

INTELLIGENT, HIGH-RESOLUTION, FIELD UPGRADEABLE, PROGRAMMABLE, DIGITAL CAMERAS



CONFIDENTIAL NOTICE:

These products are not intended for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Imperx customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Imperx for any damages resulting from such improper use or sale.

Copyright © 2012, Imperx Inc. All rights reserved. All information provided in this manual is believed to be accurate and reliable. Imperx assumes no responsibility for its use. Imperx reserves the right to make changes to this information without notice. Redistribution of this manual in whole or in part, by any means, is prohibited without obtaining prior permission from Imperx.



Imperx, Inc. 6421 Congress Ave. Boca Raton, FL 33487 +1 (561) 989-0006



Revision History

Rev 1.0	08/23/13	A.Moreno	Initial Pre-Release
Rev 1.1	04/05/13	A.Moreno	Added Tri-Level Sync input/output connection diagram
Rev 1.2	02/05/14	A.Moreno	Added SDI_B1923
Rev 1.3	04/11/14	A.Moreno	Added Control Register data for the New Color Matrix, Color Saturation, and AWB with Tracking
Rev 1.4	05/20/14	A.Moreno	Added Gennady's edits
Rev 1.5	08/28/17	R. Johnston	Corrected the HD-SDI B1923 pixel size specification



Table of Contents

1. CHA	PTER 1 – INTRODUCTION	12
1.1. BC	OBCAT HD-SDI FAMILY	13
1.2. GF	ENERAL DESCRIPTION	13
	DBCAT HD-SDI SPECIFICATIONS	16
1.3.1.	General Information	
1.3.2.	Spectral Response	
1.3.3.	Bayer Pattern Information	
1.3.4.	Technical Specifications	21
1.4. CA	AMERA CONNECTIVITY	28
1.4.1.	HD-SDI Output	28
1.4.2.	Power Supply	31
1.5. MI	ECHANICAL, OPTICAL and ENVIRONMENTAL	32
1.5.1.	Mechanical	
1.5.2.		
1.5.3.	-	
2. CHA	PTER 2 – CAMERA FEATURES	39
2.1. No	rmal Mode – Dual Output	40
2.2. FR	AME TIME CONTROL	40
2.2.1.	Frame Time (Long Integration) Control	40
2.2.2.	External Frame Time Control	41
2.3. AF	REA OF INTEREST	41
2.3.1.		-
2.4. EX	APOSURE CONTROL	43
2.4.1.	Internal Exposure Control - Electronic Shutter	
2.4.2.	Programmable Frame Time	44
2.4.3.	Automatic Exposure Control (AEC)	45
2.4.4.	Automatic Iris Control (AIC)	
Imperx, Inc.		Rev. 1.5
6421 Congre	ess Ave.	9/26/2017
Boca Raton	, FL 33487	



2.5.	TROBE OUTPUT	45
	GAIN and OFFSET	46
2.6.1.	Analog Domain – manual control	46
2.6.2.	Digital Domain – manual control	47
2.6.3.	Automatic Gain Control (AGC)	47
2.7. I	OATA OUTPUT FORMAT	48
2.8. I	PULSE GENERATOR	49
	O CONTROL	50
2.9.1.	I/O Mapping	50
2.9.2.	Electrical Connectivity	51
	TEST IMAGE PATTERNS	52
2.10.1	. Test Image patterns	52
2.10.2	. Image Superimposition	53
2.11. V	VHITE BALANCE	54
2.11.1	. White Balance	54
2.12. I	DYNAMIC BLACK LEVEL CORRECTION AND TAP BALANCING	
2.12.1	. Black Level Correction	54
2.12.2	. Tap Balancing	54
	TRANSFER FUNCTION CORRECTION – LUT	55
2.13.1		
2.13.2	. User Defined LUT	56
2.14. I	DEFECTIVE PIXEL CORRECTION	57
2.14.1	. Static Pixel Correction	58
2.14.2	Dynamic Pixel Correction	58
2.15. I	FLAT FIELD CORRECTION	58
	CAMERA INTERFACE	61
2.16.1	. Status LED	61
2.16.2	. Temperature Monitor	61
2.16.3	Exposure Time Monitor	61
2.16.4	Frame Time Monitor	61
2.16.5	Current image size	62
Imperx, Ir		Rev. 1.5
	gress Ave.	9/26/2017
Roca Rate	on FL 33487	





2.17.	LE	NS CONTROLLER	62
3. (CHAI	PTER 3 – DIGITAL IMAGE PROCESSING	63
3.1.	ov	ERVIEW	64
3.2. 3.2.	.1.	AGE ENHANCEMENT Threshold Operation	
3.2.	.2.	Multi Point Correction	67
3.3.	CO	NVOLUTION	70
4. (CHAI	PTER 4 – CAMERA CONFIGURATION	71
4.1.	ov	ERVIEW	72
4.2. 4.2. 4.2.	.1.	MERA CONFIGURATION Configuration Memory – parameter FLASH Camera Serial Protocol	
4.3. 4.3.	CA	MERA CONFIGURATION REGISTER DESCRIPTION Startup Procedure	76
4.3	.2.	Saving and Restoring Settings	76
4.3	.3.	Retrieving Manufacturing Data	78
4.3	.4.	Camera Information Registers	80
4.3	.5.	Image Size (AOI) Workspace Registers	83
4.3	.6.	Exposure Control Workspace Registers	88
4.3	.7.	AEC, AGC, AIC Workspace Registers	89
4.3	.8.	Video Amp, Gain and Offset Workspace Registers	92
4.3	.9.	Pulse Generator Workspace Registers	94
4.3	.1	Test Pattern Workspace Registers	95
4.3	.10.	Input/output Workspace Registers	97
4.3	.11.	Output Data Format	100
4.3	.12.	White Balance Workspace Registers	101
4.3	.13.	Color Correction Workspace Registers	103
4.3	.14.	Data Correction Workspace Registers	105
4.4. 4.4.		TA PROCESSING REGISTER DESCRIPTION Image Enhancement Workspace Registers	107
Imperx	, Inc.		Rev. 1.5
	_	ss Ave.	9/26/2017
Boca F	Raton,	FL 33487	

+1 (561) 989-0006



4.4.2	Convolution register	109
4.5.1	LENS CONTROLLER REGISTER DESCRIPTION Lens Controller Workspace Registers	111 111
5. CI	HAPTER 5 – BOBCAT CONFIGURATOR	114
5.1.	OVERVIEW	115
5.2.	DISCOVERY PROCEDURE	115
5.3.	GRAPHICAL USER INTERFACE	116
5.4.	MAIN GUI MENU	117
5.5.	VIEW GUI WINDOWS	122
5.6.	GUI HELP	123
5.7. 3 5.7.1	PARAMETER WINDOWS Video Amp	124 124
5.7.2	I/O Control	
5.7.3	Pulse Generator	127
5.7.4	Exposure	128
5.7. 5.	Test Image	130
5.7.6	Area of Interest (AOI)	
5.7.7	Strobe Control	
5.7.8	Color Window	
5.7.9	Processing	136
5.7.1	Data Output	138
5.7.1	1 Lens Control	139
6. CI	HAPTER 6 – BOBCAT WARRANTY AND SUPPORT	142
6.1.	ORDERING INFORMATION	143
6.2.	TECHNICAL SUPPORT	143
6.3.	WARRANTY	143
APPEN	DIX A – CAMERA CONFIGURATION REFERENCE	145
Imperx, I	nc.	Rev. 1.5
-	ngress Ave.	9/26/2017
Boca Ra	ton, FL 33487	



A.0	ABBREVIATIONS	146
A.1	SAVING AND RESTORING REGISTERS	146
A.2	CAMERA INFORMATION REGISTERS	146
A.3	IMAGE SIZE (AOI) REGISTERS	147
A.4	EXPOSURE CONTROL REGISTERS	148
A.5	VIDEO REGISTERS	148
A.6	AEC, AGC, AIC REGISTERS	149
A.7	TRIGGER REGISTERS	150
A.8	PULSE GENERATOR REGISTERS	150
A.9	TEST PATTERN REGISTERS	150
A.10	STROBE REGISTERS	151
A.11	INPUT AND OUTPUT REGISTERS	151
A.12	OUTPUT DATA FORMAT REGISTERS	151
A.13	WB AND COLOR CORRECTION REGISTERS	152
A.14	DATA CORRECTION REGISTERS	152
A.15	PROCESSING REGISTERS	153
A.16	LENS CONTROL REGISTERS	153
A.17	ENHANCEMENT 3 x 3 FILTER REGISTERS	154
A.18	MANUFACTURING DATA REGISTERS	155
APPE	NDIX B – CREATING LOOK UP TABLES	156
B.1	OVERVIEW	157
B.2	USING AN ASCII TEXT EDITOR	157
B.3	USING MICROSOFT EXCEL	159

Imperx, Inc. 6421 Congress Ave. Boca Raton, FL 33487 +1 (561) 989-0006 Rev. 1.5 9/26/2017



B.4	USING LUT Manager	160
APPI	ENDIX C – CREATING DPC AND HPC TABLES	161
C.1	OVERVIEW	162
C.2	USING AN ASCII TEXT EDITOR	162
C.3	USING AN IPXTOOLKIT DPC/HPC UTILITY	163
APPI	ENDIX D – SOFTWARE INSTALLATION	164
APPI	ENDIX E – FIRMWARE UPGRADE	166
E.1	OVERVIEW	167
E.2	BOBCAT HD-SDI UPGRADE	167
E.3	BOBCAT HD-SDI UPGRADE USING BOBCAT UPLOAD MANAGER	170
APPI	ENDIX G – POWER SUPPLIES	172



FIGURES

Figure 1.1– Interline CCD Pixel Structure.	17
Figure 1.2 – KAI (TRUESENSE) CCD typical mono spectral response (Monochrome with the	
cover glass).	18
Figure 1.3 – KAI (TRUESENSE) CCD typical UV spectral response. (UV quantum efficiency	
measured without cover glass and micro-lenses).	18
Figure 1.4 – KAI (TRUESENSE) CCD typical color spectral response. (Color with the cover glass).	19
Figure 1.5 – ICX (SONY) CCD typical mono spectral response. (Monochrome with the cover	
glass).	19
Figure 1.6– ICX (Sony) CCD typical color spectral response. (Color with the cover glass).	20
Figure 1.7 – Bayer Pattern arrangement.	20
Figure 1.8 – Camera back panel – HD-SDI output.	28
Figure 1.9 – HD-SDI Camera Power Connector Pin-Outs (Rear view).	29
Figure 1.10 – HD-SDI Camera Serial/Lens Control Pin-Outs (Rear view)	30
Figure 1.11 – C-mount HD-SDI cameras.	32
Figure 1.12 – Dimensional drawings for the SDI-B1920M, B1920C.	33
Figure 1.13 – Dimensional drawings for SDI-B1320M, B1320C, B1921M, B1921C, B1922M, B1922C, B1923M, B1923C.	34
Figure 1.14 – HD-SDI mounting plate using ¼ in 20 thread.	35
Figure 1.15 – Optical plane position for the SDI-B1920M, B1920C.	36
Figure 1.16 – Optical plane position for the SDI-B1320M, B1320C, B1921M, B1921C, B1922M, B1922C, B1923M, B1923C.	37
Figure 2.1– Dual output mode of operation.	40
Figure 2.2 – Horizontal and vertical window positioning.	42
Figure 2.3 – Slave AOIs.	42
Figure 2.4 – PAOI enabled as processing ROI.	43
Figure 2.5 – Electronic shutter position.	44
Figure 2.6– Programmable frame time.	44
Figure 2.7 – Strobe pulse positioning.	46
Figure 2.8 – AFE gain and offset.	47
Figure 2.9 – Internal pulse generator.	49
Figure 2.10 – IN1, Tri-Level Sync electrical input connection.	51
Figure 2.11– OUT1, OUT2 electrical connection.	51
Figure 2.12 – Lens Control output electrical connection.	52
Imperx, Inc.	1.5
6421 Congress Ave. 9/26/20)17
Boca Raton, FL 33487	



Figure 2.14 – Gamma corrected video signal.	56
Figure 2.15 – Custom LUT.	57
Figure 2.16 – Original image showing 'shading' effect.	59
Figure 2.17 – Flat field corrected image.	60
Figure 3.1 – Original and processed image with single threshold.	65
Figure 3.2 – Original and processed image with double threshold.	66
Figure 3.3 – Original and processed image with threshold and gray scale stretch.	67
Figure 3.4 – Single point TF correction.	68
Figure 3.5 – Multi point TF correction.	69
Figure 3.6 – Multi point image correction (a – original, b – processed).	69
Figure 3.7 – Multi point image correction (a – original, b – processed).	70
Figure 4.1– Serial protocol format.	73
Figure 4.2 – Normal write cycle.	74
Figure 4.3 – Invalid command error.	74
Figure 4.4 – Rx timeout error.	74
Figure 4.5 – Normal read cycle.	75
Figure 5.1– Discovery procedure – select port.	115
Figure 5.2 – HD-SDI CamConfig main GUI Window	116
Figure 5.3 – Main Menu.	117
Figure 5.4 – Defective pixel map.	119
Figure 5.5 – Command terminal.	120
Figure 5.6 – Download terminal.	121
Figure 5.7 – View GUI Windows	122
Figure 5.8 – Help menu	123
Figure 5.9 – About CamConfig.	124
Figure 5.10 – Video Amp parameter window	124
Figure 5.11– I/O control parameter window.	125
Figure 5.12 – Pulse generator window.	127
Figure 5.13 – Exposure control window.	128
Figure 5.14 – Test image window.	131
Figure 5.15 – AOI window.	132
Figure 5.16 – Strobe Control window.	133
Figure 5.17 – Color Window.	134
Imperx, Inc.	Rev. 1.5
6421 Congress Ave.	9/26/2017



Figure 5.18– Processing window.	137
Figure 5.19 – Data output window.	138
Figure 5.20 – Lens Control window.	139
TABLES	
Table 1.1– BOBCAT HD-SDI Family List.	13
Table 1.2 – Pixel structure for different BOBCAT HD-SDI cameras.	17
Table 1.3 – HD-SDI B1320, and B1920.	22
Table 1.4 – HD-SDI B1921, and B1922.	24
Table 1.5 – HD-SDI B1923.	26
Table 1.6 – HD-SDI B1320, B1920, B1921, B1922, and B1923 specifications.	27
Table 1.7 – BNC Connectors Pin Mapping.	29
Table 1.8 – HD-SDI Power Connector Pin Mapping.	29
Table 1.9 – HD-SDI Serial/Len Control Pin Mapping.	30
Table 1.10 – HD-SDI B1320, B1920, B1921, B1922, and B1923 data output formats.	48
Table 1.11 – BOBCAT Input Mapping.	50
Table 1.12 – BOBCAT HD-SDI Output Mapping.	50
Table 1.13 – Current camera temperature values.	82
Table 1.14 – Auto Iris 4 pin MINI plug F4-1911	174



Introduction

Key features of the BOBCAT HD-SDI cameras.



1.1. BOBCAT HD-SDI FAMILY

The BOBCAT HD-SDI series of cameras are built around a robust imaging platform utilizing the latest digital technology and components. BOBCAT HD-SDI camera series is designed around 5 different CCD imaging sensors, featuring different resolutions and frame rates. Each base model is available in monochrome and color.

Model	Resolution	Туре	Optics	CCD	CCD model
SDI-B1320M	1280 x 720	Mono	1/2'″	TRUESE	KAI-01150M
SDI-B1320C	1280 x 720	Color	1/2'″	TRUESE	KAI-01150C
SDI-B1920M	1920 x 1080	Mono	1.0"	TRUESE	KAI-2093M
SDI-B1920C	1920 x 1080	Color	1.0"	TRUESE	KAI-2093C
SDI-B1921M	1920 x 1080	Mono	2/3"	TRUESE	KAI-02150M
SDI-B1921C	1920 x 1080	Color	2/3"	TRUESE	KAI-02150C
SDI-B1922M	1920 x 1080	Mono	2/3"	SONY	ICX-674
SDI-B1922C	1920 x 1080	Color	2/3″	SONY	ICX-674
SDI-B1923M	1920 x 1080	Mono	1.0"	TRUESE	KAI-02170M
SDI-B1923C	1920 x 1080	Color	1.0"	TRUESE	KAI-02170C

Table 1.1–BOBCAT HD-SDI Family List.

1.2. GENERAL DESCRIPTION

The BOBCAT HD-SDI cameras are advanced, intelligent, high-resolution, progressive scan, fully programmable and field upgradeable CCD cameras. They are built around SONY's and TRUESENSE's line of interline transfer CCD imagers. BOBCAT HD-SDI cameras are feature rich with built in image processing engine (based on a 4 million gates FPGA), have small size, very low power consumption, low noise, and efficient and optimized internal thermal distribution. The BOBCAT HD-SDI cameras feature programmable gain, offset, electronic shutter, long time integration, strobe output, transfer function correction, temperature monitoring and user programmable and up-loadable LUT. A square pixel provides for a superior image in any orientation. The interline transfer CCD permits full vertical and horizontal resolution of high-speed shutter images. A built-in Gamma correction and user LUT optimizes the CCD's dynamic range. The cameras are fully programmable via the serial interface using a GUI based configuration utility. The adaptability and flexibility of the camera allows it to be used in a wide and diverse range of applications including machine vision,

 Imperx, Inc.
 Rev. 1.5

 6421 Congress Ave.
 9/26/2017





metrology high-definition imaging and surveillance, medical and scientific imaging, intelligent transportation systems, character recognition, document processing and many more and with a MTBF of > 660,000 hrs. It the most feature packed versatile camera line produced.



MAIN BOBCAT HD-SDI FEATURES

- 1080P/720P Mono and Color 24p, 25p, 50i, 30p (29.97), 60p (59.94)
- Color 3x10-bit (YCrCb) data with auto white balance
- RS232/RS485 serial communication
- Analog and digital gain and offset control
- Six independent horizontal and vertical AOIs
- Programmable long integration
- Automatic gain, exposure and iris control
- Automatic white balance
- Internal/External exposure control
- External Tri-Level sync input
- Left/right digital bit shift
- Test image with image superimposition
- Built in pulse generator
- Programmable I/O mapping
 - 1 genlock tri-level mapping
 - 2 programmable outputs
- Dynamic transfer function correction
- Dynamic black level correction
- Two-dimensional Flat field correction
- Defective and hot pixel correction
- Temperature monitor
- Field upgradeable firmware, LUT, DPC, HPC, FFT
- MTBF of 666,000 hours @ 40°C



1.3. BOBCAT HD-SDI SPECIFICATIONS

1.3.1. **General Information**

A CCD camera is an electronic device for converting light into an electrical signal. The camera contains a light sensitive element CCD (Charge Coupled Device) where an electronic representation of the image is formed. The CCD consists of a two-dimensional array of sensitive elements – silicon photodiodes, also known as pixels. The photons falling on the CCD surface create photoelectrons within the pixels, where the number of photoelectrons is linearly proportional to the light level. Although the number of electrons collected in each pixel is linearly proportional to the light level and exposure time, the number of electrons varies with the wavelength of the incident light. When the desired exposure is reached, the charges from each pixel are shifted onto a vertical register, VCCD, and then one row downwards in a vertical direction towards a horizontal register, HCCD. After that the electrons contained in the HCCD are shifted in a horizontal direction, one pixel at a time, onto a floating diffusion output node where the transformation from charge to voltage takes place. The resultant voltage signal is buffered by a video amplifier and sent to the corresponding video output. There are two floating diffusions and two video amplifiers at each end of the HCCD, and the charges can be transferred towards any of the outputs (depending on the mode of operation). The time interval required for all the pixels, from the entire imager, to be clocked out of the HCCD is called a frame. To generate a color image a set of color filters (Red, Green, and Blue) arranged in a "Bayer" pattern, are placed over the pixels. The starting color is typically Green for TRUESENSE CCDs and Red for SONY CCDs, but it varies from CCD to CCD. Figure 1.1 shows the CCD pixel structure. Table 1.2 shows the individual pixel structure for different BOBCAT HD-SDI cameras. Effective pixels image consists of Active and Buffer pixels. Figures 1.2-6 show the camera's spectral response. Figure 1.7 shows the Bayer pattern arrangement.



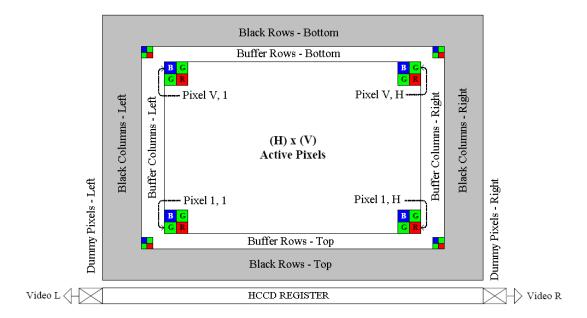


Figure 1.1– Interline CCD Pixel Structure.

Camera Type	Active Pixels	Active Lines	CCD Sensor	Pixel Size
B1320	1280	720	KAI-01150	5.50 μm sq.
B1920	1920	1080	KAI-2093	7.40 μm sq.
B1921	1920	1080	KAI-02150	5.50 μm sq.
B1922	1920	1080	ICX-674	4.54 μm sq.
B1923	1920	1080	KAI-02170	7.4 μm sq.

<u>Table 1.2 – Pixel structure for different BOBCAT HD-SDI cameras.</u>



1.3.2. Spectral Response

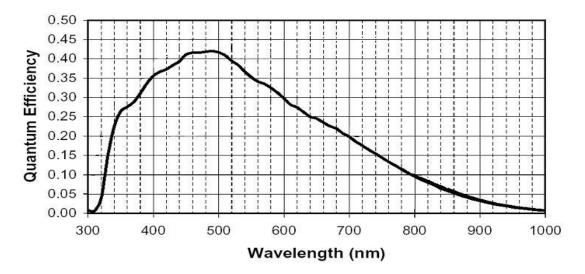
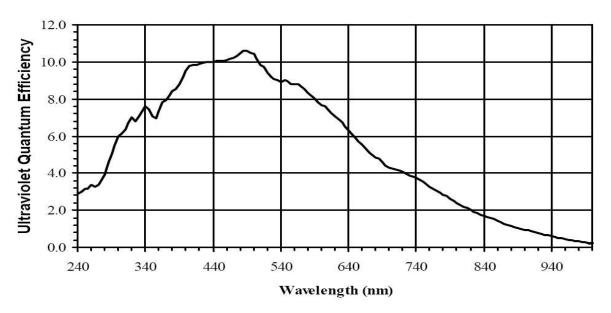
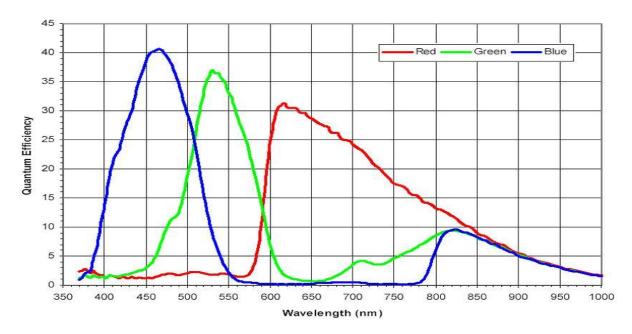


Figure 1.2 – KAI (TRUESENSE) CCD typical mono spectral response (Monochrome with the cover glass).

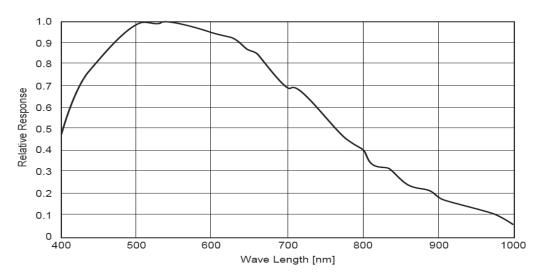


<u>Figure 1.3 – KAI (TRUESENSE) CCD typical UV spectral response.</u> (UV quantum efficiency measured without cover glass and micro-lenses).



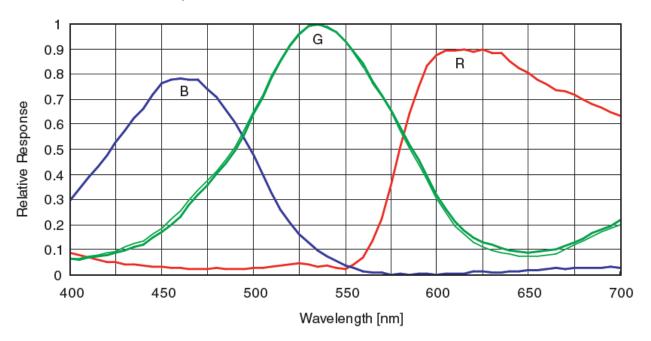


<u>Figure 1.4 – KAI (TRUESENSE) CCD typical color spectral response.</u> (Color with the cover glass).



<u>Figure 1.5 – ICX (SONY) CCD typical mono spectral response.</u>
(Monochrome with the cover glass).





<u>Figure 1.6– ICX (Sony) CCD typical color spectral response.</u> (Color with the cover glass).

1.3.3. **Bayer Pattern Information**

Bobcat is available with Monochrome or Color CCD imager. To generate a color image a set of color filters (Red, Green, and Blue) arranged in a "Bayer" pattern, are placed over the pixels. The starting color is typically **GREEN** for TRUESENSE CCDs and **RED** for SONY CCDs – Figure 1.7.

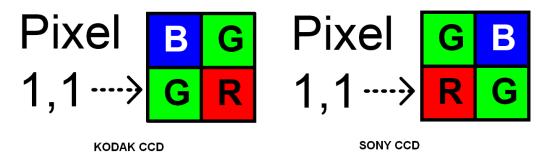


Figure 1.7 – Bayer Pattern arrangement.



1.3.4. Technical Specifications

Table 1.3, 1.4, and 1.5 on the following pages illustrate and describe features and specifications for all current Bobcat HD-SDI models.

Specifications	SDI-B1320	SDI-B1920	
Active image resolution	1280 (H) x 720 (V)	1920 (H) x 1080 (V)	
Active image area (H,V) mm	7.04 (H) x 3.96 (V)	14.208 (H) x 7.992 (V)	
Pixel size	5.50 μm	7.40 µm	
Video output	Digital, 10 bits	Digital, 10 bits	
Output structure	YUV422	YUV422	
Data clock	37.08789/37.125 MHz	37.08789/37.125 MHz	
Camera interface	HD-SDI SMPTE 292M	HD-SDI SMPTE 292M	
HD-SDI format	50p; 59.94p; 60p	23.98p; 24p; 25p; 29.97p; 30p; 50i; 59.94i; 60i	
Nominal frame rate	50/60 fps	24/25/30 fps	
Long Integration	Up to 16.777 sec	Up to 16.777 sec	
S/N ratio	60dB	60 dB	
Shutter speed	1/100000 to 1/60	1/100000 to 1/30 sec	
Analog gain	0 to 36 dB per output	0 to 36 dB per output	
Gain resolution	0.035 dB/step, 1024 steps	0.035 dB/step, 1024 steps	
Analog CDS gain	(-3.0, 0.0, +3.0, +6.0) dB	(-3.0, 0.0, +3.0, +6.0) dB	
Black level offset	1024 levels per output	1024 levels per output	
Digital gain	1.0x to 3.0x (0.1x step)	1.0x to 3.0x (0.1x step)	
Digital offset	-511 to + 511	-511 to + 511	
Auto gain/exposure	Yes, with AOI	Yes, with AOI	
Area of interest	Six Independent AOIs	Six Independent AOIs	
LUT	4 User LUTs; 8 Gamma LUTs; 8 Black Gamma LUTs	4 User LUTs; 8 Gamma LUTs; 8 Black Gamma LUTs	
Flat field correction	Yes, User FFC	Yes, User FFC	
Digital bit shift	Yes	Yes	
Tri-Level sync input	Yes	Yes	
Trigger features	No	No	
Camera Image Memory	1GB	1GB	

Imperx, Inc. 6421 Congress Ave. Boca Raton, FL 33487 +1 (561) 989-0006



Specifications	SDI-B1320	SDI-B1920	
Camera Size (W x H x L)	46 x 46 x 65.85mm	46 x 46 x 58.25	
MTBF	660,000Hrs @ 40C	660,000Hrs @ 40C	
Weight	224g	208g	
Min. illumination	1.0 Lux, f=1.4	1.0 Lux, f=1.4	
Lens Mount	C mount, 1/2" format CCD	C mount, 1.0" format CCD	
Power	5.9W, 495mA steady, 1.5 A inrush	6.0W, 500mA steady, 1.5 A inrush	
RS 232 interface	Yes	Yes	
RS 485 interface	Yes	Yes	
Auto White balance	Yes	Yes	
Auto iris	Yes	Yes	
Test image	Yes, Image superimposition	Yes, Image superimposition	
Image overlay	Yes	Yes	
Defective pixel correction	Static, Dynamic, User DPM	Static, Dynamic, User DPM	
Hot pixel correction	Static, Dynamic, User HPM	Static, Dynamic, User HPM	
I/O Control	1 tri-level sync input, 2 outputs	1 tri-level sync input, 2 outputs	
Strobe output support	Yes, Two strobes	Yes, Two strobes	
Pulse Generator	Yes	Yes	
In-camera Processing	Yes, User	Yes, User	
Camera housing	Aluminum	Aluminum	
Supply voltage range	10V min to 15VDC max	10V min to 15VDC max	
Upgradeable firmware	Yes	Yes	
Upgradeable LUT, DPM, FFC	Yes	Yes	
Operating	- 40° to + 85° C	- 40° to + 85° C	
Environmental - Storage	- 40° to + 90° C	- 40° to + 90° C	
Vibration, Shock	10G (20-200) Hz XYZ, 70G	10G (20-200) Hz XYZ, 70G	
Relative humidity	10% to 90% non-condensing	10% to 90% non-condensing	
Regulatory	FCC 15 part A, CE, RoHS	FCC 15 part A, CE, RoHS	

Table 1.3 – HD-SDI B1320, and B1920.



