

"Best Practices" Guide to Digital Cinematography using Panasonic Professional HD Cameras

*A quick reference guide to understanding and utilizing
the powerful tool sets offered by the latest cameras.*



P2HD when it counts

Panasonic
ideas for life

Introduction

When writing a “Best Practices” guide for something as vast in scope, and as subjective in interpretation as Digital Cinematography, it is impossible not to begin by stating the obvious. If you gave three identical lights to ten different cinematographers armed with the same scene from the same script, you are almost guaranteed to get ten completely different looking scenes. Does this make a “Best Practices” guide an oxymoron?

Not quite. You see, in order to “break the rules”, one has to have knowledge of what the rules are to begin with. When cinematographers gain a strong understanding of the functionality and purpose of each digital tool, they can then make creative decisions to follow, ignore, or come up with their own rules.

It is with this spirit in mind that this paper is written. This paper will attempt to bridge the gap between the tools created at a factory in Japan, and the cinematographers tasked with utilizing them in a creative manner. In this paper, when a certain practice is encouraged, and another discouraged, it is mostly based on achieving the highest quality output from the camera, as designed by its manufacturer. Naturally, whether this is desirable or not, will be something for each cinematographer to decide.

The format of this paper will be to pose commonly asked questions, and answer them in a concise but informative fashion. This paper also includes a “Quick Answers” summary of this discussion at the end for quick reference in the field.

Alright, let’s get started!

Which codec should I choose?

AVC-Intra 100 or DVCPRO HD? What about AVC-Intra 50?

With the advent of P2 technology, cinematographers using Panasonic P2 Professional Cameras now have a choice to make as to which codec to use for their production. In the days of the AJ-HDC27H tape-based VariCam there was no such decision to be made. The camera would always shoot in DVCPRO HD to DVCPRO HD tapes in 720p60. Since the P2 Cards themselves are format and frame rate agnostic, they are no longer bound by the same constants that plague a tape-based system, as such, they allow the acquisition of High Definition and Standard Definition video, at a whole variety of frame rates, onto a single card. What you can and cannot record is now defined by the camera model you are shooting rather than the recording media itself.

The question now is, if your camera offers you the ability to record in AVC-Intra 100, AVC-Intra 50 and DVCPRO HD, which one should you choose. To answer this, let's compare the specifications of each codec that directly affect a cinematographers work.

	AVC-Intra 100	AVC-Intra 50	DVCPRO HD
Bit Depth	10 bit	10 bit	8 bit
Bit Rate	100 Mb/s	50 Mb/s	100 Mb/s
Pixel Aspect Ratio	Square <i>Full 1920x1080 (in 1080p)</i>	Rectangular (Anamorphic) <i>1440x1080 (in 1080p)</i>	Rectangular (Anamorphic) <i>1280x1080 (in 1080i)</i>
Color Subsampling	4:2:2	4:2:0	4:2:2

Looking at the chart above allows us to draw our first conclusions. If image quality is the most important deciding factor in choosing your codec, then AVC-Intra 100 is the hands-down winner. With a full 10 bit record, at Full Raster (1920x1080) in 1080 mode, and a 4:2:2 Color Subsample, there just isn't a higher quality codec available in the Panasonic line of professional video cameras (as of the writing of this paper). For those shooting for quality, the only issue remaining to consider is Post Production. All of the major modern Non-Linear Editing Systems (AVID, Final Cut Pro, GrassValley, Harris, Quantel) can currently handle the AVC-Intra 100 codec in some form or another. If however, your post-production facility is running on older legacy systems, or on a currently unsupported system, you will need to investigate whether transcoding from AVC-Intra 100 to a codec the facility can handle, is available, or if some sort of base-band solution is available. If neither of these seem to be an option (which should be the exception, rather than the rule), you might have to look into shooting in DVCPRO HD, as it is very widely accepted.

If AVC-Intra 100 is so much better than the two other alternatives, why even make them available?

There are many applications where image quality is not the most important consideration. For network news, reality television, and some long-form documentaries, content is king, and acquiring that content in the most efficient way usually trumps image quality as a primordial concern. As the following chart demonstrates, giving up the Full Raster Recording, along with a bit of Color information, will allow you to achieve extended record times and lower your storage and bandwidth requirements.

Recording Time on P2 Cards: When one 32 GB card is used:

IMAGE SYSTEM	Recording method and Recording time		
	AVC-Intra 100	AVC-Intra 50	DVCPRO HD
1080/59.94i/50i	Approx. 32 min	Approx. 64 min	Approx. 32 min
1080/30PN/25PN (Native)	Approx. 32 min	Approx. 64 min	
1080/24PN (Native)	Approx. 40 min	Approx. 80 min	

This chart demonstrates that by foregoing the Full Raster Recording ability of AVC-Intra 100, as well as dropping down to a 4:2:0 Color Subsample, AVC-Intra 50 is able to provide you with DOUBLE the record capabilities of both AVC-Intra 100 and DVCPRO HD. For the applications described above (news, reality, etc...) the mastering quality level of AVC-Intra 100 is more than is needed to accomplish the work, and the extended record benefits outweigh the loss in image quality. It is important to note, that while you achieve an immediate doubling of your record time in the field onto P2 Cards, there is also a great gain when you get to post production. AVC-Intra 50 not only requires less storage space, but more importantly, it requires less infrastructure. A network built to handle DVCPRO50 standard definition footage, can now use its existing infrastructure to handle High Definition material in the same bandwidth (50 Mb/s).

ANSWER SUMMARY: If QUALITY is the defining factor, always shoot in AVC-Intra 100, as long as your Post Production facility is equipped to handle that codec. If CONTENT is more important, and achieving extended record times and bandwidth efficiencies rank higher than absolute picture quality, then AVC-Intra 50 should be explored. DVCPRO HD is a good option for those unable to shoot in the AVC-Intra Codec because of legacy post production issues, but it is an 8 bit Codec, which is inferior to AVC-Intra 100's 10 bit Mastering Quality Codec.

What do the various GAMMA MODES represent?

What’s the difference between HD, FILMLIKE, VIDEO-REC and FILM-REC?

