

## Colorimetric and Resolution requirements of cameras

Alan Roberts

### **ADDENDUM 35 : Menu settings for Panasonic P2 AJ-HPX2700**

**This document is a report of the results of tests that are the precursor of those described in the EBU technical document Tech3335. It is not an endorsement of the product.**

A brief assessment was made on a production sample of the AJ-HPX2700 (serial number J8TK0040), a HDTV camcorder with a Canon HA18x7.6 HD lens. It is very similar in form and function to the other cameras in the HPX series, particularly the 3000 and 3700, sharing many features and having a very similar menu set.

The camera has 3 ccds, 1280x720 active sensors (1370x744 total) and operates at the both 720-line and 1080-line HDTV standards. In 1080-line it can be switched between interlace (50i, 59.94i) and progressive (25psf, 29.97psf, and 23.98psf in both 2:3 and 2:3:3:2 pull-down) modes, and to 720-line HDTV (50p and 59.94p). In 720-line mode it can also record at frame rates from 1 per seconds up to the system frame rate. It can generate a “film look” in the camera, and has specific “film-look” gamma curves that incorporate many of the contrast handling features of earlier cameras, making it a great deal easier to set up. It is superficially identical to the HPX3000 and HPX3700.

The recording system is either the conventional DVCProHD format (8-bits, 1440x1080, 6.7:1 compression at 29.97Hz, 6.3:1 at 25Hz) or the newer AVC-Intra at 100Mb/s (10-bits, full resolution, H.264, I-frame only) or at 50Mb/s (¾ horizontal sample count, 4:2:0) onto solid-state P2 cards (5-cage slots in the camera). Sensitivity is specified as F/10 at 2000lux, power consumption 38 watts, weight 4.9kg without lens or viewfinder.

It is a little larger than the HDX900, being wider to accommodate the P2 cards instead of the tape mechanism, and has HDSDI output. It has striking similarities to the HPX2100, with which it should be compatible. There is a side-panel lcd display for menu setting and access to recorded files. It has many internal menus for setting the performance, such that it can then be used without external controls. It is not ideally suited to multi-camera operation (being a camcorder) but has enough features to make multi use possible. Monitoring and connectivity have been improved over previous Panasonic models; it will genlock to either analogue HD Y or analogue composite (PAL or NTSC as appropriate); there are two video outputs, one switchable between HDSDI, SDI (appropriate down-conversion), and composite (PAL or NTSC), the other between HDSDI and HD analogue Y for monitoring; it has a IEEE1394 (Firewire) output that will feed and control an external recorder. It has a LCD side-panel, useful for menu setting etc.

The camera section has 14-bit ADCs that deliver better noise performance than in earlier models. There is also an 8-second cache for pre-recording.

In this setup, the gamma correction and knee are adjusted to capture almost 2 stops of overload, and 1 stop of underexposure, to mimic film performance.

The settings derived here are from a joint test session with the HPX3000 and 3700, where it was found that the same settings could be used across the cameras, giving the same results. This means that the cameras can be freely mixed in productions.

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### **ADDENDUM 35 : Menu settings for Panasonic P2 AJ-HPX2700**

Many menu items have little or no effect on the image. Those that do so are highlighted. The full menus are given for completeness. Where three values are given {f} denotes film use, {v} video and {w} wildlife. The film mode uses the “Filmlike1” gamma curve, which very closely resembles the best that can be done with a conventional gamma curve and knee, but with a nice smooth join; there seems no point in ignoring this curve since Panasonic have clearly put much effort into its design, and it works well. The photographic speed of the camera is unchanged using this curve (“Filmlike2” is a similar curve but copes with about a stop less of overload and reduces the photographic “speed” by about a stop, also the manual knee controls have no effect in this mode so it is not possible to customise it; “Filmlike3” further reduces the exposure range and lowers the photographic “speed” of the camera by about one stop more; both these modes should produce better noise performance and thus may well be the best option for film-like work). The camera also has the “Film-Rec” curve of the Varicam. The video mode uses conventional gamma and knee settings to achieve similar results but with more contrast compression in highlights. Both modes can cope with about 1.7 stops of overexposure (about 350% measured); the video mode (with optimal knee settings) has a slightly more pronounced change of slope in the knee but the difference is marginal. The wildlife mode uses the Film-Rec gamma. The exposure range is about 11 stops.

The shutter can be set to HALF (i.e. 180°), which avoids the problem of having to work out what it should be from the field/frame rate.

Line Mix mode appears to be the equivalent of EVS in other cameras. Switched on in 25p mode, Line Mix reduces the vertical resolution to the same as 50i, thus minimising most interlace twitter artefacts although the effect is not great. There is an 8-second video cache for pre-recording.

When shooting at 59.94 field/29.97 frame rates, drop-frame time code is always used.

Viewfinder and monitoring outputs can both have markers, individually set.

The camera “Gain” switch stores many camera settings, allowing the user to set completely different conditions selectable by that switch. However, most users will want only different gain, the menu contents given here are appropriate for the range of gains quoted, it is for the user to decide which gain settings are appropriate and to set the other conditions accordingly. Beware that the recommended settings were derived during a short laboratory test of the camera; better settings may well be found once the camera goes into general use. The settings given in each switch setting are those recommended for use at the gains given, the user may select what gains to use, but noise precludes the use of higher gains.

DRS (Dynamic Range Stretching) appears to be a fully automatic knee and gamma control, untested here, but could be useful when there’s no time to derive best settings.

The camera does not have an SD mode at all.

Factory settings are underlined. Clearly, the digital processing owes much to the design of the HDX900, the menu structure is very similar, and many of the settings for the HDX900 have the same effect in this camera. Values are given for Video (v), Film look (f), and Wildlife (w). These settings include rather more detail enhancement than usual, because the camera’s basic resolution is clean enough to sustain it.

This should not be used as a substitute for reading the manual.

These settings were derived in a joint test session with the HPX3000 and 3700, where it was found that the same settings could be used in each camera, with the same results. Very possibly, the same is true with the HPX2100, but this has not yet been established.

# 1 Menus and settings

## SYSTEM SETTING

### System mode

Main video standard setting

Item	Range	description	BBC		
			v	f	w
System Mode	1080-59.94i, 1080-23.98PsF, 1080-24/PsF, 1080-50i, <u>720-59.94P</u> , 720-60P, 720-50P	Any change requires a power-off/on cycle to take effect. Different defaults for E/P models <sup>1</sup>	1080-50i	1080-50i	720-60P
Rec Format	1080-59.94i	DVCPROHD/60i, AVC-I 100/60i, AVC-I 100/30PN, <u>AVC-I 100/24PN</u> , AVC-I 50/60i, AVC-I 50/30PN, AVC-I 50/24PN	Codec selection and recording/shooting mode <sup>2,3</sup>	AVC-I 100/50i	AVC-I 100/25PN
	1080-23.98PsF, 24PsF	<u>AVC-I 100/24PN</u> , AVC-I 50/24PN			
	1080-50i	DVCPROHD/50i, AVC-I 100/50i, <u>AVC-I 100/25PN</u> , AVC-I 50i/50P, AVC-I 50/25PN			
	720-59.94P	DVCPROHD/60P, DVCPROHD/30PN, DVCPROHD/24PN, AVC-I 100/60P, AVC-I 100/30PN, <u>AVC-I 100/24PN</u> , AVC-I 50/60P, AVC-I 50/30PN, AVC-I 50/24PN			
	720-60P	DVCPROHD/24PN, <u>AVC-I 100/24PN</u> , AVC-I 50/24PN			
720-50P	DVCPROHD/50P, DVCPROHD/25PN, AVC-I 100/50P, <u>AVC-I 100/25PN</u> , AVC-I 50/50P, AVC-I 50/25PN				
Camera Mode	DVCPROHD/ 1080 60i, 59.94i	60i, 30P, 24P, 24PA	Sets pull-down mode, not needed in AVC-I. <sup>4</sup>		
	DVCPROHD/ 1080 50i	50i, 24P			
	Otherwise	24P, 25P			
VFR	On, <u>Off</u>	Variable Frame rate, 720P only			
Frame Rate	720-59.94P, 60P	1~ <u>24</u> ~60	Can also be set with the Synchro Shutter controls		
	720-50P	1~ <u>25</u> ~50			
USR SW F.Rate	720-59.94P, 60P	1~ <u>24</u> ~60	The frame rate that can be assigned to a User Button		25
	720-50P	1~ <u>25</u> ~50			
Scan reverse	<u>Off</u> , On	For lenses that invert the picture			
PC Mode Select	<u>USB host</u> , USB dev	For connection to USB hard-drive <sup>5</sup> : Host=camera control, Dev=PC control			
PC Mode	On, <u>Off</u>	Enables remote (PC) control			

