

## EBU – Tech 3335 : **Methods of measuring the imaging performance of television cameras for the purposes of characterising and setting**

Alan Roberts, March 2014

### **SUPPLEMENT 013 : Assessment of Grass Valley LDX camera**

**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.**

Data for this addendum is taken from an examination of two Grass Valley LDX-series system cameras, primarily the WorldCam, with a shorter look at the less-featured and self-contained box version of the camera.

The LDX camera range is based on a single camera head, with 3 CMOS sensors and B4 lens mount and F/1.4 prism. It has a very familiar appearance, but has some interesting new features. The system camera can be connected to its CCU by either fibre optical cable or Triax, the CCU will accept either. The camera can be fitted with either the fibre (LDX 5650, typically 3km max) or Triax (LDX 5640, typically 1.5km max) adaptor, which can be swapped in a few minutes. The camera head will retain all settings when the back is changed, or when it is swapped between CCUs.

The sensors are conventional  $\frac{2}{3}$ " size with nominal 1920x1080 active pixels, although the actual sensor is a little larger. They are not scanned in the usual way; image data is shifted virtually instantaneously into a readout store on the chip from which cells are scanned into on-chip ADCS. Thus they are frame-transfer with what is effectively a global shutter. There is no mechanical shutter. Pixels are spaced at 5 $\mu$ m, but the active area of each pixel is a little larger than usual, despite the extra complexity of the sensor.

There is no filter wheel for colour-temperature adjustment. There is a filter wheel with neutral density filters in all models; there is no mechanical control of it, it is motorised. A second filter wheel is present in all but the 'Flex' version, holding a cap and effects filters. An optional extra filter can be fitted, performing a highly unusual but useful function. This will be described in the Test section of this document.

All the versions can operate at 1920/1080i/59.94, 1920x1080i/25 and 1280x720p/59.94 and 1280p/50. The Premiere and WorldCam versions can also do 1920x1080psf/29.97 and 1920x1080psf/25, while the WorldCam can also do 1920x1080p/59.94 and 1920x1080p/50. It is possible to change between these formats without having to perform a power cycle, although the process takes several seconds. Note that there is no SD option in the camera head, although the CCU can always provide an SD output for monitoring.

The camera head has the usual range of controls and features for a system camera: analogue and digital lens-connection, intercom, sync, 4 audio channels, viewfinder (20-pin and HDMI), plus USB2 for file storage and Ethernet for remote control. The adaptors also have the usual range of controls and connectors.

Camera-head control is via a button and control wheel, and there are four assignable buttons. Most camera control can be done from controls on the head, but full control needs either the MCP or OCP as is usual for system cameras.

Camera-head power consumption (including the Triax or fibre adaptor) is approximately 34 watts, plus from a nominal 12 Volt supply (11~17V DC) or via a standard 4-pin XLR socket. The head weighs only 2.1kg, both adaptors weigh an extra 1.7kg.

# EBU – Tech 3335 : **Methods of measuring the imaging performance of television cameras for the purposes of characterising and setting**

Alan Roberts, March 2014, first draft CONFIDENTIAL

## **SUPPLEMENT 013 : Assessment of Grass Valley LDX camera**

Information for this section comes directly from the camera manual; few of the items were explored for the tests which follow. 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. Default settings, where known, are underlined. Nested menu items are inset below the items (in bold font) which call them.

Most of these menu items were not investigated at all since they have little or no influence on image performance.

This listing of menu contents is taken from the manuals for the camera and CCU. It is not complete because there are several layers of menus, some of which are best left to the experts at Grass Valley. This section should not be taken as an excuse for not reading the manuals.

Where appropriate, preferred settings are given for video (v) and film-like (f) use. These are designed to produce pictures which I like, and are intended to match criteria given in EBU R.118. They are not instructional but can be used as a good place to start from.

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

## **1 Menus and settings**

### **OPERATOR TOOLBOX menu**

<i>Item</i>	<i>Range</i>	<i>description</i>	<i>Pref</i>
<b>Indicators</b>		Viewfinder items	
Zoom indicator	On, <u>Off</u>		
Iris indicator	On, <u>Off</u>		
Focus indicator	On, <u>Off</u>		
Filter indicator	On, <u>Off</u>	Not in Flex or Premiere	
DOF indicator	On, <u>Off</u>		
Center Cross	On, <u>Off</u>		
Safe area	On, <u>Off</u>		
Safe area type	<u>16:9</u> , 15:9, 14:9, 4:3		
Marker	On, <u>Off</u>		
Marker type	<u>15:9</u> , 14:9, 4:3		
Marker style	<u>Dot</u> , Shad, Both	Dotted lines, or shading outside	
Marker shading	<u>Shad</u> , Black	Black blanks outside	
Zebra	On, <u>Off</u>	Only one zebra	
Zebra mode	<u>Level</u> , Band	Band=2.5% zone	
Zebra level	0 ... <u>90</u> ... 117%	117%? How's that?	
Zebra contrast	0 ... <u>15</u> ... 99		
Focus assist	On, <u>Off</u>	Sharp areas crawl in the v/f	
Ind white	0 ... <u>70</u> ... 99	Brightness of indicators	
Auto iris area	On, <u>Off</u>	Shows the focus target area	
<b>VF monitoring</b>	<u>YCrCb</u> , Y, R, G, R-G, B-G		
<b>VF detail</b>	On, <u>Off</u> , <u>Boost</u>		
Super coarse	On, <u>Off</u>		
Detail level	0 ~ <u>50</u> ~ 99		
Slicer	0 ~ <u>20</u> ~ 99		
Vert detail level	0 ~ <u>50</u> ~ 99		
Coarse/Fine	0 ~ <u>90</u> ~ 99		
Level dep	0 ~ <u>20</u> ~ 99	Threshold level	
Soft detail	<u>On</u> , <u>Off</u>	Lowers level for big transitions	
Soft detail lvl	0 ~ <u>50</u> ~ 99		

