IMPERX

Cheetah 3G-SDI CMOS Camera
User Guide
with SMPTE® output

The Imperx Cheetah 3G-SDI cameras provides broadcast quality video imaging with high sensitivity in a compact and ruggedized design. The camera's Sony Pregius CMOS image sensor delivers 1920 x 1080 resolution at up to 60 progressive frames per second. It provides the superior motion capture needed in a wide range of applications such as industrial imaging, surveillance, metrology, and medical and scientific imaging. The 3G-SDI cameras are easy to configure and are SMPTE 292M and 424M compliant.

Revision 1.5

IMPERX ✦
Industrial Cameras & Imaging Systems

About Imperx, Inc.

IMPERX, Inc. is a leading designer and manufacturer of high performance, high quality digital cameras, frame grabbers, and accessories for industrial, commercial, military, and aerospace imaging applications including flat panel inspection, biometrics, aerial mapping, surveillance, traffic management, semiconductors and electronics, scientific & medical Imaging, printing, homeland security, space exploration, and other imaging and machine vision applications.

Fortune 100 companies, federal and state government agencies, domestic and foreign defense agencies, academic institutions, and other customers worldwide use IMPERX products.

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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) years parts and labor. FOR GLASSLESS CAMERAS THE CCD OR CMOS 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.

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REVISION HISTORY

Revision	Date	Reviser	Comments
1.0	10/4/2017	R. Johnston	Initial release approval.
1.1	11/16/2017	R. Johnston	Added C1920 camera and updated GUI screens.
1.2	11/29/2018	K. Wetzel	Added image plane mechanical drawing; Added P-Iris Lens Control GUI screen Edited AEC/AGC text, page 28 Adjusted operating temperature and storage to: from -30 °C to +75 °C only (removed the 1.5G and 3.0G). Added "Note: Consult your lens manufacturer for P-Iris lens control power" to Ordering Information. Added P-IRIS Registers and Camera Config Registers to Appendix A. Added AEC/AGC status register. Updated Exposure formulas in Appendix A.
1.3	12/18/2019	I. Barabanova	Adjusted supply voltage range to: from 8V to 32 V. Added vibration and shock compliance. Updated storage temperature range: -40 °C to +85 °C Optical format: SDI-C1920: 1/1.23", SDI-C2010: 1/2.35"
1.4	4/14/2021	I. Barabanova	Added 3G-SDI-C1911 camera Added UKCA compliance Added Video Iris Added PS12V16A and PS12V19A Power Supplies Added Automatic Iris and P-Iris Control sections Added Appendixes B and C Updated CamConfig GUI screen shots
1.5	7/7/2021	I. Barabanova	Updated mechanical drawings Updated Dimensions and Weight specifications Added power supply range for models with Video Iris

About the 3G-SDI Camera

General

Imperx Cheetah 1080P 3G-SDI CMOS cameras provide a ruggedized imaging platform with the latest digital technology and industrial grade components. The cameras meet the Society of Motion Picture and Television Engineers standards SMPTE 292M and 424M for digital video transmission over coaxial cable.

The cameras use Sony Pregius CMOS image sensors and are available in monochrome and color.

Model	Resolution	Type	Optics	Pixel size microns	CMOS	Sensor Model
SDI-C1911M	1920 x 1080	Mono	1/1.58"	4.5	Sony	IMX-429LLR
SDI-C1911C	1920 x 1080	Color	1/1.58"	4.5	Sony	IMX-429LQR
SDI-C1920M	1920 x 1080	Mono	1/1.23"	5.86	Sony	IMX-174LLJ-C
SDI-C1920C	1920 x 1080	Color	1/1.23"	5.86	Sony	IMX-174LQJ-C
SDI-C2010M	1920 x 1080	Mono	1/2.35"	3.45	Sony	IMX-265LLR
SDI-C2010C	1920 x 1080	Color	1/2.35"	3.45	Sony	IMX-265LQR

The Cheetah 3G-SDI camera is an advanced, ruggedized, small profile 1080 progressive scan digital camera. It is fully programmable and field upgradeable and features a built-in image-processing engine, low power consumption, low noise, and high dynamic range (12 F-Stops) with frame rates up to 60 frames per second.

The camera provides programmable gain, offset, electronic shutter, strobe output, gamma correction, and programmable Look-up tables (LUT). It supports global shutter operation for superior motion capture and is fully programmable via the serial interface using a GUI based configuration utility.

The camera is suitable for many applications including machine vision, metrology, high-definition surveillance, medical, scientific imaging, intelligent transportation systems, character recognition, document processing, and more.

Key Features

- 1080p Mono and Color 23.98p, 24p; 25p; 29.97p, 30p; 50p, 59.94p, 60p

- 720p Mono and Color 50p, 59.94p, 60p (C1920 and C2010 cameras only)

- Color - 3x10-bit (YCrCb) data

- RS-232 serial communication

- Analog/digital gain and offset control

- One Area of Interest (AOI) for AEC/AGC/AIC

- Automatic gain, exposure, and iris control (AGC/AEC/AIC) with optional P-Iris control

- Automatic white balance

- Internal exposure control – manual, automatic

- Test image with image superimposition

- Programmable I/O

  o   1 genlock tri-level sync input;

  o   1 programmable TTL output

- Dynamic transfer function and gamma corrections

- Sensor temperature monitor (C1911 and C2010 cameras only)

- Video Iris (optional)

- Field upgradeable firmware

Technical Specifications

C1911 Technical Specifications

Specifications		C1911 3G-SDI
Active image resolution		1920 (H) x 1080 (V)
Pixel size		4.5 µm
Optical format		1/1.58" optical format, 10.1 mm diagonal
Video output		Digital, 10 bit
Output structure		YUV422
Data clock		37.08789/37.125 MHz
Camera interface		HD-SDI SMPTE 292M and SMPTE 424-1
SDI format		1080p: 23.98p, 24p, 25p, 29.97p, 30p, 50p, 59.94p, 60p
Dynamic range		77 dB (13 F Stops)
Shutter speed		1/50,000 to 1/24
Gain		0–48 dB, 480 steps (0.1 dB/step)
Black level offset		0–511 levels
Auto gain/exposure		Yes, with optional AEC/AGC within an AOI
Minimum illumination		0.2 lux, f=1.4
Camera control		RS-232
White balance		Auto, Once, Manual, 3200k, 5600k, Off
Area of interest		One
Test image		HD SMPTE color bars, static/moving ramp
Image overlay		Yes
I/O control		1 tri-level sync input, 2 outputs (OPTO, TTL)
Strobe output		1 strobe (2nd strobe optional), programmable position and duration
In-camera processing		Yes
Lens mount		C mount (default), Video Iris (optional), P-Iris (optional)
Camera housing		6000 series aluminum
Upgradeable firmware		Yes
Data correction		4 user LUTs; 8 Gamma LUTs; 8 black Gamma LUTs; Defective/Hot pixel correction; Threshold, Contrast enhancement, Knee correction
Sensor temperature monitor		Supported
Supply voltage range		8 V to 32 V, 1.5 A inrush 8 V to 12 V± 20%, 1.5 A inrush (for models having Video Iris)
Power consumption		3.6 W
Camera size (W x H x L)		37 mm x 37 mm x 47.2 mm
Weight		109 grams nominal
Vibration, shock		Complies with IEC60068-2-64 and IEC60068-2-27
Environmental	Operating	-30 °C to +75 °C
	Storage	-40 °C to +85 °C
Relative humidity		10% to 90% non-condensing
MTBF		>406,000 hours at 40°C
Regulatory		FCC 15 part A, CE, RoHS, UKCA

C1920 Technical Specifications

Specifications		C1920 3G-SDI
Active image resolution		1920 (H) x 1080 (V)
Pixel size		5.86 µm
Optical format		1/1.23", 13 mm diagonal
Video output		Digital, 10 bit
Output structure		YUV422
Data clock		37.08789/37.125 MHz
Camera interface		HD-SDI SMPTE 292M and SMPTE 424-1
SDI format		1080p: 23.98p, 24p, 25p, 29.97p, 30p, 50p, 59.94p, 60p 720p: 50p, 59.94p, 60p
Dynamic range		73 dB (12 F Stops)
Shutter speed		1/50,000 to 1/24
Gain		0–48 dB, 480 steps (0.1 dB/step)
Black level offset		0–511 levels
Auto gain/exposure		Yes, with optional AEC/AGC within an AOI
Minimum illumination		0.2 lux, f=1.4
Camera control		RS-232
White balance		Auto, Once, Manual, 3200k, 5600k, Off
Area of interest		One
Test image		HD SMPTE color bars, static/moving ramp
Image overlay		Yes
I/O control		1 tri-level sync input, 2 outputs (OPTO, TTL)
Strobe output		1 strobe (2nd strobe optional), programmable position and duration
In-camera processing		Yes
Lens mount		C mount (default), Video Iris (optional), P-Iris (optional)
Camera housing		6000 series aluminum
Upgradeable firmware		Yes
Data correction		4 user LUTs; 8 Gamma LUTs; 8 black Gamma LUTs; Defective/Hot pixel correction; Threshold, Contrast enhancement, Knee correction
Supply voltage range		8 V to 32 V, 1.5 A inrush 8 V to 12 V ± 20%, 1.5 A inrush (for models having Video Iris)
Power consumption		3.6 W
Camera size (W x H x L)		37 mm x 37 mm x 47.2 mm
Weight		109 grams nominal
Vibration, shock		Complies with IEC60068-2-64 and IEC60068-2-27
Environmental	Operating	-30 °C to +75 °C
	Storage	-40 °C to +85 °C
Relative humidity		10% to 90% non-condensing
MTBF		>406,000 hours at 40°C
Regulatory		FCC 15 part A, CE, RoHS, UKCA

C2010 Technical Specifications

Specifications		C2010 3G-SDI
Active image resolution		1920 (H) x 1080 (V)
Pixel size		3.45 µm
Optical format		1/2.35", 7.7 mm diagonal
Video output		Digital, 10 bit
Output structure		YUV422
Data clock		37.08789/37.125 MHz
Camera interface		HD-SDI SMPTE 292M and SMPTE 424-1
SDI format		1080p: 23.98p, 24p, 25p, 29.97p, 30p, 50p, 59.94p, 60p 720p: 50p, 59.94p, 60p
Dynamic range		71 dB (12 F Stops)
Shutter speed		1/50,000 to 1/24
Gain		0–48 dB, 480 steps (0.1 dB/step)
Black level offset		0–511 levels
Auto gain/exposure		Yes, with optional AEC/AGC within an AOI
Minimum illumination		0.2 lux, f=1.4
Camera control		RS-232
White balance		Auto, Once, Manual, 3200k, 5600k, Off
Area of interest		One
Test image		HD SMPTE color bars, static/moving ramp
Image overlay		Yes
I/O control		1 tri-level sync input, 2 outputs (OPTO,TTL)
Strobe output		1 strobe (2nd strobe optional), programmable position and duration
In-camera processing		Yes
Lens mount		C mount (default), Video Iris (optional), P-Iris (optional)
Camera housing		6000 series aluminum
Upgradeable firmware		Yes
Data correction		4 user LUTs; 8 Gamma LUTs; 8 black Gamma LUTs; Defective/Hot pixel correction; Threshold, Contrast enhancement, Knee correction
Sensor temperature monitor		Supported
Supply voltage range		8 V to 32 V, 1.5 A inrush 8 V to 12 V ± 20%, 1.5 A inrush (for models having Video Iris)
Power consumption		3.6 W
Camera size (W x H x L)		37 mm x 37 mm x 47.2 mm
Weight		109 grams nominal
Vibration, shock		Complies with IEC60068-2-64 and IEC60068-2-27
Environmental	Operating	-30 °C to +75 °C
	Storage	-40 °C to +85 °C
Relative humidity		10% to 90% non-condensing
MTBF		>406,000 hours at 40°C (Telcordia SR-332)
Regulatory		FCC 15 part A, CE, RoHS, UKCA

Camera Configuration

Cheetah SDI cameras are programmable and flexible. You can control and monitor the camera's resources (internal registers and parameter flash) using a simple, register-based, command protocol via the camera's RS-232 serial interface. The interface is bidirectional enabling you to issue commands to the camera and receive responses (either status or info) from the camera. You can also program the camera's parameters using the Cheetah SDI CamConfig graphical user interface (GUI) software.

Camera Ordering Information

When ordering a camera, please specify the camera ordering code. To create your own customer Cheetah ordering code, simply choose one element from each column in table below.

Interface	Camera model	Sensor Type	Environmental	Lens Mount	Filter/ customization options
SDI – 3G-SDI / HD-SDI Selectable (SMPTE 424-1 / 292M Selectable)	C1911 C1920 C2010	C = Color M = Monochrome	R=Ruggedized	C = Mount (Default) S = CS-Mount (Optional) I = P-Iris C (Optional) A = P-Iris CS (Optional) V = Video Iris C (Optional) H = Video Iris CS (Optional)	000 = none

Notes:

1) 000 (none) filter/customization option means that a color camera has IR filter, a monochrome camera does not have any filters.

2) Sample codes:
   SDI-C2010C-RC000: Cheetah Color camera with C-Mount and 3G-SDI / HD-SDI interface.
   SDI-C1911M-RV000: Cheetah Monochrome camera with C-Mount Video Iris and 3G-SDI / HD-SDI interface.

> ⚠ **CAUTION**   Imperx recommends using the PS12V16A or PS12V19A power supply for powering SDI-C1911, SDI-C1920, and SDI-C2010 cameras.

Power Supply Ordering Information

Part Number	Description	Compatible with
PS12V16A	Power Supply 12 V DC, 3 A, With one strobe and one trigger, 1.75 m length	C1911, C1920, C2010
PS12V19A	Power Supply 12 V DC, 3 A, With one trigger and P-Iris/Video Iris connector 1.75 m length	C1911, C1920, C2010 with P-Iris/ Video Iris lens control

Hardware

Camera Connectivity

The Cheetah 3G-SDI camera connects to outside equipment using two connectors on the back panel of the camera. The back panel also provides an LED status indicator.

mini push-pull coaxial connector

12-pin connector for power, I/O

status LED
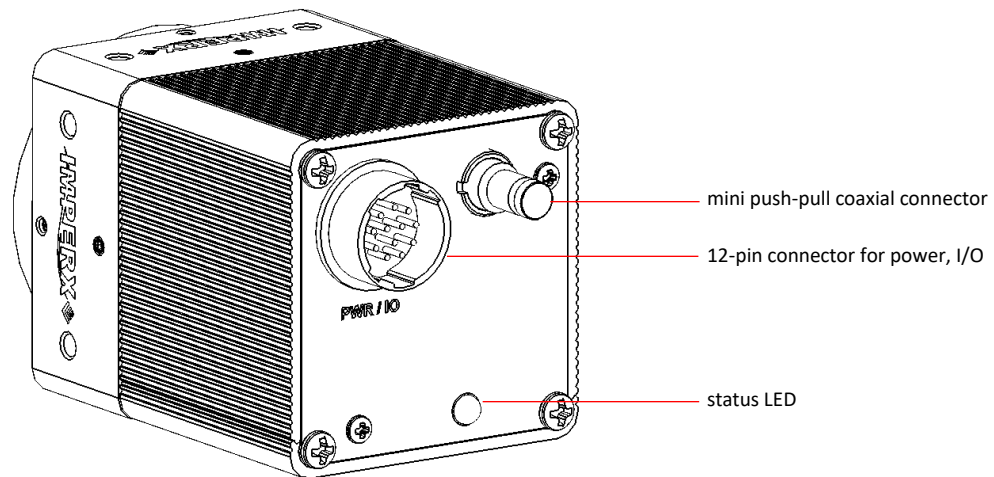
The camera provides the following:

- camera 3G-SDI output – Amphenol-RF Division 75 Ohm coaxial connector ACX1785-ND #282121-75. Imperx offers a 3G-SDI coaxial cable with 1.0/2.3 DIN to BNC male connectors available in varying lengths. The cable has a miniature quick connect/push-pull type coupling mechanism on the camera end and a BNC connector with quarter turn coupling on the host computer end. Contact Imperx for more information

- male 12-pin Hirose miniature locking receptacle #HR10A-10R-12PB(71) providing power, I/O interface, and Serial RS-232 interface. See connector pin mapping (Pin Assignments) on the following page

- status LED indicating the status of the camera (see LED Status)

- camera's model and serial number

Pin Assignments

The Hirose connector on the camera's back panel is a male type miniature locking receptacle #HR10A-10R-12PB(71). The mating part is a female Hirose type miniature locking plug #HR10A-10P-12S(73).

The Imperx PS12V16A power supply (sold separately – see section PS12V16A Power Supply) terminates in a female Hirose type miniature locking plug #HR10A-10P-12S(73) and has a DB9 connector for serial RS-232 interface and two small BNC pig-tail cables for the external Tri-Level Sync Genlock input and strobe output.
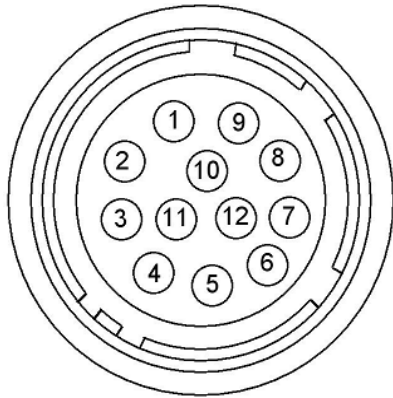
Pin	Signal	Type	Description
1	12 V DC Return	Ground Return	12 V DC Main Power Return
2	+ 12 V DC	Power – Input	+ 12 V DC Main Power
3	RS-232 RX	Communication Input	RS-232 Receive
4	RS-232 TX	Communication Output	RS-232 Transmit
5	GPIO_1B	General Purpose I/O 1B	Reserved for optional P-Iris A-Phase, or Strobe 2_Return
6	RS-232 RTN	Communication Return	RS-232 Return
7	OUT 1	TTL OUT 1	Strobe 1 Output
8	TLS IN 1	Tri-Level Sync	Tri-Level Sync Genlock Input
9	GPIO_2A	General Purpose I/O 2A	Reserved for optional P-Iris B_Enable, Power Return for Video Iris, or Input 2
10	GP IN and Out 1 Return	Ground Return	Tri-level Sync Input and Out 1 Return
11	GPIO_2B	General Purpose I/O 2B	Reserved for optional P_Iris B_Phase, Power for Video Iris, or Input 2 Return
12	GPIO_1A	General Purpose I/O 1A	Reserved for optional P-Iris A_Enable, Video iris signal, or Strobe 2_output

Connecting a Video Iris Lens

The Cheetah 3G-SDI cameras are available with optional Video Iris lens.
A Video Iris lens uses a motor for adjusting the iris position when lighting conditions change. It is equipped with an amplifier and operated by a video signal from the camera. Signals from the camera's Hirose connector provide power and control the Video Iris through an external cable.

Imperx recommends using the PS12V19A power supply that has a lens control cable terminated with a female P-Iris/Video Iris plug. The cable drawing is shown on the page 23.

> ⚠️**CAUTION** The maximum supply voltage must not exceed 14.4 V (12 V + 20%) for Cheetah SDI cameras having Video Iris.
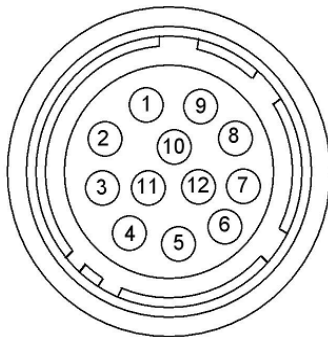
If your application requires assembling you own cable, please refer to the diagram below that shows the Video Iris connections to the Hirose connector:
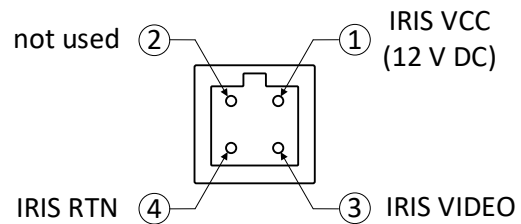
Hirose HR10A-10P-12S(73) female plug

Signal	Pin
GND	5
IRIS RTN	9
IRIS VCC	11
IRIS VIDEO	12

Video Iris jack

Pin	Signal
2	not used
4	+12 V DC RETURN
1	+12 V DC
3	VIDEO

Video Iris jack (female):

Pin	Signal Name	Use
1	+12 V DC RTN	12 V DC Main Power Return
2	+12 V DC	12 V DC Main Power
3	RS-232 RX	RS-232 Receive
4	RS-232 TX	RS-232 Transmit
5	GND	Video Iris (not used)

Pin	Signal Name	Use
6	RS-232 RTN	RS-232 Return
7	OUT1	General Purpose Output 1 (TTL)
8	TLS IN 1	Tri-Level Sync Genlock Input
9	IRIS RTN	12 V DC Power Return (Video Iris)
10	TLS IN1/OUT1 RTN	Tri-level Sync Input and Out 1 Return (TTL)
11	IRIS VCC	12 V DC Power (Video Iris)
12	IRIS VIDEO	Video Iris signal

Connecting a P-IRIS Lens

The Cheetah 3G-SDI cameras are available with optional P-Iris lens.
A P-Iris lens uses a stepper motor for adjusting the iris position when lighting conditions change. Signals from the camera's Hirose connector provide power and control the P-Iris through an external cable.

