Panasonic

AG-DVX200
TECH BRIEF

VLOG-L Based Production

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4K PROFESSIONAL

Using VLOG-L Mode

The DVX200 includes a logarithmic gamma mode, called VLOG-L. It is, in fact, the same VLOG gamma as employed in their premium VariCam 35, but adapted to the 12-stop sensor used in the DVX200. Using VLOG-L gives the user the most power over the image for post-processing and grading.

A logarithmic gamma is a different way of storing the raw sensor's brightness information; it isn't magic, but it is a more post-production-friendly storage method that provides for preservation of the maximum latitude and dynamic range, while also providing more flexibility in adjusting brightness levels in post while minimizing the prospect of "banding" in the shadow areas (the darker areas of your images). VLOG-L is not just a gamma, it is a "mode" — in the Scene File menus, you'll see it referred to as "VLOG-L Mode," not "VLOG-L Gamma." As you look through the Scene File menu, you'll see that when you enable VLOG-L mode, almost every other function in the Scene File menu becomes disabled. In VLOG-L mode the camera bypasses all that internal processing, and delivers an image that is as close to the raw sensor image as this camera can get.

Logarithmic gammas provide for more power in post, but it is incumbent upon you, the user, to process the logarithmic image into properly viewable footage. Raw camera sensor images undergo a lot of image processing before they can be said to look pleasing. The raw data off of a camera sensor needs to be de-Bayered (or "demosaicked"), it needs to be gamma-corrected from raw linear sensor data into a monitor-friendly gamma, it will need to be graded for pleasing contrast and tone, it will need noise reduction applied to it, and it will need sharpening, and it will usually need to be converted into a video-compliant format (meeting the EBU and/or ATSC specifications for UHD or HDTV). All that processing needs to happen to the signal, one way or the other. When VLOG-L Mode is turned off, the camera supplies all that processing. When VLOG-L is turned on, the camera does a bare minimum of that processing; the camera will de-Bayer the footage, convert the linear brightness data into the VLOG-L logarithmic gamma, and it will store the footage in an EBU/ATSC compliant format (8-bit 4:2:0 for recording, 8-bit 4:2:2 for output, or 10-bit 4:2:2 for output). The images will be recorded or output in a format suitable for grading, but that's where the hard work starts. You can bypass (almost) all the camera's internal processing, but you will have to replace it with post-processing.

In some ways it's much easier to shoot in VLOG-L than it is to use the camera's Scene File menu system. For one thing, you can bypass learning about what all those various Scene File menu items do, because VLOG-L disables them all! It really does mean that the job of "painting" the image is not needed on set; all painting of the image gets delayed to post-processing. When shooting in VLOG-L, pretty much all you need to do is get a proper white balance, and get proper exposure, and then shoot. However, there's far more to imagemaking than just shooting — if you were to hand an average client VLOG-L footage, without grading, they would probably be very disappointed in it. The footage needs extensive processing before it is ready for viewing, and professional colorists can charge several hundred dollars per hour to work on footage. Using VLOG-L doesn't mean less

work overall, it just delays when that work needs to be done, and shifts the burden from the camera operator (or Digital Imaging Technician) over to the editor or colorist. As such, VLOG-L is probably most suitable for shooting cinema, drama, music videos, and other types of footage where extensive post-processing, color correction, and "stylized" video are the expected final result. However, I would suggest that VLOG-L would not be a wise choice for any scenario where heavy and extensive post-production is not expected or is not the norm. For example, I would say that VLOG-L would probably be the wrong choice when shooting sports, live events, concerts, conventions, news, any live broadcast, or any scenario where you are expected to turn over the unedited master footage to the client. Furthermore, when a job requires a rapid turnaround from shooting to delivery, VLOG-L may not be the right choice in that scenario; post-processing takes time. If someone was filming a wedding and expected to deliver a same-day edit, shooting in VLOG-L may be problematic in that the post-processing rendering process might slow down your ability to deliver finished footage.

