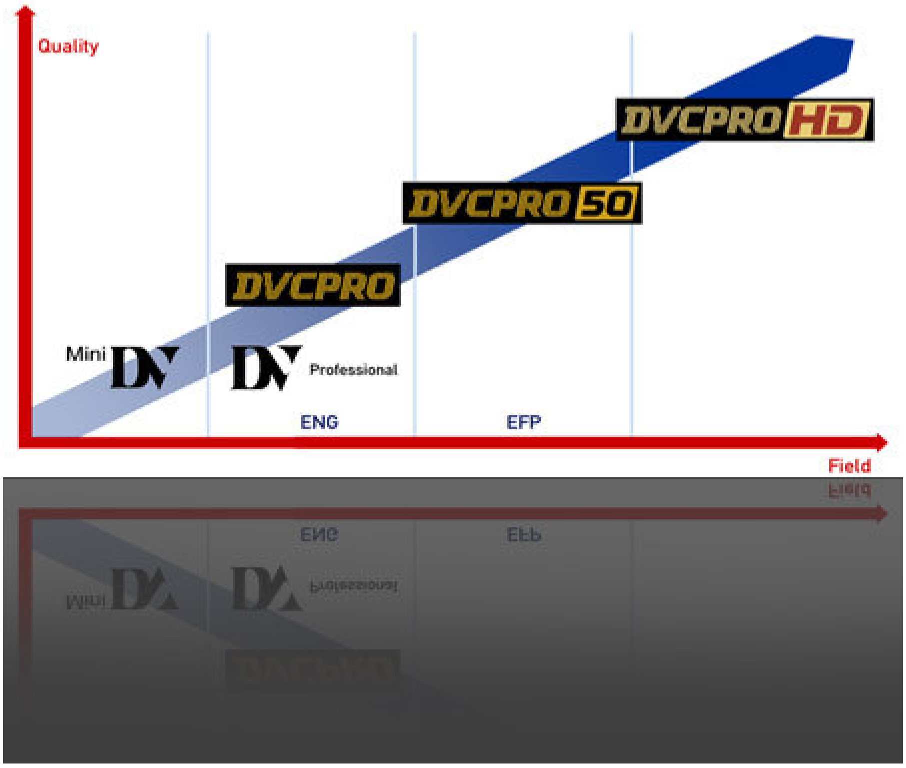
Compression and Quality

DVCPRO HD - Developed for High End HD Production



A key advantage of the AG-HVX200 is that it uses DVCPRO HD (DVCPRO 50/DVCPRO/DV). Since this high-definition format was introduced in 2000, its image and sound quality, reliability, and operating ease have earned the acclaim of broadcasters and video professionals all around the world. The original (standard-definition) DVCPRO format, introduced in 1996, has also seen wide use in broadcasting and other professional applications. Moreover, because a wide range of peripheral equipment has been developed for use with DVCPRO HD VTRs, DVCPRO HD gives you more versatility in editing and other post-production processes.

DVCPRO's Intraframe Compression System

All DVCPRO equipement uses intraframe compression with up to 100 Mbps. Data is produced and compressed independently for each frame, even in the case of DVCPRO HD and the huge amount of data it captures. This helps maintain superior pictures, sound and reliability not only in nonlinear editing, but also in tape editing using VTRs. You get greater editing flexibility and higher-quality results. Compared to DVCPRO, an MPEG2-based system uses interframe compression. A number of frames are formed into a group (called a GOP, for group of pictures) for processing. In each GOP, only frame I (for Initial) contains the entire set of image data. The subsequent frames P (Prediction) or B (Bi-directional) include the data that is different from the data in frame I.

DVCPRO HD's 4:2:2 Sampling Rate Is Most Beneficial for Professional Video Production

DVCPRO HD and DVCPRO 50 convert video signals to digital component signals at a 4:2:2 sampling (digitizing) ratio before recording. The resulting 4:2:2 digital component signal complies with the SMPTE259 Standard SDI signal specified in ITU-R601
DVCPRO HD format samples the brightness signal (Y) at 74.25 MHz and the chroma signal (Pb/Pr) at 37.125 MHz, and combines each set of four Y samples with two Pb and two Pr samples. With the large amount of information it provides for the color difference signal, this system helps maintain outstanding color resolution.