Imperx recommends using the PS12V19A power supply that has a lens control cable terminated with a female P-Iris/Video Iris plug. The cable drawing is shown on the page 23.
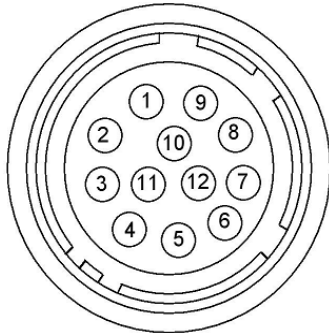
If your application requires assembling you own cable, please refer to the diagram below that shows the P-Iris connections to the Hirose connector:
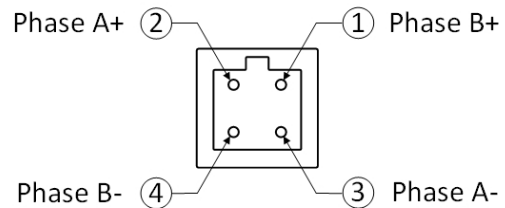
Hirose HR10A-10P-12S(73) female plug

P-Iris jack

Signal	Pin
P-Iris Phase A+	5
P-Iris Phase B-	9
P-Iris Phase B+	11
P-Iris Phase A-	12

Pin	Signal
2	Phase A+
4	Phase B-
1	Phase B+
3	Phase A-

P-Iris jack (female):

Phase A+ ② — ① Phase B+

Phase B- ④ — ③ Phase A-

Pin	Signal Name	Use
1	+12 V DC RTN	12 VDC Main Power Return
2	+12 V DC	12 VDC Main Power
3	RS-232 RX	RS-232 Receive
4	RS-232 TX	RS-232 Transmit
5	P-Iris Phase A+	Mapped to the pin 2 of a P-Iris jack
6	RS-232 RTN	RS-232 Return
7	OUT1	General Purpose Output 1 (TTL)
8	TLS IN 1	Tri-Level Sync Genlock Input

| Pin	Signal Name	Use
9	P-Iris Phase B-	Mapped to the pin 4 of a P-Iris jack
10	TLS IN1/OUT1 RTN	Tri-level Sync Input and Out 1 Return (TTL)
11	P-Iris Phase B+	Mapped to the pin 1 of a P-Iris jack
12	P-Iris Phase A-	Mapped to the pin 3 of a P-Iris jack

LED Status

The camera has a red-green-yellow LED on the back panel of the camera. The following LED colors and light patterns indicate the camera status and mode of operation:

LED Condition	Status Indication
GREEN steady ON	Normal operation. You should see a normal image coming out of the camera.
GREEN blinks at ~ 2.0 Hz	Camera is in external genlock sync mode.
YELLOW steady ON	Test mode. You should see one of the test patterns.
YELLOW blinks at ~ 0.5 Hz	Camera is in AGC/AEC mode. In this mode, changing the shutter slider does not affect the image luminance.
RED steady ON	RS-232 communication error or firmware load error. Re-power the camera and load the factory settings. If the condition is still present, contact the factory for support.
LED OFF	Power not present. Possible power supply failure or faulty external AC adapter. Re-power camera and load factory settings. If the LED is still OFF, contact the factory for RMA.

Camera Connection Diagram

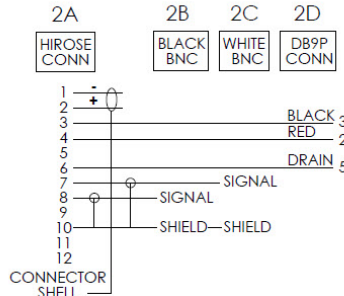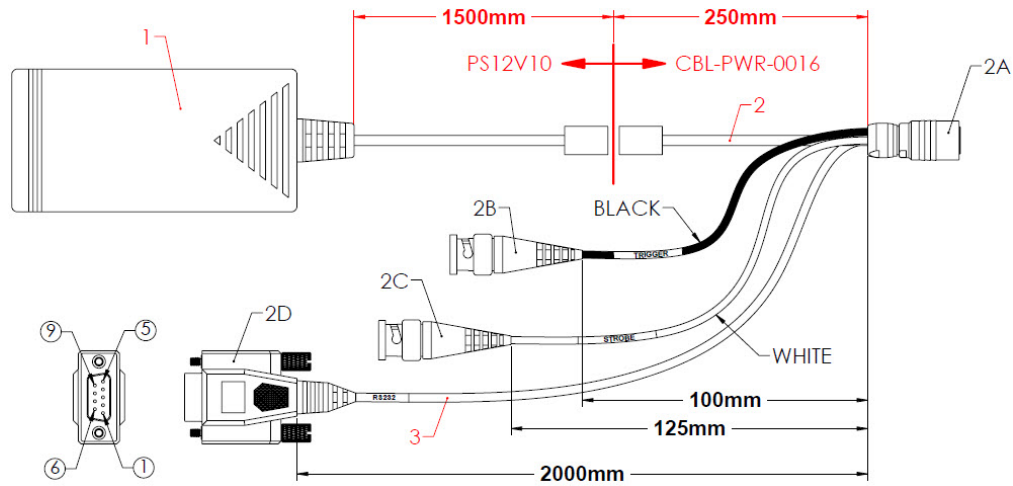The follow illustration shows an example setup of C2010 components and cabling.
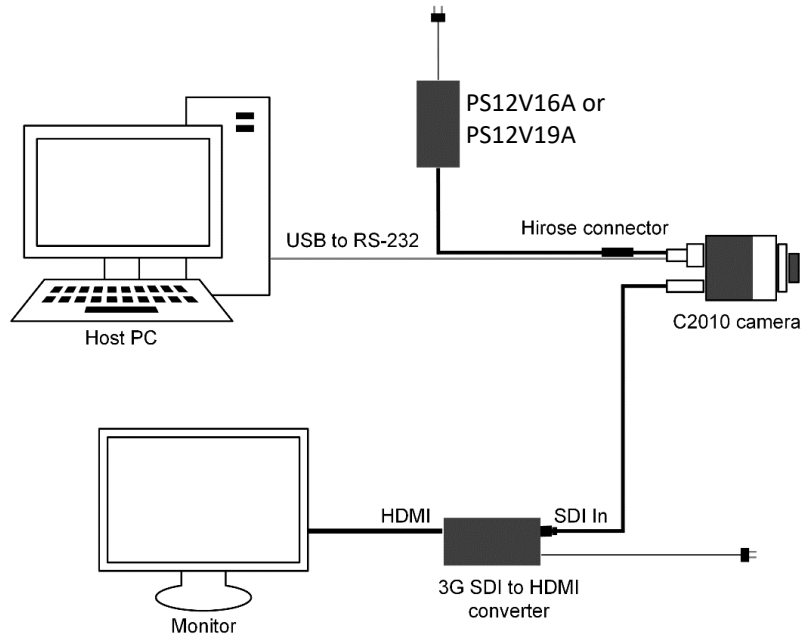
PS12V16A Power Supply

The PS12V16A power supply provides +12 V DC ± 5% and up to 3 A DC current. The operating input voltage ranges from 100 to 240 V AC.

The PS12V16A power supply is comprised of three components:

Item	Qty.
PS12V10 Universal Power Supply	1
CBL-PWR-0016 I/O and Power Cable	1
Power Cord	1

The CBL-PWR-0016 cable terminates in a female Hirose type miniature locking plug #HR10A-10P-12S(73). It has a DB9 connector for serial RS-232 interface and a small BNC pig-tail cables providing Tri-Level Sync Genlock input (black) and strobe output (white).

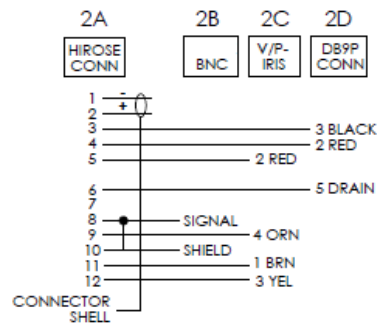| Cable Color	Pin	Signal	Description
BNC Black	Shield	In 1 Return	Tri-level Sync Genlock Input 1 Return
	Signal	In 1 Active	Tri-level Sync Genlock Input 1 Signal
BNC White	Shield	Out 1 Return	Strobe 1 Output Return
	Signal	Out 1 Active	Strobe 1 Output Signal

PS12V19A Power Supply with Support for P-Iris / Video Iris Lens Control

The PS12V19A power supply provides +12 V DC ± 5% and up to 3 A DC current to the Cheetah 3G-SDI camera with a P-Iris or Video Iris lens. The operating input voltage ranges from 100 to 240 V AC.

The PS12V19A power supply is comprised of three components:

Item	Qty.
PS12V10 Universal Power Supply	1
CBL-PWR-0019 I/O and Power Cable	1
Power Cord	1

The CBL-PWR-0019 cable terminates in a female Hirose type miniature locking plug #HR10A-10P-12S(73). It has a DB9 connector for serial RS-232 interface, small BNC pig-tail cable providing the Tri-Level Sync Genlock input, and a lens control cable terminated with a female P-Iris/Video Iris plug.

Cable Color	Pin	Signal	Description
BNC Black	Shield	In 1 Return	Tri-level Sync Genlock Input 1 Return
	Signal	In 1 Active	Tri-level Sync Genlock Input 1 Signal

PS12V16A and PS12V19A Specifications

Specifications		Description
Input		
Voltage		100–240 V AC
Frequency		50–60 Hz
Current		1 A max
Inrush Current		70 A max / 230 V AC (cold start @ 25 °C, full load)
Efficiency		Eff (av) ≥ 87.4 % (at 115 V AC & 230 V AC) Eff ≥ 78.303 % (at 230V/50Hz input @10% load for CoC Tier2)
Output		
Voltage		11.4 V to 12.6 V DC, 12 V DC nominal
Current		3 A max
Load Regulation		± 5%
Ripple & Noise		1% Vpp max for Output Voltage @ full load
Total Power		36 W Max
Protection		
Over-Voltage Protective (OVP)		V out * 180% (max)
Short-Circuit Protective (SCP)		Automatic recovery after short circuit fault being removed
Over Current Protection (OCP)		I out * 200% (max)
Safety, EMI and EMC Requirement		
Safety		UL, CUL, GS, PSE, BSMI, CB, RCM, CCC, KC, LPS
Dielectric Strength		10 mA max. cut off current
		(1) Primary to Secondary: 3000 V AC for 1 minute
		(2) Primary to Frame Ground: 1500 V AC for 1 minute
Insulation Resistance		(1) Primary to Secondary: 10 MOhm for 500 V DC
		(2) Primary to Frame Ground: 10 MOhm for 500 V DC
EMI Requirement		CE, FCC Class B, Conduction and Radiation meet
Leakage Current		Less than 3.5 mA
Grounding Test		Resistance 0.1 Ohm max @ 32 A
Environmental	Operating Storage	0 °C to +40 °C -20 °C to +80 °C
Relative humidity	Operating Storage	20% to 80% non-condensing 10% to 90% non-condensing
Regulatory		DoE VI, ErP (Lot 7), GEMS, NRCan, CEC, RoHS
Cable Length		
Supplied AC power input cable (IEC)		1.8 m (6')
Power supply output (+12 V)		1.75 m (5') ± 15 cm (6"), connector HIROSE #HR10A-10P-12S
Strobe (for CBL-PWR-0016)		12.5 cm (5") ± 1 cm (0.4") connector BNC male
Trigger		10 cm (4") ± 1 cm (0.4") connector BNC male
RS-232 Cable		2 m (6.6'), connector DB9
P-Iris/Video Iris (for CBL-PWR-0019)		14.4 cm (5.7") ± 1 cm (0.4")

# Connecting the PS12V16A / PS12V19A Power Supply

1. Connect a power cord to the PS12V10 power adapter.

2. Connect the KPPX-4P plug of the PS12V10 power adapter to the KPJX-CM-4S socket of the CBL-PWR-0016 / CBL-PWR-0019 cable .
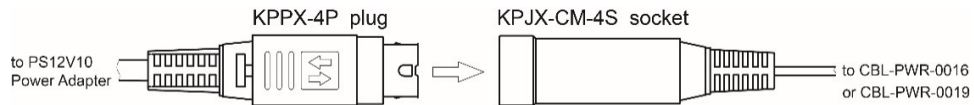
⚠**CAUTION**	Push connectors together until the locking mechanism clicks, and there is no gap between the connectors. If connectors are not securely locked, overheating may occur resulting in damage to the cable or leading to fire.

Correct position
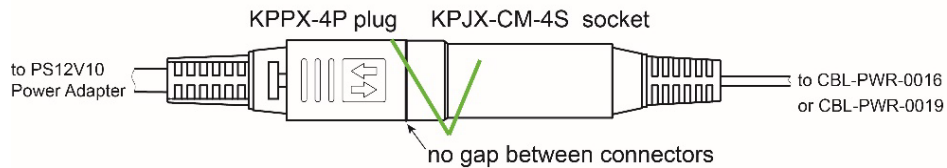
Incorrect position
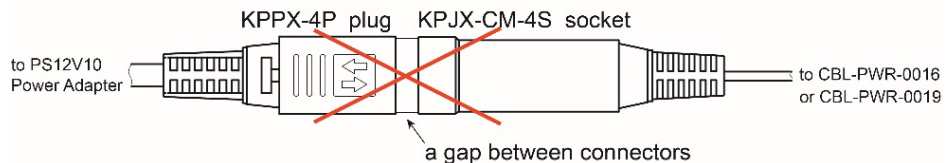
3. Connect the Hirose connector of the CBL-PWR-0016 / CBL-PWR-0019 cable to the Cheetah SDI camera.

4. Connect the Trigger cable to a tri-level sync genlock signal source.

5. Connect the RS-232 cable to a computer.

6. Connect the P-Iris / Video Iris jack to a P-Iris / Video Iris lens (PS12V19A power supply only).

⚠**CAUTION**	To disconnect the CBL-PWR-0016 or CBL-PWR-0019 cable from the PS12V10 power adapter, pull on the plug KPPX-4P. Do not pull on the cable. Doing so may result in damage to the cable.

PS12V16A Connection Diagram
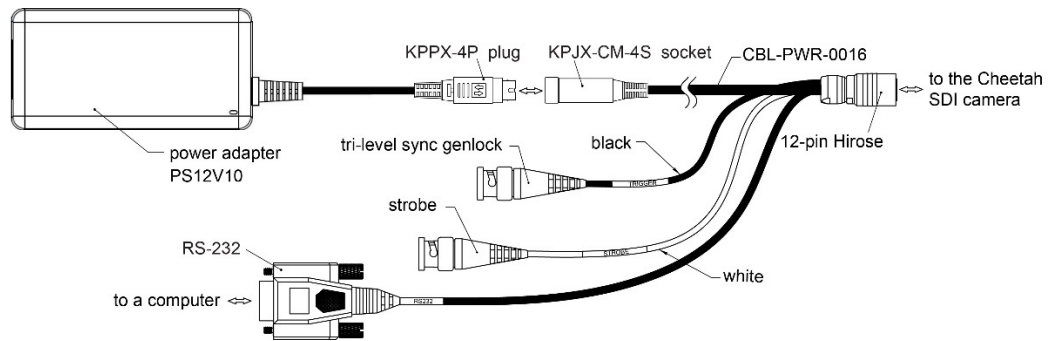
PS12V19A Connection Diagram
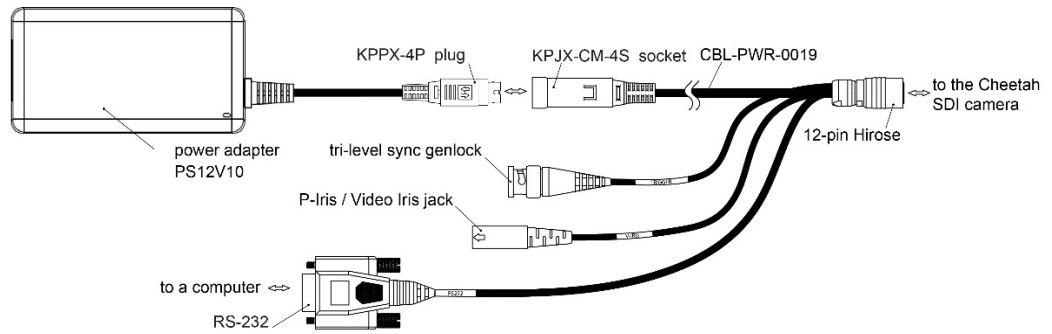
Electrical Connectivity

Tri-Level Sync Input IN1

The external inputs in Cheetah HD-SDI cameras are connected directly to the camera hardware as shown in the following figures. The input signals **Signal** and **Return** are used to connect to an external input on the outside source. For IN1, the signal level (voltage difference between the inputs **Signal** and **Return**) must not exceed 1.2 Vpp.
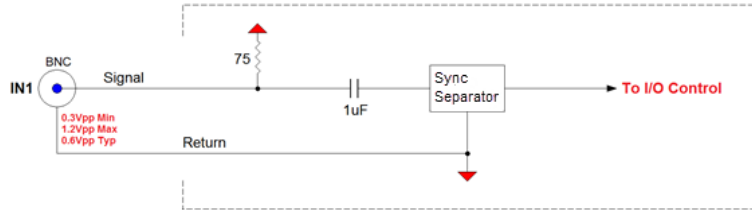
TTL Output OUT1

The OUT1 external output in Cheetah HD-SDI camera is directly connected to the camera hardware and is a TTL (5.0 Volts) compatible signal. The maximum output current must not exceed 8 mA. The following figure shows the OUT1 output external electrical connection.
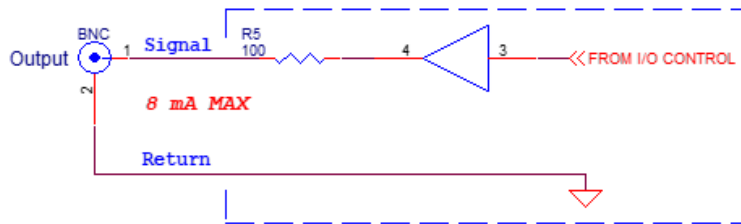
Opto-Isolated Output OUT2

Output OUT2 is an optically isolated switch. There is no pull-up voltage on either contact. The voltage across OUT2 Contact 1 and OUT2 Contact 2 must not exceed 25 volts and the current through the switch must not exceed 50 mA.
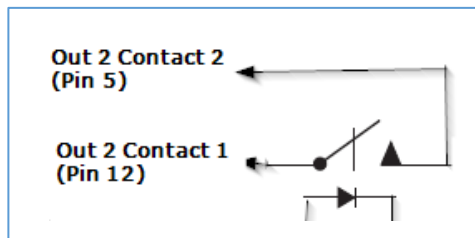
Mechanical Drawings

The camera housing is made of precision-machined aluminum. For maximum flexibility, the camera has eight M3X0.5mm mounting holes located towards the front and the back. An additional plate with ¼-20 UNC (tripod mount) and hardware ship with each camera.
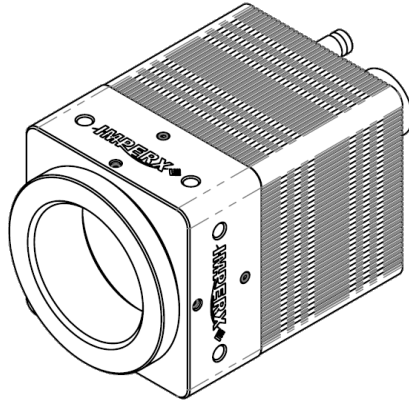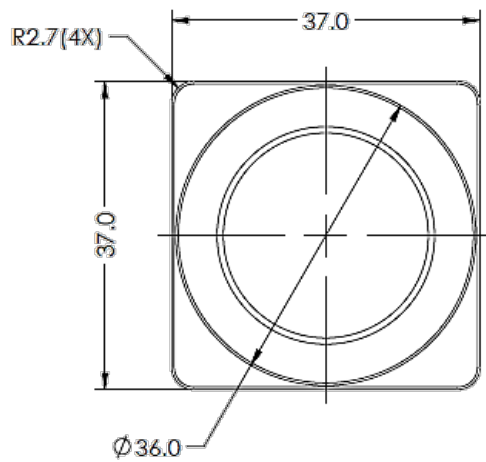
Front View: **Back View:**
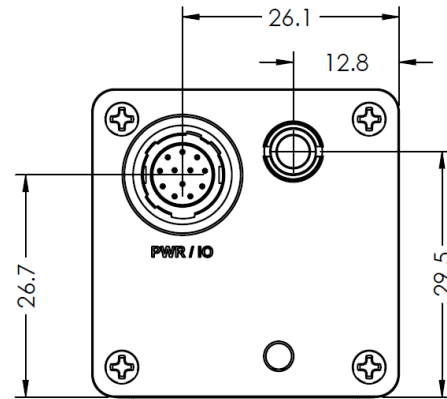
Top View
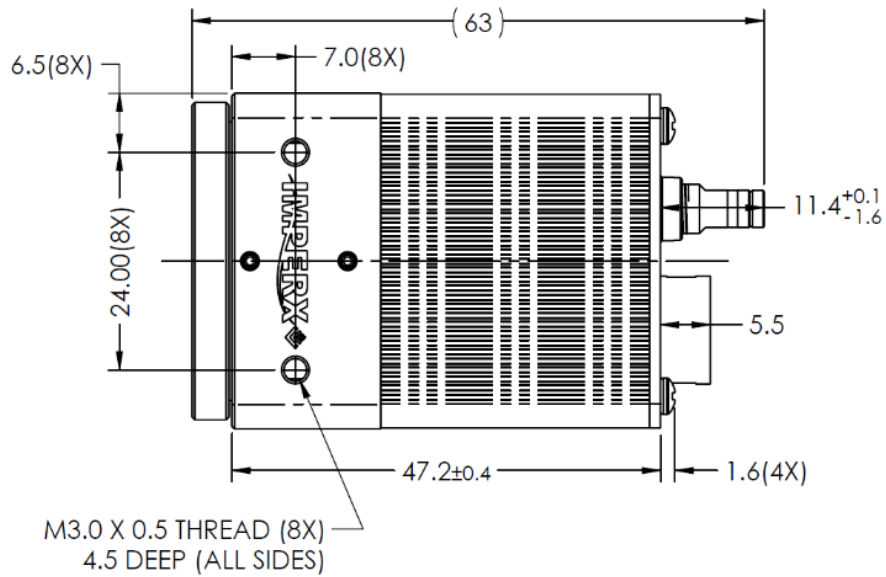
Side View with Image Plane:
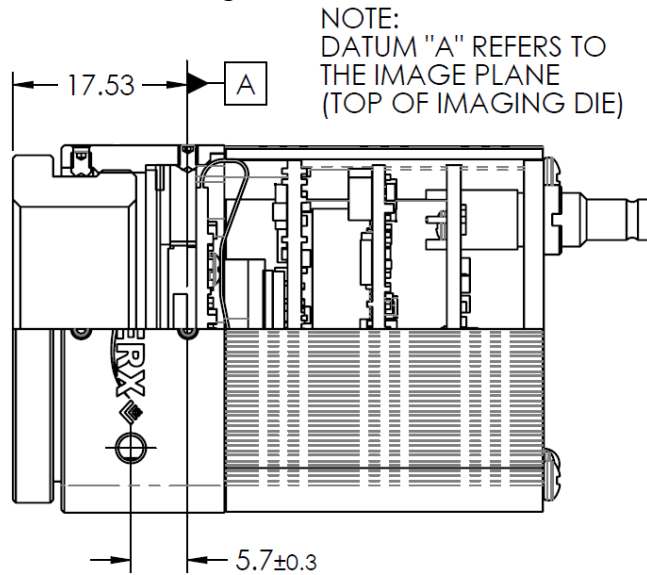
Mounting Plate
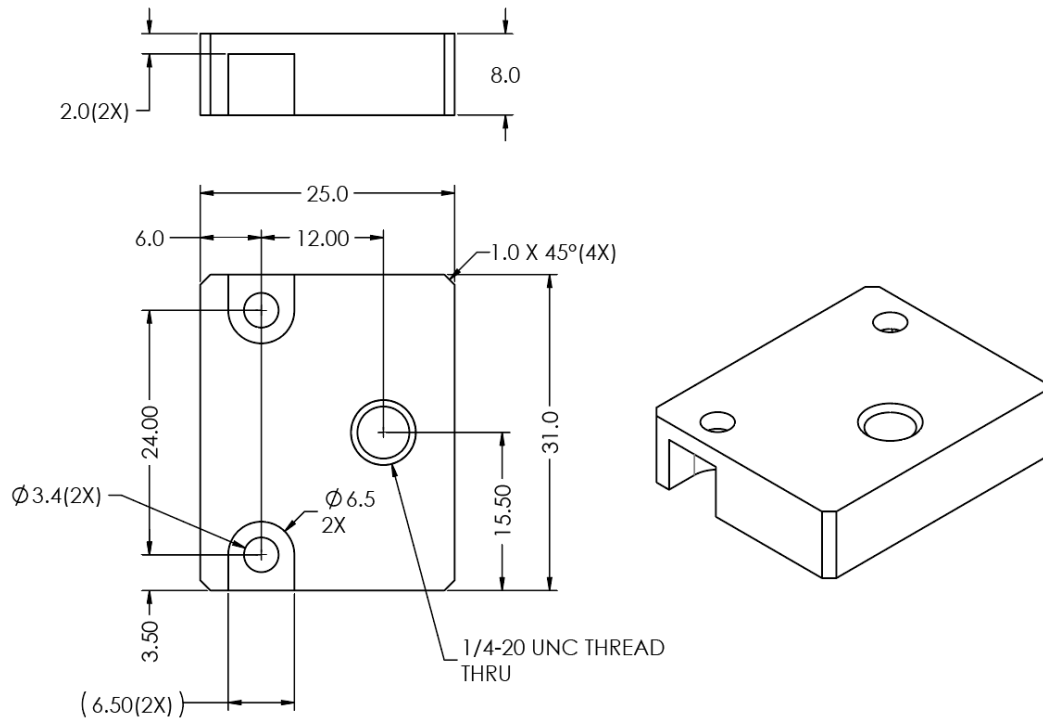
Optical

The Cheetah 3G-SDI camera cross-section comes with an adapter for C-mount lenses that have a 17.53 mm back focal distance. You can use an F-mount lens with a C-mount camera using an F-mount–to-C-mount adapter. You can purchase the adapter separately (refer to the Imperx website for more information).