**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.**

<i>Item</i>	<i>Range</i>	<i>description</i>	<i>Pref</i>
<b>Menu settings</b>			
Rotary speed	1 ~ <u>5</u> ~ 10	Sensitivity of the menu knob	
Menu display	On, <u>Time</u>	Permanent or temporary display	
Menu time	3 ~ <u>10</u> ~ 30	Seconds for Time display	
Menu white lvl	0 ~ <u>70</u> ~ 99		
<b>Intercom</b>			
Cam sidetone	0 ~ <u>75</u> ~ 99		
Tracker sidetone	0 ~ <u>75</u> ~ 99		
<b>Buttons</b>			
SW1	Call, <u>Ext1</u> , Ext2, Prod, Eng, Select	Assignable buttons	
SW1 mode	<u>Mom</u> , Alt	Push or toggle	
SW2	Iris, Zoom, FocAst, Ext1, <u>Ext2</u> , Prod, Eng		
SW2 mode	<u>Mom</u> , Alt		
Ret A/Ext1	<u>Ext1</u> , Ext2		
Ret A mode	<u>Mom</u> , Alt		
Ret B/Ext2	<u>Ext2</u> , Ext3		
Ret B mode	<u>Mom</u> , Alt		
Eng mode	<u>Mom</u> , Alt		
Pick Me mode	<u>Mom</u> , Alt	Useful for alerting the production	
LED brightness	High, Low		
VTR lens	<u>Prod</u> , Eng, Zoom, Ext1, Ext2		
VTR lens mode	<u>Mom</u> , Alt		
Ret lens	<u>Ext</u> , Zoom, FocAst		
Ret lens mode	<u>Mom</u> , Alt		
Ret 2	Zoom, <u>Ext 2</u>		
Handgrip left	<u>Prod</u> , Eng		
SXP F1	<u>None</u> , ND, FX, Bars, Prog, Back, Info, Pick Me	Lens 'super-expander' adaptor FX (effects wheel) is not available in the Flex model	
SXP F2	<u>None</u> , ND, FX, Bars, Prog, Back, Info, Pick Me		
SXP F3	<u>None</u> , ND, FX, Bars, Prog, Back, Info, Pick Me		
<b>Zoom settings</b>			
Handgrip zoom	Off, <u>On</u>		
Zoom speed	1 ~ <u>5</u> ~ 10		
Zoom curve	<u>0</u> ~ 3	0=linear, 3=steep	
Zoom/Focus	<u>Loc</u> , rem	For lens 'super-expander' adaptor	
<b>Files</b>			
Store oper file		Store operator settings	
File select	Standard, <u>OCam1</u> , Ocam2 ...	File name for storing, can be lots	
Store	Exec	Do it	
Recall Oper file		And get them back	
File select	Standard, <u>OCam1</u> , Ocam2 ...	File name to recall, can be lots	
Store	Exec	Do it	
USB		USB stick	
Name	####	Shows the name	
Free space	####	Mbytes of free space	
No of files	####	How many files on the stick	
USB files			
File select	<list of files>	Pick a file on the stick	
Delete	Exec	Delete it	
Filename	<name>	Edit the filename	
Attribute	R/W, <u>R</u>	Write-protection	
<b>Notch Ext</b>	On, <u>Off</u>	External notch filter	
<b>Ext aspect ratio</b>	16:9, <u>4:3</u>	How to show the Ext signal	

## PRODUCTION SETUP Menu

<i>Item</i>	<i>Range</i>	<i>description</i>	<i>Pref</i>
<b>Levels</b>			
Gain			
Master gain	-6.00 ~ <u>0.0</u> ~ 18.0dB	0.1dB steps, nice	
Gain presets			
Gain -	-3dB		

<i>Item</i>	<i>Range</i>	<i>description</i>	<i>Pref</i>
Gain +	<u>3</u> , 6, 9, 12dB		
Gain ++	<u>6</u> , 9, 12, 15dB		
Gain +++	9, <u>12</u> , 15, 18dB		
Black			
Black stretch	On, <u>Off</u>		
Black stretch level	0 ~ <u>50</u> ~ 99	50 is neutral, 0=Press, 99=Stretch	
Black Str type	Press, <u>Stretch</u>		
Master black	0 ~ <u>50</u> ~ 99		
Advanced			
Master black	0 ~ <u>50</u> ~ 99		
Black R	0 ~ <u>50</u> ~ 99		
Black G	0 ~ <u>50</u> ~ 99		
Black B	0 ~ <u>50</u> ~ 99		
Gamma			
Curve	BBC0.4, BBC0.5, BBC0.6, ARD, <u>ITU709</u> , Gamma-J, Gamma-S	J and S have black press, S has soft knee <sup>1</sup>	ITU709
Preset	<u>Nom</u> , Lin, Var	Lin-linear, Var allows tweaking	
Master gamma	0 ~ <u>76</u> ~ 99		
Gamma R	0 ~ <u>76</u> ~ 99		
Gamma G	0 ~ <u>76</u> ~ 99		
Gamma B	0 ~ <u>76</u> ~ 99		
White limiter	On, <u>Off</u>		Off
Master	87.7 ~ 105 ~ 109.1%		
<b>Exposure</b>			
Iris			
Auto iris	On, <u>Off</u>		
Area	<b>Top</b> , Spot S, Spot M, Spot L, Full, Bottom, Custom		
Custom area			
Area 1			
Top	0 ~ <u>57</u> ~ 99		
Bottom	0 ~ <u>86</u> ~ 99		
Left	0 ~ <u>24</u> ~ 99		
Right	0 ~ <u>76</u> ~ 99		
Area 2			
Top	0 ~ <u>27</u> ~ 99		
Bottom	0 ~ <u>57</u> ~ 99		
Left	0 ~ <u>5</u> ~ 99		
Right	0 ~ <u>95</u> ~ 99		
Peak/Average	0 ~ <u>64</u> ~ 99		
Auto iris SP	0 ~ <u>35</u> ~ 99	Auto setpoint	
Mom iris SP	0 ~ <u>50</u> ~ 99	Momentary setpoint	
Auto iris gain	<u>5</u> ~ 10		
Extended iris	On, <u>Off</u>		
Gain speed	1 ~ <u>5</u> ~ 20		
ExpTime speed	1 ~ <u>4</u> ~ 20	Exposure time speed	
Min iris	F5.6, F8, F11, <u>F16</u>		F8 <sup>2</sup>
Max iris	F1.4, <u>F2</u> , F2.8, F4, F5.6		F1.4 <sup>3</sup>
Min ExpTime	1/100, 1.200, <u>1/500</u>		
Max gain	0 ~ <u>15dB</u>		
Lighting	On, <u>Off</u>	Correction fpor 50Hz lighting at 59.94 or 60Hz lighting at 50	
Correction	-10 ~ <u>0</u> ~ +10		
Acq timing			
V-shift	On, <u>Off</u>		

<sup>1</sup> Later versions may have the RAI curve as well.

<sup>2</sup> Beyond this setting, the image will soften due to iris diffraction.

<sup>3</sup> All good HD lenses should work well wide open, unless they're very short focal length.

