Colorimetric and Resolution requirements of cameras

Alan Roberts

ADDENDUM 43 : Tests and Settings on a Toshiba IK-HD1H mini-camera

Data for this section is taken from the handbook and a very brief examination of a Toshiba IK-HD1H mini-camera as part of a group test of HDTV mini-cameras. The camera is connected via multi-core cable to a separate controller. There are no controls on the camera.

The HD1H is small (32.6x38.6x41mm) and weighs only 65 grammes, but the controller is relatively large and weighs about 1.5kg. The specification claims that it has 3 CCD sensors (⅓") but gives no indication of the pixel count. It has a C lens mount, standard amongst mini-cameras. Sensitivity is claimed to be F/6.8 at 2000lux, which is typical of 1920x1080 cameras with ⅓" sensors. It has both analogue and digital outputs (HDSDI). There are menus, allowing some rudimentary image control.

Power consumption is 10.3 watts at 12V DC.

There are no controls on the camera itself. Unfortunately, the camera shows significant response to infra-red illumination.

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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 in the manuals. For each item, the factory setting is underlined where known. “BBC” recommended settings are in the last column, where appropriate. In some instances, it is possible to alter the menus such that they produce more meaningful numbers.

Settings have been derived and are shown in the “BBC” column. Although the camera has all the options for interlaced and progressive shooting, no attempt has been made to derive a ‘film-look’ for it, since the menus do not allow sufficient control over the gamma curve to make it worthwhile.

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.

Measurement results are given in section 2, after the menus.

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

Black and white balance are performed directly from buttons on the control unit. The FILE button cycles through 5 scene files, the contents of which are in the menus (below). The camera operates in 1080i/50 or 59.94, depending on the position of a slide switch on the back of the control unit, this cannot be set from within the menus.

1 Menu items

1 SHUTTER

item	*range*	*comment*	*BBC*
Mode	Auto, Manual, SS	Auto links shutter to iris and gain.	
Manual	Off, 1/100, 1/125, 1/250, 1/500, 1/1000, 1/3000, 1/5000, 1,10000, 1/30000, 1/50000	Manual:	
SS	Off, 1/1125~560/1125	Synchro-scan: et shutter in line increments	
Level	-100~0~+100	Auto: average video aim level	
Peak/ave	00:10~05:05~10:00	Auto:	
Speed	1~10~20	Auto: response speed	
Area	Preset A, Preset B, Preset C, Preset D, Preset E	Auto: A=full frame, B=diamond, C=small rectangle, D=column, E=row	

2 GAIN

item	*range*	*comment*	*BBC*
Mode	Auto, Manual, Off	Off=fixed gain, 0dB	
Max gain	0~18dB	Auto: max gain it will go to	
Manual	0~18dB	Manual: fix in 1dB steps	

3 WHT BAL White balance

item	*range*	*comment*	*BBC*
Mode	AWB, ATW, Manual		
C. temp	3200, 5600K	AWB: Only two settings, equivalent to optical filter	
R paint	-10~0~+10	AWB: Red offset	
B paint	-10~0~+10	AWB: Blue offset	
Area	Preset A, Preset B, Preset C, Preset D, Preset E	AWB: Active area, as for shutter	
R paint	-10~0~+10	ATW: Red offset	
B paint	-10~0~+10	ATW: Blue offset	
R gain	-100~0~+100	Manual: Red gain	
B gain	-100~0~+100	Manual: Blue gain	
C. temp	3200, 5600K	Manual: colour temperature	

4 PROCESS General controls

item	*range*	*comment*	*BBC*
Gamma on/off	On, Off		On
Gamma	-10~0~+10	No clue in the manual as to what the numbers mean	0
DTL gain	-7~0~+7	Ditto	0
M. ped	-100~0~+100		
DNR	On, Off	Digital Noise Reduction: there's a warning about using this in the manual, can fail on motion content	

5 MATRIX

item	*range*	*comment*	*BBC*
Matrix	On, Off		On[1]
R Hue/Gain	-15~0~+15 / -15~0~+15	Simplified version of colour correction or multi-matrix. Separate control for hue and gain in each 60 degree sector	0
G Hue/Gain	-15~0~+15 / -15~0~+15		0
B Hue/Gain	-15~0~+15 / -15~0~+15		0
Ye Hue/Gain	-15~0~+15 / -15~0~+15		0
Cy Hue/Gain	-15~0~+15 / -15~0~+15		0
Mg Hue/Gain	-15~0~+15 / -15~0~+15		0

6 SYNC

item	*range*	*comment*	*BBC*
Mode	Int, Ext		
H phase	-650~0~+650	EXT: set horizontal phase	

[1] This is the only way to adjust colouring, but didn't need significant tweaking on test.

