



mixing
LIVE with VCAs

ALLEN & HEATH

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➤ Introduction

Not long ago VCA-equipped live mixing consoles were seldom found outside the glamorous world of big shows and stadium rock tours. It is hardly surprising that many engineers have yet to get their hands on a VCA mixer, and that the technology is still widely misunderstood. This booklet is intended to offer a simple explanation of the operation and advantages of using VCA in a mixing console. Of course, not all console manufacturers do it the same way. This article looks at the principles applied within the Allen & Heath ML Series consoles (the ML3000, ML4000, and ML5000 currently offer this asset).

The acronym VCA stands for Voltage Controlled Amplifier, an electronic device that passes audio signal with its gain controlled by an external DC voltage. The name itself can be rather unhelpful when applied to consoles, as it forces the aspiring user to think about where the voltage is going and where the control is coming from, not what they can achieve. If someone had come up with an acronym like FMS (Fader Management System) instead, maybe the concept would be more widely understood today.

Mixing consoles do not need to use VCAs to mix signals – but it helps! VCAs are simply a form of remote control fitted to enable the operator to ‘balance’ complex groups of input channels in the output mix or post fade aux mixes.

➤ Audio groups are great

Before we get on to VCA groups, let’s remember why we like to use regular audio groups. The advantage of being able to mix from a centrally located group of faders is fairly obvious; the engineer’s hands can stay around the master section of the console, where the output AFL buttons and metering are. The engineer might need to ‘balance’ the mix of some input channels that are many feet apart across the entire mixing surface. Also, once summed together into a group, the combined signals can be processed together, for example, passed through a compressor / limiter, or sent to a channel of a recorder. These are the reasons that audio groups came about.

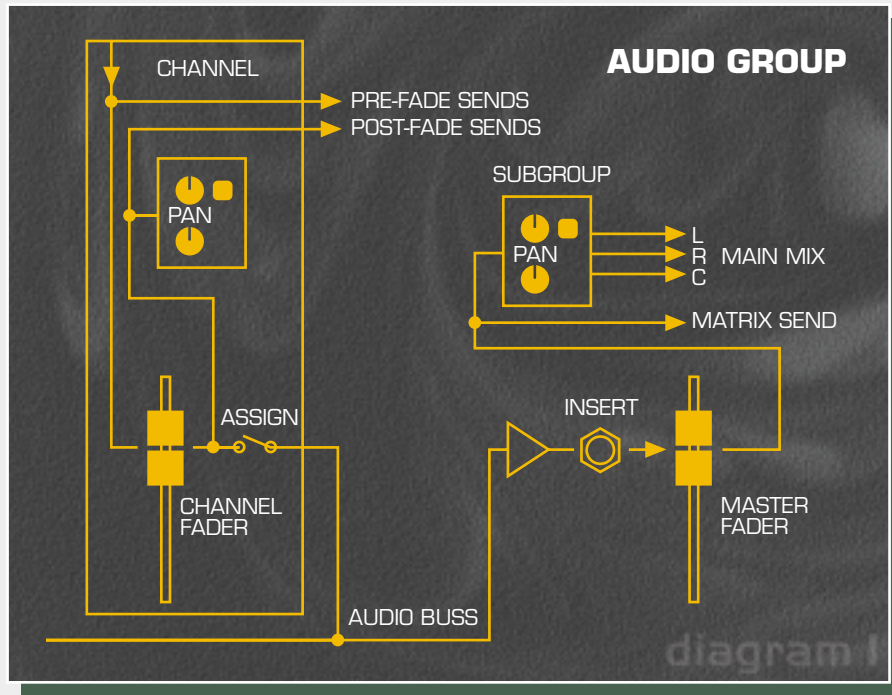
➤ So why bother with VCA groups?

If audio groups are so useful, why bother with VCA groups? The answer is that both types of groups have different assets that make them suited to performing distinct tasks. The following pages will highlight some of the things that set them apart:

Controlling inputs to LR / LCR with Audio Groups

Traditionally the only way to control a collection of input channels to a mix was by routing them to audio groups: one group for mono, two for stereo and three for LCR arrangements. This means that channel signals in the groups would be switched to a sub-buss in the central master section of the console and the sum of these channels could be controlled by 'Group' faders and pan controls - see Diagram 1.

This arrangement is needed if the group is to be interrupted by a processor such as a compressor / limiter, noise gate, or an effect such as delay, and/or if it is desirable to keep the collective integrity of the group signal separate from the 'mix' (e.g. to provide a separate track on a recording device, or a feed to a specific speaker system). These requirements involve the need for separate output channels from the console and the necessary routing circuitry throughout.