### Option mode

General options

Item	Range	description	BBC		
			v	f	w
Rec Tally	<u>Red</u> , Green, Char	Record indicator, Char puts REC in the v/f			
Access LED	Off, Slot side, LCD side, <u>Both</u>	Enables the P2-card activity LED's			
P.Off GPS Data	Hold, <u>Clear</u>	Holds GPS data while power off			

<sup>1</sup> There is no difference in the image content between 1080 and 720 modes, therefore the most relevant mode can be selected depending on the production and post-production operations. Note that Panasonic's nomenclature for formats does not accord with the EBU's: Panasonic's 1080-50i would be known in the EBU as 1920x1080i/25, the number after the slash being the frame rate.

<sup>2</sup> P=Progressive, i=Interlaced, PsF=Progressive with Segmented Frames, i.e. progressive carried via an interlaced signal, PN=Progressive Native i.e. recording only new frames. Both I and PsF will record duplicated frames to fill the time-line at the system frame rate if needed, PN won't.

<sup>3</sup> In theory, this should be the best for wildlife, because it can be set to variable frame rate up to 60fps. However, the time-code and gen-lock inputs will be at 24fps, not a standard video speed. So this mode will be difficult to use with external sound recording. If 60fps is not needed, then set to 720-50P, which will gunlock to 50Hz and time-code will make sense.

<sup>4</sup> 24PA is actually 23.98Hz when the system speed is 59.94. PA is "advance pull-down", 2:3:3:2

<sup>5</sup> The camera can be used as a hard-drive source for the editor, to move clip files, controlled either from the camera or the computer.

SDI Metadata	<u>On</u> , Off	Embed UMID data into HDSDI
Save Switch (Aud out)	On, <u>Off</u>	Disables audio out when in power "Save"
Save Switch (lcd)	<u>On</u> , Off	Disables LCD when in power "Save"
Compression Mode	<u>Normal</u> , Dark	Dark applies some black crushing. Only in DVCPROHD 720-line <sup>6</sup>

**Rec function**

Specialist recording functions

Item	Range	description	BBC		
			v	f	w
Interval rec mode	<u>Off</u> , On, One shot	Uses internal memory store			
Interval rec hold	On, <u>Off</u>	On keeps the settings through power Off			
Rec time	<u>00s01f</u> ~59s29f	Frames to be grabbed, frame count goes up to the frame rate-1			
Pause time	00h00m00s01f~ <u>00h04m59s29f</u> 29f~23h59m59s29f	Time between grabs			
Total take time	None~5day	None=continuous			
Total rec time	<u>None</u> , 00m00s01f~99m59s29f, Over100min	Report, not control			
Audio rec	On, <u>Off</u>	Sound capture during interval recording			
Start delay	<u>0sec</u> ~10sec	Delay to start interval grabs			
Pre Rec Mode	On, <u>Off</u>	8-second cache pre-recording			
Pre Rec Time	1s~ <u>8s</u>	Length of video cache			
Loop Rec Mode	On, <u>Off</u>				
Rec Start	All, <u>Normal</u>	All allows recording to start even during playback except in Interval Rec mode			
P.On Rec Slot Sel	<u>Hold</u> , Slot 1	Which P2 slot to use on power-up			

**Output sel**

Signals on the displays

Item	Range	description	BBC		
			v	f	w
Output Item	<u>Menu Only</u> , TC, Status	Puts metadata onto video outputs			
HD SDI A-B Char	On, <u>Off</u>	Superimpose characters on HDSDI feeds			
Monitor Out	VBS, <u>HDSDI</u>	Composite or HDSDI on the Monitor BNC			
Monitor Gamma	On, <u>Off</u>	Correct for Film-Rec gamma on video out <sup>7</sup>			ON
VFR/LCD Char	VF-Off, LCD-Off, <u>On</u>	Puts characters on LCD and viewfinder			
VF Mode	<u>Mem</u> , Cam	Mem=EE, Cam always shows the camera			
VF Sel	<u>Mono</u> , Color				
Thumbnail Out	On, <u>Off</u>	Puts thumbnails on monitor video outputs			
Downcon Mode	Lt-Box, <u>Squeeze</u>	Aspect ratio on SD monitor feed			

**HDSDI A-B Out Marker**

What goes on the HDSDI feeds

Item	Range	description	BBC
Marker Sw	On, <u>Off</u>	All markers	
Centre Mark	Off, <u>1</u> , 2, 3, 4	1=big, 2=big hollow, 3=small, 4=small hollow	
Safety Mark	Off, 1, <u>2</u>	1=box, 2=corners	
Safety Area	80~ <u>90</u> ~100%	Set outer box in %age	90
Frame Mark	On, <u>Off</u>		
Frame Sig	4:3, 13:9, 14:9, Vista, Snsco	Vistavision=1.85, Scope=2.35	14:9
User Box	On, <u>Off</u>	Settable box	
User Box Width	1~ <u>13</u> ~100	Size in %age	
User Box height	1~ <u>13</u> ~100		
User Box H Pos	-50~ <u>0</u> ~50	Position in %age, from middle	
User Box V Pos	-50~ <u>0</u> ~50		

**Moni Out Marker**

What goes on the monitoring feed

Item	Range	description	BBC
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<sup>6</sup> This may be a good idea, since it will increase perceived contrast and reduce noise near black, but will actually reduce the captured contrast range. Swings and roundabouts.

<sup>7</sup> This is a very welcome addition. Film-Rec gamma is very good, but difficult to use. This correction is an approximation to the curve-bending needed in post, and so should produce representative monitoring.

Centre Mark	Off, <u>1</u> , 2, 3, 4	1=big, 2=big hollow, 3=small, 4=small hollow
Safety Mark	Off, 1, <u>2</u>	1=box, 2=corners
Safety Area	80~ <u>90</u> ~100%	Set outer box in %age
Frame Mark	On, <u>Off</u>	
Frame Sig	4:3, 13:9, 14:9, Vista, Snsco	Vistavision=1.85, Scope=2.35
User Box	On, <u>Off</u>	Settable box
User Box Width	1~ <u>13</u> ~100	Size in %age
User Box height	1~ <u>13</u> ~100	
User Box H Pos	-50~ <u>0</u> ~50	Position in %age, from middle
User Box V Pos	-50~ <u>0</u> ~50	

**LCD monitor**

Simple controls

Item	Range	description	BBC
Brightness	-7~ <u>0</u> ~+7		
Color Level	-7~ <u>0</u> ~+7		
Contrast	-7~ <u>0</u> ~+7		
Backlight	<u>Normal</u> , High		
Self Shoot	Normal, <u>Mirror</u>		

**Genlock**

Item	Range	description	BBC
Genlock	<u>Int</u> , Ext	Genlock source	
GL.Phase	<u>HDSDI</u> , Composit	Which output is locked <sup>8</sup>	
H.Phase Coarse	-100~ <u>0</u> ~100	Coarse H timing	
H.Phase Fine	-100~ <u>0</u> ~100	Fine H timing	