7 OPTION

item	*range*	*comment*	*BBC*
Output	YPrPb, RGB	Analogue output signals	
RGB sync	G, All on, All off	Sync placement for RGB output	
Shading	Set, Manual, Off		
Level	-128~0~+128	Manual shading level adjustment	
Baud rate	9600, 19200bps	Control data rate	
OSD output	All on, Analog, Digital	Wrong setting here can disable the output	

To do a factory reset, select a scene file using the FILE button, press DISP is necessary to disable colour bars, press MENU UP and MENU DOWN together for at least a second.

2 Measurement results

Measurements were made with a Fujinon lens, TF4DA-8, 4mm wide angle. 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/6.8 at 2000lux (59.94Hz) or F/7.4 (50Hz), equivalent to about 160ASA with 0dB gain.

2.2 Colour performance

Using a Colorchecker chart, the colour performance was judged to be quite acceptable with the standard ITU.709 gamma curve. The yellow had a slight greenish tinge which is common in many cameras but not unusually so. Skin tones were good, and no specific colour stood out as being inaccurate apart from the orange and cyan colours being a little desaturated. The overall effect is quite good. Given that there is effectively no control over colour performance, this is quite fortunate, but the camera shows significant response to infra-red illumination which can seriously pollute some colours under some illuminants.

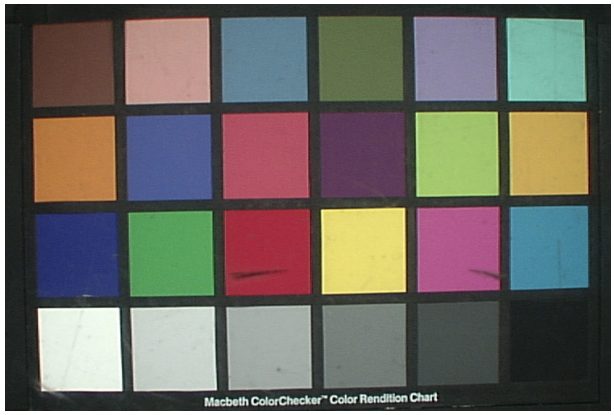

Figure 1, Macbeth chart

2.3 Resolution and aliasing

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 CCU via HDSDI.

