illunis

Operations Manual

7920 x 6004 Global Shutter CMOS

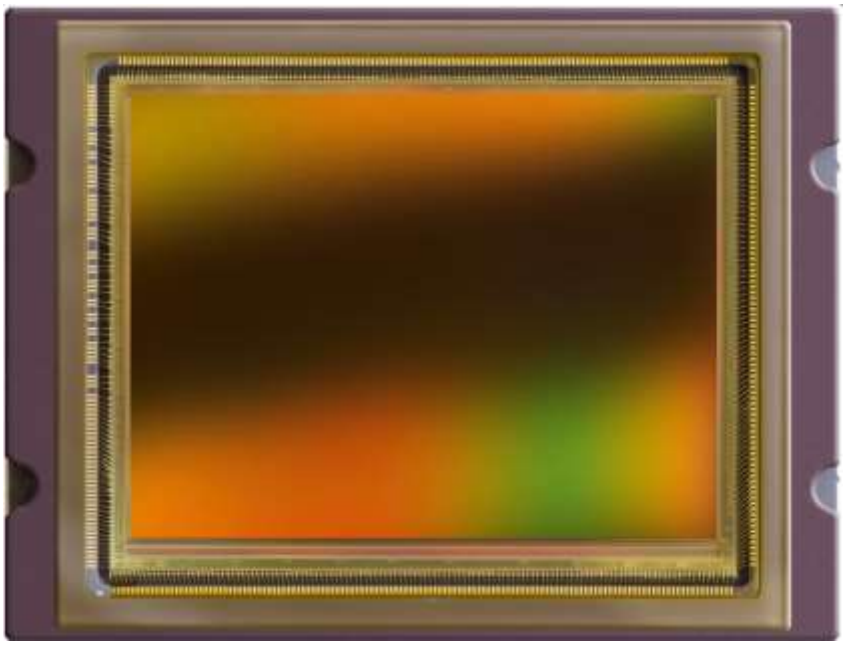
CMV-50

Rev	Date	Modification
A	4/5/2018	CMV-50 Original Document
B	3/7/19	2019 Revisions
C	5/10/19	Command Updates
D	9/20/19	Command Updates—frame rate tables

Camera Communication Default Baud Rate is 115,200

Revisions

CMV-50



Precautions

CMV-50

CMV-50 Precautions

Do not drop, damage, disassemble, immerse, repair or alter the camera.

Applying incorrect power may damage the camera electronics.

The warranty is void if the camera is opened or modified in any way.

Care must be taken in handling as not to create static discharge that may permanently damage the device.

Camera Link is a DC based interface. The camera and capture device must share the same electrical ground. Failure to do so will damage the Camera Link interface chips and/or camera and capture card.

The maximum Camera Link data rate is 85Mhz. This limits the maximum pixel clock speed to 42.5Mhz, which is provided as an overclock mode. Operation is guaranteed at 30Mhz pixel clock and below.

PoCL cables are compatible with the CMV-50 camera. PoCL camera power is not supported.

Absolute Maximum Ratings
Input Voltage: 6 to 16V DC
Storage Temperature: -40C to +70C

Recommended Maximum Ratings
Input Voltage: 9 to 14V DC
Operating Temperature: 0C to +60C
Most illunis cameras operate beyond these temperature limits, please call for details.

Recommended Operating Conditions
Input Voltage: 9-12V DC
Operating Temperature: 0C to 60
Relative humidity should not exceed 80% non-condensing.

Specifications subject to change without notice.

Contents

CMV-50

Camera Power
6-12V DC Power to the Hirose 6 pin connector.
Mating Connector: Hirose HR10A-7P-6P

PIN	SIGNAL NAME
1	+12V DC
2	DC Ground
3	Trigger In
4	Strobe Out
5	No Connect
6	No Connect

View from Camera Back

Capture Card
Any Base, Medium or Full Format Camera Link capture card
Such as: Teledyne Dalsa Xtium-CL MX4 OR-Y4CO-XMX00.

Imaging SDK
Available from your capture card supplier.

Camera Link Cables
One, two or four Camera Link cables (Mini HDR to SDR) **must be** rated at 85Mhz or more (two cables for Medium or Full Format).

The following 5M cable configurations have been tested:
Standard MDR to HDR/SDR MVC-1-1-5-5M
Available from Components Express.

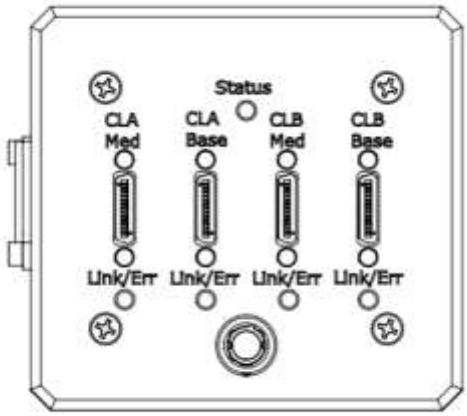
http://www.componentsexpress.com/Configurator.aspx?cnfi=1

Camera Communication Software
illunis Camera Serial Communication Software
Download at: http://illunis.com/illunis/downloads

To start imaging with the CMV-50 CL:

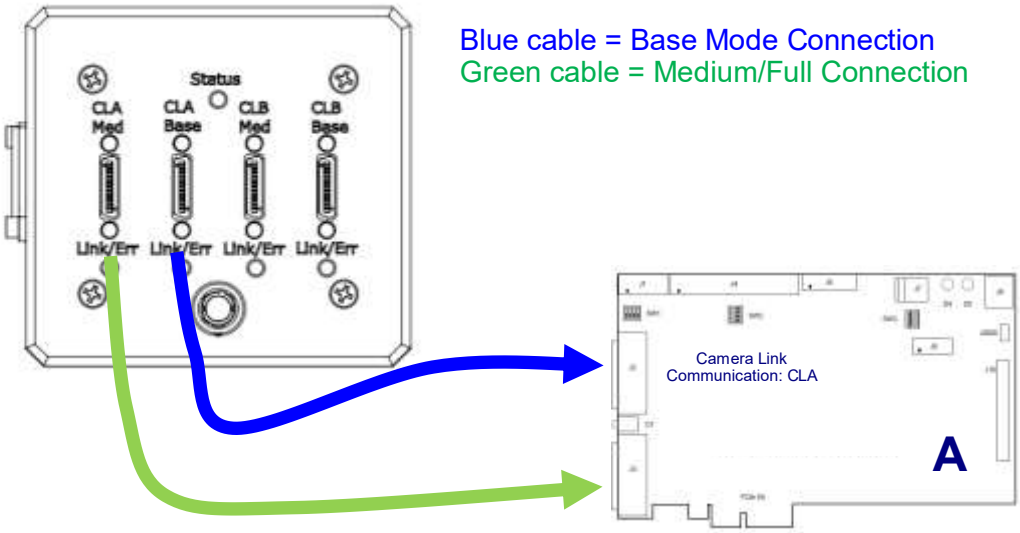
Install the capture card and software per the capture card manufacturers instructions.

Connect the CMV-50 Camera Link cables paying attention to the base and medium connections



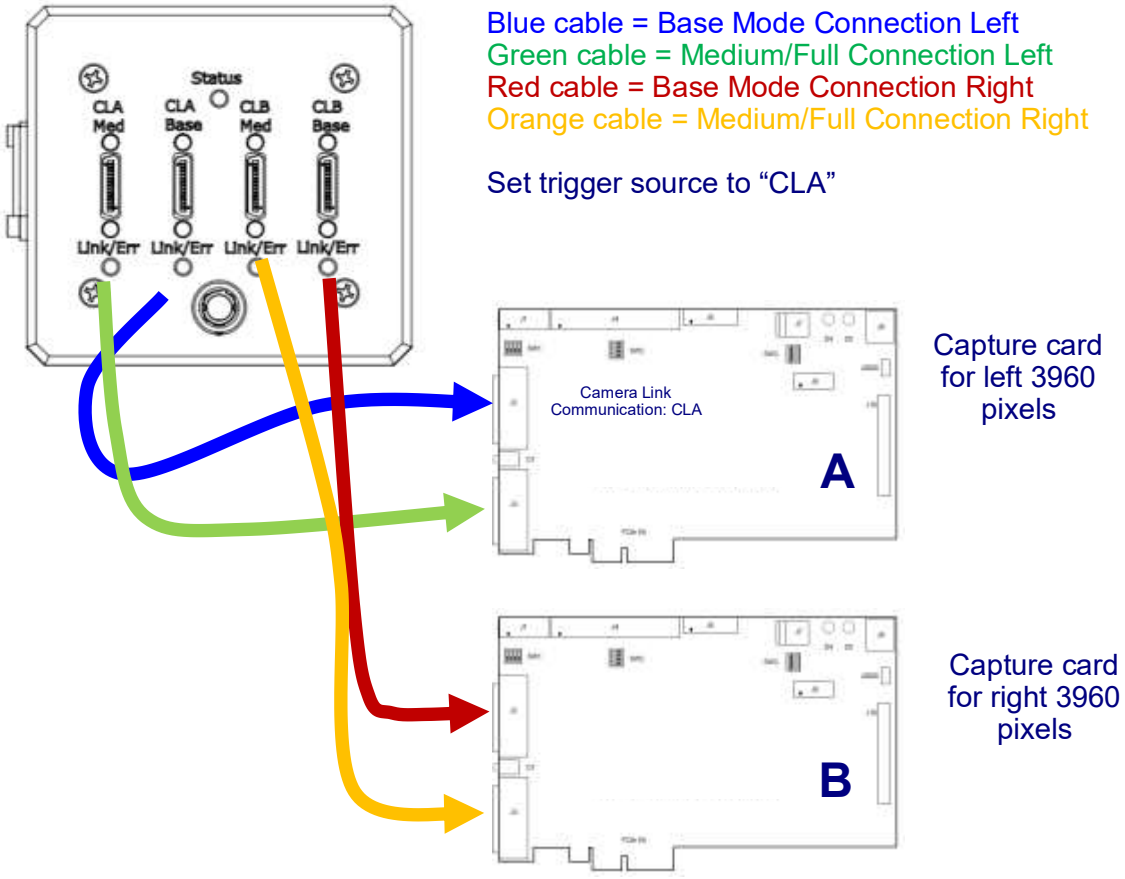
Camera Link Medium mode setup

Blue cable = Base Mode Connection
Green cable = Medium/Full Connection



Cable Connections for Camera Link Medium/Full Mode Operation.

