EBU - Tech 3335 : Methods of measuring the imaging performance of television cameras for the purposes of characterisation and setting

Alan Roberts, March 2015

SUPPLEMENT 011: Assessment of an ARRI Alexa

Tests have been conducted in line with EBU R.118. This document is a report of the results of the tests defined in Tech3335 and is not an endorsement of the product.

Tests were made on an ARRI Alexa camera, with an ARRI/Zeiss 75mm prime lens.

The camera is unconventional, in television terms. Its controls and layout do not follow the familiar form for stand-alone cameras. Also, it is rather heavy, about 7kg without attachments. It is modular in some respects, in that the cooling system is separate from the electronics, and some parts such as the recording system can be exchanged for other versions. There are several variants of the camera each aimed at a particular market.

The sensor is a single large-format CMOS with the Bayer pattern of photo-sites (3414x2198), super-35mm size, and the lens mount is PL for film-style shooting. Only in 'Open gate' recording are all the photo-sites used, for HD recordings, the central 2880x1620 is used. The viewfinder can show the image from the full sensor, thus mimicking film shooting. The image size for 4x3 shooting is stated to be 2880x2160 photo-sites and 23.76x17.82mm. This implies that the full sensor is 28.1655x18.1335mm, and that the individual photo-sites must be 8¼µm square, or 68 square microns. By comparison, a conventional 3-chip HD ⅔" camera has pixels 5µm square, 25 square microns.

There are no filter wheels, white balancing is done by adjustment of red and blue gains.

Recording is on to SxS Pro cards or CFast 2.0 cards (2 slots), depending on the model and the installed modules. Several modes are available; Apple ProRes (Quick Time), Avid DNxHD (MXF) and ARRIRAW depending on options chosen. Coding can be 4:2:2 or full 4:4:4, again depending on the options chosen.

Power supply is from conventional 12V V-lock batteries or from external power supply, 10.5 to 34V. Power consumption is typically 85 to 90 watts.

There are BNC digital connections for monitoring, return feed, and two outputs for recording (1.5/3Gb/s). Multi-pin connectors are for external control, power supply, and Ethernet. There are other connectors for 24V power output, 12V output, audio in (5-pin XLR) and out (3.5mm headphone jack), and viewfinder.

Camera control is menu-driven via a small display on the right-side. Navigation is via a jog-wheel and 6 buttons which change function with each menu item, plus a Home and Back button. Other buttons control recording and playback, power on/off and so on.

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Many of the menu items have little or no effect on image quality. The full set of menu items is given for completeness, although I cannot guarantee that it is complete or accurate (condensing a 318 page manual is not easy). In boxes with a range of numeric settings, the values indicate the range, and no scales are given. Default settings, where known, are underlined. I have not identified 'best' settings, since the factory settings work well. In most menu items, the jog wheel can be used to make selections, or change a numerical value.

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

Control buttons

On/Off	Power button, press and hold for 5 seconds to turn off
Rec	Start/stop recording
Lock	Press and hold for 3 seconds to lock/unlock most controls
Grab	Press to grab a still frame to SD card
TC	Opens the Time Code screen
WRS	Wireless remote System, only on some versions
Play	Playback screen
Info	Live Info screen, shows status and access other screens
User	User buttons screen, 3 above 3 below the screen
Menu	The menu system
Back	Press to go back in the menu structure
Home	Go to Home screen from anywhere in the menu structure

Menu settings

Time code screen

Time code

Item	range	comments
Set TC		
Set 2 time		Sets TC to the camera's internal clock
Reset		Set TC to zero
Project		Go to Project menu, to set camera fps
Options		
Source	Int TC, Ext LTC,	Ext LTC only when Mode=Free run
Mode	Rec run, Free run	
Generator	Regen, Jam sync	
User bits	Internal, UB in Ext TC	
Set UB		Edit User Bits

Info screen

Status information

Item	range	comments
Version		Serial numbers and version numbers
Media Info		Shows max frame rate, card free capacity etc
System		Shows time/date, fan speed, sensor mode and temperature, Ethernet IP address, operating time
Save to SD		Copy data to SD card
FPS Info		Shows sensor fps, project fps, Rec Out fps, Mon Out fps, SxS card max fps

User screen

User button assignment

Item	**range**	**comments**
1~3	Long list	Consult the manual for the list of options
4~6	Different long list	

PLAY screen

Clip playback

Item	**range**	**comments**
Cliplist	List of clips	Choose with the jog wheel
+10%		Advance the clip by 10% of its length
-10%		Or back 10%
Step size	1 frame, 1 second	Scrub speed
Circle clip		Mark the clip
Options		
Clip end action	Pause, Loop	
Show frame lines	On, Off	
Status info on Mon Out	On, Off	
Peaking on Mon Out	On, Off	
Peaking on EVF	On, Off	