The camera is highly sensitive in the IR spectral region. All color cameras have an IR cut-off filter installed. Monochrome cameras do not have an IR filter. If necessary, the camera can accommodate an IR filter (1 mm thickness or less) inserted under the front lens bezel.

| ⚠**CAUTION**	Avoid direct exposure to a high intensity light source (such as a laser beam). This may damage the camera image sensor!
	Avoid foreign particles on the surface of the image sensor.
	Avoid touching the image sensor. Finger oils can produce stains on the sensor decreasing image quality. If the image sensor needs cleaning use soft lint free cloth and an optical cleaning fluid.
	Do not use methylated alcohol! Please refer to the Sensor Cleaning Procedure document found in the camera's ZIP file or contact Imperx support for cleaning procedures.

TIP ⓘ	Camera performance and signal to noise ratio (SNR) depend on the illumination (amount of light) reaching the sensor and the exposure time. Always try to balance these two factors. Unnecessarily long exposures increase the amount of dark noise and thus decrease the signal to noise ratio.

Environmental

Always operate the camera within temperature and humidity specifications listed below.

Specification	Definition
Operating temperature	-30 °C to +75 °C
Storage temperature	-40 °C to + 85 °C
Relative humidity	10% to 90% non-condensing

⚠ **CAUTION**	Avoid direct exposure to moisture and liquids. The camera housing is not hermetically sealed, and any exposure to liquids may damage the camera electronics! Avoid operating in an environment without any air circulation, near an intensive heat source, strong magnetic or electric fields.

Configuration Software

Overview

The Cheetah Pregius CamConfig software ships with the 3G-SDI camera. After installing the software, you can program the camera, change its settings, and save the settings in a file or in the camera using the RS-232 interface. The software provides a help file to assist in setting up the camera.

The CamConfig software is compatible with the following operating systems:

- Windows 7, 32-bit and 64-bit

- Windows 8 and 8.1, 32-bit and 64-bit

- Windows 10, 32-bit and 64-bit

Installing the Software

Use the installation wizard to install the Cheetah Pregius CamConfig software supplied with your 3G-SDI camera.

If a previous version of the Cheetah Pregius GUI software is installed on your computer, you must remove it before completing the installation. The installation wizard will do this for you during the installation process. Or, you can uninstall a previous version yourself.

To remove previous versions yourself:
1. Open **Control Panel** on your computer.

2. Select **Programs and Features**.

3. Select the software from the list.

4. Click **Uninstall**.

Installation

1. Locate the executable file (`Cheetah_Pregius_x_x_x_xxxx.exe`) in the ZIP folder available upon registering your camera on the Imperx website.

2. Drag the file to your computer desktop. If a Security screen appears, click **OK**.
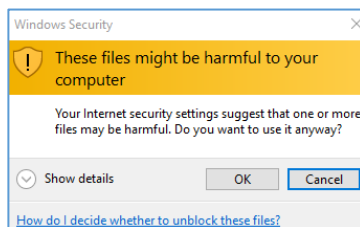
3. Double click the executable file (`Cheetah_Pregius_x_x_x_xxxx.exe`) on your desktop. The Welcome Setup screen opens. Note the recommendation to close other applications and then click **Next**.

4. When the License Agreement screen appears, read the agreement and click **I Agree**.
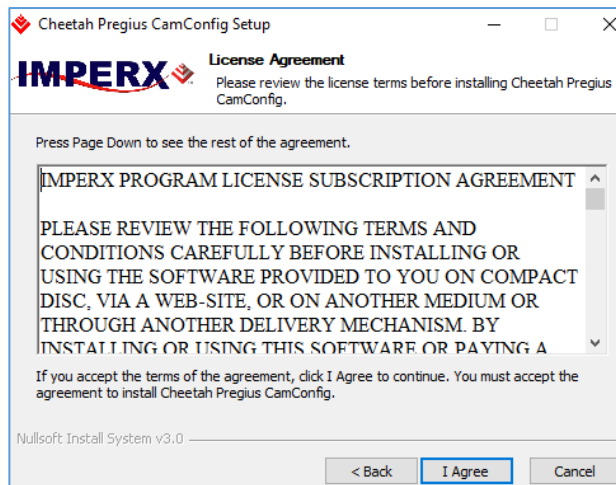
5. On the Choose Components screen, make sure the Cheetah Pregius CamConfig component is selected and then click **Next**.
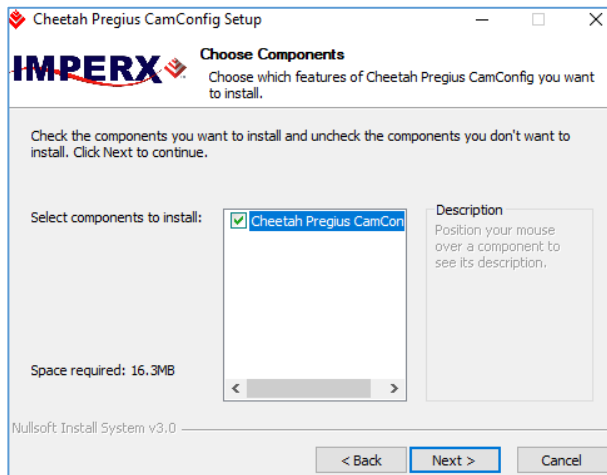
6. On the Choose Install Location screen, accept the default destination folder or click **Browse** and select a different location and then click **Install.**
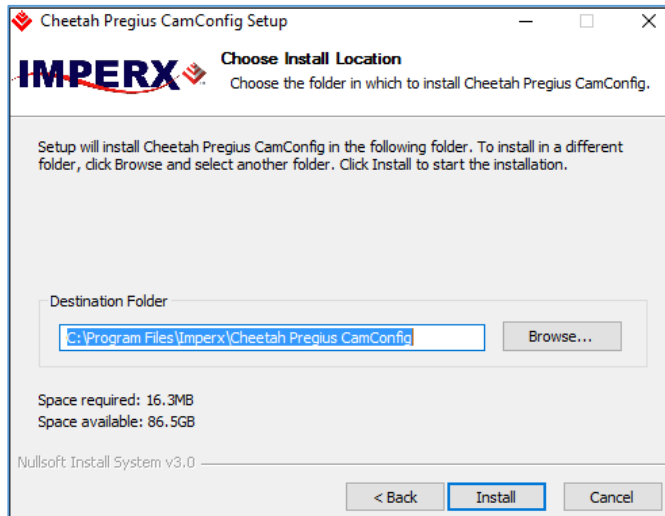
The installer prompts you to uninstall any existing versions of the software from your computer before continuing the installation.
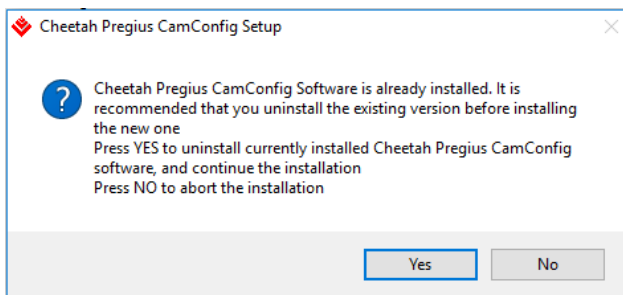
7. On the Installation Complete screen, select the check box to register your software and then click **Next**. When the Imperx website appears, complete the Subscriber Registration and click **Submit**.
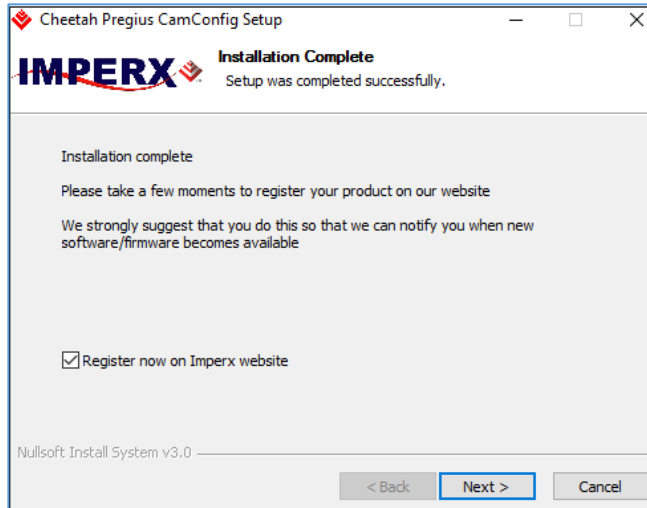
8. On the Completing Cheetah Pregius CamConfig Setup screen, click **Finish**. The Cheetah Pregius Configurator icon appears on your desktop.
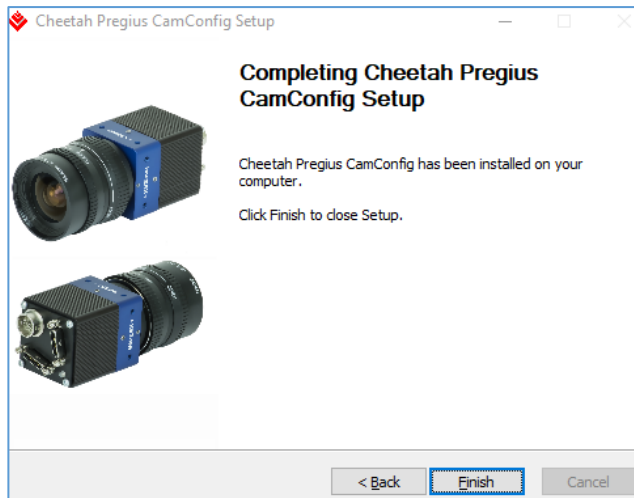
Starting CamConfig

Users sometimes install multiple frame grabbers and cameras on the same host computer. The CamConfig software automatically discovers all available Universal Asynchronous Receiver/Transmitter (UART) components on the computer and lets you select the one connected to the Cheetah 3G-SDI camera.

The CamConfig software also searches for any available COM ports installed on the host computer. It communicates with each COM port and attempts to query the attached camera. If the software detects an attached Imperx Cheetah 3G-SDI camera, it displays the port and camera type on the Select Port screen. You can repeat the discovery procedure by clicking Rescan Ports.

> **TIP** ⓘ If you do not see the camera as one of the selectable ports, make sure the RS-232 connector is plugged into the computer from the power supply. If the computer does not have an RS-232 port, you should purchase a USB-to-RS232 adapter.

Using a USB-to-RS232 adapter
1. Make sure to install the drivers from any USB device prior to connecting the USB-to-RS232 adapter to the computer. A system restart might be necessary to ensure drivers are applied properly.

2. If the device still does not work, open Device Manager, select Ports (COM & LPT), right-click on USB, and select Update Driver Software.

To select a camera for programming:
1. Open the CamConfig software.

2. On the Select Port screen, click the camera of interest.
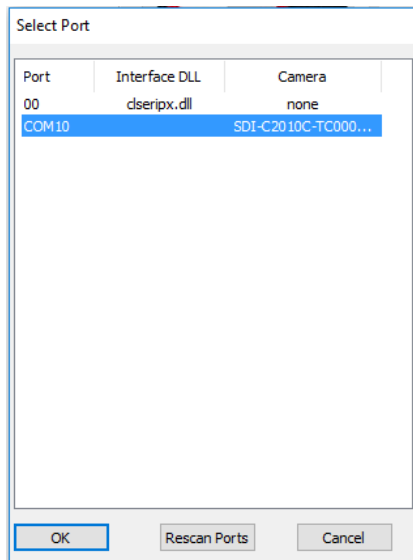
3. Click **OK**. The CamConfig Main panel appears.

Main Window

The main window appears after you select a camera. It provides menu and view options, a help file, camera information, and configuration options. The camera's name and status appear at the bottom of the main window. The status indicator next to the camera name turns red if the connection between the camera and host computer is lost.

available in cameras with P-Iris Lens Control

The window also displays real-time information about the camera's current conditions and operations based on the settings you implement. The software monitors the image size (in pixels), frame per second (FPS), frame time in milliseconds (FTM), exposure time in milliseconds (EXP), and image sensor temperature in Celsius (TMP). The Lens button appears if the camera supports P-Iris lens functionality.

> **NOTE** ✱   The C1920 does not support image sensor temperature monitor (TMP).

Menu

The Menu provides access to load options, settings, the command terminal, and more.

Run Application	
Load From...	▶
Save To...	▶
Boot From...	▶
DPM/HPM	
Command Terminal	
Connection	▶
Soft Reset	
Exit	
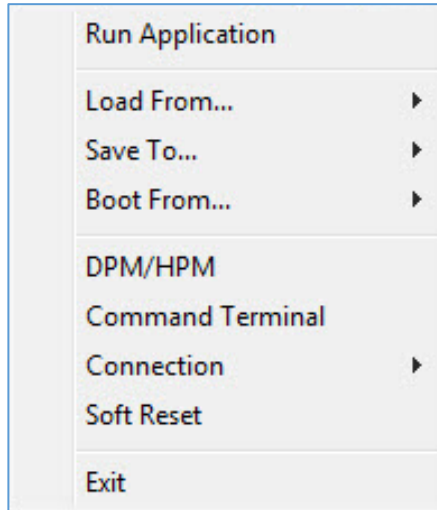
Run Application

This starts any other executable file that you normally use, such as a frame-grabber application. CamConfig remembers the location of such files in the host computer.

Load From . . .

This enables loading camera registers from a saved configuration space. Options are:

File: Loads camera registers from a saved configuration file.

Workspace: Updates the software with the current camera workspace settings.

Factory: Loads the camera registers with the original factory settings.

User Space #1 or #2: Loads the camera registers with settings saved within the camera in either camera user space #1 or user space #2.

Save To . . .

You can save the camera registers to a File, to camera User Space #1, or to camera User Space #2. Factory Space is available only for factory technicians.

Boot From . . .

This enables loading the camera registers from the Factory configuration, from User Space #1 or from User Space #2 upon powering up.

DPM/HPM

When selected, the Defect Pixel Map window shows dead or hot pixels location. The DPM and HPM (Dead and Hot Pixel Maps) are stored in the camera's non-volatile memory and are used to correct defective pixels when dead or hot pixel correction is enabled.

Dead Pixels: Pixels with sensitivity that deviates more than 15% due to fluctuations in the CMOS manufacturing process.

Hot Pixels: Pixels that during normal camera operation respond within specifications, but in long integration modes (programmable frame time) become high-intensity bright pixels.

Save To File: saves the map shown in Defect Pixel Map window into a .dpm or .hpm file.

You can download the factory DPM and HPM, add defective pixels to the factory map, and then upload the updated map to the camera using Imperx Upload Utility.
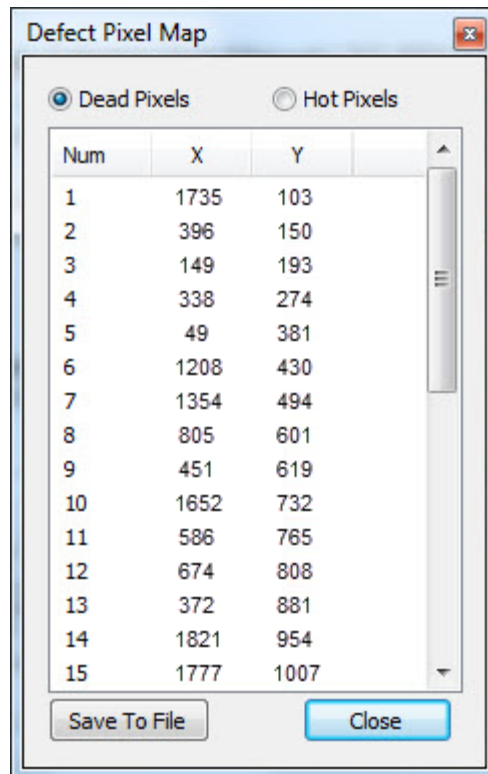
Command Terminal

The Command Terminal shows information about all commands sent to or received by the camera. It also lets you communicate directly with the camera by entering write or read commands directly into the text box on the Command Terminal screen.

To write a command to a camera register, the command terminal must send a sequence of 7 bytes to the camera. The write command must start with 0x followed by 57, the register address, and data.

Example 1:
Write to register address 0x0410, data value = 0x11223344:
Camera Write Command: <0x57> <04> <10> <11> <22> <33> <44>
To read a command from a camera register, the command terminal must send a sequence of 3 bytes to the camera. The read command must start with 0x followed by 52 and the register address.
Example 2:
Read from register address 0x0410:
Camera Read Command: <0x52> <04> <10>
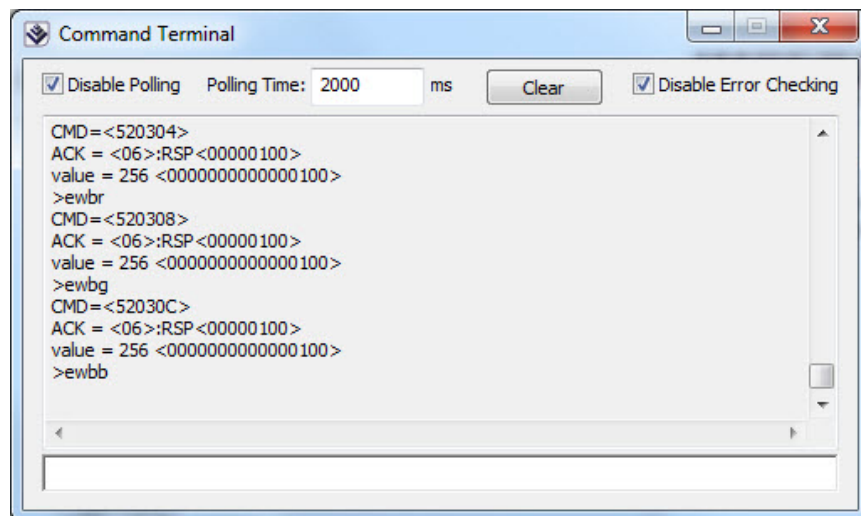
Disable Polling:	turns polling commands on or off for frame time, exposure time, frame rate, and so on.
Polling Time:	You can change the polling time in milliseconds by entering a number in the Polling Time field.
Disable Error Checking:	The software displays error messages when the camera returns a command error. You can disable error checking by selecting the Disable Error Checking check box.

Connection

Use the Connection menu to switch ports and change baud rates.
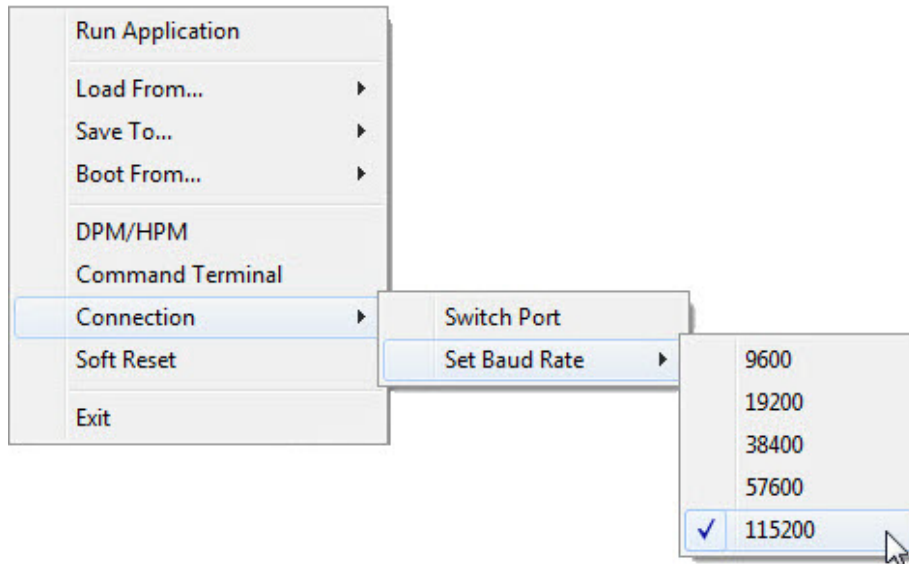
Switch Port: use this option to switch the com port/camera. You can also Rescan Ports before switching.

Set Baud Rate: use this to change the speed of data transmission. A higher baud rate number indicates the transfer of more bits per second. Baud rates are 9600, 19200, 28400, 57600, and 115200. The factory default is 115200.