Base Mode uses only CLA Base Connection



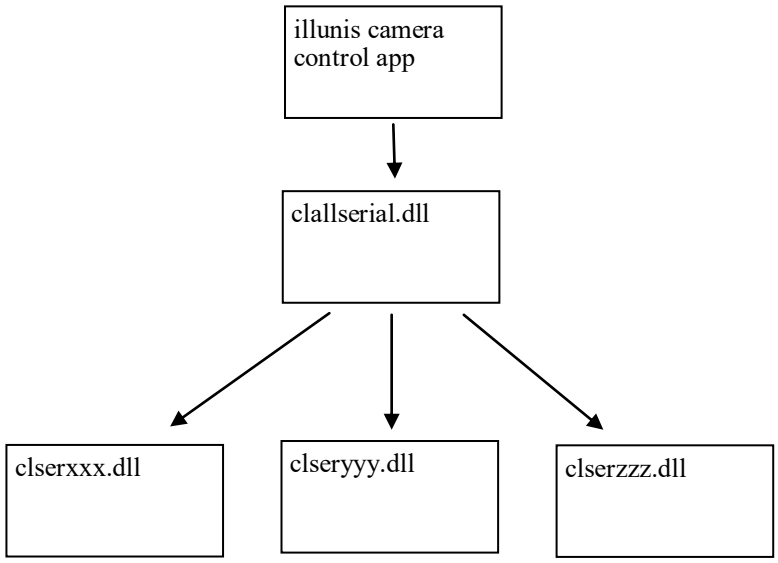
Cable Connections for Camera Link Dual Full Mode Operation

Installing the illunis Camera Serial Communication Software:

Download and install the illunis Camera Serial Communication Software from
http://illunis.com/illunis/downloads

Background:
Per the CameraLink standard, all serial communication is via the .dll clallserial.dll, which dynamically loads the serial communication .dll(s) specific to the frame grabber being used. illunis installs clallserial .dll in its application directory.

clallserial.dll examines the registry to see where the capture card specific communication dll's have been installed. The naming convention for the capture card specific communication dll's is clser***.dll where *** is the manufacturer specific dll name. The files MUST be in the form clser***.dll in order to be recognized. Some capture card manufacturers will append something like clser***x64.dll for the 64 bit version of the .dll. This file name must be changed to clser***.dll in order to be recognized by clallserial.dll.

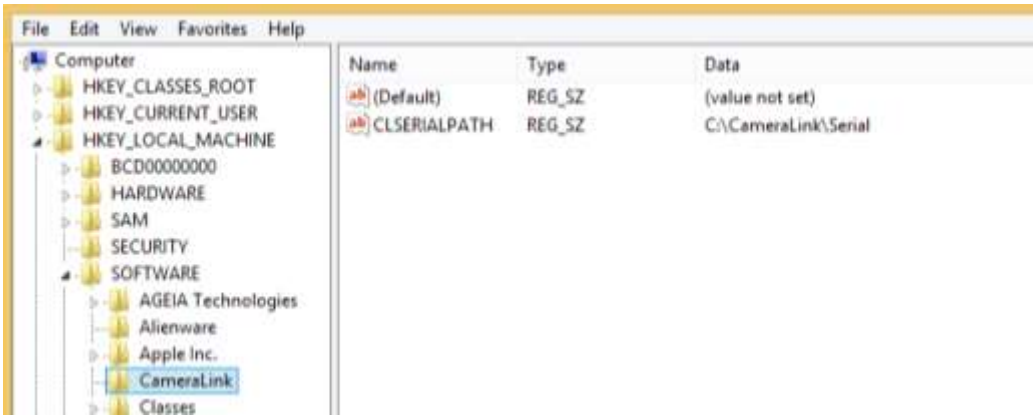


The registry:

When clallserial.dll is loaded by the illunis serial communication application, it looks at the Registry entry:

HKEY_LOCAL_MACHINE\SOFTWARE\Cameralink CLSERIALPATH.

The location pointed to by CLSERIALPATH is typically C:\Cameralink\Serial, but could be any path that a capture card install might create. It is important to note that the capture card communication dll(s), clser***.dll must be at this path location. clallserial.dll should NOT be in this location.



If the capture card communication dll is spec 1.1 compliant, the user will find this directory already created.

The illunis control app installs clallserial.dll for the appropriate operating system in the application folder. Depending on the application version, some documentation may be installed in the application folder as well.

If the registry entry above does not exist, create it as well as the directory C:\CameraLink\Serial

In either case—copy and paste the clser***.dll files to the C:\CameraLink\Serial folder.

Installing prerequisite software:

The status of these items can be checked in the Control Panel -> Programs and Features listing. If necessary download and install the following prerequisites.

1. **.NET Framework 4.6.1** to be installed from:

   https://www.microsoft.com/en-us/download/details.aspx?id=49981

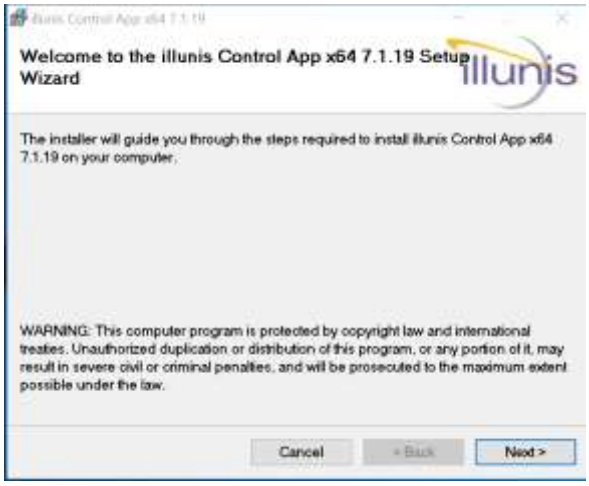
2. **Visual C++ 2010 Redistributable** from:

   https://www.microsoft.com/en-us/download/details.aspx?id=14632

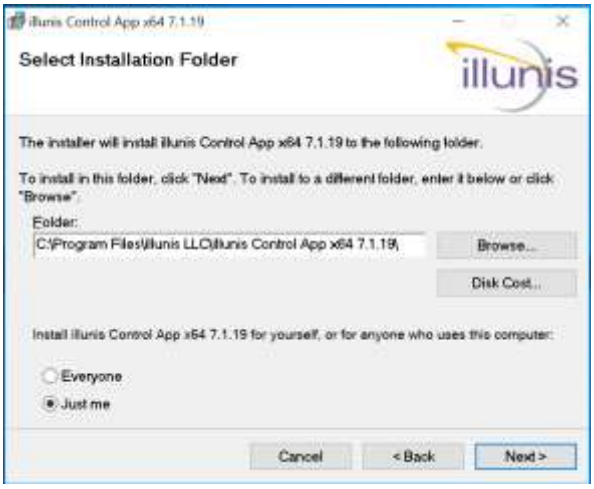
3. **Visual C++ 2013 Redistributable** from:

   https://www.microsoft.com/en-us/download/details.aspx?id=40784

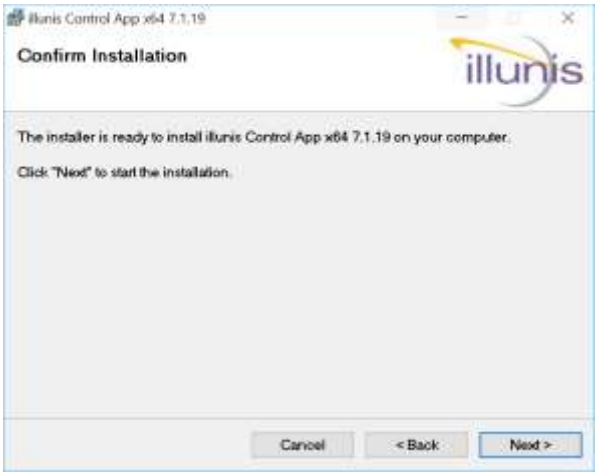
Install the Camera Serial Communication Software:



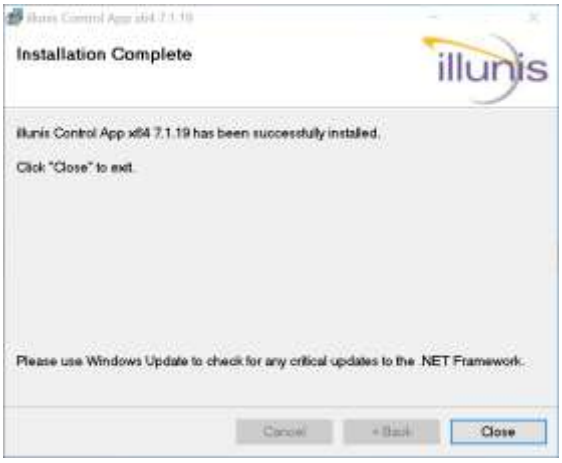
Launch the installer



Select the installation folder...



Confirm...



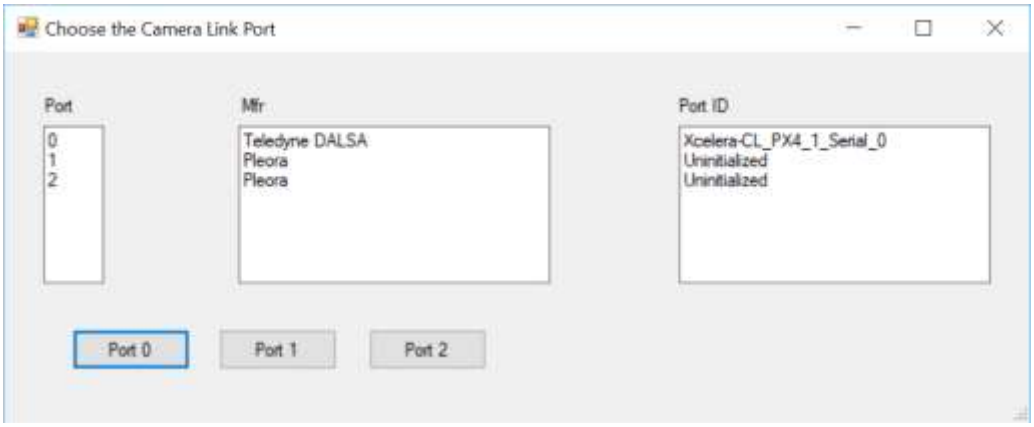
Install complete…

Note: A shortcut to the program will be placed on the desktop.

