Colorimetric and Resolution Settings for the

Sony-HVR A1/HC1

Alan Roberts

Data for this is taken from a long examination of a production model of the Sony HDV camcorder, HVR-A1E, and comparison with a HVR-HC1E. This is a HDTV camcorder, physically very similar to the standard-definition PDX10, with a single 1"/3 cmos sensor (5.9mm diagonal). It records in HDV (1080i/25, 50Hz interlaced) format onto miniDV tapes, and standard definition (576i/25) as either miniDV or DVCAM.

The camera is essentially a consumer model; the A1 has some pretensions to professional capture, such as having a removable sound pod which will accept sound via XLR connectors at mic or line level, and slightly different features from its companion, the HC1. Both have an integral lens (Zeiss, 5.1~51mm) and viewfinder, with side lcd panel, and seem aimed at the high-end consumer market rather than broadcast or professional, which would normally demand interchangeable lenses. The HC1 is the simpler camera, and incorporates a flash for stills photography.

The cameras have many internal menus for setting the performance and very few external controls, although enough to control most of the important features. There are analogue-only video outputs (components at HD and SD, composite and S-video at SD, all via multi-pin connectors) and digits via IEEE1394 Firewire (known as "i.Link" by Sony) and USB.

Measurements were made only on an A1. The normal assessment procedure for cameras could not be used, largely because the A1 does not have a selectable test signal. Therefore, testing had to be done the hard way, via the lens. Recommended settings allowing for a "video-look" and a "film-look" have been derived, although there are some serious compromises that have to be taken into account.

It is useful to think of the camera, when used with "film-look", to be mimicking a film camera and telecine, with "best light" transfer to tape. Measurement results are given after the settings tables, in order to explain the decisions. At best, the camera can deliver about 10 stops of exposure range, similar to other HD cameras, but it is easy to set the camera such that exposure range drops to 7 stops or less. In the target market for this camera, a grading operation may well not be used in post-production, so the settings should be used with care.

While HDV performance is just about acceptable, there are significant problems with its performance as an SD camera for professional or broadcast purposes. Performance, with the recommended settings, is probably adequate for consumer use. The reasons for this statement are given in the measurements section (2.2.4 and 2.2.5) of this document.

The controls for these cameras are not as flexible as for full "broadcast" cameras, so more effort was expended in measuring performance than in trying to derive a specific "look" for it. The menus are all activated via the touch-sensitive lcd panel, there are very few external physical controls. Iris control conjoins gain (to +18dB maximum), iris (F/1.8 to F/4), neutral filter (clear to 1/8), and iris again (F/4 to F/11). Very small apertures (less than F/4) soften the picture and produce visible colour-fringing due to diffraction effects in the iris. If external neutral density filters are not available when shooting in very bright light, then the shutter is the better alternative to using apertures physically smaller than F/4.

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, the values indicate the range, and no scales are given. The numbers represent the count of bars in the thermometer presentation from the left, usually 1 to 16 with 8 being the central (default) value (the HC1 often has 1 to 8 with 4 being the central, default value). Default settings are underlined. My recommendations are in the last column, labelled "use", where appropriate. Settings are given for:

h HDV recording
s SDTV recording, miniDV or DVCAM (although I do not recommend shooting SD, see measurements section below)
v Television production
f Film-look television

In the tables, items that have an important effect on picture appearance are highlighted with grey background. Items are marked A or H to show which camera they exist in (A1/HC1). The **mode** column indicates whether each menu item is available in Camera Tape (c), Camera Memory (m), or Play/Edit (p) power-switch settings. Rather than just making assertions about performance, I have included measurement results that illustrate the reasons for recommending settings.

Note that, in each power-switch mode, the menus can be separately customised, adding or removing any menu item from the entire set of menus.

This is not intended as a replacement for reading the manual.

1 Menu settings

SWITCHES and BUTTONS				
name			**feature**	**comment**
Lens L	Focus/zoom	AH	Man Focus, Auto, Man Zoom	Obvious
	Tele macro	AH	Push-push	Close focus, to about 19”
	Expanded focus	AH	Push-push	Enlargement for focusing, only in Manual
	Backlight	AH	Push-push	Opens about a stop
	Exposure/vol	AH	Lever and push-push	Volume (speaker/cans) or exposure if enabled in menu, press button to take control
R	Nightshot	AH	Off, On	
	Assign	A	Push-push	One function, assigned via menu
	Flash	H	Push-push	Control of stills flash
Lcd panel	Display/batt info	AH	Push-push	Show info, shows battery status when off
	Auto lock	AH	Off, On	Locks exposure
	W	AH	Push	Zoom wide
	T	AH	Push	Zoom tele
	Rec start/stop	AH	Push-push	Record start/stop
Back	Zoom	AH	W/T	
	Photo	AH	Push	Takes stills to Memory Stick
	Record	AH	Push-push	Start/stop
	Power	AH	Off, Camera Tape, Camera Memory, Play/Edit	Menu contents change with setting

CAMERA SET menu				Basic camera settings, Power=Camera Tape	
item	**cam**	**mode**	**range**	**comments**	**use**
Program AE	AH	cm-	Auto, Spotlight, Portrait, Beach&Ski, Sunset&moon, Landscape	Auto-exposure personalities, Auto-lock must be Off to select	
Spot meter	AH	cm-		Expose for parts of the picture, Auto-lock must be Off, enables Manual exposure	
Exposure	A	cm-	Auto, Manual	Manual allows setting from this menu	
White bal	AH	cm-	Auto, Outdoor, Indoor, One push	White balance	
Sharpness	AH	cm-	1~16, 8 (1~8, 4 in HC1)	Horizontal/Vertical detail enhancement	7 (h), 4 (s)
Shuttr speed	AH	c--	Auto, Manual (1/3~1/10,000)	Slower than 1/50 lowers frame rate	1/50
Auto shutter	AH	c--	On, Off	Works with iris and filter	
AE shift	AH	cm-	1~16, 8	Drives auto exposure aim point	
Camera color	AH	cm-	1~16, 8	Saturation, affects recording	8
Cinematone γ	A	c--	Off, Type1, Type2	Gamma, see explanation notes	Type1 (f)
Cineframe	A	c--	On, Off	Sets 25fps film mode, see explanation notes	Off
WB shift	AH	cm-	1~16, 8	Drives auto white balance aim point	
ATW sense	A	cm-	Intelligent, High, Middle, Low	Auto-White accuracy, high=tight, low=loose	
Black stretch	A	c--	On, Off	Essential for good colouring	On
Spot focus	AH	cm-		Focus specific part of the picture, Focus/Zoom switch must be Manual	
Peaking	A	cm-	Off, White, Red, Yellow	Highlights focused pixels, cancels Zebra	
Flash Mode	AH	c--	On, Auto, Auto ⊙	For stills on HC1	