Post-Production Processing

There are several crucial aspects of image processing that are necessary to turn raw (or VLOG-L Mode) footage into pleasing, monitor-ready final images. You do need to color-correct, and to gamma-correct (usually by applying an S-curve to make the images really "pop" on the monitor), but post-processing is not strictly about color and contrast! Sensor images have always needed noise reduction applied, and the DVX200 is no exception. The DVX200 does noise reduction internally when it is normally processing footage, and includes several menu options for controlling sharpening and noise, but those processes are bypassed when recording VLOG-L. If you are bypassing the internal processing by using VLOG-L mode, you should expect to do noise reduction on the recorded VLOG-L footage or the footage may look noisy, especially in the darker shadows and lower midtones. Likewise, video footage generally benefits enormously from some manner of sharpening. The DVX200 provides options for sharpening the footage, including the Detail and Coring controls. If you bypass that processing by using VLOG-L, then you're going to need to apply some sharpening in your post-production phase or, the footage may look "soft." The DVX200 resolves extremely high detail, but video needs some degree of edge enhancement (sharpening) to really make that resolved detail apparent to the viewer.

Exposing For VLOG-L

Exposing for VLOG-L is somewhat different than exposing using normal video gamma curves. Most video camera gamma curves are designed to replicate what-you-see-is-what-you-get when the footage is displayed on a video monitor. That's convenient, but there are sacrifices made in the amount of dynamic range that can be preserved when using a conventional video gamma. Furthermore, video gammas are more linear in design, and that means that more "bits" are allocated to storing the brightest stops, than are allocated to store the darkest stops. This can result in mushy shadows, and noise and banding in the shadows if you try to brighten them in post. With VLOG-L, the bits are allocated more evenly, with approximately the same number of shades of gray allocated to each of the midtone and highlight stops; and while the darkest stops do have fewer shades of gray than the midtones might, they generally have significantly more than in a conventional video gamma.

This re-allocation of bits means that VLOG-L is suitable for recording, but it is not all that suitable for viewing. It simply doesn't look "right" when displayed on a video monitor; it looks very flat and muted. As mentioned before, VLOG-L requires post-processing to convert it into something that will look suitable on a computer monitor or television.

Unlike the video gamma curves in the DVX200, VLOG-L is designed to mimic the characteristics of a film negative that has been scanned digitally. It is not designed for monitoring and exposure, it's designed to provide a broad, flat scene that can be manipulated in post production. You can use the camera's LOG VIEW ASSIST feature to preview what your footage might look like after it's been post-processed, and that might help you with setting exposure, but it's not necessarily an ideal solution because the LOG VIEW ASSIST applies typical video gamma and color to the VLOG footage; that may or may not be representative of how you intend to grade the footage when you get into postproduction. It should be thought of as a reasonable preview, but should not be relied on exclusively because you may make very different choices when grading the footage. The camera doesn't provide any way to use alternative Look Up Tables (LUTs), but if you're using an external monitor such as the Convergent Design Odyssey 7Q+ or something comparable, those monitors frequently have the ability to apply LUTs and some even allow loading in user-created LUTs. If you know the LUT you're going to be using in post, loading that into your monitor can make for a much more pleasant viewing experience during production.

You can (and should) use the zebras and the waveform monitor and the histogram as exposure tools for VLOG-L, but you have to use them differently than you would for a video gamma. The levels that you may be familiar with (such as 70% IRE for skin tones, and 100% IRE for highlights) simply aren't appropriate for use with VLOG-L; you'll have to adapt and learn to use new levels when judging the exposure of your footage.

With VLOG-L, the brightest clipped highlights will display on the zebras and on the waveform at about 80 IRE. Period. Nothing brighter than about 81 IRE will ever be displayed — even if you opened up the iris and pointed the camera at the sun, it will still never register more than 81 IRE. There's nothing wrong, and you're not "missing out" on any dynamic range; this is just the nature of the VLOG-L curve. VLOG was originally designed for the VariCam, which features over 15+ stops of dynamic range. VLOG-L maps the shadows and midtones identically to VLOG, up to the 12-stop limit at 80 IRE. VLOG's range from 80 to 109 IRE is used in full VLOG for the additional highlight stops that the VariCam's sensor can generate (stops 13, 14, and 15). Because the DVX200's sensor is capable of only 12 stops, it employs VLOG-L, which has a maximum brightness level of 80 IRE.

