

Colorimetric and Resolution requirements of cameras

Alan Roberts

ADDENDUM 46 rev 3 : Tests and Settings on a Sony PMW-350 camcorder

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.

Data for this section is taken from the handbook and two brief examinations of a Sony PMW-350. This is a 1080-line camcorder, of typical broadcast size but with much lower power consumption (18W). It runs at the normal television rates of 50Hz or 59.94Hz, 1080-line interlaced or psf, and 720p. It also runs at the film-related 23.978Hz rate. It has 3 1920x1080 CMOS sensors and thus should show rolling shutter effects. It very closely resembles the PDW700 camera, and has almost identical menus and performance.

It records full 1920x1080 images at 35Mb/s (MPEG-2), and at lower rates with lower resolution. Recording is onto Sony SxS cards which fit into two computer PCMCIA Express slots in the camera. The compression system was not tested, but is already well known and understood.

The camera 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, although it can be controlled remotely. A standard feature is a 15-second picture cache, but there is only one filter wheel (neutral density filters), colour temperature compensation is achieved by electronic gain-changing.

The menu settings result from one brief measurement session, attempting to get good settings for drama or wildlife (film-style, with full colour grading), and for live/as-live shooting (no grading), and the settings reflect that. In the reported settings, the camera captures up to 300% overexposure (about 1.5 stops, using the full video range 109%) and is mimicking a film camera and telecine, with "best light" transfer to tape (totalling about 11 stops of tonal range). The range of controls is similar to those in the HDW range of HDCAM camcorders, and so it should be possible to make it mimic negative or positive film, with resolution tailored to 35mm or 16mm, to taste. Assuming that a grading operation will be used in post-production, the settings give the colourist the same range of options as with film. Detail enhancement produced some spatial aliasing, but the Aperture compensation produced a much smoother image with complete freedom from aliasing. For use in Sport or Light Entertainment, it would probably be beneficial to switch off the Black Gamma, and to set Detail On, with Detail Level to -5 (0, factory setting, causes visible aliasing).

This revision contains test results of the SD performance of the camera, settings for shooting live/as-live, and settings for News shooting to match existing SD settings for BBC News.

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Many of the menu items have little or no effect on image quality. Those that have significant effect are highlighted. The full set of menu items is given for completeness. In boxes with a range of numeric settings, e.g. -99~99, the values indicate the range, and zero means no alteration to factory setting, not zero effect, and no scales are given. For each item, the factory setting is given where known, and the range offered. “BBC” recommended settings are in the last column, where appropriate. Factory settings, where known, are underlined. Value ranges shown as -99 ~ 99 may differ in practice, as a result of settings in lower menus.

The data files are used in “layers”, Factory, Service, Preset, User. The effect of a numeric data value in the user menus is the sum of all values for that item in all these layers. Only those in the Factory layer are absolute, thus it is vital to have all layers correctly set when entering new values, if the setup is to be copied from camera to camera. The range of values available in some items may not be those quoted in the camera manual, this is due to settings in the Factory layer which must not be altered.

There are settings for:

- Film {film} where a long-contrast film look is wanted and post-production grading is inevitable
- Video {video} where a more conventional video look is appropriate and grading is used
- Ungraded {HDu} for live/as-live shooting in HD where grading is not possible
- Ungraded {SDu} for live/as-live shooting in SD where grading is not possible
- News {news} for News shooting to match existing SD practices in BBC News

... in cases where the variants are not specified, then the most appropriate settings should be used, e.g. if only {film} and {video} are specified, then News should use the video settings.

Settings are only starting points, recommendations. They should not be used rigidly, they are starting points for further exploration. However, they do return acceptable image performance.

This listing of the menus and contents is complete, but this should not be used as an excuse for not reading the manuals.

Menu contents

TOP MENU

OPERATION	Settings for the most common controls
PAINT	Settings that normally need lab facilities to control properly
MAINTENANCE	Camera maintenance, usually best avoided
FILE	Load/save reference files etc
DIAGNOSIS	Check status of hardware/software
SERVICE	Keep out of here if at all possible

OPERATION MENUS

OPERATION 01 FORMAT

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
HD/SD	<u>HD</u> , <u>SD</u>	SD only if CBK-DV01 installed	
HD system line	<u>1080</u> , <u>720</u>	Pretty obvious	
System frequency	1080, not PAL area	<u>59.94i</u> , 29.97p, 23.98p	Lots of options
	720, not PAL area	<u>59.94i</u> , 29.97p, 23.98p	
	SD, not PAL area	<u>59.94i</u> , 29.97p	
	1080, PAL area	<u>50i</u> , 25p	
	SD, PAL area	<u>50p</u> , 25p	
Rec format	1080, 29.97p or 50p	<u>HQ1920</u> , HQ1440	Affects bit-rates as well as format ¹
	1080, not 29.97p or 50p	HQ1920, HQ1440, SP1440	
	720	<u>HQ1280</u>	
	SD	<u>DVCAM</u>	
			HQ

OPERATION 02 FORMAT MEDIA

Card formatting

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Media (A)	Execute, Cancel	Formats the cards	
Media (B)	Execute, Cancel		

OPERATION 03 INPUT/OUTPUT

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Output & i.Link	<u>HD&HDV</u> , <u>SD&HDV</u> , <u>SD&DV</u> , 480p or 576p	Set the outputs on the HD and Firewire/i.Link connectors	
23.98 Output	PsF, Pull down	Nice to see choices like these	
Source select	<u>Camera</u> , i.Link		
i.Link I/O	Enable, <u>Disable</u>		
SDI output	<u>On</u> , Off	Saves power	
HDMI output	<u>On</u> , Off		
SDI/HDMI out super	<u>On</u> , <u>Off</u>	Adds screen text to outputs for monitoring	
Video out super	<u>On</u> , <u>Off</u>		
Down converter	Crop, Letter, <u>Squeeze</u>		
Wide ID	<u>Through</u> , Auto	Adds wide-screen ID flag to SD output	

OPERATION 04 SUPER IMPOSE

Characters and markers on outputs

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Super (VF display)	<u>On</u> , Off		
Super (menu)	<u>On</u> , Off		
Super (timecode)	<u>On</u> , <u>Off</u>		
Super (marker)	<u>On</u> , <u>Off</u>		

¹ HQ mode records MPEG-2 MP@HL, 35Mb/s variable bit rate. SP records MPEG-2 MP@H-14, 25Mb/s CBR. SD records DVCAM, 25Mb/s.