set	Level	AH	c--	High, Normal, Low	Control of flash, also flash level	
Super NS		AH	c--	On, Off	IR nightshooting, only when switch is On	
NS light		AH	cm-	On, Off	IR lamp under lens	
Color slow		AH	c--	On, Off	Lowers frame rate, only on Auto exposure	
Zebra		AH	cm-	Off, 70, 100	Zebra exposure level, cancels if Peaking is set	
Histogram		AH	cm-	On, Off	Brightness histogram	
Self-timer		AH	cm-	On, Off	10-second delayed record start	
Digital zoom		AH	c--	Off, 20x, 40x	Lens is 10x, max is 120x in HC1	Off
Steadyshot		AH	c--	On, Off	Electronic image stabiliser, zooms in slightly	
Conv.lens		AH	c--	Off, Wide, Tele	Tailors Steadyshot to conversion lenses	
Full scan		A	c--	On, Off	When Off, Steadyshot doesn't change zoom	
Exposure lever		A	cm-	Exposure, AE shift	Assign Exposure lever	

MEMORY SET menu

Memory stick functions, power=Camera Memory

item		cam	mode	range	comments	use
Still set	Burst	AH	-m-	Off, Normal, Exp. brktg	Normal=3,5 or 25 frames (depends on res) at 2/second. Exp=3 frames, bracketed exposure	
	Quality	AH	-mp	Fine, Standard	Set image "quality"	
	Image size	AH	-m-	1920x1440, 1920x1080, 1440,1080, 640x480	Set image size	
All erase		AH	--p	All files, Current folder	Wipe files from Memory Sstick	
Format		AH	-mp	Yes, No	Format Memory Stick	
File No..		AH	-mp	Series, Reset	Reset restarts picture numbers at #1	
New folder		AH	-mp	Yes, No	Creates a new folder	
Rec. folder		AH	-mp	Select	Select folder to save into	
PB folder		AH	--p	Select	Select folder to play from	

PICT. APPLI. menu

Special effects, video and stills

item		cam	mode	range	comments	use
Fader		AH	c--	White, Black, Mosaic, Monotone	Video crossfades, press OK to start	
Slide show		AH	--p		Automatic slide show of recorded stills	
D. effect		A	c-p	Still, Flash, Trail, Old movie	Various naff effects	
D. effect		H	c-p	Still, Cinema effect, Flash, Trail, Old movie	Various naff effects, *Cinema effect* is same as *Cineframe* in A1	
Pict. effect		AH	c-p	Off, Sknton Detail, Neg. art, Sepia, B&W, Solarize, Pastel, Mosaic	More naff effects (Sknton Detail softens skin detail)	
Int, rec-stl		AH	-m-	On, Off	Start interval recording,(1, 5, 10 minutes)	
Shot trans	Shot trans	AH	c--	Store, Exec	Store zoom/focus settings (A and B) for transition	
	Trans time	AH	c--	2~15, 4 seconds	Set transition time	
	Trans curve	AH	c--	Linear, Soft top, Soft trans	Profile for transition	
	Start timer	AH	c--	Off, 5, 10, 20 seconds	Set delay to start transition	
	Rec. link	AH	c--	Off, Shot A, Shot B	Select shot A or B when starting	
Demo mode		H			Show-off mode	
PictBridge print		AH	--p		Print stills	

EDIT/PLAY menu

VTR matters

item	cam	mode	range	comments	use
Var. spd pb	AH	-mp	various	Various tape playback ack controls	
Rec ctrl	AH	-mp	Stop, Pause, Record	Controls for recording from firewire input	
Burn DVD	H	-mp	Exec, Cancel	Make a dvd slide show from stills	
End search	AH	cmp	Exec, Cancel	Plays final 5 seconds of latest recording, and pauses	