<i>Item</i>	<i>Range</i>	<i>description</i>	<i>Pref</i>
V-shift time	<u>0</u> ~ 99		
Exp time		Shutter	
Exp time select	<u>Off</u> , 50Hz, 60Hz, 1/200, 1/500, 1/1000, Var		
Var exp time	50 ~ 1000	Variable shutter	
Units	ms, <u>H</u> z	Display shutter as ...	
LED wall filter	On, <u>Off</u>	Tries to deal with LED problems	
<b>Color</b>			
Color temp			
Color filter	-100 ~ <u>0</u> ~ +100	<0=cooler, >0=warmer	
Color temp	2000 ~ <u>3200</u> ~ 20000K		
Tint	-150 ~ <u>0</u> ~ +150	<0=more magenta, >0=more green	
Advanced			
Gain R	0 ~ <u>50</u> ~ 99		
Gain G	0 ~ <u>50</u> ~ 99		
Gain B	0 ~ <u>50</u> ~ 99		
Range	<u>3</u> , 6dB	'Paint' range for OCP/MCP	
x	0.2 ~ 0.55	Displays approximate chromaticity of the white point	
y	0.2 ~ 0.55		
Saturation	0 ~ <u>100</u> ~ 200%	0=mono, 200%=+6dB	
Matrix	EBU, Skin, B/W, RAI, BBC, 1:1, CoolFl, <u>XGL</u> , Var1, Var2		EBU or BBC
Mat/Gam order	G/M, <u>M/G</u>	Matrix before or after gamma	M/G <sup>4</sup>
Advanced			
G->R	0 ~ <u>50</u> ~ 99	Coefficients for 'Var' matrix, explore this only under lab conditions	
B->R	0 ~ <u>50</u> ~ 99		
R->G	0 ~ <u>50</u> ~ 99		
B->G	0 ~ <u>50</u> ~ 99		
R->B	0 ~ <u>50</u> ~ 99		
G->B	0 ~ <u>50</u> ~ 99		
<b>Image control</b>			
Freeze	On, <u>Off</u>	Grabs the frame, useful in setting up	
Reverse scan	On, <u>Off</u>		
Mode	<u>Horiz</u> , Vert, Both		
Image shift			
Horizontal	-20 ~ <u>0</u> ~ +20	Pixel shift	
Vertical	-4 ~ <u>0</u> ~ +4	Line shift	
<b>Files</b>			
Store scene file		Standard, Camera or USB storing	
File select	Standard, <u>Scam1</u> , Scam2 ...	Select scene file for storing	
Store	Exec	Do it	
Recall scene file	Standard, <u>Scam1</u> , Scam2 ...	Select scene file for recall	
Recall	Exec	Do it	
Attributes			
File select	<available files>	Pick the file to work on	
Filename	<name>	Display of the name	
Attribute	<u>R/W</u> , R	Write protection	
<b>Sensitivity</b>	HQ <sup>5</sup> , <u>Nom</u> , HSens <sup>6</sup>	Q=quality, S=sensitivity	
<b>Video mode</b>	1080p/59.94, 1080p/50, 1080psf/29.97, 1080psf/25, 1080i/29.97, 1080i/25, 720p/59.94, 720p/50	This range is limited by the camera model, WorldCam most, Flex least	

<sup>4</sup> Gamma before matrix can produce lower noise, but less-good colour rendering. Matrix before gamma is the better choice.

<sup>5</sup> HQ mode is not available in the Flex model. Sensitivity drops one stop, 6dB from Nominal.

<sup>6</sup> HSens mode is not available in the Flex and Premiere models. Sensitivity rises a stop, 6dB, from Nominal.

**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.**

**CREATIVE CONTROL menu**

<i>Item</i>	<i>Range</i>	<i>description</i>	<i>Pref</i>
<b>Levels</b>			
Filters			
ND filter	<u>C</u> lear, ND ¼, ND 1/16, ND 1/64		
FX filter <sup>7</sup>	Clear, Star 4P, Sft Fcs, Cap	These can be changed, see later	
Contrast	<u>O</u> n, <u>O</u> ff	Custom bending of the gamma curve	
Shadows	0 ~ <u>50</u> ~ 99		
Midtones	0 ~ <u>50</u> ~ 99		
Highlights	0 ~ <u>50</u> ~ 99		
Knee (PwrCurves) <sup>8</sup>	<u>O</u> ff, Var, Auto	Knee in PowerCurves mode	
Knee type	Y, NAM	NAM acts on RGB	
Point	0 ~ <u>35</u> ~ 99%	Start of bend in the curve	
Fade level	<u>0</u> ~ 99	99=linear, 0=full knee	
Limit out	<u>100</u> ~ 109%		
Max in	100 ~ <u>200</u> ~ 800%	3 stops of headroom	
Saturation	<u>O</u> ff, On		
Saturation lvl	0 ~ <u>50</u> ~ 99%	Saturation control in the Knee	
<b>Advanced</b>			
Knee mode	Compat, <u>P</u> wrCurves		
Auto ref	0 ~ <u>30</u> ~ 99%	Knee ref level in Auto Knee	
Knee (Compat)	<u>O</u> ff, Var, Auto	Knee in PowerCurves mode	
Knee type	Y, NAM	NAM acts on RGB	
Slope M	0 ~ <u>50</u> ~ 99%		
Point M	0 ~ <u>60</u> ~ 99%		
<b>Advanced</b>			
Knee mode	Compat <u>P</u> wrCurves <sup>9</sup>		
Knee limit	0 ~ <u>99</u>		
Desat	<u>O</u> ff, On		
Desat level	0 ~ <u>50</u> ~ 99%		
Auto point	0 ~ <u>30</u> ~ 99%		
Auto ref	0 ~ <u>30</u> ~ 99%		
Flare	<u>O</u> ff, <u>O</u> n		
Red	0 ~ <u>10</u> ~ 99%		
Green	0 ~ <u>15</u> ~ 99%		
Blue	0 ~ <u>25</u> ~ 99%		
<b>Color</b>			
<b>Color adjustment</b>			
Color corr	<u>O</u> ff, On		
Color corr view	<u>O</u> ff, On	Show affected area in main output	
VF view	<u>O</u> ff, On	Show affected area in VF	
Set	<u>1</u> , 2, 3, 4, 5, 6	6 separate sets of settings <sup>10</sup>	
Set on/off	<u>O</u> ff, On		
Color	<u>0</u> ~ 359.9°	22.5° steps	
Width	22.5 ~ <u>101</u> ~ 360	Hue angle of affected sector	
Hue	-180 ~ <u>112</u> ~ +180	Set hue ...	
Sat	<u>0</u> ~ 99	... saturation ...	
Luminance <sup>11</sup>	<u>0</u> ~ 99	... and luminance	
Color name	B+, MG-, MG, MG+, R, R+, YL-, YL, YL+, G-, G, G+, CY, CY+, B-, B	Display only, name of colour area	
Smoothing	Sharp, <u>M</u> edium, Smooth	Filtering of changes between sectors	
Reset	<u>E</u> xec	Reset the colour corrector	

<sup>7</sup> Not available in the Flex model.<sup>8</sup> PowerCurves are not available in the Flex model.<sup>9</sup> Not available in the Flex model.<sup>10</sup> Only 3 sets available in the Flex and Premiere models.<sup>11</sup> Very unusual to find luminance adjustment on the colour corrector.