OPERATION 05 REC FUNCTION			Recording stuff
<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Slow & Quick	On, Off	Off-speed operation, disables the cache store	
Frame rate	1080, not PAL area	1~30	Available only when Slow & Quick is on. Off-speed shooting
	1080, PAL area	1~25~30	
	720, not PAL area	1~30~60	
	720, PAL area	1~25~60	
Picture cache rec	On, Off	Disables Slow & Quick, Interval Rec, Frame rec	
P. cache rec time	0-2, 2-4, 4-6, 6-8, 8-10, 10-12, 12-14, 13-15sec		
Interval rec	On, Off	Disables Slow & Quick, Cache, and Frame rec	
Frame rec	On, Off	Disables Slow & Quick, Cache, and Interval rec	
Number of frames	720, 59.94 or 50	2, 6, 12 frames	Frames to be recorded in Interval rec or Frame rec
	720, not 59.94 or 50	1, 3, 6, 9 frames	
Interval time	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 30, 40, 50sec, 1min, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 30, 40, 50min, 1 hour, 2, 3, 4, 6, 12, 24 hour	Set interval between recordings	
Pre-lighting	Off, 2, 5, 10sec	Turns camera light on before recording	

OPERATION 06 ASSIGNABLE SW			Set the user switches
<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
0	Off, Marker, ATW hold, Picture cache, Freeze mix, Focus Mag, Zebra, Shot mark 1, Shot mark 2, OK mark	Focus mag is a handy v/f magnifier for checking focus	
1	Off, Front mic, Marker, Last clip delete, ATW, ATW hold, EZ mode, Turbo gain, rev review, Rec, Picture cache, Freeze mix, Spotlight, Backlight, EVF mode, BRT disp, Histogram, Lens info, Zoom tele/wide, Zoom wide/tele, Manual focus assist, Focus mag, Zebra, Lens ret, Return video, Shot mark 1, Shot mark 2, OK mark, Color temp Sw 3200K, Color temp Sw 4300K, Color temp SW 5600K, Color temp SW 6300K, Electrical CC, CC5600K, Digital extender		
2	Off, Front mic, Marker, Picture cache, Zebra, Digital extender		
3	(Same list as for Switch 1)		
4			
5			
RET	Off, Lens ret, return video, rec review, Shot mark 1, Shot mark 2, OK mark, Focus mag		
C. temp			
Zoom speed	0~20~99	If Sw4 or 5 is set to Zoom, specifies zoom speed	

OPERATION 07 VF SETTING			The viewfinder
<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Colour	-99~0~+99	Saturation	
Mode	Color, B&W		
Peaking type	Normal, Color, Both	Color adds false colour to sharp edges	
Peaking frequency	Normal, High		
Peaking color	White, Red, Yellow, Blue	False colour peaking	
Peaking level	Low, Mid, High		
DXF rec tally	Upper, Both	Which tally to use on non-Sony vf	

OPERATION 08 MARKER			Items in the viewfinder
<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Setting	On, Off	All markers	
Center marker	1, 2, 3, 4, Off	What sort of marker	
Center H position	-40~0~+40		
Center V position	-40~0~+40		
Safety zone	On, Off		
Safety area	80, 90, 92.5, 95%		

Aspect marker	Line, Mask, <u>Off</u>	Line shows the box, Mask darkens the picture outside it	
Aspect select	15:9, 14:9, 13:9, <u>4:3</u> , 1.66, 1/1.85, 1/2.35, 1/2.4		14:9
User box	On, <u>Off</u>		
User box width	400~ <u>500</u> ~999		
User box height	70~ <u>500</u> ~999		
User box H position	-479~0~+479		
User box V position	-464~0~+464		
Guide frame	On, <u>Off</u>	Frame outline	

OPERATION 09 GAIN SWITCH

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Gain low	-3, <u>0</u> , 3, 6, 9, 12, 18, 24, 30, 36, 42dB		-3
Gain mid	-3, 0, 3, <u>6</u> , 9, 12, 18, 24, 30, 36, 42dB		0
Gain high	-3, 0, 3, 6, 9, <u>12</u> , 18, 24, 30, 36, 42dB		+6
Gain turbo	-3, 0, 3, 6, 9, 12, 18, 24, 30, 36, <u>42</u> dB		+12
Shockless gain	On, <u>Off</u>		

OPERATION 10 TLCS

Total Level Control system

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Mode	Backlight, <u>Standard</u> , Spotlight	Auto-exposure compensation	
Speed	-99~0~+99	Tracking speed	
AGC	On, <u>Off</u>	Auto gain control	
AGC limit	3, 6, 9, <u>12</u> , 18dB	Max gain AGC will go to	
AGC point	F5.6, F4, <u>F2.8</u>	Ideal aperture AGC will aim for	
Auto shutter	On, <u>Off</u>		
Auto shutter limit	1/100, 1/150, 1/200, <u>1/250</u>	Limit auto shutter will go to	
Auto shutter point	F5.6, F8, F11, <u>F16</u>	Ideal aperture auto shutter will aim for	F8 ²

OPERATION 11 ZEBRA

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Zebra select	<u>1</u> , 2, Both		
Zebra 1 level	50~ <u>70</u> ~107%		70 ³
Zebra aperture level	1~ <u>10</u> ~20%	Zebra width	
Zebra 2 level	52~ <u>100</u> ~109%		100

OPERATION 12 DISPLAY ON/OFF

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Video warning levels	On, <u>Off</u>	High/low video level warnings	
Brightness display	On, <u>Off</u>	Numerical video level	
Histogram display	On, <u>Off</u>	Very useful	
Lens info	<u>Off</u> , Meter, Feet		
Focus position	On, <u>Off</u>		
Zoom position	On, <u>Off</u>		
Audio level meter	On, <u>Off</u>		
Timecode	On, <u>Off</u>		
Battery remain	On, <u>Off</u>		
Media remain	On, <u>Off</u>		
TLCS mode	On, <u>Off</u>		
Focus mode	On, <u>Off</u>		
White balance mode	On, <u>Off</u>		
Filter position	On, <u>Off</u>		
Iris position	On, <u>Off</u>		
Gain setting	On, <u>Off</u>		
Shutter setting	On, <u>Off</u>		
Color temp	On, <u>Off</u>		
Video format	On, <u>Off</u>		
System line	On, <u>Off</u>		
Rec mode	On, <u>Off</u>		
Extender	On, <u>Off</u>		
WRR RF level	On, <u>Off</u>		
Clip number (PB)	On, <u>Off</u>		

² Beyond F/8, resolution will start to fall through iris diffraction. This is normal for 2/3" sensors.

³ Set lowish to encourage mild underexposure for film-type shooting. Set it a little higher for normal video work.

OPERATION 13 AUTO IRIS

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Iris override	On, <u>Off</u>		
Iris speed	-99~0~+99		
Clip high light	On, <u>Off</u>		
Iris window	1, 2, 3, 4, 5, 6, Var	Select the window shape	
Iris window indication	On, <u>Off</u>		

OPERATION 14 WHITE SETTING

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
White switch 	<u>Memory</u> , ATW	Set the B position of the White Balance switch	
Shockless white	Off, 1, 2, 3	Off=instant, 3 is slow	
ATW speed	1, 2, 3, 4, 5	Reaction speed when B=ATW, 1=fast, 5=slow	
AWB fixed area	On, <u>Off</u>	On=25% width x height, Off=70% w x h	
Filer white memory	On, <u>Off</u>	On holds separate white balance for each filter position	

OPERATION 15 OFFSET WHITE

Modifications to white balance

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Offset white <A>	On, <u>Off</u>		
Warm cool <A>		Display of colour temperature, only approximate	
Warm cool balance <A>	-99~0~+99		
Offset white 	On, <u>Off</u>		
Warm cool 		Display of colour temperature, only approximate	
Warm cool balance 	-99~0~+99		

OPERATION 16 SHUTTER SELECT

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Shutter select	<u>Second</u> , Degree	Show shutter time as...	