Differences in Audio Recording

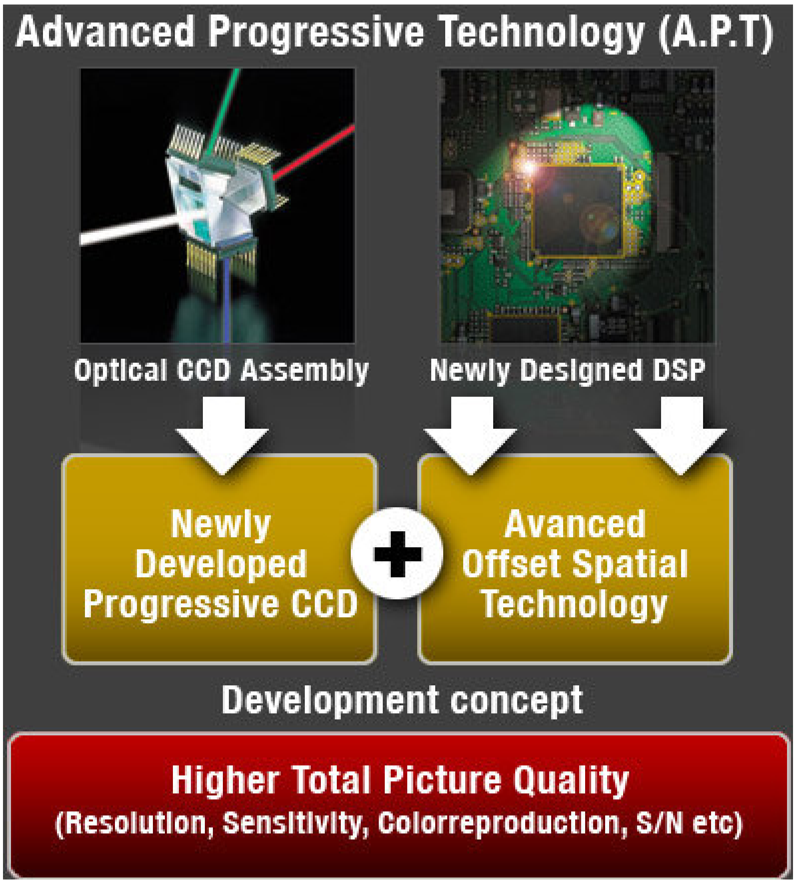
DVCPRO HD format supports professional-level audio specifications with up to eight channels of uncompressed 48-kHz, 16-bit digital sound. AG-HVX200 itself can record up to four channels of audio. In HDV, audio recorded in MP2 format is compressed to 384 kilobits per second.

Background

Advanced Progressive Technology

Panasonic's Design and Development of the AG-HVX200

The AG-HVX200 continues to redefine high quality yet cost effective HD acquisition. From its inception, Panasonic intended to create a camera that could produce compelling content for the Independent Filmmaker and the News Stringer - as well as the wide variety of HD and SD professional applications in-between. While that seems like a tall order, we believed that it was possible because we had created such a camera in Standard Definition with our AG-DVX100 series. By analyzing its success, we worked to match its strengths with similar functionality in the HD Domain for the HVX200.



The Chip Set

All camera design begins with 3 elements:
- the image capture section,
- the signal processing section, and
- the compression storage section.

The most important of these is the Imager set. Knowing that the camera needed to do SD and HD, Panasonic surveyed the technologies and their respective "trade-offs". If we used a 1/3" native resolution 1920 x1080 CCD, it wouldn't have enough sensitivity to be practical in low light because the pixels would be too small to collect sufficient light.

Likewise, a 1/3" 1280 x 720 native resolution CCD would require such a radical architectural change to achieve reasonable sensitivity and dynamic range that it would create image artifacts. These artifacts render the CCD questionable for many applications. Interlace image capture provides a gain in initial sensitivity that may permit smaller pixels but then the inherent image quality and flexibility of a true progressive imager is lost.

With those options and limitations well defined, it seemed that none of these technologies answered the needs that we heard coming from customers. Customers wanted a camera that would perform in Low Light, have good Dynamic Range and still have the resolution to work in the HD domain.

