In truth it's actually a little more complex than this, as the linear mode becomes significantly more dominant at very low gains. However, it is a useful response to have and well worth investigating.

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 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 fitted for use with a Synthesizers.com compatible system. 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.

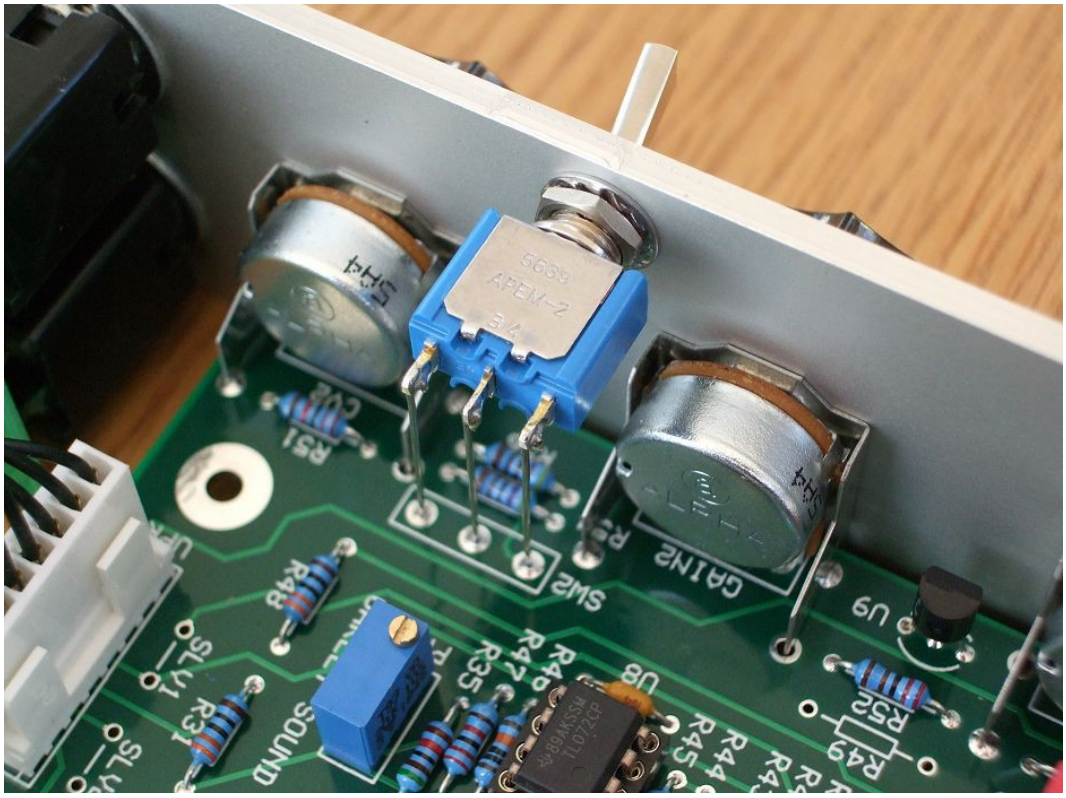
Power	***Location number***	***Schematic Pin number***
+15V	1	1
Missing Pin	2	
+5V	3	2
Module ground (0V)	4	3
-15V	5	4
Socket Ground *	6	5

+5V is not used on this module, so location 3 (pin 2) is not actually connected to anything on the PCB.

If the PWR header has been fitted and you are using the module with a standard MU power distribution system, the middle two pads of the PSU header on the board should be connected together. This link connects the socket and panel ground with the module ground.

* The DVCA-X 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.

Calibrating



The exponential/linear mode switch and multiturn trimmer for channel 2.

There are two multiturn trimmers, or presets, on each Dual VCA-X PCB. If you have a Quad VCA module you'll see that you will have two Dual VCA-X boards fitted, one of which is the master, and the other, the slave. The master handles channels 3 and 4, while the slave handles channels 1 and 2.

The trimmers can be adjusted with a small flat bladed screwdriver but a special trimming tool is recommended. Firstly, because it is plastic and is less likely to short anything out and damage the module. Secondly, the tool is designed so that its small blade sits within a circular recess and prevents the tool from slipping off the trimmer.

For the Quad VCA module the trimmers for channels 1 and 2 are more difficult to access since they are on the slave circuit board and this board is partly covered by the master circuit board. However, the trimmers on this board should be side adjust types and the little screw that needs turning is accessible, with care, from the rear of the module. For PR2 you will need to work between a large capacitor and the ribbon cable that joins the slave and master boards together.

On the Dual VCA-X board PR1 controls the top channel and PR2 controls the lower channel. For the Dual VCA module this means that PR1 controls channel 1 and PR2 controls channel 2. On the Quad VCA, since both circuit boards are labelled the same way, it should be noted that the master's PR1 and PR2 trimmers control channel 3 and 4 respectively.

The trimmer controls the gain of the VCA in exponential mode. It has no effect on the linear mode. To set up each channel you can do one of two things, either listen to the output, or

measure the voltage between the two outer solder tags of that channel's switch. The voltage method is perhaps the easiest to do if you have the Dual VCA module. However, if you have a Quad VCA then it is easiest to calibrate your module by monitoring the output level.

For the voltage method: Power up the module and allow it to settle for about five minutes. Set both the gain control fully clockwise and the switch to linear on the channel you wish to calibrate. Measure the voltage between the two outer solder tags of that channel's switch. That is, put the meter's red lead on the switch's top solder tag and put the black lead on the bottom solder tag. Adjust the trimmer until the voltage reads 0.000V +/-1mV. Do the same for the other channel.

To trim by monitoring the audio output you will need to power up the module and allow it to settle for about five minutes. Connect a constant audio signal, such as a 220Hz triangle wave from a VCO, into the IN socket on the VCA channel you wish to calibrate. Set that channel's gain control fully clockwise. Listen to the output of the VCA. Adjust the trimmer so that the volume of the signal does not change when you flip between the exponential and linear modes. Do the same for the other channel.

Final Comments

I hope you enjoy using the Oakley Voltage Controlled Amplifier module.

If you have any problems with the module, an excellent source of support is the Oakley Sound Forum at Muffwiggler.com. Paul Darlow and I are on this group, as well as many other users and builders of Oakley modules.

If you have a comment about this user manual, or have a found a mistake in it, then please do let me know.

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