While that may sound limiting, it actually gives you access to using the same LUTs that the VariCam can use, and the distribution of shades of gray is the same in VLOG-L as it is in the full-fledged VLOG. You just need to understand the levels and the limits to keep your exposure within the range that the sensor can resolve. And what it really means is, you can't go exposing skin tones at 70 IRE, or middle gray at 55 IRE; those levels need to be much lower when using VLOG-L.

There are two general schools of thought when exposing raw footage or logarithmic gamma footage: exposing for middle gray, or Expose To The Right (ETTR). Let's discuss ETTR first.

Exposing To The Right (ETTR)

Exposing To The Right is a technique based on using a histogram for exposure. A histogram shows the distribution of brightness in the image, and the further the image is shifted towards the highlights, the further right the image moves on the histogram. Proponents of the "Expose To The Right" technique argue that the darker tones and shadows are the noisiest parts of the image, so if you can lift your image up out of the shadow area, you can take advantage of the cleaner upper range of the sensor and gamma curve; later, you can drop the footage's levels back down to where proper exposure would dictate it should be. Furthermore, those who shoot raw footage frequently embrace ETTR because raw sensor data is stored linearly, not logarithmically; that means that the vast majority of available "bits" are allocated to the brightest stops, and the darkest stops receive the fewest "bits" (i.e., the least number of shades of gray that they can represent). This is indeed a concern with raw footage, but is not nearly as much of a concern when using a logarithmic gamma; a LOG gamma redistributes the bits so that they are more equally dispersed along the entire dynamic range of the sensor. As such, the value of lifting the shadows and dark tones up is less important when recording with a logarithmic curve than it would be with raw footage.

The general idea behind ETTR is to expose the image as bright as you possibly can, so long as none of the video information "clips" off the top. Regardless of how dark an image should look in the final footage, the idea is that if you expose it in the top part of the exposure range, you'll get the cleanest, lowest-noise images, and you can always push it back down to proper exposure in post. ETTR proponents use the histogram as an exposure tool to accomplish this, because the histogram plots out all the exposure levels in a given scene, and if there is any unused space on the right edge of the histogram, that means that you have room to brighten up the exposure (which will shift the histogram's graph over to the right within its frame; hence Expose To The Right). In theory, it sounds great; on still photographs, it can work great. On VLOG-L, it doesn't quite work that easily, because of the maximum 80 IRE brightness imposed by the VLOG-L curve. It means that you can never truly get the image "to the right." You can still use the ETTR technique, but you would want to use the zebras set at no higher than 80 IRE to warn you when the image was clipping. If you set your zebras at 80 IRE, you are free to expose up until the zebras appear. Anywhere that the zebras are displayed, you've clipped the image and would need to back off your exposure. Do be aware though that at higher exposure levels, even though the luminance may not have clipped yet, an individual color channel may begin clipping before the zebras display. As such, you might want to back off a little more (by setting the zebras no higher than 75 IRE), to leave a little room to minimize any clipping of chroma channels.

Now, as a general technique there's nothing wrong with ETTR, it does work and it is a reasonable choice. However, it is not necessarily the best choice, because ETTR is designed to preserve the highlights with no consideration of what happens to the midtones. It can result in retaining a lot of detail and in making the least-noisy footage, but it will mandate extensive post-production correction

on every single shot. When exposing using ETTR, skin tones may end up being recorded brighter or darker in every scene, simply based on where the highlights happen to be in that particular shot, and every shot will need to be corrected to bring the skin tones back to a reasonably consistent level so that your footage will intercut cleanly and seamlessly. And, depending on just how bright the highlights are in any given scene, ETTR may result in a scenario where the skin tones and midtones are significantly underexposed in an effort to catch and preserve all the highlights. That might make for nice highlights but it might also result in noisy skin tones and midtones, since in post production you may have to stretch the skin tones up out of the darker (and noisier) sections of the sensor. Generally, cinematography is (and should be) more about the subject than it should be about the highlights; excessive attention to the highlights may mean compromising other aspects of the footage, so a strict "ETTR" approach is not always going to provide the overall best results in a video project.