OPERATION 17 TIME ZONE

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Zone	-12.00~00.00~+14.00	In 30 minute steps	

OPERATION 18 Clip

White balance stores

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Title prefix		Text input, alphanumerics	
Number set	0001~9999	Initial part of clip name	
Update	Media A, Media B	Updates the management files, press Exec to do it	

PAINT**PAINT 01 SWITCH STATUS**

main controls

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Gamma	On, <u>Off</u>		On
Black gamma	On, <u>Off</u>		Off ⁴
Matrix	On, <u>Off</u>		On
Knee	On, <u>Off</u>		On
White clip	On, <u>Off</u>		{film} Off {video, HDu, SDu, news} On
Detail	On, <u>Off</u>		On
Aperture	On, <u>Off</u>		On
Flare	On, <u>Off</u>		
Test saw	On, <u>Off</u>	Analogue sawtooth	

PAINT 02 WHITE

colour temperatures stored by the WHITE A/B switch

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Color temp <A>	Display temp K	Shows current white balance in A	

⁴ Black stretch is ok for digging detail from the shadows, but only if the noise level is low enough, use with care.

Color temp bal <A>	-99~0~+99	Fine control	
R gain <A>	-99~0~+99	Tweaking these changes the colour temperature setting	
B gain <A>	-99~0~+99		
Color temp 	Display temp K	Shows current white balance in B	
Color temp bal 	-99~0~+99	Fine control	
R gain 	-99~0~+99	Tweaking these changes the colour temperature setting	
B gain 	-99~0~+99		

PAINT 03 BLACK

master black settings

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Master black	-99~0~+99		
R black	-99~0~+99		
B black	-99~0~+99		

PAINT 04 FLARE

Flare control

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Flare	On, Off		
Master flare	-99~0~+99		
R flare	-99~0~+99		
G flare	-99~0~+99		
B flare	-99~0~+99		

PAINT 05 GAMMA

main gamma controls

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Gamma	On, Off	All curve bending	On
Master gamma	0.35~0.45~0.9	These controls have huge range, use with care	0.45
R gamma	-99~0~+99		0
G gamma	-99~0~+99		0
B gamma	-99~0~+99		0
Gamma select	STD: 1 ~ 5 ~ 6	4=SMPTE240 (4x), 5=ITU709 (4.5x), 6=BBC (5x) ⁵	{film} HG ⁶ {video, HDu, news} STD5 {SDu} STD6
	HG: 1~4	Hypergammas for cine-look	
Gamma category	STD, HG		

PAINT 06 BLACK GAMMA

independent slope at black

<i>Item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Black gamma	On, Off		On ⁷
Gamma level	-99~0~+99	Raises ITU709 slope to about 7.5x	28 {news} -50 ⁸
Range	Low/ L.mid/ H.mid/ High	Low=to 3.6%, L.Mid=to 7.2%, H.mid=to 14.4%, High=to 28.8%	H.mid

PAINT 07 KNEE

highlight compression

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Knee	On, Off		{film} Off {video} On
Knee point	50~95~109%	One soft bend	{film} 75% ⁹ {video} 85% {news} 95%
Knee slope	-99~0~+99	Affects segment slope, slightly curved	{film} -23 ¹⁰ {video} -35 ¹¹

⁵ Standard gammas: 1=DVW camcorder-like; 2=4.5 slope at black, not sure what curve this is; 3=3.5 slope at black, ENG contrasty style; 4=SMPTE240M, MUSE 1125 spec; 5=ITU709; 6=BBC 0.4 law.

⁶ Hypergammas as in other Sonys, good for film look: 1 compresses 325% headroom down to 100%; 2 compresses 460% down to 100%; 3 compresses 325% down to 109%; 4 compresses 460% down to 109%. Use 1 and 3 for low contrast scenes, 2 and 4 for high contrast scenes. Use 1 and 2 for shooting without grading, use 3 and 4 for shooting with a full grade.

⁷ Black gamma is useful for lifting shadows, but adds noise in blacks. Use only with low gain (e.g. 6dB or less) and with noise suppression On.

⁸ BBC News likes to use this to compress shadows, automatically obtaining a black level in the pictures.

⁹ Although I recommend using Hypergammas for film look, this knee setting is good for using the ITU-709 curve instead.

¹⁰ Knee settings are designed to capture 250% overexposure (1.5 stops, the measured limit of the camera under test when using standard gamma curves) into 109% coding range, and assumes that a full colour grade will be used, with no clipping during capture. Other settings would be needed for other uses.

			{news} +30
Knee saturation	<u>On</u> , Off		On ¹²
Knee saturation level	-99~0~+99		{news} Off ¹³ 0

PAINT 08 WHITE CLIP

highlight clipping

<i>item</i>	<i>range</i>		<i>comment</i>	<i>BBC</i>
White clip	<u>On</u> , Off			{film, video} Off ¹⁴ {HDu, SDu, news} On
White clip level	NTSC area	90.0~108.0~109.0%		102% ¹⁵
	PAL area	90.0~105.0~109.0%		

PAINT 09 DETAIL (HD MODE)

<i>item</i>	<i>range</i>		<i>comment</i>	<i>BBC</i>
Detail	<u>On</u> , Off		All DETAIL compensation	{film} On {video, HDu, SDu} On {news} Off
Level	-99~0~+99		Overall level	-5 ¹⁶
H/V level	-99~0~+99		Changes mix of horizontal and vertical sharpening	0
Crispensing	-99~0~+99		Signal level range that gets crisped	
Level depend	<u>On</u> , <u>Off</u>		Detail level dependency	
Level depend level	-99~0~+99		Detail level range affected	
Frequency	-99~0~+99		Frequency of detail compensation	+99 ¹⁷
Knee aperture	<u>On</u> , <u>Off</u>		Extra detail above knee point	Off
Knee aperture level	-99~0~+99			
Limit	-99~0~+99			
White limit	-99~0~+99		Detail +ve excursion limit	
Black limit	-99~0~+99		Detail -ve excursion limit	
V detail creation	NAM, G, <u>R+G</u> , Y		Source for edge detection	

PAINT 11 DETAIL (SD MODE)

<i>item</i>	<i>range</i>		<i>comment</i>	<i>BBC</i>
Detail	<u>On</u> , Off		All DETAIL compensation	On
Level	-99~0~+99		Overall level	-30 ¹⁸
H/V level	-99~0~+99		Changes mix of horizontal and vertical sharpening	-97
Crispensing	-99~0~+99		Signal level range that gets crisped	0
Level depend	<u>On</u> , <u>Off</u>		Detail level dependency	0
Level depend level	-99~0~+99		Detail level range affected	0
Frequency	-99~0~+99		Frequency of detail compensation	+50
Knee aperture	<u>On</u> , <u>Off</u>		Extra detail above knee point	On
Knee aperture level	-99~0~+99			0
Limit	-99~0~+99			0
White limit	-99~0~+99		Detail +ve excursion limit	0
Black limit	-99~0~+99		Detail -ve excursion limit	0
V detail creation	NAM, G, <u>R+G</u> , Y		Source for edge detection	

PAINT 12 APERTURE

<i>item</i>	<i>range</i>		<i>comment</i>	<i>BBC</i>
Aperture	<u>On</u> , Off		Separate APERTURE correction	On

¹¹ This knee setting will capture about 1.5 stops of overexposure without serious white crushing. This is probably as much as any news cameraman would tolerate, but still works well.