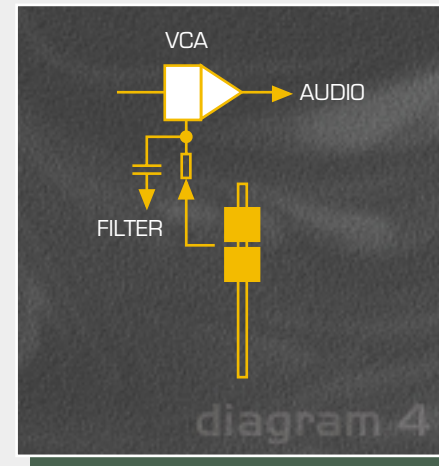
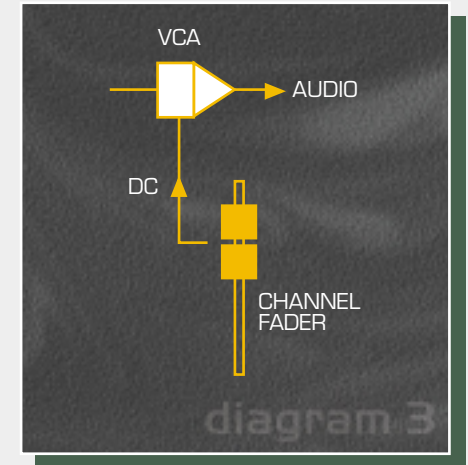
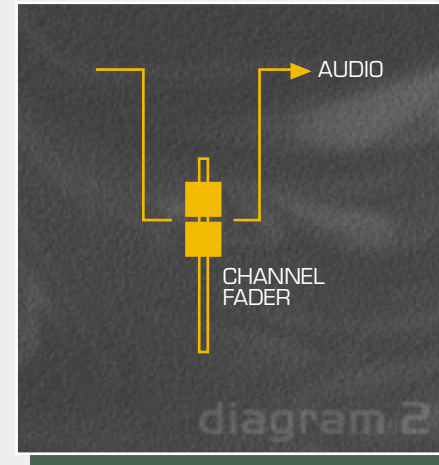


How VCA is applied within the console

The VCA equipped console has special input channels that will respond to a 'remote' control voltage (this is usually achieved by having a chip – the Voltage Controlled Amplifier – fitted to each channel).

(This type of circuitry has been used extensively in the compressor / limiter or noise gate, where the amplifier chip is controlled by a voltage related to its input signal - or sometimes an external input).

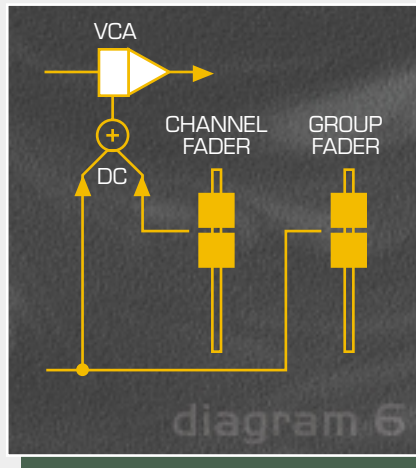
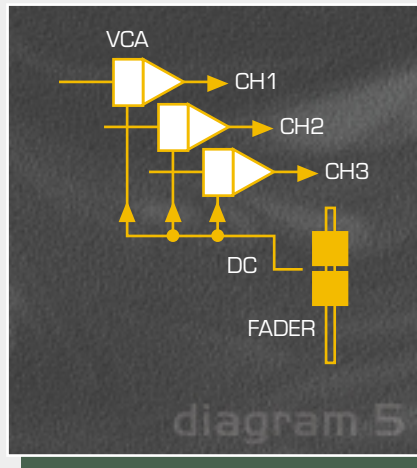
Each mixer channel is fitted with a VCA device which replaces the conventional fader circuit shown in Diagram 2. It has its level controlled by a variable DC voltage which is fed to the control port of the VCA as shown in Diagram 3. For example, the signal may be adjusted between fully off with $-5V$ applied, and fully on with $0V$. The signal passes through the VCA instead of the fader. No audio passes through the fader as it does in the non-VCA consoles. One advantage of this is that VCA faders do not suffer from such severe noise and signal loss problems that conventional faders may have when wear and tear causes the resistive surface to deteriorate.