HOME screen

Item	**range**	**comments**
FPS		Set frame rate
Jog	23.976, 24, 25, 29.97 … 60	Max value depends on rec mode
Add		Define user frame rate
High speed		Extend speed range, if camera has a licence
Delete		Delete a user frame rate
Mode		Press to accept any change of mode
Media info		Display only
SDI FPS		Set monitoring fps, usually linked
AUDIO		Shows audio levels, -45 to 0dBFS
Audio Out		Audio out Options menu
+		Audio out volume up
-		Audio out volume down
Options		Audio out sub-options, HDSDI feeds only
Left out	1, 2, 1+2	What goes into Left
Right out	1, 2, 1+2	What goes into Right
Audio out level	Manual, Unity	Unity fixes 4dBu signal to -20dBFS
CH 1+		Channel 1 gain up
CH 2+		Channel 2 gain up
Options		Audio in options menu
Record	On, Off	Mutes all audio
Channel 1 level	Manual, Unity	Unity fixes 4dBu signal to -20dBFS
Channel 2 level	Manual, Unity	Unity fixes 4dBu signal to -20dBFS
Channel 1 source	L in, R in	Audio routing
Channel 2 source	L in, R in	Audio routing
Soundroll (=tape)		Enter 'tape' name
CH 1-		Channel 1 gain down
CH 2-		Channel 2 gain down
SHUTTER	11.2, 22.5, 45, 90, 172.8, 180, 270, 358°	Set shutter angle, degrees, also shown as 1/time
Add	5 ~ 358°	Add a user shutter angle, only up to 356° in High Speed mode
Delete		Delete a user shutter angle
EI	160, 200, 250, 320, 400, 500, 640, 800, 1000, 1280, 1600, 2000, 32000	Set Exposure Index (ASA/ISO)[1]
COLOR		Colour controls
Set look	LCC	Presets. LCC=Low Contrast Curve[2]
Add		Select a file from SD card, press jog to install
Delete		Select a LOOK in the camera, press both Delete buttons to

[1] The manual states that 800 ISO is the base setting, but these tests have found that 400 may be a better choice, see the test results for details.
[2] This curve captures the maximum dynamic range with a Rec.709-style gamma. Other LOOK files can be created and loaded using ARRI's LOOK Creator software.

		delete it from the camera
CDL	On, Off	Connect to a server via Ethernet
CDL conf		
EVF		
Mon out		
Gamma		Opto-electronic transfer characteristic
Internal		
Rec out	Rec 709, LOG C	LOG C is based on the Cineon film curve. Rec 709 curve is based on the official curve[3]
Mon out	Rec 709, LOG C	
EVF	Rec 709, LOG C	
Internal		
Rec out		
WB	Auto WB, Tungsten, Fluorescent, Daylight	White balance
Add		Use jog wheel to define white balance, then CC correction (+/- G)
Rename		Give a name to a white balance setting
Delete		Delete one
Auto WB		

MENU screen

Routing to other menu screens

Item	range	comments
Recording		
Monitoring		
Project		
System		
Frame grabs		
User setups		

MENU > RECORDING screen

Item	range	comments
Internal		
Format	Off, ProRes, DNxHD, ARRIRAW	Takes ~20 seconds to change mode, power consumption rises about 15W when recording
Setting	ProRes 422, ProRes 422 HQ, ProRes 4444 XQ, DNxHD 145, DNxHD 220x, DNxHD 444	444 and 4444 modes require a software licence key
Resolution	HD 1920x1080, 2K 2048x1152, Full 2880x2160, Cropped 2578x2160	Full and Cropped are only available in 4:3 ARRIRAW mode. DNx is available only in HD
Quick format		Format video recording card
Format		Press both Format buttons to erase file allocation table
Erase		Press both Erase buttons to completely wipe the card
Prerecord		Only in ProRes mode
Prerecord	On, Off	Records before the Record button is pressed
Buffer size	220, 660, 1100MB	
Calculated duration		Shows time duration of buffer size, changes with fps and resolution
Rec out		
Frame rate		Set fps for Rec Out socket, doesn't change sensor fps
HDSDI format	422, 444, ARRIRAW, Mon Out clone, Mon Out clean	422, 444 and ARRIRAW can each be 1.5G DL, 3G SL or 3G DL. SL=1BNC, DL=2BNC
Surround mask		Set picture level outside recorded area
Scan format	P, PSF	PSF not available faster than 30fps
Output range	Legal, Extended	Legal=64~940, Extended=4~1019
Rec Out fps sets sensor fps	Off, On	On means no sensor frames are dropped

MENU > MONITORING screen

Item	range	comments
Electronic viewfinder		
Brightness		Display brightness

[3] The Rec 709 curve tested is not a full implementation of the official curve, there's a knee starting at about 50% which cannot be switched off, see the test results for details.

Rotate image	On, Off	Useful for viewfinder left/right mounting
Smooth mode		Reduces v/f judder on motion
Surround view	On, Off	Show pixels outside the recorded area
Frame lines + status		
Frame lines	On, Off	Framing help
Surround mask	Off, Black line, Color line, Mask 25%, Mask 50%, Mask 100%	
Centre mark	Off, Small dot, Medium dot, Cross	
Status info brightness		Brightness of info data
Status info	On, Off	
Electronic horizon	On, Off	Spirit level, not available on all models
LDS info		Lens info, not available on all models
Mon out		422 1.5G BNC output
Frame rate	23.976, 24, 25, 29.97, 30	Keep this the same as the sensor to avoid judder
Scan format	P, PSF	
Surround view	On, Off	
Frame lines + status		
Frame lines	On, Off	Framing help
Frame line 1	1.33:1, 1.66:1, 1.78:1, 1.85:1, 2.39:1, 2.39:1 1.3x, 2.39 2x	You can add others, consult the manual
Frame line 2		
User rectangles		Define 2 user rectangles
Color		Select line colour
Intensity		Set line brightness
Surround mask	Off, Black line, Color line, Mask 25%, Mask 50%, Mask 100%	
Centre mark	Off, Small dot, Medium dot, Cross	
Status info brightness		Brightness of info data
Status info	On, Off	
Electronic horizon	On, Off	Spirit level, not available on all models
LDS info		Lens info, not available on all models
Camera index letter	On, Off	Indentify the camera, top tight of Mon Out
Peaking	On, Off	You get to adjust the strength as well
False Color	On, Off	Highlights overexposure
Anamorphic desqueeze	1.3x, 2x, 2xmag	Corrects anamorphic lens, needs a licence
Peaking	On, Off	Also strength control
False color		Exposure control assistance
Anamorphic desqueeze	1.3x, 2x, 2xmag	Undo anamorphic lens squeeze