<i>Item</i>	<i>Range</i>	<i>description</i>	<i>Pref</i>
Col protect <sup>12</sup>	<u>Off</u> , On	Colour protection	
Co protect lvl	0 ~ <u>75</u> ~ 99		
<b>Sharpness</b>			
Detail	<u>Off</u> , On		On
Detail level	0 ~ <u>50</u> ~ 99		50v, f <sup>13</sup>
Detail source	R+G, R, G, Y		Y
Texture	0 ~ <u>50</u> ~ 99	Sharpens low-level texture	50
<b>Advanced</b>			
Vert detail lvl	0 ~ <u>25</u> ~ 99		25v <sup>14</sup> , 25f
Coarse/Fine	0 ~ <u>90</u> ~ 99		90
Level dep	0 ~ <u>20</u> ~ 99		30
Noise slicer	0 ~ <u>7</u> ~ 99		10
Texture	<u>Enabled</u> , Disabled		Enabled
Dtl flw gain	<u>Off</u> , On	Changes detail level with gain ...	
Dtl flw zoom	<u>Off</u> , On	... zoom ...	
Dtl flw iris	<u>Off</u> , On	... or iris setting	
Apt flw iris	<u>Off</u> , On	Lens aperture correction tracks iris	
Detail equalizer	<u>Off</u> , On	Set separate detail levels for ...	
Shadows	0 ~ <u>50</u> ~ 99	... low ...	
Midtones	0 ~ <u>50</u> ~ 99	... mid ...	
Highlights	0 ~ <u>50</u> ~ 99	... high levels	
Soft detail	<u>Off</u> , On	Only when Texture is disabled	
Soft detail lvl	0 ~ <u>50</u> ~ 99	Adjust detail level with transition size	
Knee detail	Off, <u>1</u> , 2, 3, 4		
<b>Skin detail</b>			
Skin gate	<u>Off</u> , 1, 2, 3, 1+2, 1+3, 2+3, 1+2+3	3 separately definable colour zones	
Auto skin off	<u>Off</u> , On		
VF view	<u>Off</u> , On	Show the zone in the VF	
Skin 1 level	0 ~ <u>50</u> ~ 99		
Skin 2 level	0 ~ <u>50</u> ~ 99		
Skin 3 level	0 ~ <u>50</u> ~ 99		
<b>Colour selection</b>			
Width 1 red	0 ~ <u>29</u> ~ 99		
Width 1 blue	0 ~ <u>40</u> ~ 99		
Color 1 red	0 ~ <u>37</u> ~ 99		
Color 1 blue	0 ~ <u>6</u> ~ 99		
Width 2 red	0 ~ <u>29</u> ~ 99		
Width 2 blue	0 ~ <u>40</u> ~ 99		
Color 2 red	0 ~ <u>37</u> ~ 99		
Color 2 blue	0 ~ <u>6</u> ~ 99		
Width 3 red	0 ~ <u>29</u> ~ 99		
Width 3 blue	0 ~ <u>40</u> ~ 99		
Color 3 red	0 ~ <u>37</u> ~ 99		
Color 3 blue	0 ~ <u>6</u> ~ 99		

## CONFIGURATION Menu

<i>Item</i>	<i>Range</i>	<i>description</i>	<i>Pref</i>
<b>Security</b>			
Installed level	No oper, <u>User 0</u> , User 1, User 2, User 3, Service	Power cycle the camera to take effect	
PIN code	<u>0000</u>	PIN code to access the service level	
<b>Customer files</b>			
Store cust scene	Exec	Store current settings	
Cust scene attr	R/W, <u>R</u>	Write protection	

<sup>12</sup> Not available in the Flex and premiere models.

<sup>13</sup> The optional extra optical low-pass filter helps greatly in film mode. Value 15 is good for 16mm, 28 for 35mm

<sup>14</sup> This can go up to 35 for interlaced pictures.

<i>Item</i>	<i>Range</i>	<i>description</i>	<i>Pref</i>
Store cust oper	Exec	Store operator settings	
Green button			
Standard scene file	<u>Fact</u> , Cust	What's loaded by the Green Button	
Standard oper file	<u>Fact</u> , Cust		
Scene file	<u>Yes</u> , No	Load Scene file ..	
Oper file	<u>Yes</u> , No	... and/or operator file	
Factory reset	<u>Exec</u>	Returns ALL settings to factory	
Disable camera	On, <u>Off</u>	Locks ALL buttons on the camera	
<b>Lens</b>			
Lens settings			
Lens connector	<u>SXP</u> , Camera	Only when Superexpander is used	
Lens IF type	Analog, <u>Digital</u>	Type of lens	
Lens IF status	OK, NOT OK	Display only, digital lens	
RE iris group	On, <u>Off</u>	Iris compensation with range extender	
Lens corrections			
CLASS	<u>Auto</u> , Off		
Reset	Exec > Busy	Reset lens aberration data table	
Status	Active, Init, Waiting, Reading, No info, Unsup, I/F NOK, Off, Init NOK	Report only	
Progress	0 ... 100%	Report only	
Shading	<u>On</u> , Off		
R saw H	0 ~ <u>50</u> ~ 99		
R par H	0 ~ <u>50</u> ~ 99		
R saw V	0 ~ <u>50</u> ~ 99		
R par V	0 ~ <u>50</u> ~ 99		
G saw H	0 ~ <u>50</u> ~ 99		
G par H	0 ~ <u>50</u> ~ 99		
G saw V	0 ~ <u>50</u> ~ 99		
G par V	0 ~ <u>50</u> ~ 99		
B saw H	0 ~ <u>50</u> ~ 99		
B par H	0 ~ <u>50</u> ~ 99		
B saw V	0 ~ <u>50</u> ~ 99		
B par V	0 ~ <u>50</u> ~ 99		
Files			
Store lens file			
File select	LCam1, LCam2, LCam3, LCam4	Select for storing	
Store	Exec	Do it	
Recall lens file			
File select	LCam1, LCam2, LCam3, LCam4	Select for recalling	
Store	Exec	Do it	
<b>Intercom</b>			
Cam mic	Off, <u>Switch</u> , Track, Prod		
Cam mic gain	0, <u>40dB</u>		
Cam prod	Off, Left, Right, <u>Both</u>	Production	
Cam eng	Off, Left, Right, <u>Both</u>	Engineering	
Cam prog	Off, Left, Right, <u>Both</u>	Programme	
Cam tracker	Off, Left, Right, <u>Both</u>	Tracker sound	
Cam tracker lvl	0 ~ <u>50</u> ~ 99		
Tracker			
Tracker mic to	<u>Off</u> , Cam, Eng, Prod, All		
Tracker mic gain	0, <u>40dB</u>		
Tracker mic pwr	On, <u>Off</u>	12Vdc to tracker mic	
Tracker mic src	Eng, <u>Side</u>	Engineering or sidetone to Tracker	
<b>Audio</b>			
Audio gain mode	Loc, <u>Ext</u>	Control from head or CU	
Audio 1 level	-22, -28, -34, -40, -46, -52, -58, <u>-64dB</u> or -10dBu ... +4dBu		
Audio 1 HPF	<u>On</u> , Off	Cut hum or wind noise	

<i>Item</i>	<i>Range</i>	<i>description</i>	<i>Pref</i>
Audio 2 level	-22, -28, -34, -40, -46, -52, -58, <u>-64dB</u> or -10dBu ... +4dBu		
Audio 2 HPF	<u>On</u> , Off	Cut hum or wind noise	
<b>Tally</b>			
On Air lamp	<u>Enable</u> , Disable	Tally lamp on front of VF	
On Air lamp lvl	0 ~ <u>99</u>		
On Air lamp handgrip	<u>Switch</u> , Input Off		
Tally lock	<u>On</u> , Off	'On' locks some camera controls	
<b>AWB settings</b>		Auto white balance	
AWB speed	1 ~ <u>4</u> ~ 40		
AWB gain	1 ~ <u>10</u> ~ 40		
<b>IP settings</b>			
IP mode	<u>Auto</u> , Manual	IP configuration mode	
IP address			
IP address 1	1 ~ <u>169</u> ~ 250		
IP address 2	0 ~ <u>254</u> ~ 255		
IP address 3	0 ~ <u>1</u> ~ 255		
IP address 4	1 ~ <u>220</u> ~ 254		
IP netmask			
Subnet mask 1	0 ~ <u>255</u>		
Subnet mask 2	0 ~ <u>255</u>		
Subnet mask 3	<u>0</u> ~ 255		
Subnet mask 4	<u>0</u> ~ 255		
Apply settings	Exec	Do it	
<b>PCID</b>	0 ~ <u>1</u> ~ 8	Select for external POC operation	
<b>Signals</b>			
VF/Main output	Main, <u>VF-HD</u> , VF-SD, VF-Ext	'Main Output' from the cable adaptor	
Extern output	<u>Ext1</u> , Ext2, Ext3	What goes to the 'Ext' socket	
TP output	<u>TP</u> , VF	Puts analog o/p on the Ref In socket	
<b>H-phase</b>	0 ~ <u>50</u> ~ 99	Main output phase	