Soft Reset

Resets all current camera settings to default values according to the current Boot From selection.

View

Use the View menu to display or hide the following panels: Gain & Exposure, Output Control, Strobe Control, I/O Control, Image Parameters, and Color Control on the screen.

✓	Gain & Exposure
✓	Output Control
✓	Strobe Control
✓	I/O Control
✓	Image Parameters
✓	Color Control
✓	Select All
	Attach Windows
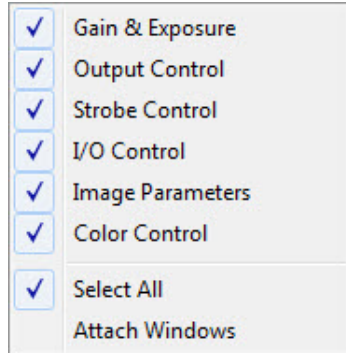
Gain & Exposure: Controls the exposure time, analog and digital gain. Maintains consistent image brightness during times of fluctuating lighting conditions. You can enable automatic exposure, gain, and iris modes simultaneously.

Output Control: Sets the output data format. Enables DPC, HPC, and test patterns.

Strobe Control: Enables and controls the camera strobe signals.

I/O Control: Enables genlock mode when connected to an external tri-level sync generator.

Image Parameters: Enables image processing features: Look-Up Tables, Gamma and Black Gamma

Color Control: Sets the white balance mode. Displays white balance coefficients values.

Select All: Enables all camera parameter windows.

Attach Windows: Attaches all camera parameter windows to the main GUI window

Help

Help provides access to a user help file and the following options:
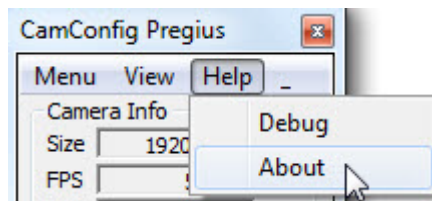
Debug: This puts the software in debug mode for test purposes and troubleshooting.

About: This provides information about the camera's firmware build, revision, image sensor, and other components.

Gain & Exposure Control

Gain & Exposure control lets you set the camera's exposure, gain, AEC, AGC, and AIC.
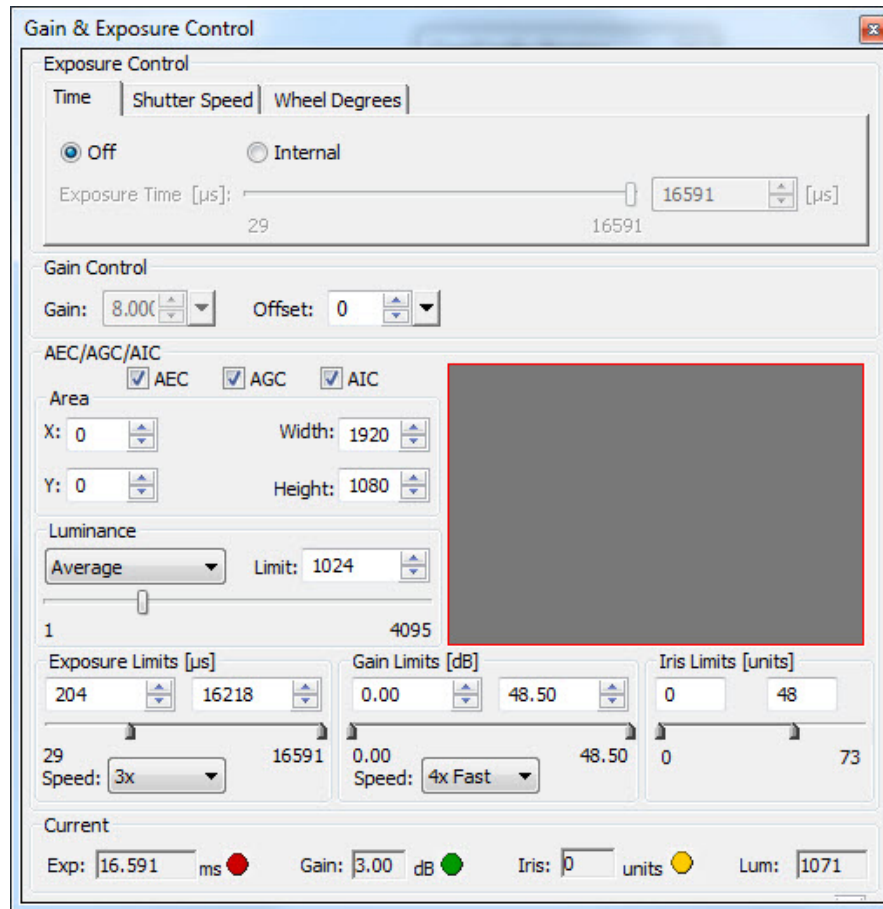
Exposure Control

Exposure control lets you set the camera's exposure time manually from the Time tab, Shutter Speed tab, or Wheel Degrees tab. The exposure time that you set on any tab automatically adjusts the exposure time in microseconds on the other two tabs. You can use a combination of exposure time and gain adjustments to achieve image luminance goals for your specific applications.

TIP ⓘ   For best image quality, always increase the exposure to the maximum allowable level before adding gain. Use gamma settings found on the Image Control screen to stretch the dark regions of the image to achieve a better match with the display characteristics of the monitor.

Time Tab

The Time tab controls the ability to set the exposure time on any of the tabs. If you enable **Internal**, the Exposure Time slider shows you the minimum and maximum exposure times available.

1. Click **Off** to disable setting manual exposure time. The exposure time is then set equal to the frame time.

2. Click **Internal** to enable setting manual exposure time.
   a. Use the slider to set the exposure in microseconds or enter the desired exposure in the box.
   b. Use the up/down scroll to fine tune the exposure setting.
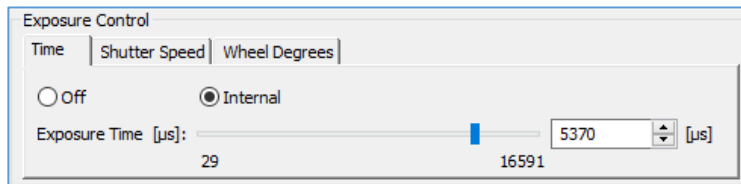
Shutter Speed Tab

Use the Shutter Speed tab to set the exposure in fractions of a second as is customary with standard photographic cameras. Select from a drop-down list of shutter speeds. After selecting a shutter speed, the equivalent exposure time in microseconds appears in the up/down slider.
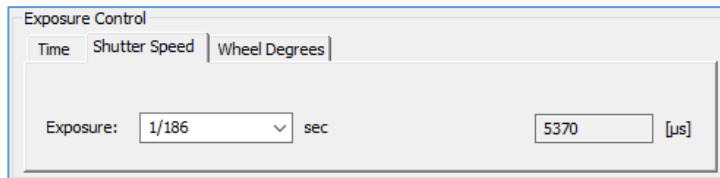
Wheel Degrees Tab

The Wheel Degrees tab represents the exposure as the rotating mechanical shutter used in motion film cameras. It lets you set the exposure time in degrees from zero (minimum exposure) to 180 (free running exposure). You can use the slider or the scroll feature to select the degrees setting. The tab also displays the degrees setting in microseconds.
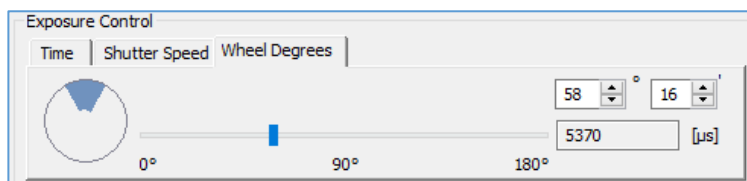
Gain Control

The gain control allows you to manually adjust gain and offset.

Use the Gain field to control the signal amplification from the camera sensor. You can set the gain value in decibels ranging from 0.0 to 48.0 dB.

> **NOTE** ✱ Settings in the 0 dB to 24 dB range operate in the analog domain.
>
> Settings in the 24.1 dB to 48 dB range operate in the digital domain.

The offset is a digital count added or subtracted from each pixel's digital value. The range is from -511 to +512 counts.

Automatic Exposure, Gain, and Iris Controls

Variable lighting conditions can affect the quality of images captured when the camera uses fixed exposure, gain, or iris settings. You can overcome changes in lighting using automatic exposure control (AEC), automatic gain control (AGC), and automatic iris control (AIC).

AEC, AGC, and AIC automatically adjust the camera to the luminance found within the Area of Interest (AOI) defined in the camera's image area. When using AEC, AGC, or AIC, the camera monitors the AOI and applies brightness changes found within the AOI to the entire image.
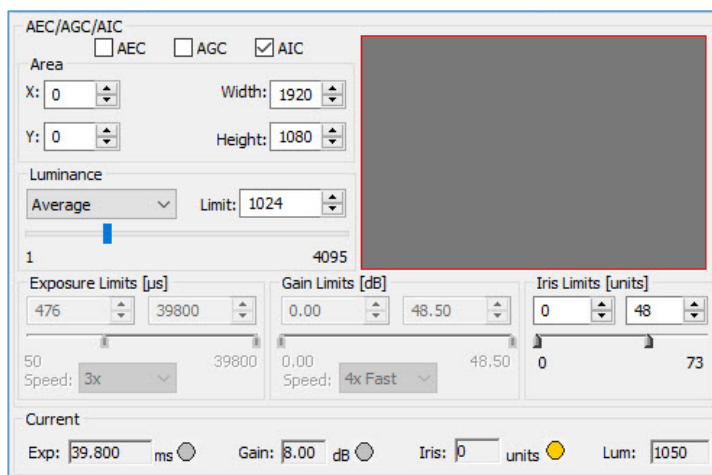
> **NOTE** ✱ Selecting the AIC check box enables automatic iris control of either a Video Iris or P-Iris lens, depending on the lens type used with the camera.
> If a camera supports only manual P-Iris control, the AIC is not available (the AIC check box is greyed out).

You can define the AOI with width and height (X and Y) coordinates and set the speed of convergence, which determines how fast the camera stabilizes after a change in luminance.

Area: Use the Area controls to define an active Area of Interest (AOI). The camera uses the image data inside the AOI to calculate the luminance for adjusting exposure, gain, and iris parameters. The camera ignores brightness changes outside of the AOI. Changes in the AOI luminance, as determined by the firmware, cause changes in the exposure, gain, and/or iris position. The camera applies them to the entire image. In other words, if AOI luminance deviates from the target (limit), the exposure, gain, and/or iris adjusts automatically to compensate.

To define an AOI:
1. Select AEC, AGC, and/or AIC.

2. Enter the AOI width/height and offset (X, Y) values in the up/down scroll fields.

   a. X offset describes the starting column for the AOI window and is the distance in pixels from the left side of the screen.

   b. Y offset describes the starting row for the AOI window and is the distance in pixels from the top of the screen.

3. Alternatively, you can draw the AOI by clicking and dragging across the display area. A red box appears, and the dimensions and offset values of the box populate the width/height and offset fields automatically.
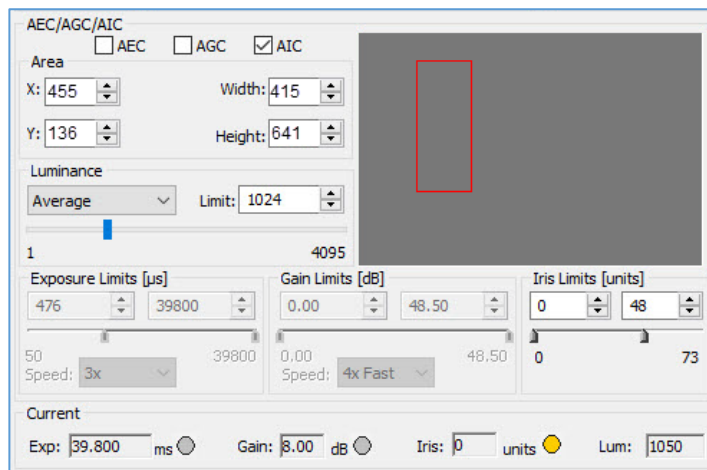
Luminance Limit: This sets the desired luminance level (in output counts), which the camera is to maintain within the image. The software adjusts the image exposure, gain, and iris as needed to maintain the image luminance at or near the target value. You can select either average or peak luminance as the target and specify the desired target output counts from 1 to 4096.

   • **Average** – the firmware calculates the average value of the image luminance (in counts) within the image or within the AOI and compares the value to the target (Limit value) to determine changes to the exposure/gain settings.

- **Peak** – the firmware calculates the peak luminance value (maximum luminance level) within the image (in output counts) or within the AOI and compares the value to the target (Limit value) to determine changes to the exposure/gain settings.

Exposure Limits: If using AEC, you can specify the range of allowable exposures from minimum to maximum in microseconds. For example, if anticipating motion within the scene, you can specify the maximum exposure to be 1 ms to avoid motion blur. Try to set the minimum exposure value as high as possible to help prevent oscillations in the AEC control loop.

Speed: Use the speed drop-down options to set the exposure convergence to 1x (slow), 2x, 3x, or 4x (fast). Convergence is the speed at which the camera stabilizes the exposure after lighting conditions change.

⚠️ **CAUTION**	Using faster convergence speeds might cause oscillations in exposure control if the scene changes luminance levels abruptly, for example, from extremely dark to extremely bright. In these conditions, use a slower convergence setting and/or increase the minimum exposure time limit.

Gain Limits: If enabled, the automatic gain control process drives gain so the calculated luminance value from the image is equal to the digital counts specified in the Luminance Limit field. However, you may want to limit the amount of gain applied by the AGC. For example, too much gain may cause the image to be noisy. You can specify the minimum and maximum gain applied by setting the Gain Limits.

Speed: The speed at which the gain converges onto the target luminance level depends on the Convergence setting. Select one of the following speed of convergence settings: 1x (slow), 2x, 3x, and 4x (fast).

Iris Limits: When enabling the automatic iris control for a P-Iris lens, you can specify the range of iris positions from minimum to maximum in steps. By default, the minimum iris limit is 0 which means the iris is Fully Open. The amount of light reaching the sensor is maximum.

The maximum iris limit is the number of steps needed to set the iris to the Fully Closed position. The amount of light reaching the sensor is minimum. The maximum possible iris limit depends on a lens model. By default, the maximum limit is set to 73. You may need to adjust this limit if the maximum number of steps of your P-Iris lens differs from 73. Please refer to the documentation on your lens for this parameter.

Current: Provides live information about the current value of the exposure time, gain, iris position, and calculated luminance value. Software polling automatically refreshes the values. Three indicators provide status of the current exposure, gain, and iris:

🟢 Green: the exposure/gain/iris value is within the set limits.

🟡 Yellow: the exposure/gain/iris has reached a minimum limit value.

🔴 Red: the exposure/gain/iris has reached a maximum limit value.

I/O Control

HD video signals have high data rates and the potential for timing jitter. Tri-level sync (genlock) resolves this potential issue by locking the HD video signals between the camera and the display monitor.

The I/O control screen lets you enable genlock mode when connected to an external tri-level sync generator. The format resolution, scan rate, and MHz settings you select for the genlock device automatically populate the I/O Control screen. Be sure to align genlock device settings with your current camera.
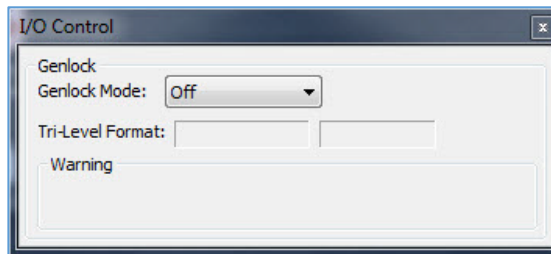
Strobe Control

The strobe output screen enables synchronizing two external light sources (strobes) with the camera timing. This helps maximize camera efficiency in low-level lighting conditions.

To enable a strobe:

1. Click **I/O Control** on the CamConfig screen.

2. Select the **Enable Strobe 1** or **Enable Strobe 2** check box.

3. Set the position and duration of each strobe by entering a value.
    The position determines when the strobe turns on.
    The duration determines how long the strobe stays on.

The strobe occurs as the exposure ends and the readout from the image sensor begins. To position the strobe at the beginning of the exposure period, set the strobe position equal to the frame period minus the exposure time. If the strobe duration is set to the exposure time, then the strobe signal will define the exposure window (refer to the following figure).
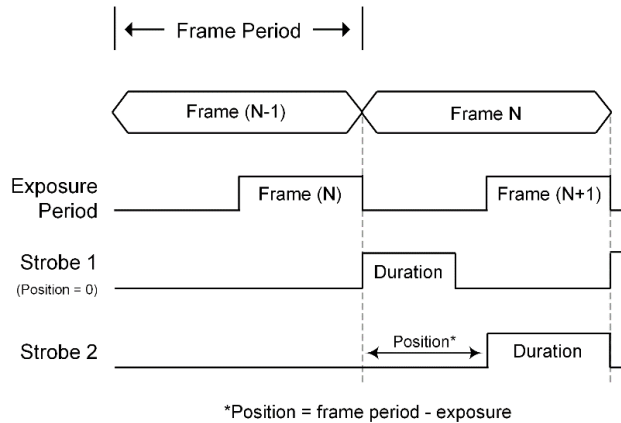
Image Control

The Image Control screen controls the image processing features implemented into the camera. This includes gamma and black gamma settings, the user-defined lookup tables, one- and two-point corrections, and threshold settings.
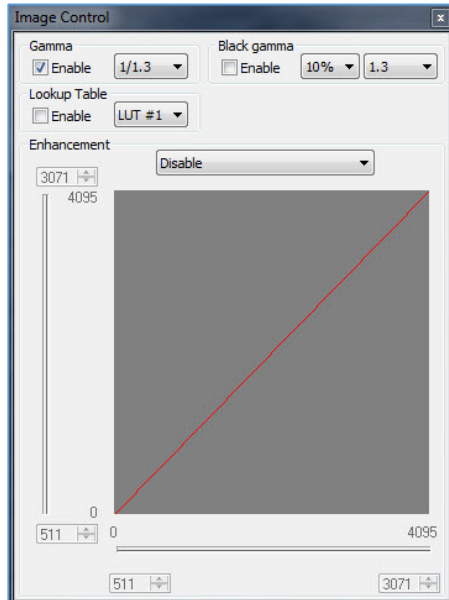
Gamma

Enabling gamma allows stretching and compressing image luminance (brightness) in a scene with wide dynamic range so both bright and dark areas are visible on the display. The drop-down menu provides a choice of eight settings ranging from darker (1.3) to brighter (1/1.3). Values from 1.3 to 2.2 compress the dark regions and stretch the brighter regions of the image so the bright regions have more detail in the display. Values from 1/1.3 to 1 / 2.2 stretch the dark intensities while compressing the bright regions so more detail is visible in the darker regions of the image.

Black Gamma

Black gamma provides adjustments to the dark parts of the image. Applying both black gamma and normal gamma enables compressing the mid-range intensities while stretching the detail in the brightest and darkest regions of the image. The drop-down menu provides a choice of eight settings ranging from darker (1.3) to brighter (1/1.3). You can also apply a weighting factor of 10%, 20%, or 30% to your black gamma settings.

Lookup Table

The Lookup Table (LUT) feature allows you to modify the original video data to create a better match between the intensity values of interest and the dynamic range of the display screen. The camera supports up to four LUTs; one is factory pre-set with Gamma 0.45. Users can upload custom LUTs using the Imperx Upload Utility. Select an LUT from the Lookup Table drop-down. The check box enables/disables your selected LUT's control of the camera's base gamma settings.

The following user-configurable LUTs are pre-programmed:

LUT#1: Gamma 0.45 (1/2.22)

LUT#2: Inverts the image intensity

LUT#3: Gain of 2x

LUT#4: Repeat: input = output.

Enhancement

The Enhancement feature gives you the ability to perform one point or two-point corrections on the images.

When customizing enhancements, you can click and drag lines or points to define knee points and slopes. Alternatively, you can use the horizontal and vertical sliders or up/down scrolls to set coordinates.

Select the following enhancement options from the drop-down menu:

Enhancement Options	Description
Disable	No enhancement operation performed.
One Point Correction	Thisperforms a single knee-point image enhancement. Click and drag the knee point to create the desired transfer function.
Two Point Correction	This performs a two knee-point image enhancement. Click and drag either knee point to create the stretch/compress image data.

Color Control

White balance adjusts the gains of the red, green and blue channels to compensate for the spectral content of the source. The Color Control screen provides several options for adjusting white balance. The screen displays the real-time white balance values of each color (red, green, and blue) based on your adjustments.
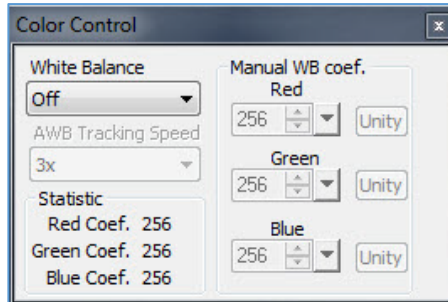
Adjusting White Balance

The White Balance drop-down provides presets you can select for controlling white balance.

White Balance Presets	Description
Off	No white balance performed.
Once	The camera analyzes only one image frame, calculates only one set of color correction coefficients, and corrects all subsequent frames with this set of coefficients.
Auto	The camera analyzes the entire frame, derives a set of correction coefficients on each frame, and applies them to the next frame.
Manual	The camera uses the correction coefficients as entered from the user.
Indoor 3200	Color temperature setting typically used for indoor lighting.
Outdoor 5600	Color temperature setting typically used for outdoor lighting.

Selecting Auto or Manual provides additional options and settings.

To set Auto or Manual white balance:

1. Click the **White Balance** drop-down and select a preset.
2. If selecting **Auto**, you can change the auto tracking speed by clicking the AWB Tracking Speed drop-down and selecting 1x, 2x, 3x, 4x, or 5x.

   Tracking speed settings control the camera's speed of response to changes in scene illumination — 1x is the slowest response, 5x is the fastest response.
3. If selecting **Manual**, use the up/down scroll to enter white balance coefficients for each color (Red, Green, and Blue). Coefficient values affect the intensity of each color and range from 0 to 4095.

TIP ⓘ	To get the best white balance for the R, G, and B coefficients when the spectral source is constant:
	1. Image a grey or white target over the camera's entire field of view using the intended lighting source.
	2. Select **Once** mode for the **White Balance**. The R, G, and B coefficients appear in the Red, Green, and Blue fields respectively. Jot down these values.
	3. Select **Manual** and load these coefficients into the camera. Leave **Manual** selected. The camera will now apply these coefficients to every frame captured.