It is helpful to think of the various GAMMA MODES in the camera as film stocks. If you were going to shoot a project on film, you could assemble a variety of film stocks from several manufacturers, study their characteristic curves (usually printed right on the box) and determine which one would record with higher contrast, and which one would lead to a slightly lower contrast look. These determinations are made by looking at how the stock responds to varying degrees of exposure to light. The same holds true for GAMMA Modes. GAMMA Modes are basically instruction sets, telling the camera what kind of a signal output to generate for every level of light input, from 0% to 100%. This instruction set can be plotted out as a graphic to allow the user to see how the camera will respond to light at each level.

Figure 1 represents the Characteristic Response of a camera, plotting out all of the GAMMA options available to the user. Which GAMMA options you have available to you will depend on the camera you own. For example, the AJ-HPX2000, will not provide you with a “FILM-REC” or “VIDEO-REC” option, while the new P2 VariCams (AJ-HPX2700 and AJ-HPX3700) offer the full set of GAMMA options plotted in Figure 1.

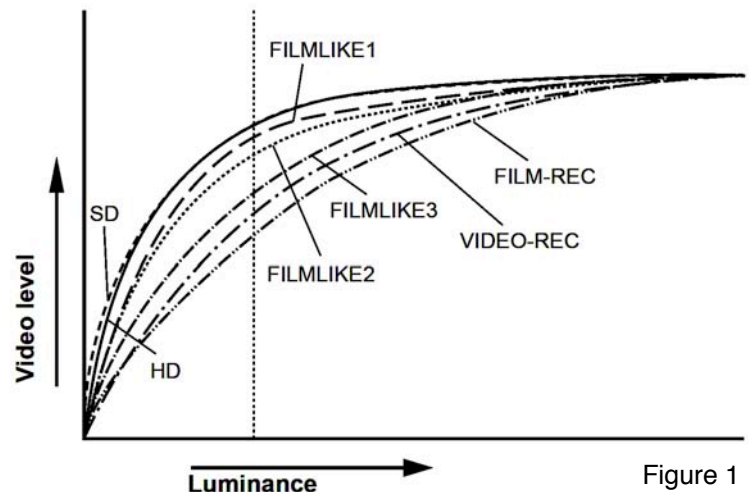


Figure 1

Okay, so how do I choose the right one for me?

To choose the right GAMMA curve for your project, it is important to understand how to read the curves in Figure 1. What the curves indicate is what level of signal output we will obtain for a given level of luminance input. As an example, if we look along the vertical dotted line, we can see that for a given amount of luminance, an HD GAMMA curve will report a higher video level output than any other GAMMA mode selection. What this tells us, is that this selection of GAMMA curve should produce an image with more contrast than any other GAMMA curve we can select. Essentially, the flatter the GAMMA curve, the more latitude and the less contrast we should perceive, all else being equal. Let’s look at an example.

Figure 2 is an example of HD Gamma. It produces a pleasing and acceptable image. If you observe the chip chart however, you can see that the 2 darkest chips almost fuse together, as do the 2 lightest chips. The ability to render linearly from dark to light seems compromised.



Figure 2

Figure 3 is an example of FILMLIKE Gamma at the same exposure as above. As discussed and noticed in Figure 1, FILMLIKE Gamma produces a noticeably lower contrast image, with softer gradations from dark to light, especially in the mid-tones and above.



Figure 3

Figure 4 is an example of FILM-REC Gamma, at the same exposure as above. As we noticed in Figure 1, for the same amount of luminance input, we get a much lower level of Video Output than in HD Gamma mode. The result is a darker, flatter, more desaturated image, with plenty of latitude left over!



Figure 4

FILM-REC looks really flat, why is that?

When shooting on film, one takes for granted that the film stock will provide us with a quasi linear response from the toe all the way to the shoulder of the characteristic curve, but as we can see in Figure 1, a regular HD Gamma curve is far from being linear. So FILM-REC Gamma was designed to give the cinematographer the equivalent of a digital negative. Something that would be able to capture the widest possible dynamic range, provide the most latitude, with the most linear response curve possible. For this reason, FILM-REC quickly became the GAMMA Mode of choice for most shooters working with the AJ-HDC27F VariCam camera.

How is this extended dynamic range accomplished in FILM-REC?

Let's imagine that we could pass the full output of the camera's imager (with normal HD video gamma response) through a system to a non-standard output signal capable of showing it. If we were to measure this output signal on an imaginary waveform monitor, its scale would go all the way to 500% (for the 27F VariCam). In order to fit all of this signal into a real video signal, we would have to clip anything above 109%. This would obviously not be a very good use of a high quality imager, so what the engineers have done is instituted a KNEE. The KNEE takes the signal from the KNEE POINT to somewhere up in this clipped region and re-maps it into the region from the KNEE POINT to 109%. This is how HD, FILMLIKE and VIDEO-REC Gamma work. One direct effect of this KNEE POINT is that we no longer have a linearity across the entire luminance range. The higher we move past the KNEE POINT, the more compression we will get in the highlights.

FILM-REC on the other hand, takes a constant gamma behavior (power law) and applies it from the noise floor, all the way to a specific clip point. That clip point is chosen by the Dynamic Level. At FILM-REC 500% Dynamic Level, the 27F VariCam re-maps the imager's entire range into the full video signal (from 0 - 109%). At FILM-REC 200% Dynamic Level, the 27F VariCam re-maps from 0-200% of the imager's range into the full video signal (from 0 - 109%). In all cases, the response attempts to track evenly throughout the range so the lower the Dynamic Level, the steeper the slope of the transfer characteristic. Standard HD video gamma (with NO KNEE) is actually equivalent to FILM-REC with 100% Dynamic Level. This is why Figure 4 (above) looks darker and flatter than Figure 2 (above). If it were possible to set Dynamic Level to 100% (the Dynamic Level range actually runs from 200% to 600%), the middle of the imager's dynamic range would be at 50 IRE and stops of available imager output are clipped at 109 IRE. At FILM-REC 500% Dynamic Level, nothing is clipped and the midpoint is now around 35 IRE.

As with film negative, FILM-REC was never originally designed to be projected as is. Film negative would have to be processed and printed to positive film stock before you could see it as it was intended to look. FILM-REC is much the same way. For many years, Panasonic recommended the use of a Gamma Base Corrector (see later in paper) while working on set to see images on the on-set monitor the way they will look after being gamma corrected in post, but there are now many other more sophisticated tools available to accomplish this task (which we will discuss a bit later). To make things even more interesting, FILM-REC was such a big hit amongst cinematographers for its smooth and linear transfer curve, that many shooters have, and still shoot it today, for its distinct look, without the desire to add more contrast and punch in post.