MENU > PROJECT screen

Item	**range**	**comments**
Sensor mode	4:3, 16:9, Open gate	4:3 and Open gate available only on some models
Rec resolution		Links to MENU > RECORDING > Internal
Codec		Links to MENU > RECORDING > Internal
Project frame rate		Select TC timebase, and playback fps
Camera index		Set camera identifier letter
Camera index color		Choose colour to show it
Next reel count		'Reel' number, pretending to be tape/film
Lens squeeze factor		This goes into file metadata
Production info		Lots of fields for roles and names

MENU > SYSTEM screen

Item	**range**	**comments**
Imaging		
Sensor mode	4:3, 16:9, Open gate	4:3 and Open gate only on some models
Sensor temperature	Standard, High humidity	
Image transform	None, Mirror horiz, Rotate 180°	
User pixel masking		Masking of faulty pixels, see the manual
Power		Voltage levels for warnings
Bat 1 (plug) warning	16	
Bat 2 (onboard) warning	11	
External sync		
Eye index	L, R	Indentifier for stereo shooting

Sensor sync	Off, Ext master, Ext slave	For syncing a pair of Alexas
HD out phase	-30 ~ +30	Clock pluses (13.4ns)
Send HD sync trigger		Sends a trigger pulse from Master to Slave
Settings sync		Consult the manual
Test signal		
Color bars	Off, On	SMPTE bars
Test tone	Off, On	1kHz with bars
Test tone level	0, -9, -18dBFS	
Display + beeper		
Display brightness		Also adjustable in HOME screen, hold BACK button in and twiddle the jog wheel
Button brightness		Set button brightness
Ren beeper mode	Off, Start, Stop, Start+Stop	
System time + date		
Time		Display only
Date		Display only
Set time + date		Use jog wheel, > and < to move around
Time zone		Select location
DST	Off, On	Daylight saving
Fan mode	Regular, Rec low	Rec low is quitter when recording, louder when not
SD card		
Format+prepare SD card		Fully wipe SD card, create folder structure
Prepare SD card		Create folder structure without wiping card
Firmware		
Select update file		Files on SD card, press both Update buttons to load
Licenced features		Stuff you pay for
Delete		Select a feature, and delete it
Install		Select a file on SD card, and install it
HW info		Show what the selected feature is

MENU > FRAME GRABS screen

Item	**range**	**comments**
File format	JPEG, TIF, DPX	Format to save
Compare grab 2 live image		
Compare mode	Interleave, Toggle	Press Compare on the Compare file screen to switch on/off
Active on EVF	On, Off	
Active on Mon out	On, Off	

MENU > SETUPS screen

User profiles

Item	**range**	**comments**
Save current setup		
Aa		Use jog wheel or > < buttons to select characters
Erase		
Clear all		
<		
>		
Done		
Load setup		Jog wheel to select, PROJECT to validate
Factory reset		

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Tests were made on an ARRI Alexa camera, with ARRI/Zeiss prime lenses.

The sensor uses the central 2880x1620 of a 3414x2198 effective photo-sites on a sensor of size 27.98x18.15mm. Thus, the viewfinder can show image information from outside the nominal picture. Since the camera shoots only 1920x1080 (or nominal 2k, which was not tested here), there is an exact ratio of 3:2 between the photo-sites and the output pixels. Thus the decoding of the Bayer pattern ought to deliver clean resolution up to 1440x810, with only minimal coloured aliasing outside that range. Since the sensor is 35mm equivalent size, the individual photo-sites must be about 8.25µm square, approximately double the area of those in a conventional ⅔" HDTV camera, which should deliver lower noise levels and/or higher contrast capture range.

All testing was done by recording onto SxS solid-state cards since this is the mode in which the camera is easiest to use and will probably be used. Live monitoring was done on a small camera viewfinder, and on a waveform monitor. The test procedures were as described and recommended by the EBU, in Tech 3335 (http://tech.ebu.ch/docs/tech/tech3335.pdf).

The prime purpose of this test was to establish the performance of the camera when used for broadcast television with the ITU Rec.709 gamma curve. For feature-film production, the LogC curve would normally be used.

ARRI have developed a new algorithm for decoding the Bayer pattern, and so it was possible to test both the original (ADA-3) and new (ADA-5) algorithms in the same camera. This affects only the resolution and aliasing, all other tests were made using the original algorithm and the change of algorithm is not expected to affect these results.