¹² Knee saturation helps to keep colours looking right when they're compressed in the knee.

¹³ Keep knee saturation off unless the scene contains bright colours which become overexposed as a result of the high knee point.

¹⁴ This allows video to go up to 109%, post-production operations must not clip this during ingest, the extra coding range is useful for capturing overexposure and allows grading to do better than otherwise.

¹⁵ 102% is safe and should not excite 'illegal colours' alarms in the normal production workflow for analogue television transmission.

¹⁶ This is a reasonable setting for Detail enhancement, but it causes some spatial aliasing, see test section below.

¹⁷ On test, one camera could not set a value above zero, implying that something had been set in a lower menu. The performance at this setting was acceptable.

¹⁸ This is a good setting for Detail enhancement, higher levels cause some spatial aliasing, see test section below.

Level	-99~0~+99	Overall level	25 ¹⁹
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PAINT 13 SKIN DETAIL

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Skin detail	On, <u>Off</u>	All skin detail on/off	Off
Area detection		Press rotary encoder to detect skin colour	
Area indication	On, <u>Off</u>	Zebra display of target area	
Level	-99~0~+99	Detail level	
Saturation	-99~0~+99	Saturation change	
Hue	0~359	Hue change	
Width	0~40~359	Target hue angle width	

PAINT 14 MATRIX

camera matrix

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Matrix	<u>On</u> , Off	All matrices	On
Preset matrix	<u>On</u> , Off	Standard matrices	On
Preset select	1 ~ 2 ~6	1=SMPTE240, 2=ITU709, 3=SMPTE-WIDE, 4=NTSC, 5=EBU(i.e.PAL), 6=ITU601	2
User matrix	On, <u>Off</u>	Roll your own matrix	Off
User Matrix R-G	-99~0~+99		
User Matrix R-B	-99~0~+99		
User Matrix G-R	-99~0~+99		
User Matrix G-B	-99~0~+99		
User Matrix B-R	-99~0~+99		
User Matrix B-G	-99~0~+99		

PAINT 15 MULTI MATRIX

multi-linear matrix, for advanced knob twiddlers only

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Multi matrix	On, <u>Off</u>	Roll your own multi-segment matrix	Off
Area indication	On, <u>Off</u>	Use zebra to show active region	
Color detection	Exec	Press rotary encoder to select current area	
Axis	<u>B</u> , B+, Mg-, Mg, Mg+, R, R+, Yl-, Yl, Yl+, G-, G, G+, Cy, Cy+, B-	16 hue angle zones	
Hue	-99~0~+99	Adjustment	
Saturation	-99~0~+99	Adjustment	

PAINT 16 V MODULATION

white vertical sawtooth lens shading correction

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
V modulation	<u>On</u> , Off		
Master v modulation	-99~0~+99	Collective control	
R v modulation	-99~0~+99		
G v modulation	-99~0~+99		
B v modulation	-99~0~+99		

PAINT 17 LOW KEY SATURATION

extra saturation control for dark bits

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Low key saturation	On, <u>Off</u>		Off ²⁰
Level	-99~0~+99	Collective control	
Range	Low, L.mid, H.mid, <u>High</u>	Same ranges as for Black Gamma	

PAINT 18 NOISE SUPPRESS

Reduces hf noise

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Noise suppress	<u>On</u> , Off		On ²¹

MAINTENANCE**MAINTENANCE 01 WHITE SHADING**

lens corrections

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Channel select	<u>Red</u> , Green, Blue	Select channel, lower items change	
R/G/B white H saw	-99~0~+99		
R/G/B white H para	-99~0~+99		

¹⁹ Aperture correction looked much more smooth and resulted in sharper pictures with fewer problems.

²⁰ Low key saturation can be useful when the noise level is low enough, use with care because it will worsen chroma noise, which might not be visible during the shoot.

²¹ Beware, noise suppression is effective in reducing noise, but can lose detail, see the test section below.

R/G/B white V saw	-99~0~+99		
R/G/B white V para	-99~0~+99		
White saw/para	<u>On</u> , Off	All on/off	On

MAINTENANCE 02 BLACK SHADING

lens corrections

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Channel select	<u>Red</u> , Green, Blue	Select channel, lower items change	
R/G/B black H saw	-99~0~+99		
R/G/B black H para	-99~0~+99		
R/G/B black V saw	-99~0~+99		
R/G/B black V para	-99~0~+99		
Master black	-99~0~+99	All on/off	On
Master gain (TMP)	-3dB to 42dB	Gain changes, only for this operation	

MAINTENANCE 03 BATTERY

voltage parameters, sets warning levels

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Info Before end	<u>5</u> , 10, 15, ... 95, 100%	Change these only if you really know what you're doing	
Info End	<u>0</u> , 1, 2, 3, 4, 5%		
Sony Before end	<u>11.5V</u> ~17.0V	Change these only if you really know what you're doing	
Sony End	<u>11.0V</u> ~11.5V		
Other Before end	11.5V~ <u>11.8V</u> ~17.0V		
Other End	<u>11.0V</u> ~14.0V		
DC in Before end	11.5V~ <u>11.8V</u> ~17.0V		
DC in End	<u>11.0</u> ~14.0V		
Detected battery	Display only		
Type detection	<u>Auto</u> / Other		Auto allows auto detection of battery type
Segment no.10	<u>11.0V</u> ~ 17.0V	These settings are for when "Other" is selected. Each voltage is the value at which the numbered segment in the battery level indicator turns off	
Segment no.9	11.0V ~ <u>16.0V</u> ~ 17.0V		
Segment no.8	11.0V ~ <u>15.0V</u> ~ 17.0V		
Segment no.7	11.0V ~ <u>14.0V</u> ~ 17.0V		
Segment no.6	11.0V ~ <u>13.5V</u> ~ 17.0V		
Segment no.5	11.0V ~ <u>13.0V</u> ~ 17.0V		
Segment no.4	11.0V ~ <u>12.5V</u> ~ 17.0V		
Segment no.3	11.0V ~ <u>12.0V</u> ~ 17.0V		
Segment no.2	11.0V ~ <u>11.5V</u> ~ 17.0V		
Segment no.1	<u>11.0V</u> ~ 17.0V		

MAINTENANCE 04 AUDIO

Boring stuff starts here

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Front mic select	Mono/ <u>Stereo</u>		
Audio ch3/4 mode	Ch1/2, <u>Switch</u>	Which source routes through to ch3 and 4	
Front mic ch1 ref	-70, -60, <u>-50</u> , -40, -30dB		
Front mic ch2 ref	-70, -60, <u>-50</u> , -40, -30dB		
Rear mic ch1 ref	-70, <u>-60</u> , -50, -40, -30dB		
Rear mic ch2 ref	-70, <u>-60</u> , -50, -40, -30dB		
Line input ref	<u>+4</u> , 0, -3, EBUL		
Min alarm volume	<u>Off</u> , Set	Minimum volume for alarm, off=almost inaudible, set=just audible	
Speaker attenuate	<u>Off</u> , 3, 6, 9, 12dB	Speaker volume control, doesn't affect headphones	
Headphone out	<u>Mono</u> , Stereo		
Reference level	<u>-20</u> , -18, -16, -12dB, EBUL	1kHz tone level	
Reference out	<u>0</u> , +4, -2dB, EBUL		
Ch1&2 agc mode	<u>Mono</u> , Stereo	Channels 1/2 as two monos or stereo pair	
Ch3&4 agc mode	<u>Mono</u> , Stereo		
Agc spec	<u>-6</u> , -9, -12, -15, -17dB	AGC saturation level	
Limiter mode	<u>Off</u> , -6, -9, -12, -15, -17dB	Limiter level for manual control	
Output limiter	On, <u>Off</u>		
Ch1 wind filter	On, <u>Off</u>		
Ch2 wind filter	On, <u>Off</u>		
Ch3 wind filter	On, <u>Off</u>		
Ch4 wind filter	On, <u>Off</u>		
Au sg (1kHz)	On, <u>Off</u> , Auto	On=1kHz on bars, Auto=1kHz when ch1 audio select switch (inside) is on Auto	
Mic ch1 level	Side1, <u>Front</u> , Front+Side1	Front=controlled by mic level control on front of camera, and so on	
Mic ch2 level	Side2, <u>Front</u> , Front+Side2		