Specifications	SDI-B1921	SDI-B1922	
Active image resolution	1920 (H) x 1080 (V)	1920 (H) x 1080 (V)	
Active image area (H,V) mm	10.56 (H) X 5.94 (V)	8.716 (H) X 4.903 (V)	
Pixel size	5.50 μm	4.54 μm	
Video output	Digital, 10 bits	Digital, 10 bits	
Output structure	YUV422	YUV422	
Data clock	37.08789/37.125 MHz	37.08789/37.125 MHz	
Camera interface	HD-SDI SMPTE 292M	HD-SDI SMPTE 292M	
HD-SDI format	23,98p; 24p; 25p; 29,97p; 30p; 50i; 59,94i; 60i	23,98p; 24p; 25p; 29,97p; 30p; 50i; 59,94i; 60i	
Nominal frame rate	24/25/30 fps	24/25/30 fps	
Long Integration	Up to 16.777 sec	Up to 16.777 sec	
S/N ratio	60dB	60dB	
Shutter speed	1/100000 to 1/30	1/100000 to 1/30	
Analog gain	0 to 36 dB per output	0 to 36 dB per output	
Gain resolution	0.035 dB/step, 1024 steps	0.035 dB/step, 1024 steps	
Analog CDS gain	(-3.0, 0.0, +3.0, +6.0) dB	(-3.0, 0.0, +3.0, +6.0) dB	
Black level offset	1024 levels per output	1024 levels per output	
Digital gain	1.0x to 3.0x (0.1x step)	1.0x to 3.0x (0.1x step)	
Digital offset	-511 to + 511	-511 to + 511	
Auto gain/exposure	Yes, with AOI	Yes, with AOI	
Area of interest	Six Independent AOIs	Six Independent AOIs	
LUT	4 User LUTs; 8 Gamma LUTs; 8 Black Gamma LUTs	4 User LUTs; 8 Gamma LUTs; 8 Black Gamma LUTs	
Flat field correction	Yes, User FFC	Yes, User FFC	
Digital bit shift	Yes	Yes	
Tri-Level sync input	Yes	Yes	
Trigger features	No	No	
Camera Image Memory	1GB	1GB	



Specifications	SDI-B1921	SDI-B1922	
Camera Size (W x H x L)	46 x 46 x 69.85mm	46 x 46 x 69.85mm	
MTBF	660,000Hrs @ 40C	660,000Hrs @ 40C	
Weight	222g	228g	
Min. illumination	1.0 Lux, f=1.4	1.0 Lux, f=1.4	
Lens Mount	C mount, 2/3" format CCD	C mount, 2/3" format CCD	
Power	6.0W, 500mA steady, 1.5 A inrush	5.6W, 470mA steady, 1.5 A inrush	
RS 232 interface	Yes	Yes	
RS 485 interface	Yes	Yes	
Auto White balance	Yes	Yes	
Auto iris	Yes	Yes	
Test image	Yes, Image superimposition	Yes, Image superimposition	
Image overlay	Yes	Yes	
Defective pixel correction	Static, Dynamic, User DPM	Static, Dynamic, User DPM	
Hot pixel correction	Static, Dynamic, User HPM	Static, Dynamic, User HPM	
I/O Control	1 tri-level sync input, 2 outputs	1 tri-level sync input, 2 outputs	
Strobe output support	Yes, Two strobes	Yes, Two strobes	
Pulse Generator	Yes	Yes	
In-camera Processing	Yes, User	Yes, User	
Camera housing	Aluminum	Aluminum	
Supply voltage range	10V min to 15VDC max	10V min to 15VDC max	
Upgradeable firmware	Yes	Yes	
Upgradeable LUT, DPM, FFC	Yes	Yes	
Operating	- 40° to + 85° C	- 40° to + 85v C	
Environmental - Storage	- 40° to + 90° C	- 40° to + 90° C	
Vibration, Shock	10G (20-200) Hz XYZ, 70G	10G (20-200) Hz XYZ, 70G	
Relative humidity	10% to 90% non-condensing	10% to 90% non-condensing	
Regulatory	FCC 15 part A, CE, RoHS	FCC 15 part A, CE, RoHS	

Table 1.4 – HD-SDI B1921, and B1922.



Specifications	SDI-B1923	
Active image resolution	1920 (H) x 1080 (V)	
Active image area (H, V) mm	10.56 (H) X 5.94 (V)	
Pixel size	7.4 μm	
Video output	Digital, 10 bits	
Output structure	YUV422	
Data clock	37.08789/37.125 MHz	
Camera interface	HD-SDI SMPTE 292M	
HD-SDI format	23,98p; 24p; 25p; 29,97p; 30p; 50i; 59,94i; 60i	
Nominal frame rate	24/25/30 fps	
Long Integration	Up to 16.777 sec	
S/N ratio	60dB	
Shutter speed	1/100000 to 1/30	
Analog gain	0 to 36 dB per output	
Gain resolution	0.035 dB/step, 1024 steps	
Analog CDS gain	(-3.0, 0.0, +3.0, +6.0) dB	
Black level offset	1024 levels per output	
Digital gain	1.0x to 3.0x (0.1x step)	
Digital offset	-511 to + 511	
Auto gain/exposure	Yes, with AOI	
Area of interest	Six Independent AOIs	
LUT	4 User LUTs; 8 Gamma LUTs; 8 Black Gamma LUTs	
Flat field correction	Yes, User FFC	
Digital bit shift	Yes	
Tri-Level sync input	Yes	
Trigger features	No	
Camera Image Memory	1GB	



Specifications	SDI-B1923		
Camera Size (W x H x L)	46 x 46 x 69.85mm		
MTBF	660,000Hrs @ 40C		
Weight	222g		
Min. illumination	1.0 Lux, f=1.4		
Lens Mount	C mount, 2/3" format CCD		
Power	6.0W, 500mA steady, 1.5 A inrush		
RS 232 interface	Yes		
RS 485 interface	Yes		
Auto White balance	Yes		
Auto iris	Yes		
Test image	Yes, Image superimposition		
Image overlay	Yes		
Defective pixel correction	Static, Dynamic, User DPM		
Hot pixel correction	Static, Dynamic, User HPM		
I/O Control	1 tri-level sync input, 2 outputs		
Strobe output support	Yes, Two strobes		
Pulse Generator	Yes		
In-camera Processing	Yes, User		
Camera housing	Aluminum		
Supply voltage range	10V min to 15VDC max		
Upgradeable firmware	Yes		
Upgradeable LUT, DPM, FFC	Yes		
Operating	- 40° to + 85° C		
Environmental - Storage	- 40° to + 90° C		
Vibration, Shock	10G (20-200) Hz XYZ, 70G		
Relative humidity	10% to 90% non-condensing		
Regulatory	FCC 15 part A, CE, RoHS		

<u>Table 1.5 – HD-SDI B1923.</u>



Note:

- 1) SDI cameras operate in MAOI mode only. Only slave AOI and processing AOI are available to the user.
- 2) SDI cameras have 1 tri-level sync input and 2 outputs. The camera provides 2 strobe outputs.
- 3) Users can select the command interface.

Model	Resolution	Туре	Optics	CCD Vendor	CCD model	Pixel size	HDSDI standard	HDSDI format
SDI-B1320C	1280x720	Color	1/2"	TRUESE	KAI-01150C	5.50 µm sq	SMPTE292M	50p; 59.94p; 60p
SDI-B1320M	1280x720	Mono	1/2"	TRUESE	KAI-01150M	5.50 µm sq	SMPTE296M	
SDI-B1920C	1920x1080	Color	1.0"	TRUESE	KAI-2093C	7.40 µm sq	SMPTE292M	23.98p; 24p;
SDI-B1920M	1920x1080	Mono	1.0"	TRUESE	KAI-2093M	7.40 µm sq	SMPTE274M	25p; 29.97p; 30p; 50i; 59.94i;
SDI-B1921C	1920x1080	Color	2/3"	TRUESE	KAI-02150C	5.50 µm sq		60i ´ ´
SDI-B1921M	1920x1080	Mono	2/3"	TRUESE	KAI-02150M	5.50 µm sq		
SDI-B1922C	1920x1080	Color	2/3"	SONY	ICX-674C	4.54 µm sq		
SDI-B1922M	1920x1080	Mono	2/3"	SONY	ICX-674M	4.54 µm sq		
SDI-B1923C	1920x1080	Color	1.0"	TRUESE	KAI-02170C	7.4 µm sq		
SDI-B1923M	1920x1080	Mono	1.0"	TRUESE	KAI-02170M	7.4 µm sq		

<u>Table 1.6 – HD-SDI B1320, B1920, B1921, B1922, and B1923 specifications.</u>



1.4. CAMERA CONNECTIVITY

1.4.1. HD-SDI Output

The interface between the BOBCAT HD-SDI camera and outside equipment is done via 3 connectors and one LED, located on the back panel of the camera – Figure 1.8.

- 1. Camera output standard HD-SDI BNC output
- 2. 12-pin Hirose (male) connector provides Power and I/O interface.
- 3. 12-pin Hirose (female) connector provides Serial RS-232/485 interface for controlling Camera features via the CamConfig GUI, and differential DC outputs for Lens Control.
- 4. USB type B programming
- 5. Status LED indicates the status of the camera refer to Status LED section.
- 6. Serial Number shows camera model and serial number.



Figure 1.8 – Camera back panel – HD-SDI output.

The male 12-pin Hirose connector provides power and all external input/output signals supplied to the camera. Refer to Fig 1.9 for connector pin-outs. Refer to Table 1.8 for corresponding pin mapping. The connector is a male Hirose type miniature locking receptacle #HR10A-10R-12PB(71). The camera's power cable (sold separately) terminates in a female HIROSE type miniature locking receptacle #HR10A-10P-12S(73), and has two small BNC pig-tail cables for

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



the external trigger input (black) and strobe output (white). BNC pin mapping is shown in Table 1.7.

Pin	Signal	Cable color	Description
Case	In 1 Return	BNC Black	User Selectable Input 1 Return
Signal	In 1 Active	DINC DIACK	User Selectable Input 1 Signal
Case	Out 1 Return	BNC White	User Selectable Out 1 Return
Signal	Out 1 Active	DIVC WITH	User Selectable Out 1 Signal

<u>Table 1.7 – BNC Connectors Pin Mapping.</u>



Figure 1.9 – HD-SDI Camera Power Connector Pin-Outs (Rear view).

Pin	Signal	Туре	Description
1	12 VDC Return	Ground Return	12 VDC Main Power Return
2	+ 12 VDC	Power - Input	+ 12 VDC Main Power
3	IRIS VCC	Power - Input	12 V Iris Power
4	IRIS Video	Analog Output	Iris Video Output
5	IRIS Return	Ground Return	12 VDC Iris Power Return
6	GP OUT Return	Ground Return	General Purpose Outputs Return
7	GP OUT 1	TTL OUT 1	General Purpose Output 1
8	TLS IN 1	Tri-Level	Tri-level Genlock Input
9	GP IN 2	TTL/LVTTL IN 2	General Purpose Input 2
10	GP IN Return	Ground Return	General Purpose Inputs Return
11	GPIO	LVTTL IN/OUT	Reserved for custom GPIO
12	GP OUT 2	TTL OUT 2	General Purpose Output 2

<u>Table 1.8 – HD-SDI Power Connector Pin Mapping.</u>



The female 12-pin HIROSE connector provides Camera Control via an RS232 serial interface and outputs Lens Control signals for Zoom, Focus, and Iris for a standard Type 1 (6V) or Type 5 (12V) C-Mount motorized lens. Refer to Fig 1.10 for connector pin-outs. Refer to Table 1.9 for corresponding pin mapping. The connector is a female Hirose type miniature locking receptacle #HR10A-10R-12SB(71). The male Hirose mating plug part number is #HR10A-10P-12P(73).

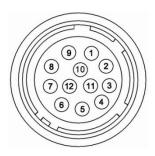


Figure 1.10 – HD-SDI Camera Serial/Lens Control Pin-Outs (Rear view)

Pin	Signal	Туре	Description
1	RS-485	Ground Return	RS-485_COM
2	RS-485	Positive	RS-485 +
3	RS-485	Negative	RS-485 -
4	IRIS(1)	Iris Closes	DC -
5	IRIS(2)	Iris Opens	DC +
6	FOCUS(1)	Focus Near	DC -
7	FOCUS(2)	Focus Far	DC +
8	ZOOM(1)	Zoom Wide	DC -
9	ZOOM(2)	Zoom Narrow	DC +
10	RS-232	Ground Return	RS-232_COM
11	RS-232	Receive	RS-232_RX
12	RS-232	Transmit	RS-232_TX

<u>Table 1.9 – HD-SDI Serial/Len Control Pin Mapping.</u>



1.4.2. **Power Supply**

The Bobcat HD-SDI camera can be powered using a universal desktop power supply adapter providing +12VDC, \pm 10%, and up to 2.5A constant DC current. A universal power supply adapter is available (for an additional price) from Imperx for all Bobcat HD-SDI camera models. The operating input voltage ranges from 90 to 240 VAC.

CAUTION NOTE

1. It is strongly recommended that you do not use an adapter other than the one that is available from Imperx for the camera!



1.5. MECHANICAL, OPTICAL and ENVIRONMENTAL

1.5.1. **Mechanical**

The camera housing is manufactured using high quality zinc-aluminum alloy and anodized aluminum. For maximum flexibility, the camera has twelve (12) M3X0.5mm mounting, located towards the front and the back. An additional plate with ¼-20 UNC (tripod mount) and hardware is shipped with each camera. Figure 1.11 shows the C-Mount HD-SDI cameras. Figure 1.12, and 1.13 shows dimensional drawings for C-Mount HD-SDI series cameras. Figure 1.14 shows mounting plate dimensional drawings. All dimensions are in millimeters.



Figure 1.11 – C-mount HD-SDI cameras.



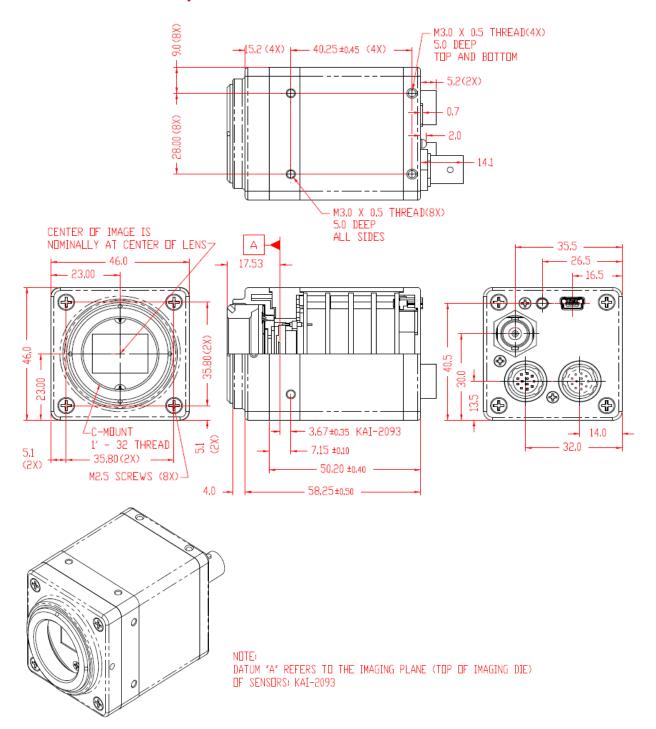
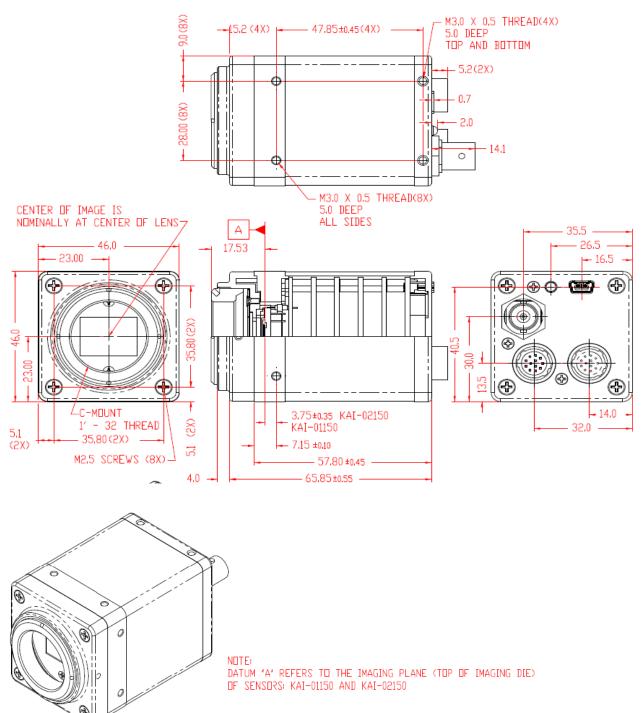


Figure 1.12 – Dimensional drawings for the SDI-B1920M, B1920C.

Imperx, Inc. 6421 Congress Ave. Boca Raton, FL 33487 +1 (561) 989-0006 Rev. 1.5 9/26/2017





<u>Figure 1.13 – Dimensional drawings for</u> SDI-B1320M, B1320C, B1921M, B1921C, B1922M, B1922C, B1923M, B1923C.

Imperx, Inc. 6421 Congress Ave. Boca Raton, FL 33487 +1 (561) 989-0006 Rev. 1.5 9/26/2017



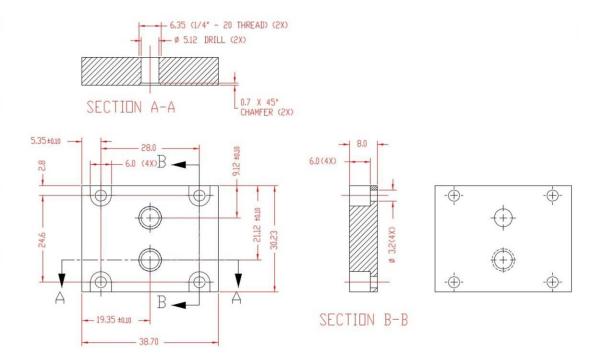


Figure 1.14 – HD-SDI mounting plate using ¼ in 20 thread.

1.5.2. **Optical**

The smaller body BOBCAT HD-SDI cameras (46 x 46) mm cross-section come with an adapter for C-mount lenses, which have a 17.52 mm back focal distance – illustrated in Figure 1.15 and Figure 1.16. An F-mount lens can be used with a C-mount camera via an F-mount to C-mount adapter, which can be purchased separately – refer to the Imperx web site for more information. The camera performance and signal to noise ratio depends on the illumination (amount of light) reaching the sensor and the exposure time. Always try to balance these two factors. Unnecessarily long exposure will increase the amount of noise and thus decrease the signal to noise ratio.

The cameras are very sensitive in the IR spectral region. All color cameras have and IR cut-off filter installed. The monochrome cameras are without IR filter. If necessary, an IR filter (1 mm thickness or less) can be inserted under the front lens bezel.

CAUTION NOTE

Imperx, Inc. 6421 Congress Ave. Boca Raton, FL 33487 +1 (561) 989-0006



- 1. Avoid direct exposure to a high intensity light source (such as a laser beam). This may damage the camera optical sensor!
- 2. Avoid foreign particles on the surface of the imager.

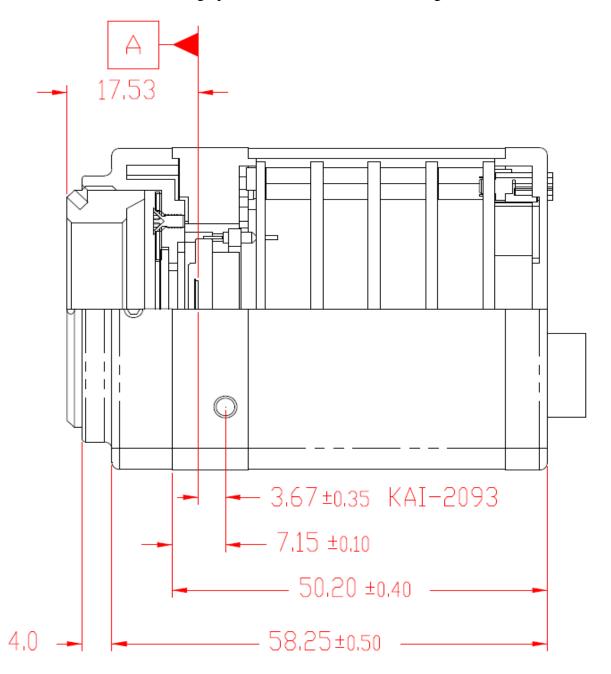
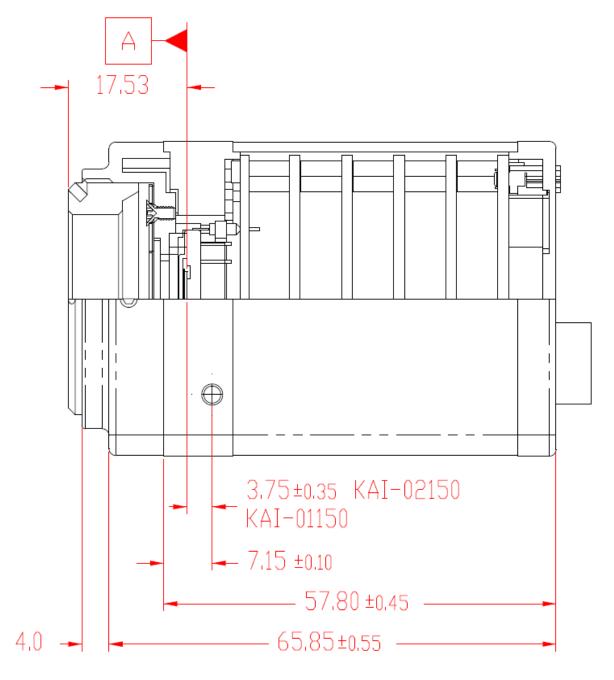


Figure 1.15 – Optical plane position for the SDI-B1920M, B1920C.

Note: DATUM "A" REFERS TO THE IMAGING PLANE (TOP OF IMAGING OF SENSORS: KAI-2093)

Imperx, Inc. 6421 Congress Ave. Boca Raton, FL 33487 +1 (561) 989-0006





<u>Figure 1.16 – Optical plane position for the SDI-B1320M, B1320C, B1921M, B1921C, B1922M, B1922C, B1923M, B1923C.</u>

Note: DATUM "A" REFERS TO THE IMAGING PLANE (TOP OF IMAGING OF SENSORS: KAI-2150/1150)



1.5.3. Environmental

The camera is designed to operate from -40^{0} to 85^{0} C in a dry environment. The relative humidity should not exceed 80% non-condensing. Always keep the camera as cool as possible. Always allow sufficient time for temperature equalization, if the camera was kept below 0^{0} C!

The camera should be stored in a dry environment with the temperature ranging from -40^0 to $+90^0$ C.

CAUTION NOTE

- 1. Avoid direct exposure to moisture and liquids. The camera housing is not hermetically sealed and any exposure to liquids may damage the camera electronics!
- 2. Avoid operating in an environment without any air circulation, in close proximity to an intensive heat source, strong magnetic or electric fields.
- 3. Avoid touching or cleaning the front surface of the optical sensor. If the sensor needs to be cleaned, use soft lint free cloth and an optical cleaning fluid. Do not use methylated alcohol!





Camera Features

This chapter discusses the camera's features and their use.



2.1. Normal Mode – Dual Output

When operating in a dual output mode, the image is split in two equal parts, each side consisting of half of the horizontal pixels and the full vertical lines. The first (left) half of the pixels are shifted out of the HCCD register towards the left video amplifier – Video L, while the second (right) half of the pixels are shifted towards the right video amplifier – Video R (Figure 2.1). In the horizontal direction, the first half of the image appears normal and the second half is left/right mirrored. The camera reconstructs the image by flipping the mirrored portion and rearranging the pixels. Dual output is the default factory mode of operation – refer to the Configuration Memory section. The image resolutions, and frame rates for different cameras are shown in Table 1.6

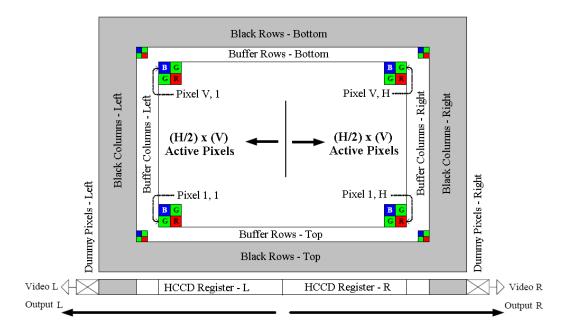


Figure 2.1– Dual output mode of operation.

2.2. FRAME TIME CONTROL

2.2.1. Frame Time (Long Integration) Control

The camera speed (frame rate) depends on the CCD "read-out" time – the time necessary to read all the pixels out of the CCD imager. The frame rate can be calculated using the following Formula 1.1:





Frame rate [fps] = 1 / read-out time [sec]

(1.1)

The user can program the camera to run slower than the nominal speed preserving the camera full resolution. The user can independently extend the camera frame time (the time required to read the entire frame out of the CCD imager). The camera frame time can be extended to ~ 16 sec, with a precision of ~ 1.0 us. Please refer to "EXPOSURE CONTROL" section for more information.

Note: Long integration doesn't interrupt HD-SDI output. Frame is captured in the Camera frame buffer. Frame is repeated on the HD-SDI output. Amount of repeating depends on the camera frame time.

2.2.2. External Frame Time Control

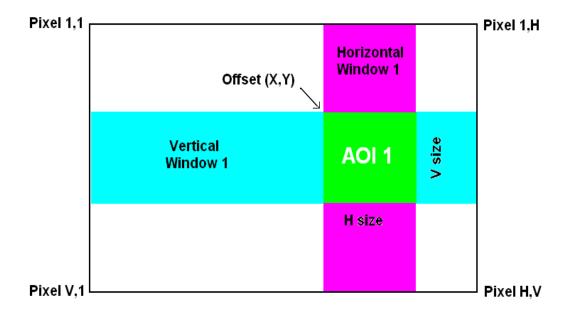
The camera speed (frame rate) can be controlled using external tri-level sync input.

2.3. AREA OF INTEREST

2.3.1. Horizontal and Vertical Window

For some applications, the user may not need the entire image, but only a portion of it. To accommodate this requirement BOBCAT provides total of 6 (six) Horizontal and Vertical Areas of Interest (AOI) and one Processing. The starting and ending point for each AOI can be set independently in horizontal direction (Horizontal Window) and vertical direction (Vertical Window), by setting the window (H & V) offset and (H & V) size — Figure 2.2. The minimum window size is two pixels/lines. The maximum horizontal window size (H) and the vertical window size (V) are determined by image full resolution as shown in Table 1.6.





<u>Figure 2.2 – Horizontal and vertical window positioning.</u>

A. Slave AOIs

AOI1 to AOI6 are assigned as slave AOIs and they MUST be selected so they are completely inside MAOI. All slave AOIs can be set independently with no restrictions for overlapping and order – Figure 2.3. In addition, each AOI can be included or excluded from the MAOI. In Figure 2.3 AOI2 to AOI6 are included in MAOI and AOI1 is excluded. The slave AOIs can be enabled in random order and based on include/exclude selection can be inside each other.

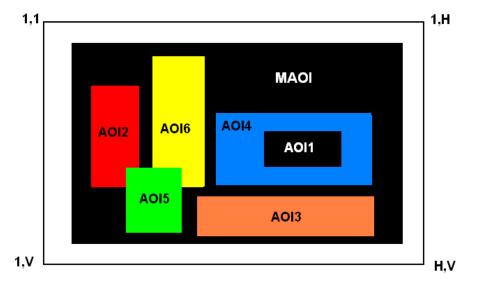


Figure 2.3 – Slave AOIs.



B. Processing AOI (PAOI)

All AOIs are functionally equal except PAOI. PAOI can be enabled as LUT or image processing Region of Interest (ROI). When enabled as LUT ROI, the LUT function will apply only to the selected ROI, all data outside of the region will not be processed with the LUT function. When enabled as processing ROI, the selected processing function will apply only to the selected ROI, all data outside of the region will not be processed with the selected function – Figure 2.4.