**1394 Settings**

Firewire controls

Item	Range	description	BBC
1394 Speed	S100 ,S200, S <u>400</u>	Firewire speed, Mb/s	
1394 In Ch	0~63, <u>Auto</u>	Assign channel number	
1394 Out Ch	0~63, <u>Auto</u>	Assign channel number	
1394 Control	<u>Off</u> , Both	External recorder, Both servos external to camera controls	
1394 Cmd Sel	<u>Rec</u> , P, Stop	External recorder, Stop or hold on RecPause	

**PAINT MENUS****RB Gain Control**

Colour balancing

Item	Range	description	BBC
R Gain AWB Pre	-200~ <u>0</u> ~200	Red gain in switch Preset balance	
B Gain AWB Pre	-200~ <u>0</u> ~200	Blue gain in switch Preset balance	
R Gain AWB A	-200~ <u>0</u> ~200	Red gain in switch A balance	
B Gain AWB A	-200~ <u>0</u> ~200	Red gain in switch A balance	
R Gain AWB B	-200~ <u>0</u> ~200	Red gain in switch B balance	
B Gain AWB B	-200~ <u>0</u> ~200	Red gain in switch B balance	
AWB A Gain Offset	On, <u>Off</u>	On adds A values above after rebalance in A	
AWB B Gain Offset	On, <u>Off</u>	On adds B values above after rebalance in B	

**RGB Black Control**

More colour balancing

Item	Range	description	BBC
Master Ped	-200~ <u>0</u> ~200	Master black level	0
R Pedestal	-100~ <u>0</u> ~100	Red ped, reports value from remote control	
G Pedestal	-100~ <u>0</u> ~100	Green	
B Pedestal	-100~ <u>0</u> ~100	Blue	
Pedestal Offset	On, <u>Off</u>	On enables these values	
R Flare	-100~ <u>0</u> ~100	Red flare correction	
G Flare	-100~ <u>0</u> ~100	Green	
B Flare	-100~ <u>0</u> ~100	Blue	

<sup>8</sup> The monitoring output, when set to SD, has about 90-line delay relative to HD output. This control determines which output is actually locked to the genlock source.

**Matrix (User preset) A,B**

Colour matrix, user settings

Item	Range	description	BBC
Matrix Table	<u>A</u> , B	Two user tweakable matrices	
Matrix R-G	-63~ <u>14</u> ~63	Settings for matrix A or B <sup>9</sup>	31
Matrix R-B	-63~ <u>2</u> ~63		-8
Matrix G-R	-63~ <u>1</u> ~63		-1
Matrix G-B	-63~ <u>4</u> ~63		4
Matrix B-R	-63~ <u>2</u> ~63		1
Matrix B-G	-63~ <u>6</u> ~63		-1
L Matrix Table	<u>Off</u> , A, B	Select matrix in Low	A
M Matrix Table	<u>Off</u> , A, B	Mid	A
H Matrix Table	<u>Off</u> , A, B	High gain setting	A

**Color Correction**

rather dangerous territory

Item	Range	description	BBC	
R (Sat/Phase)	-63~ <u>0</u> ~63	Adjusts colour in 45 degree segments, tweaks saturation and hue.  This is rather dangerous, but can be very useful for special effects. Generally, you should avoid this unless you have good test kit, including comprehensive colour test charts.		
R-Mg (Sat/Phase)	-63~ <u>0</u> ~63			
Mg (Sat/Phase)	-63~ <u>0</u> ~63			
Mg-B (Sat/Phase)	-63~ <u>0</u> ~63			
B (Sat/Phase)	-63~ <u>0</u> ~63			
B-Cy (Sat/Phase)	-63~ <u>0</u> ~63			
Cy (Sat/Phase)	-63~ <u>0</u> ~63			
Cy-G (Sat/Phase)	-63~ <u>0</u> ~63			
G (Sat/Phase)	-63~ <u>0</u> ~63			
G-Y1 (Sat/Phase)	-63~ <u>0</u> ~63			
Y1 (Sat/Phase)	-63~ <u>0</u> ~63			
Y1-R (Sat/Phase)	-63~ <u>0</u> ~63			+63/+60 <sup>10</sup>
Color Correct	<u>Off</u> , On			On

**Low Setting<sup>11</sup>**

Low Level Gain switch position

Item	Range	description	BBC		
			v	f	w
Master Gain	-3, <u>0</u> ~30dB	dB settings, 3dB steps	-3	-3	-3
H Dtl Level	0~ <u>5</u> ~63		5	3	5
V Dtl Level	0~ <u>7</u> ~31		7	5	7
Dtl Coring	0~ <u>4</u> ~60		4		
H Dtl Freq	0~ <u>18</u> ~31		31		
Level Dep	0~ <u>1</u> ~5	Low luma zone, no correction	1		
Gamma	0.30~ <u>0.45</u> ~0.75	0.01 steps	0.45		
Black Gamma	-8~ <u>Off</u> ~+8	No other controls	Off		
Black Gamma Range	<u>1</u> , 2, 3	1=20%, 2=30%, 3=40%			
Matrix Table	<u>A</u> , B, Off	User preset matrices	A		
Color Corr.	On, <u>Off</u>	12 segment adjust, see above	On		

**Mid Setting**

Mid Level Gain switch position

Item	Range	description	BBC		
			v	f	w
Master Gain	-3~ <u>3</u> ~30dB	dB settings, 3dB steps	0	0	0
H Dtl Lev	0~ <u>5</u> ~63		5	3	0
V Dtl Lev	0~ <u>7</u> ~63		7	5	0
Dtl Coring	0~ <u>8</u> ~60		8		
H Dtl Freq	0~ <u>18</u> ~31		31		
Level Dep	0, <u>1</u> ~5	Low luma zone, no correction	1		

<sup>9</sup> These matrix settings are the same as for the HPX3000 and HPX3700. They make slight improvements to the appearance of a Macbeth test chart. Very possibly, they would improve the HPX2100 as well.

<sup>10</sup> Yellow was rather green and de-saturated. This setting makes some improvement but still doesn't get it right. The user should decide whether to use it or not. As with the matrix, this may well also work in the HPX2100.

<sup>11</sup> As with colour correction and matrix, these settings for Low, Mid and High gain should work well in the HPX2100. Although the 2100 does not record in AVC-I and thus can never be as visibly sharp as this camera, the settings from the 2700 ought to have the same effects in the 2100.

Gamma	0.30~0.45~0.75	0.01 steps	0.45
Black Gamma	-8~ <u>Off</u> ~+8		Off
Black Gamma Range	<u>1</u> , 2, 3	1=20%, 2=30%, 3=40%	
Matrix Table	<u>A</u> , B, <u>Off</u>	User preset matrices	A
Color Correct	On, <u>Off</u>	12 segment adjust, see above	On

**High Setting**

High Level Gain switch position

Item	Range	description	BBC		
			v	f	w
Master Gain	-3~ <u>6</u> ~30dB	dB settings, 3dB steps	6	6	6
H Dtl Lev	0~ <u>5</u> ~63		5	3	0
V Dtl Lev	0~ <u>7</u> ~63		7	5	0
Dtl Coring	0~ <u>12</u> ~60		12		
H Dtl Freq	0~ <u>18</u> ~31		31		
Level Dep	0~ <u>3</u> ~5	Low-luma zone, no correction	1		
Gamma	0.30~0.45~0.75	0.01 steps	0.45		
Black Str	-8~ <u>Off</u> ~+8		Off		
Black Gamma Range	<u>1</u> , 2, 3	1=20%, 2=30%, 3=40%			
Matrix Table	<u>A</u> , B, <u>Off</u>	User preset matrices	A		
Color Correct	On, <u>Off</u>	12 segment adjust, see above	On		

**Additional Dtl**

Detail, extra controls

Item	Range	description	BBC
Knee Ape Lvl	<u>Off</u> , 1~5	Correction in knee compressed zone	Off <sup>12</sup>
Dtl Gain +	-31~ <u>0</u> ~31	correction, +ve going edges	0
Dtl Gain -	-31~ <u>0</u> ~31	correction, -ve going edges	0
Dtl Clip	0~ <u>54</u> ~63	Clip level of detail correction	54
Dtl Source	(R+G)/2, (G+B)/2, (2G+R+B)/4, (3G+R)/4, R, G	Doesn't make much difference except when noise level is high	
V Dtl Freq	360, 450, 540, <u>630</u> , 720		720
H. Dtl Line Mix	<u>0</u> , 1, 2H	Vertical width of detail filter, lines	0
Master Dtl	-31~ <u>0</u> ~31	Copy of master control	0