**LICENSES Menu****Information on camera licenses**

<i>Item</i>	<i>Range</i>	<i>description</i>	<i>Pref</i>
<b>Active licenses</b>			
WorldCam	<u>Unknown</u> , Not applicable, Not present, Temporary, Perpetual, Trial, Clock error	Display only	
Time left	<u>0</u> ~ 65535	Remaining time, seconds	
Elite	<u>Unknown</u> , Not applicable, Not present, Temporary, Perpetual, Trial, Clock error		
Time left	<u>0</u> ~ 65535		
Premiere	<u>Unknown</u> , Not applicable, Not present, Temporary, Perpetual, Trial, Clock error		
Time left	<u>0</u> ~ 65535		
<b>Planned licenses</b>			
License count	<u>0</u> ~ 65535	Number of licenses on the camera	
Start date	<date>	Display start date ...	
Start time	<time>	... and time ...	
Type	<u>None</u> , Premiere, Elite, WorldCam	... and type	
Duration	<u>0</u> ~ 65535	... and duration in days	
<b>New licenses</b>			
Time	<current time>	Display only	
Date	<current date>		
Change time			
Hours (24h)	<u>0</u> ~ 23		
Minutes	<u>0</u> ~ 59		

<i>Item</i>	<i>Range</i>	<i>description</i>	<i>Pref</i>
Time zone	UTC-12.00 ~ 00 ~ +12.00		
Apply time	Exec		Do it
Change date			
Days	1 ~ 31		
Months	1 ~ 12		
Year	2000 ~ 2012 ~ 2199		
Apply date	Exec		Do it
Time&data OK?	..., No, Yes		Confirms date and time
Find licenses			
Search next	Exec	Look for next license, USB or camera	
Add license	Exec	Add what you've just found	
Type	None, Premiere, Elite, WorldCam, WCam+El+Pr, WCam+El, WCam+Pr, Elite_Pr	What type it is	
Start	<start time>		
Time zone	UTC-12.00 ~ 00 ~ +12.00		
Status	Unknown, Not applicable, Not present, Temporary, Perpetual, Trial, Clock error		
Duration	0 ~ 65535		In seconds
<b>Trial license</b>			
Select type	None, Premiere, Elite, WorldCam		
Activate	Exec		
Time left	0 ~ 240		Seconds remaining

**DIAGNOSTICS Menu****Reports only, no controls**

<i>Item</i>	<i>Range</i>	<i>description</i>	<i>Pref</i>
<b>Communication</b>			
Connections			
BS connected	Yes, No	Report base station of CU connection	
C2IP panels	0 ~ 99	Show number of panels connected	
LDK connect GW	Yes, No	LDK Gateway connection	
Ser stats (DTCP)			
Ser stats (PCI)		Advanced use	
SPI stats			
<b>Transmission</b>			
Cable length	0 ~ 200%	100% is maximum for reliability	
Cable status	OK, Critic, Error, No sig		
Signal status	OK, Critic, Error, No sig		
BS > Cam			
Cable status	OK, Critic, Error, No sig		
Signal status	OK, Critic, Error, No sig		
Rx margin	-100 ~ 0 ~ 100dB	Optical signal margin	
Cam > BS			
Cable status	OK, Critic, Error, No sig		
Signal status	OK, Critic, Error, No sig		
Rx margin	-100 ~ 0 ~ 100dB	Optical signal margin	
Trans details			
Opt module	Unknown, FTLF1424P2		
Rx power (µW)	0 ~ 65535		
Rx power (dBm)	-100 ~ 0 ~ 100		
Tx power (µW)	0 ~ 65535		
Tx power (dBm)	-100 ~ 0 ~ 100		
Module temp (C)	-40 ~ 0 ~ 125		
Module temp (F)	-40 ~ 0 ~ 125		
Optical signal	OK, Loss		
Rx locked	No, Yes		
Frame locked	No, Yes		

**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.**

<i>Item</i>	<i>Range</i>	<i>description</i>	<i>Pref</i>
System locked	<u>No</u> , Yes		
Profile	3G Optimal, HD Optimal, 3G Robot, HD Robot, <u>Unknown</u>		
BS > Cam		Advanced settings use	
Data error status			
<b>Ethernet</b>			
MAC address			
Link state	Connected, <u>Disconn</u>		
Link type	<u>Unknown</u> , 10Mb/half, 10Mb/full, 100Mb/half, 100Mb/full, Negotiate		
<b>Configuration</b>			
Camera			
Type	<u>Invalid</u> , LDX80W, LDX80E, LDX80P, LDX80F		
PID			
Alias			
Device ID			
Number	<u>0</u> ~ 99		
Number	0 ~ <u>1</u> ~ 99		
Number default	1 ~ <u>18</u> ~ 99		
Adapter			
Type	<u>None</u> , 3GTriax, 3Gfibre		
Type number	<u>Unknown</u> , LDX5419, LDX5421		
Viewfinder			
Type	<u>None</u> , 2"HD, 5"HD, 7"HD, 8"LCD, 7"LCD, 9"LCD, 2"LCD		
Lens			
<b>Package info</b>			
Camera package			
Package	<u>OK</u> , Not OK		
Package 12NC	<u>0</u> ~ 65535		
Package version	<u>0</u> ~ 65535		
Component	<u>RP IC FW</u> , RP IC SW, RP VP FW, RP VP SW, RP DI FWSW, RP BOOT SW, RP CONF SW, RP APP SW, RC FW, SBB FW, SBG FW, SBR FW		
SW/FW valid	<u>OK</u> , Not OK		
SW/FW 12NC	<u>0</u> ~ 65535		
SW/FW version	<u>0</u> ~ 65535		
Adapter package			
Package	<u>OK</u> , Not OK		
Package 12NC	<u>0</u> ~ 65535		
SW/FW name	<u>RP IC FW</u>		
SW/FN 12NC	<u>0</u> ~ 65535		
SW/FW version	<u>0</u> ~ 65535		

## SERVICE Menu

<i>Item</i>	<i>Range</i>	<i>description</i>	<i>Pref</i>
<b>Pref network</b>	Serial, <u>Ethernet</u>		
<b>Test signals</b>			
Test signal	<u>Off</u> , On		
Test select	SawT, Step, SawT400, Step400	Sawtooth or steps, to 100 or 400%	
<b>Info files</b>			
Write config	Exec > Busy	Advanced use	
Write settings	Exec > Busy		
Write usage	Exec > Busy		
Copy latest	Exec > Busy		
Copy all	Exec > Busy		

<i>Item</i>	<i>Range</i>	<i>description</i>	<i>Pref</i>
<b>Log files</b>			
Write RP APP	Exec > Busy	Advanced use	
Copy latest	Exec > Busy		
<b>Calibrations</b>			
3200K Calibr	<u>Off</u> , On		
3200K reset	<u>Fact</u> , Cust		
Black calibr	Off, Running	Takes about a minute	
Status	Unknown, OK, Error, Fatal error, Needed, Temp low, Temp unst, Timeout, Filter cap, Warming up, Stabilizing, Running, Ready, Failed, Aborted		
Calibr temp	<u>37C</u> , Act	Temp at which calibration's done	
Act temp	-128 ~ <u>0</u> ~ 127C	Shows current camera temp	
<b>SD card</b>			
Format	<u>Off</u> , Running	Takes about a minute	
Status	Unknown, Running, OK, Error, No card		

## EBU – Tech 3335 : **Methods of measuring the imaging performance of television cameras for the purposes of characterising and setting**

Alan Roberts, March 2014

### **SUPPLEMENT 013 : Assessment of Grass Valley LDX camera**

Testing of the camera was done at Grass Valley in Breda. All recordings were made onto an AJA software recording system. Most testing was done on a WorldCam, on the understanding that the whole range has the same hardware in the camera, but some facilities are not available in the other models. Subjective viewing was on a large TV Logic display.