Figure 2.4 – PAOI enabled as processing ROI.

(All data within the selected ROI are processed with "One Point Correction", all data outside of the ROI are not processed)

2.4. **EXPOSURE CONTROL**

2.4.1. Internal Exposure Control - Electronic Shutter

During normal camera operation, the exposure time is fixed and determined by the readout (frame) time. The electronic shutter can be used to precisely control the image exposure time under bright light conditions. The electronic shutter does not affect the frame rate; it only reduces the number of electrons collected. Positioning a short pulse "SHUTTER", with respect to the vertical transfer pulse, VCCD – Figure 2.5, sets the exposure time. The electronic shutter pulse can be positioned within the entire frame period with a precision of 1.0us. The maximum exposure is frame time dependent and the minimum exposure is ~ 2 microseconds (camera dependent).



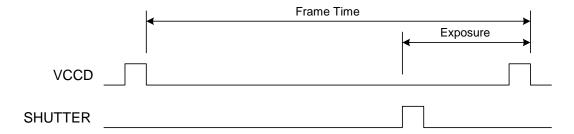


Figure 2.5 – Electronic shutter position.

2.4.2. Programmable Frame Time

Variable frame time mode provides the ability to run the camera in full resolution but at a slower frame rate than the nominal camera frame resulting in increased exposure time for the frame. During normal camera operation (no shutter), the nominal frame rate determines the integration time. The desired frame rate, and thus the new integration time, can be achieved by moving the vertical transfer pulse, VCCD, beyond the normal integration period (the standard frame time) – Figure 2.6. The resultant frame rate can be calculated using formula 2.2. The user can program the camera integration (frame time) from the nominal camera frame time to 16 sec (~ 0.0625 fps) with a precision of 1.0 us.

Frame rate [fps] = 1 / frame time [sec] (2.2)

Programmable Integration Time

Standard Frame Time

Figure 2.6– Programmable frame time.

CAUTION NOTE

VCCD

1. If the frame time is greater than 500ms the camera has to be kept still otherwise a motion smear will appear on the image.

2.



2.4.3. Automatic Exposure Control (AEC)

The camera can be set to automatic exposure (and gain) control in order to keep the same image brightness during changing light conditions. Both modes – automatic exposure and automatic gain can be enabled simultaneously. In this mode, the user sets the image brightness (luminance) to be maintained, and the camera adjusts the exposure accordingly. The user can select the average or peak brightness to be maintained. The camera starts with changing the exposure within the preset by the user min-max limits. If one of the exposure limits has been reached, the camera indicates the limit has been reached and keeps the value until the light condition change. The speed of convergence (how fast the camera stabilizes after change), can be preset by the user (four possible options are available). The AEC algorithm samples all pixels for the entire frame, but the user can select only a portion of the image (AOI) to be used as a sample collecting region. The camera displays the current luminance, current exposure and current gain. For auto gain control refer to Automatic Gain Control (AGC) section.

CAUTION NOTE

1. In some bright light conditions, a very small exposure values (~ microseconds) must be used. In such cases the camera response is not linear, i.e. equal exposure increments do not result in equal brightness increase. In some rare occasions during such conditions, an image brightness oscillation (image flipping from bright to dark) could occur. To prevent this, please change the AEC/AGC setting (exposure speed, luminance level or AOI), or change the lens iris.

2.4.4. Automatic Iris Control (AIC)

The camera has a built-in auto iris control feature, which is hardware compatible with a "Video" auto iris lens. If enabled, the camera provides an analog video signal (via 12 pin HIROSE connector), which is used by the lens to control the iris.

2.5. **STROBE OUTPUT**

The strobe output is used to synchronize an external light source with the camera timing, and thus to maximize the camera efficiency in low light level conditions. The optimal strobe signal position is achieved by the positioning of the STROBE pulse, with respect to the vertical transfer pulse VCCD (end of the frame) - Figure 2.7. BOBCAT supports two independent strobe signals. Each strobe pulse can be positioned within the entire frame timing period with a precision 1.0 us. The strobe duration can be seen from 1.0 us to 65535 us with a precision of 1.0us. The internal

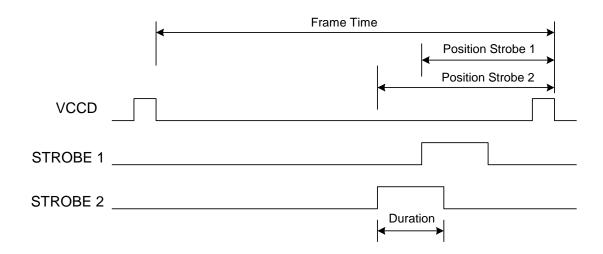
Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



camera timing has a flag for odd and even frames. Each strobe can be assigned to every frame, only odd frames, only even frames, or the strobe can be disabled. The actual strobe signal can be mapped to the corresponding camera outputs – please refer to the "I/O Control" section.

CAUTION NOTE

During Standard triggering mode, the odd/even frame flag resets with each new trigger. In this case, if the number of frames is set to 1 the strobe will be present only in "Every Frame" and "Odd Frames".



<u>Figure 2.7 – Strobe pulse positioning.</u>

2.6. GAIN and OFFSET

2.6.1. **Analog Domain – manual control**

The camera has dual analog signal processors (or Analog Front End – AFE), one per channel. It features one dual processor, each containing a differential input sample-and-hold amplifier (SHA), digitally controlled variable gain amplifier (VGA), black level clamp and a 14-bit ADC. The programmable internal AFE registers include independent gain and black level adjustment. There are 1024 possible gain levels (**gcode** 0 to 1023) and 1024 offset (clamp) levels (**gcode** 0 to 1023). Figure 2.8 shows the relationship between the video

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



signal output level and gain/offset. Theoretically, the black level should reside at 0 volts and the gain changes should only lead to increasing the amplitude of the video signal. Since the camera has two separate video outputs coming out of the CCD, there is always some offset misbalance between the video outputs. Thus, changing the AFE gain leads to a change in the offset level and to a further misbalance between the two video signals. To correct the balance between two signals for a particular gain, the user should always adjust the offset for each output – refer to the Camera Configuration section. The overall camera gain can be calculated using formula 2.3, where Fixed Gain (FG) is user selectable (- 3dB, 0, 3 dB, or 6dB).

$$VGA Gain [dB] = FG [dB] + 0.0351 x gcode$$
 (2.3)

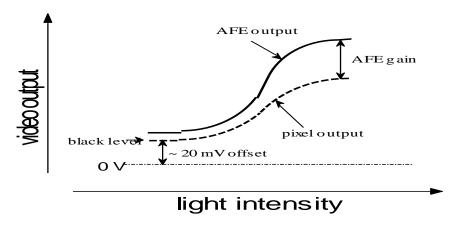


Figure 2.8 – AFE gain and offset.

2.6.2. **Digital Domain – manual control**

The camera has a built in digital gain and offset control. There are 20 possible digital gain levels from 1.0x to 3.0x with step of 0.1x, and 1024 offset levels from (-511, to + 511).

2.6.3. Automatic Gain Control (AGC)

The camera can be set to automatic gain (and exposure) control in order to keep the same image brightness during changing light conditions. In this mode, the user sets the image brightness (luminance) to be maintained, and the camera adjusts the gain accordingly. The user can select the average or peak brightness to be maintained. The camera starts with changing the gain within

 Imperx, Inc.
 Rev. 1.5

 6421 Congress Ave.
 9/26/2017



the preset by the user min-max limits. If one of the gain limits has been reached, the camera indicates the limit has been reached and keeps the value until the light condition change. The speed of convergence (how fast the camera stabilizes after change), can be preset by the user (four possible options are available). If both modes, automatic exposure and automatic gain are enabled simultaneously, the camera starts with changing the exposure first within the preset by the user min-max limits. If one of the exposure limits has been reached, the camera engages the analog gain, and changes it within the preset by the user min-max limits. The AGC algorithm samples all pixels for the entire frame, but the user can select only a portion of the image (AOI) to be used as a sample collecting region. The camera displays the current luminance, current exposure and current gain. For auto exposure control refer to Automatic Exposure Control (AEC) section.

2.7. **DATA OUTPUT FORMAT**

Model	Resolution	Туре	Optics	CCD Vendor	CCD model	Pixel size	HDSDI standard	HDSDI format
SDI-B1320C	1280x720	Color	1/2"	TRUESE	KAI-01150C	5.50 µm sq	SMPTE292M/ SMPTE296M	50p; 59.94p; 60p
SDI-B1320M	1280x720	Mono	1/2"	TRUESE	KAI-01150M	5.50 µm sq		
SDI-B1920C	1920x1080	Color	1.0"	TRUESE	KAI-2093C	7.40 µm sq	SMPTE292M/ SMPTE274M	23.98p; 24p; 25p; 29.97p; 30p; 50i; 59.94i; 60i
SDI-B1920M	1920x1080	Mono	1.0"	TRUESE	KAI-2093M	7.40 µm sq		
SDI-B1921C	1920x1080	Color	2/3"	TRUESE	KAI-02150C	5.50 µm sq		
SDI-B1921M	1920x1080	Mono	2/3"	TRUESE	KAI-02150M	5.50 µm sq		
SDI-B1922C	1920x1080	Color	2/3"	SONY	ICX-674C	4.54 µm sq		
SDI-B1922M	1920x1080	Mono	2/3"	SONY	ICX-674C	4.54 µm sq		
SDI-B1923C	1920x1080	Color	1.0"	TRUESE	KAI-02170C	7.40 µm sq		
SDI-B1923M	1920x1080	Mono	1.0"	TRUESE	KAI-02170M	7.40 µm sq		

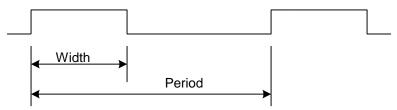
Table 1.10 – HD-SDI B1320, B1920, B1921, B1922, and B1923 data output formats.



2.8. PULSE GENERATOR

The camera has a built-in pulse generator. The user can program the camera to generate a discrete sequence of pulse or a continuous trail – Figure 2.9. The pulse generator can be used as a trigger signal, or can be mapped to one of the outputs – refer to "I/O Control" section for more information. The discrete number of pulse can be set from 1 to 65530 with a step of 1. The user has options to set:

- **Granularity** Indicates the number of clock cycles that are used for each increment of the width and the period. Four possible options are available (x1, x10, x100 and x 1000).
- **Period** Indicates the amount of time (also determined by the granularity) between consecutive pulses. Minimum value is 1, maximum is 1048576
- **Width** Specifies the amount of time (determined by the granularity) that the pulse remains at a high level before falling to a low level. Minimum value is 1, maximum is 524288



<u>Figure 2.9 – Internal pulse generator.</u>



2.9. **I/O CONTROL**

2.9.1. **I/O Mapping**

The camera has 1 external Tri-Level sync input and 2 external outputs wired to the 12 pin HIROSE connector, located on the back of the camera – please refer to Table 1.8 for more information. The user can map camera inputs to: Exposure Start, Exposure End, Mid-Exposure, Active Exposure Window, H or, V Sync, Odd/Even Frame Flag, Camera Ready, Pulse Generator, Strobe One, Strobe Two. For each mapped signal active "High", active "Low", can be selected. All possible mapping options for the camera inputs and outputs are shown in Table 1.11 and Table 1.12 respectively.

Note: CC1/CC2 is not available in HD-SDI cameras.

Input Signals	IN1	IN2
Tri-Level sync	✓	

Table 1.11 – BOBCAT Input Mapping.

Output Signals	OUT1	OUT2
Exposure Start	✓	✓
Exposure End	✓	✓
Mid-Exposure	✓	✓
Active Exposure Window	✓	✓
H-Sync	✓	✓
V-Sync	✓	✓
Odd/Even Frame Flag	✓	✓
Pulse Generator	✓	✓
Strobe One	✓	✓
Strobe Two	✓	✓

Table 1.12 – BOBCAT HD-SDI Output Mapping.



2.9.2. Electrical Connectivity

A. Inputs IN1

The external inputs in BOBCAT HD-SDI cameras are directly connected to the camera hardware – Figure 2.10 and Figure 2.11. The input signals "Signal" and "Return" are used to connect to an external Input to the outside source. For IN1 the signal level (voltage difference between the inputs "Signal" and "Return") MUST not exceed 1.2Vpp.

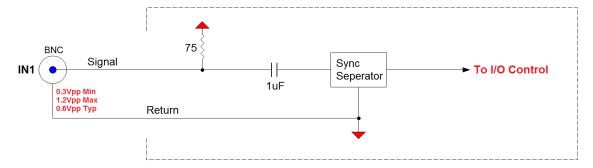


Figure 2.10 – IN1, Tri-Level Sync electrical input connection.

B. Outputs OUT1 and OUT2

The external outputs in BOBCAT HD-SDI cameras are directly connected to the camera hardware, and are TTL (5.0 Volts) compatible signals. The maximum output current MUST NOT exceed 8 mA. Figure 2.11 shows the output external electrical connection.

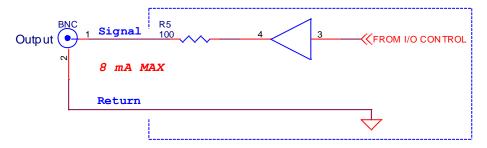
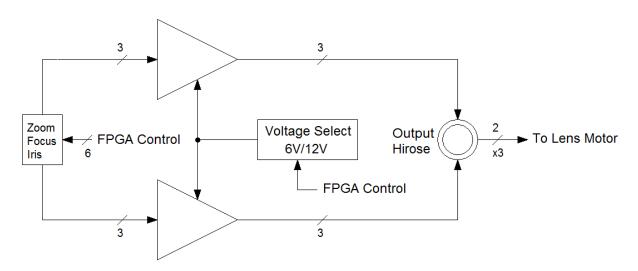


Figure 2.11– OUT1, OUT2 electrical connection.



C. Lens Control Output for Iris, Focus, and Zoom

The external Lens Control outputs in BOBCAT HD-SDI cameras are directly connected to the camera hardware, and operate in 6 or 12 volts. The maximum average output current MUST NOT exceed 400 mA with all three motors operating at the same time. Figure 2.12 shows the output external electrical connection.



<u>Figure 2.12 – Lens Control output electrical connection.</u>

D. Custom GPIO (IN/OUT)

BOBCAT (HD-SDI models) has a provision for a high-speed custom general purpose I/O – LVTTL (3.3 Volts) compatible. The maximum output current MUST NOT exceed 8 mA, and the maximum input current MUST NOT exceed 2.0 mA. This GPIO is not currently enabled. If your application requires such configuration please contact Imperx for more information.

2.10. TEST IMAGE PATTERNS

2.10.1. **Test Image patterns**

The camera can output several test images, which can be used to verify the camera's general performance and connectivity to the frame grabber. This ensures that all the major modules in the hardware are working properly and that the connection between the frame grabber and the camera is synchronized – i.e., the image framing, output mode, communication rate, etc. are properly



configured. Please note that the test image patterns do not exercise and verify the CCD's functionality.

The following test images are available:

- **Black** displays black image (value x0000)
- **Gray** displays a uniform dark gray image (value x2000)
- **White** displays a uniform white image (value 3FFF)
- **H Ramp Still** displays a stationary horizontal ramp image
- V Ramp Still displays a stationary vertical ramp image
- **H Ramp Move** displays a moving horizontal ramp image
- V Ramp Move displays a moving vertical ramp image
- Vertical Bars displays a set of 8 vertical gray bars with different gray levels
- Y/RGB Histogram displays separate Y, RGB histogram image
- **SMPTE Color Bars** displays an HD SMPTE color bar test pattern image
- **Frame Number** displays internal counter of frames (0 to 65535)
- Field Mark displays field mark: progressive modes green square on each frame; interlaced modes – green rectangle on even field, red rectangle on odd field.

2.10.2. Image Superimposition

The user has the capabilities to superimpose over a live image the following test patterns. The user can change the brightness of the superimposed image from black (invisible) to white "Crosshair" – Crosshair watermark (2 pixels and 2 lines thickness) indicating the absolute image center of the image.

- "H & V Lines" A pair of Horizontal and Vertical lines can be positioned in the image. The user can enable the lines in horizontal, vertical or both directions, and to position them at any pixel/line in the image. Since the H & V lines can be used as a measuring tool, the pixel and line positions are referenced to the CCD pixels and lines, not to the image pixels and lines. The spacing between the lines can be displayed in:
 - 1. **Pixels** Natively, the spacing between the lines is shown in pixels
 - 2. **Metrical units** In addition, the user can use these lines as a measuring tool. The user can apply a scale coefficient and thus, to calculate the spacing in linear measuring units (micrometers, millimeters or meters).

53 of 175



2.11. WHITE BALANCE

2.11.1. White Balance

The color representation in the image depends on the color temperature of the light source. Bobcat has built in algorithm to compensate for this. When white balance correction is enabled, the camera collects the luminance data for each of the primary colors R, G and B, analyzes it, and adjusts the color setting in order to preserve the original colors and make white objects to appear white. The algorithm collects data from the entire image, and can work in six different modes – "Off", "Once", "Auto" and "Manual", "Indoor 3200K", and "Outdoor 5600K". When set to "Off" no color correction is performed. When set to "Once" the camera analyzes only one image frame, calculates only one set correction coefficients, and all subsequent frames are corrected with this set of coefficients. When set to "Manual" the camera uses the correction coefficients as entered from the user. In "Auto" mode the camera analyzes every frame, a set of correction coefficients are derived for each frame and applied to the next frame. All Bobcat color cameras support white balance feature.

2.12. DYNAMIC BLACK LEVEL CORRECTION AND TAP BALANCING

2.12.1. Black Level Correction

As was described in the Gain and Offset section, the reference black level on each CCD output fluctuates around 0V. The AFE offset correction works on the entire image and if there are noise fluctuations on a line level, the AFE is not capable of correcting them. The camera has a built in dynamic signal-to-noise correction feature to compensate for this effect. In the beginning of each line the CCD has several black (masked) columns. The dark level for each tap is sampled over several of these masked pixels and the average per tap black level floor is calculated for each frame. The average floor level for each tap is then subtracted from each incoming pixel (from the corresponding tap) from the next frame.

2.12.2. Tap Balancing

Since the camera has two separate video outputs coming out of the CCD, there is always some offset misbalance between the video outputs. Thus, changing the AFE gain leads to a change in the offset level and to a further misbalance between the two video signals. To correct the balance between two signals at any particular gain, BOBCAT series of cameras have static and dynamic balancing algorithms implemented in the firmware. The algorithms compare the black and bright levels of the adjacent pixels around the tap line, and adjusts the gain and offset for each tap accordingly, until the balance has been

6421 Congress Ave. Boca Raton, FL 33487 +1 (561) 989-0006

Imperx, Inc.



reached. The selection to use static or dynamic balancing depends on the application. Please note, that if AGC is enabled, it is strongly recommended to use static balancing, because the dynamic balancing can interfere with the AGC algorithm.

2.13. TRANSFER FUNCTION CORRECTION – LUT

The LUT (Lookup Table) feature allows the user to modify and transform the original video data into any arbitrary value – Figure 2.13. Any 10-bit value can be transformed into any other 10-bit value. The camera supports 8 Gamm Lookup tables, 4 user Lookup tables (one component for mono cameras, 3 components for color cameras - RGB), each consisting of 1023 entries for each component, with each entry being 10 bits wide. The LUT is applied to the entire image unless AOI7 is enabled as "LUT ROI". In this case the LUT function will apply only to the selected ROI. The user can generate and upload his own custom LUT using the BOBCAT Configuration software – refer to Appendix B.

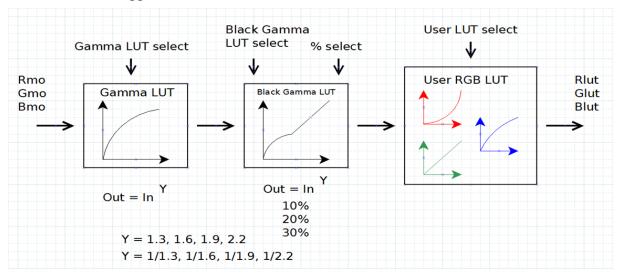


Figure 2.13 – LUT data path.

2.13.1. Standard Gamma Correction

The image generated by the camera is normally viewed on a CRT (or LCD) display, which does not have a linear transfer function – i.e., the display brightness is not linearly proportional to the scene brightness (as captured by the camera). As the object brightness is lowered, the brightness of the display correspondingly lowers. At a certain brightness level, the scene brightness decrease does not lead to a corresponding display brightness decrease. The

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



same is valid if the brightness is increased. This is because the display has a nonlinear transfer function and a brightness dynamic range much lower than the camera. The camera has a built-in 8 transfer function to compensate for this non-linearity, which is called gamma correction – Figure 2.14.

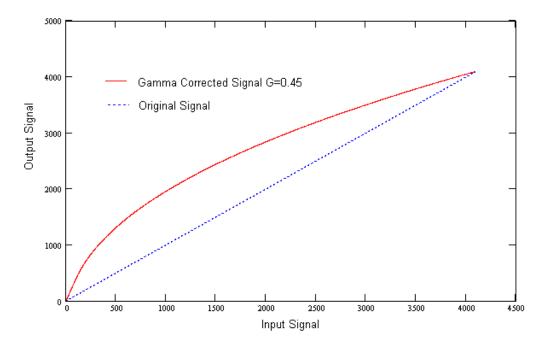


Figure 2.14 – Gamma corrected video signal.

2.13.2. User Defined LUT

The user can define any 10-bit to 10-bit transformation as a user LUT and can upload it to the camera using the configuration utility software. The user can specify a transfer function of their choice to match the camera's dynamic range to the scene's dynamic range. There are no limitations to the profile of the function. The LUT must include all possible input values (0 to 1023) – Figures 2.15.



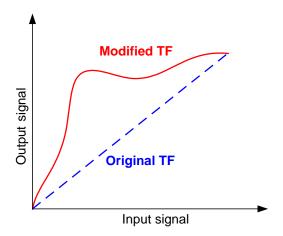


Figure 2.15 – Custom LUT.

2.14. **DEFECTIVE PIXEL CORRECTION**

A CCD imager is composed of a two-dimensional array of light sensitive pixels. In general, the majority of the pixels have similar sensitivity. Unfortunately, there are some pixels which sensitivity deviates from the average pixel sensitivity. A defective pixel is defined as a pixel whose response deviates by more than 15% from the average response. In extreme cases, these pixels can be stuck 'black' or stuck 'white' and are non-responsive to light. There are two major types of pixel defects – "Defective" and "Hot".

- 1. "**Defective**" these are pixels which sensitivity deviates more than 15% due to fluctuations in the CCD manufacturing process. Two types of defective pixels are possible:
 - a. "**DARK**" is defined as a pixel, whose sensitivity is lower than the sensitivity of the adjacent pixels. In some cases, this pixel will have no response (completely dark).
 - b. "BRIGHT" is defined as a pixel, whose sensitivity is higher than the sensitivity of the adjacent pixels. In some cases, this pixel will have full response (completely bright).
- 2. "Hot" these are pixel, which in normal camera operation behaves as normal pixel (the sensitivity is equal to the one of the adjacent pixels), but during long time integration behaves as a high intensity bright pixel. In some cases, this pixel will have full response (completely bright).



2.14.1. Static Pixel Correction

Static Defective and Hot pixel correction works with predetermined and preloaded Defective and Hot pixel maps. During factory final testing, our manufacturing engineers run a program specially designed to identify these 'defective' and "hot" pixels. The program creates a map file which lists the coordinates (i.e. row and column) of every defective pixel. This file, called the Defect Pixel Map, is then downloaded into the camera's non-volatile memory. Users may wish, however, to create and to upload their own DPM file because of the uniqueness of their operating environment or camera use. When 'Defective Pixel Correction' is enabled, the camera will compare each pixel's coordinates with entries in the 'defect' map. If a match is found, then the camera will 'correct' the defective pixel. When 'Hot Pixel Correction' is enabled, the camera will compare each pixel's coordinates with entries in the 'defect' map. If a match is found, then the camera will 'correct' the hot pixel. The "Defective/Hot Pixel Map" can be displayed upon user request.

2.14.2. **Dynamic Pixel Correction**

Dynamic pixel correction works without preloaded pixel maps. When this option is enabled, the camera determines which pixel needs correction and performs the correction automatically. Static and Dynamic "Defective Pixel Correction" and "Hot Pixel Correction" can be enabled independently or simultaneously.

2.15. FLAT FIELD CORRECTION

A CCD imager is composed of a two-dimensional array of light sensitive pixels. Each pixel within the array, however, has its own unique light sensitivity characteristics. Most of the deviation is due to the difference in the angle of incidence and to charge transport artifacts. This artifact is called 'Shading' and in normal camera operation should be removed. The process by which a CCD camera is calibrated for shading is known as 'Flat Field Correction'. Refer to Figures 2.16 and 2.17 for images acquired before and after Flat Field Correction. This feature is available as a standard feature only for cameras with 2/3" optical format or bigger.

The BOBCAT series of cameras incorporate a Flat Field Correction mechanism. The Flat Field Correction mechanism measures the response of each pixel in the CCD array to illumination and is used to correct for any variation in illumination over the field of the array. The optical system most likely introduces some variation in the illumination pattern over the field of the array. The flat field correction process compensates for uneven illumination, if that illumination is a stable characteristic of each object exposure.



During factory final testing, our manufacturing engineers run a program specially designed to identify the shading characteristics of the camera. The program creates a Flat Field Correction file, which contains coefficients describing these shading characteristics. This file is then downloaded into the camera's non-volatile memory. When Flat Field Correction is enabled, the camera will use the Flat Field Correction coefficients to compensate for the shading effect.

Each Imperx camera is shipped with the Flat Field Correction file that was created for that camera during factory final testing. Users may wish, however, to create their own Flat Field Correction file because of the uniqueness of their operating environment (i.e. lens, F-stop, lighting, etc.). Therefore, Imperx provides a Flat Field Correction utility that allows users to generate a Flat Field Correction file. This file can then be downloaded into the camera. While creating the Flat Field Correction file, it is necessary to illuminate the CCD with a light pattern that is as representative of the background illumination as possible. This illumination should be bright enough, or the exposure made long enough, so that the CCD pixels signals are at least 25 percent of full scale (for 12-bit mode the level should be at least 1000 ADUs).



Figure 2.16 – Original image showing 'shading' effect.





Figure 2.17 – Flat field corrected image.



2.16. CAMERA INTERFACE

2.16.1. **Status LED**

The camera has a dual red-green LED, located on the back panel. The LED color and light pattern indicate the camera status and mode of operation:

- **GREEN is steady ON** Normal operation. The user is expected to see a normal image coming out of the camera.
- GREEN blinks at ~ 0.5 Hz indicates programmable frame integration mode.
- GREEN blinks at ~ 2.0 Hz the camera is in external Genlock sync mode.
- YELLOW is steady ON Test mode. The user is expected to see one of the test patterns.
- YELLOW blinks at ~ 0.5 Hz the camera is in AGC/AEC mode. In this mode changing the shutter slider will not affect the image luminance.
- **RED** is steady **ON** RS232 communication error or firmware load error. Repower the camera and load the factory settings. If the condition is still present, please contact the factory for RMA.
- **LED is OFF** Power not present error. The camera has no power or indicates a camera power supply failure. A faulty external AC adapter could also cause this. To restore the camera operation, re-power the camera and load the factory settings. If the LED is still "OFF", please contact the factory for RMA.

2.16.2. **Temperature Monitor**

The camera has a built-in temperature sensor which monitors the internal camera temperature. The sensor is placed on the hottest spot in the camera. The internal camera temperature is displayed on the Camera Configuration Utility screen and can be queried by the user at any time — refer to Camera Configuration section.

2.16.3. **Exposure Time Monitor**

The camera has a built-in exposure time monitor. In any mode of operation (i.e. normal, AOI, etc.) the user can query the camera for the current exposure time by issuing a command – refer to the Exposure Control section. The current camera integration time in units of microseconds will be returned.

2.16.4. Frame Time Monitor

The camera has a built-in frame rate monitor. In any mode of operation (i.e. normal, AOI, etc.) the user can query the camera for the current frame rate by



issuing a command – refer to the Exposure Control section. The current camera speed in units of frames per second will be returned.

2.16.5. Current image size

The camera image size can change based on a camera feature selected. In any mode of operation (i.e. normal, AOI, etc.) the user can query the camera for the current image size by issuing a command – refer to the Image Size section. The current camera image size in (pixels x lines) will be returned.

2.17. LENS CONTROLLER

The camera has a built in Lens Controller that outputs Zoom, Focus, and Iris control signals to any standard Type 1 (6V) or Type 2 (12V) motorized lens. Output Lens Control signals are controlled via Bobcat CamConfig GUI, or command terminal. For Lens Control GUI operating instructions please refer to section 5.7.11, and for command terminal register values refer to section A.16.





Digital Image Processing

This chapter discusses built in Digital Image Processing algorithm in the camera and their implementation and use.



3.1. **OVERVIEW**

The camera has built-in several basic image processing functions. More functions will be added later. Please contact Imperx for more information.