**Skin Tone Dtl**

Item	Range	description	BBC
Skin Tone Dtl	<u>Off</u> , A, B, AB	Select skin tone table, reduces wrinkles	Off
Zebra VF	On, <u>Off</u>	Zebra on skin tone detector	
Zebra HD SDI A B	On, <u>Off</u>	Adds skin tone zebra to HDSDI	
Zebra Moni	On, <u>Off</u>	And on the monitor output	
Detect Table	<u>A</u> , B	Separate tables of target tones	
Skin Tone Get		Looks for skin tone	
Skin Dtl Effect	0~ <u>16</u> ~31	Sharp/Soft detail	
Y Max	0~ <u>190</u> ~255	Max luma level for skin	
Y Min	0~ <u>10</u> ~255	Min luma level for skin	
I Center	0~ <u>35</u> ~255	Saturation mean level for skin	
I Width	0~ <u>55</u> ~255	Saturation range for skin	
Q Width	0~ <u>10</u> ~90	Hue mean level for skin	
Q Phase	-180~ <u>0</u> ~179	Hue range for skin	

**Cam Main Menu 1, Knee Level**

Don't use Auto knee, manual is better

Item	Range	description	BBC		
			v	f	w
Master Ped	-200~ <u>0</u> ~200	Duplicate entry for pedestal	0		
Manual Knee	<u>On</u> , Off	Valid only if AUTO is off	On		
Knee Point	70%~ <u>93</u> ~107%	Manual break point	85		
Knee Slope	0~ <u>85</u> ~99	Gain in knee zone, about 2.5 stops overload	99	50	50
White Clip	<u>On</u> , Off		On		

<sup>12</sup> This was not specifically tested, as its relevance depends on the type of scene. Use it if there is needed detail in any part of the scene above the knee point or above 100%.

White Clip Lvl	90%~109%		109% <sup>13</sup>
A Knee Point	80%~93~107%	Auto knee point	85%
A Knee Level	100~107~109		105
A Knee Response	1~4~8	Auto knee response speed (low=fast)	4
Chroma level	Off, 99%~0%~40%	Saturation control <sup>14</sup>	0
DRS effect depth	1, 2, 3	Dynamic Range Stretch, auto-tweaks gamma and knee	1
Hi-Color Sw	On, Off	Expands colour dynamic range <sup>15</sup>	Off
Hi-Color Level	1~32	Dynamic colour expansion range	

**Gamma**

Differentials and colour tweaking

Item	Range	description	BBC		
			v	f	w
Master Gamma	0.30~0.45~0.75		0.45		
R Gamma	-15~0~15	Set R away from Master	0		
B Gamma	-15~0~15	Set B away from Master	0		
Gamma Mode Sel	HD, SD, Filmlike1, Filmlike2, Filmlike3, FilmRec, Video Rec	HD=709, SD=BBC0.4, approximately. Film-Rec is Varicam Film Rec <sup>16</sup>	HD	Film like1	Film -Rec
F-Rec Dynamic Lvl	200%, 300%, 400%, 500%, 600%	Exposure range in Film-Rec			17
F-rec Black Str Lvl	0~30%	Black Stretch specific to Film-Rec			
V-Rec Knee Slope	150~600%	Video-rec curve reaches this exposure level	18		
V-Rec Knee Point	30%~107%	Knee point specific to Video-Rec			

**Camera Settings**

Item	Range	description	BBC		
			v	f	w
Detail	On, Off	All detail	On	On	Off
Gamma	On, Off		On		
Test Saw	On, Off				
Flare	On, Off				
H-F Compe	On, Off	Wide-band aperture correction	Off		

**VF Display**

User controls (RC=remote control)

Item	Range	description	BBC		
			v	f	w
Status Mode	Normal, Film-Rec	Film-Rec disables much of what follows			
Disp Condition	Normal, Hold	Show switch status: Normal=On, Hold when ModeCheck pressed	Normal		
Disp Mode	1,2,3	1=off, 2=some, 3=all			
VF Out	Y, NAM, R, G, B	What you see, NAM=non-additive mix	Y		
VF Dtl	0~5~10	10 roughly doubles the HD detail in the v/f			
VF Dtl Coring	0~15	Avoids enhancing noise			
VF H.Dtl Freq	1~4~6				
Zebra 1 detect	0%~70~109%	Set for skin tone (BL-TR)	75	65	65
Zebra 2 detect	0~85~109%	Set for white (TL-BR)	100%		
Zebra 2	Off, Spot, On	SPOT works only if Zebra 2>1	Spot		
Low Light Lvl	Off, 10%~35%	Warns at low light level	35%		
RC menu Disp	On, Off	Shows menus in v/f when RC is connected			
Marker/Char Lvl	50%~100%	Marker/Character brightness			

<sup>13</sup> Video signals will go above 100%. Make sure that the post-production operation knows this and can deal with it.

<sup>14</sup> Use this as a saturation control, rather than tinkering in the Color Correction.

<sup>15</sup> Control over saturation in the upper part of the luma range, around the knee.

<sup>16</sup> For Filmlike 3, Panasonic recommend using manual knee (Point=85%, Slope=50), Filmlike1 and 2 effectively built-in knee. The gamma curves can be ordered by the video level from an 18% reflectance chart, HD, Filmlike1, Filmlike2, Filmlike3, Video-Rec, Film-Rec. When using Film-Rec, the Monitor Gamma function should be used (see Output Sel menu).

<sup>17</sup> This controls the exposure range of the camera in Film Rec. Set 600% in very high contrast scenes, 200% for low-contrast scenes.

<sup>18</sup> And this does the same in Video Rec mode.



Synchro scan disp	Sec, <u>Deg</u>	Seconds or degrees, only for synchro shutter	
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**VF Marker**

Viewfinder stuff

Item	Range	description	BBC
Table	<u>A</u> , <u>B</u>	Switch between AB, 2 sets of setups set below	
Centre Mark	Off, <u>1</u> ~4	Cross size/type	
Safety Mark	Off, <u>1</u> , <u>2</u>	1=box, 2=corners	
Safety Area	80%~ <u>90</u> ~100%	Size of safety area	
Frame Mark	On, <u>Off</u>	Frame marker	
Frame Sig	<u>4:3</u> , 13:9, 14:9, Vista, Cnsco	Vistavision is 1.85, Cinemascope=2.35	14:9
Frame Lvl	0~ <u>15</u>	Picture level outside frame mark, 15=same	

**VF User Box**

More viewfinder stuff

Item	Range	description	BBC
User Box	On, <u>Off</u>	Custom frame	
User Box Width	1~ <u>13</u> ~100	Width, %	
User Box Height	1~13~100		
User Box H Pos	-50~0~50	0=centred	
User Box V Pos	-50~0~50		

**VF Indicator 1**

And yet more

Item	Range	description	BBC
Extender	On, Off	Lens extender	
Shutter	On, Off	Shutter speed display	On
Filter	On, Off	Filter position	On
White	On, Off	Show AWB or Preset A/B	
Gain	On, Off		
Iris	Off, Iris	Iris (aperture/auto) display	
Camera ID	Off, <u>Bar</u>	Show camera ID over bars	
ID Position	UpperR, <u>UpperL</u> , LowerR, LowerL	Placement	
Date/Time	On, <u>Off</u>	Show time/date with camera ID	
Zoom Lvl	On, Off	Focal length	
Color Temp	On, Off		
System Mode	On, Off	Camera system speed	
Rec Format	On, Off		
Frame Rate	On, Off	Selects Dynamic Range Stretcher display	

**VF Indicator 2**

And still more

Item	Range	description	BBC
CAC	On, Off	Astigmatism correction <sup>19</sup>	
Gamma Mode	On, Off		
DRS	On, Off		
VF Gamma	On, Off	Correction for Film Rec	
Monitor Gamma	On, Off		

**VF Indicator 3**

Even more

Item	Range	description	BBC
P2 Card Remain	Off, One Card, <u>Total</u>	How much is left	
Battery	On, Off	Voltage	On
Audio Level	On, Off	Bar-graph meters	On
TC on color bar	On, <u>Off</u>		
TC	<u>Off</u> , TCG, TCR, TCG/TCR	The usual timecode stuff	
System Info	Off, Always, <u>Normal</u>	Normal=3 second display of problems	
Compression	On, <u>Off</u>	Relates to the Dark mode in Option menu, only for DVCPROHD 720p	
Save LED	<u>Save</u> , P2 Card	Save warns when in Save mode, P2 warns when card nearly full	
Rec Status	On, <u>Off</u>	Rec indicator in VF	

<sup>19</sup> Astigmatism correction for lenses that have the software to talk to the camera.