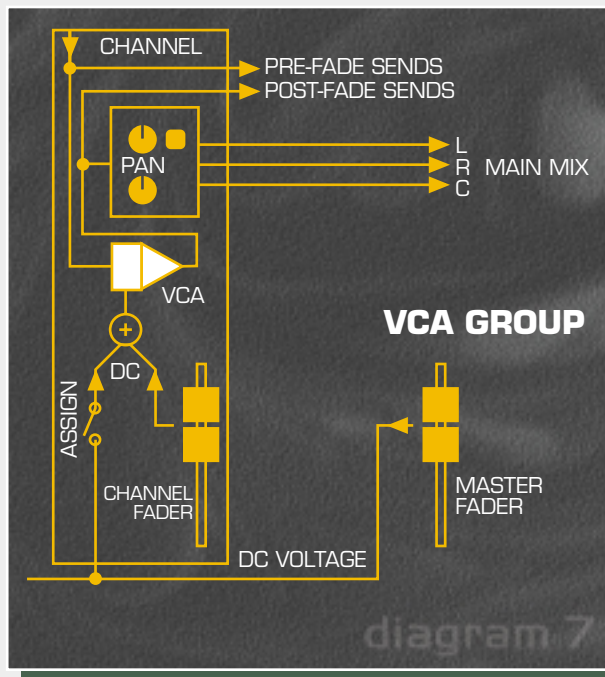
Noise filtering could be added as in Diagram 4. The benefit is longer fader life, as the crackles and dropouts typical of the typical audio fader are smoothed out.

Controlling inputs to LR / LCR with VCA Groups

One fader can control more than one channel VCA - Diagram 5.



The voltage from several faders can be summed together to control the same VCA as shown in Diagram 6. This is how the 'Groups' in the VCA equipped console are created.

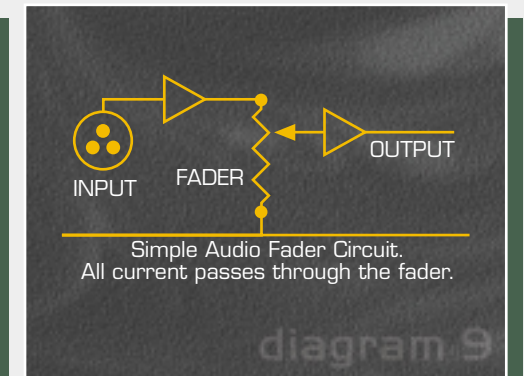
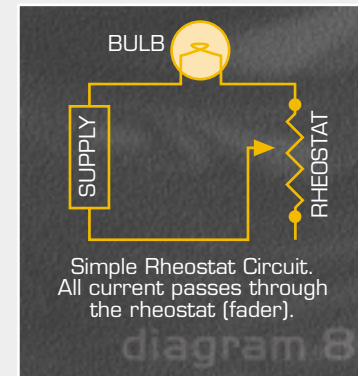


Here in Diagram 7. The audio output from the channel is routed directly to the mix busses (in this case L, C, & R). But only one group fader is needed

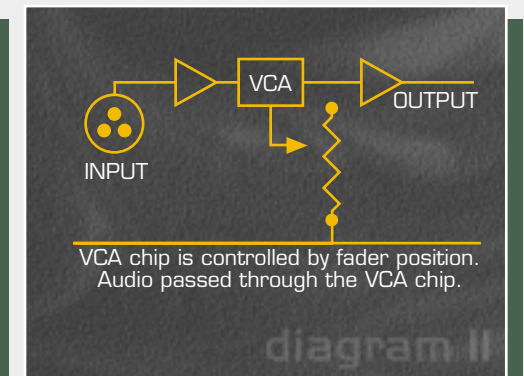
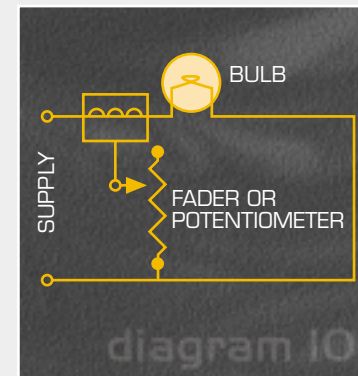
Analogies

To help you to get a firm grip on the VCA concept, here are some analogies from outside the realms of audio.

For those of you familiar with the old supply / lamp / rheostat circuit from school (and early lighting controls in theatres) you will recall that the output from the lamp was controlled by a big resistor in series with the bulb and the mains supply (Diagram 8). Several lamps could be routed through this resistor (which was a giant wire-wound fader!). This circuit is similar to the traditional non-VCA audio group (Diagram 9).



