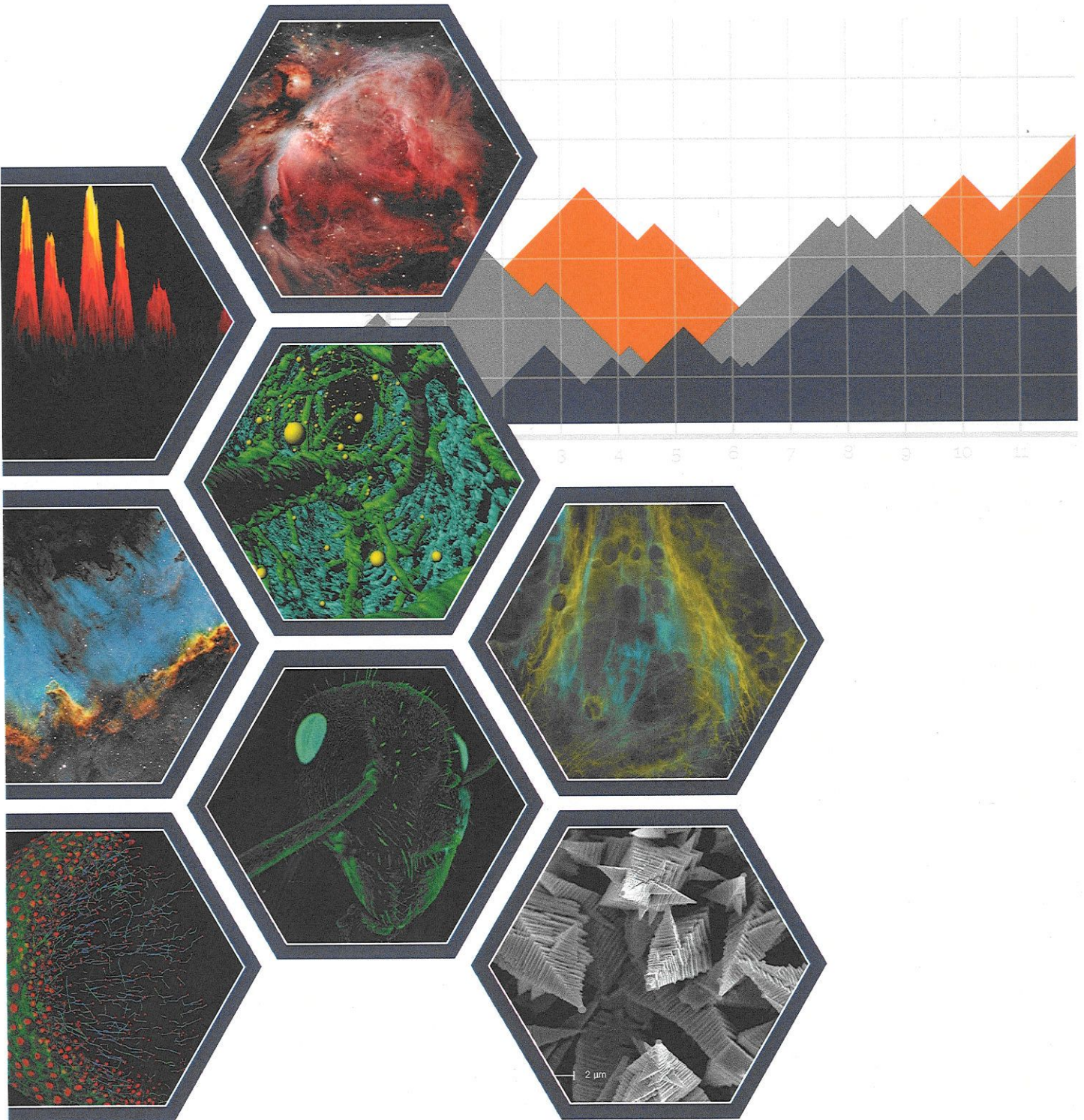


## System Performance Booklet





**System Overview**

Description	Model	Serial Number
CCD Head ▽	D Z 9 36N - BEX2-DD	CCD-21703
TE Cooler performance (✓)	High	Ultra-high ✓
Power Supply Units	PS -29	PS -40
	✓	✓
Accessories	LM-	MFL-
Serial/Batch Number		
Other		

▽ Sensor types are defined in Table 1 using the last two letters in box Model Number.