Rear1/WRR level	Side1, <u>Front</u> , Front+Side1	
Rear2/WRR level	Side2, <u>Front</u> , Front+Side2	
Audio ch3 level	Side3, <u>Front</u> , Front+Side3	
Audio ch4 level	Side4, <u>Front</u> , Front+Side4	

MAINTENANCE 05 WRR SETTING

Wireless radio mic

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
WRR Valid ch sel	<u>All</u> , Ch1	Enables both channels or just ch1	
WRR ch select	<u>Tx1</u> , Tx2		
WRR delay comp	<u>On</u> , Off	On delays sound by about 8mS	
TX		Displays selected transmitter number	
TX audio peak		Displays whether signal is limiting	
TX input level	Mic, Line	Displays whether channel is mic or line level	
TX att level			
TX lcf freq		Low cut filter	
TX system delay	<u>Auto</u> , 0~8ms		

MAINTENANCE 06 TIMECODE

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
TC out	<u>Auto</u> , Generator		
DF/NDF	<u>DF</u> , NDF	Drop frame, only in NTSC-land	
LTC UBIT	<u>Fix</u> , Time	Fix=you set data, Time=records time	
Counter display	<u>Counter</u> , Duration		

MAINTENANCE 07 ESSENCE MARK

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Ret shot mark 1	<u>On</u> , Off	Shot marking on card, see operations manual for details	
Ret shot mark 2	<u>On</u> , Off		

MAINTENANCE 08 CAMERA CONFIG

General stuff

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Rec tally blink	<u>On</u> , Off	Blinks tally at end of battery or disc	
Rec review	3, 10sec, Clip	Clip=show all the latest clip	
HDSDI remote i/f	<u>Off</u> , Chara, G-tally, R-tally	Control of remote recorder via HDSDI	
Color bars select	<u>Arib</u> , 100%, 75%	ARIB bars are actually better than SMPTE	Arib ²²
RM common memory	<u>On</u> , Off	Memory sharing for remote control box	
RM rec start	<u>RM</u> , Cam, Para	Record enable from remote control box	
Image invert	<u>On</u> , Off	Vertical mirroring	

MAINTENANCE 09 PRESET WHITE

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Color temp <P>	1500~3200~50000K	White balance in Preset White	
C temp balance <P>	-99~0~+99	Fine control of preset white	
R gain <P>	-99~0~+99		
B gain <P>	-99~0~+99		
AWB enable <P>	<u>On</u> , <u>Off</u>	Allows Preset to store an auto white balance	

MAINTENANCE 10 WHITE FILTER

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
ND filter c temp	<u>On</u> , Off	Allows a separate colour temperature setting for each ND filter position.	
ND flt c temp <1>	3200, 4300, 5600, 6300K		
ND flt c temp <2-4>	3200,4300, 5600, 6300K	Electrical equivalent of colour temperature filters. Select ... in C and D to remove them	
Electrical CC <A>	3200, 4300, 5600, 6300K		
Electrical CC 	3200, 4300, 5600, 6300K		
Electrical CC <C>	3200, 4300, 5600, 6300K, ...		
Electrical CC <D>	3200, 4300, 5600, 6300K, ...		

MAINTENANCE 11 DCC ADJUST

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
DCC function select	<u>DCC</u> , Fix	DCC is auto knee, Fix uses values below	
DCC dynamic range	400, 450, 500, 550, 600%	Exposure value the curve reaches in DCC ²⁴	

²² SMPTE colour bars are the accepted standard form HDTV production, but ARIB are more useful, the PLUGE (black-setting) bars are at -2%, +2%, 4%, while SMPTE's are at -4%, +4%. Saturation check is still in blue, versus the grey horizontal bar.

²³ **BEWARE.** Use this feature **ONLY** if you intend to use only preset white balance. It applies a considerable offset to any white balancing you do.

DCC point	-99~0~+99	Minimum knee point	
DCC gain	-99~0~+99		
DCC delay time	-99~0~+99	Reaction speed	
DCC peak filter	-99~0~+99	Sensitivity to peak exposure	

MAINTENANCE 12 AUTO IRIS 2

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Iris window	<u>1</u> , 2, 3, 4, 5, 6, Var	Size of iris window, Var=variable below	
Iris window ind	On, <u>Off</u>	Frame marker for window	
Iris level	-99~0~+99	Target value	
Iris apl ratio	-99~0~+99	Ratio of peak to mean in detection	
Iris var width	40~500~999	Frame width in Variable	
Iris var height	70~500~999	Frame height in Variable	
Iris var H pos	-470~0~+479	Centring	
Iris var V pos	-464~0~+464		
Iris speed	-99~0~+99		
Clip high light	On, <u>Off</u>	Ignores brightest areas	

MAINTENANCE 13 FLICKER REDUCE

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Mode	Auto, On, <u>Off</u>	Auto enables it when flicker's detected	
Frequency	60, 50Hz	Select lighting frequency	

MAINTENANCE 14 GENLOCK

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
H phase (HD)	-999~0~+999	Horizontal phase, HD	
H phase (SD)	-99~0~+99	Horizontal phase, SD	
Reference	Internal/ Genlock		

MAINTENANCE 15 ND COMP

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
ND offset adjust	On, <u>Off</u>	Allows separate colour balance for each filter position	
Clear ND adjust	Exec		

MAINTENANCE 16 LENS

Auto back focus

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Auto FB adjust	Exec	Works only with supported lenses	

MAINTENANCE 16 AUTO SHADING

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Auto black shading	Exec	Start automatic black shading tweak	
Reset black shad	Exec	Clear ND filter compensations	
Master gain (tmp)	-6dB~42dB	Temporary gain for this adjustment	

MAINTENANCE 17 TRIGGER MODE

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
i.Link trigger mode	Internal, <u>Both</u> , External	For recording to SxS, or i.Link (Firewire) device	

MAINTENANCE 17 CLOCK SET

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Date/Time		Set current date and time	
12H/24H	12, <u>24H</u>		
Date mode	<u>YYMMDD</u> , MMDDYY, DDMYY		

MAINTENANCE 18 LANGUAGE

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Language	<u>English</u> , Chinese		

MAINTENANCE 19 HOURS METER

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Hours (sys)		Displays cumulative hours, cannot be reset	
Hours (reset)		Displays cumulative hours since last reset	
Reset	Exec		

²⁴ Note that DCC seems to use the full exposure range of the camera, while setting manual knee only extends up to about 250%.