Proxy Rec	On, <u>Off</u>	Proxy recording to P2 and/or SD card	
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**Mode Check Ind**

What happens when you press Mode Check

Item	Range	description	BBC
Status	On, Off	Get the status screen	On
!LED	On, Off	Shows why !LED might be lit	On
Function	On, Off	Function screen	On
Audio	On, Off	Audio screen	On
CAC	On, Off	Lens tweaks	
User Sw Status	On, Off		
P.On Ind	On, Off	Get status screen up at power-on	On

**! LED**

VF warnings

Item	Range	description	BBC
Gain (0dB)	On, Off		
Shutter	On, Off		
White Preset	On, <u>Off</u>		
Extender	On, Off		
Black Gamma	On, <u>Off</u>		
Matrix	On, <u>Off</u>		
Color Correct	On, <u>Off</u>		
Filter	On, <u>Off</u>		

**OPERATION****Camera ID**

3 lines of text

Item	Range	description	BBC
ID1		Max 10 characters	
ID2			
ID3			

**Shutter Speed**

Select which speeds go onto the switch list

Item	Range	description	BBC
Synrho Scan	On, Off	Speed set by buttons near filter wheel, longest exposure depends on frame rate	
Synrho Scan 2	On, Off		
Position 1	On, Off	ON adds items to list of settings that can be cycled through using the switch below the lens.	
Position 2	On, Off		
Position 3	On, Off		
Position 4	On, Off		
Position 5	On, Off		
Position 6	On, Off		

**Shutter Select**

Item	Range	Factory	description	BBC
Position 1	[59.94] 1/60, 1/100, 1/120, 1/250, 1/500, 1/1000, 1/2000, HALF, 180d, 172.8d, 144d, 120d, 90d, 45d	180d	HALF keeps exposure at 180° irrespective of field or frame rate.	1/60
Position 2		172.8d		1/120
Position 3		144d		1/250
Position 4	120d	1/500		
Position 5	90d	1/1000		
Position 6	45d	HALF		

**User SW**

Assign user switches

Item	Range	Factory	description	BBC		
				v	f	w
User Main Sw	Inh, I.Over, S.Blk, B.Gamma, Yget, DRS, Assist, C.Temp, VFR, FRate, VF Gam, Audio Ch1, AudioCh2, RecSw, RetSW, Pre.Rec, SlotSel, PCmode	VFR <sup>20</sup>				
User 1 Sw		Y Get			Y Get <sup>21</sup>	
User 2 Sw		VF Gam <sup>22</sup>				

<sup>20</sup> This is the easiest way to shoot off speed at 720p, so is a must for wildlife shooting.

<sup>21</sup> And this is a wonderfully useful light meter, giving the luma level at the centre marker.

Marker Sel (User 3 Sw)	Inh, Y get, Assist, VF Gam, VF Mark, Rec Sw, Ret Sw, Pre Rec, Slot Sel, PC Mode	VF Mark	
Text memo (User 4 Sw)	Inh, Y get, Assist, VF Gam, VF Mark, Rec Sw, Ret Sw, Pre Rec, Slot Sel, PC Mode, Text Memo	Text Memo	

**SW Mode**

More general stuff

Item	Range	description	BBC
Ret Sw	R.Review, Cam Ret	Review last few seconds/check Genlock input	R.Review
S.Blk Lvl	Off, <u>-10</u> , -20, -30	Super black level, not a good idea	
Auto Knee Sw	Off, <u>On</u> , DRS	Disables Auto Knee switch	Off
Shd,Abb Sw Ctl	On, <u>Off</u>	Does black shading with black balance if pressed >8seconds	On
Color Bars	<u>SMPTE</u> , Full Bars, Split, Arib	SMPTE default for P model, Full for E model, daft idea. Arib=multi-format bars <sup>23</sup>	SMPTE
RC Check Sw	R.Review, Play	What haopopens when you press Record on the remote control	
Side Sw lock	On, <u>Off</u>	On disables Gain/Output/AWB switches	

**White Balance Mode**

Presets

Item	Range	description	BBC
Filter Inh	<u>On</u> , Off	Off allows separate balance data to be stored for each filter wheel position	On
Shockless AWB	Off, Fast, <u>Normal</u> , Slow1, Slow2, Slow3	Response speed to white change, 1~20 seconds	
AWB Area	<u>25%</u> , 50%, 90%	Central screen target area	
Temp Pre Sel Sw	<u>Var</u> , 3.2k/5.6k	Var always balances, 3.2/5.6 will only select the nearest of 3.2kK and 5.6kK	
Color Temp Pre SW	2300K~ <u>3200K</u> ~9900K	AWB set in Preset	
AWB A Temp	2300K~ <u>3200K</u> ~9900K	AWB set in A, reports result of rebalance	
AWB B Temp	2300K~ <u>3200K</u> ~9900K	AWB set in B, reports result of rebalance	

**Lens/Iris**

Item	Range	description	BBC
A.Iris Level	0~ <u>45</u> ~100	Auto iris target level, luma	
A.Iris Peak/Ave	0~ <u>30</u> ~100	Ratio, 0=average, 100=peak	
A.Iris Window	<u>Norm1</u> , Norm2, Centr	1=full frame, 2=not top, centre=spot	
Iris Gain	Cam, <u>Lens</u>	Where the iris gain control is	
Iris Gain Value	1~ <u>10</u> ~20	Value used when set to Cam	

**MAIN OPERATION****Battery/P2 Card**

Item	Range	description	BBC
Battery Select	Propac14, Trimpac14, Hytron50, Hytron140, <u>Dionic90</u> , Dionic160, NP-L7, Endura7, Endura10, EnduraD, PagL95, BP-GL65/95, Nicd14, TypeA, TypeB	Set your power source type and all the warnings and meters will read correctly	
Ext DC in select	<u>Ac adpt</u> , Propac14, Trimpac14, Hytron50, Hytron140, Dionic90, Dionic160, NP-L7, Endura7, Endura10, EnduraD, PagL95, BP-GL65/95, Nicd14, TypeA, TypeB		
Batt near end alarm	On, <u>Off</u>	Set near end alarm	
Batt near end cancel	<u>On</u> , Off	Mode check button cancels alarm	
Batt end alarm	<u>On</u> , Off		
Batt remain full	<u>70%</u> , 100%	Indicates full at this level	
Card near end alarm	<u>On</u> , Off	Beep near end of card	
Card near end time	<u>2min</u> , 3min	Time for beep	
Card end alarm	<u>On</u> , Off	Beep at card end	
Card Remain	<u>3min</u> , 5min	Segment size in display	

<sup>22</sup> VF Gam is essential when shooting with Film Rec gamma, so is a must for wildlife shooting.

<sup>23</sup> ARIB bars are as useful as SMPTE, and are widely used in the consumer video industry.