#### **1. Colour rendering**

The camera produced vestigial response to infra-red, IR, which will be no problem. No other tests were made, since the pictures appeared to be completely acceptable, and the extensive colour controls should make it possible to match most other cameras.

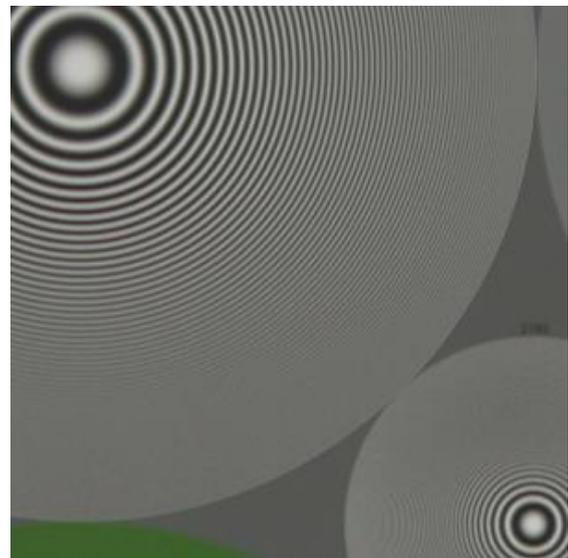
#### **2. Resolution and Aliasing**

The LDX cameras deliver images at two HD resolutions, 1920x1080 and 1280x720, and the base station also outputs SD as SDI or analogue. Measurements were made using a circular zone-plate test chart, designed for 1920x1080 television. The camera was tested using a Canon HJ21 zoom lens.

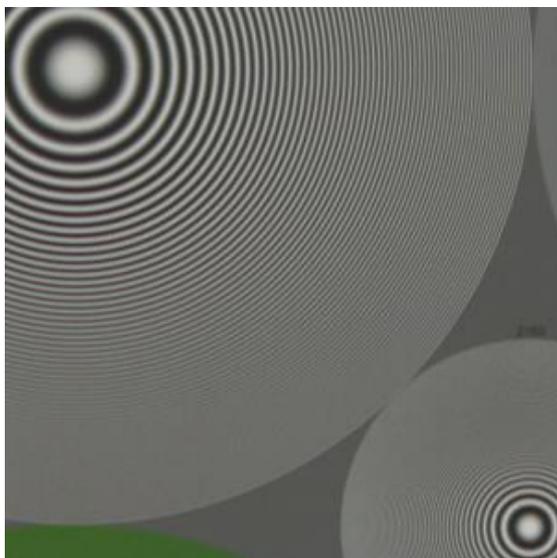
##### **2.1. Resolution at 1920x1080i/25**

The test chart was framed to fill the image, at about 3 meters and F/2.4 aperture.

Figure 1 shows a small part of the chart, one quadrant (lower right) of a luminance pattern, reaching nominally 1920 horizontally and 1080 vertically, low frequency being at the large central spot, and frequencies increasing linearly from it.



**Figure 1 Resolution, 1080i, detail off**



**Figure 2 Resolution, 1080i, default detail**

Resolution is clean up to the expected limits for interlace, rolling gently to the horizontal edge and limited vertically by the interlace process. There are low-level aliases visible in the double-frequency, smaller pattern, which indicates that optical spatial low-pass filter is allowing some unwanted frequencies to reach the sensors. This level of aliasing is unlikely to cause problems in any compression system.

In progressive mode, the vertical resolution is the same as horizontal. This mode was not recorded.

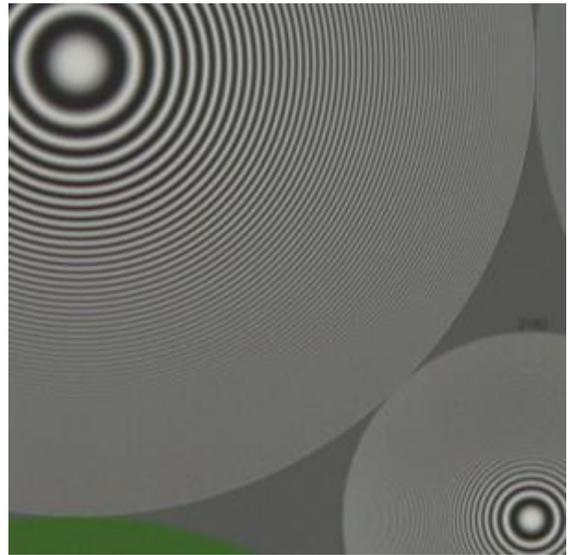
The default detail settings work well. Figure 2 shows the results, using the 'preferred' settings for video. Simply reducing the overall detail level gave a pleasingly softer picture, progressive reduction could well be useful for

produce pictures looking like 35mm or 16mm film. The balance of other settings is good.

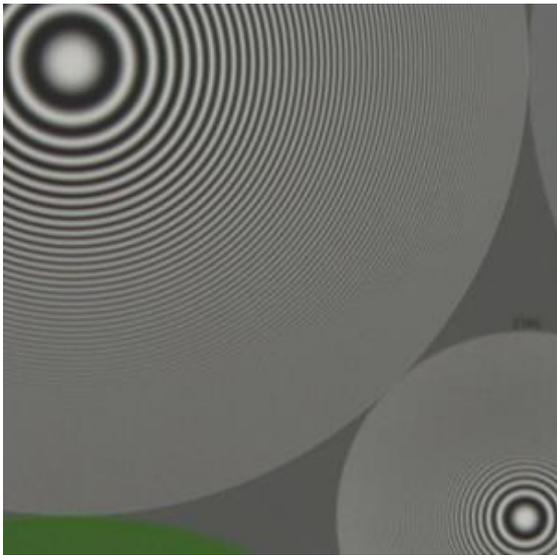
However, the camera has a special electronic filter for ameliorating the effects of LED video-wall displays. These can have highly visible detrimental effects on pictures through aliasing, so some form of filtering can be beneficial, although it would be best as a physical diffuser on the LED display itself.

Figure 3 shows the effect of the ‘LED-wall’ filter. It softens the picture a little, but has no effect on the aliasing, which is no surprise since they are caused by out-of-band optical frequencies. On test with a simulation of a LED-wall display, the level of low-frequency aliasing did reduce significantly, but not enough to stop it being annoying.

