



Video Storm LLC



Understanding Volume control on CMX-A2

Video Storm CMX-A2 DSP audio switches have extensive volume control features. This app note is intended to help explain both how the volume control functions and how to use it in your project.

Audio tone control (bass/treble/etc) and audio delay (lip sync correction) are not covered in this paper.

Understanding input volume on line level audio

CMX-A2 is a digital audio processor, so the first step in the volume control process is to digitize incoming analog audio and map it to the internal dynamic range. The analog peak-peak input range of CMX-A2 is 5.6V, so the conversion function is:

$$\text{Internal 24b code} = (\text{Analog_voltage}/5.6) * 2^{24}$$

There are two important points here:

1. Any voltages above 5.6V will be clipped. However, audio gear should never output levels this high (4.25V is typical maximum).
2. The internal digital level is scaled based on the assumption that your input reference level is around ~5V max. If your input level is lower you can use the input gain feature to correct for this.

For digital inputs, this process is simpler. Incoming PCM audio is mapped as follows:

- 24b PCM inputs map directly to the internal 24b dynamic range
- Lower resolution PCM inputs are automatically zero extended to the internal 24b dynamic range

To correct for input signals that are too weak, you can use the input gain feature. The gain for each input is a value between 0-255, normally set to 128.

Input gain is applied as: $\text{Corrected_gain} = \text{input} * (\text{setting}-128)/2$

Since input gain is usually only used to gain up a weak signal, you will always use settings greater than 128. However, it is very important to only use this on inputs that are weak (analog signal levels < 5Vpp, or digital levels below reference). If you apply positive gain to full scale signals you will get clipping (very obvious distortion).

Input gain is automatically saved in flash so it only needs to be set once.

Understanding output volume on line level audio

Output volume is applied to the digital signal before it goes either to the DAC (analog) or the SPDIF transmitter (digital). The volume setting is a value 0-255, with 192 being 0 dB (nominal). Each step above 192 adds 0.2 dB, while each step below 192 subtracts 0.2 dB.

This resolution provides for very fine logarithmic volume adjustment. CMX-A2 also features adjustable internal level ramping which smoothly applies all gain changes for the best customer experience.

If your inputs are full range (or adjusted to full range via input gain), you will never use volume settings much above 192. Once again, this is to avoid clipping the signal.

In Control4, our driver maps code 200 to the 100% volume level and code 0 to the 0% volume level. This effectively gives you +0.4dB to -96dB in 0.4dB steps. Depending on the rating of your power amps and speakers, this may not be ideal. Adjust the MAX_GAIN and MIN_GAIN settings in the properties tab of the driver to achieve the best range and resolution.

Analog audio DAC

The DACs (digital to analog converters) have a full scale range of 4.25 Vpp. The conversion function from internal digital signal to analog is:

$\text{Analog_voltage} = 4.25 * (24\text{b_digital_code}) / (2^{24})$

Since our output range is a little lower than the input range, there is an effective -2.4 dB difference in analog voltages passed through the switch. If this is undesirable in your system, just use volume code 220 for your nominal instead of 192.

You may also notice a difference between the nominal volume levels between the analog and digital inputs/outputs. This is unavoidable because different source equipment uses different digital reference levels. However, this can easily be tuned out using our input gain settings.

Netplay audio

Volume control for audio received via streamed connections is handled based on your audio configuration. There are two volume control options available:

1. Network audio volume controls handled as input volume (default)
2. Network audio volume controls forwarded to output volume settings

Network volume as input volume

In the default mode, the volume slider controls on your mobile device are applied to the network stream BEFORE being sent to the matrix switch.

Additionally, the output volume of the switch is automatically set to the configured full scale default (normally 192) and un-muted when the network connection is started. The prior volume level and mute state are also automatically restored to each affected output when the network stream is ended.

The result is that each output zone volume will be controlled directly from the mobile device while streaming is active. You can still use your control system to adjust output volume as well, but remember that this will not change the setting on the mobile device. Final volume is input volume (controlled by mobile) plus output volume (controlled by C4). Generally it is better to not use the C4 volume much in network streaming mode just to avoid confusion.

Full volume on the mobile device is treated at input volume = 0db. Anything less than full volume will attenuate the input. This is why NetPlay automatically sets the output volume to full scale (0db) in this mode (this gives the mobile device the full range of control).

The mobile devices automatically remember the last volume setting used for each virtual speaker, so after the initial adjustment you should not have problems with unintentionally setting the volume to max.

If you are not using the CMX-A2 as the volume endpoint in some or all zones, you will need to add Director code to the `networkevent_ncon_x` and `networkevent_ndcn_x` events. The `networkevent_ncon_x` should un-mute and set the volume to max. The `networkevent_ndcn_x` should turn off that zone (disconnect command). This is not necessary for all outputs where CMX is the volume endpoint, since NetPlay will do this automatically.

Network volume as output volume

Forwarding the network volume to the output volume controls is an optional mode you can use if your customer prefers to use C4 volume controls even when streaming from their mobile device.

When this mode is enabled, the volume is adjusted as follows:

When a new connection is made:

1. The output volume for all connected zones is set to $\text{zone_default} * \text{mobile_vol}$ if mobile_vol is 50% and zone default is 90, then effective default is 45
2. All connected zones are unmated
3. Further volume updates from mobile will repeat step 1. Otherwise volume is controlled normally via C4 devices
4. This allows C4 devices to always see the final volume applied to each room

When disconnected:

1. Volume and mute state are restored to prior states (before connect)

If one or more zones does not use CMX as the volume endpoint, then you must enable the “bypass volume” option for that zone. This will always pass the audio as 0 dB to that output while still updating the drivers volume properties with the calculated volume above. This allows you to use Director code on the Volume_changed event to tie the actual endpoint volume to the mobile volume (reported by the driver).