STANDARD SET menu

General VTR matters

item		cam	mode	range	comments	use
VCR HDV/DV		AH	--p	Auto, HDV, DV	Playback mode, Auto does not work with Edius	
Rec format		AH	c-p	HDV1080i, DV	Camera and recording mode	HDV 1080i
DV set	Rec mode	A	c-p	DVCAM, DV SP	SD mode, only when Format is DV	
	Rec mode	H	c-p	SP, LP	SD mode, only when Format is DV	
	Wide select	AH	c--	16:9 wide, 4:3	Aspect ratio	
	Audio mode	AH	c--	FS32K, FS48K	Audio data rate, 32k=4ch 12-bit, 48k=2ch 16 bit	
	Audio mix	AH	--p	1~16, 8	Balance ch ½ with ¾ in 32k mode	
Volume		AH	cmp	1~16, 8	Speaker/cans level, also on Exposure/Vol switch	
Audio ch sel		A	--p	CH1 CH2, CH1, CH2	Playback audio channels	
Multi-sound		H	--p	Stereo, CH1, CH2	Playback audio channels	
Mic NR		A	c--	On, Off	Mic noise reduction	
Mic level		AH	c--	Auto, Manual	Internal/3.5mm mic level, manual control is here	
Ext sur mic		AH	c--	Wide stereo, Stereo	Setting for ECM-HQP1 surround mic	
XLR set	AU.ch1 level	A	c--	Auto, Manual	Channel 1 (Left) level, manual control is here	
	AU.ch2 level	A	c--	Auto, Manual	Channel 2 (Right) level, manual control is here	
	AU man gain	A	c--	Separate, Linked	Links level controls	
LCD.vf set	LCD bright	AH	cmp	1~32, 16	Lcd panel (flip-out) contrast	
	LCD bl level	AH	cmp	Normal, Bright	Lcd panel brightness	
	LCD color	AH	cmp	1~15, 8	Lcd panel saturation	
	VF b light	AH	cmp	Normal, Bright	Viewfinder (monocular) brightness	
	VF power	A	cmp	Auto, On	Viewfinder off when lcd open	
	VF colour	A	cmp	On, Off	Viewfinder monochrome	
	Allscan mode	A	cmp	On, Off	Underscan lcd in HDV mode, setting does not survive power cycle	
Component		A	cmp	576i, 576p/576i, 1080i/576i	Select display type for component output	
Component		H	cmp	576i, 1080i/576i	Select display type for component output	
i.LINK conv		AH	c-p	On, Off	Off=output as recorded, On=output SD	
Downconvert		A	c-p	Squeze, Letter box, Edge crop	For all downconversions	
TV type		H	c-p	16:9, 4:3	For all downconversions	
USB select		AH	c-p	Memory stick, PictBridge Print	View or print stills	
Disp guide		AH	cmp		Help with screen layout, touch controlled	
Status check		AH	c-p		Shows interesting things, more on A1	
TC/UB set	TC/UB disp	A	c-p	TC, UB	Change time display between time code and user bits	
	TC preset	A	c-p		Set time code	
	UB preset	A	c-p		Set user bits	
	TC run	A	c-p	Rec run, Free run	Time code continuation	
	TC make	A	c-p	Regenerate, Preset	Regen makes continuous TC, Preset changes it	
	UB time rec	A	c-p	On, Off	On sets user bits to time-of-day	
Markers	Centre	A	cm-	On, Off	Centre cross	
	4:3	A	cm-	On, Off	4:3 mask	
	Safety zone	A	cm-	On, Off	80% margin, overscan	
	Guide frame	A	cm-	On, Off	"Rule of thirds" markers	
Guide frame		H	cm-	On, Off	"Rule of thirds" markers	
Color bar		A	c--	Off, Type1, Type2	Type1 is SMPTE	
Color bar		H	c--	Off, On	Only SMPTE	
Data code		AH	c-p	Off, Date/time, Camera Data	Playback info, data=camera settings (e.g. exposure)	
Remaining		AH	c-p	Auto, On	Auto shows remaining tape on play	
Remote ctrl		AH	cmp	On, Off	Disables remote control	
Rec lamp		AH	cm-	On, Off	Red light	
Beep		AH	cmp	On, Off	Annoying beep whenever you do anything	
Disp output		AH	cmp	Lcd panel, V-out/panel	Sends all v/f data on video output	
Menu rotate		AH	cmp	Normal, Opposite	Reverses sense of rotation	
Calibration		AH	c-p		Realigns touch screen menus	
Date rec		A	c--	On, Off	Superimpose date/time on recording	

Quick rec (HDV)	A	c--	On, Off	Off =normal (slow uptake), On=crash start (wrecks Avid)	Off
Assign button	A	cmp	No assign, Status check, Steadyshot, One push WB, Histogram, Color bar	Assign something to the Assign button	
A.shut off	H	cmp	5min, Never	Auto shut off	

TIME/LANGUAGE menu

Down to the basic

item		cam	mode	range	comments	use
Clock set		AH	cmp		Set time and date	
World time		AH	cmp		Set local offset from home (e.g. GMT)	
Language	"E" variants	AH	cmp	German, Greek, English, Simplified English, Spanish, French, Italian, Dutch, Portuguese, Russian, Arabic, Persian	This is really dangerous, how do you get back if you set it to something silly?	English
	"P" variants	AH	cmp	English, Simplified English, Latin American Spanish, Traditional Chinese, Simplified Chinese or Thai		

2 Measurements

In order to explore the gamma-correction curve (and thus to establish the exposure range over which the camera works) and resolution, tests had to be done via the lens, since there is no internal test signal. All measurements were made on frames extracted from recordings, either HDV or DV as appropriate, thus they deal with pictures as they are available to the normal user, and not to a user who takes the camera output to some other recording format.

2.1 Gamma correction and exposure range

A calibrated Macbeth chart (Fig.1) was used, exposed at one-stop intervals; the grey scale on the chart thus presented a large number of data points on the curve throughout the contrast range.

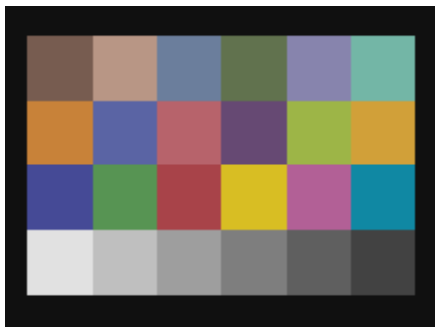

Figure 1, Macbeth chart

At first sight, there appears little difference between the four versions (Fig.2) (*Black Stretch* is the normal gamma curve with *Black Stretch* switched on, *Black Stretch* seems not to affect either of the *Cinetone* curves). All four clearly have a built-in "knee" function to cope with highlights.