Exposing For Middle Gray

An alternative method of exposure would be to expose for middle gray. Video systems are frequently referencing "middle gray" or "18% gray." 18% gray is a photographic and film standard, it's a shade of gray that reflects 18% of the light that hits it. It is frequently incorporated into test charts, and you can easily buy an "18% gray card" at photography stores. 18% reflectiveness represents approximately the average overall brightness of many scenes, and camera autoexposure systems are typically designed to expose to where the scene represents approximately 18% reflectance levels. In Ansel Adams' "Zone System", middle gray is known as Zone V.

When exposing for middle gray, you'll find the zebras and the waveform monitor vastly more useful than the histogram. In this section I'll refer to exposure levels in terms of IRE levels.

In conventional video gammas, middle gray is usually exposed properly at somewhere around 50 to 55 IRE. However, not so in VLOG-L. In VLOG-L, middle gray is properly exposed at 42 IRE. If you happen to have a gray card in your scene, it should show up on your waveform monitor at approximately 42 IRE for "proper" exposure (note, here I am using the term "proper" in an idealized, mathematical way; the artistic merits of the scene may very well dictate that the exposure needs to be higher or lower than this).

The VLOG-L gamma curve maps the following brightness levels to the following IRE levels:

0% reflectance (black):	7.3 IRE
18% reflectance (middle gray):	42 IRE
90% reflectance (white):	61 IRE
absolute clipped superwhite:	80 IRE

If you are using test charts, you will likely have access to 18% "middle gray" and 90% "white"; many gray cards sold in photographic stores will have 18% gray on one site, and 90% white on the other. 90% reflectance doesn't necessarily indicate "pure white" or the brightest object that can be seen or recorded; rather it is (as its name suggests) a white where 90% of the light that hits it is reflected. The

camera is capable of seeing and rendering brightness above 90% reflectance, as illustrated by the fact that 90% reflectance is mapped to 61 IRE, but in VLOG-L the camera can resolve up to 80 IRE. That translates into approximately 1.5 stops of exposure latitude above 90% reflectance before reaching maximum clip.

In VLOG-L, the curve is laid out so that there are 8 stops below middle gray, and 4 stops above middle gray. You can, of course, choose to modify that by underexposing middle gray some; if you underexpose by one stop, you'll then have 7 stops below middle gray and 5 stops above it. In all cases you'll get 12 stops of dynamic range; the recommended allocation is for middle gray to be at 42 IRE with 8 stops below and 4 stops above, but you can shift that on an as-needed basis, so long as you account for it in post. This is one reason why it is such an excellent idea to shoot a standardized test chart at the head of every scene, so the colorist knows exactly what the intended exposure was and can account for any individualized decisions that were made on a scene-to-scene basis.

The technique of exposing towards middle gray is similar to conventional video gamma exposure, where you frequently will have some typical "anchor points" in your exposure plan (such as having Caucasian skin highlights peak at about 70 IRE on a standard video gamma, and keeping your highlights at or below 100 IRE). Keeping skin tones comparable shot-to-shot makes matching footage easier in post, obviously; keeping middle gray levels constant will make matching VLOG-L footage easier in post too.

Exposing for a logarithmic gamma isn't necessarily as simple as putting an 18% gray card in the scene and exposing it for 42 IRE. It can be that simple, if you want it to be, but there are steps you can take to perhaps improve the images the camera generates. The question is usually one of balancing noise versus retaining highlights. As with all digital camera sensors, the darkest regions of the image are typically the areas that show the most noise. Exposing To The Right is a technique designed to lift the image up out of the noisy area and have it render in the "sweet spot" of the sensor's exposure range, which you can then drop down to proper exposure in post-production while avoiding some of the sensor noise. And that's a valid technique, but it does sacrifice some of the sensor's dynamic range (dropping the footage back down crushes off the darkest tones), and it can result in highly inconsistent midtones from shot to shot. When you overexpose the image, you also run the risk of clipping the highlights earlier. When you properly expose the image, you may maintain the highlights but you may also encounter some noise in the shadows. If you are filming a scene where there are a lot of very bright highlights, you may actually need to underexpose the scene to preserve those highlights, even if it means pushing your subject down into the noisier darker sections of the sensor's range. Or, you may just have to bite the bullet and accept that sometimes highlights clip and there's nothing you can do about it — or, rather, there may be nothing that you should do about it; compromising the quality of the main subject in a quest for preserving highlights may not be an acceptable tradeoff in some cases.