3.2. **IMAGE ENHANCEMENT**

In many imaging applications the user will have a dark object on a bright background, many dark and bright spots or shadows, or the light will not be sufficient, so the resulting image will have a low contrast, and/or a very low dynamic range. To improve the image quality in such conditions, BOBCAT offers a set of image enhancing features – thresholding and multi-point image correction. The processing function is applied to the entire image unless PAOI6 is enabled as "Processing ROI". In this case the processing function will apply only to the selected ROI.

3.2.1. Threshold Operation

In many applications, the binary images are much simpler to analyze that the original gray scale one. The process, which converts the regular gray scale image to binary, is called "Thresholding". Thresholding is a special case of intensity quantization (binarization) where the image can be segmented into foreground and background regions, having only two gray scale levels "white" and "black". Selecting the threshold value is very critical for the binary image quality, and it is to a great extend scene dependent. If a threshold level is chosen correctly, this will produce a well-defined boundary of the object, which is essential. In some cases, it is desirable if part of the image is binary and some is grayscale image. The camera has built in four thresholding modes:

3.2.1.1. Single Threshold Binary

If the image is a high contrast scene and has well defined bright and dark regions a simple binarization technique can be used for thresholding – Formula 3.1. The binary image output is converted to "white" for all gray level values higher or equal to the selected threshold point X1, and to "black" for all gray levels lower than X1. The user can set the optimal threshold value. Figure 3.1 shows the original and the processed image with single threshold.

Output signal => "WHITE" if (input signal
$$\geq X1$$
)

"BLACK" if (input signal $\leq X1$)

(3.1)



3.2.1.2. **Dual Threshold Binary**

If the image has a low contrast and does not have well defined dark and bright regions, the simple threshold operation does not yield good results. In such cases a dual (known also as interval or window) thresholding technique has to be implemented – Formula 3.2. The binary image output is converted to "white" for all gray level values between the selected threshold interval X1 and X2, and to "black" for all gray levels outside (X1, X2) interval. The user can set the optimum X1 (Low) and X2 (High) threshold values, please note that $X^2 > X^2$. Figure 3.1 shows the original a processed image after a dual threshold operation.

Output signal => "BLACK" if (input signal \leq X1)

"WHITE" if (X1 < input signal < X2)

"BLACK" if (input signal \geq X2) (3.2)

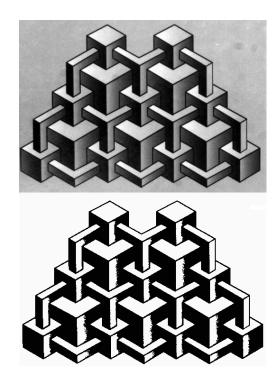
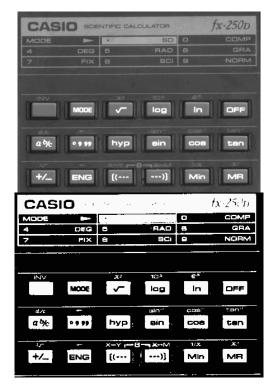


Figure 3.1 – Original and processed image with single threshold.





<u>Figure 3.2 – Original and processed image with double threshold.</u>

3.2.1.3. **Dual Threshold with Gray Scale**

In some low contrast imaging applications, the simple threshold operation along with a superimposed gray scale image might yield a good result. In such cases a dual thresholding technique with a gray scale has to be implemented – Formula 3.3. The image output is a gray scale image for all gray level values between the selected threshold interval X1 and X2, "black" for all gray levels lower than X1, and "white" for any gray levels higher than X2. The user can set the optimum X1 (Low) and X2 (High) threshold values, please note that X2 > X1. The image gray scale range is only from values X1 to X2.

Output signal => "BLACK" if (input signal
$$\leq$$
 X1)
"Gray Scale" if (X1 < input signal \leq X2)
"WHITE" if (input signal \geq X2) (3.3)

3.2.1.4. **Dual Threshold with Gray Scale Stretch**

In some low contrast applications, the threshold operation along with a gray scale stretch might yield a good result – Figure 3.3. This is similar to dual threshold with a gray scale, but the image gray scale is digitally stretched to full 12-bit gray scale – Formula 3.4. The user can set the optimum X1 (Low) and X2 (High) threshold values, note that X2 > X1.



Output signal => "BLACK" if (input signal \leq X1)

"Full Gray Scale" if (X1 < input signal < X2)

"WHITE" if (input signal \geq X2) (3.4)

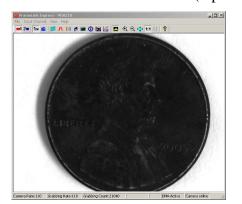




Figure 3.3 – Original and processed image with threshold and gray scale stretch.

3.2.2. Multi Point Correction

Multi point correction is a modification of the slope of the camera transfer function (TF), which results in the suppression or enhancement of certain image regions. The original camera transfer function is linear and maps the data 1:1. The new (corrected) transfer function has one or two sets of variables (X, Y) and based on the relation between the variables a correction of certain image regions can be achieved. The camera has two built in correction modes.

3.2.2.1. Single Point Correction

The simplest image enhancement can be achieved by a linear modification of the original transfer function. If the image brightness is weighted towards a particular region (dark or bright), this region needs to be suppressed, and the less present (the flat) region needs to be enhanced. The range of the correction is determined by the location of the break point (X1, Y1) – Figure 3.4. This point (X1, Y1) divides the camera transfer function into two regions (two lines). The slope of these lines (the angle between the X axis and the line) determines the power of the correction. If the angle is less than 45° degrees, the grayscale range will be suppressed. If the angle is more than 45° degrees, the grayscale range will be enhanced. The user can set the optimum (X1, Y1) values.



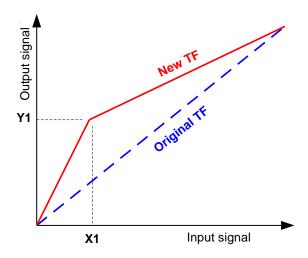


Figure 3.4 – Single point TF correction.

3.2.2.2. Multi Point Correction

If the image brightness is weighted towards two particular regions – dark and bright, and in the same time mid region has a low dynamic range a multi-point correction will produce much better results compare to the single point correction. The range of the correction is determined by the location of a pair of the break point (X1, Y1) and (X2, Y2) -Figure 3.5a. The camera transfer function is divided into three regions (three lines), which allows multiple grayscale regions to be corrected independent of each other. If the angle is less than 45° degrees, the grayscale range will be suppressed, if the angle is 45° degrees, the gray scale will not change. If the angle is more than 45° degrees, the grayscale range will be enhanced. The user can set the optimum (X1, Y1) and (X2, Y2) values, note that X2 > X1. Figure 3.5b shows some of the most typical correction curves. If the angle in the mid-range (between X1 and X2) is negative, the grayscale range will be reversed. Curve TF 1 enhances the dark image regions and suppresses the bright ones. TF 2 – suppresses the dark and bright image parts and enhances the mid-range. TF 3 - enhances the bright image regions and suppresses the dark ones. TF 4 – enhances the bright and dark image parts and suppresses the mid-range.



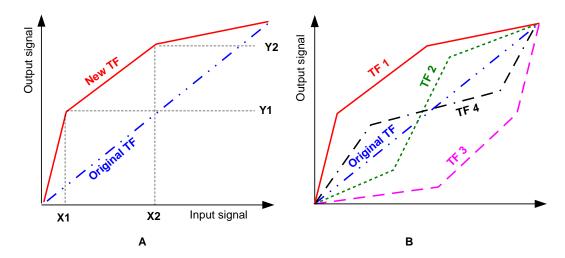
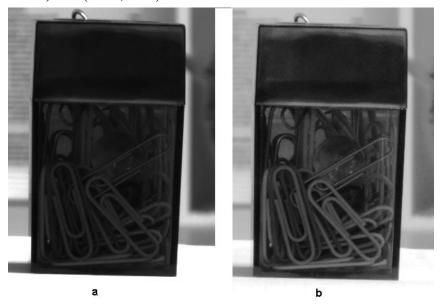


Figure 3.5 – Multi point TF correction.

Figure 3.6 shows an original image (left) and processed one (right). The original image has two dominant regions – predominantly dark subject with a very bright bottom section and a relatively flat gray region. To correct the image, we will use "TF 1" type correction with points (650, 1950) and (2200,1760).



<u>Figure 3.6 – Multi point image correction (a – original, b – processed).</u>

CAUTION NOTE

Due to space limitations in the camera FPGA, the "Image processing" module is disabled for the color Bobcat cameras. For more information please contact Imperx.

 Imperx, Inc.
 Rev. 1.5

 6421 Congress Ave.
 9/26/2017



3.3. **CONVOLUTION**

Monochrome Cameras applies a 3 x 3 area filter for the RAW output. Color cameras apply a 3 x 3 area filter for the RGB output. The center pixel and eight surrounding pixels are multiplied by the corresponding filter coefficient, and added together. The result is brightness of the central pixels. Depending on the image pattern the user can reduce noise, apply edge enhancement, and extract the image contour.

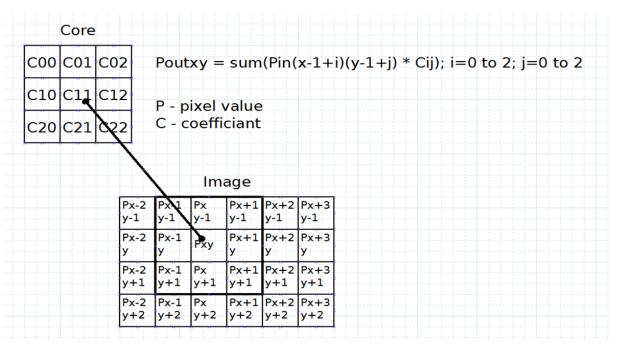


Figure 3.7 – Multi point image correction (a – original, b – processed).





Camera Configuration

This chapter discusses how to communicate with the camera and configure the camera's operating parameters.



4.1. **OVERVIEW**

The Bobcat HD-SDI series of cameras are highly programmable and flexible. All of the cameras resources (internal registers, video amplifiers and parameter FLASH) can be controlled by the user. The user communicates with the camera using a simple, register-based, command protocol via the Camera's RS-232 serial interface. The interface is bi-directional with the user issuing 'commands' to the camera and the camera issuing 'responses' (either status or info) to the user. The entire camera registers and resources can be configured and monitored by the user. The camera's parameters can be programmed using the Bobcat Configurator graphical user interface.

4.2. CAMERA CONFIGURATION

4.2.1. Configuration Memory – parameter FLASH

The camera has a built-in configuration memory divided into 4 segments: 'work-space', 'factory-space', 'user-space #1' and 'user-space #2'. The 'workspace' segment contains the current camera settings while the camera is powered-up and operational. All camera registers are located in this space. These registers can be programmed and retrieved via commands issued by the user. The workspace is RAM based and upon power down all camera registers are cleared. The 'factory-space' segment is ROM based, write protected and contains the default camera settings. This space is available for read operations only. The 'user-space #1' and 'user-space #2' are non-volatile, FLASH based and used to store two user defined configurations. Upon power up, the camera firmware loads the work-space registers from the factory-space, user-space #1 or user-space #2 as determined by a 'boot control' register located in the configuration memory. The 'boot control' register can be programmed by the user (refer to Camera Configuration Section). The user can, at any time, instruct the camera to loads its workspace with the contents of the 'factoryspace', 'user-space #1' or 'user-space #2'. Similarly, the user can instruct the camera to save the current workspace settings into either the 'user-space #1' or 'user-space #2'.

The non-volatile parameter FLASH memory also contains Defective Pixel Map, Hot Pixel Map, Flat Field Correction Coefficients, LUT 1 and LUT 2, which can be loaded to the camera internal memory upon enabling the corresponding camera feature. The user can create its own DPM, HPM, FFCC, and LUT tables and upload them to the parameter FLASH using the Bobcat Configurator graphical user interface.



4.2.2. Camera Serial Protocol

In order to access the camera registers and resources a sequence of bytes needs to be transmitted to the camera via the Camera's RS-232 serial interface. This is an RS-232, asynchronous, full-duplex, serial protocol, with 1 start bit, 8 data bits, 1 stop bit, no hand shake, and no parity – Figure 4.1. The default baud rate is configurable (9600, 19200, 38400, 57600 and 115200 – default).

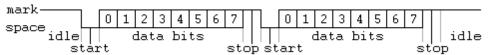


Figure 4.1– Serial protocol format.

Each camera control register can be updated independently. In terms of the serial protocol, all registers are defined as 16-bit address (hex format), and 32-bit data (hex format). Camera registers using less than 32-bits in width must be padded with '0's on writes, and unused bits are ignored on reads. Register data is always "packed low" within 32-bit data words for registers defined less than 32-bits.

There is a latency delay for each command due to command execution and data transmission over the serial port. This latency varies from command to command because of resource location and command response length.

4.2.2.1. Write Operation

In order to write to any given camera register, a sequence of 7 bytes should be sent to the camera. If there is no error the camera returns one byte acknowledge for the write command <Ack> - Figure 4.2. If there is an error the camera returns two bytes not-acknowledge for the write command – the first byte is <Nac> <Err>, the second is the error code – Figure 4.3, and 4.4:

```
Write to camera (7 Bytes): <Write_Cmd> <Address> <Data>

1<sup>st</sup> byte: 0x57 (Write Command)

2<sup>nd</sup> byte: <Register Address_High> MSB

3<sup>rd</sup> byte: <Register Address_Low> LSB

4<sup>th</sup> byte: <Register Data Byte 4> MSB

5<sup>th</sup> byte: <Register Data Byte 3> ...

6<sup>th</sup> byte: <Register Data Byte 2> ...

7<sup>th</sup> byte: <Register Data Byte 1> LSB

Write Acknowledge (1 Byte): <Ack>
```

Imperx, Inc. 6421 Congress Ave. Boca Raton, FL 33487 +1 (561) 989-0006 1st byte: 0x06 (Acknowledge)



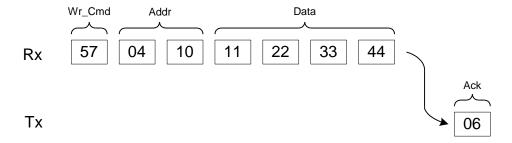


Figure 4.2 – Normal write cycle.

Write Not-acknowledge (2 Bytes): <Nak> <Error Code>

1st byte: 0x15 (Not-acknowledge)

2nd byte: <XX> (Nck Error Code. See Error Code Description section)

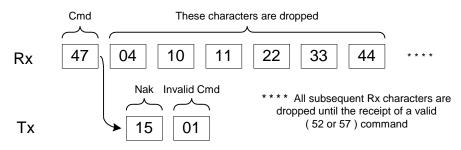


Figure 4.3 – Invalid command error.

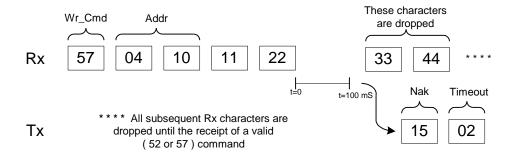


Figure 4.4 – Rx timeout error.

Example: Write to register address 0x0410, data value = 0x11223344:

 \Rightarrow Camera Write Command: $\langle 0x57 \rangle \langle 04 \rangle \langle 10 \rangle \langle 11 \rangle \langle 22 \rangle \langle 33 \rangle \langle 44 \rangle$

4.2.2.2. **Read Operation**

Imperx, Inc. 6421 Congress Ave. Boca Raton, FL 33487 +1 (561) 989-0006



In order to read from any given camera register, a sequence of 3 bytes should be sent to the camera. If there is no error the camera returns 5 bytes – one byte acknowledge for the read command <Ack> and four bytes of data <DD> <DD> <DD> <DD> - Figure 3.4. During read operation the camera does not return an error or <Nac>. The only exception is the case of invalid command –Figure 4.5. If the user specifies a wrong address, the camera returns acknowledge <06> and four bytes of data <00> <00> <00> <00>.

Read from camera (3 Bytes): <Read_Cmd> <Address> 1st byte: 0x52 (Read Command) 2nd byte: <Register Address Low> 3rd byte: <Register Address_High> The camera returns (5 bytes): <ACK> <Data> 1st byte: 0x06 (Acknowledge) 2nd byte: <Register Data Byte 4> MSB 3rd byte: <Register Data Byte 3> ... 5th byte: <Register Data Byte 2> ... 6th byte: <Register Data Byte 1> LSB Rd_Cmd Addr Rx 52 10 04 Data Ack Tx 06 11 22 33 44

Figure 4.5 – Normal read cycle.

Example: Read from camera register address 0x0410:

⇒ Camera Read Command: <0x52> <04> <10> Camera returns register data payload value 0x11223344:

 \Rightarrow Register data <0x06><11><22><33><44>

4.2.2.3. Error Code Description

To manage camera reliability, not-acknowledge error codes are defined as follows:

x00 - No error

Imperx, Inc. 6421 Congress Ave. Boca Raton, FL 33487 +1 (561) 989-0006 Rev. 1.5 9/26/2017





- x01 Invalid command. An invalid command (not 52 or 57) has been sent to the camera.
- x02 Time-out.
- x03 Checksum error
- x04 Value less then minimum
- x05 Value higher than maximum
- x06 AGC error
- x07 Supervisor mode error
- x08 Mode not supported error

4.3. CAMERA CONFIGURATION REGISTER DESCRIPTION

4.3.1. **Startup Procedure**

Upon power on or receipt of an 'SW_Reset' command, the camera performs the following steps:

- 1. Boot loader checks Program FLASH memory for a valid Firmware image and loads it into the FPGA.
- 2. The camera reads the 'Boot From' register from the parameter FLASH and loads its workspace from one of the configuration spaces as determined by the 'Boot From' data. The available configuration spaces are: 'Factory...', 'User #1...', 'User #2...'
- 3. The camera is initialized and ready to accept user commands.

4.3.2. Saving and Restoring Settings

Operational settings for the camera may be stored for later retrieval in its non-volatile memory. Three separate configuration spaces exist for storing these settings: 'factory' space, 'user #1' space and 'user #2' space. The factory space is pre-programmed by factory personnel during the manufacturing process. This space is write protected and cannot be altered by the user. Two user spaces are also provided allowing the user to store his/her own preferences. The camera can be commanded to load its internal workspace, from either of the three configuration spaces, at any time. The user can also define from which space the camera should automatically load itself following a power cycle or receipt of a reset ('SW Reset') command.

4.3.2.1. **Boot From**

This register determines which configuration space (factory, user#1 or user #2) should be loaded into the camera following a power cycle or reset ('SW Reset') command. Upon a power cycle or reset, the camera reads the

 Imperx, Inc.
 Rev. 1.5

 6421 Congress Ave.
 9/26/2017



'boot from' value from non-volatile memory and loads the appropriate configuration space.

Address : 0x6000

Data (1-0) : 00 - Boot from Factory

01 – Boot from User #1 10 – Boot from User #2

Data (31-2) : N/A

4.3.2.2. Load From Factory

The 'Load From Factory' command instructs the camera to load its workspace from the factory space. All current workspace settings will be replaced with the contents of the factory space. This is a command, not a register. The act of writing to this location initiates the load from the factory.

Address: 0x6060

4.3.2.3. **Load From User #1**

The 'Load From User #1' command instructs the camera to load its workspace from the user #1 space. All current workspace settings will be replaced with the contents of the user #1 space. This is a command, not a register. The act of writing to this location initiates the load from the user #1.

Address: 0x6064

4.3.2.4. **Load From User #2**

The 'Load From User #2' command instructs the camera to load its workspace from the user #2 space. All current workspace settings will be replaced with the contents of the user #2 space. This is a command, not a register. The act of writing to this location initiates the load from the user #2.

Address: 0x6068

4.3.2.5. Load MFG Default Gain

The 'Load MFG Default Gain' command instructs the camera to load its default gain and offset settings from the manufacturing space. Different settings will be loaded for "slow" and "fast" camera speed. This is a command, not a register. The act of writing to this location initiates the load the default gain and offset settings.

Address: 0x606C

4.3.2.6. **Save to User #1**

The 'Save To User #1' command instructs the camera to save its workspace to the user #1 space. All current workspace settings will be saved to the user #1 space. This is a command, not a register. The act of writing to this location initiates the save to user #1 space.

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



Address: 0x6074

4.3.2.7. **Save to User #2**

The 'Save To User #2' command instructs the camera to save its workspace to the user #2 space. All current workspace settings will be saved to the user #2 space. This is a command, not a register. The act of writing to this location initiates the save to user #2 space.

Address: 0x6078

4.3.2.8. **SW Reset**

The 'SW_Reset' command instructs the camera to initiate software reset, which resets the camera and loads its workspace from one of the configuration spaces as determined by the 'Boot From' data. Although, this is a command, the user MUST write a specific data 0xDEADBEEF in order to initiate the reset sequence.

Address : 0x601C

Data : 0xDEADBEEF

4.3.2.9. **BAUD Rate Selector**

This register sets the communication baud rate between the camera and computer.

Address : 0x0604

Data (2:0) : 000 – 9600

001 - 19200 010 - 38400 011 - 57600

100 – 115200 (default)

Data (31:3) : N/A

4.3.3. Retrieving Manufacturing Data

The camera contains non-volatile memory that stores manufacturing related information. This information is programmed in the factory during the manufacturing process.

4.3.3.1. **Firmware Revision**

These registers return the camera main firmware revision.

Main FW revision

Address : 0x6004

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017





Data (31:28) : <FW image>
Data (27:24) : <CCD Type>
Data (23:0) : <FW revision>

I/O FW revision

Address : 0xE004

Data (31:28) : <I/O FW image>

Data (27:24) : Reserved

Data (23:0) : <I/O FW revision>

4.3.3.2. Firmware Build Number

These registers return the firmware build number, which tracks custom firmware for specific applications.

Main FW build number

Address: 0x6008

Data : <FBN revision>

I/O FW build number

Address: 0xE008

Data : <I/O FBN revision>

4.3.3.3. **Assembly Part Number**

This register returns the camera assembly part number – the complete assembly part number is 4 registers.

Address : 0x7004, 0x7008, 0x700C, 0x7010

Data : <Assembly Part Number>

4.3.3.4. Camera Serial Number

This register returns the camera serial number - the complete serial number is 2 registers.

Address : 0x7014, 0x7018

Data : <Camera Serial Number>

4.3.3.5. CCD Serial Number

This register returns the CCD imager number – the complete CCD number is 2 registers.

Address : 0x701C, 0x7020

Data : <CCD Serial Number>

4.3.3.6. **Date of Manufacture**

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



This register returns the camera date of manufacture – The complete date of manufacture is 2 registers.

Address : 0x7024, 0x7028

Data : <Date of Manufacture>

4.3.3.7. Camera Type

This register returns the camera type – The complete assembly is 4 registers.

Address : 0x702C, 0x7030, 0x7034, 0x7038

Data : <Camera Type>

4.3.4. Camera Information Registers

The camera has a set of information registers, which provide information for the camera current status, frame rate, exposure time, image size, etc.

4.3.4.1. Horizontal Frame Size (Max, Min)

This register returns the minimum/maximum horizontal image frame size in pixels. The maximum horizontal image size is a dynamic parameter and changes based on the LVAL selection.

Address : 0x6080

Data (15:0) : <Minimum Horizontal Size>
Data (31:16) : <Maximum Horizontal Size>

4.3.4.2. **Vertical Frame Size (Max, Min)**

This register returns the minimum/maximum vertical image frame size in lines. The maximum vertical image size is a dynamic parameter and changes based on the FVAL selection.

Address : 0x6084

Data (15:0) : <Minimum Vertical Size>
Data (31:16) : <Maximum Vertical Size>

4.3.4.3. Current Minimum Frame Time

This register returns the current minimum frame time in us.

Address : 0x6088

Data (23:0) : <Minimum Frame Time>

Data (31:24) : N/A

4.3.4.4. Current Minimum Line Time

This register returns the current minimum line time in pixels.

Address : 0x608C

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017





Data (15:0) : N/A

Data (31-16) : <Minimum Line Time>

4.3.4.5. **Current Minimum Exposure**

This register returns the current minimum possible camera exposure time in us.

Address : 0x6094

Data (23:0) : <Minimum Camera Exposure>

Data (31:24) : N/A

4.3.4.6. **Current Maximum Exposure**

This register returns the current camera maximum exposure time in us. The maximum camera exposure is a dynamic parameter and changes based on the camera mode of operation.

Address : 0x6090

Data (23:0) : <Current Maximum Camera Exposure>

Data (31:24) : N/A

4.3.4.7. Current Camera Exposure

This register returns the current camera exposure time in us.

Address : 0x609C

Data (23:0) : <Current Exposure Time>

Data (31:24) : N/A

4.3.4.8. Current Frame Time

This register returns the current camera frame time in us.

Address : 0x60A0

Data (23:0) : <Current Frame Time>

Data (31:24) : N/A

4.3.4.9. **Current Image Size**

This register returns the current image frame size in pixels. The image size is a dynamic parameter and changes based on the camera mode of operation.

Address : 0x60B0

Data (15:0) : <Current Horizontal Size>
Data (31:16) : <Current Vertical Size>

4.3.4.10. Current Gain & Luminance Status

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



This register returns the current analog gain and the current average image luminance during normal, AGC and Tap Balance operation.

The Current Analog Gain (register bits D11:D0) displays:

- The current slider gain for tap 1 during normal operation.
- The calculated AGC gain for tap1 when AGC/AEC is enabled.
- The calculated analog gain for tap 2 when tab balancing is enabled.

Address : 0x60B4

Data (11:0) : <Current Analog Gain>

Data (23:12) : <Current Average Luminance>

Data (24) : <Analog Gain Minimum Limit Reached>
Data (25) : <Analog Gain Maximum Limit Reached>

Data (27, 26) : N/A

Data (28) : <Exposure Minimum Limit Reached>
Data (29) : <Exposure Maximum Limit Reached>

Data (31, 30) : N/A

4.3.4.11. Current Camera Temperature

This register returns the current camera temperature in degrees Celsius. The temperature resolution is 0.25°C – Table 1.13.

Address : 0x6010

Data (9:0) : <Current Camera Temperature>

Data (31:10) : N/A

Temperature	Register Value
	01 1111 1111
+127.75 °C	
•••	•••
+0.25 °C	00 0000 0001
0° C	00 0000 0000
-0.25 °C	11 1111 1111
•••	•••
-128 °C	10 0000 0000

Table 1.13 – Current camera temperature values.



4.3.4.12. Tri-Level sync detected format

This register returns the detected HD Tri-Level sync format.

Address : 0x0618

Data (3:0) : 0x0 - 1080p@23.98

0x1 - 1080p@24 0x2 - 1080p@25 0x3 - 1080p@29.97 0x4 - 1080p@30 0x5 - 1080i@50 0x6 - 1080i@59.94 0x7 - 1080i@60 0x8 - 720p@50

0x9 - 720p@59.94 0xA - 720p@60 0xF - unknown

others - reserved

Data (31:4) : N/A

4.3.5. Image Size (AOI) Workspace Registers

4.3.5.1. **MAOI**

The maximum image size is fixed as per the SMPTE standard and cannot be changed.

4.3.5.2. **AOI 1**

This set of register enables AOI #1 and sets the appropriate window size and offset in horizontal and vertical direction.

AOI 1 Enable

Address : 0x020C

Data (1:0) : 00 - AOI 1 disable

01 – AOI 1 include 10 – AOI 1 exclude

11 - N/A

Data (31:2) : N/A

AOI 1 Horizontal Offset

Address : 0x024C

 Imperx, Inc.
 Rev. 1.5

 6421 Congress Ave.
 9/26/2017



Data (11:0) : <value> AOI 1 offset in horizontal direction

Data (31:12) : N/A

AOI 1 Horizontal Width

Address : 0x022C

Data (11:0) : <value> AOI 1 width in horizontal direction

Data (31:12) : N/A

AOI 1 Vertical Offset

Address : 0x028C

Data (11:0) : <value> AOI 1 offset in vertical direction

Data (31:12) : N/A

AOI 1 Vertical Height

Address : 0x026C

Data (11:0) : <value> AOI 1 height in vertical direction

Data (31:12) : N/A

4.3.5.3. **AOI 2**

This set of register enables AOI #2 and sets the appropriate window size and offset in horizontal and vertical direction.

AOI 2 Enable

Address : 0x0210

Data (1:0) : 00 - AOI 2 disable

01 – AOI 2 include 10 – AOI 2 exclude

11 - N/A

Data (31:1) : N/A

AOI 2 Horizontal Offset

Address : 0x0250

Data (11:0) : <value> AOI 2 offset in horizontal direction

Data (31:12) : N/A

AOI 2 Horizontal Width

Address: 0x0230

Data (11:0) : <value> AOI 2 width in horizontal direction

Data (31:12) : N/A

AOI 2 Vertical Offset

Address : 0x0290

 Imperx, Inc.
 Rev. 1.5

 6421 Congress Ave.
 9/26/2017



Data (11:0) : <value> AOI 2 offset in vertical direction

Data (31:12) : N/A

AOI 2 Vertical Height

Address : 0x0270

Data (11:0) : <value> AOI 2 height in vertical direction

Data (31:12) : N/A

4.3.5.4. **AOI 3**

This set of register enables AOI #3 and sets the appropriate window size and offset in horizontal and vertical direction.