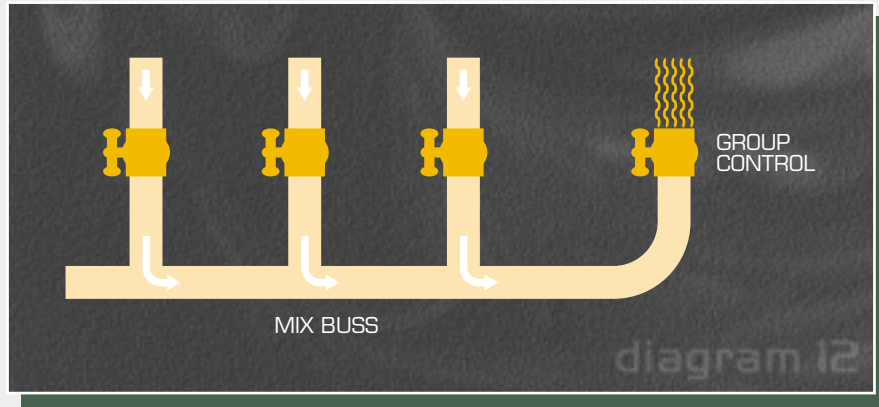
Then along came the thyristor, a solid state device which uses a control voltage to control the output level (sound familiar? Diagram 10). This is basically what is in the dimmer control for lamps. One advantage is that the control slider or pot can be some distance away from the circuit handling the output (e.g. a lighting desk controls lamp dimmers that are many metres away). This works in a similar way to the VCA control in a mixing console - Diagram 11.



➤ Analogies

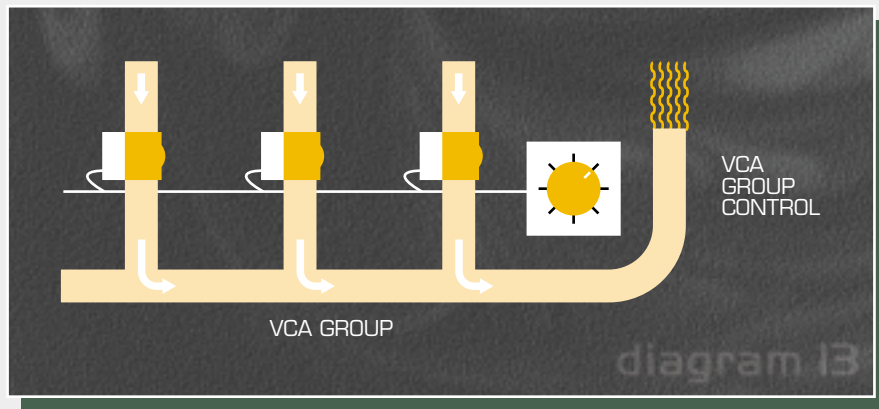
Ok, so you're not that hot with electricity – how about plumbing? A tap (faucet) is used to control the flow (output) of water through a pipe – several pipes can be routed to a larger pipe before being sent elsewhere. The total flow of this group of channels can now be controlled by a valve (large tap) in this pipe - Diagram 12.

This is similar to the traditional non-VCA audio group where the taps in the small pipes are the channels, the small taps are the channel faders, the large pipe is the group buss and the valve is the group fader.



If the taps in the pipes were to be replaced with motorised valves like those in a modern central heating system and then wired back to a thermostat, the individual valves could still be set locally but the thermostat would act as a overall remote control for the levels flowing through the system - Diagram 13.

Here the thermostat control would be similar in operation to the VCA master fader in a console controlling a group of channels