All four curves will accommodate 250% exposure, but the performance near black (Fig.3) is very different, curve-fitting has revealed the underlying equations:

***Normal*: (A1/HC1)**

$V = 3.6L$ for L<0.018, else

$V = (1+0.089)L^{0.485} - 0.089$

Compressed 4:1 for V>0.88

***Black Stretch*: (A1)**

$V = 4.5L$ for L<0.018, else

$V = (1+0.072)L^{0.485} - 0.072$

Compressed 3.5:1 for V>0.87

This is very similar to the ITU.709 curve, recommended for HDTV cameras:

$V = 4.5L$ for L<0.018, else

$V = (1+0.099)L^{0.45} - 0.099$

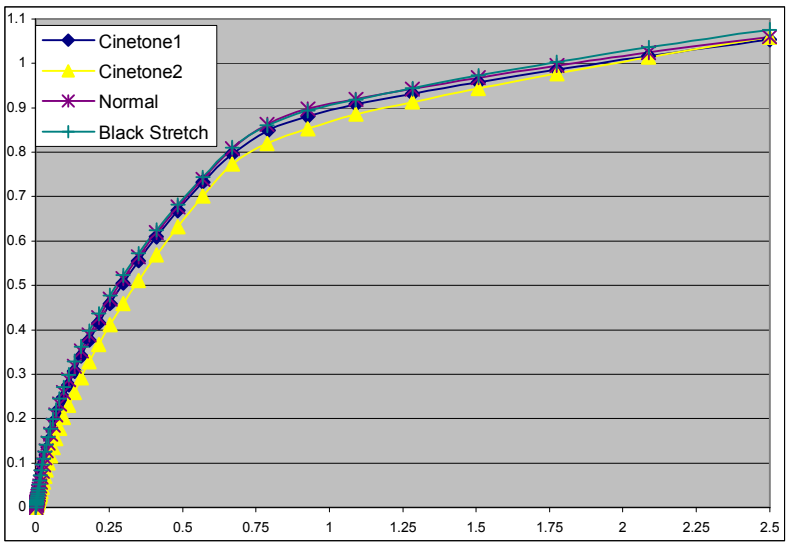

Figure 2, gamma-correction curves

***Cinetone1*: (A1)**

$V = 3.3L$ for L<0.018, else

$V = (1+0.088)L^{0.5} - 0.088$

Compressed 4:1 for V>0.86

***Cinetone2*: (A1)**

$V = 1.8L$ for L<0.018, else

$V = (1+0.071)L^{0.58} - 0.071$

Compressed 4:1 for V>0.83

Clearly, *Cinetone2* has substantial "Black Press" and is intended to mimic low-contrast film, as projected, while *Cinetone1* does a reasonable job of mimicking negative film in the same way that Varicam's *Film-Rec* mode does. The contrast or exposure range that each curve can capture depends on the definition of the lower limit. Normally, I measure the exposure level at which

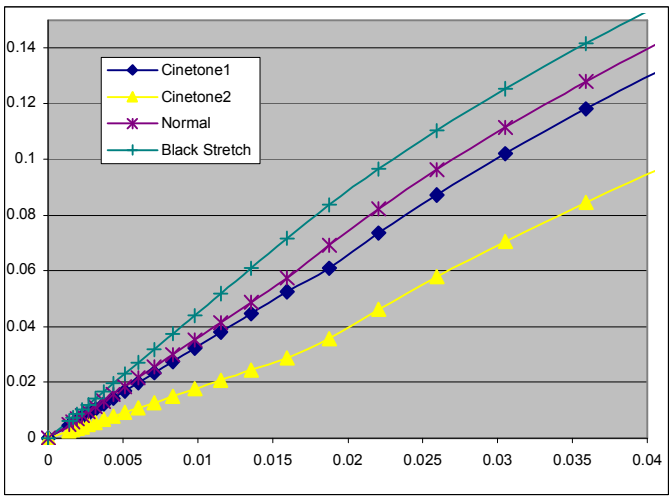

Figure 3, gamma-correction near black

the gamma-corrector output produces 1% or 2% video signal, and express contrast range as the peak exposure (250% in this case) divided by this value. For the four found curves, this results in:

	Exp 1%	Ratio	Stops	Exp 2%	Ratio	Stops
Normal	0.0029	862:1	9.75	0.0055	454:1	8.85
Black Stretch	0.0021	1190:1	10.25	0.0045	555:1	9.15
Cinetone1	0.0030	833:1	9.7	0.0061	410:1	8.68
Cinetone2	0.0055	454:1	8.85	0.0109	230:1	7.85

Using the *Black Stretch* setting, colour rendition is quite good; in the chromaticity diagram (Fig.4) of Macbeth chart colours (tungsten illumination), each colour is shown at it's specified, rebalanced, chromaticity, and a cross shows where the camera places it. *Normal* setting is satisfactory for consumer use, but not for professional or broadcast HDTV capture.

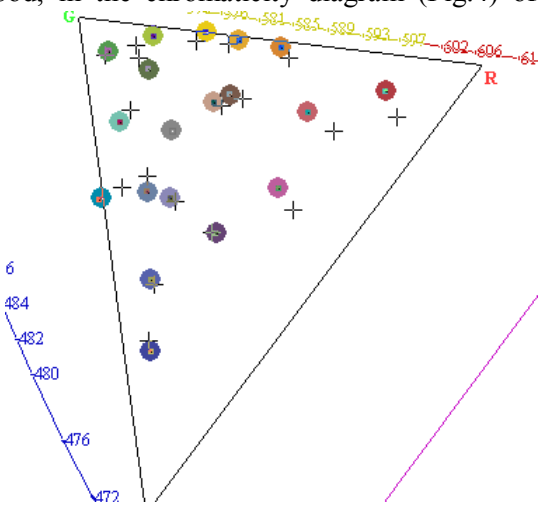

Figure 4, chromaticity diagram

Errors are reasonably well distributed, reds are over-saturated and hue-shifted towards magenta, but there is no significant correction that can be made using the *Camera color* control apart from reducing from the default setting (middle, 8) by one or two steps. However, such increases in saturation are perfectly normal in television and are to be expected. Skin tones are acceptable.

Other distortions occur with other settings, particularly, the *Cinetone1* setting is quite good provided the reduction on contrast range can be tolerated.

2.2 Sharpness and resolution

This camera is of considerable interest for several reasons. It uses a single sensor, so must use interpolation to extract RGB signals, the filter performing this function should, ideally, not cause excessive aliasing within the video bandwidth. It also works in three modes (HD video, HD film-look, SD video), the requirements for each being quite different.

Figure 5, Zone Plate test chart

The test card was a BBC Zone Plate, designed for 1080-line television. This reproduction of it (Fig.5) shows the layout, but also shows considerable aliasing caused by the scaled reproduction here. The squirrel was there to hold flags identifying camera settings. Each circular zone is a phase-space of spatial frequencies, with zero (dc) in the middle, extending to 1080 lines/picture height (l/ph) vertically, and 1920 lines/picture width (l/pw) horizontally. The scales are linear, so it is relatively easy to make measurements. In the camera, the image is recorded as 1440 pixels by 1080 lines, i.e. a pixel-based aspect ratio of 4:3, but this illustration is shown with the correct aspect ratio.