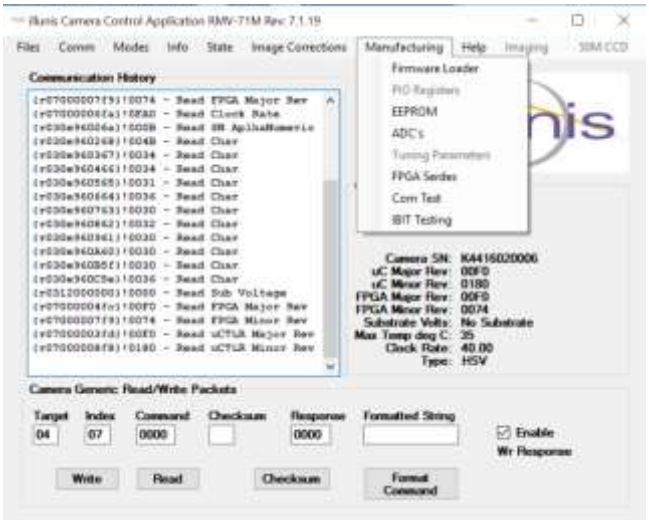
Power up the camera and run the illunis Camera Serial Communication Software.

If there are multiple clserxxx.dll's for multiple cards installed, a choice of possible connections will be presented.

If there is only a single capture board present and one clserxxx.dll, the application will simply connect to that card/port.



illunis Camera Serial Communication Software Main Window:

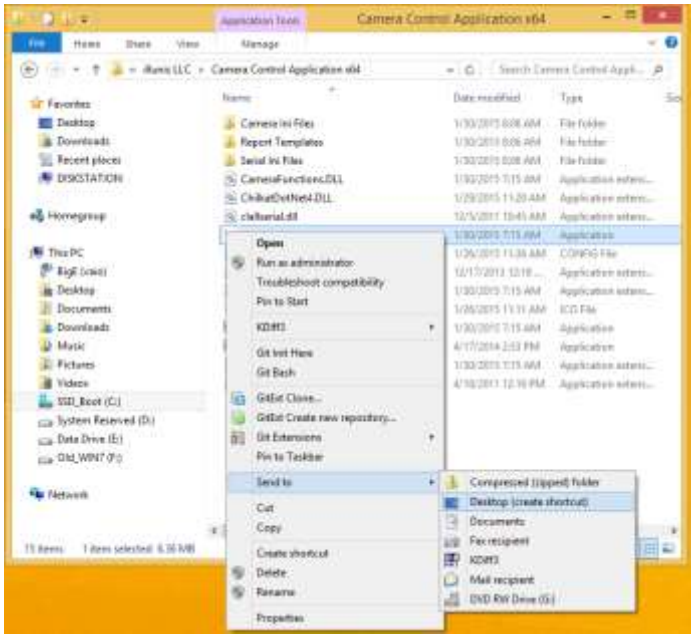


Disabled Menus

By default, sensitive menu items are disabled to prevent inadvertent changes to the camera state. To enable them, a new shortcut has to be created on the desktop.

First, delete the desktop shortcut created by the installer.

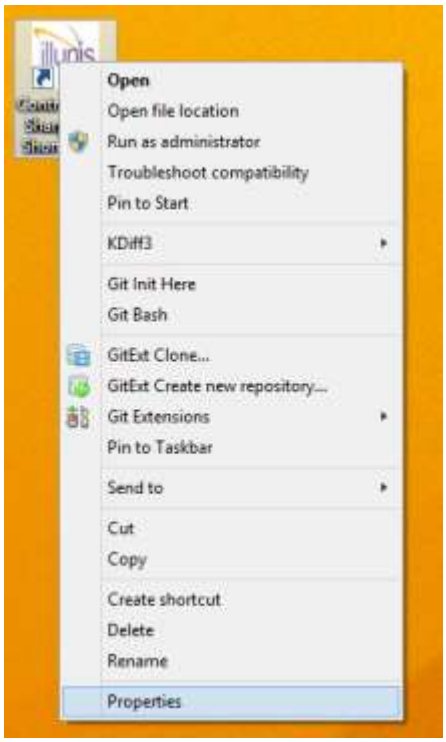
Creating a new shortcut for program options:



Create a new Shortcut

Navigate to the program install directory and right click on the file with the illunis icon and extension .exe. Choose -> Send to -> Desktop. This creates a new desktop shortcut icon.

Adding options to the shortcut command line:



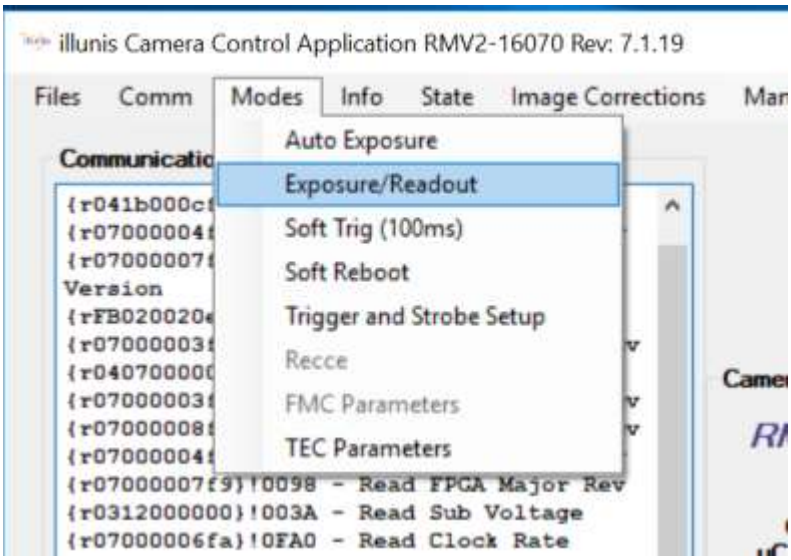
Right click on the newly created desktop icon and select Properties.

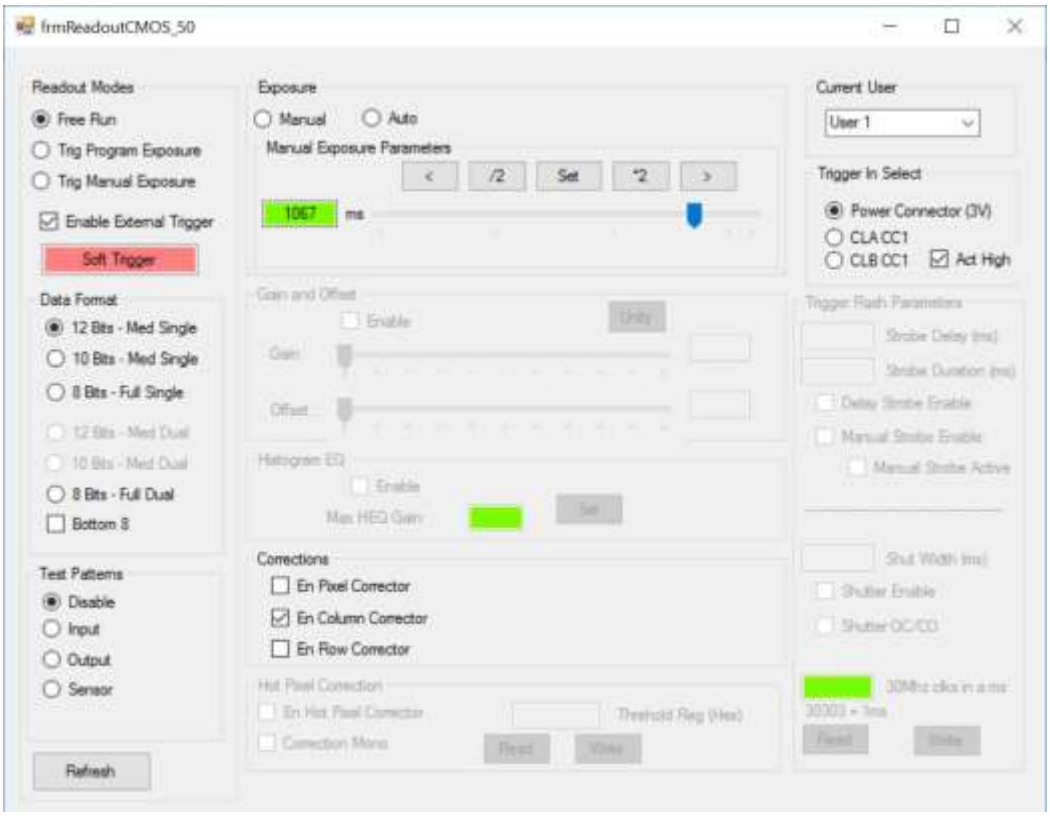
Add a space and the words **expert baud=115200** after the close quote on the Target: line of the dialog box: .exe" expert

Choose OK.
When the program is launched, all menus will be enabled. **NOTE: Use care with all menus enabled as some changes cannot be undone and may require the camera be returned to the factory for remedy.**

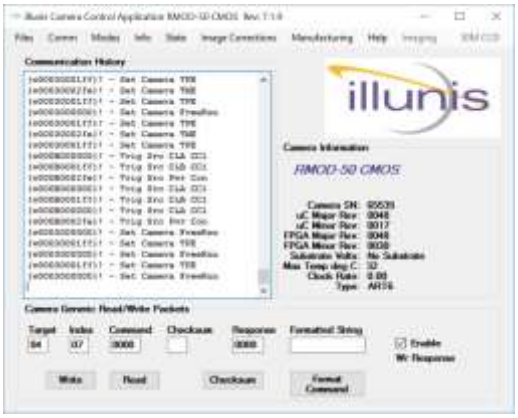
Exposure / Readout:

Start with this dialog box as most of the immediately useful controls are located here.





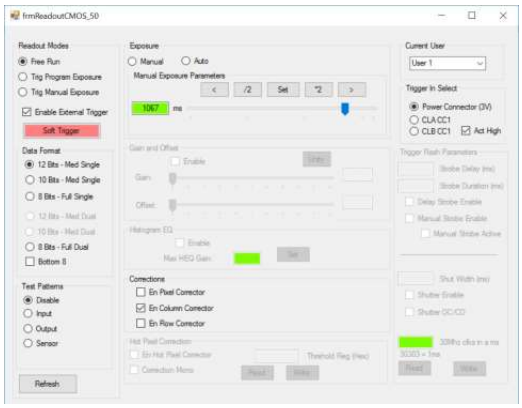
Camera Control Application Details:



Main Dialog

The main dialog box provides access to the various functions of the camera. Menus are used to access sub-dialogs. A generic camera register read/write feature is provided.

In addition, a history of communication is also provided in this dialog box.



Modes->Exposure and Readout

This dialog box is used to set the Readout Mode, Free Run, or Trigger, as well as the bit depth and exposure of the camera. In addition, the user can set the Camera Link mode, test patterns, digital gain and offset, and histogram equalization.

Pre-defined windowing modes can be selected. A reset (Enable TG) is available.

Modes->Trigger and Strobe Setup

This dialog box is used to set the trigger source and polarity. The strobe output is only available in the Trigger Exposure Mode.

Camera Control Application Details:

Manufacturing->Firmware Loader

The firmware loader dialog is used to load FPGA and Microprocessor code as well as the EEPROM configuration data.