1 Colour performance

There are very few camera menu controls which affect the image. Signals can be recorded in either 444 or 422 sampling, and in ProRes or DNxHD, and using the ITU.709 gamma curve or ARRI's proprietary Log-C curve. The 709 curve was used for all the tests.

The camera's 709 curve does not fully accord with the actual ITU Rec.709 curve since it has a gentle but wide-range knee compression near white and a further non-linearity near black. However, over the lower range of the 709 curve, it does seem to be a reasonably accurate version of the standard, but the knee point is at about 50% video level, so exposure control is critical. This makes it difficult to make the measurements recommended in EBU Tech.3335, since there is no clear indication of peak-white exposure.

Figure 1 Colorchecker

Fig.1 shows a Colorchecker chart captured in this mode; clearly the card's contrast has been reduced, and the colours are all desaturated but of the correct hue.

2 Opto-electronic transfer function, gamma-correction

A series of exposures of the Colochecker chart were taken, at several different exposures, and the signal levels of the grey scale were measured each time. The results are all plotted together in Fig. 2, together with the theoretical ITU709 gamma-correction curve for comparison (the magenta line). The theoretical curve has been adjusted to match the lower part of the camera curve, peak signal level occurs at about 9.6% of peak exposure, which implies that the built-in knee is set to capture over 3 stops of overexposure. Slight deviations from a smooth curve are probably due to my assumption that the chart patches have the manufacturer's specified reflectances rather than the actual values from measurement, that the lighting was perfectly flat, and that the lens performance was ideal. Nevertheless, the curve is good enough for this purpose.

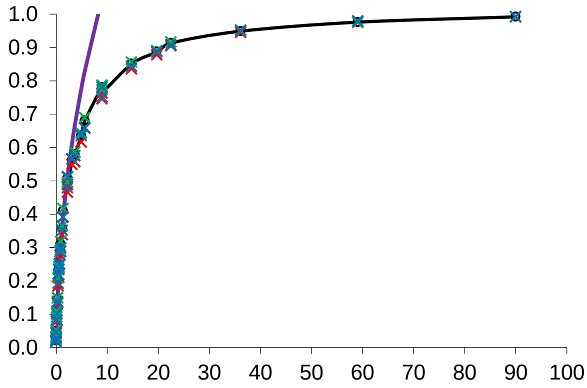

Figure 2 Gamma-correction, signal vs patch

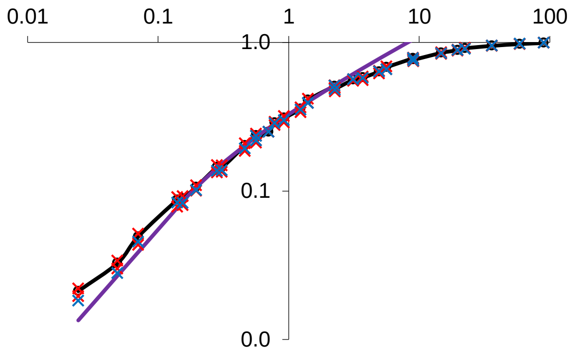

Figure 3 Gamma correction, log axes

Fig. 3 shows the same data plotted with log axes. Here the measurement discrepancies are exaggerated at low exposure and signal levels, but the fit is still good enough as an indication of the gamma curve. Clearly the fit between the data and the officvial curve is good over much of the midde range, from about 5% signal level to about 50%, although the slope near black appears to be a little less than the specified 4.5.

3 Exposure range

This is normally calculated as the ratio of the exposure which just causes white clipping to the exposure level below which no details can be seen. The unusual nature of the gamma curve makes assessment almost impossible, since the compression of highlights is highly progressive, never seeming to reach an actual clipping point. Nevertheless, the Colorchecker grey scale used for the measurements of the gamma-correction provided some basis for a dynamic range estimate.

All the measurements of the grey scale produced values which did not clip, either at black or white. So the dynamic range must exceed the dynamic range of the chart (in photographic stops) plus the range of exposure values used to make those measurements. The chart reflectances range from 90.01% to 3.13%, a range of 28.76:1, about 4¾ stops, and the exposures ranged from T2 to T22, a range of 7 stops. Thus the dynamic range explored for this test must be about 11¾ stops, so the claim of 14 stops seems entirely reasonable, even when using the 'normal' ITU.709 gamma curve.

4 Sensitivity

The normal specification for camera sensitivity is the lens transmission (T) number for which the camera produces exactly 100% luma level from a 90% reflection card lit at 2000 lux. Few manufacturers actually use the T number. A figure of F/8 to F/11 is normal for a ⅔" conventional HDTV camera (see other camera test reports in this series).

Measurement always assumes that either the gamma curve is switched off, or that it is a conventional television gamma curve with no knee to compress tones near white. The Alexa does not allow for such measurements because the gamma curve contains a gentle but long-range knee which compresses over a considerable luma range. However, there is an argument to be made for using the mid-grey performance rather than peak white, since mid-grey is where the important colours such as skin tones will conventionally be placed. The Kodak 'Gray card' provides the solution, and EBU Tech.3335 has been modified to allow this.