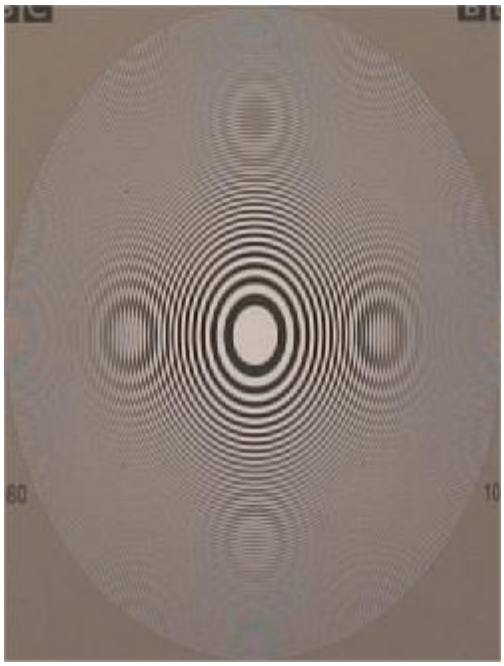

Figure 6, single zone circle

Recordings were made in each camera mode, with *Sharpness* settings from minimum to maximum sharpness. Software then extracted frequency responses from captured still frames such as this, a cropping of one circular zone, shown here (Fig.6) as an elliptical zone because of the HDV non-square pixel sampling. Alias patterns are clearly visible as circular patterns not centred on dc, the centres of these may be

easy to locate, but the action of the RGB-extracting filter tends to confuse by placing aliases where they are not expected. The direct measurement of these frames is highly confusing, some skill is needed to interpret them, so I have drawn the extracted responses as graphs.

Data-extraction is non-trivial; specialised software was used to establish the frequency response, plus a considerable degree of interpretation was needed to make sense of the results, which must not be taken as 100% reliable, they are intended only to illustrate what is going on, and not as a set of exact measurements. Nevertheless, sufficient data could be extracted to produce a reliable analysis of the camera's performance.

2.2.1 1080i horizontal

The camera's horizontal response (Fig. 7) has a zero at 1440 l/pw, caused by the HDV sampling. The basic frequency response (the orange curve, *Sharpness* setting 1, minimum) clearly shows aliasing between 1440 and 1920, this occurs because the Zeiss lens is rather too sharp for the camera, and the sensor has 1920 pixels horizontally while the recording sub-samples at 1440. Ideally, the filter which produces RGB signals from the single sensor should suppress these alias signals, it is a little disappointing that they are so clearly visible. The effect of this on a real picture will be to produce an artificial "busy-ness" on high detail such as cloth patterns, roofing tiles etc.

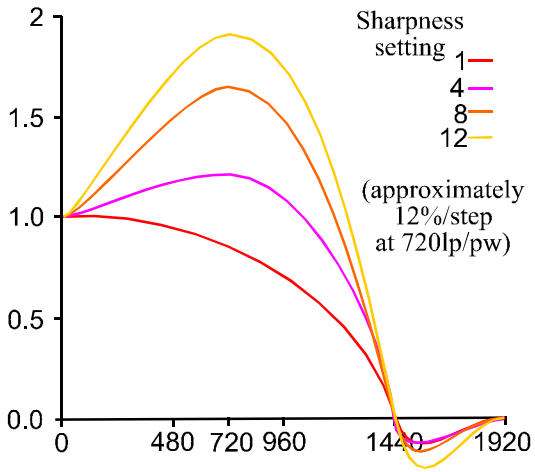

Figure 7, 1080i horizontal response

The effect of the *Sharpness* control is to boost content centred on 720 l/pw. This shows that the detail enhancement works on the 1920-pixel data, and uses a detail-extracting filter probably with coefficients -¼, ½, -¼. This is as good as can be done in such a camera. However, the control is rather vicious, the measurement at setting 12 is dubious, and setting to 16 gave an image too difficult to work with.

Since the *Sharpness* filter acts on the full 1920 structure, it tends to emphasise the aliases above 1440 l/pw as well as the wanted frequencies below that. I recommend not using excessive amounts of *Sharpness*, to avoid this. Conventionally, the *Sharpness* control might be used to maximally flatten the frequency response, a setting of 2 or 3 would do that, but is not the ideal solution. For that, it is better to look at edges, fortunately, the Zone Plate test card has a black/white transition that is suitable (Fig.8). Clearly a setting of 8 (middle) causes a slight overshoot in the transition from grey to white and black to grey, but not the other way. A setting of 7 appears to be about right for images to be captured sharply but without the trade-mark outline ringing so common in SD video production.

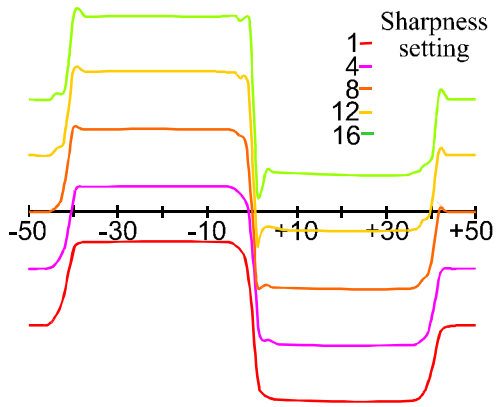

Figure 8, 1080i edges

2.2.2 1080i vertical

Vertical response is far more interesting, because the camera needs to make two phase-interleaved 540-line fields, so it ought to be easy, but it rarely is (Fig.9). At 540 l/ph there is a dip in the response, but not a null. Undoubtedly this is caused by the interpolation of the Bayer pattern, and frequencies above this are a mixture of base-band (wanted) and

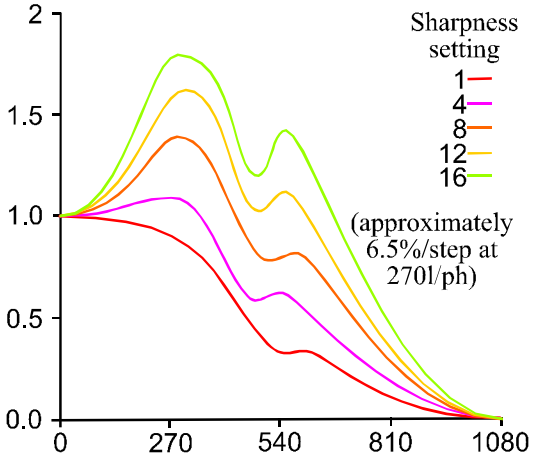

Figure 9, 1080i vertical response

aliased (unwanted) frequency content.