There is no one overall "right" answer, there is only a question of your priorities — if you cannot stand clipped highlights under any circumstances, maybe you should use ETTR, understanding that in the quest to preserve every bit of highlight detail you might end up underexposing the image, resulting

in noisier images. If you cannot abide noise at all, maybe you should consider establishing a "noise floor," an IRE level which you will not allow the important elements of your image to fall into. Perhaps you find the range from 0 to 15 IRE too noisy for your tastes, so you may choose to overexpose your images so that the darkest significant details in the image are at least 15 IRE or brighter. Such overexposure may possibly result in clipped highlights, and will certainly lead to reduced dynamic range, but perhaps that's the tradeoff you're willing to make for minimizing any appearance of image noise. In general, I advise against overexposing VLOG-L when it can be avoided; the asymmetrical nature of the curve (8 stops below, 4 stops above middle gray) mean that overexposing will shift that balance even further; if one were to overexpose by two stops, they'd have a curve with 10 stops below middle gray and only two stops above! My advice is to expose middle gray at 42 IRE whenever possible.

Using The Zebras And Waveform Monitor With VLOG-L

Placing middle gray at 42 IRE, 90% white at 61 IRE, and black at 7 IRE gives a wide exposure range that allows for 4 stops of exposure over middle gray, and 8 stops under middle gray. Using these general exposure levels, you'll find that properly-exposed highlights on skin tones will usually range between about 42 IRE for dark-skinned subjects up to a maximum of about 55 IRE for light-skinned subjects. When shooting in REC 709 gamma, I'm used to setting my zebras at 70 and 100; I would expose for there to be just a little bit of 70-IRE zebras on the brightest highlights on Caucasian skin tones; then I would swap over to Zebra 2 (set to 100 IRE) to check for highlight clipping. At 100 IRE, that would show areas that were approaching clipping, without necessarily meaning that they were indeed clipping. Modifying this approach for VLOG-L, I now set Zebra 1 at 55 IRE, and Zebra 2 at 75 IRE. In this way I can use the same monitoring tools that I'm used to, in the same way I'm used to, but gain the wider latitude and post flexibility of VLOG-L.

Using the waveform monitor is slightly more challenging with VLOG-L; you have to get used to the idea that nothing, ever, will appear at about 81 IRE or above. The waveform monitor won't look as "full" as it does when shooting traditional video gammas. This is not representative of a loss of dynamic range; in fact, when in VLOG-L mode, you'll be getting more dynamic range than you can get in any other gamma curve — regardless of how the waveform monitor or histogram look. The full range of the DVX200's sensor is always being used, and is being accounted for in VLOG-L. At 100% full saturation of the sensor, VLOG-L maps that image data up to 80 IRE. Therefore, when looking at the waveform monitor, when in VLOG-L mode, you'll never see the waveform display anything at 81 or above. And if you have your zebras higher than 80, they will never trigger. And this is also why the histogram doesn't occupy the full range to the right, and why overexposed/clipping images will clip at about the 80% point in the histogram, rather than at the far right edge (like they would if you were recording in a normal video gamma).

You need to know this so you don't go assuming that your images are underexposed; failure to observe this will likely result in you grossly overexposing your VLOG-L images. Remember the target levels given earlier in this article: middle gray should be at about 42 IRE, and 90% white should be at 61 IRE. If your scene is lit and exposed so that you're hitting those levels on your waveform monitor (or

zebras), then your scene is being fully and properly exposed. If you want to double-check, you can use the LOG VIEW ASSIST user button; it will preview a basic Rec.709 LUT onto the image, and you'll instantly see the full range expressed on the waveform monitor and/or histogram. Trust the exposure levels that are given in this article, and you'll be properly exposing your images and gaining the full benefit of the 12 stops of dynamic range that the DVX200 can deliver.