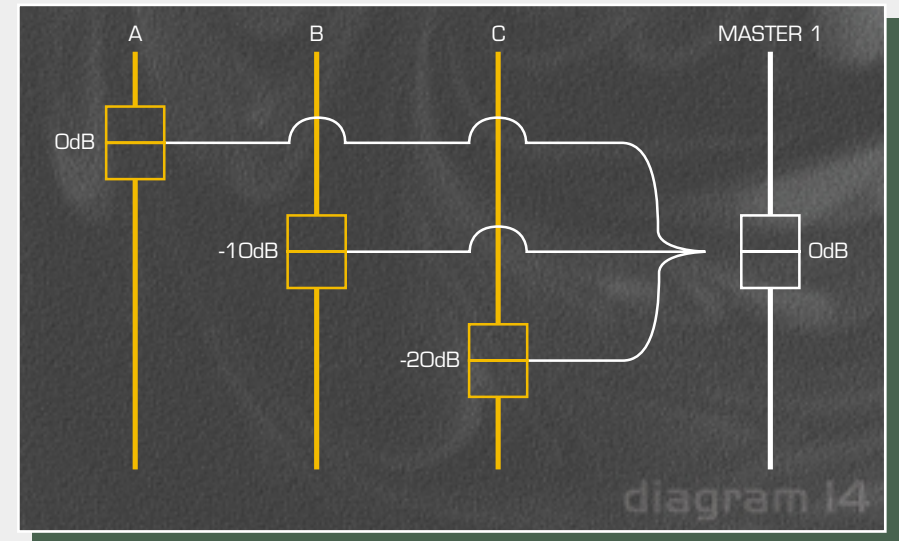


➤ Levels within VCA Groups

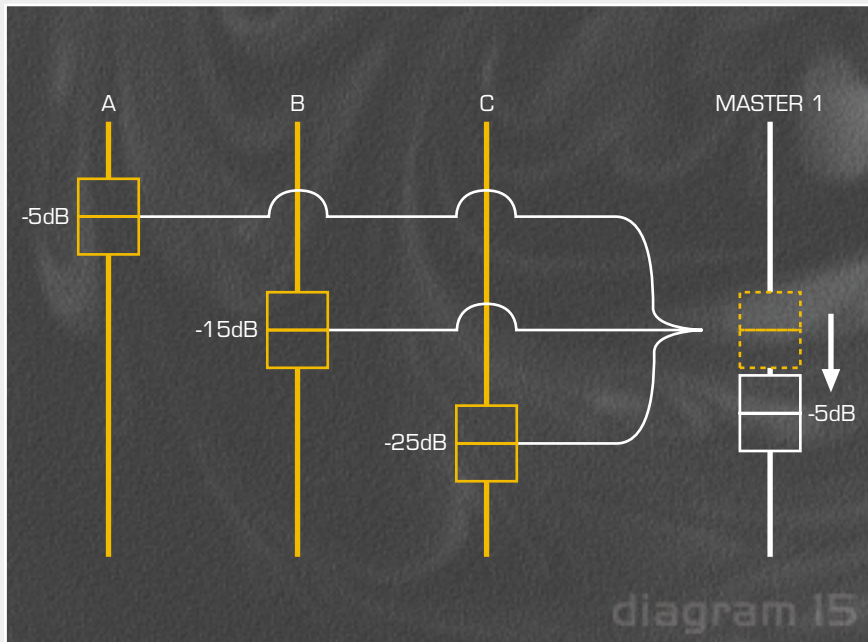
A VCA group is quite simply a means of remote controlling multiple inputs using a single group fader. This affects the signal level back at the channels and not within some additional mixing stage later in the console audio path. We need to understand that both the channel fader and the group fader affect the level just as they do when you are working with conventional audio groups.

The voltage from both faders sum together to control the VCA. It may seem that if you raise both faders you get twice the level and that the more group faders assigned the greater the level, but the circuit is designed for the channel fader to be unaffected by any assigned group faders set to their marked '0' on position.

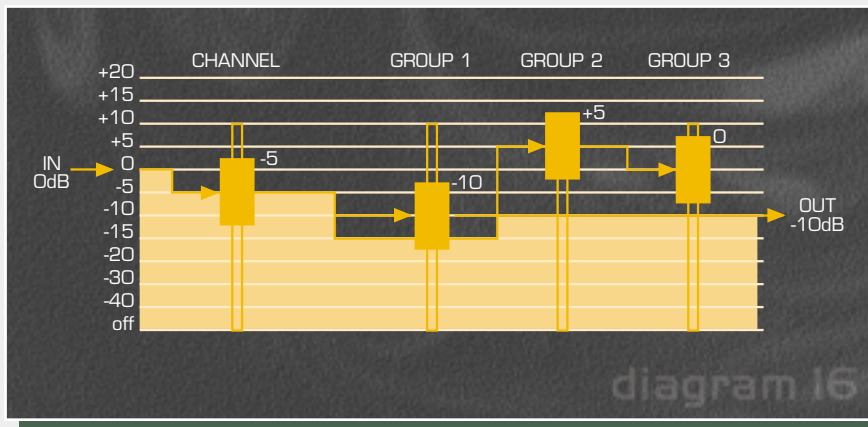
Operationally you could think of this as audio passing through two faders in series. However, no audio passes through these faders. The way we achieve this on the ML Series is to set the VCA to produce 0dB unity gain when the control voltage is 0V. This represents the signal passing through without change of level. With all assigned group faders up at their '0' position they each provide 0V which of course sums to 0V total, no change in channel fader level. When a group is pulled back it produces a negative voltage thus attenuating the VCA. When it is pushed up to boost the signal to +10dB maximum it produces a positive voltage thus providing the VCA gain. This is why you should start with the VCA group faders set to their '0' position when VCA mixing.