The *Sharpness* control appears to produce a boost centred on about 270 l/ph (1080/4). The shape of the boosting appears to match a filter with coefficients of -¼, 0, ½, 0, -¼, i.e. the same filter as is used horizontally, but used in the lines of the field rather than the frame, as would be expected in an interlaced camera.

Again, a *Sharpness* setting of 7 produces acceptable pictures, higher settings show ringing on edges and produce disturbing inter-line twitter on interlaced displays.

2.2.3 1080 cineframe vertical

The *Cineframe* setting is supposed to produce a "film-look", presenting complete frames rather than interlaced fields. Delivery of such signals is known as Progressive with Segmented Frames (psf) and is the conventional way that film is scanned for television. In conventional film scanning, each field is derived directly from the film frame, but many electronic cameras and image processing systems use the interlaced signal to derive the film-like frame. When done well (e.g. in a Snell & Wilcox hardware Arc) this is very successful because it uses more than one input frame for analysis and may be adaptive as well. The cheapest way to do this is to duplicate alternate fields, throwing away the others, which can look very nasty indeed.

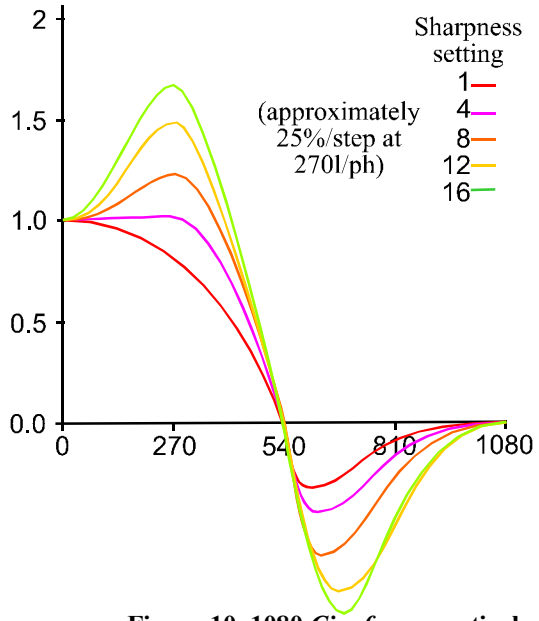

Figure 10, 1080 *Cineframe* vertical

When done properly in the camera, the sensor should be progressively scanned, so the interlace artefacts should go away, and *Sharpness* could work at higher frequencies. But the same basic shape is clearly present (Fig.10); and there are no base-band frequencies above 540, only alias. This confirms that the *Cineframe* mode does not derive the entire frame directly from the sensor, but interpolates it from one interlaced field (i.e. field-doubling). This comes as no surprise.

The *Sharpness* control is still centred on 270 l/ph indicating that the same filter has been used, and acts upon alternate lines, with coefficients -¼, 0, ½, 0, -¼. However, there is a difference, the aliased frequencies above 540 l/ph are all lower in amplitude than in the interlaced case (by about 3dB) confirming interpolation from a single interlaced field rather than the simplistic field duplication.

It is probably best to ignore the *Cineframe* camera mode and always shoot interlaced, using a software de-interlacer to mimic film motion. Combined with use of the *Cinetone1* gamma curve, this should result in a reasonable film-look. The simplistic processing used in the camera does not perform well. However, if a lens diffuser is used, the alias content may well be low enough to avoid problems from the aliases (by eliminating the higher frequencies that cause aliases) and this mode may be useful. For example, a wide-angle lens adaptor may well be exactly the right solution for shooting film-style since they generally do not transmit the full spatial frequency range with full amplitude, acting as a softening filter or diffuser.

Again, a *Sharpness* setting of 7 seems suitable, if *Cineframe* is to be used at all.

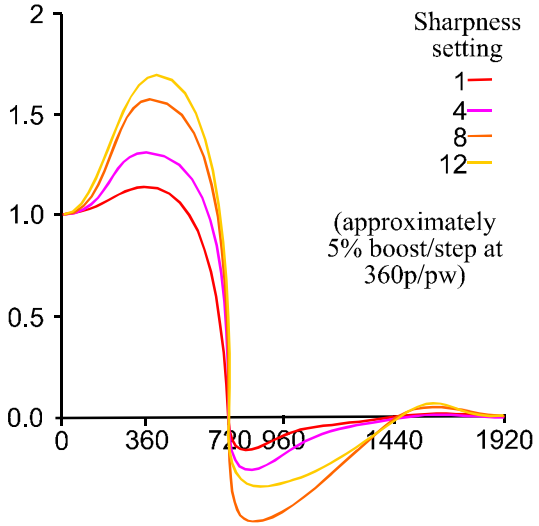

Figure 11, 576i horizontal response

2.2.4 576i horizontal

The camera can be used to record standard definition (SD)

pictures either in conventional mini-DV or in DVCAM formats. For this, the camera must perform a down-conversion. Ideally, this would be done in the filter used for extraction of RGB signals from the Bayer pattern, but…..