AOI 3 Enable

Address : 0x0214

Data (1:0) : 00 - AOI 3 disable

01 – AOI 3 include 10 – AOI 3 exclude

11 - N/A

Data (31:2) : N/A

AOI 3 Horizontal Offset

Address : 0x0254

Data (11:0) : <value> AOI 3 offset in horizontal direction

Data (31:12) : N/A

AOI 3 Horizontal Width

Address : 0x0234

Data (11:0) : <value> AOI 3 width in horizontal direction

Data (31:12) : N/A

AOI 3 Vertical Offset

Address : 0x0294

Data (11:0) : <value> AOI 3 offset in vertical direction

Data (31:12) : N/A

AOI 3 Vertical Height

Address : 0x0274

Data (11:0) : <value> AOI 3 height in vertical direction

Data (31:12) : N/A

4.3.5.5. **AOI 4**

 Imperx, Inc.
 Rev. 1.5

 6421 Congress Ave.
 9/26/2017



This set of register enables AOI #4 and sets the appropriate window size and offset in horizontal and vertical direction.

AOI 4 Enable

Address : 0x0218

Data (1:0) : 00 - AOI 4 disable

01 – AOI 4 include 10 – AOI 4 exclude

11 - N/A

Data (31:2) : N/A

AOI 4 Horizontal Offset

Address : 0x0258

Data (11:0) : <value> AOI 4 offset in horizontal direction

Data (31:12) : N/A

AOI 4 Horizontal Width

Address : 0x0238

Data (31:12) : N/A

AOI 4 Vertical Offset

Address : 0x0298

Data (11:0) : <value> AOI 4 offset in vertical direction

Data (31:12) : N/A

AOI 4 Vertical Height

Address : 0x0278

Data (11:0) : <value> AOI 4 height in vertical direction

Data (31:12) : N/A

4.3.5.6. **AOI 5**

This set of register enables AOI #5 and sets the appropriate window size and offset in horizontal and vertical direction.

AOI 5 Enable

Address : 0x021C

Data (1:0) : 00 - AOI 5 disable

01 – AOI 5 include 10 – AOI 5 exclude

11 - N/A

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



Data (31:2) : N/A

AOI 5 Horizontal Offset

Address : 0x025C

Data (11:0) : <value> AOI 5 offset in horizontal direction

Data (31:12) : N/A

AOI 5 Horizontal Width

Address : 0x023C

Data (11:0) : <value> AOI 5 width in horizontal direction

Data (31:12) : N/A

AOI 5 Vertical Offset

Address : 0x029C

Data (11:0) : <value> AOI 5 offset in vertical direction

Data (31:12) : N/A

AOI 5 Vertical Height

Address : 0x027C

Data (11:0) : <value> AOI 5 height in vertical direction

Data (31:12) : N/A

4.3.5.7. **AOI 6**

This set of register enables AOI #6 and sets the appropriate window size and offset in horizontal and vertical direction.

AOI 6 Enable

Address : 0x0220

Data (1:0) : 00 - AOI 6 disable

01 – AOI 6 include 10 – AOI 6 exclude

11 - N/A

Data (31:2) : N/A

AOI 6 Horizontal Offset

Address : 0x0260

Data (11:0) : <value> AOI 6 offset in horizontal direction

Data (31:12) : N/A

AOI 6 Horizontal Width

Address : 0x0240

Data (11:0) : <value> AOI 6 width in horizontal direction

 Imperx, Inc.
 Rev. 1.5

 6421 Congress Ave.
 9/26/2017

Boca Raton, FL 33487

+1 (561) 989-0006 87 of 175





Data (31:12) : N/A

AOI 6 Vertical Offset

Address : 0x02A0

Data (11:0) : <value> AOI 6 offset in vertical direction

Data (31:12) : N/A

AOI 6 Vertical Height

Address : 0x0280

Data (11:0) : <value> AOI 6 height in vertical direction

Data (31:12) : N/A

4.3.6. Exposure Control Workspace Registers

4.3.6.1. **Exposure Control Mode**

This register sets the exposure control mode and for the camera.

Address : 0x0544

Data (1:0) : 00 - off - no exposure control

10 – internal – exposure control register 0x0548

sets the camera exposure

Others - reserved

Data (31:2) : N/A

4.3.6.2. **Exposure Time Absolute**

This register sets the actual camera exposure time when "Internal" exposure mode is selected.

Address : 0x0548

Data (23:0) : <value> – actual exposure time in micro seconds.

Data (31:24) : N/A

4.3.6.3. **Programmable Frame Time (Long Integration) Enable**

This register enables a programmable frame time mode. The user can extend the camera frame time beyond the camera free-running frame time up to ~ 16 seconds. This is also known as long integration.

Address : 0x0550

Data (0) : 0 – disable programmable frame time.

1 – enable programmable frame time

Data (31:1) : N/A

4.3.6.4. Programmable Frame Time (Long Integration) Absolute

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017





This register sets the actual frame time in microseconds.

Address : 0x0558

Data (23:0) : <value> – actual frame time in micro seconds.

Data (31:24) : N/A

4.3.7. AEC, AGC, AIC Workspace Registers

4.3.7.1. **Auto Exposure Control (AEC)**

This register enables the auto exposure control.

Address : 0x0150

Data (0) : 0 – disable auto exposure control

1 – enable auto exposure control

Data (31:1) : N/A

4.3.7.2. **Maximum Exposure Time Limit**

This register sets the maximum exposure time limit during AEC. The automatic exposure control process will keep the camera exposure always below the set level. This is to prevent motion smear. The Minimum Exposure Time Limit is factory preset.

Address : 0x05B0

Data (23:0) : <value> – maximum exposure time limit

Data (31:24) : N/A

4.3.7.3. **Minimum Exposure Time Limit**

This register sets the minimum exposure time limit during AEC. The automatic exposure control process will keep the camera exposure always below the set level.

Address : 0x05C8

Data (23:0) : <value> – minimum exposure time limit

Data (31:24) : N/A

4.3.7.4. Exposure Correction Speed

This register sets the exposure correction speed during AEC. The automatic exposure control process can set the algorithm convergence speed, i.e. how long it takes to reach the desired exposure.

Address : 0x0174

Data (1:0) : 00 - 1x speed - slow

01 - 2x speed 10 - 3x speed

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017





11 - 4x speed – fast

Data (31:2) : N/A

4.3.7.5. **Auto Gain Control (AGC)**

This register enables the auto gain control.

Address : 0x0154

Data (0) : 0 – disable auto gain control

1 – enable auto gain control

Data (31:1) : N/A

4.3.7.6. **Maximum Gain Limit**

This register sets the maximum analog gain limit during AGC. The automatic gain control process will keep the camera analog gain always below the set level.

Address : 0x0160

Data (9:0) : <value> – maximum analog gain limit

Data (31:10) : N/A

4.3.7.7. **Minimum Gain Limit**

This register sets the minimum analog gain limit during AGC. The automatic gain control process will keep the camera analog gain always below the set level.

Address : 0x018C

Data (9:0) : <value> – minimum analog gain limit

Data (31:10) : N/A

4.3.7.8. **Gain Correction Speed**

This register sets the gain correction speed during AGC. The automatic gain control process can set the algorithm convergence speed, i.e. how long it takes to reach the desired gain.

Address : 0x0178

Data (1:0) : 00 - 1x speed - slow

01 - 2x speed 10 - 3x speed

11 - 4x speed – fast

Data (31:2) : N/A

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



4.3.7.9. Luminance Level Threshold

This register sets the desired luminance level to be maintained during AEC or AGC process.

Address : 0x0158

Data (11:0) : <value> – desired luminance level

Data (31:12) : N/A

4.3.7.10. Luminance Type Selection

This register sets the luminance mode to be used during AEC or AGC process. The correction algorithm can use the average luminance for the entire frame or the peak luminance in the frame.

Address : 0x017C

Data (1:0) : 00 - average luminance

01 – peak luminance

10 or 11 – reserved

Data (31:2) : N/A

4.3.7.11. Region of Interest Selection (AOI)

This set of register sets the region of interest to be used during AEC or AGC process. The correction algorithm can use as a sampling (data collection) region the entire frame or only a portion (AOI) of it.

AOI Horizontal Offset

Address : 0x0168

Data (11:0) : <value> AOI offset in horizontal direction

Data (31:12) : N/A

AOI Horizontal Width

Address : 0x0164

Data (11:0) : <value> AOI width in horizontal direction

Data (31:12) : N/A

AOI Vertical Offset

Address : 0x0170

Data (11:0) : <value> AOI offset in vertical direction

Data (31:12) : N/A

AOI Vertical Height

Address : 0x016C

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



Data (11:0) : <value> AOI height in vertical direction

Data (31:12) : N/A

4.3.7.12. Auto Iris Control (AIC)

This register enables the auto iris control.

Address : 0x014C

Data (0) : 0 - disable auto iris control

1 – enable auto iris control

Data (31:1) : N/A

Gain and Offset Workspace Registers

4.3.8. Video Amp, Gain and Offset Workspace Registers

4.3.8.1. **Pre-amplifier Gain – Channel 1**

This register sets the pre-amplifier analog gain for channel 1.

Address : 0x0000

Data (1:0) : 00 - -3.0 dB pre-amplifier gain channel 1

01 - 0.0 dB pre-amplifier gain channel 1

10 – +3.0 dB pre-amplifier gain channel 1

11 – +6.0 dB pre-amplifier gain channel 1

Data (31:2) : N/A

4.3.8.2. **Analog Gain – Channel 1**

This register sets the main analog gain for channel 1.

Address : 0x0004

Data (9:0) : <value> – analog gain channel 1

Data (31:10) : N/A

4.3.8.3. **Analog Offset – Channel 1**

This register sets the analog offset for channel 1.

Address : 0x0008

Data (9:0) : <value> - analog offset channel 1

Data (31:10) : N/A

4.3.8.4. **Pre-amplifier Gain – Channel 2**

This register sets the pre-amplifier analog gain for channel 2.

Address : 0x0010

Data (1:0) : 00 - 3.0 dB pre-amplifier gain channel 2

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



01 - 0.0 dB pre-amplifier gain channel 2 10 - +3.0 dB pre-amplifier gain channel 2

11 – +6.0 dB pre-amplifier gain channel 2

Data (31:2) : N/A

4.3.8.5. **Analog Gain – Channel 2**

This register sets the main analog gain for channel 2.

Address : 0x0014

Data (9:0) : <value> – analog gain channel 2

Data (31:10) : N/A

4.3.8.6. **Analog Offset – Channel 2**

This register sets the analog offset for channel 2.

Address : 0x0018

Data (9:0) : <value> – analog offset channel 2

Data (31:10) : N/A

4.3.8.7. Digital Gain

This register sets the main digital gain. The digital gain is applied to both channels. The step is 0.1x

Address : 0x0180

Data (4:0) : <value> - digital gain

Data (31:5) : N/A

4.3.8.8. **Digital Offset**

This register sets the main digital offset. The digital offset is applied to both cannels.

Address : 0x0184

Data (9:0) : <value> – digital offset

Data (31:10) : N/A

4.3.8.9. Black Level Correction

This register enables the black level correction.

Address : 0x0114

Data (0) : 0 – disable black level correction

1 – enable black level correction

Data (31:2) : N/A

4.3.8.10. **Tap Balance**

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



This register enables the tap balance. If the "Tap balance once" is to be used, the register has to be set every time from "00" to "10".

Address : 0x0110

Data (1:0) : 00 - no tap balance

01 – dynamic automatic tap balance

10 – dynamic balance taps once

11 – static automatic tap balance

Data (31:2) : N/A

4.3.9. Pulse Generator Workspace Registers

4.3.9.1. **Pulse Generator Timing Granularity**

This register sets the pulse generator main timing resolution. The main resolution is in microseconds, and 4 granularity steps are possible -x1, x10, x100, x1000 (x1000 is equal to 1ms timing resolution).

Address : 0x0530

Data (1:0) : 00 - x1

01 - x1010 - x100

11 - x1000

Data (31:2) : N/A

4.3.9.2. Pulse Generator Pulse Width

This register sets the value of the pulse width in microseconds.

Address : 0x0534

Data (18:0) : <value> – pulse width in microseconds

Data (31:19) : N/A

4.3.9.3. Pulse Generator Pulse Period

This register sets the value of the pulse period in microseconds.

Address : 0x0538

Data (19:0) : <value> – pulse width in microseconds

Data (31:20) : N/A

4.3.9.4. Pulse Generator Number of Pulses

This register sets the number of the pulses generated.

Address : 0x053C

Data (15:0) : <value> – number of discrete pulses

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



Data (16) : 1 – continuous pulse generation

Data (31:17) : N/A

4.3.9.5. **Pulse Generator Enable**

This register enables the pulse generator.

Address : 0x0540

Data (0) : 0 – disable pulse generator operation

1 – enable pulse generator operation

Data (31:1) : N/A

4.3.1 Test Pattern Workspace Registers

4.3.1.1 Test Mode Select

This register selects the test mode pattern.

Address : 0x012C

Data (3:0) : 0x0 - no test pattern

0x1 - black image - 0x000 0x2 - gray image - 0x1FF 0x3 - white image - 0xFFF

0.4 white image – 0xFFF

0x4 – steady horizontal image ramp 0x5 – steady vertical image ramp

0x6 – moving horizontal image ramp

0x7 – moving vertical image ramp

0x8 - 8 gray scale vertical bars

0x9 – H & V lines superimposed over live image

0xA to 0xF - reserved

Data (31:4) : N/A

4.3.9.6. **H & V Lines Superimpose Enable**

This register enables the H & V lines superimposed over live image.

Address : 0x0130

Data (0) : 0 – disable lines superimposed

1 – enable lines superimposed

Data (31:1) : N/A

4.3.9.7. **H1 Superimposed Line Position**

This register set the position of the horizontal line H1 (top) position.

 Imperx, Inc.
 Rev. 1.5

 6421 Congress Ave.
 9/26/2017



Address : 0x0138

Data (11:0) : <value> – H1 line position

Data (31:12) : N/A

4.3.9.8. **H2 Superimposed Line Position**

This register set the position of the horizontal line H2 (bottom) position.

Address : 0x013C

Data (11:0) : <value> – H2 line position

Data (31:12) : N/A

4.3.9.9. V1 Superimposed Column Position

This register set the position of the vertical column V1 (left) position.

Address : 0x0140

Data (11:0) : <value> - V1 column position

Data (31:12) : N/A

4.3.9.10. **V2 Superimposed Column Position**

This register set the position of the vertical column V2 (right) position.

Address : 0x0144

Data (11:0) : <value> – V2 column position

Data (31:12) : N/A

4.3.9.11. Superimposed Lines Brightness

This register set the brightness of the superimposed cross and H & V lines.

Address : 0x0148

Data (11:0) : <value> – line brightness

Data (31:12) : N/A

4.3.9.12. Center Cross Superimpose Enable

This register enables center cross, superimposed over live image. This shows the optical image center.

Address : 0x0134

Data (0) : 0 – disable cross superimposed

1 – enable cross superimposed

Data (31:1) : N/A

4.3.9.13. **Overlay Mode**

This register selects the overlay mode pattern.

Address : 0x0610

 Imperx, Inc.
 Rev. 1.5

 6421 Congress Ave.
 9/26/2017



Data (0) : 0 – disable Y histogram

1 – enable Y histogram

Data (1) : 0 – disable RGB histogram

1 – enable RGB histogram

Data (2) : 0 - disable Frame number

1 – enable Frame number

Data (3) : 0 – disable Field mark

1 – enable Field mark

Data (4) : 0 - disable SMPTE test pattern

1 – enable SMPTE test pattern

Data (31:5) : N/A

4.3.10. Input/output Workspace Registers

4.3.10.1. **OUT1 Output Polarity**

This register sets the polarity (active Low or High) for the OUT1 output.

Address : 0x0590

Data (0) : 0 - active LOW

1 – active HIGH

Data (31:1) : N/A

4.3.10.2. **OUT1 Output Mapping**

This register maps the various internal signals to OUT1 camera output.

Address : 0x0594

Data (3:0) : 0000 – Deselect

0001 – Exposure Start 0010 – Exposure End 0011 – Mid Exposure

0100 – Active Exposure Window

0101 – H-Sync 0110 – V-Sync

0111 – Odd/Even Frame Flag

1010 – Camera Ready1011 – Pulse Generator1100 – Strobe One

1101 – Strobe Two

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



1110 – Software (Bit Toggle)

Others - reserved

Data (31:4) : N/A

4.3.10.3. **OUT2 Output Polarity**

This register sets the polarity (active Low or High) for the OUT2 output.

Address : 0x0598

Data (0) : 0 - active LOW

1 – active HIGH

Data (31:1) : N/A

4.3.10.4. **OUT2 Output Mapping**

This register maps the various internal signals to OUT2 camera output.

Address : 0x059C

Data (3:0) : 0000 – Deselect

0001 – Exposure Start 0010 – Exposure End 0011 – Mid Exposure

0100 – Active Exposure Window

0101 – H-Sync 0110 – V-Sync

0111 – Odd/Even Frame Flag

1010 – Camera Ready1011 – Pulse Generator1100 – Strobe One

1101 – Strobe Two

1110 – Software (Bit Toggle)

Others - reserved

Data (31:4) : N/A

4.3.10.5. **Strobe #1 Select**

This register sets the Strobe #1 mode of operation.

Address : 0x055C

Data (1:0) : 00 – disable Strobe #1

01 – enable Strobe #1 each frame

10 – enable Strobe #1 odd frames only

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



11 – enable Strobe #1 even frames only

Data (31:2) : N/A

4.3.10.6. **Strobe #1 Position**

This register sets the position of the strobe #1 pulse with respect of the end of the frame.

Address : 0x0568

Data (23:0) : <value> – strobe #1 pulse positions in

microseconds

Data (31:24) : N/A

4.3.10.7. **Strobe #2 Select**

This register sets the Strobe #2 mode of operation.

Address : 0x0560

Data (1:0) : 00 – disable Strobe #2

01 – enable Strobe #2 each frame

10 – enable Strobe #2 odd frames only

11 – enable Strobe #2 even frames only

Data (31:2) : N/A

4.3.10.8. **Strobe #2 Position**

This register sets the position of the strobe #2 pulse with respect of the end of the frame.

Address : 0x056C

Data (23:0) : <value> – strobe #2 pulse positions in

microseconds

Data (31:24) : N/A

4.3.10.9. **Strobe #1 Duration**

This register sets the duration of the strobe pulse (the same for both strobes).

Address : 0x0564

Data (23:0) : <value> – strobe pulse duration in microseconds

Data (31:24) : N/A

4.3.10.10. **Strobe #2 Duration**

This register sets the duration of the strobe pulse (the same for both strobes).

Address : 0x05B4

 Imperx, Inc.
 Rev. 1.5

 6421 Congress Ave.
 9/26/2017



Data (23:0) : <value> – strobe pulse duration in microseconds

Data (31:24) : N/A

4.3.11. Output Data Format

4.3.11.1. Negative Image Enable

This register inverts the image from positive to negative.

Address : 0x0188

Data (0) : 0 - positive image

1 – negative image

Data (31:1) : N/A

4.3.11.2. Over/Under Shoot register

This register inverts the image from positive to negative.

Address : 0x01A8

Data (0) : 0 - disable: Output data range 64 - 940 for Luma

(Y) and 64 - 960 for Chroma (Cr and Cb)

1 – enable: Output data range 4 – 1019 for both

Luma and Chroma

Data (31:1) : N/A

4.3.11.3. **SDI output format**

This register selects SDI output format. The 1080 line format is available in the SDI-B1920, B1921, B1922, and B1923. The 720 line format is available only in the SDI-B1320.

Address : 0x060C

Data (3:0) : 0x0 - 1080p@23.98

0x1 - 1080p@24 0x2 - 1080p@25 0x3 - 1080p@29.97 0x4 - 1080p@30

0x4 - 1000p@50 0x5 - 1080i@500x6 - 1080i@59.94

0x7 - 1080i@60

0x8 - 720p@50

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



0x9 - 720p@59.940xA - 720p@60

others - reserved

Data (31:4) : N/A

4.3.11.4. Tri-Level sync mode

This register selects Tri-Level sync mode.

Address : 0x0614

Data (0) : 0x0 - disable

0x1 - genlock

Data (31:1) : N/A

4.3.11.5. Tri-Level sync shift

This register selects Tri-Level Vsync shift in pixel

Address : 0x015C Data (8:0) : <value>

Data (9) : direction 0 - right, 1 - left

Data (31:1) : N/A

4.3.12. White Balance Workspace Registers

4.3.12.1. **WB Select**

This register selects which white balance mode will be used – Off, Once, Auto, Manual, Indoor 3200K, and Outdoor 5600K.

Address : 0x0300 Data (2:0) : 000 – Off

> 001 – WB Once 010 – WB Auto 011 – WB Manual 100 – Indoor 3200K 101 – Outdoor 5600K

110, 111 - N/A

Data (31:3) : N/A

4.3.12.2. Auto WB Tracking Speed

 Imperx, Inc.
 Rev. 1.5

 6421 Congress Ave.
 9/26/2017





This register selects which auto white balance tracking speed will be used -1x, 2x, 3x, 4x, and 5x.

Address: 0x0340

Data (2:0) : 000 - 1x; slowest

001 - 2x010 - 3x011 - 4x

100 - 5x; fastest (no tracking)

101 – Outdoor 5600K

101, 110, 111 - N/A

Data (31:3) : N/A

4.3.12.3. **WBC Red**

This register contains the white balance correction coefficients for Red. In manual mode, the user enters the value, in Once or Auto, the camera returns the actual (calculated) coefficient.

Address : 0x0304

Data (11:0) : <value>; 000hex ... FFFhex; 1 step 1/256; range

 $0.000 \dots + 15.996$

Data (31:11) : N/A

4.3.12.4. **WBC Green**

This register contains the white balance correction coefficients for Green. In manual mode, the user enters the value, in Once or Auto, the camera returns the actual (calculated) coefficient.

Address : 0x0308

Data (10:10) : <value>; 000hex ... FFFhex; 1 step 1/256; range

 $0.000 \dots + 15.996$

Data (31:11) : N/A

4.3.12.5. **WBC Blue**

This register contains the white balance correction coefficients for Blue. In manual mode, the user enters the value, in Once or Auto, the camera returns the actual (calculated) coefficient.

Address : 0x030C

Data (0:11) : <value>; 000hex ... FFFhex; 1 step 1/256; range

: 0.000 ... + 15.996

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



Data (31:12) : N/A

4.3.13. Color Correction Workspace Registers

4.3.13.1. Color Matrix Coefficients Crr

This register sets the digital gain for Crr.

Address : 0x0310

Data (0:01) : <value>; 000h....7FFh; 1 step 1/256; range

-4.000...+3.996

Data (31:12) : N/A

Color matrix coefficient Cgr

This register sets the digital gain for Cgr.

Address : 0x0314

Data (0:11) : <value>; 000h....7FFh; 1 step 1/256; range

-4.000...+3.996

Data (31:12) : N/A

Color matrix coefficient Cbr

This register sets the digital gain for Cbr.

Address : 0x0318

Data (0:11) : <value>; 000h....7FFh; 1 step 1/256; range

-4.000...+3.996

Data (31:12) : N/A

Color matrix coefficient Crg

This register sets the digital gain for Crg.

Address : 0x0328

Data (0:11) : <value>; 000h....7FFh; 1 step 1/256; range

 $= -4.000 \dots + 3.996$

Data (31:12) : N/A

Color matrix coefficient Cgg

This register sets the digital gain for Cgg.

Address : 0x032C

Data (0:11) : <value>; 000h....7FFh; 1 step 1/256; range

 $= -4.000 \dots + 3.996$

Data (31:12) : N/A

 Imperx, Inc.
 Rev. 1.5

 6421 Congress Ave.
 9/26/2017



Color matrix coefficient Cbg

This register sets the digital gain for Cbg.

Address : 0x0330

Data (0:11) : <value>; 000h....7FFh; 1 step 1/256; range

 $-4.000 \dots + 3.996$

Data (31:12) : N/A

Color matrix coefficient Crb

This register sets the digital gain for Crb.

Address : 0x0334

Data (0:11) : <value>; 000h....7FFh; 1 step 1/256; range

 $= -4.000 \dots + 3.996$

Data (31:12) : N/A

Color matrix coefficient Cgb

This register sets the digital gain for Cgb.

Address : 0x0338

Data (0:11) : <value>; 000h....7FFh; 1 step 1/256; range

: $-4.000 \dots + 3.996$

Data (31:12) : N/A

Color matrix coefficient Cbb

This register sets the digital gain for Cbb.

Address : 0x033C

Data (0:11) : <value>; 000h....7FFh; 1 step 1/256; range

: $-4.000 \dots + 3.996$

Data (31:12) : N/A

4.3.13.2. **Offset Red**

This register sets the digital offset for Red.

Address : 0x031C

Data (10:0) : <value>; 000h....7FFh; - 1024 ... + 1023

Data (31:11) : N/A

4.3.13.3. **Offset Green**

This register sets the digital offset for Green.

Address : 0x0320

Data (10:0) : <value>; 000h....7FFh; - 1024 ... + 1023

 Imperx, Inc.
 Rev. 1.5

 6421 Congress Ave.
 9/26/2017



Data (31:11) : N/A

4.3.13.4. **Offset Blue**

This register sets the digital offset for Blue.

Address : 0x0324

Data (10:0) : <value>; 000h....7FFh; -1024 ... + 1023

Data (31:11) : N/A

4.3.14. Data Correction Workspace Registers

4.3.14.1. User LUT Select

This register selects which User LUT will be used.

Address : 0x0118

Data (2:0) : 000 - User LUT disabled

001 – User LUT #1 selected 010 – User LUT # 2 selected 011 – User LUT #3 selected 100 – User LUT #4 selected

 $101 \dots 111 - N/A$

Data (31:1) : N/A

4.3.14.2. Gamma LUT Select

This register selects which Gamma LUT will be used.

Address : 0x011C

Data (2:0) : 000 - Gamma Y = 1.3

001 – Gamma Y = 1.6 010 – Gamma Y = 1.9 100 – Gamma Y = 2.2 101 – Gamma Y = 1/1.3 110 – Gamma Y = 1/1.6 111 – Gamma Y = 1/2.2

Data (31:3) : N/A

4.3.14.3. Black Gamma LUT Select

This register selects which Gamma LUT will be used.

Address : 0x01AC

Data (2:0) : 000 - Gamma Y = 1.3

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



 $001 - Gamma \ Y = 1.6$

010 - Gamma Y = 1.9

100 - Gamma Y = 2.2

101 - Gamma Y = 1/1.3

110 - Gamma Y = 1/1.6

111 - Gamma Y = 1/2.2

Data (31:3) : N/A

4.3.14.4. Black Gamma LUT % Select

This register selects which Gamma LUT will be used.

Address : 0x019C

Data (1:0) : 00 – 10%

01 - 20%

10 - 30%

11 - N/A

Data (31:2) : N/A

4.3.14.5. **DPC Enable**

This register enables the DPC (Defective Pixel Correction).

Address : 0x0120

Data (1:0) : 00 - DPC disable

01 – Static DPC enable

10 – Dynamic DPC enable

11 – Static and Dynamic DPC enable

Data (31:2) : N/A

4.3.14.6. **HPC Enable**

This register enables the HPC (Hot Pixel Correction).

Address : 0x0124

Data (1:0) : 00 - HPC disable

01 – Static HPC enable

10 – Dynamic HPC enable

11 – Static and Dynamic HPC enable

Data (31:2) : N/A

4.3.14.7. **FFC Enable**

This register enables the FFC (Flat Field Correction).

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017





Address : 0x0128

Data (0) : 0 - FFC disable

1 – FFC enable

Data (31:1) : N/A

4.4. DATA PROCESSING REGISTER DESCRIPTION

4.4.1. Image Enhancement Workspace Registers

4.4.1.1. Enhancement Mode Selector

This register selects the image enhancement mode of operation.

Address : 0x0400

Data (3:0) : 0x0 – enhancement disable

0x1 – single threshold binary 0x2 – dual threshold binary

0x3 – dual threshold with gray scale

0x4 – dual threshold with contrast enhancement

0x5 – single point correction 0x6 – multi point correction

Data (31:4) : N/A

4.4.1.2. **Point X1 Position**

This register selects the position value for point X1.

Address : 0x0404

Data (11:0) : <value> – point X1 position value

Data (31:12) : N/A

4.4.1.3. Point X2 Position

This register selects the position value for point X2.

Address : 0x0408

Data (11:0) : <value> – point X2 position value

Data (31:12) : N/A

4.4.1.4. **Point Y1 Position**

This register selects the position value for point Y1.

Address : 0x040C

Data (11:0) : <value> – point Y1 position value

Data (31:12) : N/A

 Imperx, Inc.
 Rev. 1.5

 6421 Congress Ave.
 9/26/2017





4.4.1.5. Point Y2 Position

This register selects the position value for point Y2.