A useful feature of this dialog is the ability to save and restore the camera to and from a file. If there are problems with the camera, the camera state may be saved to a file and then emailed to illunis for support.

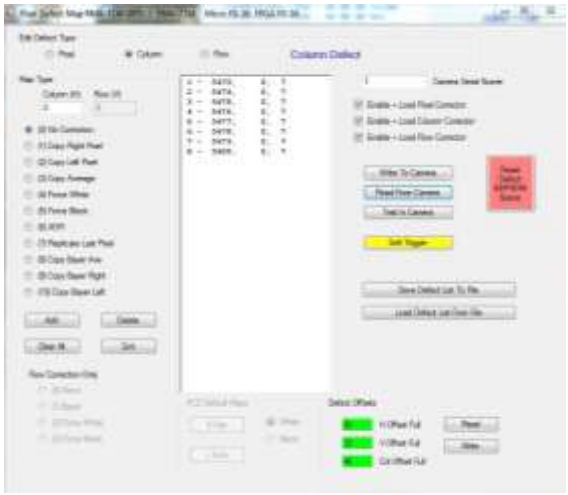


Image Corrections->Sensor Defects->Defect Editor

The defect corrector editor dialog allows editing of the defect corrector tables.

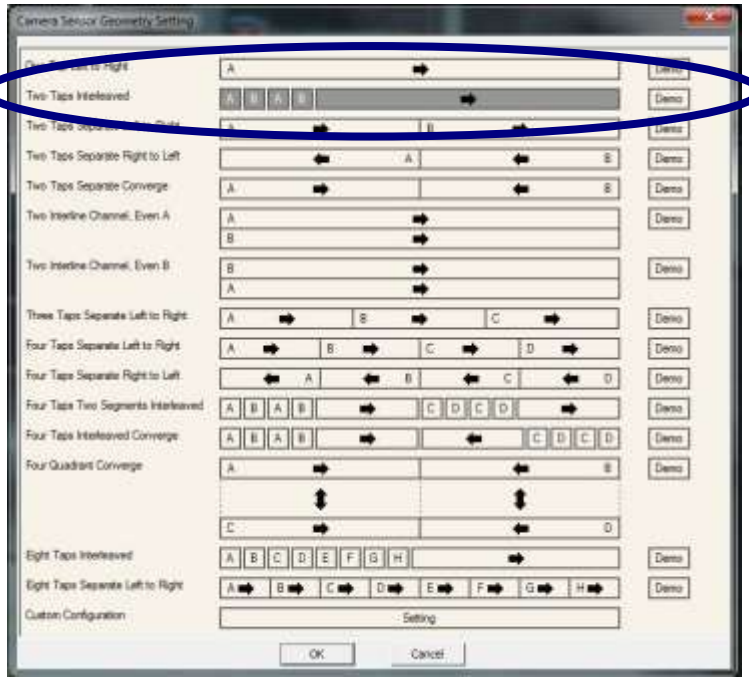
General Comments:

The control application is for communication with the camera until the user application takes over these functions. All buttons and sliders show the command that is being executed in the application main window.

In the main window, there is a generic read and write section allowing any command that can be found in the manual to be sent to the camera and see its response.

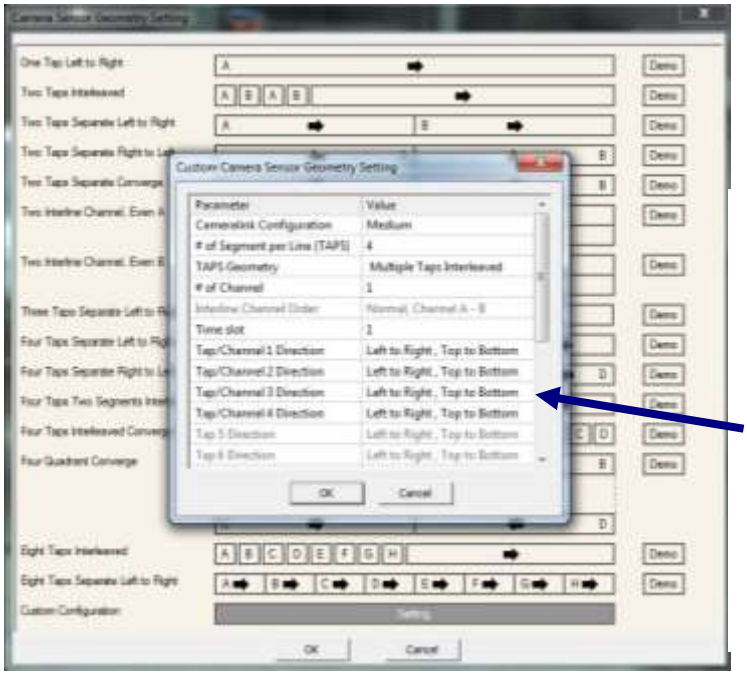
NOTE: If a camera mode is changed, the corresponding change in the capture environment will have to be made as they are independent.

Teledyne Dalsa CamExpert Setup



Base Format

2 pixels per clock
Left to Right,
Top to Bottom

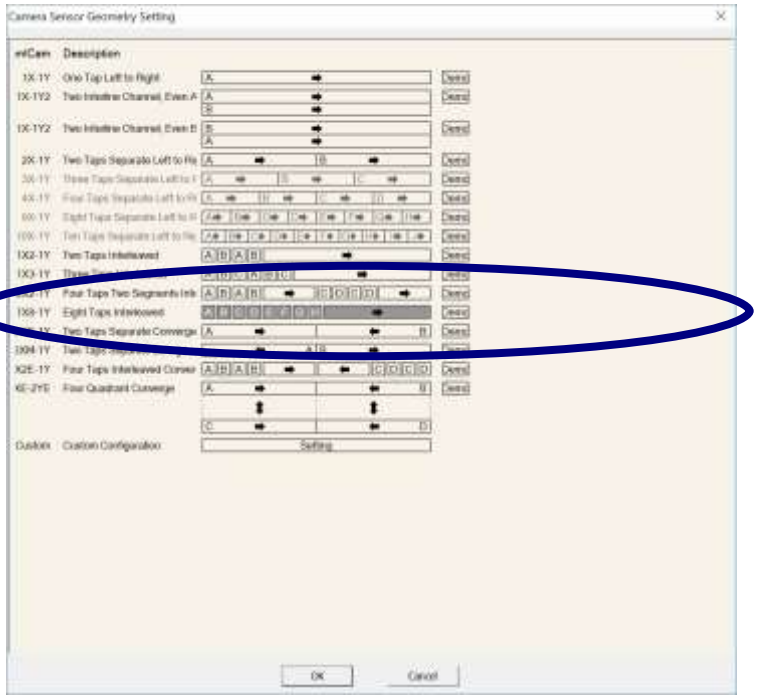


Medium Format

4 pixels per clock
Left to Right,
Top to Bottom

Note: Changing from Top to Bottom to Bottom to Top will flip the image vertically !

Teledyne Dalsa CamExpert Setup



Full Format

8 pixels per clock
Left to Right,
Top to Bottom

Camera Power

6-12V DC Power to the Hirose 6 pin connector.
Mating Connector: Hirose HR10A-7P-6P

PIN	SIGNAL NAME
1	+12V DC
2	DC Ground
3	Trigger In
4	Strobe Out
5	No Connect
6	No Connect

View from Camera Back

USB3 Port Note

The USB camera connection requires a USB 3.0 compliant hardware port. The camera will not function connected to a USB 2.0 hardware port

Imaging SDK for USB3 and GigE

illunis cameras utilize Pleora embedded USB3 hardware inside the camera. The imaging application/SDK are available to download from:

https://supportcenter.pleora.com/s/topic/0TO340000004X6dGAE/ebus-sdk?tabset-25adb=81d66&tabset-0c866=2

Go to downloads to select and download the current viewer for your environment.

USB3 Cables

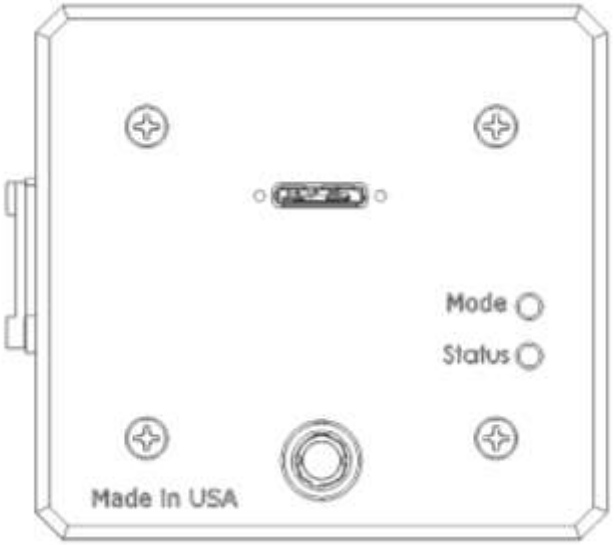
illunis recommends L-com cables, the camera requires a Micro-b connector.
http://www.l-com.com/usb-usb-30-vision-cable-assemblies-type-a-and-micro-b-with-thumbscrews

GigE Cables

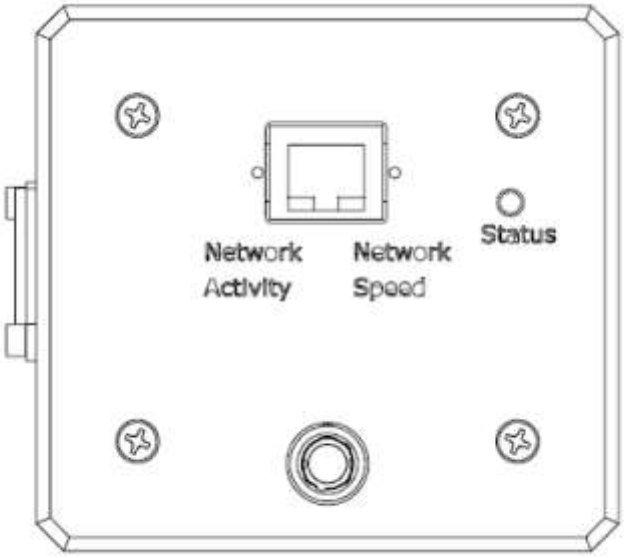
Any Cat 6 ethernet data cable is suitable for GigE cameras.

To start imaging with CMV-50 USB3 or GigE:

Install eBus SDK software.
Connect the CMV-50 USB3 or GigE cable to the camera and PC.
Connect the power cable to the camera and apply power.