The response (Fig.11) shows a null at 720 l/pw as expected, and one at 1440 as well. So it is evident that the down-conversion has been done on the HD signal, and not directly from the sensor. This is disappointing, since the down-conversion has not suppressed the higher frequencies. It is also apparent that the down-conversion filter itself is a relatively simple one, because it inherently boosts frequencies at around 360 l/pw. Thus, the *Sharpness* control's effect has been enhanced by the down-conversion process. It is also obvious that the *Sharpness* filter has the same form as for vertical HD, i.e. -¼, 0, ½, 0, -¼.

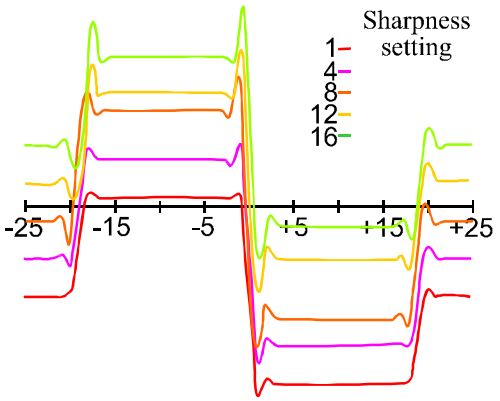

Figure 12, 576i edges

As a result, very little extra *Sharpness* is needed, perhaps none at all, but as for HDV operation, it is a good idea to look at edges rather than frequency responses (Fig.12). There is no setting of *Sharpness* that does not produce an overshoot, but setting 4 is a reasonable compromise. Certainly, the default setting of 8 produces significant overshoots, which may be acceptable for consumer production, but in a semi-professional camera it should be possible to minimise this sort of effect, it is a shame that it cannot be eliminated completely.

2.2.5 576i vertical

In the light of the revelations found above, it should come as no surprise that the vertical response is not exactly what we want either. Ideally, the camera should change the interpolation filter that extracts RGB from the Bayer pattern of pixels on the sensor such that it delivers the fields of the 576-line signal directly. Then, no aliases would ever be present in the output picture

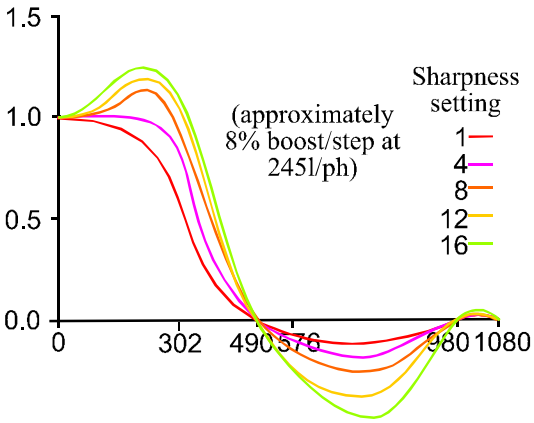

Figure 13, 576i vertical response

However, no camera is ideal, and again it is evident (Fig.13) that the down-conversion is done on the interlaced HD signal and not on the sensor output. The basic response (orange, *Sharpness*=1) has nulls at 490 and 980 l/ph, and shows considerable aliasing above 490. Since the 576i system is not normally expected to carry content above about 70% of 576 l/ph (about 400 l/ph), this is worrying. The aliasing appears in the pictures as interlace twitter, and is quite visible as a general "busy-ness".

The *Sharpness* control has its peak at about 302 l/ph, 28% of 1920. A filter that has such a response has coefficients -⅛, -⅛, 0, 0, ½, 0, 0, -⅛,-⅛ which uses inputs from the lines of the original HDTV signal, but omitting alternate pairs of lines. It boosts frequencies between 490 and 980 as well as those below 490, greatly adding to the alias content of the picture There is no *Sharpness* setting that delivers vertical resolution that does not have visible aliasing. This is a disappointment, leading to a conclusion that this camera is not really suited to shooting SD, better to shoot HDV and perform the down-conversion in software or hardware after recording.

The vertical frequency content between 490 and 980 l/ph appears as an alias (Fig.14, 396 by 497 pixels, enlarged to avoid printing problems). Clearly there is an interaction between the Bayer-extraction filter and the down-conversion process. There are also some diagonal frequencies, near 1920, that show aliases, which are likely to cause cross-colour in a PAL coded signal. It is also clear that the same down-converter is used for deriving the SD output of the camera when it is in HDV mode. Thus there is no advantage in using a separate recorder for SD, the damage has already been done. By comparison, the interlaced version (Fig.15) shows no such problems.