MAINTENANCE 20 VERSION

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Version		Displays firmware version	
Version up	Exec	Updates the firmware	

FILE**FILE 01 ALL**

None of this affects pictures or sound

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Display mode	<u>Date & Time</u> , Model name	What appears in the file list	
All file load	Exec	All file stores everything	
All file save	Exec		
File ID	Exec	Up to 16 characters, description	
All preset	Exec	Return to Preset values	
Store all preset	Exec	Store current settings as preset	
Clear all preset	Exec	Clear to factory settings	
3 sec clr preset	On, <u>Off</u>	Allows Menu Cancel switch to clear presets	

FILE 04 SCENE FILE

less dangerous memory stick stuff

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
1		Up to 5 files in camera, 100 on a stick. Deals with Paint, shutter and white balance. Goes into sub-menu to do the load/save.	
2			
3			
4			
5			
Standard		Returns to standard setting	
Display mode	<u>Date & Time</u> , Model name	What appears in the file list	
Scene recall mem	Exec	Brings up secondary menus to save/load scene files from internal memory	
Scene store mem	Exec		
Scene recall SxS	Exec	Brings up secondary menus to save/load scene files from SxS card	
Scene store SxS	Exec		
F.ID		16 characters file name	

FILE 03 REFERENCE

less dangerous memory stick stuff

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Reference store	Exec	Save REF file in from memory stick into camera	
Reference clear	Exec	Reset REF file to factory settings	
Reference load	Exec	Read REF file from memory stick	
Reference save	Exec	Save Ref file to memory stick	
F.ID		16 characters file name	
Scene white data	On, <u>Off</u>	Allow/disallow white data in scene file	

FILE 04 LENS FILE

<i>item</i>	<i>range</i>	<i>comment</i>	<i>BBC</i>
Display mode	<u>Date & Time</u> , Model name	What appears in the file list	
Lens recall mem	Exec	Brings up secondary menus, load/save files to internal memory	
Lens store mem	Exec		
Lens recall SxS	Exec	Brings up secondary menus, load/save files to SxS card	
Lens store SxS	Exec		
F.ID		16 characters file name	
Source		Shows memory number of last loaded lens file	
Lens no offset	Exec	Clear the lens file	
Lens auto recall	<u>Off</u> , On, S.no	Enables auto loading of lens file, if lens can talk to the camera to identify itself	
Lens ID	Exec	Name of connected lens, if it can talk to the camera	
Lens Manufacturer	Exec	Manufacturer	
M V modulation	-99~0~+99	Vertical sawtooth lens compensation	
Lens center H	-40~0~40	Compensates horizontal position of lens centremarker And vertical	
Lens center V	-40~0~40		
Lens R flare	-99~0~+99	White balance compensation	
Lens G flare	-99~0~+99		
Lens B flare	-99~0~+99		
Lens W-R ofst	-99~0~+99		
Lens W-B ofst	-99~0~+99		
Shading ch select	<u>Red</u> , Green, Blue	Select channel	

Lens R/G/B H saw	-99~0~+99		
Lens R/G/B H para	-99~0~+99		
Lens R/G/B V saw	-99~0~+99		
Lens R/G/B V para	-99~0~+99		

2 Measurement results

All measurements were made using the HDSDI output. Pictures were displayed on a Sony 32" grade 1 CRT monitor, a waveform monitor, and recorded using proprietary software for analysis.

2.1 Sensitivity

Sensitivity was not measured directly. The specification claims F/12 at 2000lux for 59.94Hz, F/13 for 50Hz.

2.2 Colour performance, Gamma curves, Exposure range

Using a Colorchecker chart, the colour performance was judged to be very good with the standard ITU709 gamma curve. The yellow had the usual slight greenish tinge which is common in many cameras but not unusually so. Skin tones were very good, and no specific colour stood out as being inaccurate. The picture did not seem to be as highly saturated as in other Sony cameras, and consequently was rather more acceptable.

The other gamma curves were not investigated since they are all copies of curves which have already been tested in other cameras.



Figure 1 Colorchecker chart

Although the camera menus hint that 600% overexposure can be coped with by the Hypergamma curves, it was not possible to get such high levels by using the conventional gamma curves. The maximum overexposure which could be dealt with that way was about 1.5 stops, about 300%. The gamma settings in the menu reflect that. It is assumed that the Hypergamma curves really do cope with more overexposure.

The camera shows no response to infra-red illumination.

2.3 Resolution and aliasing, 1080-line

All testing was done with a circular zone plate test chart having 6 sinusoidally modulated patterns. The six patterns explore luminance and chroma channels on the top row, RGB channels on the bottom row, the samples shown here are each only one quadrant of the luminance (grey scale) pattern. Images were captured uncompressed from the control unit via HDMI converted to HDSDI.

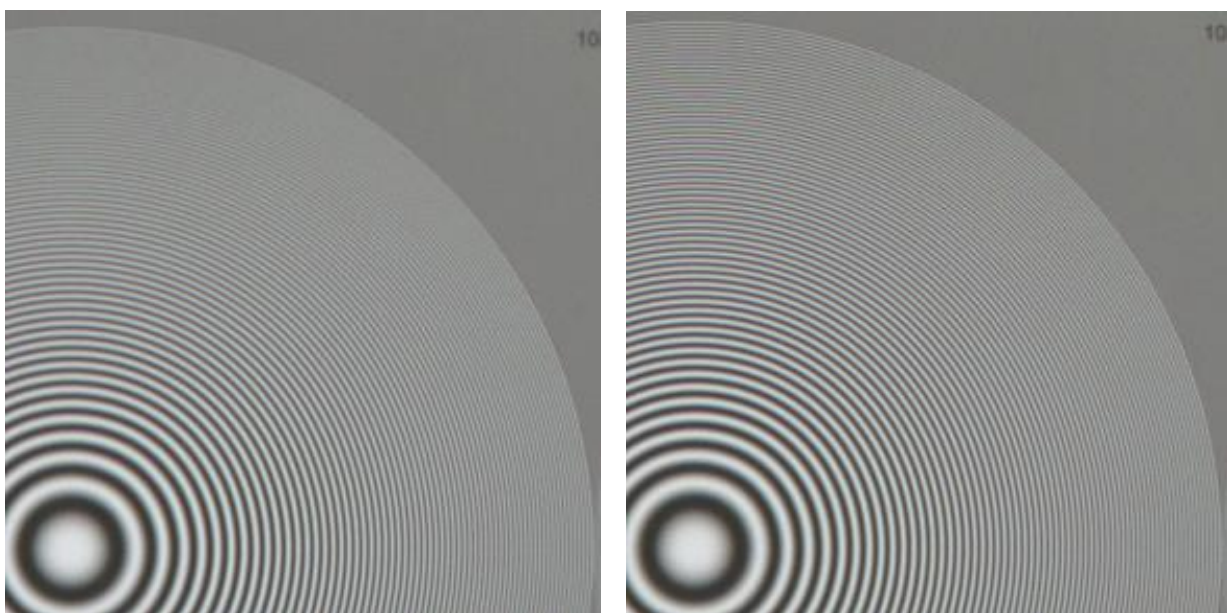


Figure 2 resolution, detail off (a) interlaced

(b) progressive

In 1080-interlaced mode, 1920x1080i/25 in EBU parlance, there are no visible null zones or aliases. Resolution is well maintained horizontally and vertically, and there is clearly an optical spatial low pass filter to prevent aliasing. Vertical resolution falls cleanly, resulting from the interpolation process needed to generate interlace from a progressive sensor. Clearly, the sensors are full 1920x1080.