Camera Back
USB3



Camera Back
GigE

To start imaging with the CMV-50:

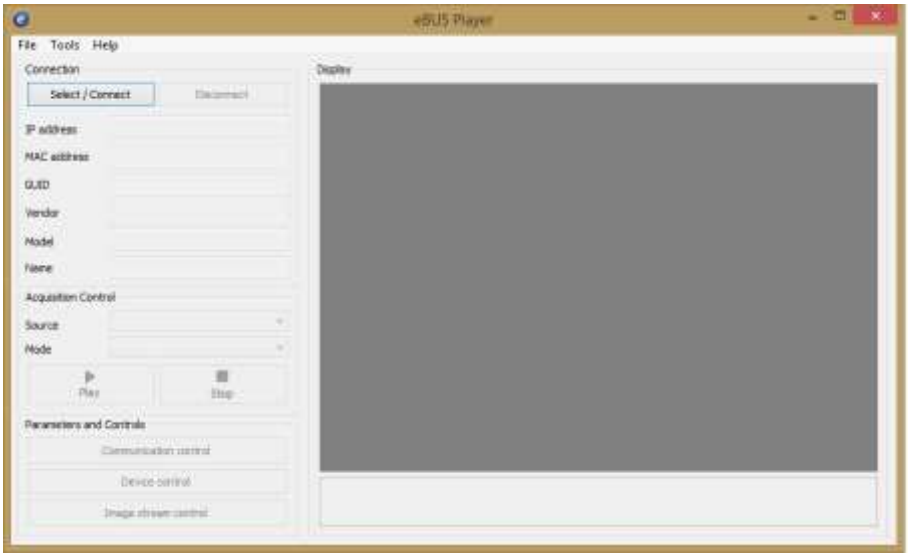
Install the Pleora eBus SDK software

Additional SDK documentation and resources are available from:
https://supportcenter.pleora.com/s/topic/0TO340000004X6dGAE/ebus-sdk?tabset-25adb=d1819&tabset-0c866=2&tabset-3b862=2

Additional eBus Player documentation and resources are available from:
https://supportcenter.pleora.com/s/topic/0TO34000000PW53GAG/ebus-player?tabset-25adb=70906&tabset-ec78c=2

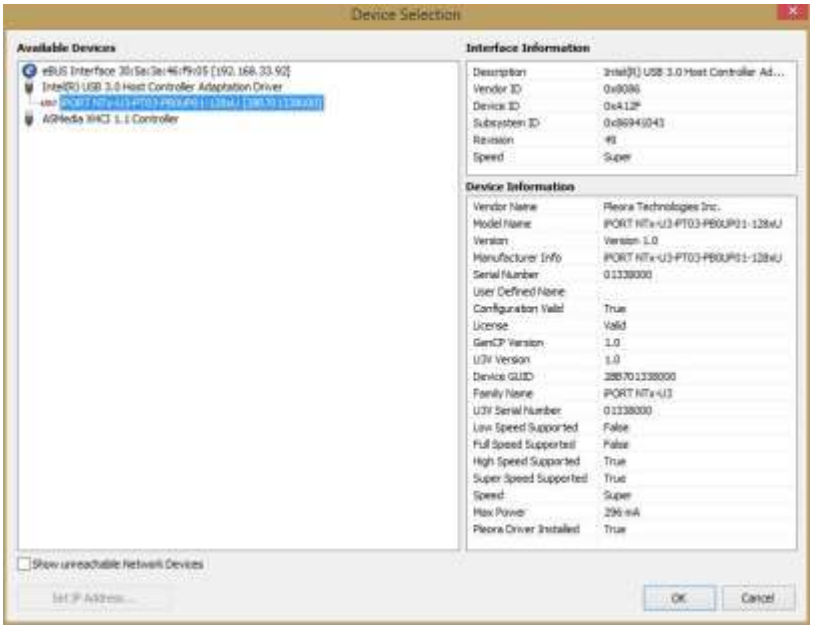
Install the illunis Camera Serial Communication Software. Follow the installation instructions beginning on page 8 of this manual, then return here prior to running the camera control application.

To begin imaging, launch the eBus player.

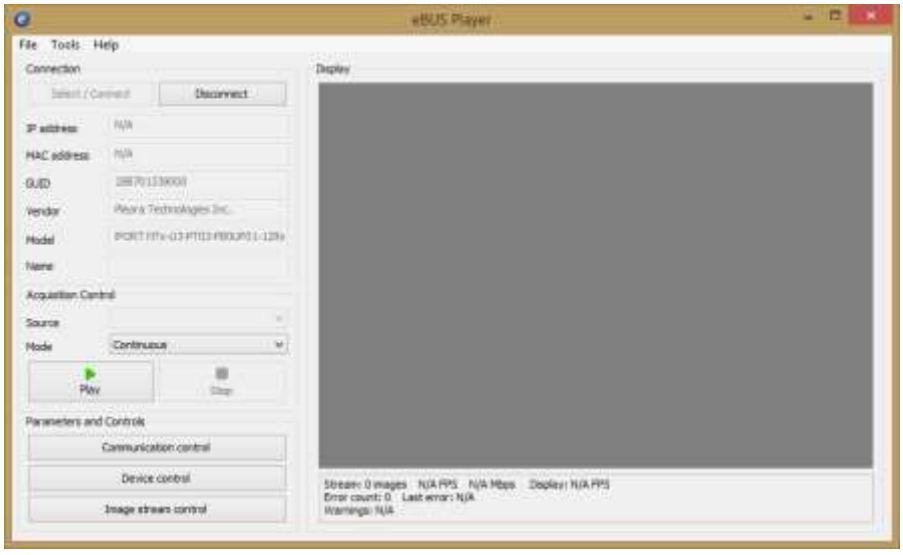


Press Select/Connect to choose either the GigE or USB3 camera connected to the PC.