Address : 0x0410

Data (11:0) : <value> – point Y2 position value

Data (31:12) : N/A

4.4.1.6. **Processing and LUT AOI (PAOI)**

This set of register enables the processing and/or LUT AOI and sets the appropriate window size and offset in horizontal and vertical direction. The processing algorithm or LUT will be implemented ONLY within the selected AOI.

PAOI Enable

Address : 0x0224

Data (1:0) : 00 - PAOI disable

01 – Reserved

10 – PAOI enabled as processing AOI

11 – PAOI enabled as LUT AOI

Data (31:2) : N/A

PAOI Horizontal Offset

Address : 0x0264

Data (11:0) : <value> PAOI offset in horizontal direction

Data (31:12) : N/A

PAOI Horizontal Width

Address : 0x0244

Data (11:0) : <value> PAOI width in horizontal direction

Data (31:12) : N/A

PAOI Vertical Offset

Address : 0x02A4

Data (11:0) : <value> PAOI offset in vertical direction

Data (31:12) : N/A

PAOI Vertical Height

Address : 0x0284

Data (11:0) : <value> PAOI height in vertical direction

Data (31:12) : N/A



4.4.2. Convolution register

This set of registers enables the convolution and sets the digital gain for Cxy coefficients.

Convolution Enable

Address : 0x0430

Data (0) : 0 - Disable

1 - Enable

Data (31:1) : N/A

C00 coefficient

Address : 0x0434

Data (11:0) : <value>; 000h...FFFh; 1 step 1/64; range

-32 ... + 31.984

Data (31:12) : N/A

C01 coefficient

Address: 0x0438

Data (11:0) : <value>; 000h...FFFh; 1 step 1/64; range

 $-32 \dots + 31.984$

Data (31:12) : N/A

C02 coefficient

Address : 0x043C

Data (11:0) : <value>; 000h...FFFh; 1 step 1/64; range

-32 ... + 31.984

Data (31:12) : N/A

C10 coefficient

Address : 0x0440

Data (11:0) : <value>; 000h....FFFh; 1 step 1/64; range

 $-32 \dots + 31.984$

Data (31:12) : N/A

C11 coefficient

Address : 0x0444

Data (11:0) : <value>; 000h...FFFh; 1 step 1/64; range

 $-32 \dots + 31.984$

Data (31:12) : N/A

 Imperx, Inc.
 Rev. 1.5

 6421 Congress Ave.
 9/26/2017

Boca Raton, FL 33487



BOBCAT HD-SDI Hardware User's Manual

C12 coefficient

Address : 0x0448

Data (11:0) : <value>; 000h...FFFh; 1 step 1/64; range

-32 ... + 31.984

Data (31:12) : N/A

C20 coefficient

Address : 0x044C

Data (11:0) : <value>; 000h...FFFh; 1 step 1/64; range

-32 ... + 31.984

Data (31:12) : N/A

C21 coefficient

Address : 0x0450

Data (11:0) : <value>; 000h...FFFh; 1 step 1/64; range

-32 ... + 31.984

Data (31:12) : N/A

C22 coefficient

Address : 0x0454

Data (11:0) : <value>; 000h...FFFh; 1 step 1/64; range

 $-32 \dots + 31.984$

Data (31:12) : N/A

Convolution offset

Address: 0x0458

Data (10:0) : <value>; 000h....7FFh; range – 1024 ... +1024

Data (31:11) : N/A



4.5. LENS CONTROLLER REGISTER DESCRIPTION

4.5.1. Lens Controller Workspace Registers

4.5.1.1. Pulse Width

This register sets the lens controller motor pulse width.

Address : 0x042C

Data (3:0) : 0x0 - 1 ms

: 0x1 - 2 ms: 0x2 - 4 ms: 0x3 - 8 ms

. NT/A

Data (31:8) : N/A

4.5.1.2. **Voltage**

This register sets the lens controller control voltage.

Address : 0x042C

Data (7:4) : 0x0 - 6 volts

: 0x1 - 12 volts

Data (31:8) : N/A

4.5.1.3. **Zoom Travel Distance**

This register sets the number of motor control pulses to control zoom travel distance.

Address : 0x0424

Data (11:0) : 0x001 – min travel distance (GUI slider, Wide)

: 0xFFF – max travel distance (GUI slider, Narrow)

Data (23:16) : 0x01 - Zoom Wide (slider/window #), (GUI, <)

0x02 - Zoom Narrow (slider/window #), (GUI, >)
 0x04 - Zoom Wide (full, 0xFFF pulses), (GUI, <<)

: 0x08 – Zoom Narrow (full, 0xFFF pulses),(GUI,>>)

: 0x10 - Zoom Stop

Data (15:12) : N/A Data (31:24) : N/A

4.5.1.4. **Zoom Speed**

This register sets the distance between pulses to control zoom speed.

Address : 0x0428

Data (7:0) : 0x01 - minimum speed (GUI, SPD)

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017

Boca Raton, FL 33487



BOBCAT HD-SDI Hardware User's Manual

0xFF - maximum speed (GUI, SPD)

Data (31:8) : N/A

4.5.1.5. Focus Travel Distance

This register sets the number of motor control pulses to control focus travel distance.

Address : 0x041C

Data (11:0) : 0x001 – min travel distance (GUI,Near)

: 0xFFF – max travel distance (GUI,Far)

Data (23:16) : 0x01 - Focus Near (slider/window #), (GUI, <)

: 0x02 - Focus Far (slider/window #), (GUI, >)

: 0x04 - Focus Near (full, 0xFFF pulses), (GUI, <<)

: 0x08 – Focus Far (full, 0xFFF pulses), (GUI, >>)

: 0x10 - Focus Stop

Data (15:12) : N/A Data (31:24) : N/A

4.5.1.6. Focus Speed

This register sets the distance between pulses to control focus speed.

Address : 0x0420

Data (7:0) : 0x01 – minimum speed (GUI, SPD)

: 0xFF - maximum speed (GUI, SPD)

Data (31:8) : N/A

4.5.1.7. Iris Travel Distance

This register sets the number of motor control pulses to control iris travel distance.

Address : 0x0414

Data (11:0) : 0x001 – min travel distance (GUI slider, Close)

: 0xFFF – max travel distance (GUI slider, Open)

Data (23:16) : 0x01 - Iris Close (slider/window #), (GUI, <)

0x02 - Iris Open (slider/window #), (GUI, >)
 0x04 - Iris Close (full, 0xFFF pulses), (GUI, <<)

: 0x08 - Iris Open (full, 0xFFF pulses), (GUI, >>)

: 0x10 - Iris Stop

Data (15:12) : N/A Data (31:24) : N/A

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017

Boca Raton, FL 33487





4.5.1.8. **Iris Speed**

This register sets the distance between pulses to control iris speed.

Address : 0x0418

Data (7:0) : 0x01 – minimum speed (GUI, SPD)

0xFF – maximum speed (GUI, SPD)

Data (31:8) : N/A





BOBCAT Configurator

This chapter provides a quick reference to using the BOBCAT HD-SDI Configurator camera configuration utility for BOBCAT HD-SDI series cameras.



5.1. **OVERVIEW**

Camera configuration utility software and Bobcat Camera Configurator (CamConfig) are provided with each camera. After installing the program, the user can program the camera, change its settings and save the settings in a file or in the camera. The configuration utility includes an interactive help file, which will guide you through the camera setup.

5.2. **DISCOVERY PROCEDURE**

Often times, multiple frame grabbers and cameras may be installed into a computer at the same time. The CamConfig utility provides an intelligent, automated method of 'discovering' and 'searching' all available UART components in your PC and allowing the user to select the one that is connected to the Bobcat HD-SDI camera. The Bobcat search engine will search for any available COM port installed on the PC as well. It will then communicate with each COM port and attempt to query the attached camera. If it finds an attached Imperx Bobcat camera, it will read the 'camera type' information from the camera. Bobcat camera name will be displayed in the list box which includes all ports and cameras that it discovered. The user can then select the camera of interest by highlighting the entry and clicking on the 'OK' button. Clicking on the 'Rescan Ports' button causes the above discovery procedure to be repeated. Please note the frame grabber has to be HD-SDI Express version compliant. Figure 5.1 illustrates the CamConfig select port window.

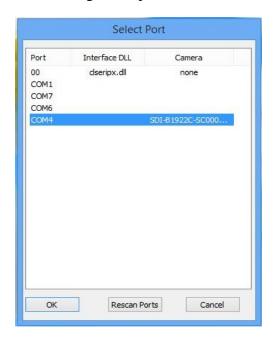


Figure 5.1– Discovery procedure – select port.



5.3. GRAPHICAL USER INTERFACE

After having selected the desired camera, the Bobcat CamConfig Graphical User Interface (GUI) main window will appear – illustrated in Figure 5.2. The GUI Interface is very intuitive and self-explanatory. The basic features are:

- **1.** Compact Design small 140x400 (pixels) saves space when user displays image and control at the same time.
- **2. Real Time Data** updates camera information in real time while camera is working. Gives quick and general information about camera configuration status.
- **3. Dockable Windows** all configuration windows (Gain, AOI, Genlock...) can be separated and "docked" in the main GUI with just one click.
- **4. Configurable** user can customize the main menu by selecting the sub windows and also memorize the last setting.

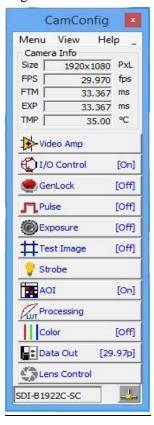


Figure 5.2 – HD-SDI CamConfig main GUI Window



The configuration utility includes an interactive help file, which will guide you through the GUI controls and camera settings. On the main window, the user can see useful camera information – Current Image Size (Size), Number of Frame per second (FPS), the Frame Time (FTM), Exposure Time (EXP) and Temperature of the CCD sensor (TMP). Additional information can be obtained by clicking on the buttons shown in the CamConfig window, such as Video Amp, I/O Control, Genlock, etc. The bottom of the main utility window is camera name and status of HD-SDI connection. If the connection between the camera and the computer is lost a red cross will appear above the connection icon.

5.4. MAIN GUI MENU

All panels in the Bobcat HD-SDI CamConfig share the same general control options and menus for "File", "View" and "Help" – Figure 5.3.

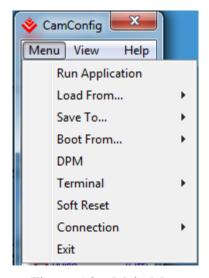


Figure 5.3 – Main Menu.

Run Application: Select and start other executable files (Frame-Grabber

application, etc.) that you normally use. CamConfig will remember the path of last executable file that you used, so the next time when you start the application without having to type-

in the location.

Load From: Loads the camera registers from a saved configuration space:

File, Workspace, Factory Space, User Space #1 or User Space

#2.

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017

Boca Raton, FL 33487 +1 (561) 989-0006





File – loads the camera registers from a saved configuration file

Workspace – updates the GUI with the current camera workspace settings

Factory – loads the camera registers with the original (factory) settings.

User Space #1 – loads the camera registers with camera settings saved in the user space 1.

User Space #2 – loads the camera registers with camera settings saved in the user space 2.

Save To:

Saves the camera registers to File, User Space #1 or User Space #2. Factory Space is disabled for regular users and it is available only for manufacturing technicians.

File – saves the current camera settings to a configuration file

Factory Space – saves the current camera settings to the camera Factory space. This is restricted command and is disabled for regular users.

User Space #1 – saves the current camera settings to the camera User space 1.

User Space #2 – saves the current camera settings to the camera User space 2.

Boot:

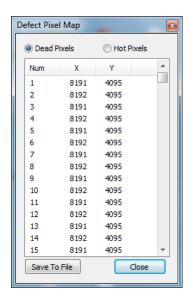
This menu selects the 'Boot From' source. Upon power up, the camera will load its registers from the selected 'Boot From' source: Factory, User #1 or User #2. Bobcat camera will be release with 'Factory' Setting and user can save and boot camera with their own configurable features.

DPM:

Defect Pixel Map – When selected, the DPM window will show defected pixels location. The defective pixel map is stored in the camera's non-volatile memory and read out when running bad pixel correction – Figure 5.4. Defected pixels are categorized as:

Imperx, Inc. 6421 Congress Ave. Boca Raton, FL 33487 +1 (561) 989-0006 Rev. 1.5 9/26/2017





<u>Figure 5.4 – Defective pixel map.</u>

Dead Pixels – pixels with sensitivity that deviates more than 15% due to fluctuations in the CCD manufacturing process.

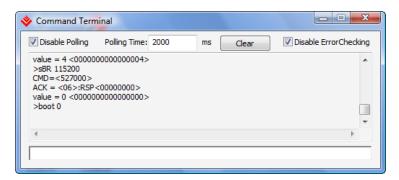
Hot Pixels – pixels that during normal camera operation are normal, but in long integration modes (programmable frame time) behave as high-intensity bright pixels.

The user can display two submenus: Command Terminal and Download Terminal.

Command Terminal — shows information about all the commands sent to or received from the camera. User can type in Bobcat command directly in the text box provided — Figure 5.5. All commands must start with 0x followed by ADDRESS and DATA, without spaces — refer to chapter 4 for more information. The "Disable Polling" check box will turn on/off the polling commands (such as Frame Time, Exposure time, Frame Rate and Sensor Temperature) in the dialog windows. The user can change the polling time by entering the desired number in the window. If for some reason the camera returns an error, when command was sent to the camera, the GUI will respond with a pop-up window displaying an error message. The user has option to disable the error checking by enabling the "Disable Error Checking" box.

Terminal:





<u>Figure 5.5 – Command terminal.</u>

Download Terminal – One of the great features in Bobcat configuration utility is download terminal. User can upgrade the camera firmware and up-load to the camera any custom LUT, DPM or FFC – Figure 5.6.

File Type – from the pull-down menu the user can select the appropriate type of file to up-load to the camera.

File Path – enter the file path manually into the edit box or click the '...' button to browse through folders.

Load File – after selecting the file, click on "Load File" button to start the up-load process.

Cancel – stops the up-load process.

Progress Bar – displays the progress status of the up-load process.

Terminal window – provides information about the download process (completion, errors, etc.)



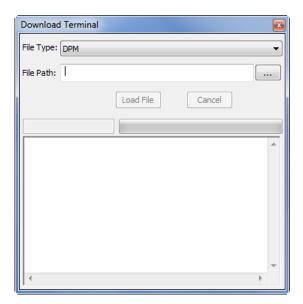


Figure 5.6 – Download terminal.

Download Procedure:

- 1. Select correct 'File Type" before downloading. Several options are possible: DPM, HPM, LUT1, LUT2, Application FW, Application FW 1/O, Register space.
- 2. Type in or select the correct data file of this feature in 'File Path'
- 3. Click on 'Load File' button to start downloading
- 4. Wait for the progress bar to finish (100%)
- 5. Reboot the camera and restart the GUI for the changes to take into effect.

Connection:

The user can select the connection type between the camera and the computer:

- 1. Switch Port If checked, "Select Port" window will popup. The user can select new RS-232 port, which connect to current camera.
- 2. Set Baud Rate the user can set the communication baud rate: 9600, 19200, 38400, 57600 or 115200 (default value).

Exit:

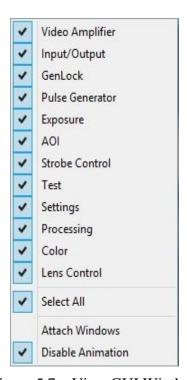
Terminates the application.

Imperx, Inc. 6421 Congress Ave. Boca Raton, FL 33487 +1 (561) 989-0006 Rev. 1.5 9/26/2017



5.5. **VIEW GUI WINDOWS**

The 'View' menu allows the user to select which camera parameter window to be displayed on the main CamConfig GUI window – Figure 5.7.



<u>Figure 5.7 – View GUI Windows</u>

Video Amplifier: Controls the camera analog and digital gain and offset, tap

balancing, black level correction. Optional – controls RGB

settings.

Input/output: Maps the internal input and output signals to the camera

external inputs.

Genlock: Controls the camera genlock features.

Pulse Generator: Enables and controls the internal pulse generator.

Exposure: Sets the exposure, frame time, AEC, AGC, and AIC modes.

Test: Enables the internal test pattern generator.

AOI: Sets up to 6 regions of interest.

Strobe: Enables and controls the camera strobe signals.

 Imperx, Inc.
 Rev. 1.5

 6421 Congress Ave.
 9/26/2017

Boca Raton, FL 33487 +1 (561) 989-0006





Processing: Enables the built-in basic image processing functions.

Color: Sets the gain and offset for the primary R G B colors. Sets the

white balance mode. Displays WBC values.

Data Out (Settings): Sets for the data format – output format, DPC, HPC, FFC

controls.

Select All: Enables all camera parameter windows.

Attach Window: Attaches all camera parameter windows to the main GUI

window.

Disable Animation: Disables animated features of windows preview when moving

the mouse cursor over the buttons.

5.6. **GUI HELP**

The main "Help" menu is shown on Figure 5.8

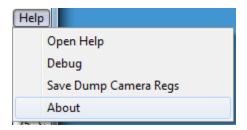


Figure 5.8 – Help menu

Open Help: Opens an interactive help file.

Debug: Puts the GUI in a debug mode for test purposes and

troubleshooting.

About: Provides information about application version and important

camera parameters such as Firmware revision, Assembly Part

Number, etc. – Figure 5.9.





Figure 5.9 – About CamConfig.

5.7. **PARAMETER WINDOWS**

Bobcat Cameras have many features that can easily be programmed using the Bobcat graphical user interface (GUI) or via simple register commands using the Command Terminal. The main parameter windows are described below.

5.7.1. **Video Amp**

Video Amp window allows the user to adjust the Analog or Digital gain and offset. Manual entry and sliders are available for adjusting the individual parameters – Figure 5.10.

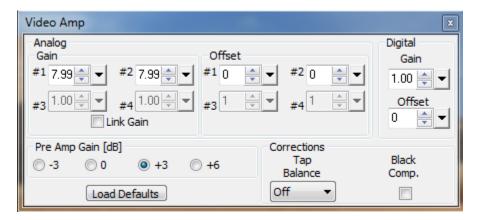


Figure 5.10 – Video Amp parameter window



Analog: The user can set the desired analog gain (0 to 36 dB, 1024)

discrete values) and offset (0 to 1023, 1 step increment) for each channel via the sliders or by entering the desired

values.

"Link Gain" and "Link Offset" links the corresponding channels together (dual tap camera only), and the gain or

offset difference between them will be preserved.

Pre-Amp Gain: The user can select the preamplifier gain for the camera (the

same for both channels). 4 options are possible -3 dB, 0, +3 dB, and +6 dB. The default Pre-Amp Gain value is camera dependent and it is set for the best camera performance.

Digital: The user can set the desired digital gain (1.0x to 3.0x, 0.1x

increment) and digital offset (-511 to +511, 1 step increment) via the slider or by entering the desired value. The selected value for gain or offset is applied to both

channels.

Load Defaults: Loads the Manufacturing default gain and offset settings.

The settings might be different for "Slow" and "Fast"

modes.

Corrections: Tap balance – when selected enables automatic tap

balancing. Four options are available - Off, Auto, Once,

Static.

White balance - when selected enables automatic white

balance. This feature is optional.

Black Comp – when selected enables "Black Compensation" and automatically determines and

compensates for black level.

5.7.2. **I/O Control**

The camera has 2 external outputs. The user can map all available internal output signals to all external camera outputs – Figure 5.11.



Figure 5.11– I/O control parameter window.



Output:

The user can map each of the camera outputs to OUT1, OUT2. 11 signals are available for mapping. For each input, the user can set the signal level to active "High" or active "Low".

- 1. Exposure Start a short pulse (2 us) indicating the beginning of the camera exposure in trigger mode.
- 2. Exposure End a short pulse (2 us) indicating the end of the camera exposure in trigger mode.
- 3. Mid Exposure a short pulse (2 us) indicating indicates the middle of the camera exposure in trigger mode.
- 4. Active Exposure Window a signal indicating the duration of the camera exposure in trigger mode.
- 5. H-Sync a short pulse (2 us) synchronized with the camera line timing.
- 6. V-Sync a short pulse (2 us) synchronized with the camera frame timing.
- 7. Odd/Even Frame Flag a signal indicating if the frame is ODD or EVEN. It alternates every frame. When "Active High" ODD is LOW.
- 8. Trigger Pulse maps the input trigger pulse to the output with no delay (as is).
- 9. Trigger Pulse Delayed maps the input trigger pulse to the output with delay set by the Exposure Delay Register.
- 10. Camera Ready a signal indicating when the camera is ready to accept the next trigger pulse.
- 11. Pulse Generator maps the internal pulse generator waveform to the output.
- 12. Strobe 1 maps "Strobe One" signal to the corresponding external output.
- 13. Strobe 2 maps "Strobe Two" signal to the corresponding external output.
- 14. Deselect no signal is mapped.



5.7.3. Pulse Generator

In this window, the user can configure the parameters of the Internal Pulse Generator – Figure 5.12.

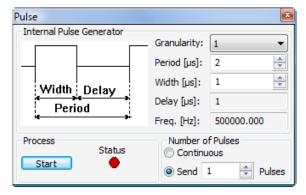


Figure 5.12 – Pulse generator window.

Granularity: Sets the granularity for the internal counters. Granularity can be

set to 1x, 10x, 100x or 1000x.

Period: Sets the pulse period in microseconds.

Width: Sets the pulse width in microseconds.

of Pulses: Sets the number of pulses generated. Two modes are available:

- 1. Continuous provides a continuous operation. To stop the process, you have to press the "Stop" button.
- 2. Fixed # of pulses the user can set only a discrete number of pulses ranging (1 to 65500) to be generated. To stop the process, you have to press the "Stop" button. Otherwise, the process stops automatically after the last pulse is sent.

Process: Start – starts and stops the process of Internal Pulse Generator.

When the process is in progress, the 'Start" button becomes a 'Stop" button.

Status – provides the status of the process:

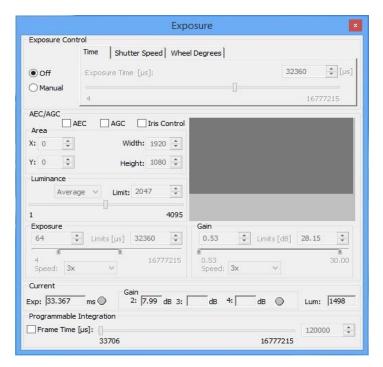
Red – the process is on hold,

Green – the process is working.



5.7.4. **Exposure**

This window controls the camera exposure, line and frame time, AEC, AGC and AIC modes of operation – Figure 5.13.



<u>Figure 5.13 – Exposure control window.</u>

Exposure Control: Sets the camera exposure:

- 1. Off no exposure control.
- 2. Manual internal camera register controls exposure
- 3. Exposure Time Slider sets the actual camera exposure in microseconds. The minimum exposure time adjusts accordingly, based on the camera mode of operation. The slider can only be used when "Manual" mode is enabled.
- 4. External Shutter Speed Slider sets the actual camera exposure in seconds. The minimum exposure time adjusts accordingly, based on the camera mode of operation. The slider can only be used when "Manual" mode is enabled.



5. Exposure Wheel Degrees slider – sets the actual camera exposure in degrees exposure in microseconds. The minimum exposure in degrees. The minimum exposure adjusts accordingly, based on the camera mode of operation. The slider can only be used when "Manual" mode is enabled.

Programmable Integration:

Variable frame rate mode provides the ability to run the camera in full resolution and at a frame rate slower than the nominal camera frame rate. The user can change "Frame Time" in microseconds. The maximum frame time is ~ 16 seconds.

AEC/AGC:

The camera can be set to automatic exposure and gain control in order to keep the same image brightness during changing light conditions.

Enables – enables which feature to be used:

- 1. AEC enables Automatic Exposure Control (AEC) mode. The user can change "Area", "Exposure" and "Luminance". "Gain" cannot be adjusted.
- 2. AGC enables Automatic Gain Control (AGC) mode. The user can change "Area", "Gain" and "Luminance". "Exposure" cannot be adjusted.
- **3.** AIC enables Automatic Iris Control (AIC). The camera provides an analog video signal (via 12 pin HIROSE connector), compatible with "Video" iris lens control.

Area – sets an active region of significance. Only the image inside the selected region will be used in the data collection AEC/AGC algorithm. Any brightness changes outside of the region will be ignored. The changes as determined by the algorithm will apply to the entire image. The user can enter the region of significance by setting the active window size (Width, Height) and offset (X, Y). Image location (1.1) is top left corner. The user can set the desired window size by typing the numbers directly, or by selecting the desired size in the provided gray square window. To do this, simply draw the window with the mouse in the gray square.

Luminance – sets the desired luminance level to be maintained in the image. The comparison algorithm will adjust the image gain and exposure accordingly, so the image luminance is



always close to the desired one. The user can select which luminance type to be used in the algorithm:

- 1. Average the average value of the image luminance will be used in the comparison algorithm.
- 2. Peak the peak luminance value (maximum luminance level) will be used in the comparison algorithm.

Exposure – sets the maximum/minimum exposure time, which can be reached in the AEC mode in order to avoid motion smear if a fast-moving object is monitored. The user can select the speed of convergence 1x (slow), 2x, 3x and 4x (fast).

Gain – sets the maximum/minimum analog gain, which can be reached in the AGC mode. The user can select the speed of convergence 1x (slow), 2x, 3x and 4x (fast).

Current – Provides live information about the current value of the Exposure time, Gain and Luminance. The values will be refreshed every time polling is done.

5.7.5. Test Image

This window sets the test image mode. Several test images are available for selection, including pattern superimposing over live image – Figure 5.14.

Ping:

Checks the serial connection status of the camera:

GREEN – followed by a brief "OK", indicates a successful connection.

RED – followed by and "ERR", indicates no connection.

YELLOW – "Ping" command was sent to the camera. A few seconds after pinging, the indicator becomes gray and the message disappears.

Test Mode: **Test Patterns** – the camera can output eight test patterns:

- 1. Off test mode is off.
- 2. Black displays black image.
- 3. Gray Image displays a uniform dark gray image.
- 4. White Image displays a uniform white image.
- 5. H Ramp displays a stationary horizontal ramp image.
- 6. V Ramp displays a stationary vertical ramp image.
- 7. H Ramp move displays a moving horizontal ramp image.



- 8. V Ramp move displays a moving vertical ramp image.
- 9. Vertical Bars displays a set of 8 vertical gray bars with different gray levels.
- 10. Y/RGB Histogram displays separate Y,RGB histogram image.
- 11. SMPTE Color Bars displays and HD SMPTE color bar test pattern image.
- 12. Frame Number displays internal frame counter (0 to 65535)
- 13. Field Mark displays field mark: progressive modes green square on each frame; interlaced modes green rectangle on even field, red rectangle on odd field.

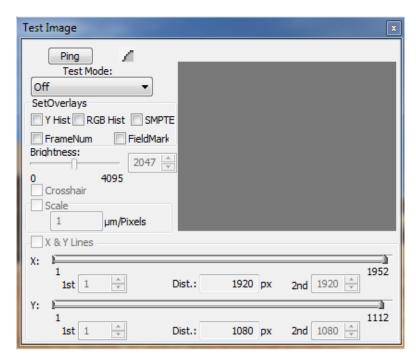


Figure 5.14 – Test image window.

Superimposed: This mode superimposes a test pattern over live image (not available during H & V binning):

Crosshair – superimposes a cross, located in the center of the CCD images. A small cross will appear in the gray square window.



H&V Lines – superimposes a pair of H and/or V lines. Dual sliders are available to select the horizontal and vertical position of the lines. Each line location will be visible in the gray square window. The sliders range from 1 to the maximum number of pixels/lines available on the sensor.

Brightness – sets the brightness of the crosshair and H&V lines, ranges from 0 to 4095.

Scale – provides the ability to measure distance between the lines in pixels or in linear units. The uses must enter a scale calibration value.

5.7.6. Area of Interest (AOI)

AOI is used to select one or more regions of interest. A total of seven independent AOIs can be generated, and the user can select the size of each horizontal and vertical window. Horizontal and Vertical binning is also available to change the H and V resolution of the image – Figure 5.15.

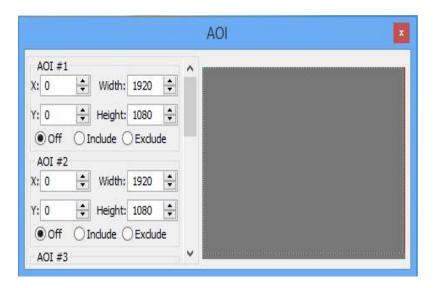


Figure 5.15 – AOI window.

AOI#:

Bobcat supports up to six slave independent horizontal and vertical regions of interest could be enabled. If slave AOIs is to be used MAOI MUST be enabled. All slave AOIs have to be positioned within the MAOI. The slave AOIs can be set to be included or excluded from the MAOI After enabling the selected AOI, the user can enter the desired region of interest by setting the active window size (Width, Height) and offset (X, Y). Image location (1.1) is top left corner. The user can set the

Imperx, Inc. 6421 Congress Ave. Boca Raton, FL 33487 +1 (561) 989-0006 Rev. 1.5

9/26/2017



desired window size by typing the numbers directly, or by selecting the desired size in the provided gray square window. To do this enable the window first, press the corresponding numerical number on the keyboard, and then draw the window with the mouse in the gray square. Different AOIs will be displayed with different colors.