The camera was exposed to the 'white' side of a Kodak card (specified 90% reflectance) and grey (18%) sides simultaneously. They were lit at 2000 lux with tungsten light. The camera was set to ISO 160 in order to get clip-capture with the lowest noise content. The lens aperture was adjusted to make the 18% card produce 50% and then 40% luma level as indicated on the waveform monitoring. In a conventional video camera, the 18% reflectance should produce a mid-grey level when the 90% reflectance produces peak white, however the convention with the ARRI Alexa seems to be to set exposure to produce 38% luma from 18%, therefore both approaches were measured.

T (SIO160)	18% side	90% side
4 (+5/10)	50.9%	71.6%
5.6 (+1/10)	41.4%	64%

The T numbers were not read from the lens barrel, but from the meta-data sent from the lens to the camera. Since standard speed for the camera is ISO 800, then the camera will need 2⅓ stops less light to achieve the same signal levels, thus the sensitivity at ISO 800 must be approximately T/11 to produce 50%, T/13.5 to produce 38%. Thus the Alexa is at least one stop more sensitive than conventional ⅔" HDTV cameras.

5 Video Resolution

Resolution tests were made by exposing the camera to a circular zone plate test chart, containing patterns to test luma, R G and B, and chroma channels. In each case, the chart was framed to fill the image width on the live-monitoring 1920x1080 feed.

5.1 Video Resolution, original algorithm

Fig. 4 shows two quadrants of the luma pattern, plus one of the smaller pattern which explores double the nominal resolution. The smaller pattern (top right) explores the 4k frequency range (3840x2160). Since the sensor performs a 3:2 down-conversion from 2880x1620 to 1920x1080, the normal extinction line joining the maximum horizontal and vertical frequencies only grazes the diagonal limit of the pattern (the null centres are at 2880 horizontally and 1620 vertically). There is some low-level coloured aliasing beyond 1440 horizontally and 810 vertically, but the overall impression is of a clean image even though it does not fully fill the 1920x1080 space. There is a low-level coloured null zone centred at 1440,810, as expected, diagonal response.

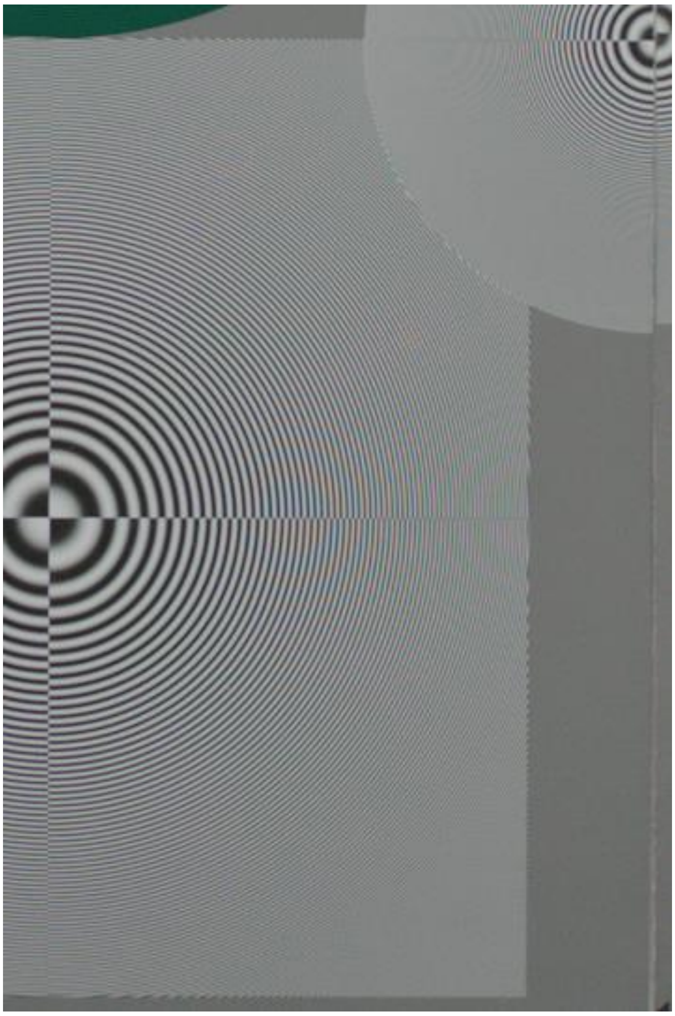

Figure 4 resolution, old algorithm, luma

Fig. 5 shows the colour resolution, red and green (blue is the same as red).

The red pattern shows more aliasing than does the green, but the level is low, indicating that the optical spatial low-pass filter is well matched to the output resolution. Evidently, the filter does not have a sharp cut, since some aliasing is visible in the double frequency pattern but the level is not high enough to cause significant problems in 'real' pictures. The overall impression is of good cleanliness, which is quite unusual in a single-sensor camera.