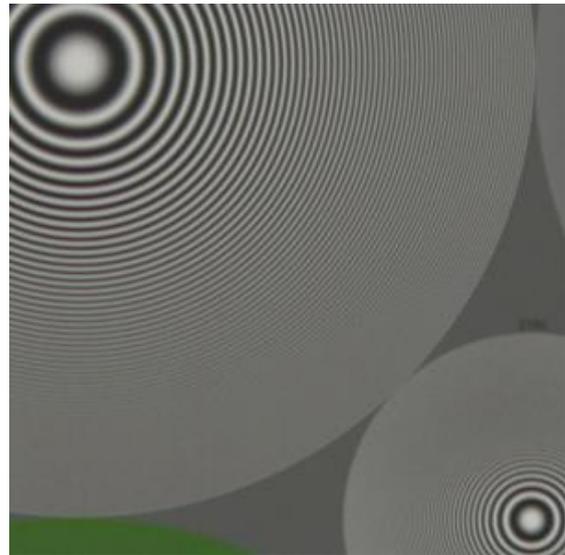
The camera under test had been fitted with an extra optical filter in the Effects wheel. This can replace any of the standard filters, but it seems obvious that it could replace the ‘Soft Focus’ filter, which is very soft. This optional filter is calculated to have an approximately  $\text{Sin}(x)/x$  shape with zero responses at precisely 1920 and 1080 (strictly speaking at 960 cycles/picture width and 540 cycles/picture height).



**Figure 3 Resolution, 1080, LED-wall filter**



**Figure 4 Resolution, 1080i, LED-wall plus optical filter**



**Figure 5 Resolution, 1080i, optical filter**

Figure 4 shows the effect of this filter. It has the desired effect for a film look, since it eliminates the high-frequency aliases as well and the result is a super 16mm look, even with all the detail control settings unchanged.

Figure 5 shows the effect of the optical filter without the LED-wall electronic filter. It eliminates the high-frequency aliases and still produces the smooth film-type look. This is by far the nicest way to get this look, since the detail controls cannot cause any aliasing. As a personal opinion, I would discard the Soft Focus filter and install this one instead, it is far more useful.

The detail enhancement section of the menu is quite complex, offering a great deal of options. One worth mentioning is called ‘Detail equalizer’, which has separate controls for enhancement in shadows, highlights and mid-tones. These were not explored, but offer endless hours of amusement for the inveterate knob-twiddler.

## 2.2. Resolution at 1280x720p/50

The down-conversion to 1280x720 inevitably produces some aliases, even though the source image from the sensors is always progressive (it's in the nature of the reading process). They are not excessive, but can be almost completely eliminated by using the optional optical low-pass filter. There is no need to change any detail settings for this mode. This is quite unusual.

Figure 6 shows the result with the detail settings as optimised for 1080. There is a little horizontal aliasing, but clearly not enough to worry about. However, there is significant vertical aliasing, which is almost inevitable since down-conversion demands the use of line delays as well as pixel delays, and the temptation is to use non-square filtering which requires fewer line delays.



Figure 6 Resolution, 720, HD detail settings



Figure 7 Resolution, 720p, with optical filter

But, the optional optical low-pass filter makes a big difference here, Figure 7 shows the result. The out-of-band aliases (those in the double-frequency smaller pattern) are removed as expected, and the in-band aliases are reduced. The overall result is quite good.

## 2.3. Resolution at SD (625i/25)

Although the camera does not have a SD mode, the base unit always generates a SD output. The analogue output is for monitoring only, but an SDI output can be used for programme feed as well. Therefore, the SDI output was tested.

The zone late chart was framed as before, filling the image. Figure 8 shows the result. There are horizontal aliases at low-level, but vertically there are second-order aliases, where the interlacing and down-converting processes interact with each other. These aliases enforce the view that the SD output should not be used for programme-making, only for monitoring.

For this test, the detail settings were all as had been optimised for video use. The down-converter in the base unit has extra detail enhancement controls, setting the level to 10 is a reasonable compromise between sharpness and aliasing. These controls were not extensively explored.



Figure 8 Resolution, SD from 1080i



Figure 9 Resolution, SD, HD from 1080i, detail off



Figure 10 Resolution SD from 1080p

However, since the down-conversion is made on the programme-chain output of the camera, it must be affected by the HD detail settings. Figure 9 shows the effect of turning HD detail off. Clearly, the alias levels are lower, both horizontally and vertically. Figure 10 shows the effect of setting the camera to 1920x1080p/50, eliminating interlace in the HD image. The mid-frequency vertical aliases disappear, to be replaced by much lower-level aliases at high frequency, again as expected.

## 2.4. Gamma and Contrast Range

The camera has a good selection of gamma curves, some inherited from SD practice and included for historical continuity. However, since this is an HD camera, only the ITU709 curve was used in the tests. It appears to be a good implementation of the curve, rendering the 18% side of a Kodak Gray card at about 43% when the white (90%) side is exposed to produce 100% video.

To measure the contrast range, a grey scale (Colorchecker chart) was exposed to produce exactly 100% video on the peak white patch. The lens aperture was noted. Then, without changing the gain, the knee was manipulated to compress highlights as much as possible, and the iris then opened to achieve 100% video again on the white patch. The lens 'gain' was exactly 3 stops, 800%.

The knee was then turned off so that the level of peak white could be set accurately, and noted as F/2.8. Then the lens progressively closed down until the lowest two patches on the grey scale were only just visibly different, when viewed on the monitor, and this exposure setting was noted (F/13), 4½ stops. The reflectivities of the 'white' and 'black' patches are 90.01 and 3.13% respectively, a ratio of 28.76:1, almost 6 stops.

Thus the dynamic range is about 13½ stops, which is rather good.

The knee function is almost as complex as the detail settings. The knee itself can be set to start at zero, and there's no sharp point in the curve. It is possible to emulate virtually any curve by using a mixture of the controls, and since there are so many of them, it would take far too long to deal with all of them. It is easy to generate a log-type curve for film emulation, or a curve with a sharp knee at, say 80%. And, once such a curve has been set, there are further controls for manipulating contrast in shadows, highlights and mid-tones, as well as the more usual black-stretch (which can also do black-press). With such a wide range of controls, and the 13.5 stop dynamic range, there can be little excuse for producing overloaded pictures such as are common in sports production.

I have made no recommendation on knee and curve adjustment, but would strongly encourage users to explore these controls, and find combinations which suit the circumstances.

## 2.5. Sensitivity

The normal sensitivity for a 2/3" system camera is between F/11 and F/12 for a 89.9% reflectivity white illuminated at 2000lux. The camera was measured in 'Nom' sensitivity mode (Production setup > Sensitivity).

The white side of a Kodak Gray card (0% reflectance) was lit at 2000lux. With normal ITU709 gamma and all knee functions switched off, and gain at 0dB, peak white was achieved at about F/11.5. The specification claims F/12. The difference is within measurement error range.

The sensors are nominally 2/3" size and therefore the photo-sites are spaced at exactly 5µm, which is normal for system cameras. However, this camera is different in that it used frame-transfer rather than scanning to produce the output. Another difference is that the frame store is integral with the photo-sites, meaning that pixel data is read into the store in only two clock cycles, into a storage cell which sits within the 5µm square of the photo-site. The chip fabrication uses 0.18µm electrode widths, which makes it possible to have the necessary five active devices within the cell, and still have adequate active area for light absorption. So the active area of the photo-site is about 20µm<sup>2</sup> which is not significantly less than in equivalent cameras. This explains the high sensitivity, and the high dynamic range, since the output signal is not shifted between cells where gradual pollution is inevitable.