A Word About LUTs

Look Up Tables (LUTs) are used in color grading to tell the monitor how to transform logarithmically-encoded footage into properly-viewable footage. LUTs have become commonplace; many nonlinear editors and coloring suites support the use of LUTs, and many external monitors and recorders also support loading and displaying LUTs. Having an accurate LUT in your monitor can help to get a better feel for how your footage will actually look when graded.

A LUT transforms a certain input, into a certain output. It looks up the input color and gamma, and transforms it into an output color and gamma. For any fixed given input, there will be a fixed given output. This much should seem obvious, but where one can run into trouble is in not understanding that different cameras will output different color data from their sensors. That means the LUT will be receiving different input, and will be transforming it into different output! It seems obvious when you think about it, but sometimes people don't think about it, and end up getting themselves in a little bit of trouble in post. The key point to understand here is that if you want to use a LUT with your DVX200, it ideally should be a LUT that was engineered and designed to work with DVX200 footage. Even though the Varicam and GH4 both also use VLOG-L, their sensors won't output identical images to a DVX200, and as such, differences in the sensor output will mean differences in the final image. Just because both cameras use VLOG-L, and can share LUTs, that doesn't mean that they will create identical images. You may still have to do some adjustment to get them to match in post..

That doesn't mean you're restricted to only using DVX200-designed LUTs; you can use anything you want, you can try a variety and see what you prefer, you can mix and match to your heart's content -- so long as you understand that you're making an artistic choice at that point, and not necessarily a "correct" choice (as far as resulting in accurate color and accurate tones). For the most accurate color and the most accurate tones, you'd ideally want to use a LUT that was designed specifically for the DVX200 to produce accurate color and tone.

Several external monitors and recorders have integrated LUT capability. I've used the Sound Devices PIX-E5H and Convergent Design Odyssey 7Q+; both have built-in "Panasonic 709" LUTs, but those LUTs are not accurate for the DVX200. Panasonic offers a downloadable V709 LUT for the DVX200 which is actually the Varicam LUT, designed to render a stylized V709 color palette. V709 is not the same as Rec 709; it's not standardized color, it's a stylized color palette used on the Varicam called V709. While Panasonic's own LUT is not specifically optimized for the DVX200, it will get the footage close to being correct; it just will need some adjusting in post after applying the LUT.

10-Bit vs. 8-Bit Recording

The DVX200's internal recordings are all done at 8-bit quantizing and 4:2:0 color sampling. These recordings may be perfectly suitable for many purposes and jobs, but 8-bit is not as robust as 10-bit, and 4:2:0 is not as robust as 4:2:2 or 4:4:4 color sampling (obviously).

When working with VLOG-L, you'll likely be stretching and pushing the footage quite a bit. You can achieve better results by using 10-bit 4:2:2 external recording, than you would from the camera's internal 8-bit 4:2:0 recording. It's not that you can't work with 8-bit 4:2:0, it's just that -- well, 10-bit 4:2:2 is better. The further you push the footage, the more 10-bit and 4:2:2 will hold up as compared to 8-bit and 4:2:0. Having a fuller, more robust recording to work with gives you more leeway to push and stretch the footage in post. If you utilize an external 10-bit 4:2:2 recorder, you may gain a signficant advantage in recording fidelity; but only you can determine if the increase is worth the cost, data management, and equipment management that using an additional recorder would involve.

Summary

VLOG-L gives the widest dynamic range and the most post-production flexibility from a DVX200. If your project can afford the time to conduct the proper post-processing required, VLOG-L gives you the broadest canvas on which to paint your images. Exposing properly for VLOG-L is the key to getting the best results; aim to expose an 18% gray card at about 42 IRE, keep your Caucasian skin highlights to below 55 IRE, and set your Zebra 2 to 75 IRE to keep from clipping highlights.

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