ANSWER SUMMARY : GAMMA Mode selection is akin to picking a film stock for your camera. The GAMMA curve you select will determine the video signal output generated by the camera for varying degrees of luminance input. HD, VIDEO-REC, and FILMLIKE 1 & 2, are fairly punchy, and contrasty curves that are ideally suited for live broadcast applications (News, Sports, Reality/Contest shows, etc...) because they are “Air-Ready” and don’t require any post processing to achieve full dynamic levels (0% black to 100% white). FILMLIKE 3 and FILM-REC, provide a wider dynamic range and latitude to the camera as well as a more linear transfer curve, but usually at the cost of a flatter, less punchy image, that needs to be Color Corrected in Post. This setting is ideal for applications that already follow this type of workflow, such as Narrative Features, Episodic Television, Music Videos and Commercials.

I’ve decided to shoot in FILM-REC... now what?

What controls do I have?

As mentioned earlier, one of the goals behind the creation of a FILM-REC Gamma Mode was to provide the cinematographer with a quasi linear transfer curve much like we could expect from film. One way to achieve this linearity of transfer was to do away with the KNEE Point and KNEE Slope controls. You might be saying to yourself... “those are the tools I use to dial in my highlights! What gives?” What happened is that these tools which could possibly create a kink in what would otherwise be a smooth linear curve, have been replaced with more subtle and linear functioning tools called “DYNAMIC LEVEL” and “BLACK STRETCH LEVEL.” Dynamic Level allows you to determine how flat/steep you want the linear transfer curve to be, and Black Stretch Level allows you to favor more or less detail in the shadow areas of the image.

Figure 5 is a page from the camera menus of the new P2 VariCam AJ-HPX3700. The two functions directly beneath the GAMMA MODE SEL function are your controls over DYNAMIC LEVEL and BLACK STRETCH LEVEL. It is important to note that while most cameras will still allow you to make changes to the KNEE Point and KNEE Slope parameters, these parameters will have NO EFFECT on the final image when the GAMMA MODE is set to FILM-REC.



Figure 5

What is the range of Dynamic Level and Black Stretch Level?

In the tape-based VariCams (AJ-HDC27F & AJ-HDC27H Models) and in the AJ-HPX3000, the Dynamic Level range goes from 200% to 500%. In the new P2 VariCams (AJ-HPX2700 & AJ-HPX3700 Models) this has now been increased to allow up to 600% Dynamic Level. 600% was added because of the increased dynamic range brought about by improvements in the imagers noise levels. Since the signal is quieter, the camera raises the response in the shadows a bit more aggressively and then re-maps the rest of the signal accordingly, thus yielding more latitude. The Black Stretch Level has remained the same in all of the models above, providing a range from 0% to 30%.

What should I set my Dynamic Level and Black Stretch Level to?

While it would seem logical to want to use the widest possible dynamic range at all times by going to the highest settings available, this is not always the wisest solution. It is very important to consider what codec you are recording to when making this decision (refer back to the top of this paper for codec considerations). If you are recording to DVCPRO HD, whether to tape on a AJ-HDC27H VariCam or to P2 on a AJ-HPX3700 VariCam, you will always be recording an 8 bit image. As such, the recorded image can only possibly contain 256 shades of gray. So when you are photographing a low contrast scene, and you are then pushing your Dynamic Level to 500%, you might find that you are not gaining any additional tonal benefits on your recorded image as you have exceeded the limitations of an 8 bit signal. The same is true for your Black Stretch Level which might introduce noise in the shadow areas as you push past your 8 bit limit. It has been found that when recording in FILM-REC 500% Dynamic Level, with an 8 bit codec, that quantization tends to occur in the shadows, leading most people to rate the camera at slower speeds, effectively reducing the dynamic range of the camera by putting normal exposure closer to the clip point. You might find that in DVCPRO HD, the

ideal sweet spot might be between 200% - 300% in Dynamic Level, and that leaving Black Stretch Level at 0% will give you the cleanest image possible.

If, however, you are shooting in AVC-Intra 100, you are now dealing with a 10 bit recording (1024 shades of gray). This amount of bit depth leaves plenty of room for additional detail recording. With 10 bit recording, you can rate the camera at higher speeds without the fear of noisy blacks. Combine this with a quieter signal from the imager, and you obtain significant increases in dynamic range. In AVC-Intra 100, you might find that the ideal sweet spot might now be in the range of 400 - 600% in Dynamic Level, and that you can raise your Black Stretch Level up to 20% with very little noise in the shadow areas of your image.

Are there any other settings I should watch for in FILM-REC Mode?

It's a good question. There is a function in some cameras called "HIGH COLOR." The purpose of this function is to increase the saturation in the image areas above the KNEE Point. Let's say you are shooting an interview subject against a blue sky. If the brightness level of the sky was very elevated in comparison to the exposure of the camera set for your subject, you will quickly see the sky go from blue to white as it reaches near a clipping point. HIGH COLOR would then allow you to instruct the camera to look at all of the areas in your image that are exposed at the KNEE Point and above, and add 20% of saturation back into those areas (in the new P2 VariCams this amount is selectable from 1 to 32%). The catch is that for this function to work, you actually need a KNEE Point. As we discussed above, there is no KNEE Point or KNEE Slope controls when you choose FILM-REC as your GAMMA Mode. So rather than not function at all, the HIGH COLOR function will then add 20% (or 1 to 32% on the new P2 VariCams) of saturation to the ENTIRE image when FILM-REC is selected, not only to the portions above the KNEE Point in exposure. This can often result in some form of chroma bleed, or an overall loss of detail as the camera boosts the overall chroma.

So if you select FILM-REC as your GAMMA Mode, be sure to leave HI-COLOR set to OFF. If you find that you would like to add a bit more chroma to the overall image, you are much better off using the CHROMA LEVEL function in small increments, or increasing values in the MATRIX by equal amounts (use this method for the tape-based VariCams that do not have a CHROMA LEVEL function - more on the Matrix a little later).