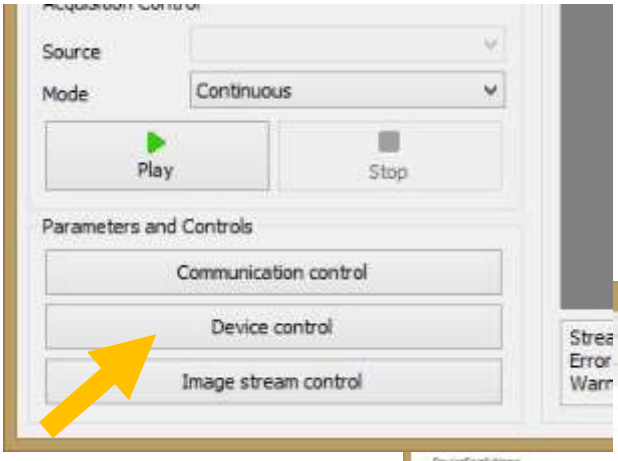
Select the camera and press OK



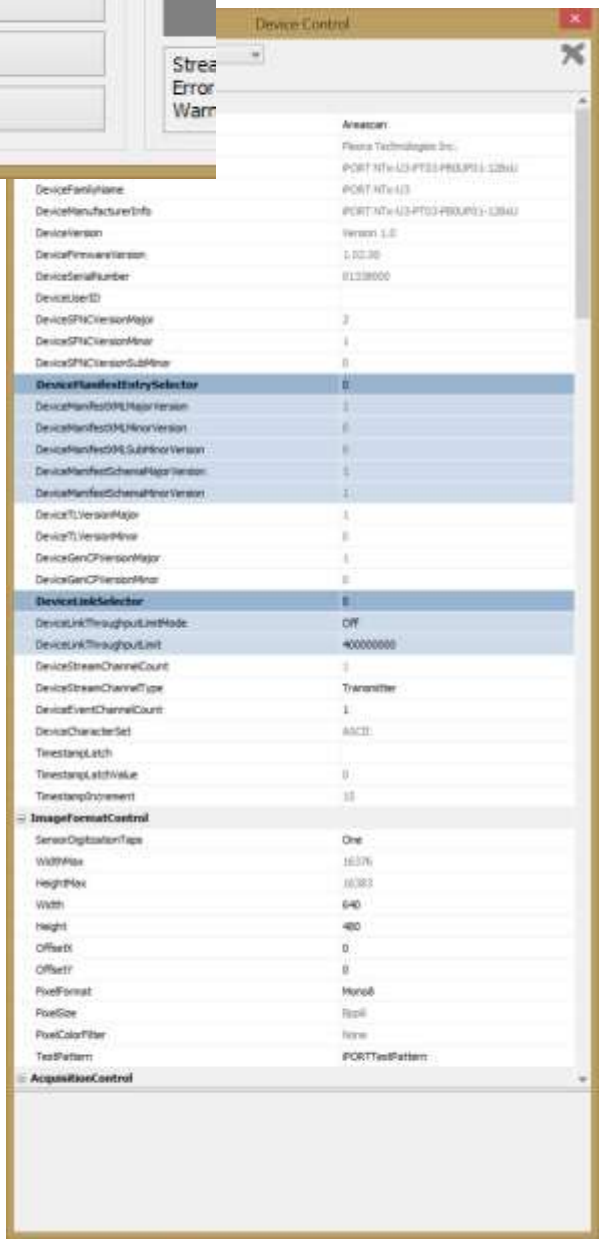
eBus Player is ready to image

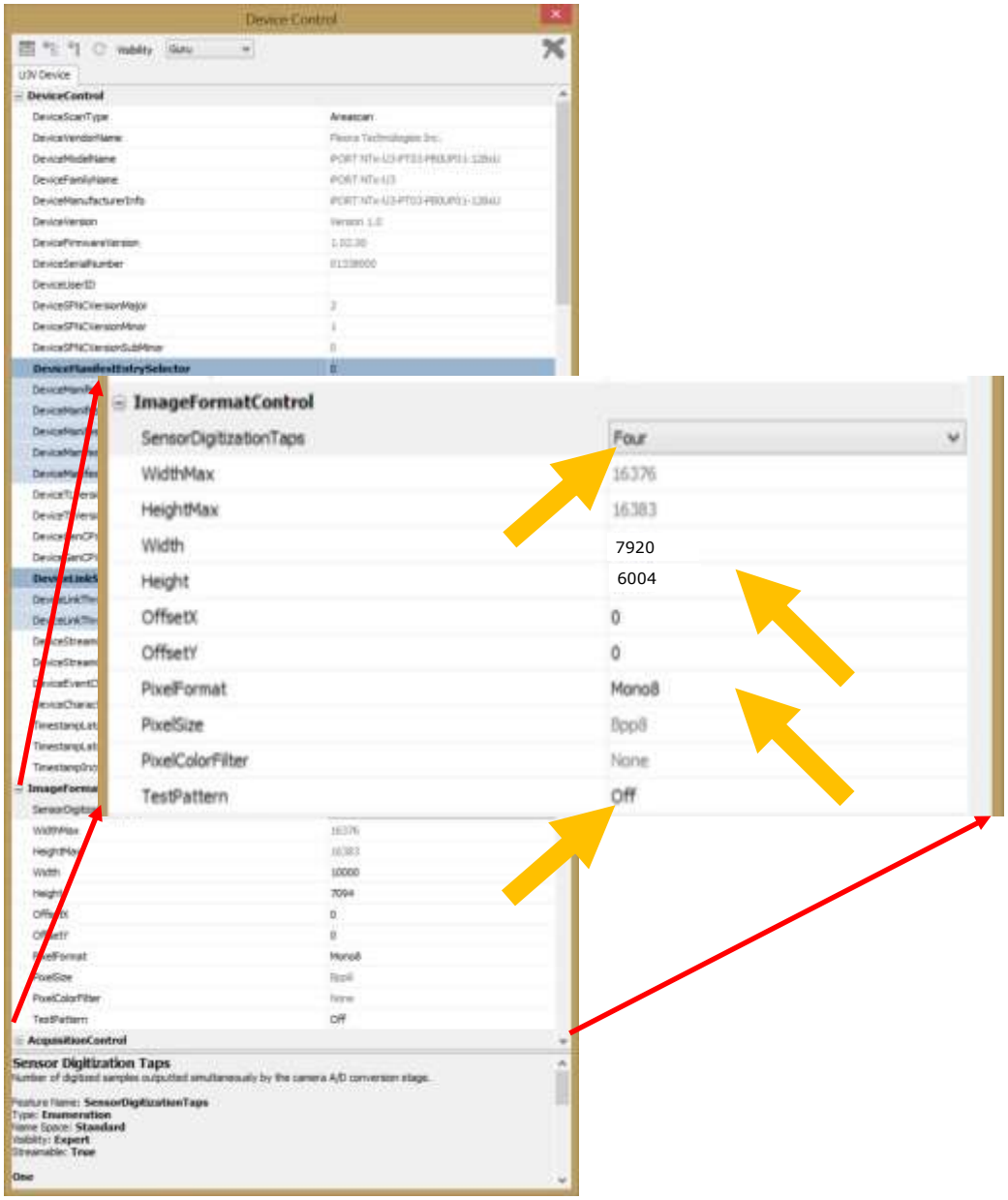


Configure the player:



Select Device Control

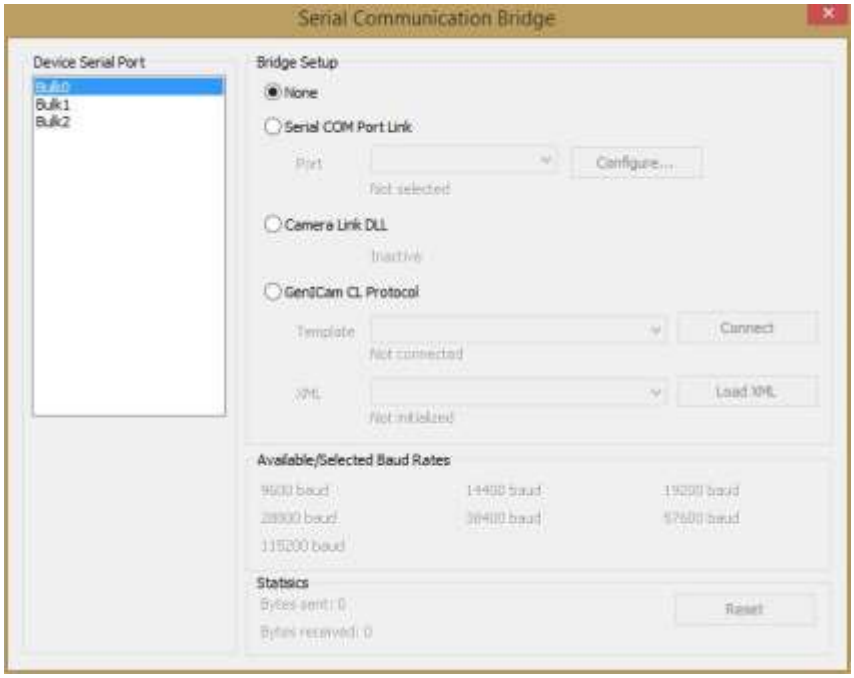


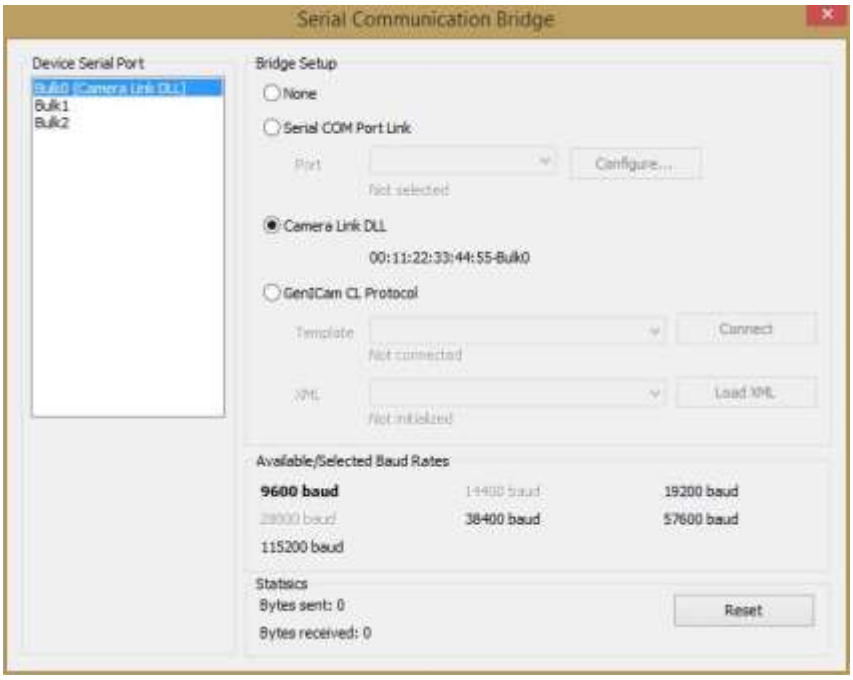


Set the Device Control parameters

Set the raster to **Width** = 7,920, **Height** = 6004
Turn the **TestPattern** = off
Set the **SensorDigitationTaps** = **Two** or **Four**
Set the **PixelFormat** = **Mono8** or **Mono12Packed**

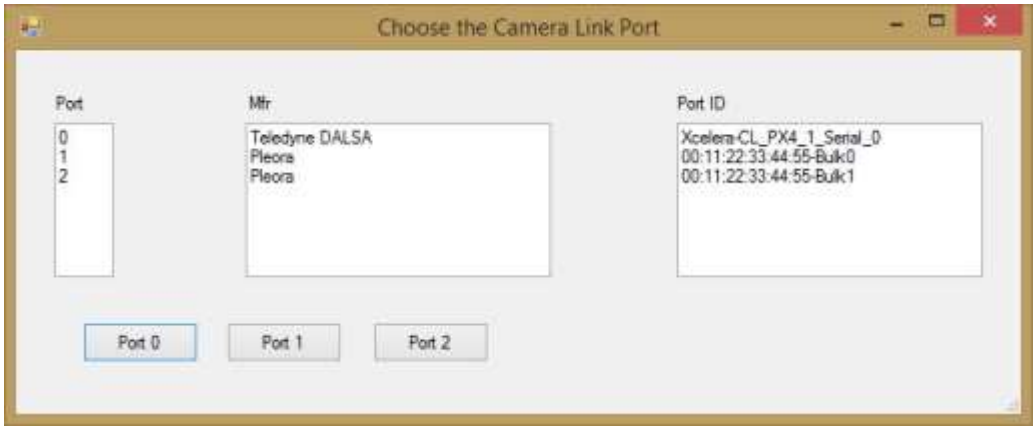
To establish serial communication with the camera, from the Tools Menu on the viewer, choose Serial Communication Bridge



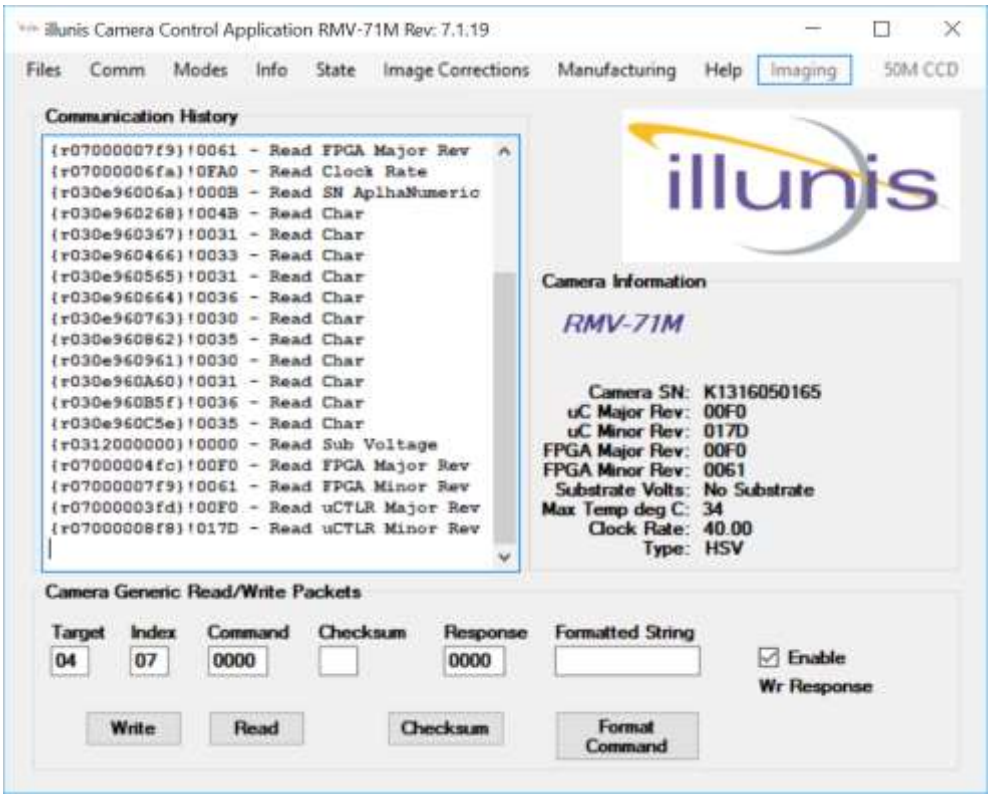


Choose Camera Link DLL - **THEN LEAVE THIS WINDOW OPEN**

Run the illunis Camera Serial Communication Software that was installed previously:

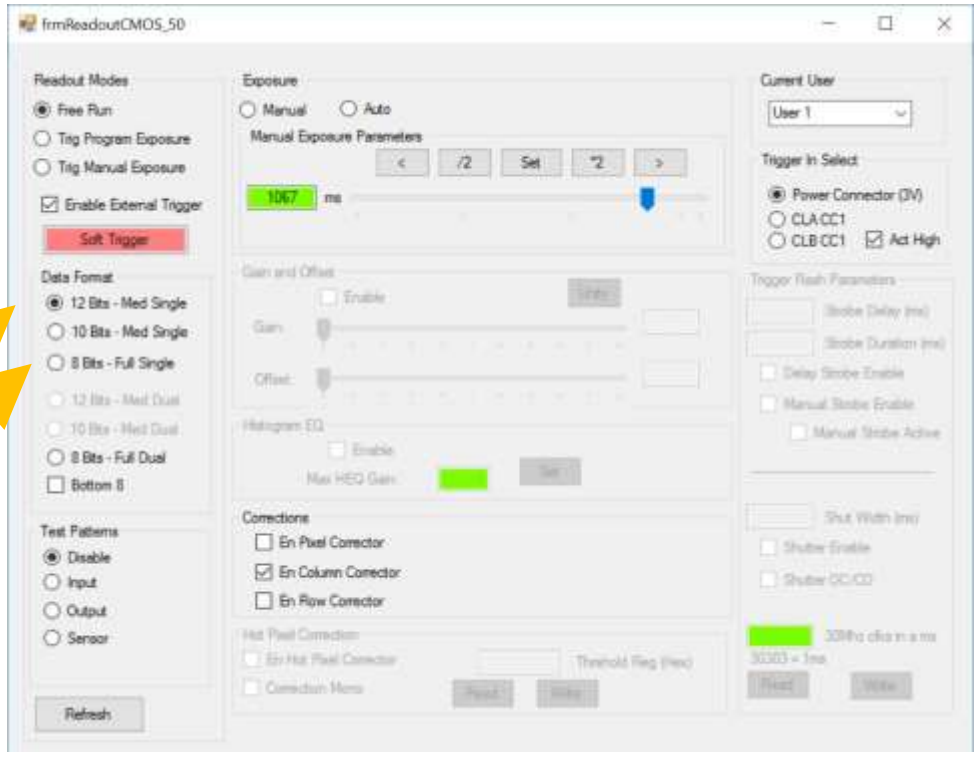


Choose the **BULK0** Interface



The camera serial communication software main window will appear.

From the **Modes** menu choose Exposure/Readout

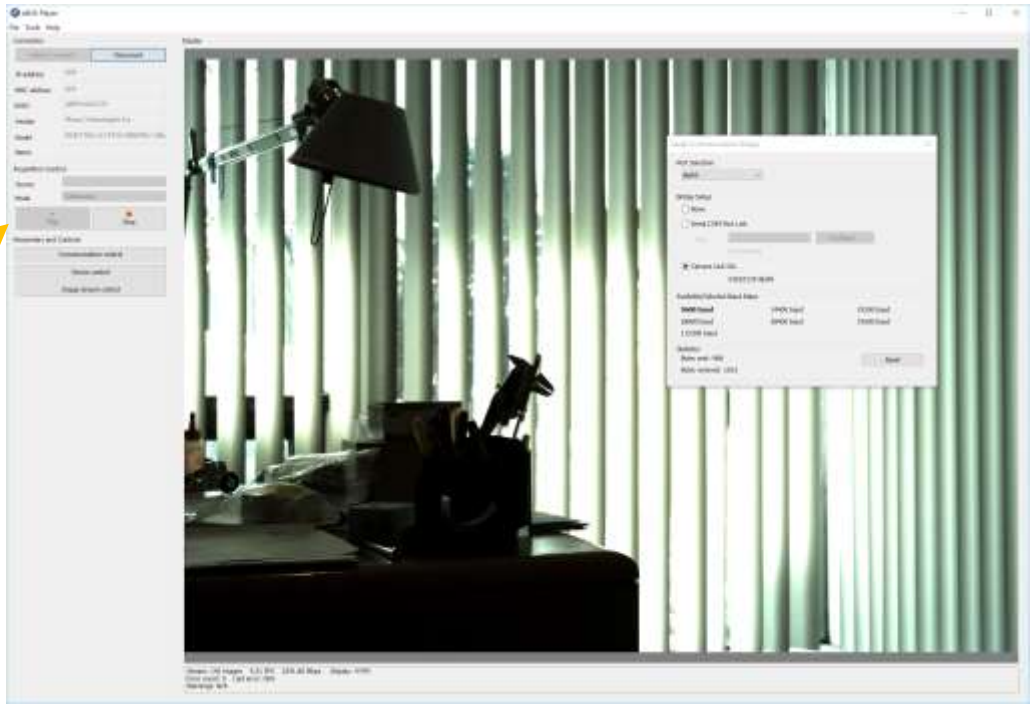


Choose the same settings that were set in the Player Device Control earlier.

For the CMV-50 the following frame rates apply

USB3
Select **Single Full** and Data format = **8Bits** 6.8fps
Select **Single Full** and Data format = **12Bits** 3.4fps

GigE
Select **Single Full** and Data format = **8Bits** 2.4fps
Select **Single Full** and Data format = **12Bits** 1.6fps



General Comments:

See the Getting Started Camera Link section for more camera control application dialog box documentation.

In the main window, there is a generic read and write section allowing any command that can be found in the manual to be sent to the camera and see its response.

NOTE: If a camera mode is changed, the corresponding change in the eBus Player will have to be made as they are independent.

CMV-50 Sensor Specifications:

The CMV-50 Camera incorporates the ams/CMOSIS CMV50000 sensor.

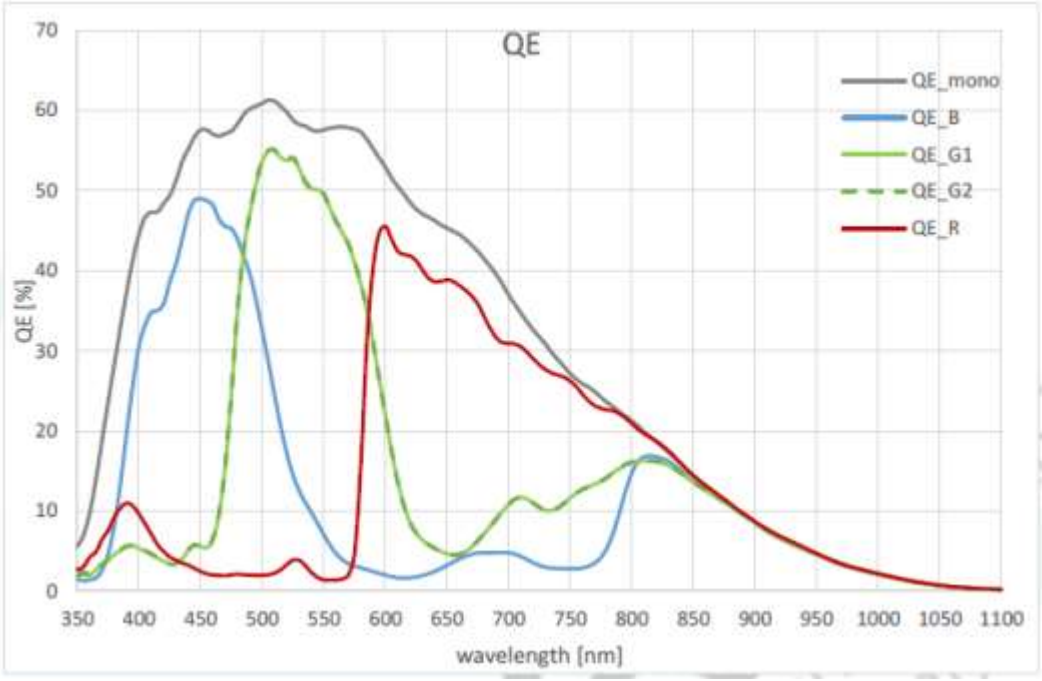
Sensor Features

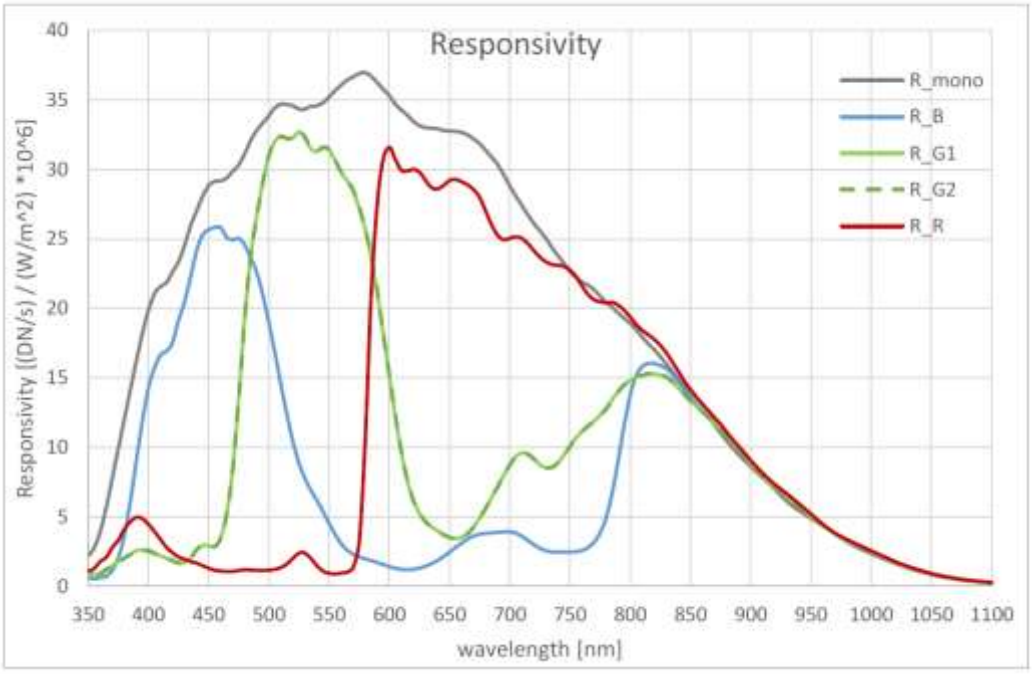
- 7,920 x 6004 active pixels with a 4.6 µm pitch.
- 8160 x 6048 total pixels = 49,351,680.
- Frame rate at full resolution is maximum 30 frames /sec.
- Windowing capability in vertical row increments.
- Multi window capability.
- 24 digital outputs digitized at 12 bits.
- On chip timing for Free Run and Trigger Modes.
- Mono or Bayer pattern.
- On chip binning and subsampling.
- On chip HDR based on two exposures on column readout.