5.7.7. **Strobe Control**

This window sets the camera strobe signals. Two independently controlled strobe signals are supported – Figure 5.16.

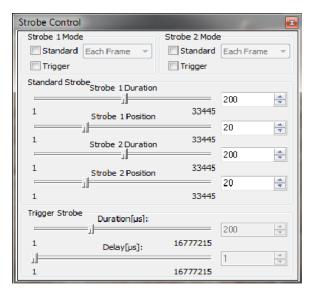


Figure 5.16 – Strobe Control window.

Strobe 1 Mode: Sets the Strobe 1 mode of operation. The strobe can be

disabled or enabled. When enabled the strobe can be set to appear "Each Frame", "Odd Frames" only or "Even Frames" only. In addition, in trigger mode, the user can add a strobe pulse associated with rising edge of the trigger

pulse.

Strobe 2 Mode: Sets the Strobe 2 mode of operation. The strobe can be

disabled or enabled. When enabled the strobe can be set to appear "Each Frame", "Odd Frames" only or "Even Frames" only. In addition, in trigger mode, the user can add



a strobe pulse associated with rising edge of the trigger pulse.

Standard Strobe: Controls the strobe position and pulse duration for Strobe 1

and Strobe 2. The user can set the individual strobe position relative to the beginning of the frame, via the slider or by entering the desired value. The strobe pulse duration can be set for each strobe individually. The user can set the strobe position and duration within the camera frame period with 1

us resolution.

Trigger Strobe: Sets the duration and delay of a strobe sync pulse (with

respect to the trigger pulse) sent to the camera output. The user can set the strobe duration and the delay from 0 to

16777215 us.

5.7.8. Color Window

This window sets Brightness, Contrast, Saturation, Hue, and Offset for the primary RGB colors by using a Color Correction Matrix (CCM). In addition, the color window provides different White Balance modes including Auto White Balance with tracking and displays the calculated white balance coefficients – Figure 5.17. The Color Window is disabled for the Mono cameras.

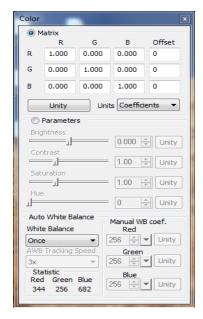


Figure 5.17 – Color Window.





Matrix: User sets RGB gain, and offset coefficients.

Parameters: Color Matrix slider control of Brightness, Contrast,

Saturation, and Hue.

White Balance: Sets the White Balance mode of operation.

1. "Off" – No white balance is performed.

2. "Once" – the camera analyzes only one image frame, calculates only one set correction coefficients, and all subsequent frames are corrected with this set of coefficients.

- 3. "Auto" the camera analyzes the entire frame, a set of correction coefficients are derived for each frame and applied to the next frame.
- 4. "Manual" the camera uses the correction coefficients as entered from the user.
- 5. Indoor 3200K color temperature setting typically used for indoor shooting.
- 6. Outdoor 5600K color temperature setting typically used for outdoor shooting.

AWB Tracking: User Selects the Auto White Balance Tracking Speed from

1x to 5x. The entire frame is used to evaluate the color balance and updates are made to identity AWB multipliers every frame. The magnitude of the changes applied to the multipliers controls the speed and smoothness of the

operation.

Manual WBC: User enters manually the white balance coefficients for each

color. The range is from 0 to 4095 (255 is equal to 1.0x).

The user has option to set all coefficients to "Zero".

Statistic: Displays the current (calculated) white balance coefficients

per color.

RGB Gain: The user can set individually the desired digital gain for

each primary color R G B (1.0x to 4.0x, 0.001x increment) via the slider or by entering the desired value. The user has

option to set all gains to "Unity" (1.0x)

R G B Offset: The user can set individually the desired digital offset for

each primary color R G B (-511 to +511, 1 step increment)



via the slider or by entering the desired value. The user has option to set all offsets to "Zero

5.7.9. **Processing**

This window controls the image processing features implemented into the camera. Currently only one Image Enhancement is implemented – Figure 5.18. More features will be added later. Please contact Imperx for more information. This window will be disabled for the color cameras.

Processing AOI: Disabled – no PAOI functionality.

Enhancement – the selected processing function will apply only to the selected ROI, all data outside of the region will

not be processed with the selected function.

Lookup Table – the LUT function will apply only to the selected ROI, all data outside of the region will not be

processed with the LUT function.

Gamma: enables/selects Gamma LUT.

Black Gamma: enables/selects Black Gamma LUT.

Lookup Table: enables/selects User LUT, and Black Gamma LUT% **Convolution:** Enable – Enables convolution (3 x 3 filter) function.

Details – Sets convolution coefficients/offset



Enhancement: are available:

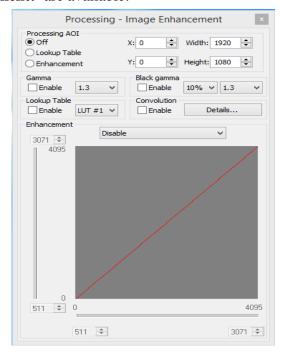


Figure 5.18– Processing window.

Disable – no enhancement operation will be performed.

Single Threshold Binary – single point threshold operation will be performed. Set the desired threshold level X1 using the horizontal (bottom) slider (left portion).

Dual Threshold Binary – two-point threshold operation will be performed. Set the desired upper threshold level X2 using the horizontal (bottom) slider (right portion), and the lower one X1 – horizontal (bottom) slider (left portion).

Dual Threshold Gray – two-point threshold operation with gray scale mid. values will be performed. Set the desired upper threshold level X2 using the horizontal (bottom) slider (left portion), and the lower one X1 – horizontal (bottom) slider (right portion).

Dual Threshold Contrast Enhancement – two-point threshold operation with gray scale stretch will be performed. Set the desired upper threshold level X2 using the horizontal (bottom) slider (left portion), and the lower one X1 – horizontal (bottom) slider (right portion).

One Point Correction – single point image enhancement operation will be performed. Set the desired X1-point level

Rev. 1.5

9/26/2017



using the horizontal (bottom) slider (left portion). Set the desired Y1-point level using the vertical (side) slider (bottom portion).

Two Point Correction – two-point image enhancement operation will be performed. Set the desired X1-point level using the horizontal (bottom) slider (left portion), and X2-point – the horizontal (bottom) slider (left portion). Set the desired Y1-point level using the vertical (side) slider (bottom portion), and Y2-point – the vertical (side) slider (top portion).

Side Slider: Multipurpose dual slider, controls the Y1 and Y2 positions for

single and two-point image enhancement.

Bottom Slider: Multipurpose dual slider, controls the X1 and X2 positions for

single and two-point image enhancement. Controls the lower

and upper threshold levels for single and dual threshold.

Gray Box: Multipurpose graphical interface. The user can set the desired

X1, (X1, X2), (X1, Y1) or (X2, Y2) points directly. Grab with the mouse the yellow dots (dot) and move them in the gray

square window until the desired result is achieved.

5.7.10 Data Output

Data Output window provides full control of the camera digital data output – Figure 5.19.

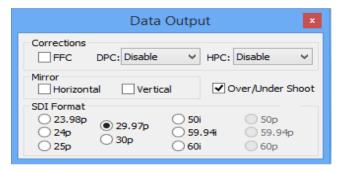


Figure 5.19 – Data output window.

Corrections: FFC – enables Flat Field Correction (FFC). Each HD-SDI

camera comes with a built-in Flat Field Map (FFM) to compensate for shading effects intrinsic to the imager. The

user can upload load a custom FFM.



DPC – enables Defective Pixel Correction (DPC). Each HD-SDI camera comes with a built-in Defective Pixel Map (DPM) to correct for defective pixels. The user can upload a custom DPM.

HPC – enables Hot Pixel Correction (HPC). Each HD-SDI camera comes with a built-in Hot Pixel Map (HPM) to correct for hot pixels. The user can upload a custom HPM

SDI Format: – sets the output HD-SDI format. Supported formats for the SDI-B1920/1921/1921/1922/1923 cameras include 1080/23.98p, 1080/24p, 1080/25p, 1080/29.97, 1080/30p, 1080/50i, 1080/59.94i, and 1080/60i. Supported formats for the SDI-B1320 include 720/50p, 720/59.95p, and 720/60i.

Mirror: Horizontal – enables horizontal mirroring of image

Vertical – enables vertical mirroring of image

Over/Under Shoot: enables over/undershoot of data.

5.7.11 Lens Control

Lens Control window provides Zoom, Focus, and Iris motorized lens output control signals – Figure 5.20.

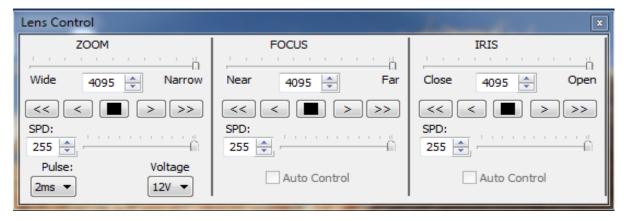


Figure 5.20 – Lens Control window.

Zoom Slider/Entry Window: Sets the number of lens motor drive pulses to control motor travel distance. The selections range from 1 (minimum travel) to 4095 (maximum travel).

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017

+1 (561) 989-0006





Zoom Buttons: << Sets full travel (4095 pulses) in Wide direction.

>> Sets full travel (4095 pulses) in Narrow direction.

< Sets Entry Window value in Wide direction

> Sets Entry Window value in Narrow direction.

Stops Motor.

Zoom SPD Slider/Entry Window: Selects the distance between lens motor drive pulses to control speed. The selection ranges from 1 (minimum speed) to 255 (maximum speed).

Focus Slider/Entry Window: Sets the number of lens motor drive pulses to control motor travel distance. The selections range from 1 (minimum travel) to 4095 (maximum travel).

Focus Buttons: << Sets full travel (4095 pulses) in Near direction.

Sets full travel (4095 pulses) in Far direction.Sets Entry Window value in Near directionSets Entry Window value in Wide direction.

Stops Motor.

Focus SPD Slider/Entry Window: Sets the distance between lens motor drive pulses to control speed. The selection ranges from 1 (minimum speed) to 255 (maximum speed).

Iris Slider/Entry Window: Sets the number of lens motor drive pulses to control motor travel distance. The selections range from 1 (minimum travel) to 4095 (maximum travel).

Iris Buttons: << Sets full travel (4095 pulses) in Close direction.

>> Sets full travel (4095 pulses) in Open direction.

< Sets Entry Window value in Close direction

> Sets Entry Window value in Open direction.

Stops Motor.

Iris SPD Slider/Entry Window: Sets the distance between lens motor drive pulses to control speed. The selection ranges from 1 (minimum speed) to 255 (maximum speed).

Pulse: Sets pulse width to 1ms, 2ms, 4ms, or 8ms providing fine to coarse adjustments to help fine-tune control lens motor speed and travel distance.

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017

Boca Raton, FL 33487





Voltage: Sets motor driver pulse voltage to 6 or 12 volts.





Warranty BOBCAT and Support

This chapter discusses the camera's warranty and support.



6.1. ORDERING INFORMATION

Bobcat Camera Ordering Codes					Sample Code: SDI-B1921C-TC3
Interface: SDI	Camera Number: B1921	Sensor Type: C	Sensor Manuf.	Lens Mount: C	Filter Option: 3
HD-SDI Output	B1320 - 1280 x 720	M - Monochrome	T - Truesense	C - C Mount	0 - None
	B1920 - 1920 x 1080	C - Color	S - Sony		1 - No IR Filter (Color Cameras come with IR Filter)
	B1921 - 1920 x 1080	W - VS(Glassless) with micro lens			2 - With IR Filter (Mono Cameras come without IR Filter)
	B1922 - 1920 x 1080	U - UV (Glassless) without micro Lens			3 - With Clear Cover Glass
	B1923 - 1920 x 1080	X - UV Quartz without Micro lens			4 - Mounted Cover Glass to Custom base onto Sensor
		Q - Quartz			
					Ordering Notes:
		-			All HD-SDI CCD cameras use Interline Transfer CCD
					PS12V04 12 VDC power supply (Sold Seperately)
					PS12V05 12 VDC power supply W/Auto Aris (Sold Seperately
					C mount 1 /1.8" is about 8.923mm diagonal.

6.2. TECHNICAL SUPPORT

Each camera is fully tested before shipping. If for some reason the camera is not operational after power up please check the following:

- 1. Check the power supply and all I/O cables. Make sure that all the connectors are firmly attached.
- 2. Check the status LED and verify that it is steady ON, if not refer to the LED section.
- 3. Enable the test mode and verify that the communication between the frame grabber and the camera is established. If the test pattern is not present, power off the camera, check all the cabling, frame grabber settings and computer status.
- 4. If you still have problems with the camera operation, please contact technical support at:

Email: techsupport@imperx.com

Toll Free 1 (866) 849-1662 or (+1) 561-989-0006

Fax: (+1) 561-989-0045

Visit our Web Site: www.imperx.com

6.3. **WARRANTY**

Imperx warrants performance of its products and related software to the specifications applicable at the time of sale in accordance with Imperx's standard warranty, which is 2 (two)

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



year parts and labor. FOR GLASSLESS CAMERAS THE CCD IS NOT COVERED BY THE WARRANTY.

Do not open the housing of the camera. Warranty voids if the housing has been open or tampered.

IMPORTANT NOTICE

This camera has been tested and complies with the limits of Class A digital device, pursuant to part 15 of the FCC rules.

Copyright © 2013 Imperx Inc. All rights reserved. All information provided in this manual is believed to be accurate and reliable. No responsibility is assumed by Imperx for its use. Imperx reserves the right to make changes to this information without notice. Redistribution of this manual in whole or in part, by any means, is prohibited without obtaining prior permission from Imperx. Imperx reserves the right to make changes to its products or to discontinue any product or service without notice, and advises its customers to obtain the latest version of relevant information to verify, before placing orders, that the information being relied on is current.

IMPERX PRODUCTS ARE NOT DESIGNED, INTENDED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT APPLICATIONS, DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS, WHERE MALFUNCTION OF THESE PRODUCTS CAN REASONABLY BE EXPECTED TO RESULT IN PERSONAL INJURY. IMPERX CUSTOMERS USING OR SELLING THESE PRODUCTS FOR USE IN SUCH APPLICATIONS DO SO AT THEIR OWN RISK AND AGREE TO FULLY INDEMNIFY IMPERX FOR ANY DAMAGES RESULTING FROM SUCH IMPROPER USE OR SALE.





Camera Configuration Reference

This appendix provides a quick reference to the camera configuration workspace registers.



A.0 ABBREVIATIONS

RW – read/write, **RO** – read only, **WO** – write only

 ${\sf MAX_HRZ_SZE}$, ${\sf MIN_HRZ_SZE}$ – ${\sf Max}$. and ${\sf Min}$. horizontal image size – camera dependent

 ${\sf MAX_VER_SZE}$, ${\sf MIN_VER_SZE}$ — Max. and Min. vertical image size — camera dependent

LIN_TIM_MIN – Minimum Line time – camera dependent

FRM_TIM_MIN – Minimum Frame time – camera dependent

FRM_TIM_ACT – Actual Current Frame time - variable

FRR_EXP_MIN – Minimum Exposure time – camera dependent

A.1 SAVING AND RESTORING REGISTERS

Address	Register Name	Type	Usage	MIN Value	MAX Value
			00 - Factory,		
0x6000	Boot From	RW	01 - User 1,	0x00000000	0x00000002
			10 - User 2		
0x6060	Load From Factory	WO	Command	0x00000000	
0x6064	Load From User1	WO	Command	0x00000000	
0x6068	Load From User2	WO	Command	0x00000000	
0x606C	Load MFG Default Gain	WO	Command	0x00000000	
0x6074	Save to User1	WO	Command	0x00000000	
0x6078	Save to User2	WO	Command	0x00000000	
0x0604	RS-232 Baud Rate Selector	RW	<baud value=""></baud>	0x00000000	0x00000004

A.2 CAMERA INFORMATION REGISTERS

Address	Register Name	Туре	Value
0x6004	Firmware Revision	RO	<firmware revision=""></firmware>
0x6008	Firmware Build Number	RO	<firmware build="" number=""></firmware>
0xE004	I/O Firmware Revision	RO	<i firmware="" o="" revision=""></i>
0xE008	I/O Firmware Build Number	RO	<i build="" firmware="" number="" o=""></i>
0x600C	Test Register	RW	0x76543210
0x601C	Soft Reset	WO	0xDEDBEEF
0x6080	Horizontal Frame Size	RO	<max_hrz_sze, min_hrz_sze=""></max_hrz_sze,>

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



0x6084	Vertical Frame Size	RO	<max_ver_sze, min_ver_sze=""></max_ver_sze,>
0x6088	Current Minimum Frame Time	RO	<frm_tim_min></frm_tim_min>
0x608C	Current Minimum Line Time	RO	<lin_tim_min> , <clk_per_psc></clk_per_psc></lin_tim_min>
0x6090	Current Maximum Exposure	RO	<frm_tim_act></frm_tim_act>
0x6094	Current Minimum Exposure	RO	<frr_exp_min></frr_exp_min>
0x6098	Current Frame Number	RO	<current frame="" number=""></current>
0x609C	Current Camera Exposure	RO	<current exposure=""></current>
0x60A0	Current Frame Duration	RO	<frm_tim_act></frm_tim_act>
0x60B0	Current Image Size	RO	<pre><curt_ver_sze>, <crnt_hrz_sze></crnt_hrz_sze></curt_ver_sze></pre>
0x60B4	Current AEC/AGC Status	RO	<status values=""></status>
0x6010	CCD Temperature	RO	<current ccd="" temperature=""></current>

A.3 IMAGE SIZE (AOI) REGISTERS

Address	Register Name	Туре	Usage	MIN Value	MAX Value
0x020C	AOI 1 Enable	RW	00 – Off, 01 – Include, 10 - Exclude	0x00000000	0x0000001
0x0210	AOI 2 Enable	RW	00 – Off, 01 – Include, 10 - Exclude	0x00000000	0x0000001
0x0214	AOI 3 Enable	RW	00 – Off, 01 – Include, 10 - Exclude	0x00000000	0x0000001
0x0218	AOI 4 Enable	RW	00 – Off, 01 – Include, 10 - Exclude	0x00000000	0x0000001
0x021C	AOI 5 Enable	RW	00 – Off, 01 – Include, 10 - Exclude	0x00000000	0x0000001
0x0220	AOI 6 Enable	RW	00 – Off, 01 – Include, 10 - Exclude	0x00000000	0x0000001
0x0224	PAOI Enable	RW	00 - Off, 11 – LUT AOI 10 – Process. AOI,	0x00000000	0x00000003
0x022C	AOI 1 Horizontal Width	RW	<width value=""></width>	0x00000001	MAX_HRZ_SZE
0x0230	AOI 2 Horizontal Width	RW	<width value=""></width>	0x00000001	MAX_HRZ_SZE
0x0234	AOI 3 Horizontal Width	RW	<width value=""></width>	0x00000001	MAX_HRZ_SZE
0x0238	AOI 4 Horizontal Width	RW	<width value=""></width>	0x00000001	MAX_HRZ_SZE
0x023C	AOI 5 Horizontal Width	RW	<width value=""></width>	0x00000001	MAX_HRZ_SZE
0x0240	AOI 6 Horizontal Width	RW	<width value=""></width>	0x00000001	MAX_HRZ_SZE
0x0244	PAOI Horizontal Width	RW	<width value=""></width>	0x00000001	MAX_HRZ_SZE
0x024C	AOI 1 Horizontal Offset	RW	<offset value=""></offset>	0x00000000	MAX_HRZ_SZE - 1
0x0250	AOI 2 Horizontal Offset	RW	<offset value=""></offset>	0x00000000	MAX_HRZ_SZE - 1

Imperx, Inc. 6421 Congress Ave. Boca Raton, FL 33487 +1 (561) 989-0006 Rev. 1.5 9/26/2017



BOBCAT HD-SDI Hardware User's Manual

0x0254	AOI 3 Horizontal Offset	RW	<offset value=""></offset>	0x00000000	MAX_HRZ_SZE - 1
0x0258	AOI 4 Horizontal Offset	RW	<offset value=""></offset>	0x00000000	MAX_HRZ_SZE - 1
0x025C	AOI 5 Horizontal Offset	RW	<offset value=""></offset>	0x00000000	MAX_HRZ_SZE - 1
0x0260	AOI 6 Horizontal Offset	RW	<offset value=""></offset>	0x00000000	MAX_HRZ_SZE - 1
0x0264	PAOI Horizontal Offset	RW	<offset value=""></offset>	0x00000000	MAX_HRZ_SZE - 1
0x026C	AOI 1 Vertical Height	RW	<height value=""></height>	0x00000001	MAX_VER_SZE
0x0270	AOI 2 Vertical Height	RW	<height value=""></height>	0x00000001	MAX_VER_SZE
0x0274	AOI 3 Vertical Height	RW	<height value=""></height>	0x00000001	MAX_VER_SZE
0x0278	AOI 4 Vertical Height	RW	<height value=""></height>	0x00000001	MAX_VER_SZE
0x027C	AOI 5 Vertical Height	RW	<height value=""></height>	0x00000001	MAX_VER_SZE
0x0280	AOI 6 Vertical Height	RW	<height value=""></height>	0x00000001	MAX_VER_SZE
0x0284	PAOI Vertical Height	RW	<height value=""></height>	0x00000001	MAX_VER_SZE
0x028C	AOI 1 Vertical Offset	RW	<offset value=""></offset>	0x00000000	MAX_VER_SZE - 1
0x0290	AOI 2 Vertical Offset	RW	<offset value=""></offset>	0x00000000	MAX_VER_SZE - 1
0x0294	AOI 3 Vertical Offset	RW	<offset value=""></offset>	0x00000000	MAX_VER_SZE - 1
0x0298	AOI 4 Vertical Offset	RW	<offset value=""></offset>	0x00000000	MAX_VER_SZE - 1
0x029C	AOI 5 Vertical Offset	RW	<offset value=""></offset>	0x00000000	MAX_VER_SZE - 1
0x02A0	AOI 6 Vertical Offset	RW	<offset value=""></offset>	0x00000000	MAX_VER_SZE - 1
0x02A4	PAOI Vertical Offset	RW	<offset value=""></offset>	0x00000000	MAX_VER_SZE - 1
1	•				

A.4 EXPOSURE CONTROL REGISTERS

Address	Register Name	Туре	Usage	MIN Value	MAX Value
0x0544	Exposure Control Mode	RW	00 - Off, 10 - Int	0x00000000	0x00000002
0x0548	Exposure Time	RW	<exposure value=""></exposure>	FRR_EXP_MIN,	FRM_TIM_ACT
0x0558	Frame Time	RW	<frame time="" value=""/>	FRM_TIM_MIN	0x00FFFFF

A.5 VIDEO REGISTERS

Address	Register Name	Туре	Usage	MIN Value	MAX Value
0x0000	PreAmp Gain Ch. 1	RW	003dB, 01 - 0dB, 10 - +3db, 11 - +6db	0x00000000	0x00000003
0x0004	Analog Gain Ch. 1	RW	<analog gain="" value=""></analog>	0x00000000	0x000003FF
0x0008	Analog Offset Ch. 1	RW	<analog offset="" value=""></analog>	0x00000000	0x000003FF

Imperx, Inc. 6421 Congress Ave. Boca Raton, FL 33487 +1 (561) 989-0006 Rev. 1.5 9/26/2017



BOBCAT HD-SDI Hardware User's Manual

0x0010	PreAmp Gain Ch. 2	RW	003dB, 01 - 0dB, 10 - +3db, 11 - +6db	0x00000000	0x00000003
0x0014	Analog Gain Ch. 2	RW	<analog gain="" value=""></analog>	0x00000000	0x000003FF
0x0018	Analog Offset Ch. 2	RW	<analog offset="" value=""></analog>	0x00000000	0x000003FF
0x0180	Digital Gain	RW	<digital gain="" value=""></digital>	0x00000000	0x00000014
0x0184	Digital Offset	RW	<digital offset="" value=""></digital>	0x00000000	0x000003FF
0x0110	Tap Balance	RW	00 - Off, 01 – Auto Dyn, 10 – Once Dyn, 11 - Static	0x00000000	0x00000002
0x0114	Black Level Correction	RW	1 - Enable, 0 - Disable	0x00000000	0x0000001

A.6 AEC, AGC, AIC REGISTERS

Address	Register Name	Туре	Usage	MIN Value	MAX Value	
0×0140	Auto Iris Control	RW	1 - Enable,	0x00000000	0x00000001	
000140	Auto ins Control	IXVV	0 - Disable	0.000000000	0x0000001	
0x0150	Auto Exposure Control	RW	1 - Enable,	0x00000000	0x00000001	
0.0100	Auto Exposure Control	1744	0 - Disable	0.00000000	0,00000001	
0x0154	Auto Gain Control	RW	1 - Enable,	0x00000000	0x00000001	
0,0104	rate cam control	1777	0 - Disable	0x0000000	000000001	
0x0158	Luminance Level Threshold	RW	<luminance Threshold Value></luminance 	0x00000001	0x00000FFF	
0x05B0	Maximum Exposure Limit	RW	<max. exp.="" value=""></max.>	Min. Exp. Value	FRM_TIM_ACT	
0x05C8	Minimum Exposure Limit	RW	<min. exp.="" value=""></min.>	FRR_EXP_MIN	Max. Exp. Value	
0x0160	Maximum Gain Limit	RW	<max. gain="" value=""></max.>	Min. Gain Value	0x000003FF	
0x018C	Maximum Gain Limit	RW	<min. gain.="" value=""></min.>	0x00000001	Max. Gain Value	
0x0164	AOI Horizontal Width	RW	<width value=""></width>	0x00000001	MAX_HRZ_SZE	
0x0168	AOI Horizontal Offset	RW	<offset value=""></offset>	0x00000000	MAX_HRZ_SZE - 1	
0x016C	AOI Vertical Height	RW	<height value=""></height>	0x00000001	MAX_VER_SZE	
0x0170	AOI Vertical Offset	RW	<offset value=""></offset>	0x00000000	MAX_VER_SZE - 1	
0x0174	Exposure Correction Speed	RW	00 - 1x, 01 - 2x,	0x00000000	0x00000003	
0.0174	Exposure Correction Opeed	1744	10 - 3x, 11 - 4x	0x00000000	020000000	
0x0178	Gain Correction Speed	RW	00 - 1x, 01 - 2x,	0x00000000	0x00000003	
0,0170	Can Corrodion Opeou	1744	10 - 3x, 11 - 4x	- CAUCOUCOU	0,00000000	
0x017C	Luminance Type Selection	RW	00 - Average,	0x00000000	0x00000003	
0,0170		IXVV	01 - Peak	- CACCCCCCCCC		



A.7 TRIGGER REGISTERS

Address	Register Name	Туре	Usage	MIN Value	MAX Value
0x0584	Tri-Level sync mode	RW	0x00 - Off, 0x10 – Tri-Level mode	0x00000000	0x00000010
0x0528	Tri-Level sync shift	RW	<tri-level of="" pclk="" shift="" sync=""></tri-level>	0x00000000	0x000003FF

A.8 PULSE GENERATOR REGISTERS

Address	Register Name	Туре	Usage	MIN Value	MAX Value
0x0530	Pulse Gen. Granularity	RW	00 - 1x, 01 - 10x, 10 - 100x, 11 -1000x	0x00000000	0x00000003
0x0534	Pulse Gen. Pulse Width	RW	<pulse width=""></pulse>	0x00000001	0x0007FFFF
0x0538	Pulse Gen. Pulse Period	RO	<pulse period=""></pulse>	0x00000001	0x001FFFFF
0x053C	Pulse Gen. # of Pulses	RW	<number of="" pulses=""></number>	0x0000001	0x0000FFFF
0x0540	Pulse Gen. Enable	RW	1 - Enable, 0 - Disable	0x00000000	0x00000001

A.9 TEST PATTERN REGISTERS

Address	Register Name	Туре	Usage	MIN Value	MAX Value
0x012C	Test Mode Selector	RW	0x0 - Off, 0xX - Test Mode	0x00000000	0x00000009
0x0130	H&V Lines Superimpose	RW	1 - ON, 0 - Off	0x00000000	0x00000001
0x0134	Cross Superimpose	RW	1 - ON, 0 - Off	0x00000000	0x00000001
0x0138	H1 Superimpose Line Position	RW	<h1 line="" position=""></h1>	0x0000001	MAX_VER_SZE
0x013C	H2 Superimpose Line Position	RW	<h2 line="" position=""></h2>	0x0000001	MAX_VER_SZE
0x0140	V1 Superimpose Column Position	RW	<v1 column="" position=""></v1>	0x0000001	MAX_HRZ_SZE
0x0144	V2 Superimpose Column Position	RW	<v2 column="" position=""></v2>	0x0000001	MAX_HRZ_SZE
0x0148	Superimposed Lines Brightness	RW	<brightness value=""></brightness>	0x00000000	0x00000FFF
0x0610	Test Overlay	RW	00000 – Off, XXXXX – Overlay Mode	0x00000000	0x0000001F