In 1080-progressive mode, there is clearly more vertical resolution.

Since the resolution is quite clean, it is possible to use some detail enhancement to sharpen the pictures a little. Excessive levels of enhancement cause artificial brightening of the image due to asymmetric enhancements (separate control of positive- and negative-going edge gain is missing in this camera, although there are settings to limit the excursions, which isn't the same thing), and can cause null zones to appear where the enhancement is effectively adding a separate gamma correction as a function of frequency.

Detail settings were derived which sharpen the picture without suffering from such problems, detail level -5, aperture level +25. Normally, the Aperture function is a correction for the mathematically precise falling of resolution with frequency, as a result of the sensor sampling process, and a reasonably high level actually does correct for this droop quite well. The Detail control is best thought of as an artistic control, because it is highly customisable and therefore quite difficult to get right. In this combination, the results work very well together.



Figure 3 resolution, progressive, detail on

2.4 Resolution, 720-line

Performance at 720p was tested using the same zone plate chart, at the same framing, thus the 1280x720 image should not resolve more than the central 2/3 of the resolution pattern by both width and height. Again, detail enhancement was turned off for this test.

There is little or no evidence of aliasing from the higher frequencies, clearly the down-sampling has been done rather well. There is a vertical null zone centred on 630 lines, and a fainter one centred on 960 lines. The one at 960 is due to third harmonic distortion of the sensor's 1080-line vertical resolution (the camera gamma does not exactly match the gamma of the print medium). The one at 630 is due to the same distortion, but this time of the output format's 720-line structure. Neither should be any problem in real use.

Performance at 720p is good.

2.5 Resolution, SD 576-line

Performance at SDTV was tested in the same way, thus only a small central portion of the chart should be preserved, approximately 37% by 53%.

Clearly, the horizontal down-scaling from 1920 to 720 pixels has been done quite well, there is little or no aliasing visible except near the 720 extinction frequency, which is normal. But, vertically, there is a clear aliasing visible. Vertical frequency content appears to have been resampled twice, since the centre of the alias pattern has been moved from 1080 to 540-lines, using a filter which does not adequately reject the higher frequencies.

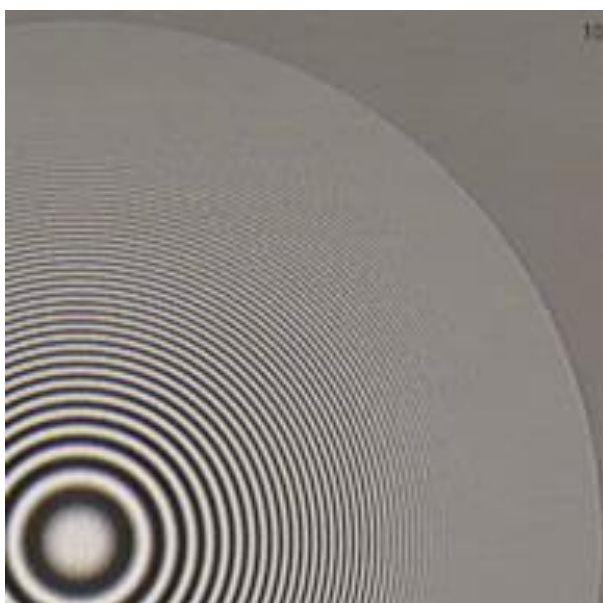


Figure 4 Resolution, 720p, detail off

Since the alias content from the higher frequencies is being presented as lower frequencies, they cannot subsequently be rejected by any normal processing, and the factor setting for SD detail enhancement emphasises this content significantly, and unacceptably.

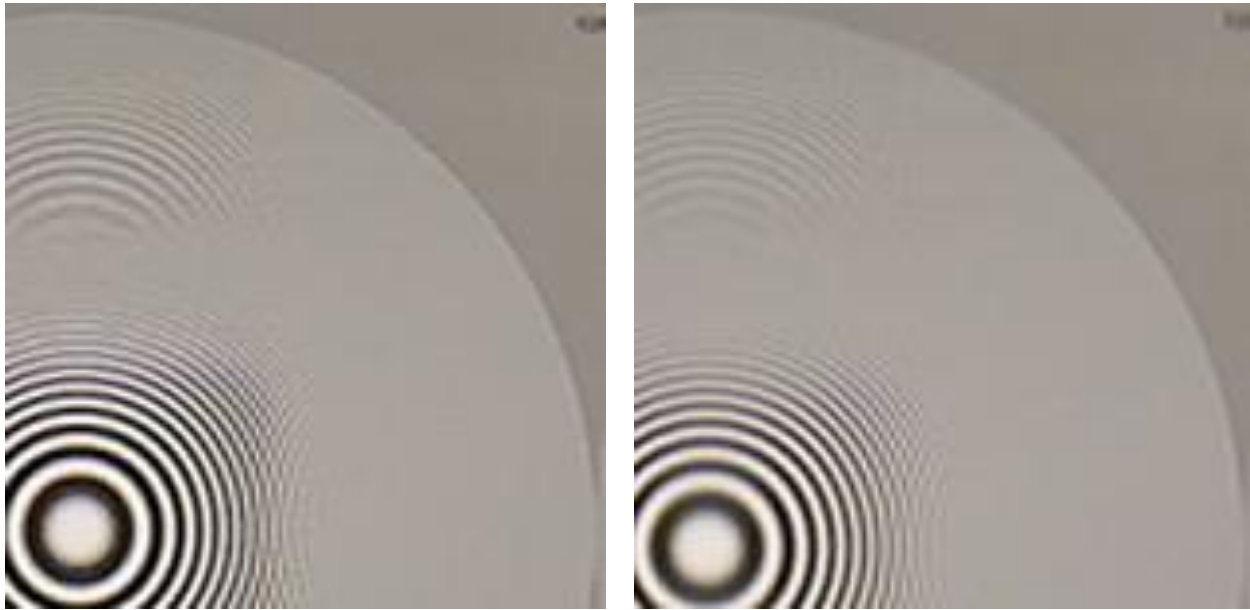


Figure 5 Resolution, SD 576-line, (a) factory detail (b) optimised detail

The optimised settings for down-conversion considerably improve the appearance of the aliasing, but cannot eliminate them altogether. While the SD performance is adequate, it is not as good as is possible with sufficiently complex down-conversion re-sampling filters.

Note that, for shooting in SD mode, the camera needs to have an option card, CBK-DV01, installed (or enabled). The camera can be set in HD mode (such that the SDI output is SD), and yet record SD, which does not produce the best results. For best SD performance, the camera must be set to SD such that the SDI output is SD.

2.6 Video Noise

The specification claims that video noise level is -56dB, or -59dB with noise suppression switched on.

Measurements were taken on an evenly lit white card, exposed at various levels. Image files were captured via HDSDI as data files, then transcoded and decoded in software before performing a software noise analysis. The plot shows the noise level in dB versus video signal level.