**CCD Details**

Manufacturer / Model No.	Pixels	Serial Number
E2V CCD42-40	2048x2048, 13.5µm x 13.5µm	15233-11-06

Special Features	(✓)	(✓)
NIMO		Nikon F-mount with Shutter ✓
Fringe Suppression		Custom Cables
Shielded Anti-Blooming		

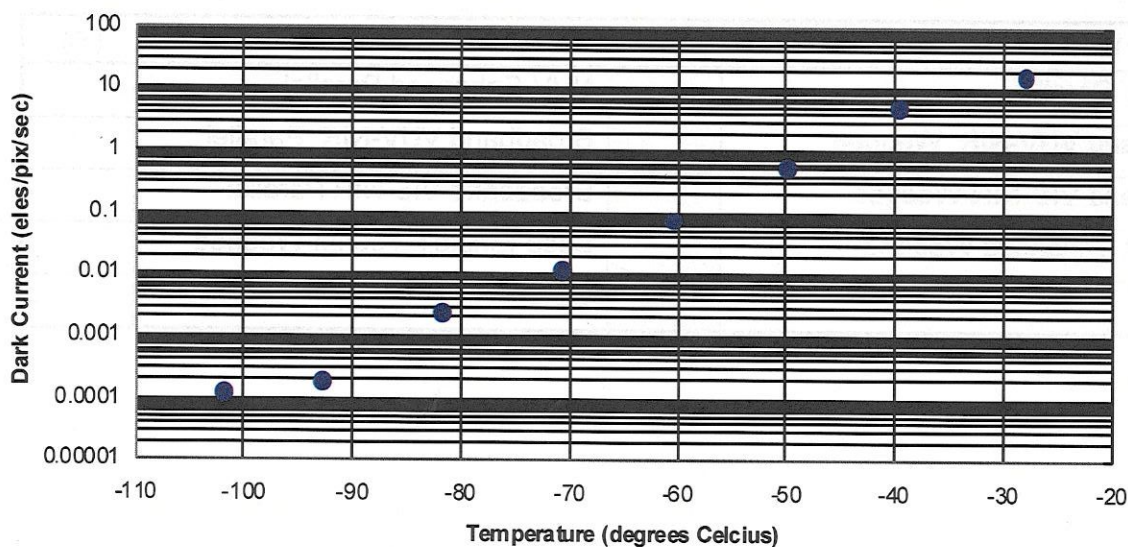
Window Variant	(✓)	(✓)
VUV-UV Parallel		NUV-Enhanced Parallel
Broadband VUV-NIR Wedged		Broadband VUV-NIR Parallel ✓
Broadband VIS-NIR Wedged		Broadband VIS-NIR Parallel
VIS-NIR Enhanced Wedged		Bose-Einstein 780nm Wedged
None		Other

**Summary of System Test Data**

**Readout Noise  $\diamond 1$  and Base Mean Level  $\diamond 2$**

A/D Rate MHz - all 16 bit	Preamp setting	CCD Sensitivity $\diamond 3$		Single Pixel Noise		Base Mean Level	
		e- per A/D count		electrons rms		A/D counts	
		High Sensitivity Mode	High Capacity Mode	High Sensitivity Mode	High Capacity Mode	High Sensitivity Mode	High Capacity Mode
5.0	x1	5.9	23.5	35.7	127.4	2396	908
5.0	x2	3.1	12.5	29.4	86.5	3794	916
5.0	x4	1.6	6.5	25.9	66.9	4601	922
3.0	x1	4.3	18.2	21.6	88.8	1083	887
3.0	x2	2.2	9.8	13.4	53.1	1997	1586
3.0	x4	1.1	5.3	10.9	45.0	3017	2961
1.0	x1	4.0	18.6	10.0	44.8	909	1167
1.0	x2	2.1	10.1	7.7	33.2	1496	1970
1.0	x4	1.1	5.3	6.9	28.2	2573	3464
0.05	x1	4.0	19.3	5.6	20.2	916	1167
0.05	x2	2.1	10.1	4.8	14.8	1487	1955
0.05	x4	1.1	5.3	4.3	13.2	2540	3411
<b>Saturation Signal per pixel <math>\diamond 14</math></b>				111468		electrons	

**CCD Dark Current**



<b>Minimum Dark Current Achievable <math>\diamond 4</math></b>	0.000121	electrons/pixel/sec		
<b>@ Sensor Temperature of <math>\diamond 5</math></b>	-101.96	°C	16.0	°C cooling water
<b>CCD Dark Current Uniformity better than <math>\diamond 6</math></b>	0.855	electrons/pixel/sec		



**Linearity and Uniformity**

Linearity better than ♦7	1	% over 16 bits
Response Uniformity better than ♦8	1.85	%