A.10 STROBE REGISTERS

Address	Register Name	Туре	Usage	MIN Value	MAX Value
0x055C	Strobe 1 made coloator	RW	00 - Off, 01 - Each,	0x00000000	0x00000003
UXUSSC	0x055C Strobe 1 mode selector	KVV	10 - Odd, 11 - Even	0x00000000	0x00000003
0×0560	0x0560 Strobe 2 mode selector	RW	00 - Off, 01 - Each,	0x00000000	0x00000003
0.0000		IXVV	10 - Odd, 11 - Even	0.000000000	0.00000000
0x0564	Strobe 1 duration	RW	< S1Duration Value>	0x00000001	FRM_TIM_ACT
0x05B4	Strobe 2 duration	RW	< S2Duration Value>	0x00000001	FRM_TIM_ACT
0x0568	Strobe 1 position	RW	<s1 position="" value=""></s1>	0x00000001	FRM_TIM_ACT
0x056C	Strobe 2 position	RW	<s2 position="" value=""></s2>	0x00000001	FRM_TIM_ACT

A.11 INPUT AND OUTPUT REGISTERS

Address	Register Name	Туре	Usage	MIN Value	MAX Value
0x0580	IN1 Polarity Selector	RW	1 - Active H, 0 -Active L	0x00000000	0x00000001
0x0584	IN1 Input Selector	RW	<input map=""/>	0x00000000	0x00000005
0x0588	IN2 Polarity Selector	RW	1 - Active H, 0 -Active L	0x00000000	0x00000001
0x058C	IN2 Input Selector	RW	<input map=""/>	0x00000000	0x00000005
0x0590	OUT1 Polarity Selector	RW	1 - Active H, 0 -Active L	0x00000000	0x00000001
0x0594	OUT1 Output Selector	RW	<output map=""></output>	0x00000000	0x000000F
0x0598	OUT2 Polarity Selector	RW	1 - Active H, 0 -Active L	0x00000000	0x0000001
0x059C	OUT2 Output Selector	RW	<output map=""></output>	0x00000000	0x000000F

A.12 OUTPUT DATA FORMAT REGISTERS

Address	Register Name	Туре	Usage	MIN Value	MAX Value
0x0188	Negative Image	RW	1 - Enable, 0 - Disable	0x00000000	0x00000001
0x060C	SDI Output Format	RW	<sdi format=""></sdi>	0x00000000	0x0000000A



A.13 WB AND COLOR CORRECTION REGISTERS

Address	Register Name	Туре	Usage	MIN Value	MAX Value
0x0300	Auto White Balance	RW	00 - Off, 01 - Once,	0x00000000	0x00000005
	Mode		10 - Auto, 11 – Manual,		
			100 – Indoor 3200K, 101 – Outdoor 5600K		
0x0340	Auto White Balance	RW	000 − 1x, 001 − 2x,	0x00000000	0x00000004
	Tracking Speed		010 – 3x, 011 – 4x,		
			100 – 5x		
0x0304	WBC Red	RW	<value></value>	0x00000000	0x000007FF
0x0308	WBC Green	RW	<value></value>	0x00000000	0x000007FF
0x030C	WBC Blue	RW	<value></value>	0x00000000	0x000007FF
0x0310	Color Matrix Coef. Crr	RW	<value></value>	0x00000000	0x000007FF
0x0314	Color Matrix Coef. Cgr	RW	<value></value>	0x00000000	0x000007FF
0x0318	Color Matrix Coef. Cbr	RW	<value></value>	0x00000000	0x000007FF
0x031C	Offset Red	RW	<value></value>	0x00000000	0x000003FF
0x0320	Offset Green	RW	<value></value>	0x00000000	0x000003FF
0x0324	Offset Blue	RW	<value></value>	0x00000000	0x000003FF
0x0328	Color Matrix Coef. Crg	RW	<value></value>	0x00000000	0x000007FF
0x032C	Color Matrix Coef. Cgg	RW	<value></value>	0x00000000	0x000007FF
0x0330	Color Matrix Coef. Cbg	RW	<value></value>	0x00000000	0x000007FF
0x0334	Color Matrix Coef. Crb	RW	<value></value>	0x00000000	0x000007FF
0x0338	Color Matrix Coef. Cgb	RW	<value></value>	0x00000000	0x000007FF
0x033C	Color Matrix Coef. Cbb	RW	<value></value>	0x00000000	0x000007FF

A.14 DATA CORRECTION REGISTERS

Address	Register Name	Туре	Usage	MIN Value	MAX Value
UVUTTA	User Look-Up-Table Select	RW	00 – Disable, 01 – LUT 1, 10 – LUT2, 11 – LUT3, 100 – LUT4	0x00000000	0x00000004
0x011C	Gamma Look-Up-Table	RW	00 - Disable, 01 Y = 1.3, 10 = 1.6, 11 = 1.9, 100 = 2.2, 101 = 1/1.3, 110 = 1/1.6, 111 = 1/1.9, 1000 =	0x00000000	0x00000008

Imperx, Inc. 6421 Congress Ave. Boca Raton, FL 33487 +1 (561) 989-0006



BOBCAT HD-SDI Hardware User's Manual

			1/2.2		
0x0120	Defective Pixel Correction	RW	1 - Enable, 0 - Disable	0x00000000	0x00000001
0x0124	Hot Pixel Correction	RW	00 – Disable, 01 – Static, 10 – Dynamic, 11 - All	0x00000000	0x00000003
0x0128	Flat Field Correction	RW	00 – Disable, 01 – Static, 10 – Dynamic, 11 - All	0x00000000	0x00000003
0x019C	Black Gamma LUT % Select	RW	00 – 10%, 01 – 20%, 10 – 30%	0x00000000	0x00000002
0x01A8	0x01A8 Over/Under Shoot Register	RW	0 – Disable: Range 64- 940 Luma (Y), 64-960 Chroma (CrCb)	0x00000000	0x00000001
			1 – Enable: Range 4 – 1019 for YCrCb		
0x01AC	Black Gamma LUT Select		00 – Disable, 01 Y = 1.3, 10 = 1.6, 11 = 1.9, 100 = 2.2, 101 = 1/1.3, 110 = 1/1.6, 111 = 1/1.9, 1000 = 1/2.2	0x00000000	0x00000008

A.15 PROCESSING REGISTERS

Address	Register Name	Туре	Usage	MIN Value	MAX Value
0×0400	0x0400 Enhancement Mode	RW	0000 - Off,	0x00000000	0x0000006
0.0400		KVV	< Mode Select>	0.00000000	
0x0404	Point X1 position	RW	<point value="" x1=""></point>	0x00000000	0x00000FFF
0x0408	Point X2 position	RW	< Point X2 Value >	0x00000000	0x00000FFF
0x040C	Point Y1 position	RW	< Point Y2 Value >	0x00000000	0x00000FFF
0x0410	Point Y2 position	RW	< Point Y2 Value >	0x00000000	0x00000FFF

A.16 LENS CONTROL REGISTERS

Address	Register Name	Туре	Usage	MIN Value	MAX Value
0x0414	Iris Travel Slider	RW	Open/Close Iris	0x0000001	0x00000FFF
0x0414	Iris Close	RW	Iris Close	0x00010001	0x00010FFF
0x0414	Iris Open	RW	Iris Open	0x00020001	0x00020FFF
0x0414	Iris Close Full	RW	Iris Close Full (0xFFF)	0x00040XXX	
0x0414	Iris Open Full	RW	Iris Open Full (0xFFF)	0x00080XXX	
0x0414	Iris Stop	RW	Iris Stop	0x00100XXX	

Imperx, Inc. 6421 Congress Ave. Boca Raton, FL 33487 +1 (561) 989-0006 Rev. 1.5 9/26/2017



BOBCAT HD-SDI Hardware User's Manual

0x0418	Iris Speed Slider	RW	Control Iris Speed	0x00000001	0x000000FF
0x041C	Focus Travel Slider	RW	Focus Near/Far	0x00000001	0x00000FFF
0x041C	Focus Near	RW	Focus Near	0x00010001	0x00010FFF
0x041C	Focus Far	RW	Focus Far	0x00020001	0x00020FFF
0x041C	Focus Near Full	RW	Focus Near Full (0xFFF)	0x00040XXX	
0x041C	Focus Far Full	RW	Focus Far Full (0xFFF)	0x00080XXX	
0x041C	Focus Stop	RW	Focus Stop	0x00100XXX	
0x0420	Focus Speed Slider	RW	Control Focus Speed	0x00000001	0x000000FF
0x0424	Zoom Travel Slider	RW	Zoom In/Out	0x00000001	0x00000FFF
0x0424	Zoom Out	RW	Zoom Out	0x00010001	0x00010FFF
0x0424	Zoom In	RW	Zoom In	0x00020001	0x00020FFF
0x0424	Zoom Out Full	RW	Zoom Out Full (0xFFF)	0x00040XXX	
0x0424	Zoom In Full	RW	Zoom In Full (0xFFF)	0x00080XXX	
0x0424	Zoom Stop	RW	Zoom Stop	0x00100XXX	
0x0428	Zoom Travel Speed	RW	Controls Zoom Speed	0x00000001	0x000000FF
0x042C	Pulse Width	RW	0 -1ms, 1 – 2ms 2 – 4ms, 3 – 8ms	0x00000000	0x00000003
0x042C	Voltage	RW	0 – 6V, 1 – 12V	0x00000000	0x0000010

A.17 ENHANCEMENT 3 x 3 FILTER REGISTERS

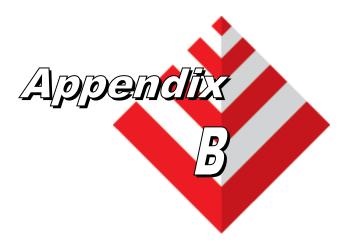
0x0430	Filter 3 x 3 Select Register	RW	0 – Disable, 1 - Enable	0x00000000	0x00000001
0x0434	Coefficient C00	RW	Step 1/64; range -/+ 32	0x00000000	0x00000FFF
0x0438	Coefficient C01	RW	Step 1/64; range -/+ 32	0x00000000	0x00000FFF
0x043C	Coefficient C02	RW	Step 1/64; range -/+ 32	0x00000000	0x00000FFF
0x0440	Coefficient C10	RW	Step 1/64; range -/+ 32	0x00000000	0x00000FFF
0x0444	Coefficient C11	RW	Step 1/64; range -/+ 32	0x00000000	0x00000FFF
0x0448	Coefficient C12	RW	Step 1/64; range -/+ 32	0x00000000	0x00000FFF
0x044C	Coefficient C20	RW	Step 1/64; range -/+ 32	0x00000000	0x00000FFF
0x0450	Coefficient C21	RW	Step 1/64; range -/+ 32	0x00000000	0x00000FFF
0x0454	Coefficient C22	RW	Step 1/64; range -/+ 32	0x00000000	0x00000FFF
0x0458	Filter Offset	RW	Range -1024+1023	0x00000000	0x000007FF



A.18 MANUFACTURING DATA REGISTERS

Address	Register Name	Туре	Value
0x7004	Assembly Part Number	RO	<assembly number_1="" part=""></assembly>
0x7008	Assembly Part Number	RO	<assembly number_2="" part=""></assembly>
0x700C	Assembly Part Number	RO	<assembly number_3="" part=""></assembly>
0x7010	Assembly Part Number	RO	<assembly number_4="" part=""></assembly>
0x7014	Assembly Serial Number	RO	<assembly number_1="" serial=""></assembly>
0x7018	Assembly Serial Number	RO	Assembly Serial Number_2
0x701C	CCD Serial Number	RO	<ccd number_1="" serial=""></ccd>
0x7020	CCD Serial Number	RO	<ccd number_2="" serial=""></ccd>
0x7024	Date of Manufacturer	RO	<date manufacturer_1="" of=""></date>
0x7028	Date of Manufacturer	RO	<date manufacturer_2="" of=""></date>
0x702C	Camera Type	RO	<type camera_1="" of=""></type>
0x7030	Camera Type	RO	<type camera_2="" of=""></type>
0x7034	Camera Type	RO	<type camera_3="" of=""></type>
0x7038	Camera Type	RO	<type camera_4="" of=""></type>





Creating Look Up Tables

This appendix provides a reference on how to create a lookup table using the ASCII editor, Excel spreadsheet, and IpxToolkit: Lut Manager SW.



B.1 OVERVIEW

The Lookup Table file can be created using any standard ASCII text editor or by using Microsoft Excel. Additionally, any spreadsheet or mathematical program capable of generating a comma delimited (.csv) file can be used.

See Appendix E for software load procedure.

B.2 USING AN ASCII TEXT EDITOR

A custom LUT (lookup table) can be prepared using any ASCII text editor, such as "Notepad" or similar. Alternatively, any spreadsheet program (i.e. Microsoft Excel) can be used by converting the spreadsheet into a comma delimited (.csv) file. In either case, the file must be renamed to include the .lut extension. The .lut file has two main sections: a header and a table. The 'header' section is a free text area of up to 256 ASCII characters. Each line of the header section must be terminated in a comma. The 'table' section of the file contains an array of 1024 lines for mono camera, 1024*3 lines for color camera with each line containing an input value followed by a comma and an output value. The input values represent incoming pixels and the output values represent what each incoming pixel should be converted into as an output pixel.

The format of the .LUT file for mono camera is as follows:

```
-- Look Up Table input file example,
-- lines beginning with two dashes are comments,
-- and are ignored by parser,
:Header,
-- this is the text that will get displayed with a 'glh'
command,
Function is 'Negative Image',
Created by John Doe,
Date 1/14/09,
:Table,
-- input output,
      0,4095
      1,4094
      2,4093
      3,4092
      4,4091
      4095,0
```



The format of the .LUT file for color camera is as follows:

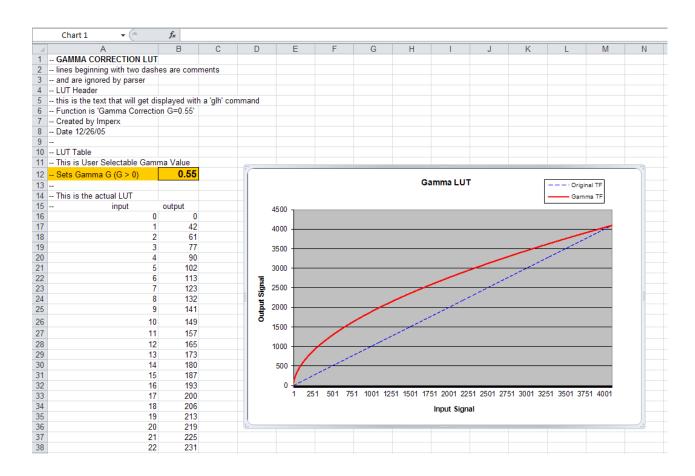
```
-- Look Up Table input file example,
-- lines beginning with two dashes are comments,
-- and are ignored by parser,
:Header,
-- this is the text that will get displayed with a 'glh'
Function is 'Negative Image',
:Table R,
--input R, output R
0,1023
1,1022
2,1021
3,1020
4,1019
1023,0
:Table G,
--input G, output G
0,1023
1,1022
2,1021
3,1020
4,1019
1023,0
:Table B,
--input B, output B
0,1023
1,1022
2,1021
3,1019
1023,0
```



B.3 USING MICROSOFT EXCEL

The .LUT file can be created in Excel as follows:

- 1 create the spreadsheet as shown below (note that 1024 (1024*3) rows are required in the table).
- 2 add the necessary equations into the output cells to generate the transfer function required.
- 3 save the file as a .csv (comma delimited format).
- 4 rename the .csv file to an extension of .lut.

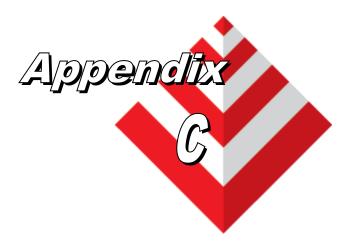




B.4 USING LUT Manager

The .LUT file can be created in LUT Manager. The LUT manager is a plugin Of IpxToolkit SW. Please refer to the IpxToolkit documentation.





Creating DPC and HPC Tables

This appendix provides a reference on how to create a DPC and HPC table using an ASCII editor, and the IpxToolkit DPC/HPC Utility.



C.1 OVERVIEW

The Defective Pixel Map (DPM) and Hot Pixel Map (HPM) are provided with each camera. If the user wants to create its own DPM or HPM file, he/she can use any standard ASCII text editor or Microsoft Excel. Additionally, any spreadsheet or mathematical program capable of generating a comma delimited (.csv) file can be used.

C.2 USING AN ASCII TEXT EDITOR

A custom Defective Pixel Map (DPM) and Hot Pixel Map (HPM) can be prepared using any ASCII text editor, such as "Notepad" or similar. The file must have a .dpm extension for DPM map and .hpm extension for HPM. The .dpm (or .hpm) file has two main sections: a header and a table. The 'header' section is a free text area of up to 256 ASCII characters. Each line of the header section must be terminated in a comma. The 'table' section of the file contains an array of lines with each line containing an X (pixel number) value followed by a comma and a Y (line number) value. All pixels are listed in the DPM (or HPM) in order of increasing Y location. If the Y location is identical, the listing is in order of increasing X location. After editing save each file with the appropriate file extension. The maximum number of pixels in the DMP list is 128, and in HPM list is 1024.

Here is a simple example how to create a DPM. Create the DPM file with extension .dpm using "Notepad" or any other editing software. Locate the defective pixels in the camera and enter them in order starting with the smallest pixel number of the line number first. The file looks like this:

```
-- Defective Pixel Map,
-- Date: 7/21/2009,
-- Model#: ICL-B0610M,
-- Serial#: 060380,
:Table,
-- Column(X),Row(Y)
4,1
588,1
78,5
82,27
405,300
```

Note.

In this example, the first table entry is pixel 4 from line 1, the next entry is pixel 588 from line 1, and the next entry is pixel 78 from line 5 and so on.

 Imperx, Inc.
 Rev. 1.5

 6421 Congress Ave.
 9/26/2017



C.3 USING AN IPXTOOLKIT DPC/HPC UTILITY

The .dpm/.hpm files can be created in IpxToolkit DPC/HPC Utility. Please refer to the IpxToolKit documentation.





Software Installation

This appendix explains how to install the Bobcat CamConfig software.



Use the following steps to install the Bobcat Configurator software supplied on a CD. Note that 'click' refers to the left mouse button.

1. If a version of Bobcat Configurator was previously installed on this machine, then you must first remove it:

To remove the application files:

- 1.1 Click on "Start".
- 1.2 Click on "Settings".
- 1.3 Click on "Control Panel".

Double click on "Add or Remove Programs" for Windows XP or "Programs and Features" for Windows Vista and Windows 7.

- 1.5 Click on "Bobcat Configurator".
- 1.6 Click on "Remove".
- 1.7 If the 'Bobcat Configurator InstallShield Wizard' pops-up then do the following,

otherwise go to step 1.8:

Click on "Remove".

Click "Next".

Click "Yes".

Click "Finish".

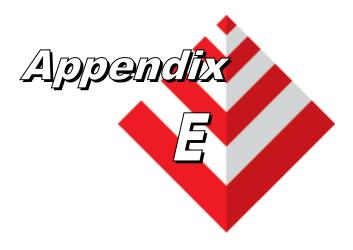
- 1.8 Click on "Yes".
- 1.9 Click on "Close".
- 2. After having removed a previous version or if a version of Bobcat Configurator was NOT previously installed on this machine then:

The first step is to install the application files:

- 2.1 Insert the Bobcat Configurator CD into the appropriate drive; the setup.exe file will run automatically. Note: If it does not start automatically, click on "Start", "Run", enter or browse to "(CD drive): setup.exe" and click "OK".
- 1.2 Wait for the "Bobcat Configurator InstallShield Wizard" screen to appear.
- 1.3 Follow the on-screen instructions.
- 2.4 Click "Finish". This completes the software installation.
- 2.5 Reboot your computer.

For additional information and the latest updates and downloads, please visit our website at www.imperx.com





Firmware Upgrade

This appendix explains how to upgrade the Bobcat Firmware, DPH, HPM, FFC, LUT and camera registers for Bobcat HDSDI cameras.



E.1 OVERVIEW

Bobcat Camera series supports user FirmWare (FW) and Workspace registers upgrade, along with a custom DPC, HPC, FFC and LUT tables upload. The upload utility software is provided as a part of CamConfig GUI, shipped with each camera. After installing the program, the user has access to a 'download' utility window, which allows the user to download newly released firmware or other files into the camera's non-volatile memory. To receive the latest FW and RGS files, please contact Imperx. **The FW of HD-SDI camera consists of two parts: Application Firmware and I/O Application Firmware.** The user Application Firmware file normally is called "SDI_XXXXX_RU_ABC.rpd" where "XXXXXX" represents the camera type and "ABC" represents the version number. The user I/O Application Firmware file normally is called "IO_SDI_BXXXX_RU_ABC.rpd" where "ABC" represents the version number. The Factory Space upgrade file is normally called "SDI_YYYYY_RU_RA_rgs" where "YYYYYY" represents the camera type and "A" represents the version number.

E.2 BOBCAT HD-SDI UPGRADE

The user can select to upload either new Camera Firmware, Camera Factory Register Space, a Lookup Table, a Defect Pixels Correction table, a Hot Pixels Correction table or a Flat Field Correction file by selecting the appropriate path/filename of the file can be entered manually into the edit box or browsed to by clicking on the '...' button. Clicking on the 'Load File...' button begins the download process. The user must be familiar with the entire procedure and must follow it precisely. To start a Bobcat upgrade, follow the described steps:

Start Application Bobcat CamConfig go to Main Menu and from submenu "Load From..." select "Factory Space". Wait until camera is initialized.

Go to Main Menu and from submenu "Terminal", select Download Terminal.

When "Download Terminal" is opened, from File Type, you have to select what file you want to upload to the Camera: Application Firmware Image (rpd), Factory Space (rgs) file), DPC, HPC, FFC or LUT – Figure E.1.

DPC, HPC, FFC and LUT Upgrade: When you select the appropriate file for this particular camera you have to press button "Load File" and wait to finish the process of uploading. This could take few minutes. When everything is done you should get the message "Done!" Re-power the camera.

FW Upgrade: When you select the appropriate Application Firmware Image (I/O Application Firmware Image) file for this particular camera you have to press button "Load File" and wait to finish the process of uploading. This could take few minutes. When everything is done you should get the message "Done! Reset FPGA and the current new version of your camera firmware" – Figure E.3.

Imperx, Inc. Rev. 1.5 6421 Congress Ave. 9/26/2017



RGS Upgrade: When you select the appropriate Factory Space file for this particular camera you have to press button "Load File" and wait to finish the process of uploading. This could take few minutes. When everything is done you should get the message "Uploading is finished successfully". Please re-power your camera after Factory Space upgrading —Figure E.4.

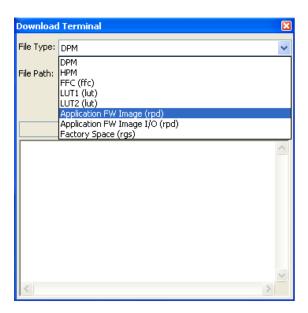


Figure E.1

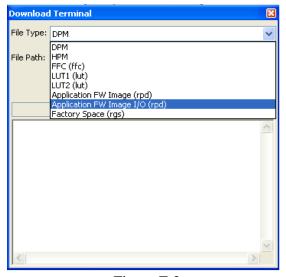


Figure E.2



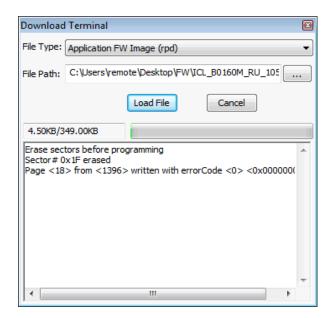


Figure E.3

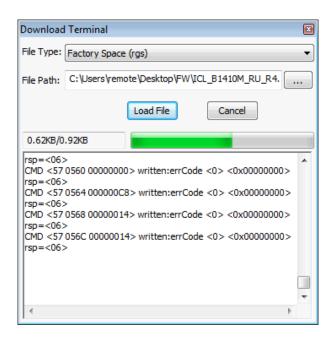


Figure E.4



E.3 BOBCAT HD-SDI UPGRADE USING BOBCAT UPLOAD MANAGER

The user can upload FW, LUT, HPC, DPC, FFC by Bobcat Upload Manager. Please refer to the Bobcat Upload Manager documentation.



CAUTION NOTE

It is strongly recommended that you DO NOT USE any other communication software to upgrade the camera FW, RGS, DPC, HPC, FFC and LUT files.

If the user selects to upgrade camera firmware (.RPD file) and camera factory register space (.RGS file), the camera firmware (.RPD) must be upgraded first.

During camera RGS or FW upgrade the camera power must be on all the time, and the process must not be interrupted. If the camera is disconnected or the process canceled, this will result in a user application firmware corruption. If such event occurs start the upload process again until completion. If the upgrade process cannot be completed, the camera will power with the default Factory Firmware so you can start the upgrade process again. If you need more information, please contact Imperx.

If the user selects to upgrade camera firmware and camera factory register space, the camera firmware must be upgraded first.

During camera RGS or FW upgrade the camera power must be on all the time, and the process must not be interrupted. If the camera is disconnected or the process canceled, this will result in a user application firmware corruption. If such event occurs start the upload process again until completion. If the upgrade process cannot be completed, the camera will power with the default Factory Firmware so you can start the upgrade process again. If you need more information, please contact Imperx.

During DPC, HPC, FFC or LUT upgrade the camera power must be on all the time, and the process must not be interrupted. If the camera is disconnected or the process canceled, start the upload process again until completion. If the upgrade process cannot be completed, the corresponding camera function will not work. This will not affect the overall camera performance, so you can start the upgrade process again. If you need more information, please contact Imperx.





Powers Supply

This appendix has power supply models and cameras for Bobcat HD-SDI series cameras.



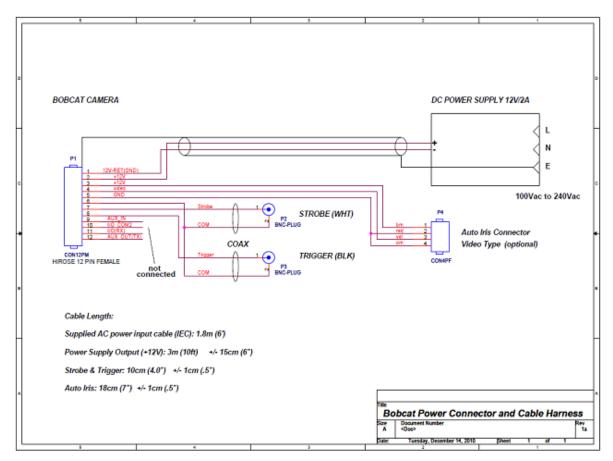


Model: PS12V04 Bobcat standard power supply ordered separately.

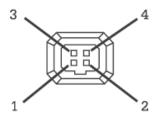


Trigger & Strobe pigtail with Male BNC connectors





Model: PS12V05 Auto Iris 4 pin Video Type Option power supply ordered separately.



P4 CON4PF: 4 pin MINI plug E4-191J

Pin	Signal	Туре	Cable	Description
1	IRIS + 12 VDC	Power	Brn	+ 12 VDC Main Power @ 1A Max
2	IRIS Return	Ground Return	Red	12 VDC Iris Power Return
3	IRIS Video	Video Signal	Yell	Iris Video Output
4	IRIS Return	Ground Return	Orn	12 VDC Iris Power Return

<u>Table 1.14 – Auto Iris 4 pin MINI plug E4-191J.</u>

Imperx, Inc. 6421 Congress Ave. Boca Raton, FL 33487 +1 (561) 989-0006 Rev. 1.5 9/26/2017



Power Supply Specs:

Cable length:

Supplied AC power input cable (IEC): 1.8m (6') 100 - 240 Vac, 50 - 60Hz 1A

Power supply Output ($\pm 12V$): 3m (± 15 cm (6") connector HIROSE #HR10A-10P-12S

Strobe & Trigger: $10\text{cm} (4") \pm 1\text{cm} (0.5")$ connector BNC male

Auto Iris Option: $18 \text{cm} (7") \pm 1 \text{cm} (0.5")$ Video type 4 Pin MINI plug connector E4-191J

Electrical:

Over-Voltage Protective Installation

Short-circuit Protective Installation

Protection Type: Auto-Recovery

10 -15 VDC 12VDC nominal, 2 A.

Load regulation \pm 5%

Ripple & Noise 1% Max.

Regulatory:

Class 1

Safety standards UL60950-1,EN60950-1,IEC60950-1

Safety (1) EMC UL/CUL,CE,TUV,DoIR+C-Tick,Semko,CCC, FCC

Safety (2) BSMI,FCC