## 2.6. Noise

A home-made test card with 6 patches at various grey levels was lit with a studio luminaire, approximately 3,000K. The card was exposed twice, using neutral density filters to vary the exposure levels.

Figure 11 shows the noise measurements with the camera in 'Nom' (nominal) sensitivity mode, detail off, and 0dB gain. As expected, noise is higher in the blue channel. If the noise is from analogue circuitry alone, then the distribution should follow the slope of the gamma-correction curve, rising continuously towards black, increasing by about 17dB between white and black. However, in modern cameras, the analogue circuitry contributes little to the actual noise, it is more influenced by shot noise, which rises with signal level. The net result is often a flat distribution of noise levels. The rise here near black implies that there is some analogue circuitry noise, which is quite normal. Although there is probably some noise reduction in the camera, I could find no control over it.

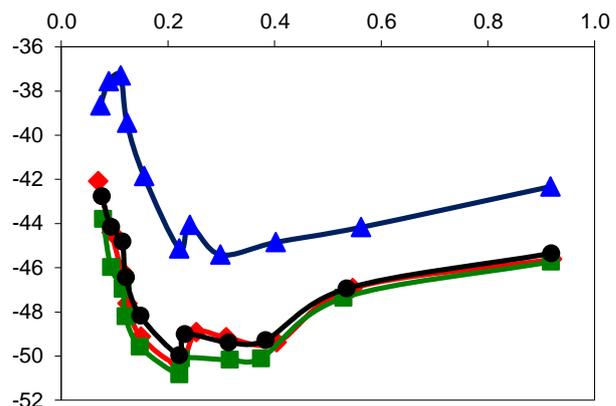


Figure 11 Noise levels, 'Nom' sensitivity

However, it has already been shown that any noise reduction does not seem to affect the resolution, and thus is probably only a mild reduction. Noise level near mid-grey is about -50dB, which is acceptable.

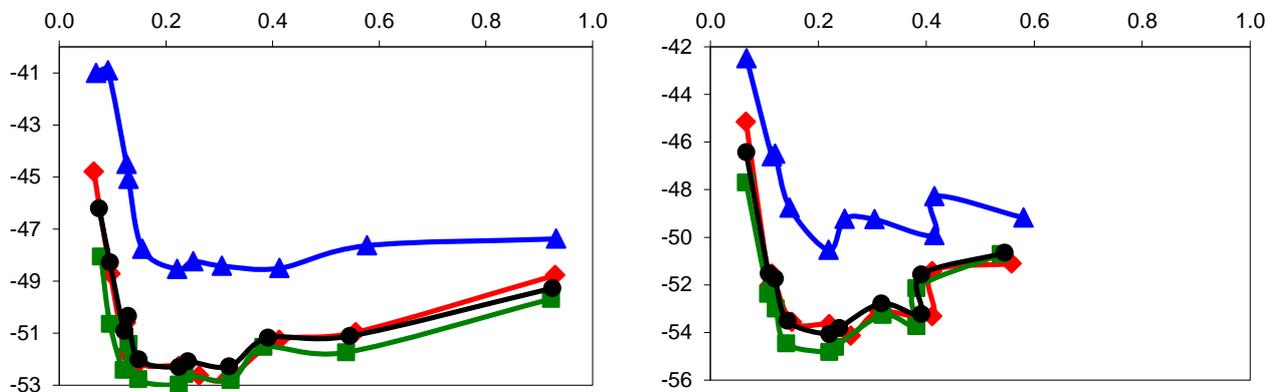


Figure 12 Noise levels, 'HQ' mode, a) 0dB gain

b) -3dB gain

In 'HQ' (high quality) sensitivity mode the gain is reduced and therefore the headroom reduces as well.

Figure 12 shows the noise distributions. Noise levels now fall to about -52.5dB at mid-grey. At -3dB gain, the noise drops to about -54dB.

If the camera is white-balanced to daylight, the internal gain of the blue channel will fall considerably, and that in red rise a little. Therefore, the overall noise levels should be a little lower, typically 1 or 2dB.

All these tests were made using the fibre cable connection. Since the modulation system used on the Triax cable is different, it was thought worth-while to check to see how it affected the noise levels. For this test, 'HSens' (high sensitivity) mode was used to ensure higher noise levels which should stress any compression and transmission system. Figure 13 shows the difference in noise levels between signals captured at the head and the base unit.

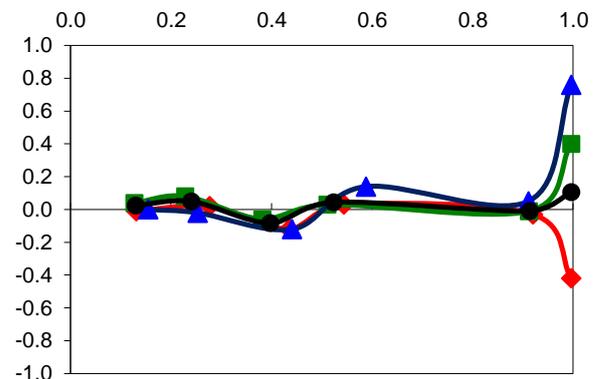


Figure 13 Noise, Triax performance

Over most of the signal range the difference is less than 0.15dB, the increased differences near white are probably due to clipping and can be safely ignored. It would have been preferable to record at the head and base unit simultaneously, such that one could be subtracted from the other to check for correlation, but only one recording system was available during the tests. Nevertheless, this test shows that the Triax system does not significantly change the noise performance.

## 2.7. Fixed-pattern noise

No fixed pattern noise was visible at any gain setting.

## 2.8. Rolling shutter effects

In a conventional CMOS-sensor camera, the sensor is not read out as a still frame, it is continuously scanned in a process known as "rolling shutter". However, the LDX cameras have a 'global' shutter, in which the entire image is moved from the photo-sites into adjacent stores from which it is subsequently processed. Therefore, there should be no scanning problems.

The camera was exposed to a small, battery-powered fan, and the speed adjusted until the blades strobed slowly. Figure 14 shows a still from a moving sequence. The fan is rotating clockwise so the left-hand blade is rising against interlace while the right-hand blade is falling. In a normal CMOS camera, or one with scanning tubes, the right-hand blade would be grossly expanded, the left shrunk. There is no evidence of that here. The camera has a global shutter, there are no scanning problems.



Figure 4 Motion test

## 2.9. Conclusions

The WorldCam performs very well. There is no reason to believe that the Premiere, Elite or Flex would perform any differently since they all use a common head and processing. In the same way, the smaller box-camera should also perform to the same level although it has limited facilities.

The camera easily qualifies for EBU R.118 Tier 1, since it has all the necessary features and facilities, and performs within the target levels. Resolution is good, aliasing low, noise levels within acceptable limits. Sensitivity and dynamic range are particularly good. Performance at 720p and SD are both good, but can be improved significantly if the optional extra optical low-pass filter is fitted. However, it should be noted that this cannot be fitted to the Flex model, which has only one filter wheel.

Neither camera responds to infra-red (IR) and there are no motion problems due to scanning of the sensor.