Output Control

The Output Control screen provides full control over the camera's digital data output.
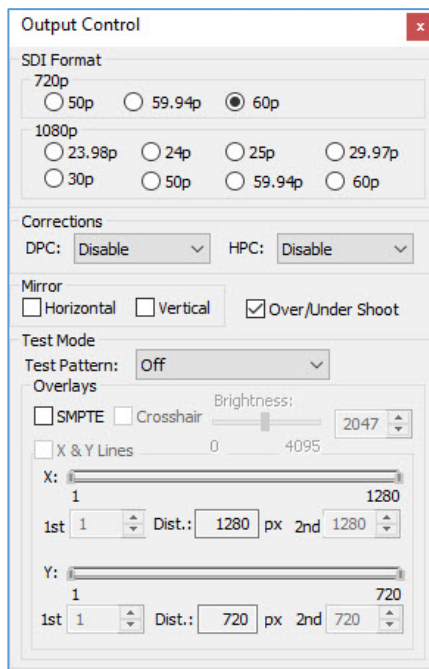
Use the following functions to control or test the camera's data output:

SDI Format: Select the progressive scanning rate supported by your monitor. Options are:
720p: 50p, 59.94p, 60p (C1920 and C2010 cameras only).
1080p: 23.98p, 24p; 25p; 29.97p, 30p; 50p; 59.94p, 60p.

Corrections: The camera provides static Dead Pixel Correction (DPC) and Hot Pixel Correction (HPC) independently or simultaneously. Static DPC and HPC correction works with predetermined and preloaded pixel correction maps created at the factory.

The maps identify the coordinates of dead and hot pixels. The camera uses these maps to correct the pixels during output.

Mirror: Select Horizontal to flip the image horizontally. Select Vertical to flip the image vertically.

Over/Under Shoot: The SMPTE standard specifies data ranges for overshoot/undershoot values. When enabled, overshoot words and undershoot words provide for dynamic range "headroom" in processing. The following table provides the digital range assignments for different word sizes on a parallel signal bus.

Overshoot/Undershoot Check Box	Bit Range	10-bit (hex)
If Enabled	Overshoot words range	0x3AD-0x3FB (941-1019) Y 0x3C1-0x3FB (961-1019) CbCr
If Disabled	100% white signal level	0x3AC (940) Y 0x3C0 (960) CbCr
If Disabled	0% black signal level	0x64 (64)
If Enabled	Undershoot words range	0x04-0x3F (4-63)

Test Patterns

Use the test mode controls to generate test patterns for gauging image quality. The GUI provides several types of test patterns.
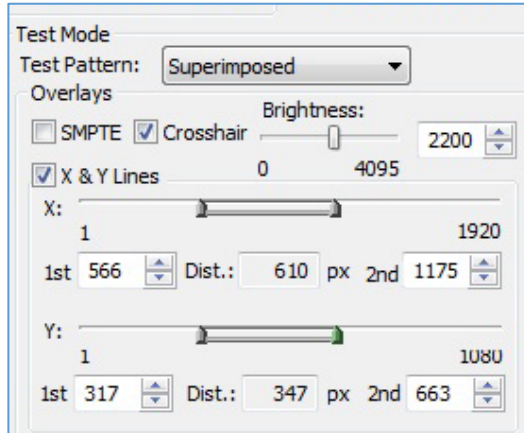
Test Pattern: Click the drop-down and select any of the following test patterns to appear on your monitor:

Test Patterns	Description
Off	Exits test mode.
Black	Generates a black screen.
Gray Image	Generates a gray screen.
White Image	Generates a white screen.
H Ramp	Generates a horizontal intensity ramp, decreasing the output code value by one count on each column moving left to right across the display.
V Ramp	Generates a vertical intensity ramp, decreasing the output code value by one count on each new row starting from the top and moving down the display.
H Ramp Move	Generates a moving horizontal intensity ramp.
V Ramp Move	Generates a moving vertical intensity ramp.
Vertical Bars	Generates vertical color bars. Select the SMPTE check box to change the color bars to the HD SMPTE color bars test pattern.
Superimposed	The following Overlays section describes Superimposed mode.

Overlays

Superimposed mode allows you to overlay patterns on live video. The Output Control screen provides several options:

Crosshair: Selecting the Crosshair check box displays a single crosshair centered in the middle of the image. You can adjust the brightness of the crosshair to improve its visibility on top of the images.
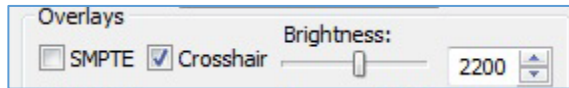
SMPTE: Selecting the SMPTE check box displays the SMPTE color bar test pattern.

X & Y Lines. Selecting the X & Y Lines check box superimposes a pair of horizontal and vertical lines on the image. You can enable the lines in horizontal direction, vertical direction, or both directions. You can position the lines at any pixel or line in the image.
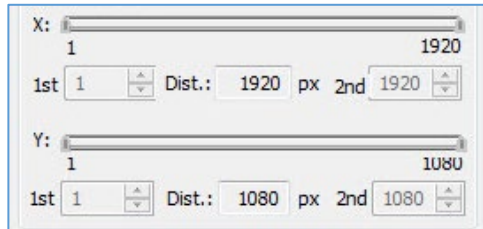
Since the spacing between parallel lines can serve as a measuring tool, the software references the pixel and line positions to the image sensor's pixels and lines, not to the image pixels and lines.

The spacing between the lines can appear in either pixels or metrical units. When using the lines as a measuring tool, you can apply a scale coefficient and calculate the spacing in linear measuring units (micrometers, millimeters, or meters).

P-Iris Lens Control

If your camera uses a P-Iris lens, the CamConfig GUI provides a P-Iris Control screen for manual control over the iris position. Depending on the lens type, the iris position and limits are shown in steps (Default lens type) or f-numbers (Kowa LM25JC5MM-IR, Xenoplan XNP 1,4/17, or Computar MG5020KC lenses).
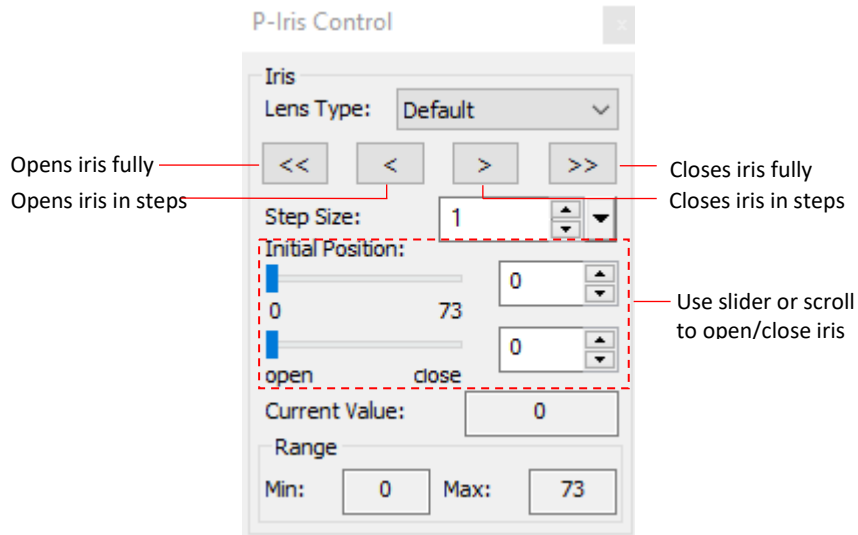
Settings	Description
Lens Type	Select the P-iris lens on your camera from the drop-down. The options are: • Default • Kowa (LM25JC5MM-IR) • Xenoplan (XNP 1,4/17) • Computar (MG5020KC)
`<<` `>>`	Use the iris buttons to fully open or fully close the iris.
`<` `>`	Opens/Closes the iris with the number of steps defined in the *Step Size.*
Step Size	Sets the iris step.
Current Value	Displays current iris position.
Range	Shows register minimum/maximum values of iris.

Camera Features

Exposure Control

During normal camera operation with exposure control off, the readout frame time determines the exposure time. However, the camera's electronic exposure control can precisely control the image exposure time under bright light conditions. The electronic exposure control does not affect the frame rate; it only changes the exposure time. When Internal exposure control is active, the camera controls the start of exposure so the new exposure ends just as the readout of the current frame ends and the readout of the next frame begins. The maximum exposure is equal to the frame time, and the minimum exposure is about 25 microseconds.

Automatic Exposure Control

You can set the camera to automatic exposure control (AEC) to keep the same image brightness during changing light conditions. You can enable both AEC and automatic gain control (AGC) independently or together.

In AEC mode, you can set the image luminance (brightness) target, and the camera adjusts the exposure accordingly. If selecting an Area of Interest (AOI) (entering X, Y settings), the camera adjusts the exposure to maintain the target luminance calculated only within the AOI. You can select the target luminance to be either the average luminance or peak luminance within the image or within the AOI.

The camera adjusts the exposure starting within the preset established by the user-specified minimum/maximum limits. When AEC and AGC are enabled, exposure is always varied first until the exposure reaches the maximum limit. The camera then indicates the exposure maximum limit has been reached and begins increasing the gain until either the luminance target is achieved or the maximum gain limit is reached.

You can preset the speed of convergence (how fast the camera stabilizes after change) from four possible options. The camera displays the current luminance, current exposure, and current gain. For auto gain control, refer to Automatic Gain Control section.

⚠ CAUTION	In some rapidly changing and bright light conditions, an image brightness oscillation (image intensity flipping from bright to dark) could occur. To prevent this, increase the AEC minimum exposure setting, decrease the convergence speed, and/or decrease the lens iris.

Automatic Gain Control

Automatic gain control (AGC) enables the camera to maintain the same image brightness during changing light conditions. In AGC mode, you can set the image luminance (brightness), and the camera will adjust the gain accordingly. Luminance options are average or peak.

The camera starts by changing the gain within the specified min-max limits.

- If reaching one of the gain limits, the camera indicates reaching the limit and keeps the value until the light condition change. You can set the speed of convergence from four possible options.

- If enabling AEC mode and AGC mode together, the camera starts by changing the exposure first within the specified min-max limits.

- If reaching the maximum exposure limit, the camera adds gain and changes it within the specified min-max limits.

The AEC/AGC algorithm samples all pixels for the entire frame, but you can select only a portion of the image (AOI) to calculate the luminance level. The camera displays the current luminance within the frame (or AOI, if selected), the current exposure, and the current gain.

Video Iris Control

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

P-Iris Control

You can control the iris position of a P-Iris lens manually or let the camera adjust the iris by enabling Automatic Iris Control (AIC).

The AIC enables the camera to maintain the same image brightness during changing lighting conditions. In AIC mode, you can set the image luminance (brightness), and the camera will adjust the iris accordingly. Luminance options are Average or Peak.

The camera starts by changing the iris within the specified min-max limits.

If one of the iris limits is reached, the camera indicates the limit has been reached and maintains this value until the lighting conditions change.

⚠️ **CAUTION**	In some rapidly changing and high intensity lighting conditions, the AEC/AGC/AIC control loops may become unstable so that image brightness oscillations (image intensity flipping from bright to dark) occur. To prevent this, increase the AIC minimum iris position, decrease the maximum AGC gain and/or increase the minimum AEC exposure time

You can enable AIC, AEC (Automatic Exposure Control), and AGC (Automatic Gain Control) independently or together. With all three controls enabled together, the camera provides the best image quality by adjusting the iris, gain, and exposure

The AIC controls the amount of light passing through a lens by changing the iris opening.

The AGC affects the maximum signal-to-noise ratio (SNR) by adjusting the amplification of a video signal. Increasing gain reduces the maximum SNR.

The AEC controls both the amount of light captured by the image sensor and the SNR by adjusting the time an electronic shutter stays open. Generally speaking, longer exposure times equate to improved SNR and the maximum exposure limit value should be as high as possible without introducing motion smear in the image.

NOTE ✳	When enabling AIC (for a P-Iris lens), AEC, or AGC, you need to specify the minimum and maximum limits of the iris position, exposure, and gain. The camera uses the gain and exposure limits to determine the initial conditions for the AEC and AGC algorithms. Otherwise, the camera applies the default ones.

Default limits	Value	Description
Gain Limits		
Gain Minimum Limit	0 dB	
Gain Maximum Limit	48 dB	
Exposure Limits		
Exposure Minimum Limit	Varies	Depends on camera model.
Exposure Maximum Limit	Varies	Depends on current frame time.
Iris Limits		
Iris Minimum Limit	0 steps	The iris is Fully Open (max. aperture).
Iris Maximum Limit	73 steps	The iris is Fully Closed (min. aperture). The maximum limit varies based on the lens model. You may need to adjust the iris maximum limit if the **maximum number of steps** of in the lens differs from 73 (73 is pre-set value for the Kowa LM25JC5MM lens in default (factory) configuration). Please refer to the documentation on your P-Iris lens for this parameter or contact a lens distributor for more information.

If AIC (for a P-Iris lens), AEC, and AGC modes are enabled together, the camera starts by changing the iris position first. Depending on initial lighting conditions, the camera applies AIC, AEC, and AGC algorithms according to either Case 1 or Case 2 shown below.

CASE 1
When the current image luminance **is lower than the** target image luminance, the camera expands the iris opening allowing more light through the lens. When the iris is Fully Open, the camera indicates the minimum iris limit (in steps) has been reached. (The iris is Fully Open when the current iris position (in steps) is minimum.) The camera then increases the exposure until the exposure reaches the maximum limit. The camera indicates the exposure maximum limit has been reached and increases the gain until either the target image luminance is achieved, or the maximum gain limit is reached.

The camera maintains these values until the lighting conditions change and starts by decreasing the gain first to decrease the image luminosity. If the gain minimum limit is reached, the cameras decreases the exposure until it reaches the minimum limit. The camera then indicates the exposure minimum limit has been reached and closes the iris until either the target luminosity is achieved, or the iris is Fully Closed (maximum iris limit is reached).

CASE 2
When the current image luminance **is higher than the** target image luminance, the camera contracts the iris opening allowing less light through the lens. When the iris is Fully Closed (maximum iris limit is reached), the camera indicates the maximum limit has been reached. (The iris is Fully Closed when current P-Iris position (in steps) is maximum.) The camera then

decreases the exposure until either the luminance target is achieved, or the minimum exposure limit is reached.

The camera maintains these values until the lighting conditions change. The camera then follows the algorithm described in **Case 1** to increase the image luminance starting with iris adjustments to increase image luminance.

> **NOTE** ✱   The size of an iris opening (aperture) affects a depth of field (DOF). The larger the aperture, the smaller the depth of field and only objects within a narrow range (distance) will be in focus. The smaller the aperture, the greater the depth of field and objects over a greater range will be in focus .
>
> A long exposure causes a blurring effect when capturing fast-moving objects.

The AIC/AEC/AGC algorithm samples all pixels for the entire frame. The camera displays the current luminance within the frame, the current exposure, the current gain, and the current iris position.

I/O Control

The camera supports one tri-level sync input for analog video synchronization, one TTL output (strobe), and one opto-isolated strobe (or optional Video Iris or P-Iris). You can enable genlock mode when connected to an external tri-level sync device providing input/output synchronization of frame rates.

A second opto-isolated strobe is available. An optional P-Iris control can replace the second opto-isolated strobe. A custom interface cable to support the second strobe and firmware update are required. Contact IMPERX customer service for details.

Strobe Control

The 3G-SDI camera supports two independently controlled strobe signals. Typically, the strobe output synchronizes an external light source or additional cameras with the master camera timing. The strobe activates at the end of the exposure period just as the readout period begins. If using internal exposure control, you can position the strobe to occur when the exposure time starts by using the strobe delay feature. You can position each strobe pulse within the entire frame-timing period with a precision of 1.0 microsecond. You can set the strobe position and duration from 1.0 microsecond to the maximum frame time with a precision of 1.0 microsecond.

Gamma Control

The camera's built-in processing engine enables adjustments to the luminance (brightness) of an image on the monitor. Using gamma correction, you can control, stretch, or compress the image luminance with eight different gamma curves from darker (2.2) to brighter (1/2.2).

You can also apply black gamma correction specifically to adjust the darker portions of an image or the brighter portions of the image and apply one of four User configurable LUTs. The User configurable LUTs are pre-programmed as follows:

LUT#1: Gamma 0.45 (1/2.22)

LUT#2: Inverts the image intensity

LUT#3: Gain of 2x

LUT#4: Repeat: input = output.

The Image enhancement tab also provides the ability to apply one-point or two-point knee corrections to the image.

Color Control

The camera provides white balance options for controlling image color under different lighting conditions. White balance control options are Off, Once, Auto, Manual, Indoor 3200K, and Outdoor 5600K.

Image Sensor's Analog and Digital Gain

The image sensor allows you to apply up to 48 dB of gain to the image prior to A/D conversion. The first 24 dB of gain is analog gain and some improvement in noise performance may result. The camera applies the last 24 dB of gain digitally, which affects both signal and noise equally.
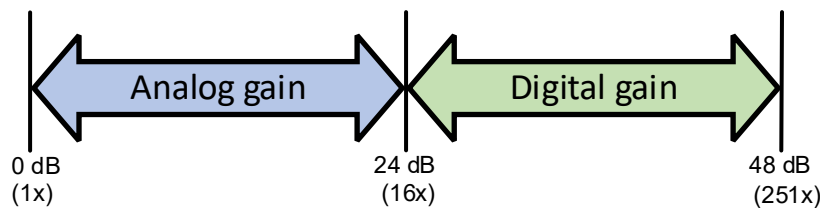
To change the analog/digital gain, use *Analog* control providing 480 gain steps. Each step increases the gain by 0.1 dB.

Image Sensor Technology

A CMOS camera is an electronic device for converting light into an electrical signal. The C1920 camera contains the 1st Generation Sony Pregius CMOS (Complementary Metal-Oxide Semiconductor) image sensor with 5.86-micron square pixels. The C2010 camera contains 2nd Generation Sony Pregius CMOS image sensor with 3.45-micron square pixels. The C1911 is built around the 3rd Generation Sony Pregius CMOS image sensor with 4.5-micron square pixels. The Sony Pregius image sensors have groundbreaking performance with sensitivity better than traditional Charge Coupled Device (CCD) image sensors. The sensors have extremely low dark current and virtually no fixed pattern noise, which has been the bane of traditional CMOS image sensors.

The Sony CMOS image sensor consists of a two-dimensional array of sensitive elements called silicon photodiodes, also known as pixels. The photons falling on the CMOS surface create photoelectrons within the pixels. 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 camera reaches the desired exposure time, it shifts the charges from each pixel photodiode onto a storage register within the pixel, reads out one row at a time, and then digitizes each pixel to 12 bits. Frame time, or read-out time, is the time interval required for all the pixels to be read out of the image sensor. While reading out the image from the storage registers within each pixel, the camera captures the next image. The exposure ends just as the readout of the previous frame ends and the next frame begins.

Unlike traditional CCD image sensors, the Sony CMOS image sensor digitizes each pixel within a row simultaneously. This allows for more settling time, which lowers the overall noise floor and provides improved sensitivity. The low noise floor, combined with a reasonably large pixel charge capacity, translates into a large dynamic range of 71 dB (12-bits) or 12 F-stops for 3.45-micron pixel and 77 dB (13-bits) or 13 F-stops for 4.5-micron pixels.

The camera allows you to apply up to 48 dB of gain to the image. The first 24 dB of gain is analog gain and some improvement in noise performance may result. The camera applies the last 24 dB of gain digitally, which affects both signal and noise equally.

A set of color filters (red, green, and blue) arranged in a Bayer pattern over the pixels generates color images. The starting color is Red for SONY Pregius image sensors. The following figures show the sensor's color response.