When using VCA groups, changing the master fader level affects all assigned faders equally (but they do not move). The example shown in Diagrams 14 & 15 show that by reducing the master fader level from 0dB to -5dB, levels in all assigned channels are reduced by that amount.



A channel can be assigned to more than one VCA group. The effect of this is demonstrated in the example in Diagram 16. Here the channel is assigned to three VCA groups. With the positions set as shown the resulting audio output is -10dB. If any fader is right down then the resulting output is always fully off. Assigning a channel to more than one VCA group can provide very sophisticated control of the mix as described later



► The Benefits of Audio and VCA Groups

You should now have an idea of the difference in operation between Audio and VCA groups. Here are some more points to consider in the operation of a VCA-equipped console:

- 1 ► VCA controls post fader levels but not the pre-fade sends – monitor mixes done from FOH pre-fade auxiliaries are not affected.
- 2 ► Muting the VCA group will remotely turn on the mutes of channels assigned to it. ALL sends from the channel will be affected. The VCA groups act as additional mute groups.
- 3 ► The VCA group affects the channel level before its pan and routing controls meaning that only one fader is needed for creating stereo and LCR groups. Creating a conventional stereo audio group requires two faders, one panned left the other right into the mix, a quick way of using up the groups on your hard pushed non-VCA console. VCA groups neither have nor need pan controls of their own.
- 4 ► When the fader level of an audio group is changed, the balance of effects (e.g. reverb) in the mix that originated from the instruments / channels in that group (via the channel aux sends) will not follow the group fader movements unless the effect is returned to only that audio group. The problem occurs when an effect unit is shared by different groups of channels, (e.g. reverb on backing vocals and strings) which is returned to the stereo mix via input channels. In this situation if the backing vocals level is lowered in the mix by bringing the group faders back 3dB or so, the level of reverb on these vocals (the 'wet' signal) will remain unaltered and will therefore be too loud in the mix. This situation does not arise if a VCA group is used because when the VCA group fader is lowered, the post-fade auxiliary send to the reverb from the backing vocal input channels is also reduced - so the balance between 'wet' and 'dry' vocal is maintained.
- 5 ► Input channels may be controlled by more than one VCA master fader (in the early days, assignment was often done by 'thumbwheel' switches, therefore multiple assignment was impossible.) This can be very useful – for example, different sections of backing musicians in a show could have their own VCA group fader, e.g. drums / percussion / keyboards & bass / rhythm guitars etc. All these sources could also be assigned to another VCA group, so the whole of the backing could be 'trimmed' for different pieces of music, while individual groups can be brought out and back into the mix as required. This overall VCA trim is referred to as a 'Backing Master'. A VCA master fader that controls the whole mix is known as a grand master.

- 6 ➤ A VCA group of input channels can be auditioned using after-fade listen (AFL) in-place - this allows the engineer to hear the balance of the group in the mix, pan pot positions are followed, so stereo imagery is heard. Not so common is the expensive facility to audition the assigned input channels using 'remote control' of the assigned input channels PFL - This can be extremely useful for checking a group of radio mics for example, before the group fader is pushed up.
- 7 ➤ Channels can be assigned to the VCA groups using hard or soft switching. The advantage of the latter is that 'snapshots' or memories of the VCA group assignments can be stored and recalled by the console's on-board computer or by an off-board controller via midi or RS232. Channels can be isolated from these changes of 'scenes' by making them 'edit safe'. This can be combined with a soft muting system so the snapshots can contain both the VCA and Mute assignments.
- 8 ➤ A VCA group and an audio subgroup can be combined when you need both level control and inserted processing. For example, you could route several backing singer channels to an audio group to insert some compression. The processed signal is returned to the main mix in the usual way. You could also assign those channels to a VCA group giving you complete level control back at the channels. This maintains the effects and multiple output balance as you adjust the VCA group fader. The audio group fader does not need to be adjusted and should be left at its 'O' open position.
- 9 ➤ The signal path is short and clean, direct to the mix. The VCA group fader simply acts as a remote controller of the inputs. It provides a more logical control of the console gain structure back where it is needed, avoiding the distortion which would result with heavily driven audio groups cut back with low fader levels.
- 10 ➤ A further benefit is the ability to filter out the fader interference and noise which would otherwise shorten the working life of the conventional audio fader.
- 11 ➤ Radio mics and monitors - in a show situation performers may be fitted with radio mics, fed to the monitor. Monitor sources are usually set pre-fade, but to avoid backstage noise being heard, they can be set post-fade. When a performer leaves the stage the fader can be pulled down - but if the engineers is riding an audio group fader rather than individual channel faders, the mic will be quiet in the house system but not in the monitors. VCA groups get around this by correctly affecting the post fade feeds to the monitors as well.