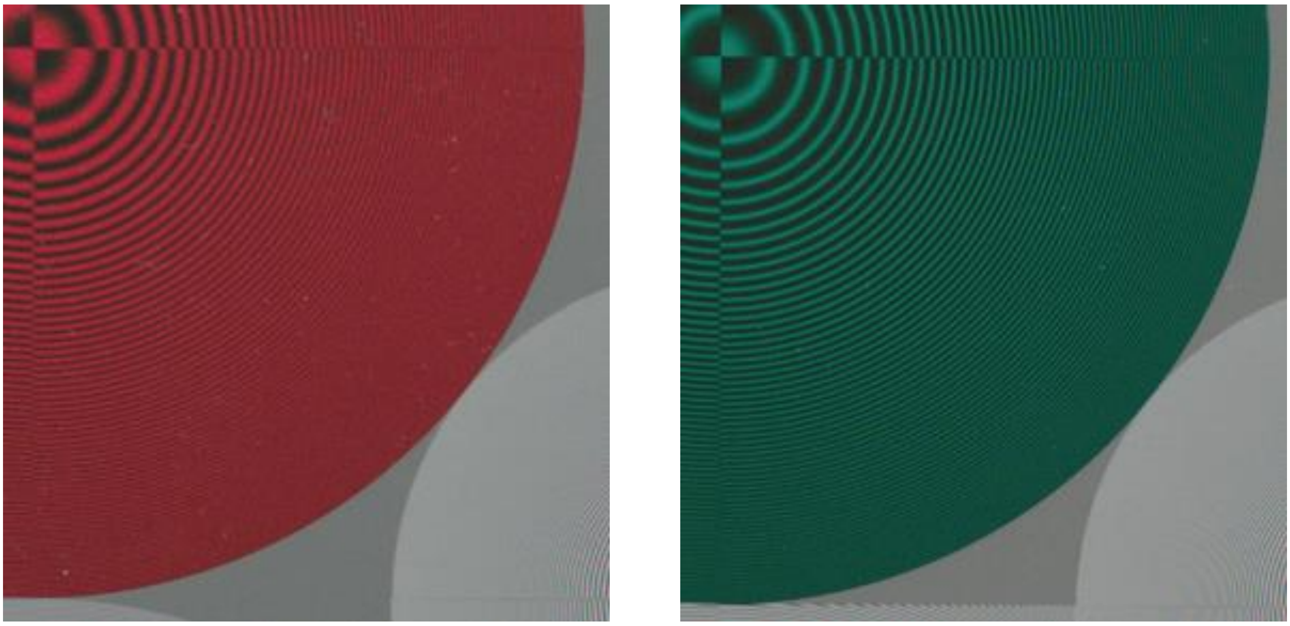

Figure 5 Resolution, old algorithm, red and green

5.2 Video Resolution, new algorithm (ADA-5)

Fig. 6 shows the luma resolution with the new algorithm. The level of coloured aliasing is clearly lower, and there appears to be horizontal and vertical resolution above the Nyquist limits of 1440 and 810 respectively. The diagonal, coloured, null zone at 1440,810 is still there, as are the coloured null zones in the smaller, double-frequency pattern centred at 2880 and 1620 respectively.

However, the impression is of considerably improved resolution in the image.

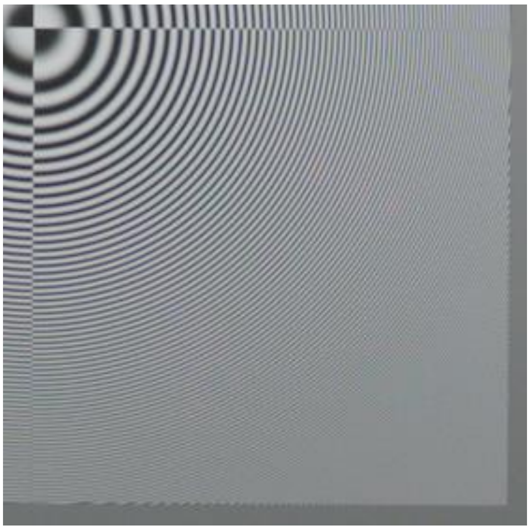

Figure 6 Resolution, new algorithm, luma

Fig. 7 shows the colour resolution, red and green (again, blue is the same as red). Here the effect of the new algorithm is more clearly visible. The resolution in red is considerably better, much of the aliasing has been eliminated. This hints