Spectral Responses

Cheetah C1911 Spectral Response

Sony IMX429
Color Spectral Response

Sony IMX429
Mono Spectral Response
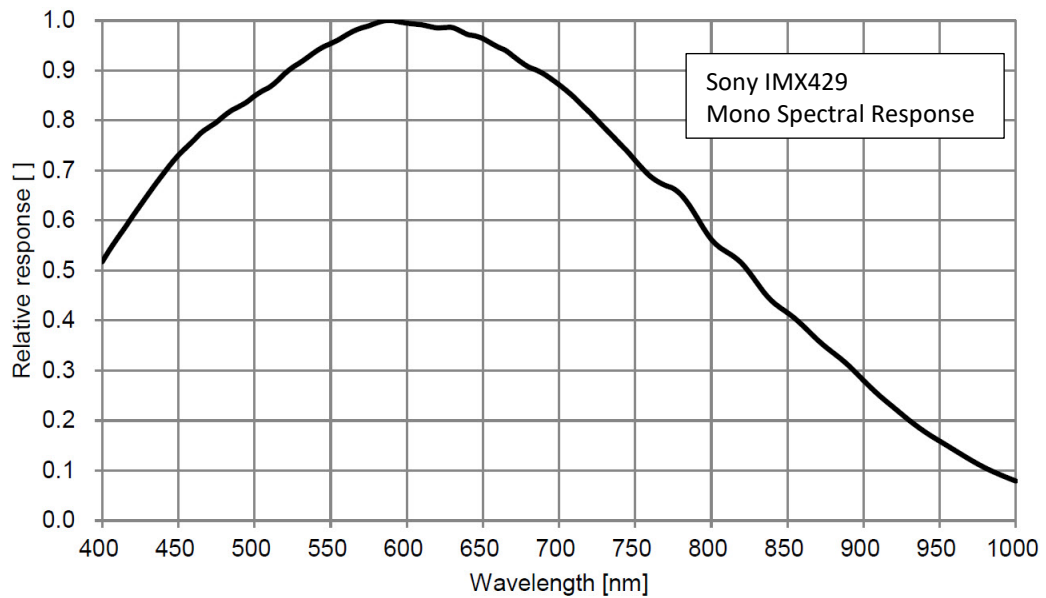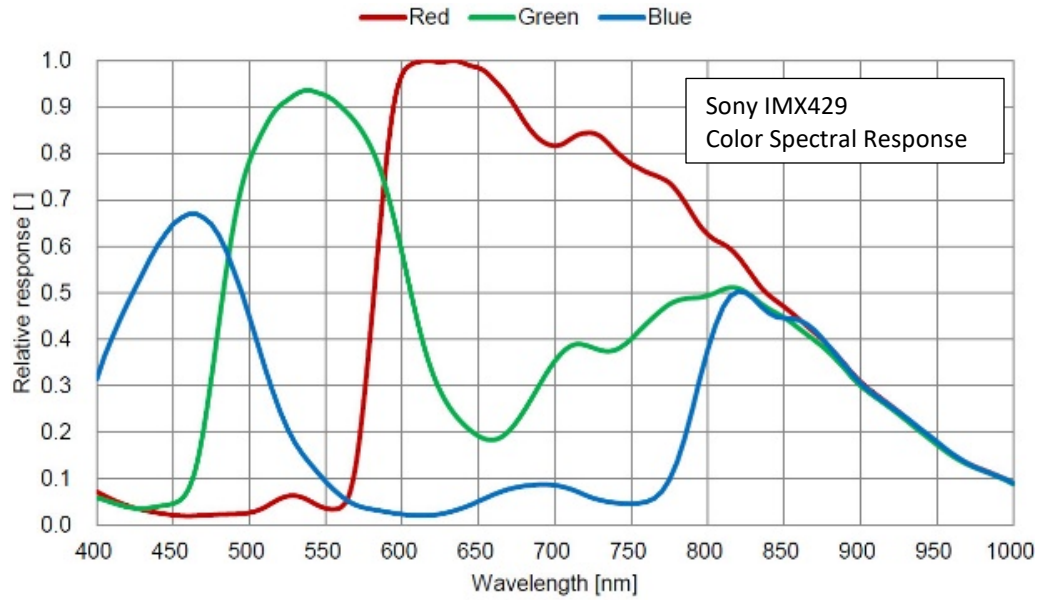
Cheetah C1920 Spectral Response

Sony IMX174
Color Spectral Response

Sony IMX174
Mono Spectral Response
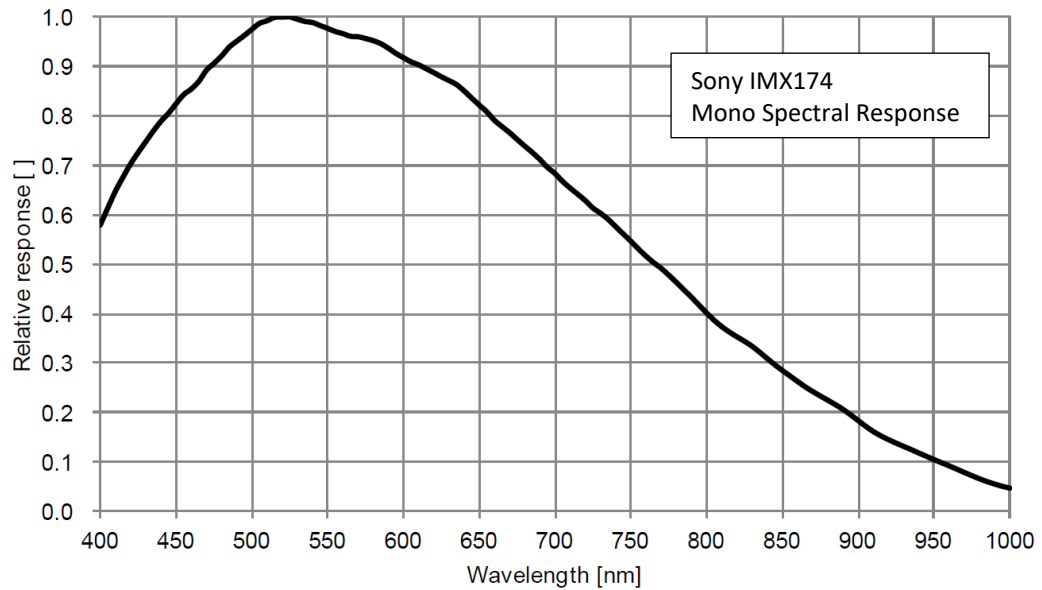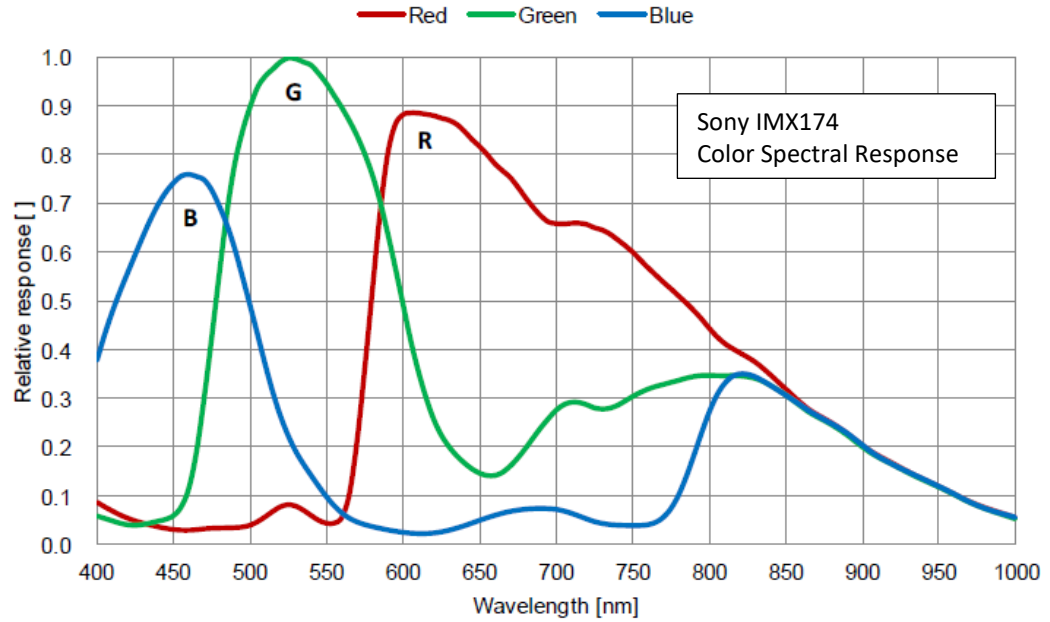
Cheetah C2010 Spectral Response

Sony IMX265
Color Spectral Response

Sony IMX265
Mono Spectral Response
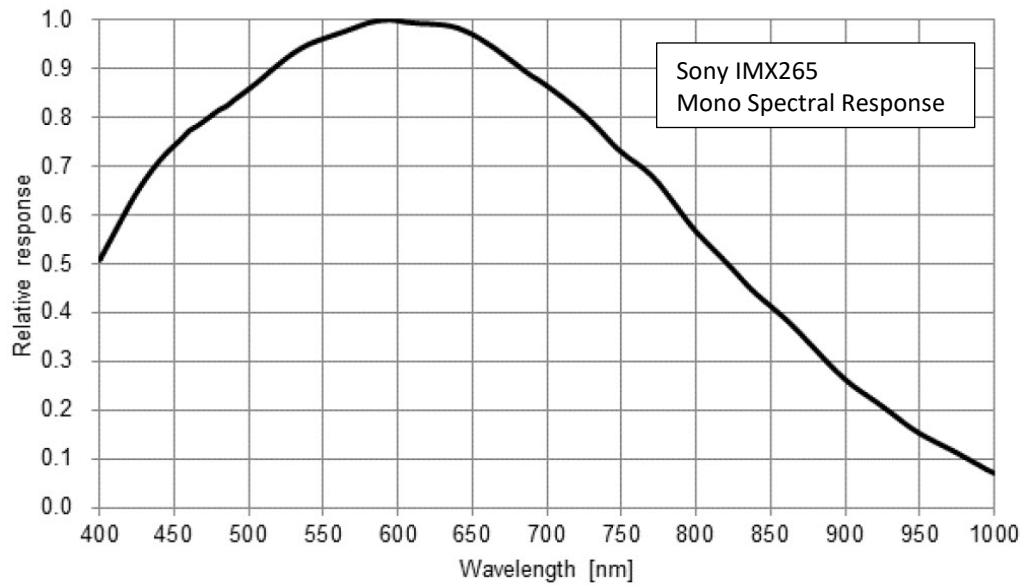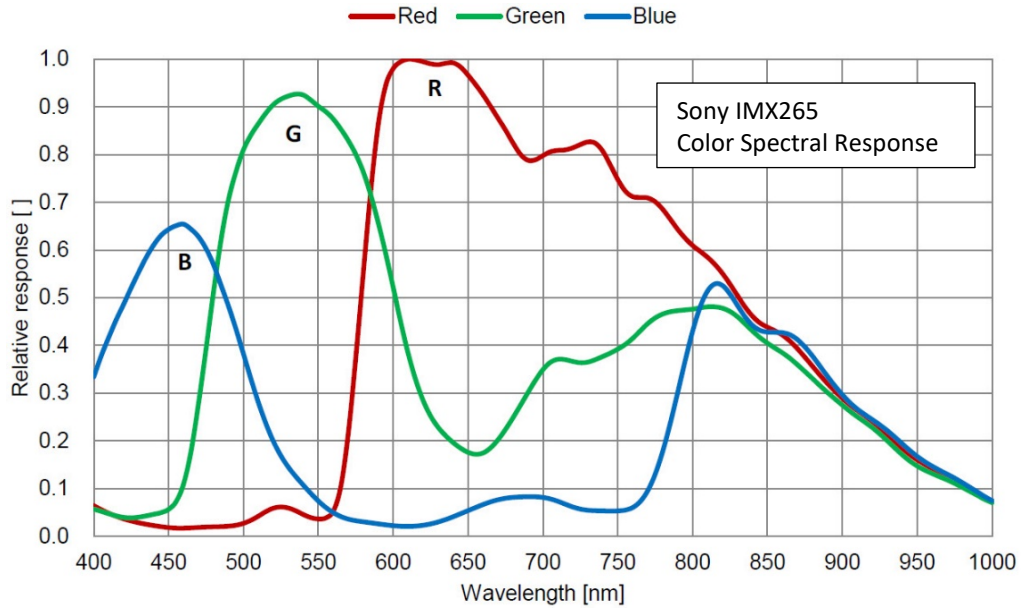
Register-based Commands

You can control all of the cameras resources (internal registers, video amplifiers and parameter flash) using a simple, register-based command protocol (Appendix A – Camera Register) with the Camera's RS-232 serial interface. The interface is bi-directional. You issue commands, and the camera issues responses (status or information type).

Configuration Memory

The camera provides configuration memory divided into these 4 segments: work-space, factory-space, user-space #1, and user-space #2.

The work-space segment contains the current camera settings while the camera is powered-up and operational. All camera registers are located in this space. You can program and retrieve the registers by issuing commands. The work-space is RAM based. Powering down the camera clears the work-space memory.

The factory-space segment is ROM based and write protected. It contains the default camera settings. This space is available for read operations only.

The user-space #1 and user-space #2 segments are non-volatile and Flash-based. The camera allows you to save the contents of the workspace to either one of these memory spaces and allows you to load these contents into the workspace. In this way, you can easily save and restore up to two different camera configurations.

Upon powering up the camera, the firmware loads the work-space registers from the factory space and user-space #1 or user-space #2 as determined by a boot control register stored in the configuration memory. At any time, you can instruct the camera to loads its workspace with the contents of the factory-space, user-space #1, or user-space #2. You can also instruct the camera to save the current workspace as either user-space #1 or user-space #2.

The non-volatile parameter Flash memory also contains Lookup tables (LUTs) and DPM/HPM maps that you can update using the Bobcat Upload Manager program.

Camera Serial Protocol

To access the camera registers and resources, transmit a sequence of bytes to the camera using the 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 handshake, and no parity. The following diagram illustrates the RS-232 serial protocol format. You can configure the default baud rate as 9600, 19200, 38400, 57600, or 115200 (default).
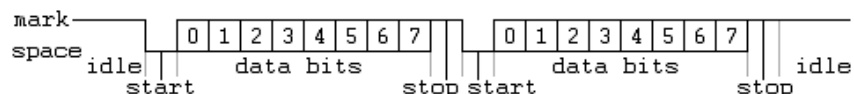
You can update each camera control register independently. The serial protocol defines all registers as 16-bit address (hex format) and 32-bit data (hex format). Camera registers using fewer than 32-bits in width must be padded with 0s on writes; unused bits are ignored on reads. Register data is always packed low within 32-bit data words for registers defined less than 32-bits.

Each command experiences delay 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.

Write Operation

To write to any given camera register, send a sequence of 7 bytes to the camera. If no errors occur, the camera returns a one byte acknowledge for the write command <Ack>.

Write to camera (7 Bytes): <Write_Cmd> <Address> <Data>
               1st byte: 0x57 (Write Command)
               2nd byte: <Register Address_High> MSB
               3rd byte: <Register Address_Low> LSB
               4th byte: <Register Data Byte 4> MSB
               5th byte: <Register Data Byte 3> …
               6th byte: <Register Data Byte 2> …
               7th byte: <Register Data Byte 1> LSB

Write Acknowledge (1 Byte): <Ack>
               1st byte: 0x06 (Acknowledge)
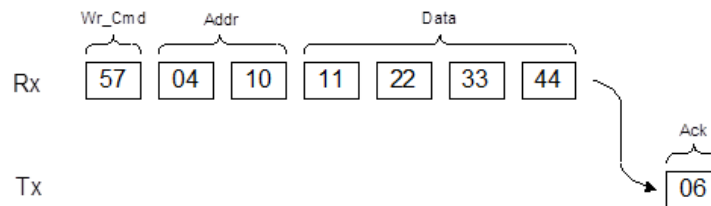
If an error occurs, the camera returns a two-byte not-acknowledge message for the write command. The first byte is <Nac> <Err>, the second is the error code as shown in the following diagrams:

Write not-acknowledge (2 Bytes): <Nak> <Error Code>
               1st byte:0x15 (Not-acknowledge)
               2nd byte: <XX> (Nck Error Code. See Error Code Description section)
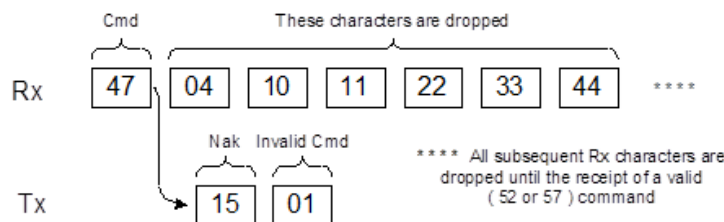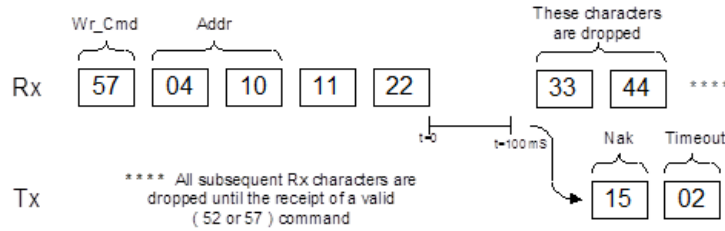
Example: Write to register address 0x0410, data value = 0x11223344:
Camera Write Command: <0x57> <04> <10> <11> <22> <33> <44>

Read Operation

To read from any given camera register, send a sequence of 3 bytes 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>.

During read operation, the camera does not return an error or <Nac>. The only exception is the case of invalid command shown in the Normal read cycle diagram below. If you specify 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
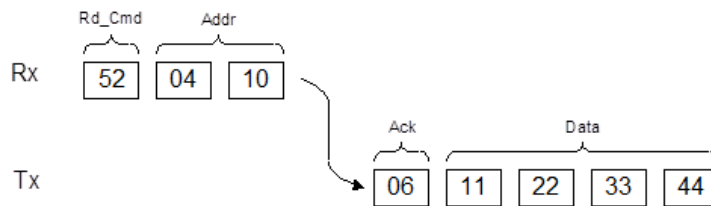
Example: Read from camera register address 0x0410:

        Camera Read Command: <0x52> <04> <10>

Camera returns register data payload value 0x11223344:
        Register data <0x06> <11> <22> <33> <44>

Error Code Description

To manage camera reliability, use the following not-acknowledge error codes:

x00 – No error
x01 – Invalid command. An invalid command (not 52 or 57) sent to the camera.
x02 – Time-out
x03 – Checksum error
x04 – Value less than minimum
x05 – Value higher than maximum
x06 – AGC error
x07 – Supervisor mode error
x08 – Mode not supported error

Appendix A – Camera Registers

This appendix provides a quick reference to the 3G-SDI camera configuration workspace registers.

Abbreviation	Description
RW	read/write
RO	read only
WO	write only

Saving and Restoring Registers

Address	Register Name	Data		Type	Usage
0x6000	Boot From	Data (1:0) Data (31:2)	00 – Factory 01 – User 1 10 – User 2 <N/A>	RW	Defines Configuration file to load upon power up
0x6060	Load From Factory	Command		WO	Writing to this register loads the Factory configuration
0x6064	Load From User 1	Command		WO	Writing to this register loads the User Space #1 camera Configuration
0x6068	Load From User 2	Command		WO	Writing to this register loads User Space #2 configuration
0x6074	Save to User 1	Command		WO	Writing to this register saves the camera config. to User Space #1
0x6078	Save to User 2	Command		WO	Writing to this register saves the camera config to User Space #2
0x0604	RS-232 Baud Rate Selector	Data (2:0) Data (31:3)	000 – 9600 001 – 19200 010 – 38400 011 – 57600 100 – 115200 <N/A>	RW	Defines RS-232 interface Baud rate

Camera Information Registers

Address	Register Name	Data		Type	Usage
0x6004	Firmware_Revision	Data (23:0) Data (27:24) Data (31:28)	<FW Revision > <CMOS color> <Firmware image>	RO	Returns Camera main firmware revision
0x6008	FPGA EPCS Customer ID	Data (15:0) Data (19:16) Data (23:20) Data (27:24) Data (31:28)	<Customer ID > <EPCS Type> <FPGA Type> <CMOS Chip ID> >Applications Type>	RO	Returns Firmware parameters
0x6010	Camera Temp.	Data (9:0) Data (31:10)	<Temperature Value> <N/A>	RO	TEMP = $246.312 - 0.304 * D(9:0)$; where D(9:0) is Temp. value in decimal. d560 (max) to d920 (min).
0x601C	Software Reset	<DEADBEEF> in HEX		WO	Resets the camera firmware after writing a special code: DEADBEEF
0x609C	Cam_Exp_Time	Data (23:0) Data (31:24)	<Current exposure increment from 6 (Hex) (Max) to 464(H) (Min) > <N/A>	RO	Exposure increment (1,118 increments)
0x60A0	Frame_Period	Data (23:0) Data (31:24)	<Frame Time > <N/A>	RO	Frame time in micro-seconds
0x60B4	AGC & Luminance Status	Data (11:0) Data (23:12) Data (24) Data (25) Data (27:26) Data (28) Data (29) Data(31,30)	<Current AGC Gain> <Current Average Luminance> <Analog Gain Min. Limit reached> <Analog Gain Max Limit reached> N/A <Exposure Min Limit Reached> <Exposure Max Limit Reached> N/A	RO	Current AGC analog Gain and Luminance Status

Gain, Exposure and AEC/AGC/AIC

Address	Register Name	Data		Type	Usage
0x0544	Exposure Control Mode	Data (1:0) Data (31:2)	00 – off – no exposure control 10 – internal – exposure control register 0x0548 sets the camera exposure Others – reserved N/A	RW	Determines mode.
0x0548	Internal Exposure Timer	Data (23:0) Data (31:24)	<value> – exposure increments** Exposure increment 0006 H (max exp) 464H (min exp) N/A	RW	Exposure is divided into 1,118 equal increments based on frame time.

**To calculate exposure in units of microseconds, use the calculated line times and minimum exposures listed in the table below to calculate the exposure increment or exposure time in the equations below:
1) Exposure time = [(1124 – Exposure increment (Decimal)) *Line Time] + Min Exposure

To calculate Exposure increment from Exposure Time:
2) Exposure Increment = 1124 – [(Exposure time (us) - Min Exposure)) / Line Time]. Convert Decimal to Hex.

Frame Rate (fps)	Max Exp	Min Exp	Line Time
60	16,591	29	14.81395
59.94	16,608	29	14.82916
50	19,907	32	17.77728
30	33,169	44	29.6288
29.97	33,202	44	29.65832
25	39,800	50	35.55456
24	41,458	51	37.03667
23.98	41,499	51	37.07335

Address	Register Name	Data		Type	Usage
0x0150	AEC_Control Enable	Data (0) Data (31:1)	0 – disable AEC 1 – enable AEC N/A	RW	
0x0154	AGC_Control Enable	Data (0) Data (31:1)	0 – disable auto gain control 1 – enable auto gain control N/A	RW	
0x014C	AIC_Control Enable	Data (0) Data (31:1)	0 – disable AIC 1 – enable AIC N/A	RW	Enables Video Iris
0x0158	Luminance Target	Data (11:0) Data (31:12)	<value> – desired luminance level in counts N/A	RW	

Address	Register Name	Data		Type	Usage
0x017C	AEC AGC Luminance Average or Peak Select	Data (1:0)	00 – average luminance 01 – peak luminance 10 or 11 – reserved	RW	
		Data (31:2)	N/A		
0x0004	CMOS_Sensor_Gain	Data (8:0)	<value> –gain	RW	Gain, 0 dB to 48 dB (0.1 dB per step).
		Data (31:9)	<N/A>		
0x0008	CMOS_Offset	Data (8:0)	<value> – analog offset	RW	Offset Value: 0x0000 to 0x01FF.
		Data (31:9)	<N/A>		
0x0160	AGC_Gain Maximum Limit	Data (8:0)	<value> – max. AGC gain limit	RW	0 to 48dB in 0.1 dB steps (1E0H max).
		Data (31:9)	N/A		
0x018C	AGC_Minimum_Gain Limit	Data (8:0)	<value> – min. AGC gain limit	RW	
		Data (31:9)	N/A		
0x0164	AEC AGC_AOI Horizontal Width	Data (10:0)	<value> AOI width in horizontal direction	RW	AEC/AGC AOI X Width (780H max).
		Data (31:11)	N/A		
0x0168	AEC AGC_AOI 'X' offset	Data (10:0)	<value> AOI offset in horizontal direction	RW	AEC/AGC Area X Offset
		Data (31:11)	N/A		
0x016C	AEC AGC_AOI Vertical Height	Data (10:0)	<value> AOI height in vertical direction	RW	AEC/AGC AOI Y Height (438H Max).
		Data (31:11)	N/A		
0x0170	AEC AGC_AOI Y Offset	Data (10:0)	<value> AOI offset in vertical direction	RW	AEC/AGC AOI Y Offset from bottom of image.
		Data (31:11)	N/A		
0x0174	AEC_Convergence Speed	Data (1:0)	00 – 1x speed – slow 01 – 2x speed 10 – 3x speed 11 – 4x speed – fast	RW	
		Data (31:2)	N/A		
0x0178	AGC_Convergence Speed	Data (1:0)	00 – 1x speed – slow 01 – 2x speed 10 – 3x speed 11 – 4x speed – fast	RW	
		Data (31:2)	N/A		
0x05B0	AEC Exposure Max	Data (10:0)	<value> – maximum exposure time limit in exposure increments Max exposure is 6 increments Min exposure is 1124 increments (See Internal Exposure Timer Register 0x0548 description)	RW	AGC Exposure The frame time is divided into 1118 exposure increments.
		Data (31:11)	N/A		

Address	Register Name	Data		Type	Usage
0x05C8	AEC_Mini mum_Expo sure Limit	Data (10:0)	\<value\> – minimum exposure time limit in exposure increments. Max exposure is 6 increments Min exposure is 1124 increments (See Internal Exposure Timer Register 0x0548 description)	RW	
		Data (31:11):	N/A		

Image Processing

Address	Register Name	Data		Type	Usage
0x0400	Enhancem ent Mode	Data (3:0)	000 – Enhancement disabled 001 – Not Defined 010 – Not Defined 011 – Not Defined 100 – Not Defined 101 – One Point Correction 110 – Two Point Correction 111 – Not Defined	RW	Image Enhancement modes
		Data (31:4)	N/A		
0x0118	LUT_Select or	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 … 111 – N/A	RW	Look-Up-Table selector.
		Data (31:1)	N/A		
0x011C	Gamma _Enable	Data (3:0)	0000 – LUT disable 0001 - Gamma Y = 1.3 0010 – Gamma Y = 1.6 0011 – Gamma Y = 1.9 0100 – Gamma Y = 2.2 0101 – Gamma Y = 1/1.3 0110 – Gamma Y = 1/1.6 0111 – Gamma Y = 1/1.9 1000 – Gamma Y = 1 / 2.2	RW	Gamma Look-Up-Table.
		Data (31:4)	N/A		
0x01AC	Black Gamma	Data (3:0)	N/A 0000 – Black Gamma disable 0001 - Black Gamma Y = 1.3 0010 – Black Gamma Y = 1.6 0011 – Black Gamma Y = 1.9 0100 – Black Gamma Y = 2.2 0101 – Black Gamma Y = 1/1.3 0110 – Black Gamma Y = 1/1.6 0111 – Black Gamma Y = 1/1.9 1000 – Black Gamma Y = 1 / 2.2	RW	
		Data (31:4)	N/A		

Address	Register Name	Data		Type	Usage
0x019C	Black Gamma Values	Data (1:0) Data (31:2)	00 – 10% 01 – 20% 10 – 30% N/A	RW	Selects Black Gamma values 10%, 20%, and 30%.