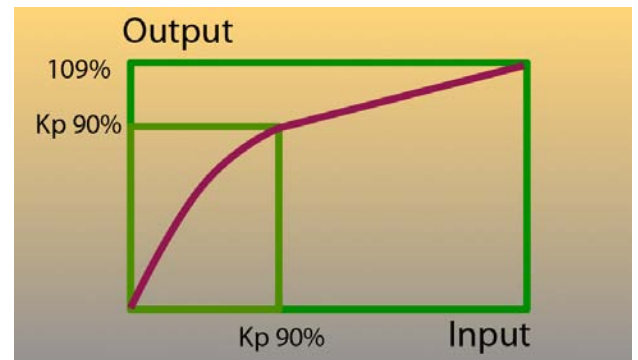


ANSWER SUMMARY : In FILM-REC, you lose control over KNEE Point and KNEE SLOPE. You gain control over two new functions : DYNAMIC LEVEL, which determines how flat you want the linear transfer curve to be, and BLACK STRETCH LEVEL, which determines how much detail you want to see in the shadow areas of the image. In FILM-REC, you also want to be mindful of the codec in which you will be recording. DVCPRO HD being an 8 bit codec might not be able to take full advantage of a DYNAMIC LEVEL set at 500-600% and might introduce noise as you increase your BLACK STRETCH LEVEL. AVC-Intra 100 on the other hand, being a 10 bit codec, is ideally suited to take advantage of the expanded range brought on by a 400 -600% DYNAMIC LEVEL setting. It can also handle some amount of BLACK STRETCH LEVEL without introducing any visible noise. Lastly, when in FILM-REC, make sure that HI-COLOR is set to “OFF”, or you will be adding chroma to the entire image, and not just to the areas exposed above the KNEE POINT.

What is DRS (Dynamic Range Stretch)?

Anybody making the transition from Film to Digital Video as an acquisition tool will immediately have noticed one of the major differences between the two: Highlight Control. Film emulsion has a very extended dynamic range, giving the cinematographer the ability to record information deep into the shadows and up into the highlights. While some digital video systems have achieved very good low light control, highlights are still an area where more control would be welcomed. As illustrated on the following chart, the conventional method of providing highlight control to the cinematographer has been through the use of a Gamma curve and a Knee circuit.

The current approach allows the cinematographer to set a Knee Point above which the highlights will start being compressed to the degree indicated by the Knee Slope. This setting can usually be adjusted manually or by setting the points to be enacted upon automatically (AUTO KNEE). One important element to consider with a Knee circuit, is that it has no control over the shadow areas of your image. So while it is able to provide a bit more latitude to your highlights, it does nothing to expand your abilities to record in the shadows.



DRS is a new approach to latitude control. It replaces the Gamma and Knee circuitry entirely. In a very bright region of the frame, the camera in DRS Mode will respond with FILM-REC with a 500% Dynamic Level to manage the highlights. In a very dark region of the frame, DRS will use an equivalent of FILM-REC with a 100% Dynamic Level (standard video gamma - the Dynamic Level range actually runs from 200% to 600%) to bring out shadow detail. DRS will choose appropriate Dynamic Levels for each sector of the frame, automatically and in real time.

Let’s see what this means in plain English.

In Figure 6, we have a subject posed near bright windows. Not an uncommon element to have to photograph.



Figure 6

When DRS is activated, it divides the entire image into sectors, where the average luminance levels are determined.

Where highlights are encountered, FILM-REC at High Dynamic Levels (400-500%) are applied. Where shadows are encountered, FILM-REC at Low Dynamic Levels (i.e. 200%) are applied. All of this dynamically and automatically.

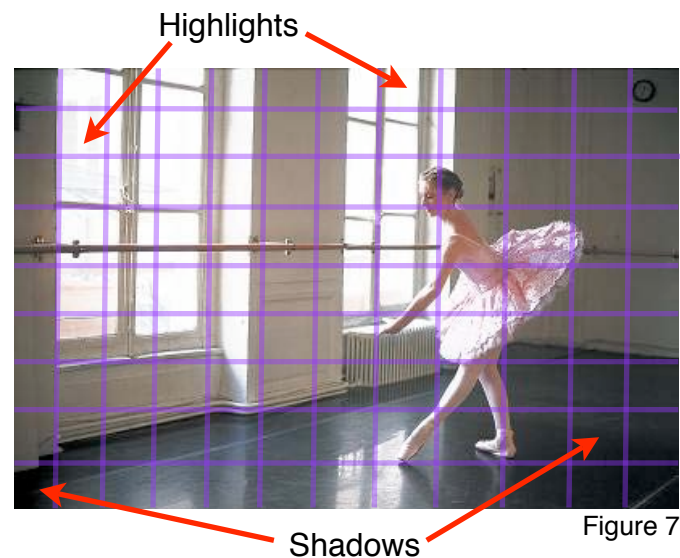


Figure 7

With DRS activated, we now have detail back in our Highlights and our Shadow areas.



Figure 8

How do I activate DRS?

DRS is an “ON or OFF” function. You can evaluate its effectiveness and results by looking at your monitor output signal.

The DRS function is assigned to one of the camera’s USER switches or the AUTO-KNEE switch, where it is activated by the push of a button. Some users prefer to assign DRS to the AUTO-KNEE switch, because unlike the USER switches, the AUTO-KNEE switch will not disable DRS whenever the battery is changed or any time the camera is powered down.



The only control you have over how DRS will perform its task, is with a function called “DRS Effect Depth Level.” In the KNEE/LEVEL Menu in your camera, you will be able to select DRS Effect Depth Level 1, 2 or 3. All three settings will affect the amount of shadow information to the same degree, but will compress highlights by differing amounts. Setting 1, applying the least amount of highlight compression, and Setting 3 applying the most.



This sounds great, why not just have it “ON” all the time?

There are many great reasons to use DRS, but there are also plenty of circumstances in which you would not want to.

DRS comes in really handy in instances where the cinematographer does not have control over the lighting elements. Run-and-gun shooting, man-on-the-street style interviews, and many other occasions where you are asked to throw a camera on your shoulder and start shooting. This applies especially to daytime exterior shooting, where

a bright sun might put you in circumstances of bright key light and deep dark shadows. A great example would be trying to follow an interview subject down a sunny street, as he enters a vehicle, drives for a bit, pulls into a dimly lit underground garage, and then emerges back into a sunny apartment. Without the right lighting and grip tools, it would be very difficult to control this wide array of contrast ranges. Opening up your stop to expose for the dark shadows will leave you susceptible to clipping and over-exposure on any bit of highlight hit, be it the sun, or lighting fixtures in the garage.

DRS provides a one-button tool that can assist in these difficult situations, by dynamically (“as needed”) applying compression to the highlight portions of the frame, and simultaneously stretching out detail in the shadow areas of the frame.