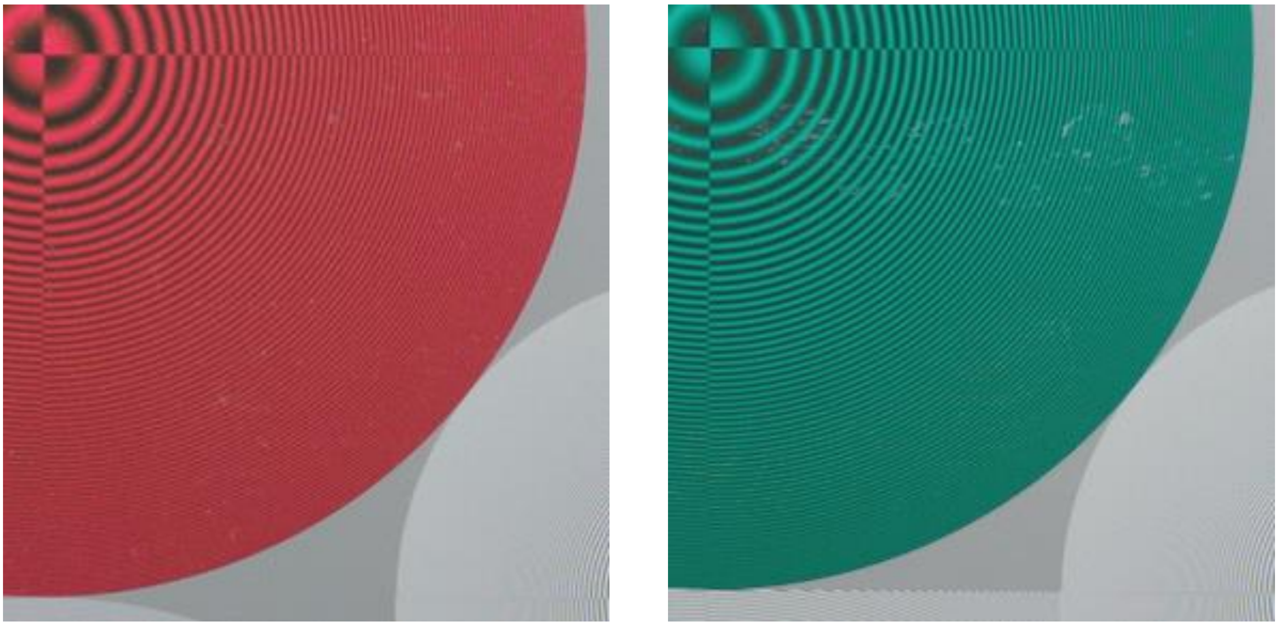

Figure 7 Resolution, new algorithm, red and green

that the work done in developing the new algorithm was largely aimed at improving colour performance, and that the improvement is luma performance is a consequence rather than the original aim.

The overall performance of the new algorithm is much better than the original, particularly in the colour channels, and is well worth having. The new algorithm (ADA-5) is available in SUP 11 or olater.

6 Video Noise

To measure how the noise changes with 'speed', the camera was exposed to the white side of a Kodak Gray card. To measure the noise profile (the way noise changes with video signal level at constant camera 'speed'), it was exposed to a custom-made reflectance chart consisting of 6 large grey patches approximately equally spread from black to white visually. The lighting was made as even as possible with two luminaires, and the lens defocused a little to eliminate any dust or minor blemishes. Since the Bayer pattern decoder affects noise levels, measurements were made with both the old and new algorithm.

6.1 Video Noise, old algorithm

Fig. 8 shows the change of noise with camera 'speed', in 4 steps from ISO200 to ISO1600. The horizontal axis is marked in dB; -6.02dB is ISO200, 0dB is 400, +6.02 is 800, +9.03dB is 1600. For each exposure, the aperture was adjusted to get a video level of 50%.

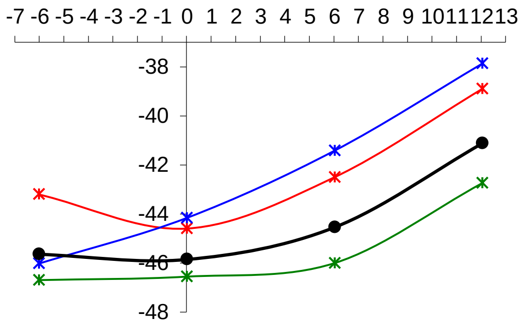

Figure 8 Noise vs gain, 50% luma level, old

The curves are normally expected to rise with a slope of 3dB noise level per 6dB of camera gain or 'speed'. This holds true above ISO600 (3dB gain) but the curves flatten at lower gains, indicating the presence of a noise 'floor', a level below which they will not go. The target noise level for the EBU R.118 Tier 1 category is -48dB. The camera does not reach that level. However, that does not properly represent the camera.

Fig. 9 shows the noise profile, measured from three exposures of the 6-step grey scale. The points have a degree of scatter which is quite normal for this method of measurement, and so only a trend line is plotted, rather than a line through all the points. There is no evidence of 'shot noise', which would cause the curve to turn upwards near 100% signal level.

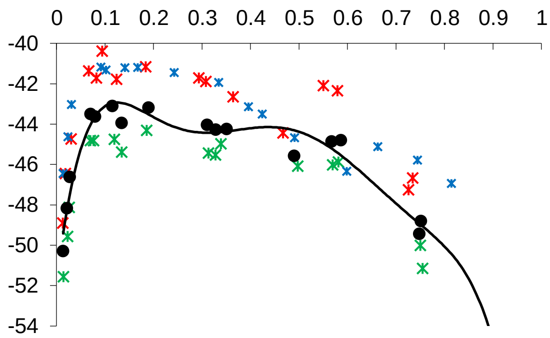

Figure 9 Noise profile, ISO400, old algorithm

This line should normally continue to rise as the signal level falls, since the noise is due in part to analogue noise in the sensor, which is subject to the rising gain in the gamma-correction. However, this curve turns and reduces below 10% video level. In many cameras this would be due to noise reduction, but the Alexa is different. The large dynamic range is achieved by double-reading of the sensor, and so it is likely that this lowering of noise at low video levels is affected by this process. The net result is that the pictures do not look as noisy as these figures show, since we normally judge noise levels near black, where the actual level is about 10dB lower than expected. For this reason, it might be permissible to pass the camera for EBU R.118 Tier 1 HD, even though technically it does not meet the target of -48dB at mid-grey.

This has highlighted a problem in the simplified recommendations in EBU R.118, where a single noise figure is used to categorise cameras. Work has now started to find a way to interpret noise levels for visual appearance and for the effects they have on compression coders to provide a solution.