Clearly the challenge in creating the best image was to find the optimal pixel density and size to balance sensitivity and dynamic range with resolution in a true progressive imager. The result? The HVX200 uses a technology that we have named Advanced Progressive Technology or A.P.T. This solution cleverly employs a spatial offset (a well known resolution enhancing technique) in 2 planes (biaxially) simultaneously to allow the use of larger pixels than one would have thought possible.

Take another look at the three technologies discussed above and contrast them with the Spatial Offset strategy. The chart directly below shows the native resolution of the Panasonic HD chip array along with others currently on the market. One can see only Panasonic utilizes biaxial spatial offset, that is both a horizontal and a vertical shift.

	Pixel count	Type	Spatial Offset Methodology
Panasonic	Company A	Company B	Company C
950 x 540	960 x 1080	1280 x 720	1440 x 1080
Progressive	Interlace	Progressive	Interlace
Horiz./Vert.	H only	N none	H only

While pixel count is one of the many important factors that determine picture quality, it is not the only one that should be considered. Using a progressive type chip along with a precise implementation of Spatial Offset can optimize the resolution that is possible.

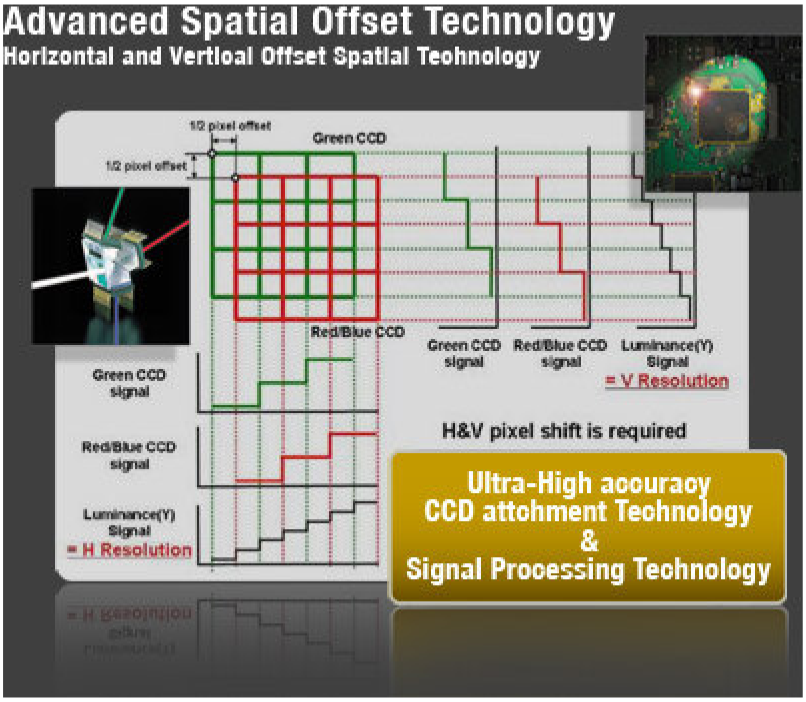
In general, two important concepts need to be considered:
(a) Spatial Offset technology will improve the resolution by a factor of 1.5 provided the gain in resolution is not offset by the quality of the lens.
(b) Interlace CCD resolution is equivalent to 70% of the vertical pixel count of the progressive CCD.

So, if one were to apply the Spatial Offset formula (for each manufacturer that has it) to their chip set and reflect the impact of being interlace (for those that are) the table above would be changed to the following:

	Pixel count	Type	Pixel shift
Panasonic	Company A	Company B	Company C
1440 x 810	1440 x 756	1280 x 720	2160 x 756
Progressive	Interlace	Progressive	Interlace
Horiz./Vert.	H only	N none	H only

Certainly this is a theoretical "best case scenario" and other factors must be taken into consideration when designing a camera such as the HVX200.