So when would you not want to use this tool?

If you are in a controlled environment, or have the proper lighting and grip tools to control your image, the use of an automated tool such as DRS might fight the look you are trying to obtain intentionally. Let’s say you are trying to create a sense of mystery in your frame, with deep dark shadows and silhouettes. With DRS “ON”, the DRS circuit will assume your blacks are underexposed and will attempt to push more detail into the shadows. The more light you took away with negative fill, or flagging, the more detail DRS would try to bring back, clearly defeating the purpose of the scene. To compound the problem, the more DRS has to lift the shadows, the more noise you will be introducing into your image as the DRS circuit has to essentially push GAIN into the shadow areas.

Another important element to consider is that, as mentioned earlier, the DRS circuit over-rides the GAMMA Curve selection and the KNEE Point and Slope controls. As a cinematographer trying to create a specific look, those are some of the most powerful tools in your digital toolbox, and to have them taken away in place of an automated circuit would severely hamper your ability to make small and measured changes to the characteristics of your images.

ANSWER SUMMARY : DRS (Dynamic Range Stretch) is a fully automated dynamic range expansion tool that will compress highlight information, and boost shadow detail, simultaneously, on a sector by sector basis, in realtime, at the push of a button. It is a great tool to use in “Run-and-Gun” situations where controlling lighting and dynamic range is very difficult. Daytime exteriors with rapidly changing conditions are a prime target for this tool. DRS should be avoided when you have all of the right tools (Lighting, Grip) to control and carve out a specific look. Its automated functionality will quickly conflict with your abilities to predict and create a consistent specific look for your scenes (adding shadow detail where you intentionally tried to omit it).

What are the *MATRIX* and *COLOR CORRECTION* for? *What do they do?*

While your GAMMA Mode selection will affect how your camera responds to light, the MATRIX and COLOR CORRECTION tools will affect how your camera reproduces color. Combined and in good hands, they are probably the most powerful image manipulation tools located inside your camera. You will use these tools when trying to match up two or more cameras on a multi-camera shoot, when trying to match your camera to cameras made by other manufacturers, or when trying to “paint” a particular “look” into your camera.

Here’s a look at the MATRIX and COLOR CORRECTION Menus in the AJ-HPX3700.

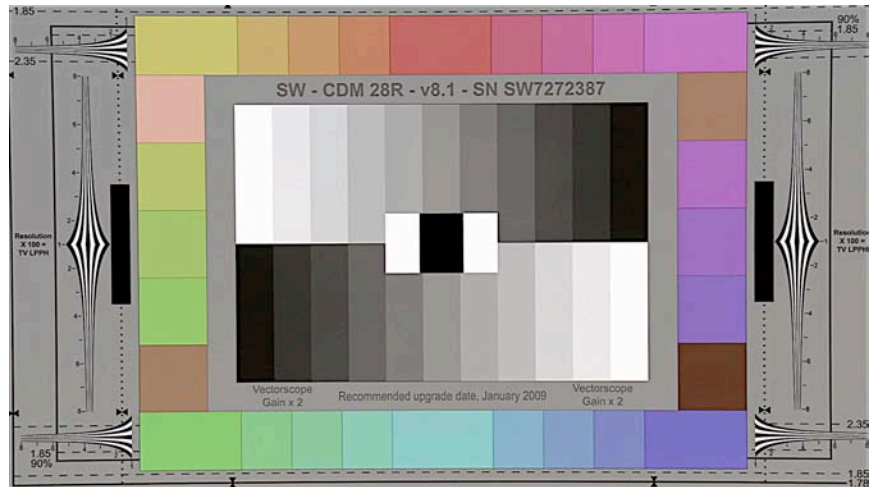


What if I’m not into “Painting a Look”, should I just turn those functions off?

Here’s the deal. Even though you might not want to “paint” your camera, the camera has to have some kind of instruction set on how to reproduce colors, whether you pick this instruction set, or whether you use the factory default selection. Most of Panasonic’s professional line of video cameras ship from the factory with a bias on the “safe” side of things. That is to say that they will reproduce colors in a slightly more desaturated way than is visible to the eye. A good reason for this is that if you “Factory RESET” your camera, and then throw it over your shoulder to go shoot a football game, there is very little chance of getting color bleed, or even recording illegal colors (if exposure and other parameters are set correctly). This is very important for a manufacturer of widely distributed broadcast cameras. That being said, if you are shooting narrative content and want to reproduce a particular color palette, you should not feel limited to shooting at factory presets. The cameras provide you with an extensive array of tools to create customized looks. Let’s take a closer look...

The chart to the right is known as a ChromaDuMonde chart. It is manufactured and distributed by DSC Labs. (more information can be found at www.dsclabs.com)

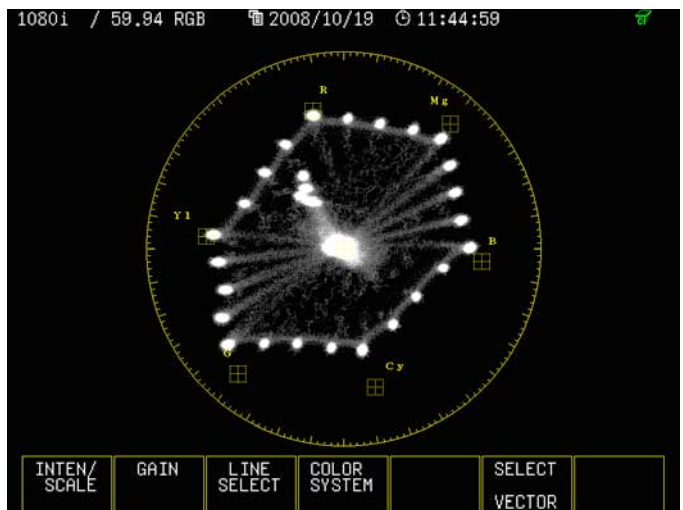
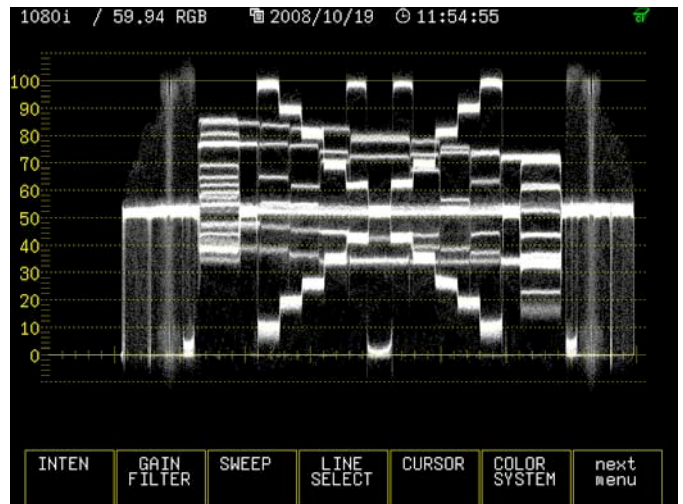
The image is a still grab from 1080p video acquired in AVC-Intra 100 on a AJ-HPX3700 P2 VariCam. Before recording this image, the camera was reset through a “Factory Initialize” and the KNEE was turned off.