**Battery Setting 1**

Decide which batteries exist in the list

Item	Range	description	BBC
Propac14	<u>Auto</u> , Manual (11~ <u>13.8</u> ~15)	Select each battery with * Auto/Manual controls whether you can set the warning level voltage manually. Be sensible with this and you'll never have silly battery warnings	
Trimpac14	<u>Auto</u> , Manual (11~ <u>13.6</u> ~15)		
Hytron50	<u>Auto</u> , Manual (11~ <u>13.2</u> ~15)		
Hytron140	<u>Auto</u> , Manual (11~ <u>13.0</u> ~15)		
Diconic90	<u>Auto</u> , Manual (11~ <u>13.6</u> ~15)		
Diconic160	<u>Auto</u> , Manual (11~ <u>13.1</u> ~15)		
NP-L7	<u>Auto</u> , Manual (11~ <u>12.9</u> ~15)		
Endura7	<u>Auto</u> , Manual (11~ <u>13.2</u> ~15)		
Endura10	<u>Auto</u> , Manual (11~ <u>13.2</u> ~15)		
EnduraD	<u>Auto</u> , Manual (11~ <u>13.2</u> ~15)		
PagL95	<u>Auto</u> , Manual (11~ <u>13.5</u> ~15)		
BP-GL65/95	<u>Auto</u> , Manual (11~ <u>13.6</u> ~15)		

**Battery Setting 2**

Continued

Item	Range	description	BBC
Nicd14			
Near End	11.0~ <u>13.8</u> ~15.0		
End	11.0~ <u>13.4</u> ~15.0		
TypeA			
Full	12.0~ <u>15.1</u> ~17.0		
Near End	11.0~13.6~15.0		
End	11.0~ <u>12.9</u> ~15.0		
TypeB			
Full	12.0~ <u>15.1</u> ~17.0		
Near End	11.0~13.6~15.0		
End	11.0~ <u>12.9</u> ~15.0		

**Mic/Audio 1**

Item	Range	description	BBC
Front VR Ch1	<u>Off</u> , Front, WL, Rear, All	Where the audio control is, Ch1	
Front VR Ch2	<u>Off</u> , Front, WL, Rear, All	Audio control, Ch2	
Mic Lowcut Ch1	<u>Off</u> , Front, WL, Rear	Bass-cut filters, to 200Hz	
Mic Lowcut Ch2	<u>Off</u> , Front, WL, Rear		
Mic Lowcut Ch3	<u>Off</u> , Front, WL, Rear		
Mic Lowcut Ch4	<u>Off</u> , Front, WL, Rear		
Limiter 1	On, <u>Off</u>		
Limiter 2	On, <u>Off</u>		
Auto Level Ch3	On, <u>Off</u>		
Auto Level Ch4	On, <u>Off</u>		
Test Tone	<u>Off</u> , Normal, Always, ChSel	Which channel(s) get test tone	

**Mic/Audio 2**

Item	Range	description	BBC
Front Mic Power	On, <u>Off</u>	Phantom power	
Rear Mic Power	On, <u>Off</u>	Phantom power	
Monitor Select	<u>Stereo</u> , Mix	What's monitored	
Front Mic level	<u>-40</u> , -50dB		
Rear Mic Ch1 Level	-50, <u>-60dB</u>		
Rear Mic Ch2 Level	-50, <u>-60dB</u>		
Rear Line In Level	-3, 0, <u>+4dB</u>		
Audio Out level	-3, 0, <u>+4dB</u>		
Headroom	18, <u>20dB</u>	Ref level, Factory=(50) 18dB, (59.94) 20dB	18dB
Wireless Warn	On, <u>Off</u>	Warns when radio mic level is poor	
Wireless Type	<u>Single</u> , Dual	Mono/Stereo wireless	

**TC/UB**

Time code and User Bits

Item	Range	description	BBC
TC Mode	<u>DF</u> , NDF	Always NDF at 50 and 24fps	NDF
UB Mode	<u>User</u> , Time, Date, Ext, TCG,	User bits data	

	FrmRate, Regen		
VITC UB MODE	User/Ext, Time, Date, TCG, FrmRate, Regen		
TCG Set Hold	On, Off	Store TC when powered down	
First Rec TC	Preset, Regen	How TC is started	
P.Off LCD Display	On, Off	TC display when power OFF	
TC Out	TCG, TCG/TCR		
TC Disp Sel	24F, 30F	Base for 59.94 frame count, always 25 at 50	
TC Video Synchro	0, 1, 2, 3	Correction for TC, refer to the manual	
Rec Review Regen	On, Off	On uses recorded TC on replay	

**UMID Set/Info**

Item	Range	description	BBC
Country		Input your data, displays "No-Info" until you do so	
Organization			
User			
Device Node			ID number of the product

**FILE MENUS****SD Card Read/Write**

Item	Range	description	BBC
R.Select	1~8	File number to read	
Read		load from file	
W.Select	1~8	File number to write	
Write		write to file	
Card Config		Format SD card	
Title Read		load user data	
Title1-8		Title, max 8 characters	

**Cam Card R/W Select**

Decide what gets saved on the card

Item	Range	description	BBC
System Mode R/W	On, Off	System and Camera Modes	
ID Read/Write	On, Off	On=save cam ID to card	
User Menu Select R/W	On, Off	Load/save Menu items that are/aren't marked	
System Menu R/W	On, Off		
Paint Menu level R/W	On, Off		
Paint Menu Sw R/W	On, Off		
VF Menu R/W	On, Off		
Cam Ope menu R/W	On, Off		
Main Ope Menu R/W	On, Off		
Mainte Menu R/W	On, Off		

**CAC File Card Read**

Lens astigmatism correction

Item	Range	description	BBC
Card file select.	1~32	Select astigmatism data table	
Read		Read it	
Delete		Delete it	
Title read		Read file name	
Title scroll		Scroll CAC files: press rotate Jog wheel	
01-32		File name, 27 characters max	

**File Read Screen**

Item	Range	description	BBC
Title.		Shows file name	
Yes		Files are recorded in camera	
No (Cancel)		Or not	
Mem store no	Empty, 1~32	Store number to record to, Empty looks for an empty one	
Title scroll	1~25	Scroll CAC files: press rotate Jog wheel	
01-32		File name, 27 characters max	

**Lens File**

Item	Range	description	BBC
File No.	<u>1</u> ~64	Lens file number	
Read		Read it	
Write		Write it	
Reset All		Reset lens file data	
Title1-64		Max 12 characters	

**Lens File Card R/W**

Item	Range	description	BBC
Card File Select	<u>1</u> ~64	64 lens files in pages of 8	
Read			
Write			
Title Read			
Title1-8		Create a title	

**Scene**

Item	Range	description	BBC
Read User Data.			
Scene Sel	<u>1</u> ~16	16 scene files	
Read			
Write			
Reset		Create a title	
Title scroll	1~12	Scroll files: press rotate Jog wheel	
Title1-5		Create a scene file	
1~16		Display up to 16 file names	

**Initialise**

Item	Range	description	BBC	Reset
Read Factory Data.		Resets User/Scene data		
Write User Data		Save User data in the camera		

**MAINTENANCE****Lens Adj**

Item	Range	description	BBC
F2.8 adj	On, <u>Off</u>		
F16 adj	On, <u>Off</u>		

**Black Shading**

Item	Range	description	BBC
Correct	<u>On</u> , Off		On
Detection (Dig)		This makes it happen	

**White Shading**

Item	Range	description	BBC
Correct	<u>On</u> , Off		On
Saw/Para	-255~ <u>0</u> ~255	Values for R/G/B, H/V, Para/Saw	

**Lens File ADJ**

Item	Range	description	BBC
RB Gaijn Ctrl Reset	On, <u>Off</u>		
Lens R Gain Offset	-200~ <u>0</u> ~200		
Lens B Gain Offset	-200~ <u>0</u> ~200		
Lens R Flare	0~100		
Lens G Flare	0~100		
Lens B Flare	0~100		

**CAC ADJ**

Item	Range	description	BBC
CAC Control	<u>On</u> , Off	Chromatic aberration correction	
CAC File Delete		Clear memory and file	