For a 1/3" imager, increasing pixel density beyond an optimum level will decrease the Modulation Transfer Function, even though lines of resolution might increase. Modulation Transfer Function (MTF) is a quantitative measure of imager quality to describe the ability of the lens to transfer object contrast. Creating a good-looking and reasonably sensitive Standard Definition Imager in the 1/3" format is very difficult; creating a 1/3" HD imager with a usable sensitivity is even more difficult. Sensitivity and dynamic range are determined by the capacity of the charge well that defines a pixel, and this is determined by the size of that pixel. The grain structure of film must contend with the same rules. Big pixels or film grains are more sensitive than small ones, and smaller imagers require smaller pixels to achieve a similar resolution. For a camera to work in news applications, or any "run and gun" operation, a minimum sensitivity and dynamic range must be delivered. Panasonic moved ahead with the decision to use a 960 X 540 progressive imager in conjunction with the Horizontal and Vertical Spatial Offset strategy. This strategy provides the HVX200 with the low light performance and the dynamic range that we've heard from customers was critical in their applications.

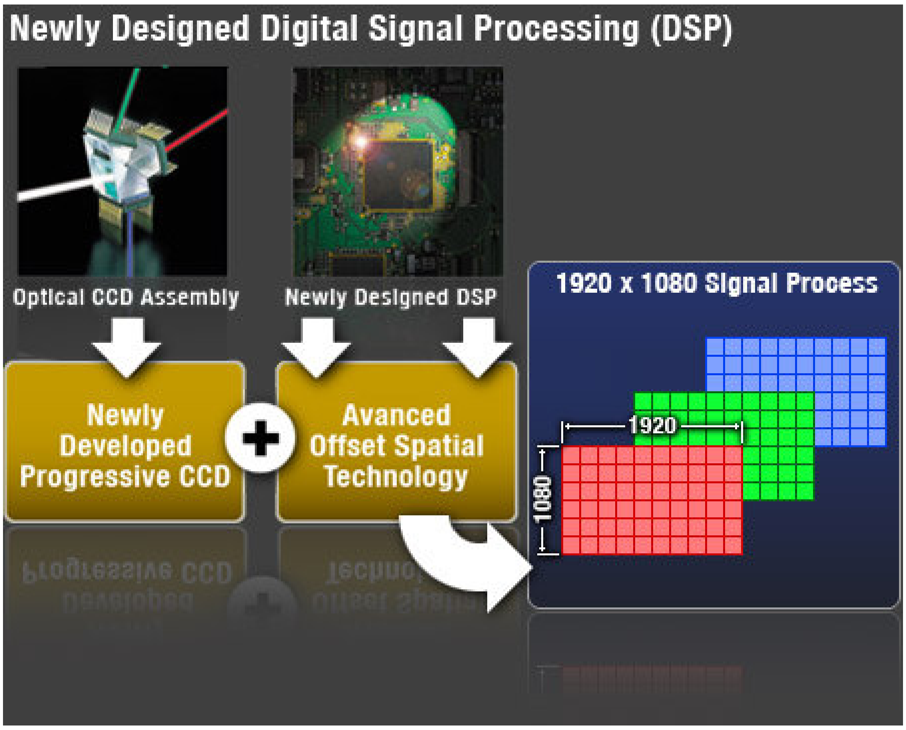


The diagram illustrates how additional resolution can be gained by Pixel Shift or Spatial Offset of the red and blue elements with respect to green.

The optical block for this professional DVCPRO HD camcorder is assembled using highly accurate, patented technology to precisely set the Horizontal and Vertical pixel shift to ½ pixel. This gives the advantage of better dynamic range and sensitivity with minimal compromise in resolution.

Digital Signal Processing

The Optical CCD Assembly output (from the R, B and G image sensors) is then converted into a digital electronic signal. At this point the signal processing circuit becomes the next most important element in determining the camera's performance.