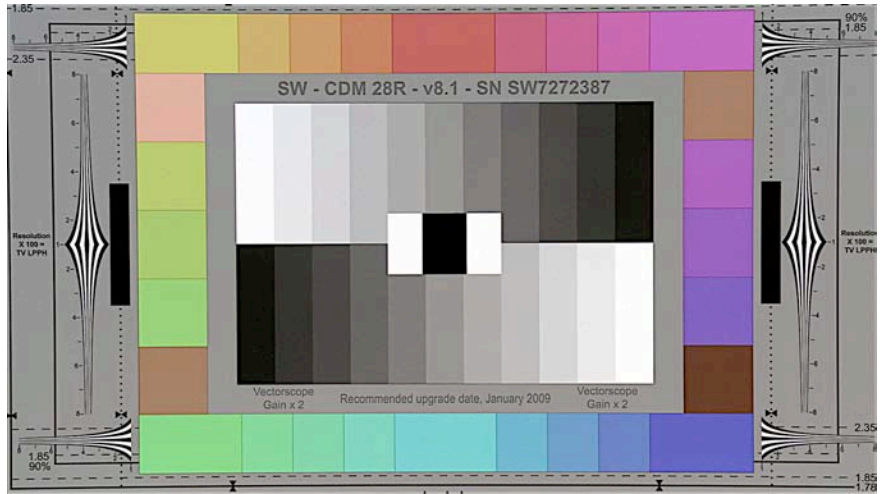
Just looking at the chart, everything seems great. You have good color separation and tonality. But if you look closely at the Vectorscope image below, you can see that some colors are not exactly on target, and that in all of those instances the targets are shy on saturation (Cyan, Magenta, Blue and Green). In the case of Blue and Green, we are also off hue as well.

A common misconception is that simply performing a white balance, or Red and Blue Gain adjustments would solve this problem, but this is not true. The image is already properly white balanced, and any gain adjustments would just shift your white point around and not correct for specific color rendition.

Let’s look at the chart now, with MATRIX and COLOR CORRECTION adjustments applied to it.



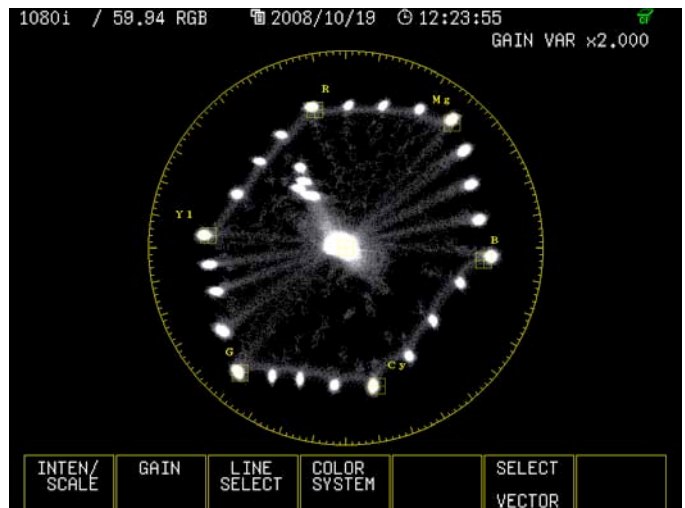
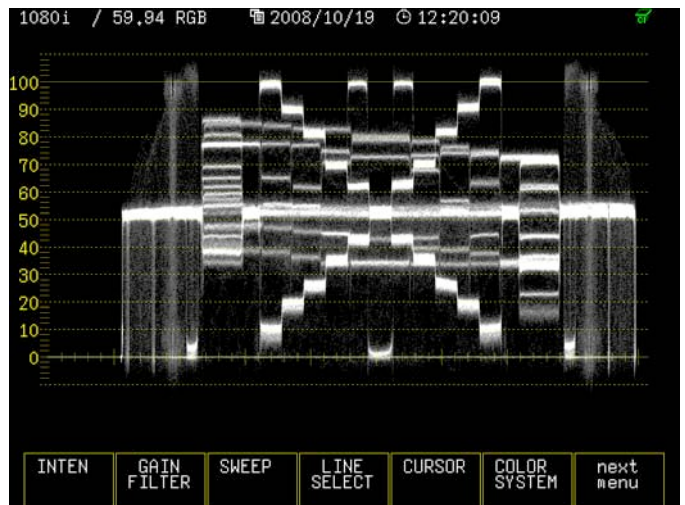
By dialing in the MATRIX and COLOR CORRECTION, you are able to get a one-for-one reproduction of the colors represented in the chart. Notice that the white balance has not changed at all, but that we were able to dial in very specific corrections to just certain colors, within certain ranges of hue and saturation.



This is by no means a “fancy” look, or a “painted” look, but it will allow the camera to more faithfully reproduce in its recorded signal what the human eye would see while on set. One can easily see how this can be an amazingly creative tool for a talented and adventurous DP wanting to create new and innovative color palettes.

What if I don't have a Color Chart and Scopes?

As we could see in the FACTORY RESET version of the chart, there's nothing wrong with shooting the camera in this fashion. Although it might not be optimized for the highest color fidelity reproduction, it is certainly more than acceptable, and a very viable means of acquiring images. If you are going to stray from the “safe” settings the camera ships with, in either trying to achieve more accurate color rendition or to find a unique look for your project, you should ensure that you have a very good way of evaluating the results of your work. This evaluation should comprise at the very least, a properly calibrated broadcast quality monitor, a good viewing environment, and some form of signal



measurement tool (Vectorscope/Waveform Monitor). If you are out in the field running-and-gunning with your black-and-white viewfinder, the last place you should be making adjustments are in the MATRIX and COLOR CORRECTION menus. Remember, better safe than sorry!