In order to make the measurements more certain, the camera gain was set to +18dB, and the results modified by 18dB to compensate. Also, the measurement files were high-pass filtered to remove any image shading and tilt, and a further 6dB gain applied to avoid any effects due to premature data quantising. So, a further 6dB compensation has been applied to the results, so the graph is representative the camera performance at normal 0dB gain setting.

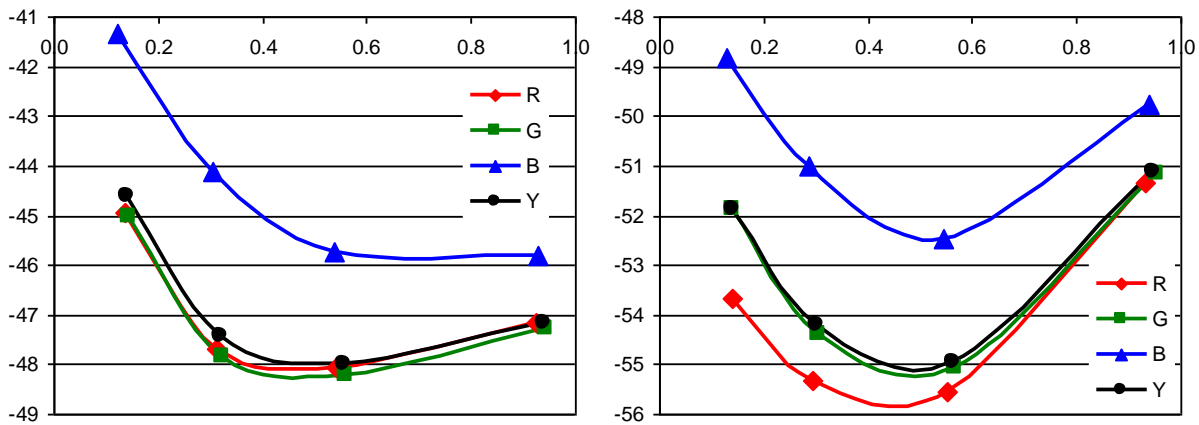


Figure 6 Video noise levels (a) neat camera

(b) noise suppression on

As expected, blue is considerably more noisy, because silicon is much less sensitive to blue than red. The distribution of noise level versus signal level should, ideally, follow the slope of the gamma curve (ITU709 in this case). Noise levels near black should rise significantly, and the curves shown are as expected for a camera with gamma-correction done in the digital domain, and without any image processing to gain a noise advantage at the expense of resolution. However, the rise in noise levels near white are unexpected in a camera with 2/3" sensors. The normal explanation for a rise near white is shot noise, but that should only be relevant in cameras with significantly smaller sensors.

The values at mid-grey are representative of the performance in linear mode (since the slope of the ITU-709 curve is unity at approximately mid-grey). The luma noise values at mid-grey are about -48dB for the 'neat' camera with noise suppression off, and about -55dB with noise suppression on, an improvement of about 7dB, which is worth having. However, it is quite clear that these are only the lowest or best values of noise, at other luma levels the noise level is significantly higher; the improvement near white is from -47.1 to -51.1dB, only about 4dB; near black, the improvement is from -44.6 to -51.9dB, about 6.3dB. Clearly, the noise reduction is video-level dependant. To test the other implications of noise reduction, two more exposures were made of the zone plate, at +18dB gain and low exposure level (artificially raised with post-production gain to see the effect).

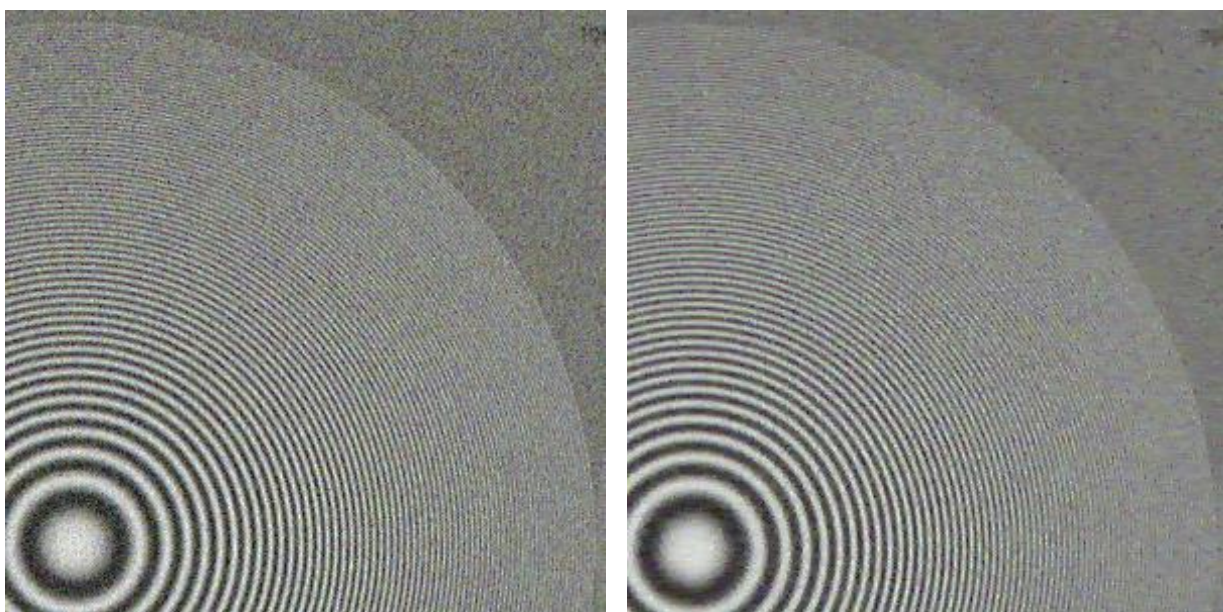


Figure 7 Resolution, +18dB (a) NS off

(b) Noise suppression on

Evidently, the noise suppression is effective, but has lost some resolution, and has left a rather plastic appearance to noise in the plain area. There are also some noise spikes which have escaped the noise suppressor, which has probably become confused by the zone plate signal itself. Nevertheless, noise suppression is worth having provided the resolution loss can be tolerated.

2.7 Rolling shutter

The camera has 3 CMOS sensors, and can therefore be expected to have a rolling shutter through the scanning process. Thus the camera can be expected to make moving edges lean away from the motion, flash exposure to cause part-field/frame illumination, and for pictures shot when the camera is vibrating to appear to have been shot through a jelly.

To demonstrate this, a rotating fan was recorded, rotating clockwise, with the camera shutter set to 1/1000. The downward motion of blades on the right is highly expanded, the upward motion of blades on the left is highly compressed. There is no cure for this, it is the price to be paid for having CMOS sensors with rolling shutter. The effect is much less marked when the shutter is set normally, 1/50 second for 50Hz operations, but is still visible.



Figure 8 Rolling shutter (a) fan static

(b) fan rotating, 1/1000 shutter

2.8 Conclusion

The camera performs well in all aspects, although the best recording format is not considered to be acceptable for top quality broadcast HDTV (50Mb/s is considered to be the minimum acceptable rate for MPEG-2). SD performance is not quite as good as it could be, but is quite adequate for most purposes.