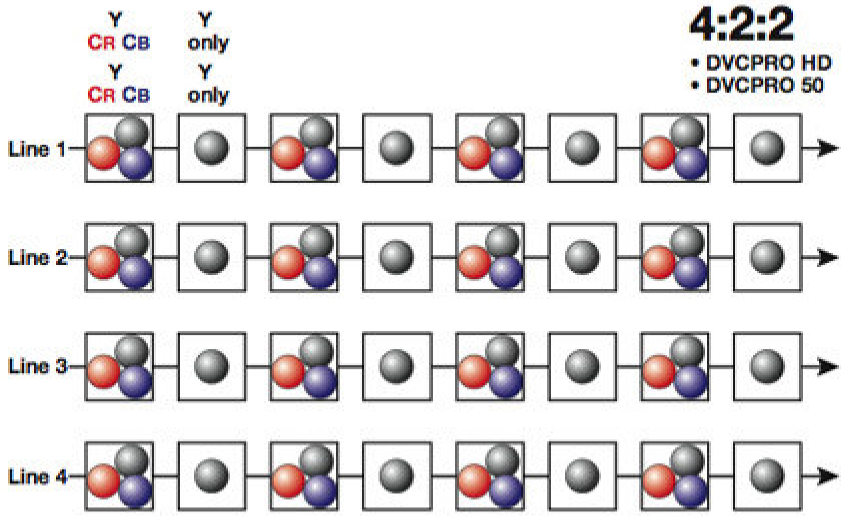
For the AG-HVX200, Panasonic designed a new Digital Signal Processing (DSP) chain using 14 Bit A/D conversion with a 19 Bit DSP system. This allows for extreme control over the images. Strategically this DSP is always working in the 1080 progressive mode (at either the 60 or 50 frame rate, depending upon the geographically defined model). This means the optical image is converted to a 1080 progressive picture (1920 x 1080 pixel count) inside of the DSP. From there all image processing will be performed in the 1920 x 1080 domain, and it is only after this stage that format conversion takes place. For example, if a 720P/50P signal is desired, this conversion happens following the DSP image manipulation in order to produce the maximum image quality

Intra Frame DVCPRO HD Compression

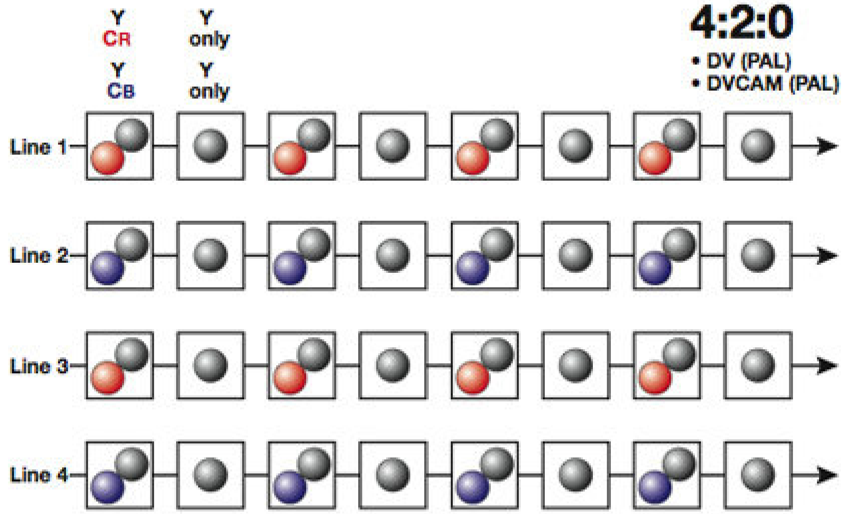
The AG-HVX200 capitalizes on the well-founded and well-accepted extensible DVCPRO algorithm, an intra frame compression scheme that lends itself to post-production manipulation. Each frame stands on its own - data is produced and compressed independently for each frame, even in the case of High Definition. This maintains superior pictures and ultimate flexibility. This is especially true when shooting high speed moving objects, panning the camera, or employing the over-crank and under-crank capabilities of the camera. The beauty of the camera is that it can even act as its own frame rate converter so that special effects can be reviewed immediately.

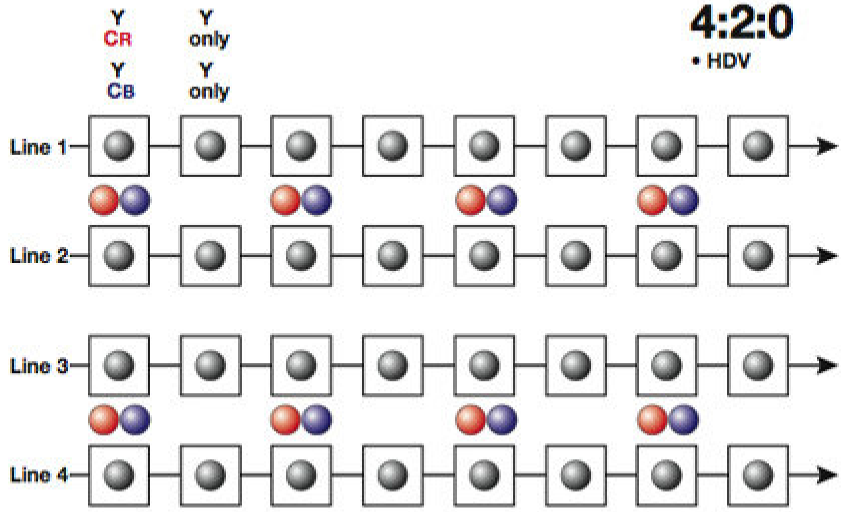
Although AG-HVX200 is optimized for DVCPROHD recording in either 1080 or in 720, it also works very well in the DVCPRO50, DVCPRO25 and DV domains. Having this flexibility makes it the GO anywhere, RECORD-anything camera.