ANSWER SUMMARY : The MATRIX and COLOR CORRECTION tools determine how the camera reproduces color in your video image. These tools are crucial when trying to balance the look of two or more cameras in a multi-camera shoot. Even if all of your work is in the single camera world, the MATRIX and COLOR CORRECTION tools will allow you to set up your camera to more faithfully reproduce in its recorded signal, what your eyes would see while on set. Beyond just achieving a norm, you can take things a step further and actually “paint” a custom color palette into your camera for a specific look or show. Should you venture down this creative path, however, MAKE SURE you have the proper tools to evaluate your custom settings. These tools must include a properly calibrated broadcast quality monitor, signal measurement tools (Vectorscope/Waveform Monitor) and preferably also a calibrated chart (DSC’s ChromaDuMonde, etc...)

Should I “paint” in the camera or leave it to Post?

What if my clients want to get a sense of the final look right on set?

This is the million dollar question that floats around every forum, and every production meeting in town. Needless to say, we will not be providing an answer to this question. We will actually stay as far from this controversy as possible. Suffice it to say, that there are a million good reasons for a cinematographer, who in consultation with the director and other creative heads, decides to paint the camera on set, using the expansive tools available at his/her disposal to essentially “bake in” the final look of the show, right on set. There are probably also another few million reasons why a cinematographer would choose not to do that, but rather to capture the most amount of possible information the camera can record, bring all of this usable data into post production, and color and shape the final image in a post grading suite. It is the latter scenario that we will now discuss.

As we noticed in the case of the FILM-REC Gamma Mode selection, this method of acquiring images was designed to provide the cinematographer with a wider latitude, higher dynamic range and flatter transfer curve. The downside was that the image on the monitor was not as dynamic and “punchy” as the final product would end up looking after it went through color correction. So how do we resolve the issue of wanting to shoot “safe”, yet having the ability to see on set, what the final image will look like?

Panasonic’s first answer to that question was the AJ-GBX27G.



A stand-alone gamma correction unit that you would route the output of your video signal to. This unit allowed you to view on your output monitor, a more “punchy” and vibrant image, without having to “bake it” in the camera.

Panasonic then moved away from this approach, into actually including a gamma correction function right into its professional line of BT-LH monitors. This was a great approach, but it did limit cinematographers into having to use Panasonic branded monitors on top of having their Panasonic cameras.

In the new P2 HD VariCams (AJ-HPX2700 and AJ-HPX3700), this has been taken one step further. You can instruct the camera to make GAMMA compensations on the Monitor Output, the Viewfinder Output and the LCD Output, without affecting the recorded signal. This way you are not bound by any viewing device in applying Gamma base correction to your images, in a non-destructive way.

What if I want to pre-viz more than just Gamma correction?

With the advent of RAW acquisition video cameras (which Panasonic does not manufacture), there has been increasing demands in the industry for image pre-visualization on set. Those cameras often require image debayering or some level of image processing to get to a viewable linear image on a monitor. Once this image is viewable, “looks” can be created through the use of 2D and 3D Look-up tables (LUTs) to further guide the look towards a final product. The great news for Panasonic camera owners is that the more powerful the tool sets become, the easier it is for them to build really elaborate LUTs for their already linear cameras.

One such manufacturer is IRIDAS (www.speedgrade.com). They provide an on-set color pre-viz tool called SpeedGrade OnSet 2007, which allows cinematographers to establish looks by grading still-frames right on a Mac or Windows laptop.

Another such company, is Gamma and Density (www.3cp.gammadensity.com/products). They make a product called 3cP that is designed to allow the cinematographer to create looks on set, that will flow all the way through post production and final grading.

For those looking for a real-time passthrough 3D LUT converter, you can check in with the folks at Grass Valley, and a product called LUTher. (www.thomsongrassvalley.com)

Their LUTer box allows you to process your image using a 3D LUT in real-time to your monitor.

Developments change rapidly. By the time this paper comes to you, there may be yet a dozen more solutions to this problem.

ANSWER SUMMARY : The question of whether to “Bake in” a look into the camera, or leave most of it for Post, is something that only the cinematographer, the Director, and other creatives can assess on a project-by-project basis, after evaluating all of the artistic, and financial repercussions. There is no cookie cutter answer, nor should there be one. If, however, you do decide to shoot “safe” in order to provide yourself with more options in post, know that there are plenty of tools available to pre-visualize your look on set. Gamma Monitoring controls are provided right on board Panasonic’s two new P2 HD VariCams (AJ-HPX2700 and AJ-HPX3700), and more elaborate color correction pre-visualization tools are available from IRIDAS, Gamma & Density, and Grass Valley.

What about 4:4:4?

Who uses that much data?

With the new AJ-HPX3700 P2 HD VariCam, Panasonic has entered into the realm of 4:4:4 acquisition. The nomenclature of 4:4:4, stands for the ability to record in full RGB mode, rather than just in YUV. This is not a big deal for live broadcast applications (News, Sports, Reality, etc...) since it is very difficult for the human eye to visually perceive the difference between a 4:4:4 RGB image and a 4:2:2 Component image (especially if that image is in motion). But in the world of visual effects, it’s a whole different story. Computers can read the full color information of a video clip. In a time where mattes are getting increasingly complex and rich, having the full color information to composite from becomes a very big asset.

There is currently no way of recording 4:4:4 images onto P2 Cards directly in the camera. The camera has to be docked via DUAL LINK HD-SDI to a 4:4:4 image recorder. Some current options are: D5-2K onto cassette tapes, using Panasonic’s own AJ-HDP2000 2K Processor for its AJ-HD3700B D-5 HD VTR.



or Hard Drive Recording units by manufacturers such as Codex Digital (<http://www.codexdigital.com>)



and S.two (www.stwo-corp.com).