Data Out and Test Patterns

Address	Register Name	Data		Type	Usage
0x060C	3G-SDI Output Format	Data (3:0) Data (31:4)	0x0 – 1080p@23.98 0x1 – 1080p@24 0x2 – 1080p@25 0x3 – 1080p@29.97 0x4 – 1080p@30 0x5 – 1080p@50 0x6 – 1080p@59.94 0x7 – 1080p@60 0x8 – 720p@50 0x9 – 720p@59.94 0xA – 720p@60 others – reserved N/A	RW	
0x0120	DPC_Enable	Data (0) Data (31:1)	0 – DPC disable 1 – DPC enable N/A	RW	Enables Defective Pixel Correction.
0x0124	HPC_Enable	Data (0) Data (31:1)	0 – HPC disable 1 – HPC enable N/A	RW	Enables Hot Pixel Correction.
0x0610	SMPTE Test Pattern	Data (1:0) Data (31:2)	00– disable SMPTE test pattern 10– enable SMPTE test pattern N/A	RW	
0x0584	Genlock_select	Data (1:0) Data (31:2)	00 - Disable Genlock 10 - Enable Genlock N/A	RW	Genlock.
0x012C	Test_Mode_Selector	Data (3:0)	0x0 – live image 0x1 – black image – 0x000 0x2 – gray image – 0x1FF 0x3 – white image – 0xFFF 0x4 – steady horiz image ramp 0x5 – steady vertical image ramp 0x6 – moving horiz image ramp 0x7 – moving vertical image ramp 0x8 – 8 gray scale vertical bars 0x9 – H & V lines superimposed over live image – enables X & Y lines below. 0xA to 0xF - reserved	RW	

Address	Register Name	Data		Type	Usage
		Data (31:4)	N/A		
0x0130	Superimpose X & Y Lines	Data (0)	0 – disable X&Y lines 1 – enable X&Y Lines	RW	
		Data (31:1)	N/A		
0x0134	Superimposed_ Cross Hair	Data (0)	0 – disable cross hair 1 – enable cross hair	RW	
		Data (31:1)	N/A		
0x0148	Cross Hair and X&Y Line Brightness	Data (11:0) Data (31:12)	<value> – line brightness N/A	RW	default 2047.
0x015C	Horizontal Image Mirror	Data (1:0) Data (31:2)	00 – disable Horizontal and Vertical flip 01 – Horizontal Flip only 10 – Vertical Flip only 11 – Horizontal and Vertical flip N/A	RW	
0x0138	Superimpose Horizontal Row Position #1	Data (10:0) Data (31:11)	<value> – H1 line position N/A	RW	H1 Line, Row position Range: 1 to 1080.
0x013C	Superimpose Horizontal Row Position #2	Data (10:0) Data (31:11)	<value> – H2 line position N/A	RW	H2 Line, row position Range 1 to 1080.
0x0140	Superimpose_X Vertical Column Position #1	Data (10:0) Data (31:11)	<value> – V1 column position N/A	RW	Y1 Column Position Range: 1 to 1920.
0x0144	Superimpose Vertical Column Position #2	Data (10:0) Data (31:11)	<value> – V2 column position N/A	RW	Y2 Column Position Range: 1 to 1920.

Color

Address	Register Name	Data		Type	Usage
0x0300	White Balance Options	Data (2:0)	000 – Off 001 – WB Once 010 – WB Auto 011 – WB Manual 100 – Indoor 3200K 101 – Outdoor 5600K 110, 111 – N/A	RW	
		Data (31:3)	N/A		
0x0340	White Balance Tracking Speed	Data (2:0)	000 – 1x speed 001 – 2x speed 010 – 3x speed 011 – 4x speed 100 – 5x speed 101, 111 – N/A	RW	AWB tracking / update rate
		Data (31:3)	N/A		
0x0304	WB_Red	Data (11:0)	<value>; 000hex ... FFFhex; 1 step 1/4095 range	RW	White Balance Manual Gain for Red.
		Data (31:12)	N/A		
0x0308	WB_Green	Data (11:0)	<value>; 000hex ... FFFhex; 1 step 1/4095; range	RW	White Balance Manual Gain for Green.
		Data (31:12)	N/A		
0x030C	WB_Blue	Data (11:0)	<value>; 000h….FFFh; 1 step = 1/4095	RW	White Balance Manual Gain for Blue.
		Data (31:12)	N/A		
0x01B0	DC_Offset_Red	Data (10:0)	<value>; 000h….3FFh; -512 . . . + 511; two's complement	RW	Sets the digital offset for Red.
		Data (31:11)	N/A		
0x01B4	DC_Offset_Green	Data (10:0)	<value>; 000h….3FFh; -512 . . . + 511; two's complement	RW	Sets the digital offset for Green.
		Data (31:11)	N/A		
0x01B8	DC_Offset_Blue	Data (10:0)	<value>; 000h….7FFh; -512 . . . +511; two's complement	RW	Sets the digital offset for Blue.
		Data (31:11)	N/A		

Strobe

Address	Register Name	Data		Type	Usage
0x055C	Strobe One Enable	Data (1:0)	00 – disable Strobe #1 01 – enable Strobe #1 each frame	RW	Standard.
		Data (31:2)	N/A		
0x0560	Strobe Two Enable	Data (1:0)	00 – disable Strobe #2 01 – enable Strobe #2 each frame	RW	Optional.
		Data (31:2)	N/A		
0x05B4	Strobe Two Duration	Data (23:0)	<value> – strobe pulse duration in microseconds	RW	Strobe 2 duration, 1 to Max Frame Time.
		Data (31:24)	N/A		
0x0564	Strobe One Pulse Width	Data (23:0)	<value> – strobe pulse duration in microseconds	RW	Strobe 1 duration, 1 to Max Frame Time.
		Data (31:24)	N/A		
0x0568	Strobe One Position	Data (23:0)	<value> – strobe #1 pulse position in microseconds with respect to Start of Readout	RW	Strobe 1 position, 1 to Max Frame Time.
		Data (31:24)	N/A		
0x056C	Strobe Two Position	Data (23:0)	<value> – strobe #2 pulse position in microseconds with respect to Start of Readout	RW	Strobe 2 position, 1 to Max Frame Time.
		Data (31:24)	N/A		

P-Iris Controls

Address	Register Name	Data		Type	Usage
0x014C	Video Iris / P-Iris Enable	Data (0) Data (31:1)	0 – manual mode 1 – enable Video Iris / P-Iris N/A	RW	Enables Video Iris / P-Iris function
0x0414	P-Iris step Value	Data (7:0) Data (31:8)	<Step Size for Close and Open Step commands> N/A	RW	Step size increment. Smaller step size = finer resolution
0x0418	Close P-Iris one Step (Reg 0414)	<COMMAND>		WO	Writing to this register closes the iris one step
0x041C	Open P-Iris one Step (Reg 0414)	<COMMAND>		WO	Writing to this register opens the iris one step
0x0420	Close P-Iris FULL	<COMMAND>		WO	Writing to this register closes the iris fully
0x0424	Open P-Iris FULL	<COMMAND>		WO	Writing to this register opens the iris fully
0x0428	P-Iris position	Data (7:0) Data (15:8) Data (23:16) Data (31:24)	<Current IRIS Position> Min Value 1 – always 0 Min Value 2 – always 0 Max Value – Depends on lens model. Set to Kowa = 73	RO	Provides iris position value
0x0194	Auto Iris maximum Aperture	Data (7:0) Data (31:8)	<Maximum Iris Aperture> N/A *Note: Contents of Reg 0194 must be less than Reg 0198	RW	Max aperture = 0. Higher values limit iris range.
0x0198	Auto Iris minimum Aperture	Data (7:0) Data (31:8)	<Minimum Iris Aperture> N/A	RW	Min. Aperture is dependent upon Iris manufacture. Contact Imperx for assistance.

Appendix B: Creating DPC/HPC table

Overview

Dead Pixel Correction and Hot Pixel Correction work with predetermined and preloaded Dead and Hot pixel maps. The Dead Pixel Map (DPM) and Hot Pixel Map (HPM) are downloaded into the camera's non-volatile memory.

You can edit the original (factory installed) DPM/HPM file, create your own file and upload it to fit the unique requirements of your operating environment or camera use.

Downloading DPM/HPM Files

To download the original DPM or HPM file, follow steps below:

1. Open the camera's software GUI.

2. Click **Menu** and select **DPM/HPM**.
   The **Defect Pixel Map** screen appears.
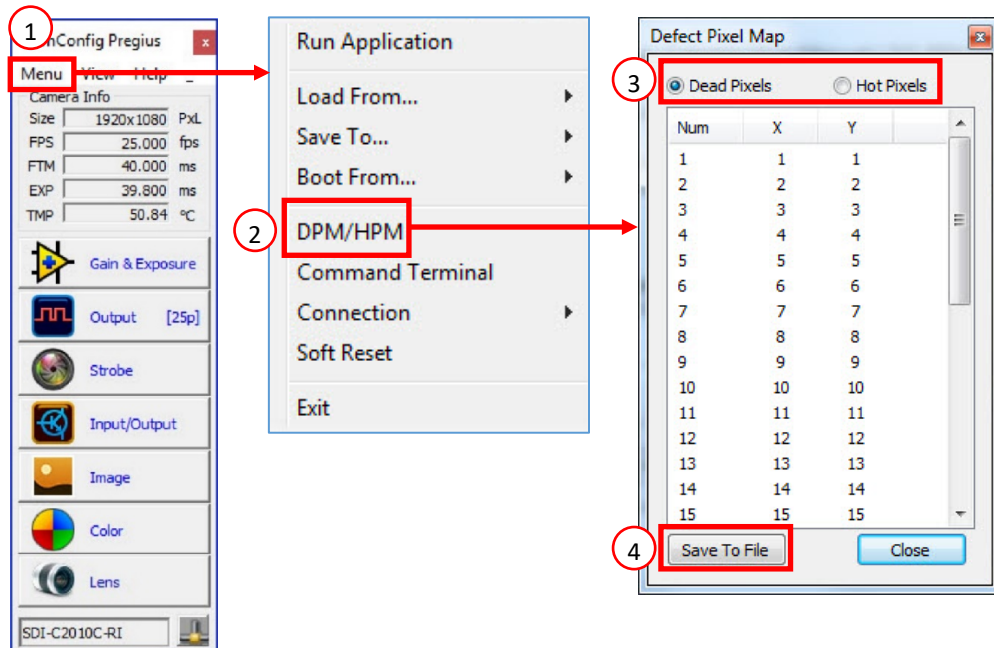
3. Select **Dead Pixels** or **Hot Pixels.**

4. Click **Save to File**. Navigate to where you want to save the file and create a file name and extension based on the type of file:
   - Use the extension .dpm if saving a Dead Pixel Map.
   - Use the extension .hpm if saving a Hot Pixel Map.

Editing DPM/HPM Files

You can edit DPM and HPM files in Microsoft Notepad or any other editing software. The file is a simple text file and looks like this:

```
-- Defective Pixel Map,
-- Date: 12.12.2019,
-- Model#: SDI-C2010M,
-- Serial#: 900001,
:Table,
-- Column(X),Row(Y)
          1920,155
          832,332
          103,893
           650,1017
           701,1017
          1712,1053
           914,1067
```

Pixel maps have 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 with a comma. The table section of the file contains an array of lines with each line containing an X (column number) value followed by a comma and a Y (row number) value.

All pixels are listed in the DPM or HPM in order of increasing Y (row) location. If there are multiple hot or dead pixels in the same row (Y location is identical for both defective pixels), the listing is in order of increasing X (column) location.

The maximum number of pixels in the DPM is 128 and in the HPM is 1024.

To edit the original DPM or HPM file, you need to identify dead/hot pixels, locate and adjust their coordinates, and accurately place pixels' coordinates into the pixel map.

Finding Dead Pixels

To see the defective pixels that are not in the factory DPM:

1. Make sure that the *DPC* is set to Static on the Output Control screen.
    The camera corrects the known pixel defects automatically.

2. Make sure that the camera resolution is set to maximum.

3. Capture an image with a uniform light source illuminating the sensor at about 50% ADU capacity (~500 for 10-bit).

4. Identify any visible defective pixel and add them to the DPM as described in Locating and Adding Pixel Coordinates.

5. To upload the new DPM into the camera, see Uploading DPM / HPM Files.

Finding Hot Pixels

To see the hot pixels that are not in the factory HPM:

1. Make sure that *HPC* is set to Static on the Output Control screen.
   The camera corrects the known hot pixels automatically.

2. Set the longest exposure time and slowest frame rate expected.

3. Put the lens cap on the camera.

4. Run the camera for at least 45 minutes at ambient temperature around 18–22 °C or higher.

5. Capture an image (or series of images).

6. Identify all visible hot pixels and add them to the HPM as described in Locating and Adding Pixel Coordinates.

7. To upload the new HPM into the camera, see Uploading DPM / HPM Files

Locating and Adding Pixel Coordinates

Follow the steps below to find first pixel coordinates, locate and adjust defective pixel coordinates, and accurately place defective pixel coordinates into the pixel map.

STEP 1: Find the First Pixel Coordinates
Your frame grabber's first pixel coordinates can affect the location accuracy of hot pixel coordinates. So, you must find the image sensor's first pixel coordinates and potentially adjust the hot pixel coordinates based on your findings.
Click the first pixel at the upper most left corner of the screen to find your frame grabber's first pixel X, Y coordinates.
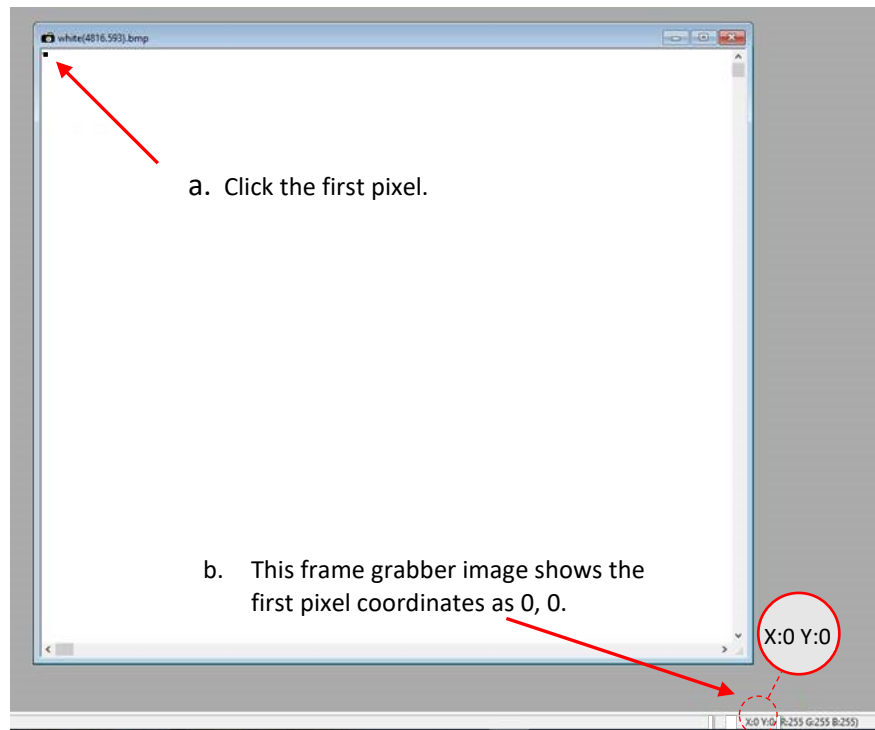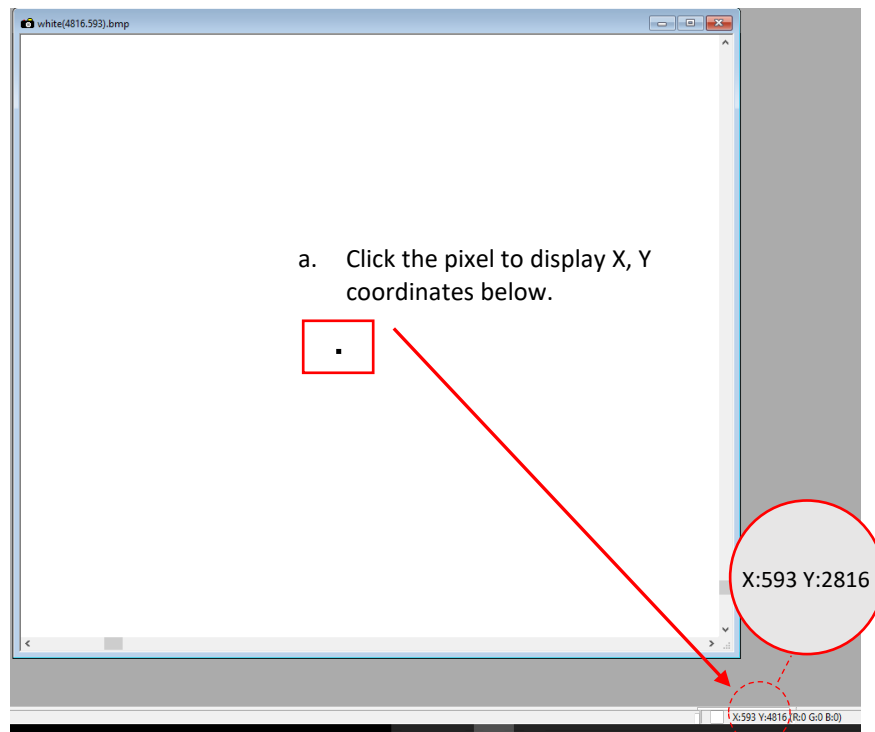

The coordinates will be either 0, 0 or 1, 1:

- If your frame grabber's first pixel coordinates are 0,0, you must add 1 to both the X and Y coordinates of the bad pixel.

- If the first pixel coordinates are 1, 1, do not add 1 to either coordinate.

STEP 2: Find Hot Pixel Coordinates
Click the hot pixel to find its X, Y coordinates.

The coordinates are 593, 2816 — where X (Column) = 593 and Y (Row) = 2816.

IMPORTANT: Frame grabbers from different manufacturers may display pixel location coordinates in different order, for example:

<div align="center">

X (Column), Y (Row) or,
X (Row), Y (Column).

</div>

You must put defective pixel coordinates into the pixel correction map file in this order: **X (Column), Y (Row)**.

If your frame grabber identifies pixel coordinates by X **(Row)**, Y **(Column)**, you <u>must</u> transpose the coordinates to X (**Column**), Y (**Row**) before entering them into the pixel map files. For example, if the 593, 2816 coordinates in the screen above had been displayed in this order, where X:593 is row and Y:2816 is column, you would have had to transpose the coordinates to 2816, 593.

STEP 3: Adjust Defective Pixel Coordinates
As described in **STEP 1**, if the first pixel coordinates are 0, 0, you must adjust the hot pixel coordinates by adding 1 to both coordinates as shown in the following:

<div align="center">

593 (+1), 2816 (+1) = 594, 2817

</div>

- If the frame grabber pixel coordinates are Column (X), Row (Y), then go to **STEP 4**.

- If the frame grabber pixel coordinates are Row (X), Column (Y), then transpose the coordinates to the form Column, Row and then go to **STEP 4**.

STEP 4: Add Hot Pixel Coordinates to Hot Pixel Map

Place the hot pixel coordinates in the Hot Pixel Map file in ascending (increasing) numerical order of the Y (row) coordinate. The value of all Y coordinates should progressively increase as you look down the list of X, Y coordinates.

Example 1: Different Y coordinates

```
-- Defective Pixel Map,
-- Date: 12.12.2019,
-- Model#: CLF-C4120M-RC,
-- Serial#: LAC001,
:Table,
-- Column(X),Row(Y)
701,1017
100,1018
4005,1019
2241,1020
458,1021
1712,1053
914,1067
3954,1546
2516,1670
1111,2149
95,2364
594,2817
433,2828
205,2899
```

Row coordinates are in ascending order (increasing Y values).

Example 2: Identical Y coordinates

```
-- Defective Pixel Map,
-- Date: 12.12.2019,
-- Model#: CLF-C4120M-RC,
-- Serial#: LAC001,
:Table,
-- Column(X),Row(Y)
650,1017
698,1017
701,1017
100,1018
4005,1019
2241,1020
458,1021
1712,1053
914,1067
3954,1546
2516,1670
1111,2149
95,2364
433,2828
205,2899
```

Column coordinates are in ascending order (increasing X values).