All but the 25Mb formats sample color at 4:2:2, this means the luminance signal (Y) and the chroma signal (Cr/Cb) have a high quality color ratio. Because 4:2:2 sampling offers higher color resolution, it minimizes “jaggies” at chroma edges - and thus is suitable for image compositing (Illustration, below).



DVCPRO, DV (NTSC), and DVCAM (NTSC) use a 4:1:1 sampling rate. DVCAM (PAL) and DV (PAL) use a 4:2:0 sampling rate (Second Illustration, below). Although these are formats where the color signal resolution is half of what one gets in 4:2:2 sampling, the degradation of the video quality during post-production is less than that from a structure like that of HDV, which uses a different version of 4:2:0 sampling wherein the luminance line does not correspond to the color difference line.





(ISO/IEC 13818-2 standard)

Ultimately all of the decisions that were made in the design, planning and development stages of the AG-HVX200 camcorder were to allow the capture of great images. If the camera as a tool stands in the way of creativity, Panasonic did not succeed in their objectives. The success or failure of those early decisions can best be judged by the resulting images. So far, the results have been resoundingly positive.

Panasonic HVX200

Specifications

GENERAL

Supply Voltage:	DC7.2V / 7.9V, Battery or DC Input	
Power Consumption:	11.6W (when viewfinder is used) 12.0W (when LCD monitor is used) 14.0W (Max)	
Operating Temperature:	0°C to +40°C	
Operating Humidity:	10% to 85% (no condensation)	
Weight:	Approx. 2.5kgexcluding battery and accessories, Approx. 2.85kgwith P2 card x 2 and battery (5400Ah)	
Dimensions (WxHxD):	168.5 x 180 x 390 mm excluding prominent parts	

CAMERA

Pick-up Device:	3CCD (1/3-inch interline transfer type and progressive modes supported)	
Lens:	LEICA DICOMAR lens with optical image stabilizer, motorized/manual mode switching,13 x zoom, F1.6 (f=4.2mm to 55mm) (35mm equivalent: 32.5mm to 423mm)	
Filter Diameter:	82mm	
Optical Color Separation:	Prism system	
ND Filter:	1/8, 1/64	
Gain Selection:	(50i/50p mode) 0/+3/+6/+9/+12/+18 dB, Slow shutter (1/12): Gain fix (0 dB) (25p/25pN/ mode) 0/+3/+6/+9/+12/ dB Slow shutter (1/12): Gain fix (0 dB), VFR record frame rate 25pN below: Gain fix (0 dB)	
Shutter Speed (Preset):	50i/50p mode:	1/50 (OFF), 1/60, 1/120, 1/250, 1/500, 1/1000, 1/2000 sec.
	25p/25pN mode:	1/25, 1/50 (OFF), 1/60, 1/120, 1/250, 1/500, 1/1000 sec.
	25p/25pN mode:	1/25, 1/50 (OFF), 1/60, 1/120, 1/250, 1/500, 1/1000 sec.
Shutter Speed (Variable):	50i/50p mode:	1/50.0 sec.to 1/248.9 sec.
(Video Cam Mode)	25p/25pN mode:	1/25.0 sec to 1/248.9 sec.
(Film Cam Mode)	Aperture Angle:	10°to 350°
Slow Shutter Speed:	50i/50p mode:	1/25, 1/12 25p/25pN mode: 1/12
Minimum Luminance:	3 lux (F1.6, +12 dB Gain, at 1/25 shutter)	

Video P2 General (DVCPRO HD, 1080i/720p)