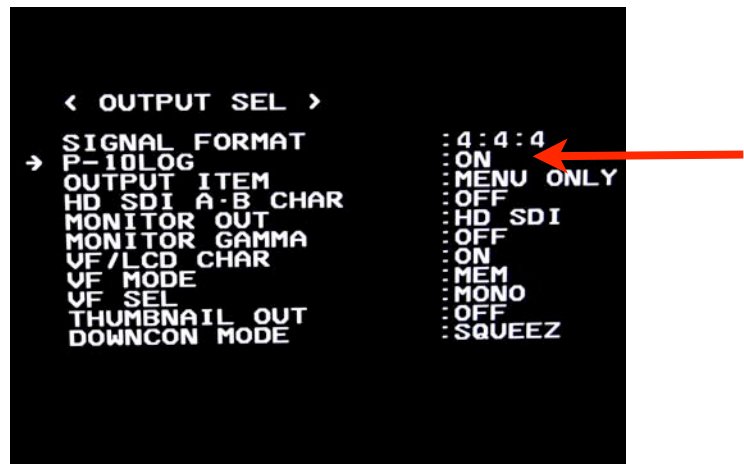


We can undoubtedly expect more competition in this realm, as the race for bigger and better file acquisition moves on. It is important to note that you can record AVC-Intra 100 at 4:2:2 onto your P2 Cards, while simultaneously feeding out DUAL LINK 4:4:4 to an external recorder. Essentially creating a “Mastering Quality” offline, and an even higher color fidelity online record out of the DUAL LINK ports on the back of the camera.

I noticed I can select P-10LOG as an option, what is that?

When you set the GAMMA Mode on the AJ-HPX3700 P2 VariCam to FILM-REC, and you set the DYNAMIC LEVEL to 600%, you have an option to output in a 4:4:4 Mode called “P-10LOG”.

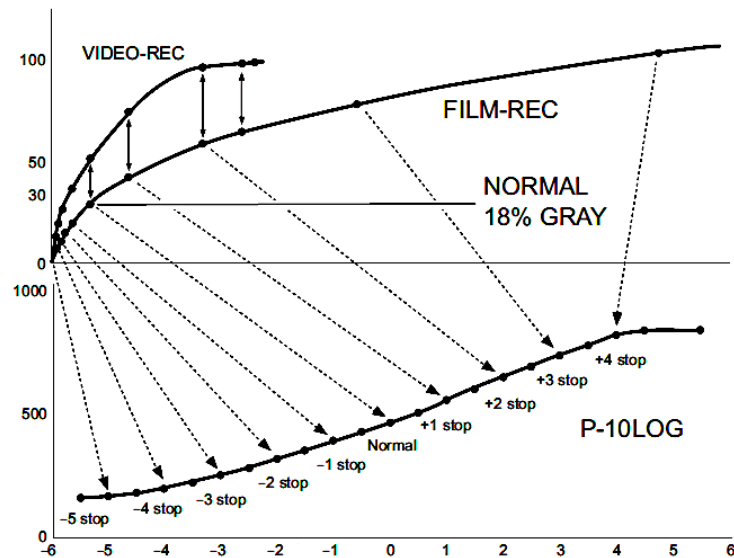
In P-10LOG Mode, a LUT is applied to the transfer characteristic to remap FILM-REC with a 600% DYNAMIC LEVEL (.45 Master Gamma and Black Stretch OFF) to a base 10 Log as specified by Cineon. Additionally, there is also a 2D LUT applied to CbCr to match the colors to an inter-positive generated from a specific film stock, assuming the MATRIX is set to Factory Preset.



Why would I need this?

This function was designed to accomplish a very specific task: to allow you to shoot with the AJ-HPX3700 P2 VariCam and go directly to a film print with no other manipulation required. Essentially, providing you with the ability to print film dailies from your recorded DPX files.

One possible use for this function would be if you had a film project and were planning to use a traditional optical film process (process negative, print film rushes, conform, etc...) and you wanted to incorporate some digital cinematography acquisition into that project. In that instance, you could shoot in P-10LOG Mode, print your DPX files to film along with the rest of your film dailies, and proceed with your edit and conform as if you were dealing with a project that had originated entirely on film.



This application is obviously very specific and will probably not apply to the vast majority of the North American market. For most people seeking to shoot in 4:4:4 Mode to capture the most amount of data for VFX or DI workflows, it is best to set P-10LOG to “OFF”.

If not P-10LOG, then what should I use to capture the most amount of data coming from the sensor in 4:4:4 Mode?

The short answer is FILM-REC, at 600% DYNAMIC LEVEL, and all else set to zero (Black Stretch Level, etc...). This merits some explanation.

As we have noted above, P-10LOG is not a RAW or SENSOR Mode for the camera. It is simply a method for allowing you to print your DPX dailies directly to Kodak film stock. Yet, whenever we see the word LOG used in other digital cinema cameras it almost always refers to some type of raw mode response (S-Log, Pana-Log, etc...). In those camera systems, those raw mode responses are optimized to efficiently map their imager’s full dynamic range onto a 10 bit file, for later remapping back to a linear response at higher bit depths in post production for linear color correction. For the AJ-HPX3700 P2 VariCam, that “Sensor Mode” is in fact FILM-REC at 600% DYNAMIC LEVEL with other settings at zero.

This might seem surprising at first, but as we have seen in the earlier section of this paper (*How is this extended dynamic range accomplished in FILM-REC?*), FILM-REC at 600% DYNAMIC LEVEL re-maps the imager’s entire range into the full video signal (from 0 - 109%), making it the optimal setting for acquiring the most amount of imager information.

FILM-REC is a very empowering tool for cinematographers. You can use its extended dynamic range and latitude as a “digital negative” (while using pre-viz tools to dial-in a more “punchy” look on set), or you can light and expose for the smooth linear response that this Mode provides, and create beautiful images that require very little coloring or manipulation in post production.

ANSWER SUMMARY : 4:4:4 recording on the AJ-HPX3700 is mainly going to benefit Visual Effects work. While human eyes have a hard time seeing the difference between 4:2:2 and 4:4:4 images, computers can very easily make that distinction and can use all of the available color information to draw cleaner mattes in Green/Blue Screen work and other such difference matte applications. P-10LOG is a 4:4:4 Mode that was very specifically designed to allow you to shoot with the AJ-HPX3700 P2 VariCam and go directly to a film print with no other manipulation required. Essentially, providing you with the ability to print film dailies from your recorded DPX files. This is a pretty rare scenario. You will most likely shoot in 4:4:4 Mode for VFX or DI workflows, and in these cases (and all others that do not involve a direct print to Kodak film stock), this function should be set to “OFF”. To get the most sensor data possible in 4:4:4, you should set the GAMMA Mode to FILM-REC at 600% DYNAMIC LEVEL , P-10LOG to “OFF” and all other settings at zero.

About the Author:

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