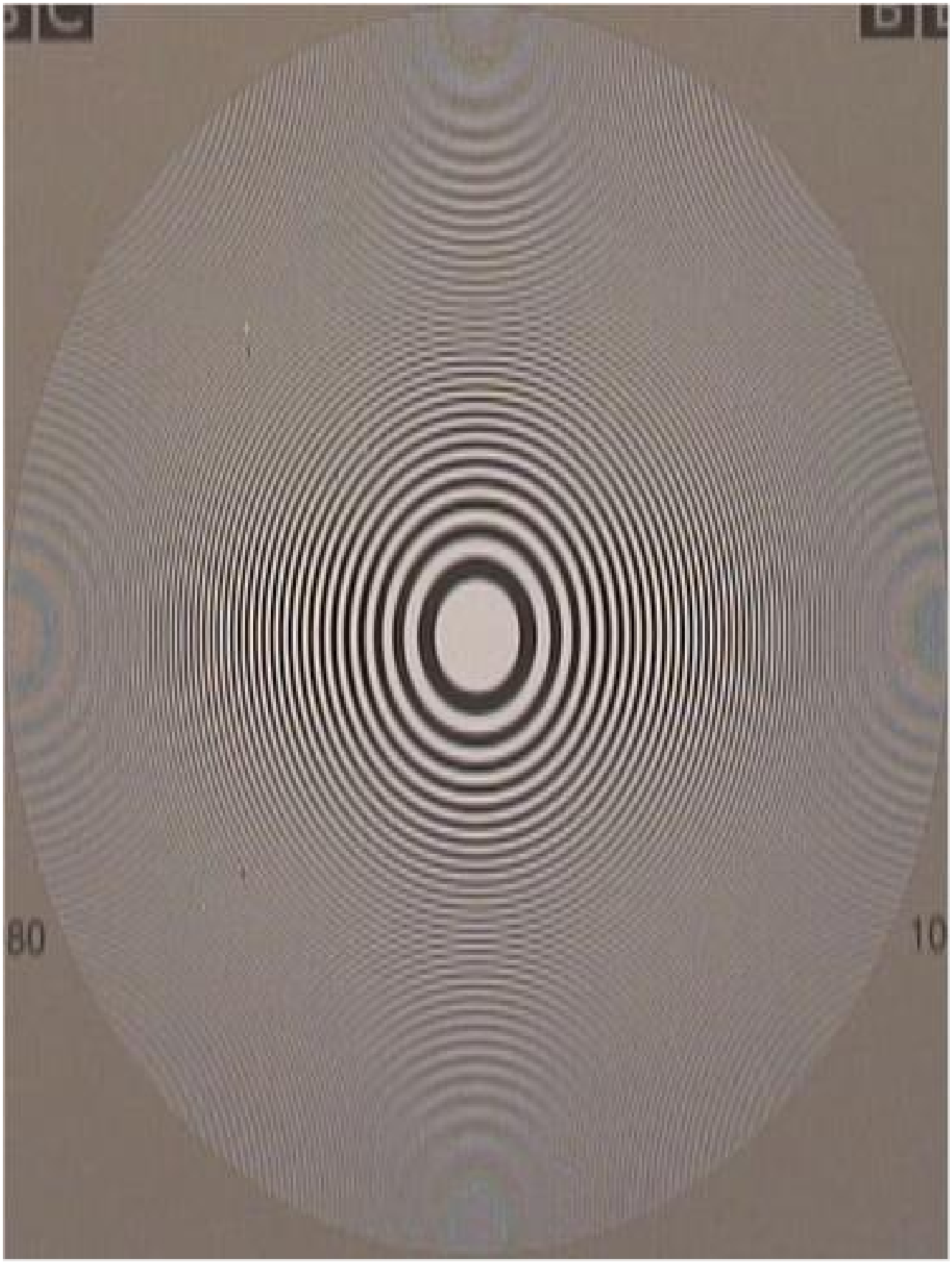

Figure 14, single zone, *Cineframe* mode, *Sharpness*=8

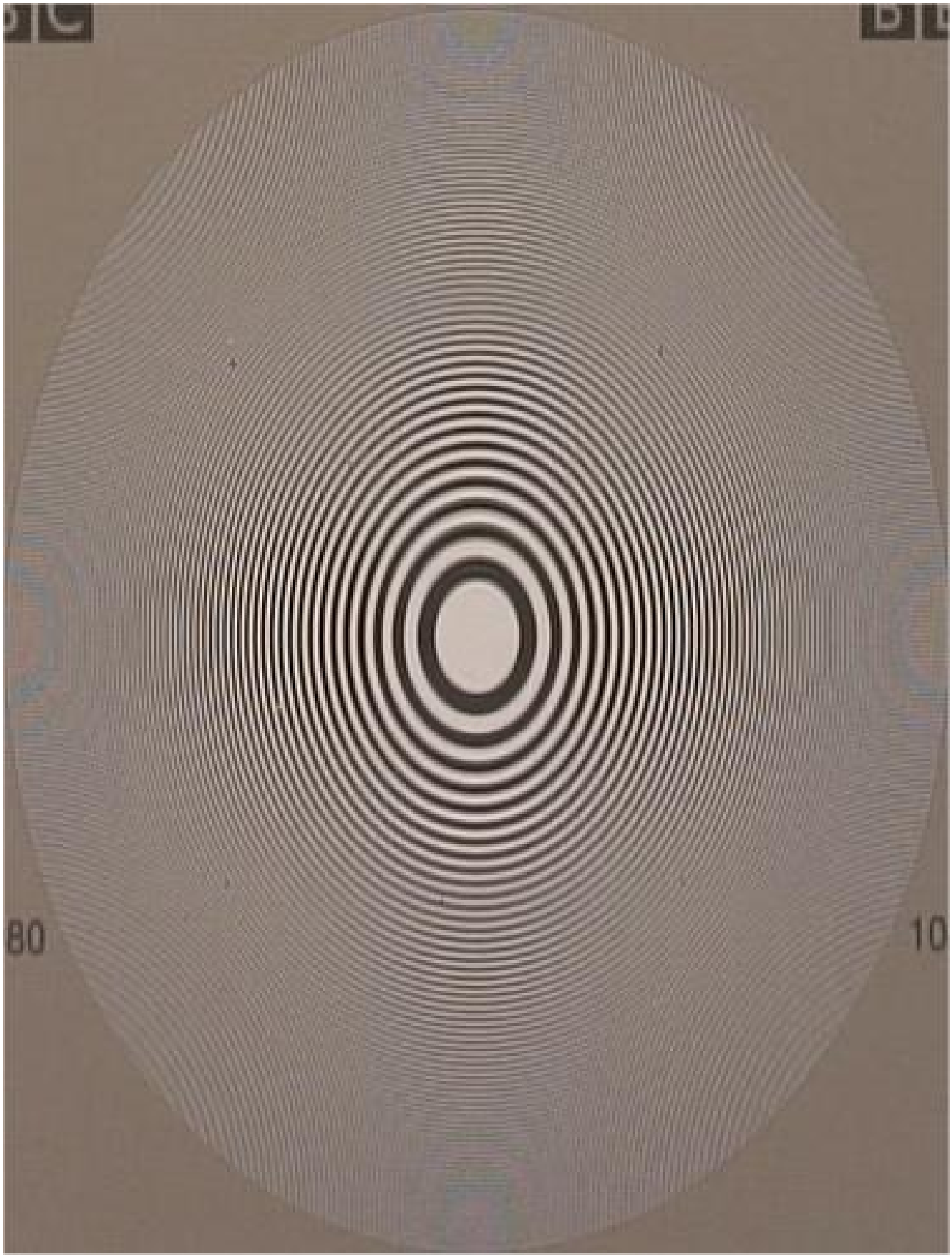

Figure 15, single zone, interlaced, *Sharpness*=8