Both types of grouping are important in live mixing. We know that no audio passes through a VCA group. This means that you cannot insert signal processing into such a group. Nor can you send the group signals elsewhere such as into the matrix mix. This is where the **audio group** has its key benefits:

- 1 ➤ You can insert signal processing such as compressors or EQ into a group of signals. A common application is a bunch of backing vocal channels sharing

the same compressor where space, time, or budget do not allow one device per channel.

- 2 ➤ You can send the group of signals out of the console to be used elsewhere, for example, a sub mix for recording. Say you are recording a show on one of the popular budget 8-tracks now available. You don't have enough tracks to record every channel separately so you could record the lead sounds from the channel direct outputs and group the rest using the audio groups.
- 3 ➤ You can mix the group into the matrix when creating a different balance for special feeds such as speaker fills and broadcast. A popular application for the matrix is to provide a stereo recording feed. Here, typical of the smaller venue, boosting some of the instrument groups above the main PA mix can compensate for the necessary lack of acoustically loud backline in the PA.

The reality is that with a VCA equipped console fewer audio groups are needed as the level control function is given to the VCA groups with audio groups used only for insertion and matrix feeds. This further enhances the value of the 'dual mode' function on the ML Series where unused audio group masters can be reversed with the auxes to make better use of the controls for monitors and other aux applications.

➤ The VCA bells and whistles

Having understood how the VCA group works let's now look at the controls you would typically find in this section of the VCA console.

VCA Master Fader This is the main control. It affects the assigned channel post-fade but not pre-fade levels. Its normal 'O' position is clearly marked as a reminder of the usual starting and mix position. Some consoles provide a little LED indicator that lights when the fader is at or close to this position. The fader typically offers +10dB boost above 'O' but you should avoid boosting where possible. It is better to mix by cutting from 'O' rather than boosting. Remember that the channel VCA has a finite amount of boost available.

VCA Mute On some consoles this acts as a master fader on/off switch. On other consoles, the ML Series included, this acts as a remote control to turn all the assigned channel mute switches on. Pressing a VCA master mute turns on all associated channel mutes conveniently muting all its sends including the pre-fade monitors. If you set the master fader to 'O' you could think of the VCA mute acting as another mute group for the console.

VCA PFL/AFL Not all consoles offer this feature. At first it may seem strange to provide audio monitoring here as no audio passes through a VCA group. However, the master PFL/AFL switch simply acts as a remote control to turn on all the assigned channel PFL/AFL switches. The ML4000 and ML5000 include switching between PFL and AFL. AFL has the obvious benefit of letting the operator hear the contribution the assigned channels are making to the mix both in level and panned

image. For example you could check how the stereo drum mix fits into the full PA mix. The application of PFL is not so obvious as it mixes all the assigned channel pre-fade signals into the headphones, a potential 'mess' of sound! However, consider a 'radio mic' group. Selecting VCA PFL lets the operator quickly check signal presence and quality of all the active radios before bringing the group into the mix. It can help save the day by catching that buzzing or crackling source before going live.

➤ **Setting up VCA Groups**

It's a simple process to set up VCA groups on ML Series consoles: 1. Press EDIT GROUP (or 'ASSIGN' on ML3000) - the key flashes. 2. Press MUTE on the master group you want to edit - it flashes. 3. Press the channel MUTE keys to assign or remove them from the group. 4. Check which channels are assigned by checking the channel SAFE/EDIT led's (individual group led's on ML5000 and ML4000 channels, one led to indicate any group assignment on ML3000). 5. Press the next master to edit. Press EDIT GROUP when finished to return to exit edit mode.