Sampling Frequency:	Y: 74.25 MHz, Pb/Pr: 37.125 MHz
Quantizing:	8 bits
Compression:	Compression ratio 1/6.7, DCT + variable length code
Recording Bit Rate:	100Mbps

Audio P2 General (DVCPRO HD, 1080i/720p)

Sampling Frequency:	48 kHz / Quantizing 16 bits / 4ch
Frequency Characteristics:	20 Hz ro 20kHz

Memory Card

Recording Format:	DVCPRO HD:	1080i/50i, 1080i/25p (over 50i), 720p/50p, 720p/25p (over 50p), 720p/25pN (Native record)
	DVCPRO 50/DVCPRO/DV:	576i/50i, 576i/25p (over 50i)
Audio Recording Format:	PCM digital recording 48 kHz /16 bits 4ch (DVCPRO HD / DVCPRO 50), 2ch/4ch selectable (DVCPRO / DV)	
Recording Time*:	4 minutes with one AJ-P2C004HG (DVCPRO HD, 4ch, 1080/50i) (Approx.) 8 minutes with one AJ-P2C008HG (DVCPRO HD, 4ch, 1080/50i)	

* Time shown above is when you record a series of 1 shot to P2 card. Depending on numbers of shots you record, time will get shorter than the number shown above.

VTR part General

Recording Format:	DV (Digital Video SD)
Tape Format:	576i/50i (PAL), 576i/25p (25p convert to 576i/50i and record)
Frame Rate:	50i, 25p
Recording Audio Signals:	PCM digital recording, 16 bits: 48kHz/2ch or 12 bits: 32kHz/4ch
Wow & Flutter:	Below measurable limits
Recording Tracks:	Digital video / audio signals: helical track
Time code:	helical track (sub-code area)
Tape Speed:	
Quality Series Tape SP mode:	18.831mm/sec, LP mode: 12.568mm/sec
Recording Time:	SP mode: 60 minutes, LP mode: 90 minutes (When using AY-DVM63)
FF/Rew Time:	Approx.140 sec. (when AY-DVM63 is used)

VIDEO connectors

Video Out:	Analog component, Y: 1.0Vp-p , 75Ω, Pb/Pr: 0.7Vp-p , 75Ω (720p, 1080i, 576i for monitor)
Video In/Out:	Analog composite, Pin Jack x 1, 1.0Vp-p , 75Ω (In/out automatically switched, Input DV tape mode only)
S-video In/Out:	4-pin, Y/C Y: 1.0Vp-p , 75Ω, C: 0.3Vp-p , 75Ω (In/out automatically switched, Input DV tape mode only)

AUDIO connectors

XLR In:	XLR (3 pin) x 2 (Input 1 / Input 2), Input: High impedance, Line: 0dBu, MIC: -50/-60dBu (selectable in menu)
Line In/Out:	Pin Jack x 2 (Input 1 / Input 2) (automatically switched), In: High impedance 316 mV, Out: 600Ω, 316 mV
Microphone/Line Input:	XLR x 2(Input 1 / Input 2), LINE / MIC selectable Line: 0dBu, MIC: -50/-60dBu (selectable in menu GUI)
Internal Microphone:	Stereo Microphone
Phones:	Stereo Mini jack (3.5mm diameter)

OTHER connectors

IEEE 1394:	4-pin Digital input/output, based on IEEE 1394 standard
USB:	Type mini B connector (USB ver.2.0)
Camera Remote:	Zoom, Rec (Start/Stop) Super Mini jack (2.5mm diameter) Focus Iris, Mini jack (3.5mm diameter)

DC Input:	2P x 1, 7.9V

Monitor, Speaker, AC Adapter, and Other packages

LCD Monitor:	3.5 inches, LCD color Monitor, 210,000 pixels
Viewfinder:	0.44 inches, LCD color Viewfinder, 235,000 pixels
Internal Speaker:	28mm round shape x 1
AC Adapter:	Weight: 160g, Dimensions: 70 (W) x 44.5 (H) x 116 (D)mm
Supplied Accessories:	AC adapter/charger, AC Cord, DC Cord, Battery (5400mAh), Wireless remote controller, Microphone holder, Shoulder strap, Component Video cable, P2 card soware driver install (CD-ROM