As shown in the **Example 1** above, the Y coordinate of 594, 2817 is higher than **2364** and lower than **2828**. Do not add hot pixel coordinates at the end of the list unless the Y coordinate is the highest of all Y values.

NOTE ✱ If adding a hot pixel with a Y location identical to one or more other hot pixels, insert its coordinates based on the order of increasing X location.

As shown in the **Example 2** above, the Y coordinate of 698, 1017 is identical to two other hot pixels. Place its coordinates between **650,** 1017 and **701,** 1017 because its X location (698) is higher than 650 but lower than 701.

STEP 5: Save your HPM

Save your Hot Pixel Map with file extension .hpm.

Creating a New DPM/HPM File

You can create your own HPM files 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 .dpm or .hpm file extension. The files look like this:

```
-- Defective Pixel Map,
-- Date: 2.23.2018,
-- Model#: SDI-C2010M-RC,
-- Serial#: 900001,
:Table,
-- Column(X),Row(Y)
            125,155
            850,332
           1520,893
            650,1017
            701,1017
           1712,1053
            914,1067
```

Pixel maps have 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 with a comma. The table section of the file contains an array of lines with each line containing an X (column number) value followed by a comma and a Y (row number) value.

All pixels are listed in the HPM in order of increasing Y (row) location. If the Y location is identical, the listing is in order of increasing X (column) location.

The maximum number of pixels in the DPM list is 128 and in HPM list is 1024.

To create a DPM/HPM file:

1. Identify dead/hot pixels (refer to the sections Finding Dead Pixels and Finding Hot Pixels).

IMPORTANT: When creating a new pixel map, you need to get all dead and hot pixels visible. Make sure that the *DPC* and *HPC* are set to Off on the **Output Control** screen of the CamConfig GUI, so the camera will not correct the known pixel defects.

2. Locate and adjust hot pixels' coordinates (refer to the section Locating and Adding Pixel Coordinates , **STEP1 – STEP3**).

3. Place pixels' coordinates into the pixel map and save the file (refer to the section Locating and Adding Pixel Coordinates **STEP4, STEP5**).

Uploading DPM / HPM Files

After saving the maps, you can upload them to the camera using the Imperx **Upload Utility**. The Upload Utility enables uploads of DPM, HPM, LUT, and other files to your camera.
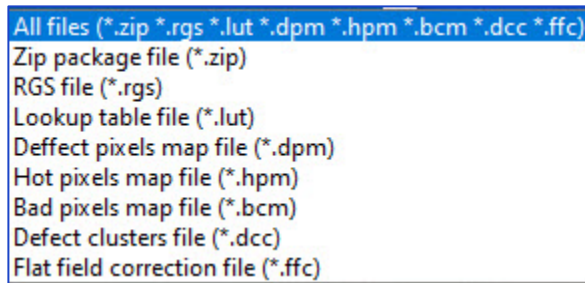
To upload the DPM/HPM file:

1. Connect and power up your camera.

2. Start the Imperx **Upload Utility** and wait for the Utility to detect the camera. If the utility does not detect the camera, click **Refresh** to restart the device collection.
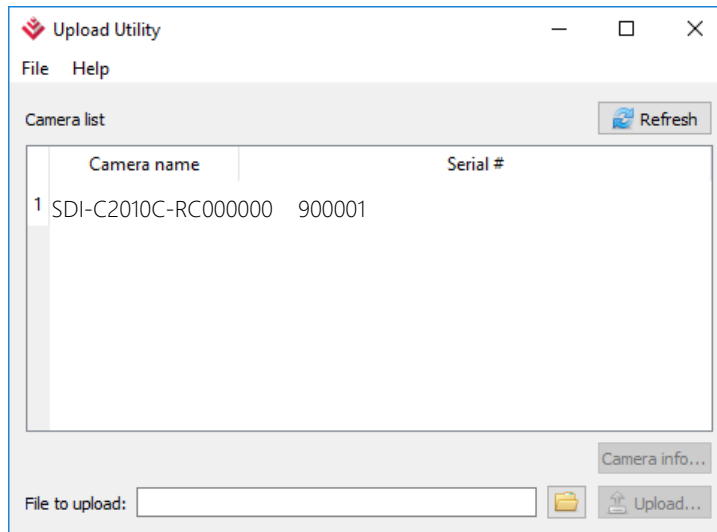
3. Select the camera to update if more than one appears.
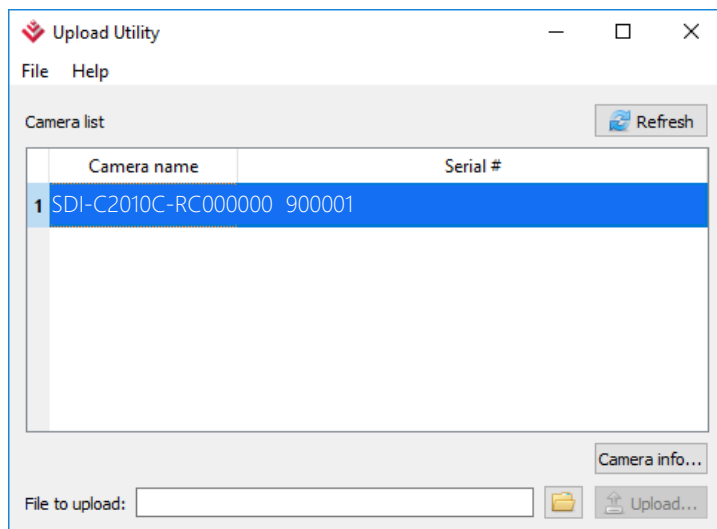
4. Browse for either the edited .dpm file or .hpm file, select it, and click **Upload**.
   Wait for the upload to finish.

All files (*.zip *.rgs *.lut *.dpm *.hpm *.bcm *.dcc *.ffc)
Zip package file (*.zip)
RGS file (*.rgs)
Lookup table file (*.lut)
Deffect pixels map file (*.dpm)
Hot pixels map file (*.hpm)
Bad pixels map file (*.bcm)
Defect clusters file (*.dcc)
Flat field correction file (*.ffc)

5. After the upload is completed, do a power cycle on the camera.

6. After the camera re-starts, run **CamConfig** and open **Image Control** screen.

7. Make sure that *DPC* or *HPC* is set to **Static** so that the camera uses the maps you loaded.

8. Retake images as described in the Finding Dead Pixels and Finding Hot Pixels sections to ensure all defective and hot pixels are now corrected.

Appendix C: Look Up Tables

Creating an LUT Using a Text Editor

You can use any ASCII text editor, such as Notepad or similar, to create a custom LUT. Alternatively, any spreadsheet program (i.e. Microsoft Excel) can be used by converting the spreadsheet into a comma delimited (.csv) file. In either case, rename the file to include the .lut file 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 4096 lines 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 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 5/28/20,
:Table,
-- input output,
     0,4095
     1,4094
     2,4093
     3,4092
     4,4091
     :
  4095,0
```

Creating an LUT Using Microsoft Excel

The LUT file can be created in Excel as follows:

1. Create the spreadsheet as shown below (note that 4096 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.
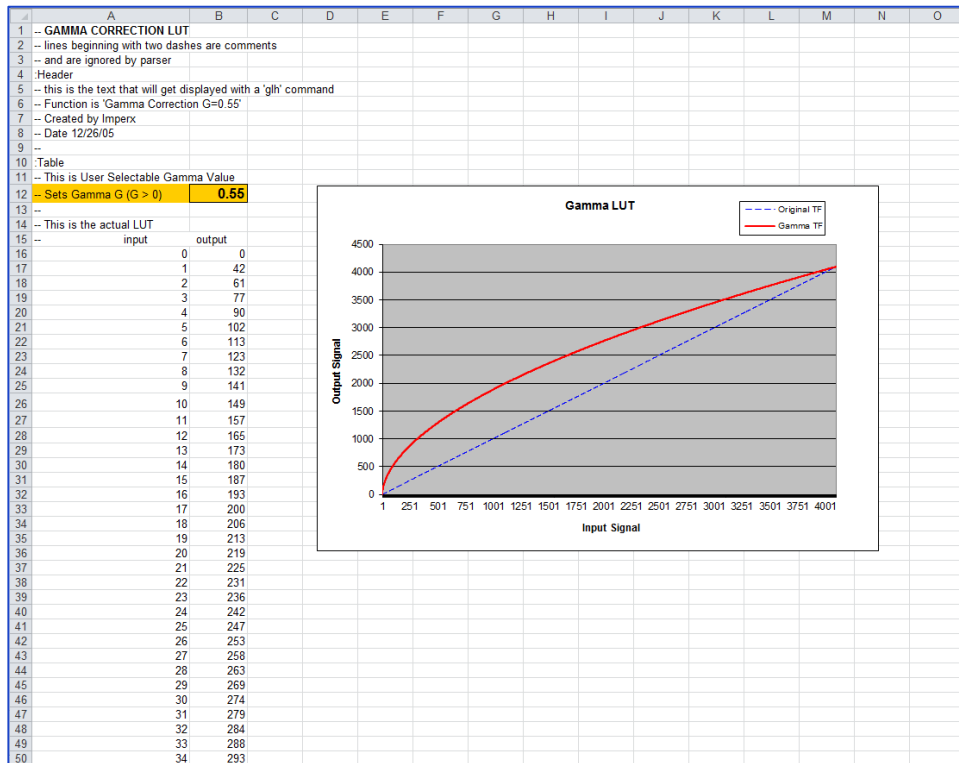
Creating an LUT Using Imperx Toolkit

1. On the Tools tab, open LUT Manager utility.

2. Create a new LUT file. On the Create LUT dialog box, select the LUT type, set the input and output bit depth to 12, and click **OK**.
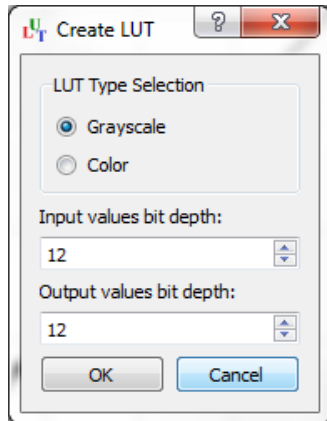
3. Click **Customize** under the LUT plot.

4. Click **More**, set **Curve type** to Dots and **Formula** to User.

5. Type in a formula for the new LUT.
   The following operands and operations are available:

Operation	Description
+	Addition
-	Substraction
*	Multiplication
/	Division
^	Raise to the power of
cos()	Cosine function
sin()	Sine function
tan()	Tangent function
acos()	Arc-Cosine function
asin()	Arc-Sine function
atan()	Arc-Tangent function
sqrt()	Square root
ln()	Log natural
exp()	Exponent

Operator	Description
x	x-value
pi	Mathematical constant approximately 3.1415926535897932

6. For a color camera, you can set a transfer function for each channel. Use R, G, and B tabs on the left to switch between the channels.

7. To save the LUT file, go to **File > Save as….**

Example

A modified sigmoid function can be used to enhance low contrast images. The modified sigmoid function is given below:

$$F(x) = \frac{1}{1 + e^{-a(x-b)}}$$

where **x** is the input pixel value.

a is a contrast factor. It determines the steepness of the curve (0.5 – low gain; 10 -high gain).

b is a threshold level. It determines a sigmoid's midpoint. A midpoint is the brightness of input pixels that is used as a reference. If the brightness of an input pixel is higher than a midpoint, the output pixel value is increased. Otherwise, the output pixel value is decreased.

In the LUT Manager window, type in the following formula under the *Formula* control (with a=4 and b=2):
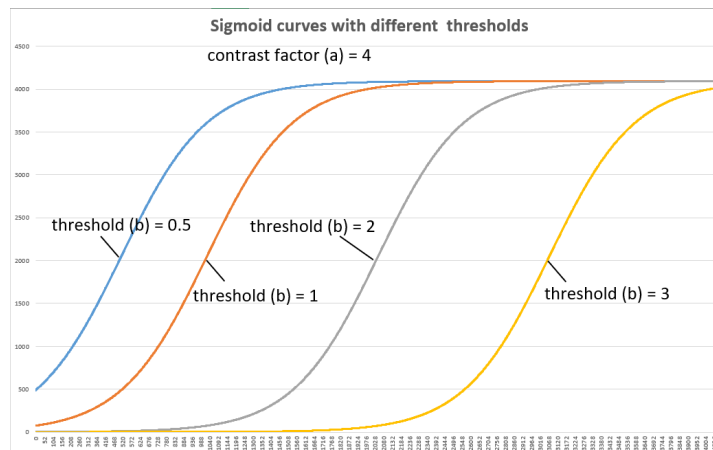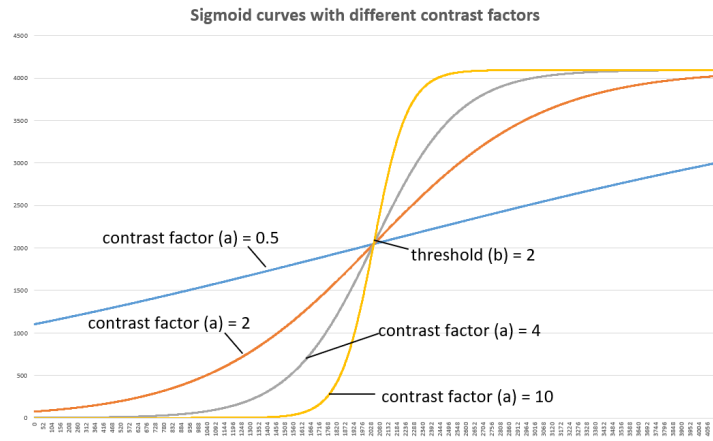
4095*(1/(1+(exp(-4*(x/(4095/4)-2)))))

The function is scaled so that the input and output pixel values are within the range from 0 to 4095 (for a 12-bit image).
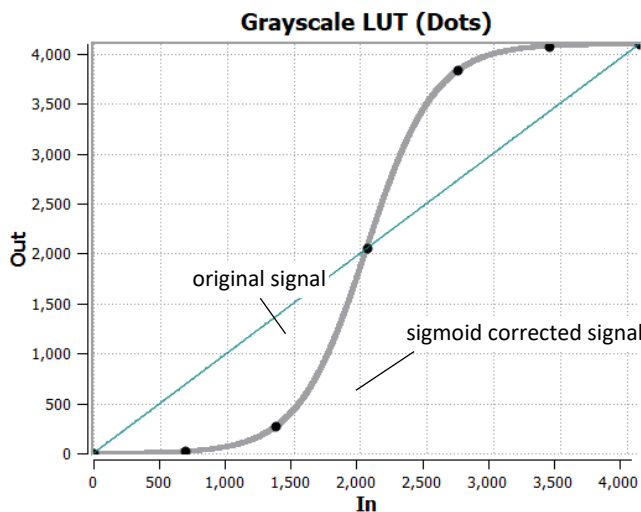

To adjust the overall brightness and contrast of the image, use both threshold and contrast factor parameters. The threshold value controls the amount of brightness, and the contrast factor controls the difference between pixels.

The sigmoid curves with varied threshold and contrast factor parameters are shown below:

Sigmoid curves with different contrast factors

contrast factor (a) = 0.5

threshold (b) = 2

contrast factor (a) = 2

contrast factor (a) = 4

contrast factor (a) = 10

Sigmoid curves with different thresholds

contrast factor (a) = 4

threshold (b) = 0.5

threshold (b) = 2

threshold (b) = 1

threshold (b) = 3

To apply a convex part of the curve within the range from 0 to 4095, use the following formula:

2*4095*(1/(1+(exp(-2*(x/(4095/4)))))-0.5)

Grayscale LUT (Dots)

the midpoint is shifted to the 0; 0 position
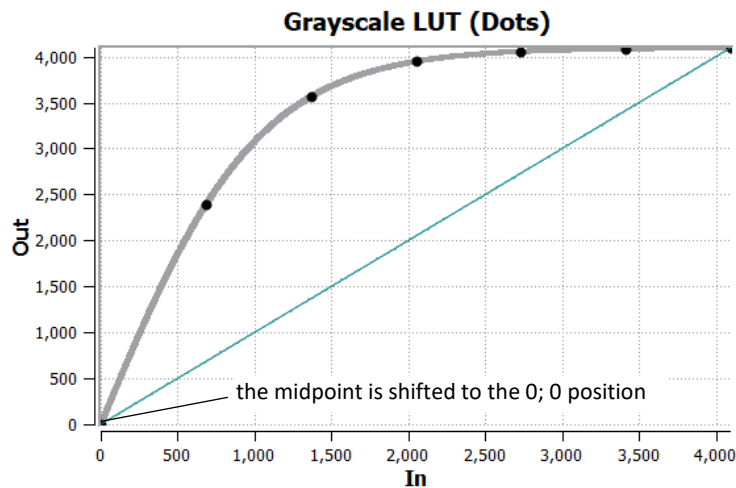
To apply a concave part of the curve within the range from 0 to 4095, use the following formula:

2*4095*(1/(1+(exp(-2*(x/(4095/4)-4)))))

Grayscale LUT (Dots)

the midpoint is shifted to the 4095; 4095 position
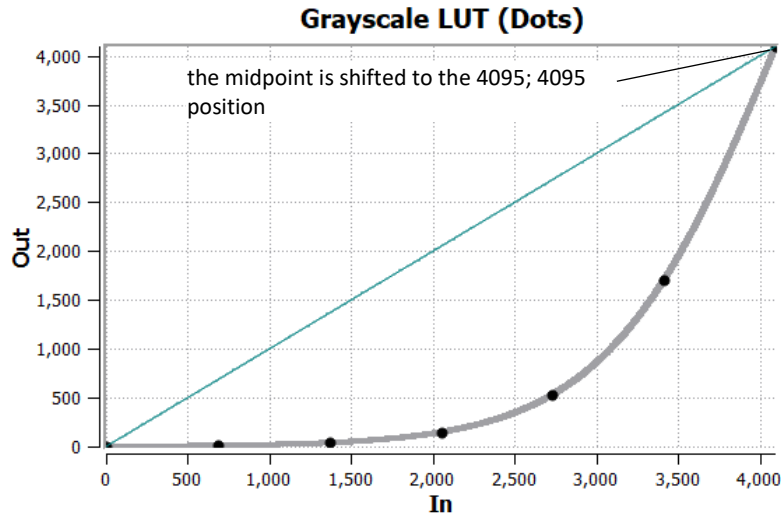
Uploading the LUT File

After saving the LUT into the .lut file, you can upload it into the camera using **Error! Reference source not found.** from the main Menu.

Alternatively, you can use Imperx **Upload Utility**. The Upload Utility enables uploads of HPM, LUT, and other files to your camera.
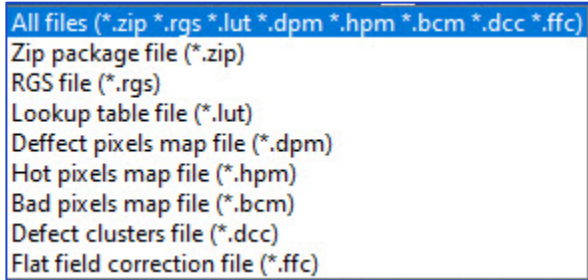
To upload the LUT file:
1. Connect and power up your camera.

2. Start the Imperx **Upload Utility** and wait for the Utility to detect the camera.
   If the utility does not detect the camera, click **Refresh** to restart the device collection.
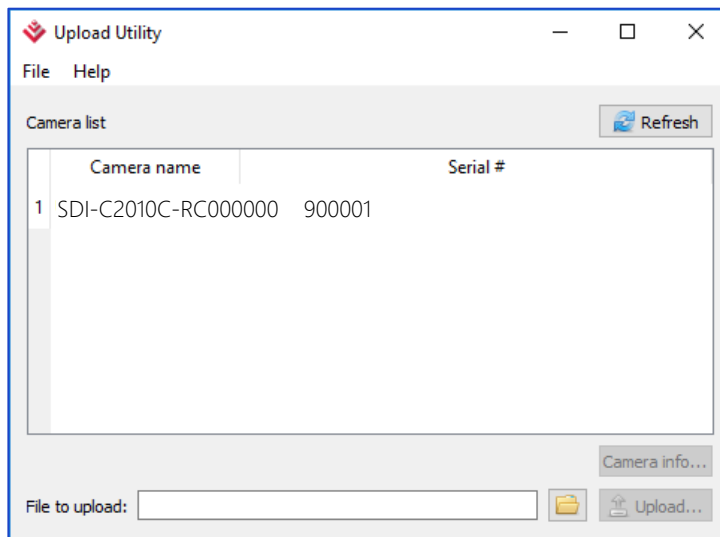
Select the camera to update if more than one appears.
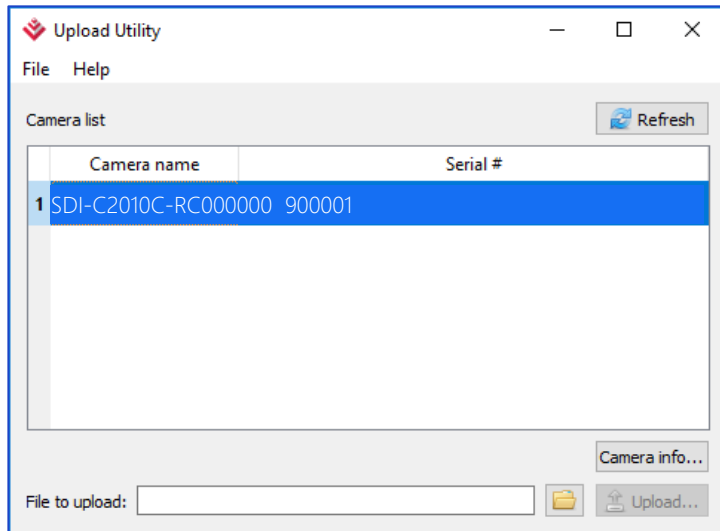
3. Browse for the .lut file, select it, and click **Upload**.
   Select to which camera's LUT (LUT1–LUT4) to upload the .lut file you created.
   Wait for the upload to finish.

All files (*.zip *.rgs *.lut *.dpm *.hpm *.bcm *.dcc *.ffc)
Zip package file (*.zip)
RGS file (*.rgs)
Lookup table file (*.lut)
Deffect pixels map file (*.dpm)
Hot pixels map file (*.hpm)
Bad pixels map file (*.bcm)
Defect clusters file (*.dcc)
Flat field correction file (*.ffc)

4. After the upload is completed, do power cycle the camera.

5. After the camera re-starts, start the software GUI and select **Data Correction**.

6. Set *LUTEnable* to the LUT you uploaded.
   The camera then uses the LUT you uploaded.