6.2 Video Noise, new algorithm

Fig. 10 shows the noise profile. The curve shape is largely unchanged, and the levels are generally about 1dB better than with the old algorithm.

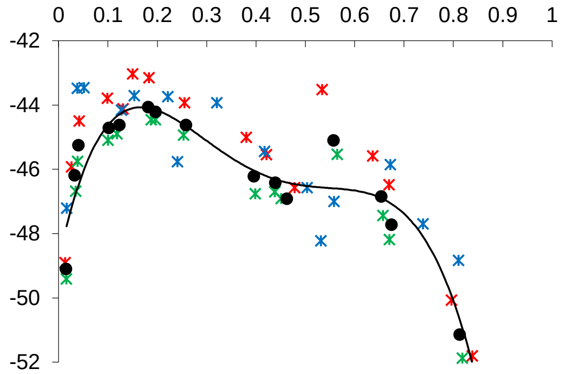

Figure 10 Noise profile, new algorithm

7 Motion portrayal, rolling shutter

Since this is a CMOS camera, the image data is most likely read from the sensor by scanning, rather than by taking a very brief, global, reading of the values into a store for later scanning. This process, called ‘rolling shutter’, is the same as scanning in a vacuum tube camera or CRT television set, and can cause severe geometrical distortions when there is significant motion in the image.

My normal test for this is to set up a small fan, rotating at a speed designed to cause strobing of the fan blades. The fan was set such that the total diameter of the blades filled about 50% of the image height.

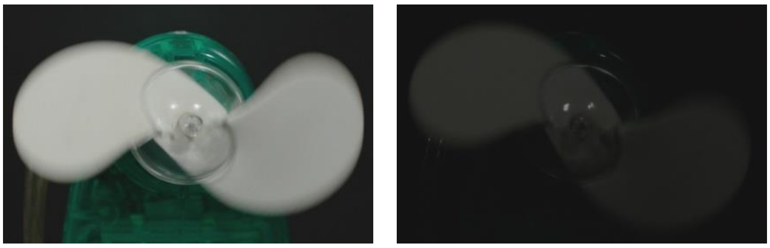

Figure 11 Rotating fan

Fig. 11 shows the fan at high and low exposure levels.

In the high exposure (left) the right-hand blade is 8% taller than that on the left. Since the fan is rotating clockwise, this is to be expected. The same distortion is visible in the low exposure. This level of distortion is not noticeable in practice; the design of the scanning process has largely eliminated the effect in this camera.

8 Infra-red response (IR)

No video camera should respond to IR. The simple test for this is to take a remote control unit and point it into the lens, then start pressing buttons. If the IR LED is seen lit or flashing, then the camera must be responding to IR since all consumer remote controls use LEDs which emit ‘light’ at about 930nm, well beyond the red extreme of the visible range.

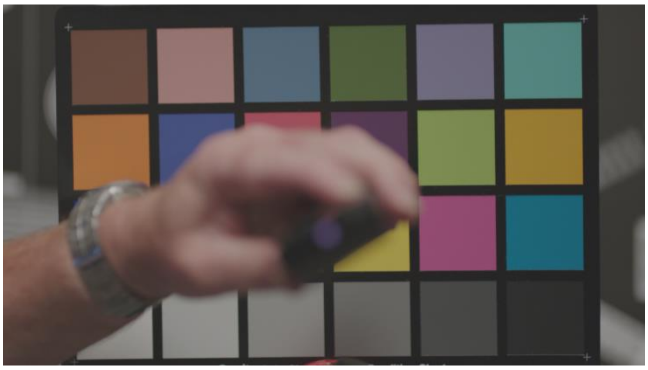

Figure 12 IR response

Fig. 12 shows the Alexa producing a low-level response to IR. While clearly visible, it is a desaturated magenta which shows that IR is getting into all three sensor channels almost equally. Although undesirable, the level is probably acceptable in practical usage. Any camera which does show a response to IR will show odd colour behaviour under some lighting conditions, and will potentially have unstable black level, due to this light pollution.

9 Conclusion

The camera has very few of the controls normally found in a video camera, but has good connectivity, allowing full-resolution external monitoring and recording.

The test procedures were as described and recommended by the EBU, in Tech 3335 (http://tech.ebu.ch/docs/tech/tech3335.pdf).

Video performance is exceptionally good in terms of resolution and aliasing, and the revised Bayer-pattern decoder gives a worthwhile improvement, particularly in the chroma channels.

There would be no quality advantage to making external recordings via the HDSDI output.

The noise profile is not typical of a conventional television camera, and suppresses the noise near black because of the apparently non-standard gamma-correction curve and/or unusual method of reading the sensor. This has the effect of making the pictures look rather less noisy than they actually are. Noise levels, although not quite achieving the EBU R.118 target level of -48dB at mid-grey (missing by only 1dB), are acceptable because noise near black is very low and the level of spatial aliasing is exceptionally low, particularly with the revised Bayer-pattern decoder.

Colour performance is very good, and although the camera does respond a little to infra-red illumination the level is acceptably low.

Motion portrayal is good; the effects of the rolling shutter are nicely suppressed.

Although this report should not be read as an endorsement of the camera, on the evidence of these tests, it could qualify for HD Tier 1 even though the noise at mid-grey is not strictly within the limits, because noise near black is very low and resolution and aliasing are exceptionally good for a single-sensor camera.