Panasonic

**AG-DVX200**
TECH BRIEF

# 4:2:0 8-Bit Internal Recording and 4:2:2 10-Bit External Output

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4K PROFESSIONAL

## 4:2:0 8-Bit Internal Recording and 4:2:2 10-Bit External Output

Internally, the DVX200 records in many different frame sizes and recording formats (MP4, MOV, and AVCHD), but all the recordings share these properties: they're all quantized to 8-bit, and they all use 4:2:0 color subsampling. And while the DVX200 can't internally record 10-bit 4:2:2, it can output 10-bit 4:2:2 through its HDMI and SDI ports, so it's available to record externally.

### Why 4:2:0 8-Bit Internal?

One of the primary design decisions regarding the DVX200 was to make it as affordable as possible, not only to buy, but to use. In that context it was decided that the DVX200 should use inexpensive, non-proprietary SDXC memory cards. Additionally, long recording times are a priority; since the DVX200 may be used in a wide variety of recording environments and may be used for long-duration recordings (such as for events or speeches), it was determined that lower bandwidth recording would provide the best combination of long recording times and inexpensive recording media. Keeping the bitrate to 100 megabits per second (or lower) allows for over an hour of recording on a 64GB SDXC card, while ensuring rock-solid reliability.

Understanding the need for limited bitrate, the next task was to engineer a codec that delivered good picture quality while meeting that bitrate expectation. Video compression nearly exclusively uses "lossy" technology; information is discarded to reduce the data rate, and priorities are balanced to maintain the best image quality while discarding the least-important information. 10-bit quantizing and 4:2:2 color sampling are both desirable elements to have, if all things were equal and a large bitrate were possible to suitably encode those aspects of the image. But within the context of the desire for long recording times on inexpensive media, it was determined that 8-bit 4:2:0 provides sufficient image quality for many potential uses. Professional video has used 8-bit digital encoding for decades; all DVD and Blu-Ray discs are encoded as 8-bit 4:2:0; and all HDTV broadcasts are done in 8-bit 4:2:0. 8-bit 4:2:0 can look very good. 10-bit 4:2:2 provides even more information, but takes up substantially more space to record it, and for many recordings and many jobs, it's simply not necessary.

There are many jobs where 10-bit and/or 4:2:2, while nice, are not absolutely required (as evidenced by the massive body of work that's been recorded on 8-bit 4:2:0 cameras over the last twenty years). Some broadcasters and some jobs may require 10-bit or 4:2:2, but many don't, and for those that don't, the DVX200 provides inexpensive internal long-format record capability on commodity media cards.

### 4:2:2 10-Bit External Output

10-bit 4:2:2 recording, when given sufficient bandwidth, produces images that are more detailed, and easier to color grade, and easier to chroma key, and easier to composite, than 8-bit 4:2:0 does. 10-bit 4:2:2 is superior to 8-bit 4:2:0 when it can be adequately recorded (meaning, when there is sufficient bitrate available to afford devoting the necessary bits to recording the additional information.) Recording 4K or UHD footage at 10-bit 4:2:2 in high-quality intraframe encod-

ing (such as Apple's ProRes HQ) takes up approximately 880 megabits per second, or nearly 9 times as much data as the camera's internal recordings(!) Those ProRes HQ recordings would be higher quality than the camera's internal codec could deliver, yes, but such recordings could never be made on an inexpensive SDXC card, and even if they could, you would only be able to record about 7 minutes of footage on a 64GB memory card, rendering it impractical for many uses. Furthermore, the camera hardware necessary to support a 10-bit 4:2:2 encoding chip, and the hardware necessary to support a proprietary high-speed memory recording card that can handle that much bandwidth (such as MicroP2), would both have increased the cost of the camera itself, and the more-expensive recording media would have increased the operational cost of the camera.

Undoubtedly, there are some jobs that would benefit significantly from 4:2:2 recording, and some jobs that require 10-bit recording. Indeed, there are some broadcasters and employers that will specify 10-bit 4:2:2 as a minimum requirement. For those scenarios, Panasonic has taken the approach of providing good-quality 8-bit 4:2:0 recordings internally, and 10-bit 4:2:2 output for use with external recording devices.

Renting or buying an external recorder can provide a way to deliver 10-bit 4:2:2 footage for clients who require it. There are many recorders on the market; generally they support Apple ProRes and/or Avid's DNxHD codec, at 10-bit depth and 4:2:2 color sampling. The DVX200's HDMI and SDI output ports provide Full HD video at up to 59.94 progressive frames per second, and its HDMI output port provides Ultra High Definition video at up to 29.97 progressive frames per second and 4K video at 24.00P, both with full resolution and 10 bit quantizing, and 4:2:2 color sampling. Additionally, the DVX200's HDMI 2.0 output port can provide UHD at 50.00P or 59.94P frames per second, using 8-bit quantizing and 4:2:0 color sampling.

Using an external recorder allows you to use high-speed, high-capacity solid-state disk drives or other recording media that can handle the high bitrate of FHD, UHD or 4K 10-bit 4:2:2 data. Using a high-quality external recorder allows you to capture the full 10-bit 4:2:2 image that the DVX200 can create.

A note on internal recording: the DVX200 cannot simultaneously support 10-bit 4:2:2 output and its own internal recording; when choosing to output 10-bit 4:2:2 data, the internal recording is disabled. When internal recording is enabled, the DVX200 can output 8-bit 4:2:2 (8-bit 4:2:0 in UHD 50P/59.94P), but when configured to output 10-bit, it cannot record internally.

### Additional Benefits To An External Recorder

Using an external recorder may also bring a number of other benefits that may make them interesting for more than just their external recording capability.

External recorders such as the Convergent Designs Odyssey 7Q+, Sound Devices PIX-E5H, and Atomos Ninja Assassin typically include their own monitors, which give you an additional monitor that can be used on-camera or as a director's monitor.

These external monitors usually include a wide variety of exposure tools and focusing tools that can be used even while recording. While the camera itself is limited in what tools can be used during recording, the external recorder isn't, and providing false color, or a full-screen waveform monitor, or a highly magnified focus assist during recording can be a big help during production.

These external recorders also can streamline VLOG-L production. VLOG-L recording is usually targeted towards extensive post production, and VLOG-L footage benefits significantly from the additional bit depth of 10-bit and the additional color sampling of 4:2:2. External recorders also typically feature Look Up Table (LUT) support, which can be quite useful when recording in VLOG-L; you can usually import a LUT into the recorder's monitor, and the recorder can apply that LUT to the footage so that you see and monitor your footage as a preview of what it will look like after grading in post-production. This is similar to the camera's own LOG VIEW ASSIST function, but it's certainly easier to use an external monitor's built-in LUT capability than it is to constantly hold down a User Button on the camera to employ the LOG VIEW ASSIST. Additionally, many external recorders can load multiple LUTs simultaneously, giving you more flexibility than the simple LOG VIEW ASSIST can provide.

## Summary

All engineering is a compromise; a famous saying in engineering is: "Do you want good, fast, and cheap? Pick two."

The DVX200 is engineered to be an affordable, all-in-one camera designed to meet most challenges and perform well at most tasks. The engineers developed the camera to support 8-bit 4:2:0 recording as a general-purpose recording format that provides the best combination of image quality, long recording times, and inexpensive media. If you encounter jobs that need more than what the internal recording can provide, the DVX200's 10-bit 4:2:2 output is there for pairing with an external recorder to provide even higher quality for those situations.

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