Further information on assigning, checking and using VCA groups can be found in any ML Series user guide - available on www.allen-heath.com.

➤ **Snapshot Memories and Automation**

We are probably all familiar with programming channel mutes into the console memory system, great for simple recalling of different channel on/off settings according to band or scene. Level automation of an analogue console can be achieved either with motorised faders or VCAs under computer control. This feature is technically complex and costly and relegated to only the more expensive live or theatre consoles. It is beyond the scope of this article.

However, there is another aspect of snapshot memory automation on the VCA equipped console that opens up a host of new possibilities making the job of mixing easier for the operator of the more complex production. The VCA assignments could be stored and recalled from the snapshot memories meaning that which channels are affected by a group master fader can be changed on a scene by scene basis. You could assign one VCA group as 'solo' and therefore always use this fader to balance the lead sound regardless of which channel takes the solo part. Simply step through pre-programmed memories. This feature is provided on the ML Series where the channel mutes and/or VCA assignments can be stored in 128 memories. On ML5000 there is an onboard snapshot manager. The ML3000 & ML4000 use the ML Series archiver software for PC - available free from our website. Snapshot changes can also be linked to external sequencers and controllers via MIDI further automating the process. The result is sophisticated show control without costing the earth.

➤ **Do VCAs Degrade the sound?**

Audio signals in a VCA console pass through a VCA circuit even when they are not assigned to any VCA groups. Like anything else in the signal path, the VCA

devices do colour the sound to some extent, though modern high-quality parts certainly have negligible effect compared to the early designs which tended to suffer from thermal tracking problems and restricted dynamic range. It is worth remembering that using audio groups means routing a signal through the group circuitry which will also colour the sound to some degree. Audio group faders can also become noisy with wear and tear. The Allen & Heath ML series use the latest industry standard VCA devices. These components were selected following extensive listening tests and were chosen for their proven audio quality.

➤ **VCA for the real world**

Why has Allen & Heath entered the VCA mixer arena? By introducing a VCA range we are seeking to bring previously exclusive technology to as wide a customer base as possible. We have wanted to do this for many years, but we have had to wait patiently until the rising quality and falling costs of VCA devices made it possible to build VCA mixers at a price that our customers can justify paying. Our experience with VCAs began in the early 1980s when we were asked to retrofit them to a number of Syncon and Sigma recording consoles. Our first off-the-shelf VCA desk was the GS3V, a project studio mixer which we began producing in 1991.

Back in the mid-nineties, when we began working on the live VCA range concept that was to become the ML series, we quickly concluded that we did not want to simply add VCAs to an existing design. Each aspect of a console's feature set interacts with every other aspect, so by introducing VCAs into the equation, we had to re-evaluate all the other features in order to come up with a rounded package. We really wanted to keep the group/aux swapping feature that users have found so useful in the GL series. The essence of this concept is that by swapping one or more aux masters on to group master controls, the engineer can get benefits such as full 100mm faders, mutes and inserts for their aux mixes. This is ideal in flexible rental or installation applications where a single desk might be used for front-of-house, monitoring or combined roles. We quickly found that this asset was even more useful in a VCA mixer, as the VCA groups usually allow the engineer to use fewer audio groups, so more auxes can be swapped to the group masters. If there is one thing that customers on real world budgets hate, it is paying for functions that they are not using. The more benefit they can get from the available controls the better.

The ML5000 was the first in the series and made its debut at PLASA 1999. Since then we have continued to design consoles that make VCAs available at ever lower price points, resulting in the ML4000 followed by the ML3000. The ML3000 is a particularly exciting product for us, as it is bringing VCAs and LCRplus to users such as community theatres, small churches and music bars for the first time. Speaking to engineers working in these venues, it is very clear that they are just as passionate about their work as the people behind the faders on stadium tours, and we believe that they have the knowledge and the desire to embrace the technologies that we want to offer them.

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AP4810

VCA Mixing Consoles:

ML5000

- 32/40/48 channels
- 4 stereo channels
- 16 aux sends
- 8 VCA groups
- 8 Audio groups
- Onboard VCA/mute automation
- 24 channel sidecar expansion

ML4000

- 24/32/40/48 channels
- 2 stereo channels
- 12 aux sends
- 8 VCA groups
- 8 Audio groups
- Programmable VCA/mute automation
- 24 channel sidecar expansion

ML3000

- 24/32/40 channels
- 2 stereo channels
- 8 aux sends
- 8 VCA groups
- 4 Audio groups
- Programmable VCA/mute automation
- Links to other MLs