CAC File No.	<u>1</u> ~32	32 files	
Title Scroll	<u>1</u> ~25	Scroll through the files	
01		Up to 32 file names per page	
02			
03			
04			
05			
06			
07			
08			

**Diagnostic 1**

Show software versions

Item	Range	description	BBC
Camsoft Main			
Cam Table			
Pulse FPGA			
UCIG FPGA			
FM FPGA			
Char FPGA			
DC FPGA			

**Diagnostic 2**

More software versions

Item	Range	description	BBC
Syscon Soft			
LCD Soft			
P2CS OS			
P2CS AP			
Sh4Ctrl FPGA			
PRCCTRL FPGA			
SYSIF FPGA			
AVC-I Soft			
AVC-I FPGA			

**Hours Meter**

Usage record

Item	Range	description	BBC
Operation		10h	
P.On times			

**Option**

Some more

Item	Range	description	BBC
Eng Security	On, <u>Off</u>	Turns all menus off. DON'T DO THIS unless you're happy to send the camera back to Panasonic to have it turned back on	Off
Frame Rate UB	<u>Frm Rate</u> , Menu	FRM Rate sets frame rate into User Bits	
1394 Config	<u>Dflt(000)</u> , 001~255	DVCPro/DV connection	
1394 Gap Count	0~ <u>40</u> ~63	Interval between data packets	
Audio out delay	Delayed, <u>Through</u>	Speaker/headphone delay to compensate for compression delay	
Fan mode	Off, <u>Auto</u>	Auto recommended unless noise is a problem, remember to turn it to Auto afterwards	

**Area Setting**

Some more

Item	Range	description	BBC
Area Select	<u>NTSC</u> , NTSC J, PAL	SD option	PAL
Area Set		Display of current selection	

## 2 Measurement results

### 2.1 Colour performance

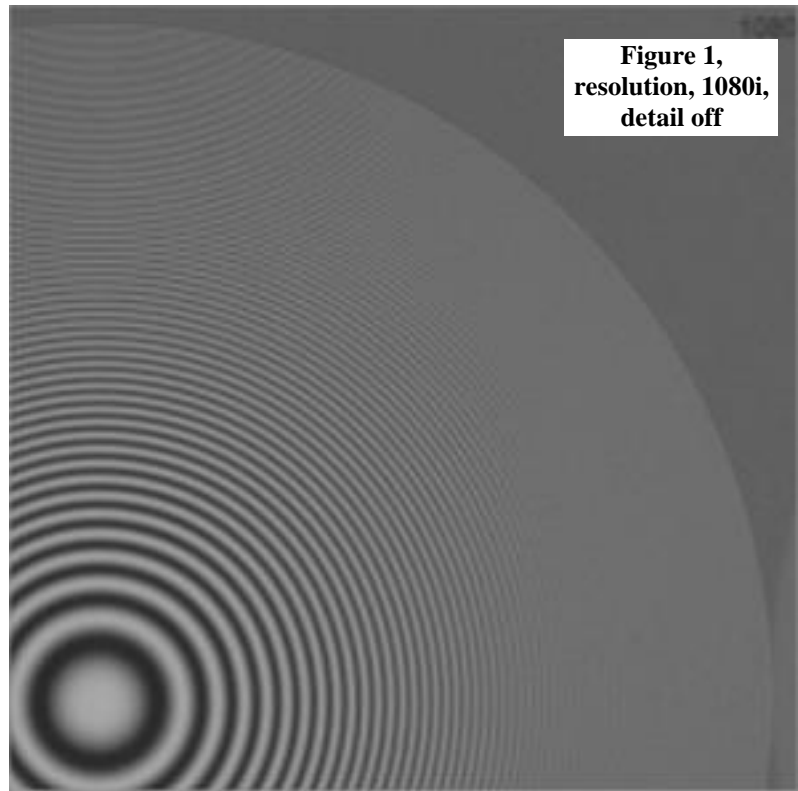
Assessments were made visually, using Macbeth charts.. Performance was good, there were no surprises. However, the red, yellow and orange patches were somewhat improved using the matrix and colour correction settings in the tables.

### 2.2 Resolution

A HDTV zone plate chart was used, containing six circular patterns that fully explore the spatial frequency performance of the camera, up to 1920x1080 pixels per width and height.. Modulation is cosine rather than square wave. Each pattern is a “phase space” map of the possible frequencies that the camera can be expected to deal with, reaching 1920 pixels/picture width (960 cycles) horizontally, and 1080 lines/picture height (540 cycles) vertically.

#### 2.2.1 Resolution, 1080p

*Figure 1* shows a single quadrant of one pattern; for this exposure, the camera detail enhancement was turned off, so this is the native performance.

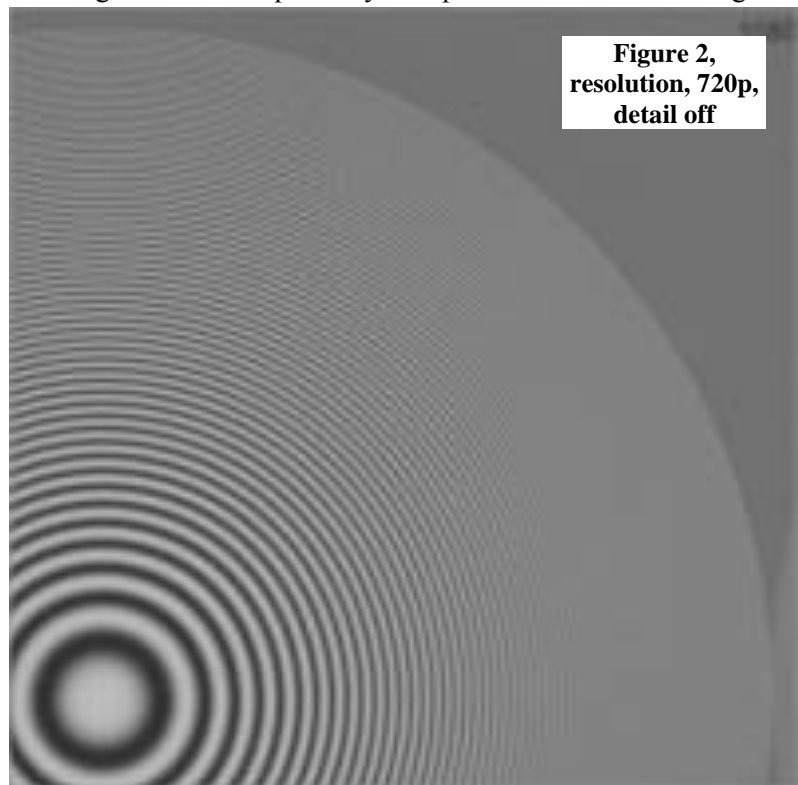


There is no hint of diagonal aliasing, confirming that there is probably no “precision offset” of the green sensor from those of red and blue. Horizontal resolution is clean up to 1280 pixels-worth with very faint aliasing beyond, but vertically there is clear aliasing above 720-lines. . This is good evidence that a good “quarter-wave” filter (bi-refringent crystal) has been included in the optical path, but only for horizontal filtering, which is rather strange.

#### 2.2.2 Resolution, 720p

*Figure 2* shows the same quadrant at 720p. again without detail enhancement. The results are virtually identical. The obvious conclusion is that this is a good 720p camera, with a decent up-conversion to 1080.

There is no advantage in using this camera in 1080-line mode, apart from removing the need for external up-conversion.





### 2.2.3 Resolution, via AVC-I 100

There is no resolution loss either horizontally or vertically, when recording in AVC-I. There is the normal drop in horizontal resolution by a factor of  $\frac{3}{4}$  when recording in DVCPROHD mode. AVC-I is significantly better than DVCPROHD.

### 2.2.4 Detail enhancement

The camera needs little assistance from detail enhancements. The levels have been kept low in the tables. *Figure 3* shows the result of setting the camera to progressive scanning, and “video” detail enhancement.