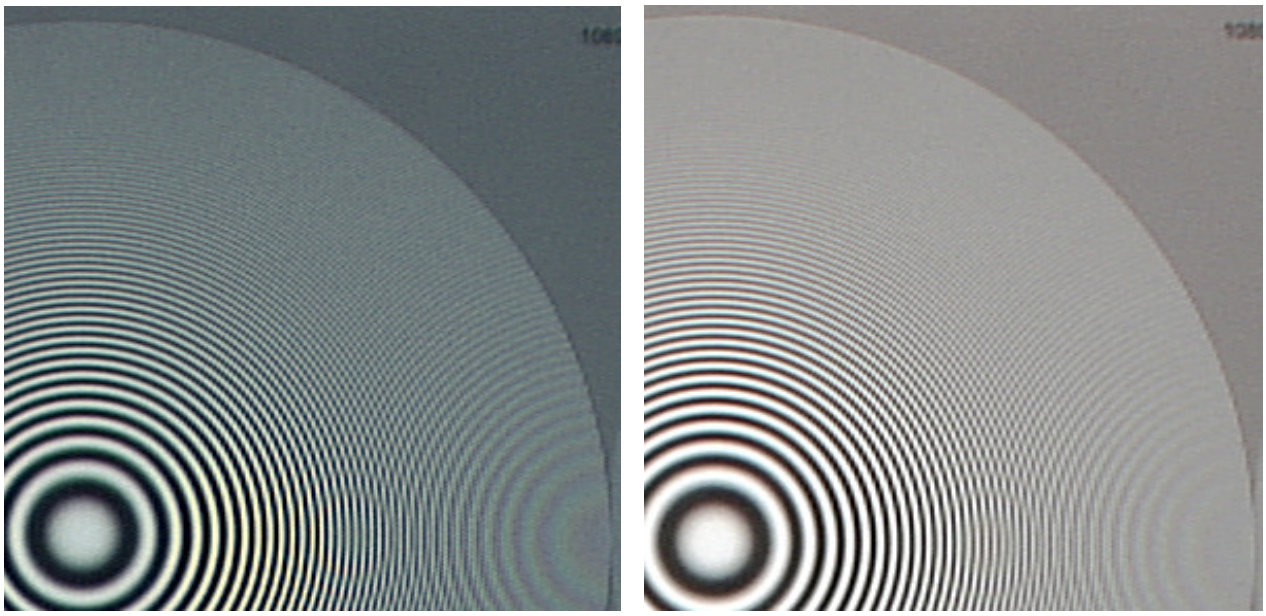

Figure 2 Zone plate (a) detail=0 **(b) detail=+2**

The camera does not have progressive modes, only interlaced. Horizontal aliasing is clearly present, but not vertical. However, vertical resolution does not seem to extend beyond about 720 lines, which, together with the level and frequency of the horizontal aliases, points to the sensors being 1280x720 rather than the full 1920x1080 expected of a broadcast camera. Clearly, there is no optical filter to prevent high-frequencies from reaching the sensors. But, there is no diagonal aliasing, and this implies that the sensors are co-sited, there is no precision offset. The exposure differences are incidental.

Detail enhancement is a little severe, but at level +2 the aliases have not been enhanced too much, and the same setting level is valid for 50 and 59.94Hz. The camera actually performs better with low levels of detail, zero is acceptable, negative values better still. Level -7 is equal to no detail enhancement.

2.4 Video Noise

The specification claims the luma channel noise level to be -56dB, with factory settings (0dB gain).

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 unweighted noise level in dB versus video signal level.

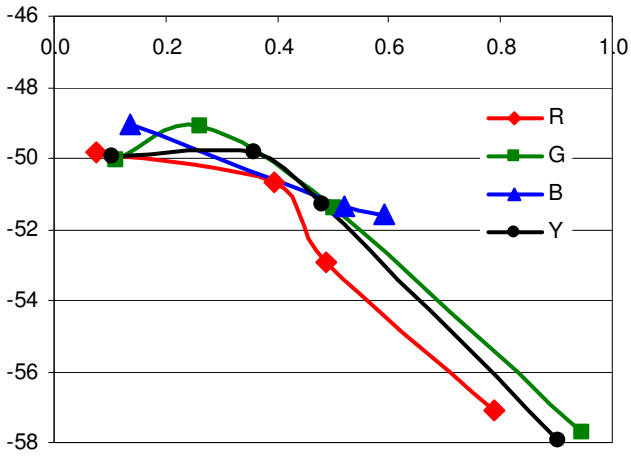

Fig. 3 Camera head noise

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, and the graph is representative of the camera performance at normal 0dB gain setting. The blue curve has no value at high luma level because the source data was accidentally clipped by slight overexposure.

Unusually, green is more noisy than either red or blue over much of the signal range. The distribution of noise level versus signal level should, ideally, follow the slope of the gamma curve (presumably ITU709 in this case), and the values at mid-grey are then representative of the performance in linear mode (since the slope of the ITU-709 curve is unity at this value). Clearly, the luma noise value at mid-grey is about -51dB. This figure agrees well with subjective assessment of the images. It is not unusual for measurements of HD cameras to differ significantly from the specification claims, and the closeness of this measurement to the specification is quite unusual. The noise level is unexpectedly low, presumably because the sensors are only 1280x720, and the pixels are therefore relatively large for the size of the image format (3.75µm spacing; 1920x1080 pixels in a ⅔" camera are 5 µm spaced, and so sensitivity or noise performance should be about 5dB worse, which it is).

The lowish noise level near black is odd, because it should be significantly higher due to the higher slope of the gamma curve near black. This is possibly evidence that gamma-correction has been done on the analogue signal before other processing, and with amplifiers with a limited gain-bandwidth product, thus resolution is lost at low signal levels, but noise is lower as well. In a camera in this part of the marker, it works, but leads to some odd colour-rendering effects because gamma-correction is before the matrix, and detail at low brightness is lost.

The noise reduction facility reduces luma noise by about 1.5dB, and so may be worthwhile when extra gain is needed, but at the price of a slight loss in resolution