**Response Defects**

<b>White/Black Spots ♦9</b>			(X, Y) Number of Pixels																																																																																	
<table border="1" style="width: 100%; height: 100%;"> <tr><td style="text-align: center;">X</td><td style="text-align: center;">Y</td></tr> <tr><td style="text-align: center;">( X , X )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> </table>	X	Y	( X , X )		( , )		( , )		( , )		( , )		( , )		( , )		( , )		( , )		( , )		( , )		<table border="1" style="width: 100%; height: 100%;"> <tr><td style="text-align: center;">Number of Pixels</td></tr> <tr><td style="text-align: center;">X</td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> </table>	Number of Pixels	X														<table border="1" style="width: 100%; height: 100%;"> <tr><td style="text-align: center;">X</td><td style="text-align: center;">Y</td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> <tr><td style="text-align: center;">( , )</td><td></td></tr> </table>	X	Y	( , )		( , )		( , )		( , )		( , )		( , )		( , )		( , )		( , )		( , )		( , )		( , )		( , )		<table border="1" style="width: 100%; height: 100%;"> <tr><td style="text-align: center;">Number of Pixels</td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> <tr><td style="text-align: center;"> </td></tr> </table>	Number of Pixels													
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**Dark Current Defects**

<b>Hot Spots ♦12</b>			(X, Y)																																																																																																																																																											
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<b>Hot Columns ♦13</b>	Column numbers indicated.		<input type="text" value="X"/>	<input type="text" value="X"/>																																																																																																																																																										



**Test Conditions**

Readout Noise tested at	-90	°C with	16	°C water
Base Mean Level measured at	-90	°C with	16	°C water
Dark Current Uniformity tested at	-50	°C with	16	°C water
Blemishes tested at	-50	°C with	16	°C water

**Custom Testing**

**System Passed for Shipping**

Signed

Date

**P. SCOTT**

**23<sup>RD</sup> FEBRUARY 2018**

	HEADBOARD	FPGA
Hardware Version #	AF	20.12
	SOLIS	SDK
Shipping Software Version #	--	--
	SOLIS	SDK
Testing Software Version #	4.30.30034.0	2.102.33034.0

▽ **Table 1; Key code to define the meanings of the last two letters in the Model Number**

Sensor Options			
OE	Open electrode	BV	BI + VIS (550nm) optimised
FI	Front illuminated (FI)	BR	BI + NIR (850) optimised
UV	FI+UV coating	BR-DD	BI + NIR +deepdepletion
FO	FI + Fibre optic	BN	BI with no AR coating
FI-DD	FI + deep depletion	FK	Fast Kinetics (masked; 3011 only)
BU2	Back Illuminated (BI) + 250nm UV optimised	KT	Kodak FI coating
BU	BI + UV (350nm) optimised		



**Performance Notes**

- ◆1 Readout Noise is measured for both single pixel (SP) and fully vertically binned (FVB) with the CCD in darkness at temperature indicated and minimum exposure time. Noise values will change with pre-amplifier gain selection [PAG].
- ◆2 Average electronic DC offset for CCD in darkness at temperature indicated and minimum exposure time under dark conditions measured by single pixel (SP) for imaging systems and by (FVB) for spectroscopic systems.
- ◆3 Sensitivity is calculated in photoelectrons per A/D count from measurements of the Photon Transfer Curves.
- ◆4 Dark current falls exponentially with temperature. However, for a given temperature the actual dark current can vary by more than an order of magnitude from device to device. The devices are specified in terms of minimum dark current achievable rather than minimum temperature.
- ◆5 Minimum temperature achieved for thermoelectric (TE) cooler set to maximum value with water cooling
- ◆6 RMS (root mean square) deviation of dark current for fully binned operation for spectroscopic cameras, or full resolution image for imaging cameras, under dark conditions at temperature indicated (pixel/column defects not included). This variation is mainly cosmetic since it is fully subtractable without significant loss of performance.
- ◆7 Linearity is measured from a plot of Counts vs. Signal over the 16 bit dynamic range. Linearity is expressed as a %age deviation from a straight line fit. This quantity is not measured on individual systems.
- ◆8 RMS (root mean square) deviation from the average response of the CCD in fully binned operation for spectroscopic cameras, or full resolution image for imaging cameras, illuminated with uniform white light (defects not included).
- ◆9 White/black spots have signals >25% above/below the average (i.e >25% contrast) with uniform illumination across the sensor.
- ◆10 Columns whose signals have >10% contrast in binned operation with uniform illumination across the sensor for spectroscopic cameras,  $\geq 10$  black spots per column for imaging cameras.
- ◆11 Pixels which absorb charge as it is clocked through the defective area. When the light source is switched off, the signal from the trap appears to drop off more slowly than the signal from the surrounding pixels.
- ◆12 A spot can be up to 3 pixels in size. For Grade A devices, hot spots are counted if they exhibit >50 times the maximum specified dark current at the test temperature indicated.
- ◆13 A column is considered defective if >10 pixels are affected, or if the column exhibits >2 times the maximum specified dark current at the test temperature indicated.
- ◆14 Saturation Signal per pixel is measured at 1MHz PreAmp x1 High Sensitivity mode