Resolution is only slightly improved, but increases in the detail enhancement level generally do not produce pictures which look any sharper, so it is wise to keep this low and use the native performance of the camera. The camera delivers more resolution than does the Varicam HDC27F/H simply because ASVC-I records the full bandwidth, so this camera looks sharper without assistance from detail enhancement.

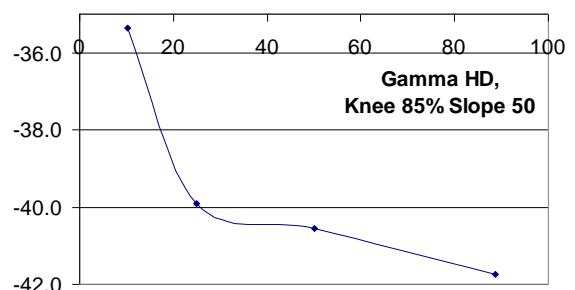
For a “film-look”, even lower levels are advisable, avoiding all risks of video overshooting on sharp edges. For wildlife shooting, it is probably best to turn it off altogether, although a small amount may be acceptable.

advisable to Although the “Film-like” gamma curves give a good impression of a film look, the Film-Rec curve is more subtle and has been used to great effect in many BBC productions, and is therefore recommended for getting a film look from this camera.

## 2.3 Video Noise Levels

Video noise was measured by recording a white card, uniformly lit, and performing numerical analysis in software. A high-pass filter was used to remove all horizontal frequencies below about 5% of the nominal maximum of half-sampling frequencies, horizontally and vertically. The camera gain was set to +6dB, the highest setting recommended here. Results are shown as noise level, as measured, versus luma signal level.

*Figure 4* shows “video” mode, using the HD gamma curve (actually ITU709), and demonstrates shows a good correlation between noise level and the slope of the gamma curve. This proves that there is no special noise processing going on in the camera. The noise level at about 45% luma level (typical of shaded skin tones) is about -40.5dB; allowing for the 6dB gain in the camera, this would become -46.55dB at 0dB gain, and -49.5dB at -3dB gain. This is not a particularly good performance, but it is broadly similar, indeed a little better than, that of the original HDC27F Varicams, and so is not a step backwards.



**Figure 4 Noise, Video mode**

Under normal circumstances, the noise near black (at about 3% luma level) should be about 16dB greater than the noise near white, this is the ratio of the gains near black and white, since the gamma-correction curve amplifies noise differentially depending on level. Any deviation from this form of noise distribution indicates that noise is being limited; in normal use the video compressor would be expected to do this, particularly with 8-bit systems such as DVCPROHD and HDCAM. For these measurements, the HDSDI output of the camera was used, but in 8-bit mode to suit the measurement software, so there is a measurement noise floor at about -54dB. To keep clear of this noise floor, measurements were all taken at +6dB gain. Therefore the plotted results are all 6dB pessimistic.

This noise level is significantly higher than the claimed -54dB, but will not be modified by any 8-bit recording. It does, however, restrict the useful dynamic range of the camera to about 10 stops. The results are not surprising; although not achieving the claimed noise level of -54dB, the pictures did not look particularly noisy during the tests.

Since the gamma curve for wildlife usage is the “Film Rec” version, more measurements were made, with dynamic range set to 200% and 600%. There is a difference of about 1dB near black, other wise the curves are remarkably similar. The difference near black could easily be due to the slight difference in luma levels for these measurement points. Also, there is remarkably little difference between these curves and that for the conventional gamma curve. While a little surprising (the slopes of these curves show considerable differences), it is reassuring that the noise performance is little affected by the choice of gamma curves, there are no advantages to obtained in this way.

## 2.4 Conclusion

This is a 720p camera with a decent internal up-converter. Horizontal resolution is very well maintained and is refreshingly alias-free but there is a noticeable amount of vertical aliasing, which is a pity. Detail enhancement can be used at significantly higher levels than on any previous Panasonic HDTV camcorder without causing visible ringing, but it is still a good idea to keep the levels low for artistic reasons. The settings for this camera can be used in the HPX3000 and 3700 to the same effect, and should work just as well in the HPX2100 albeit only for recording DVCPROHD (the HX2100 does not have AVC-I coders). Thus it should be possible to mix the 2700 and 2100 in the same production, or the 3000 and 3700, and there should be little problem with using the 2700 or 2100 with either of the 3000 and 3700, subject to limitations in the recording coder in the 2100.

It has a good selection of gamma-correction curves, taken from all previous camcorders, with which specific “looks” are fairly easy to achieve. Noise is a little higher than ideal, but within acceptable limits for most purposes, especially if the camera is used at -3dB gain.

Recording should use the newer AVC-I coder (MPEG4, H.264, I-frame only), which has full 1920x1080 (or 1280x720) resolution and 4:2:2 sub-sampling. It was not possible to evaluate this fully during the short time available for these tests. However, it is possible to extrapolate using a few assumptions. I have a “rule of thumb” for video compression systems; MPEG2 (12-frame GoP, variable-bit-rate) uses  $\frac{1}{3}$  the data rate of intra-frame compression (e.g. DV, HDCAM, DVCPROHD) for the same resolution and level of artefacts, while MPEG4 (12-frame GoP, variable-bit-rate) uses  $\frac{1}{4}$ . But, the previous HD camcorder formats

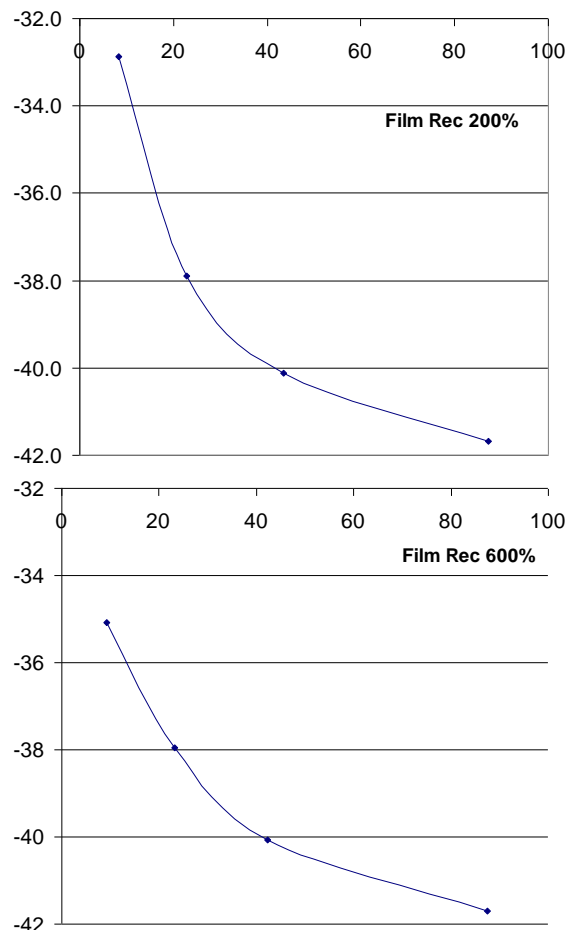


Figure 5, noise, Film Rec

(HDCAM, DVCPROHD) record only 1440 luma samples whereas AVC-I at 100Mb/s records the full 1920 ( $\frac{1}{3}$  more) pixels, and records only I frames, thus the GoP length is 1 frame.

So, AVC-I should produce a significantly lower level of artefacts than does DVCPROHD at the same data rate. My rule of thumb estimates that it should use half the DVCPROHD data rate for the same resolution, or  $\frac{2}{3}$  the rate allowing for the extension to full resolution. Thus, AVC-I at 100Mb/s should produce the same artefact level as DVCPROHD were it to have a data rate of 150Mb/s instead of 100. The lower rate version, AVC-I 50 records the same resolution as DVCPROHD, at half the data rate, and so should be roughly comparable in terms of compression artefacts

Since there is no resolution advantage in this camera in recording at 1080-line, it would make more sense to record 720p and have twice the frame rate, and to use the AVC-I 100 recording format to reduce the level of artefacts, rather than either DVCPROHD or AVC-I 50.