Sensor Specifications

- Full well charge: 14,500e
- QE: 61% (@ 510)
- SNR: 41.6dB
- Temporal Noise: 8.8e
- Conversion factor: .27DN/e
- Dynamic range: 64dB
- Dark Current: .24 e/s—sensor at 20C
- Fixed Pattern noise: < 0.20 (rms of full swing)
- PRNU: < 1.0 rms

CMV-50 Sensor Pixel Response:





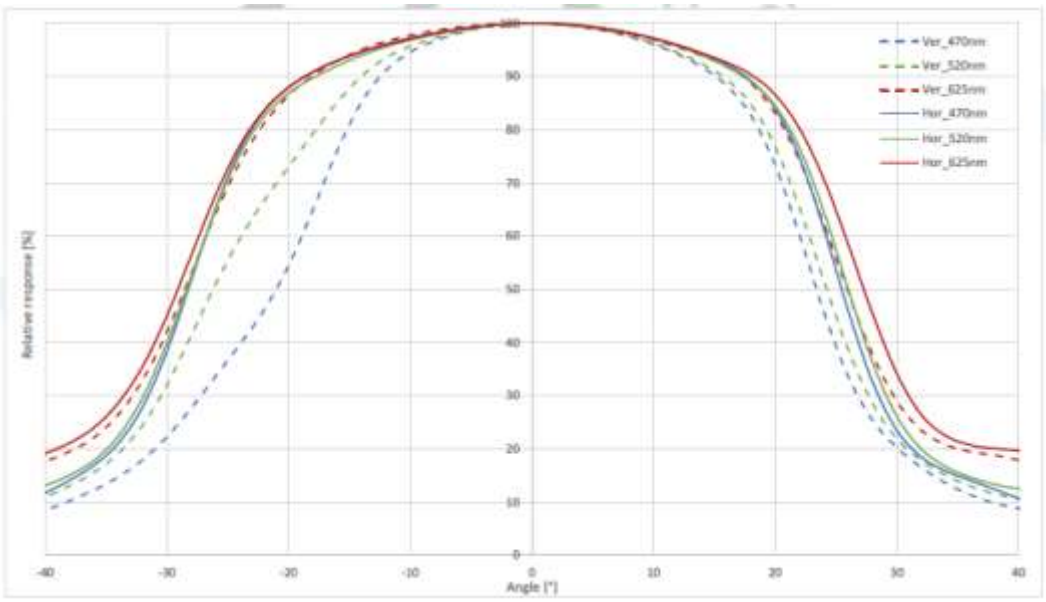
CMV-50 Specifications:

Item	CMV-50
Active Image	7920 x 6004 (Windowing optional)
Sensor Type	ams/CMOSIS CMV-50000
Pixel Size	4.6 µm x 4.6 µm
Sensor Output	24 taps
Data Output	8/12 bits
Output Format	Mono or Bayer
Camera Interface	Base, Medium, Full or Dual Full Camera Link USB3, GigE
Electronic Shutter	Global shutter
Max. Frame Rate at Full Res 8 bits/pixel	3.4 Base CL, 6.8 Medium CL, 13.6 Full CL, 27 Dual Full CL 6.8 USB3, 2.4 GigE
Pixel Clock	Programmable PLL
Shutter Speed	Increments of 10us.
Windowing	V increments of 1 rows
Black Level	Adjustable
Analog Gain	1,2,4X
Digital Gain	1/16th to 16X for each Bayer Color
Exposure Modes	Free Run, Program Triggered, Pulse Width Triggered
External Trigger	3.3-5.0V TTL
Software Trigger	Per Camera API
Dynamic Range	64dB
Defect Correction	Pixel + Column + Row
Lens Mount	M58, Nikon F, Canon EF, M72
Power	6-14V DC, Max TBDW
Environmental	Operating 0C to 60C, Storage –40C to +85C Camera Link tested to –30C to 70C.
Vibration/Shock	10G (20-200Hz) XYZ 70G 10ms

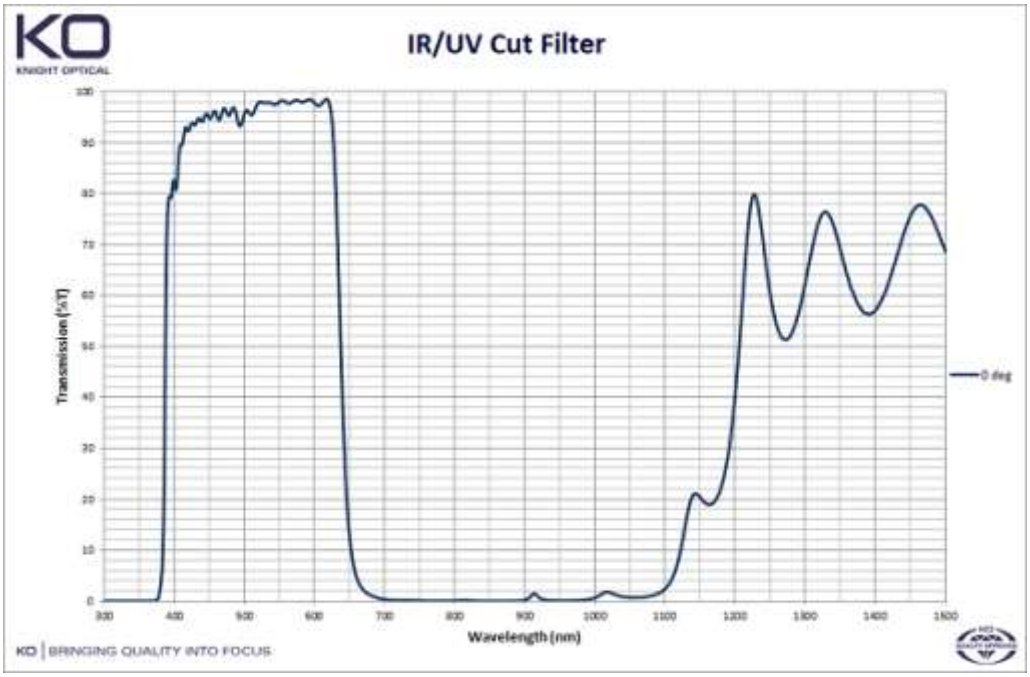
CMV-50 Specifications:

Item	CMV-50
Full Well	14,500e- Normal Mode 58,000e- Binning Mode
Conversion Gain	0.27 DN/e
Responsivity	0.16 dn/ph at 510nm
Temporal Noise	8.8e- Normal Mode 22e- Binning Mode
Dynamic Range	64 dB Normal Mode 68 dB Binning Mode
SNR Max	41.6 dB Normal Mode 47.6 dB Binning Mode
Shutter efficiency 1/PLS	1/8000 at 520nm,f/8
Dark Current	0.24 e/s at 20C Sensor temperature 66.2 e/s at 60C Sensor temperature
DC Doubling	5.1C
DCNU	Dark Current Non Uniformity 0.72 e/s at 20C Sensor temperature 14.2 e/s at 60C Sensor temperature
DSNU	Dark Current Non Uniformity (FPN) 24.5e < 0.2% RMS
PRNU	Photo Response Non Uniformity < 1.0% RMS
QE	58/61/53/14.5% @450/510/600/850nm (Monochrome) 49/55/45% @ 450/510/600nm (Color Device) With Micro lens

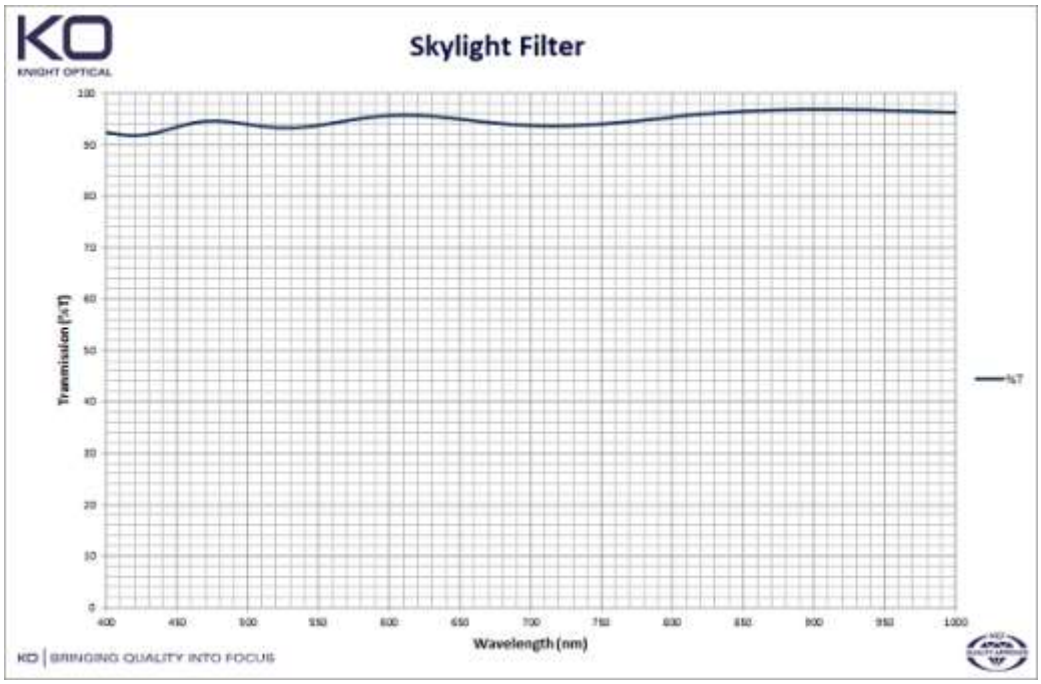
CMV-50 Sensor Microlens Angular Response:



CMV-50 IR/UV Filter response:



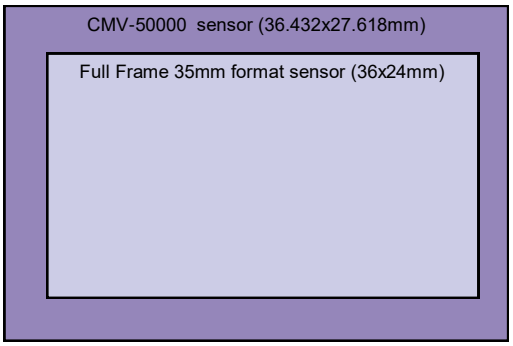
CMV-50 Skylight Filter response:



CMV-50 Sensor Size

The ams/CMOSIS CMV-50000 sensor is slightly larger than the standard 35mm format. The CMV-50000 has a diagonal of 45.717mm vs the 43.3mm diagonal of the 35mm format. This results in an decrease in effective focal length of 43.3/47.717 = 0.947X.

Thus, a 50mm focal length lens for a 35mm camera will have an effective 47mm focal length.

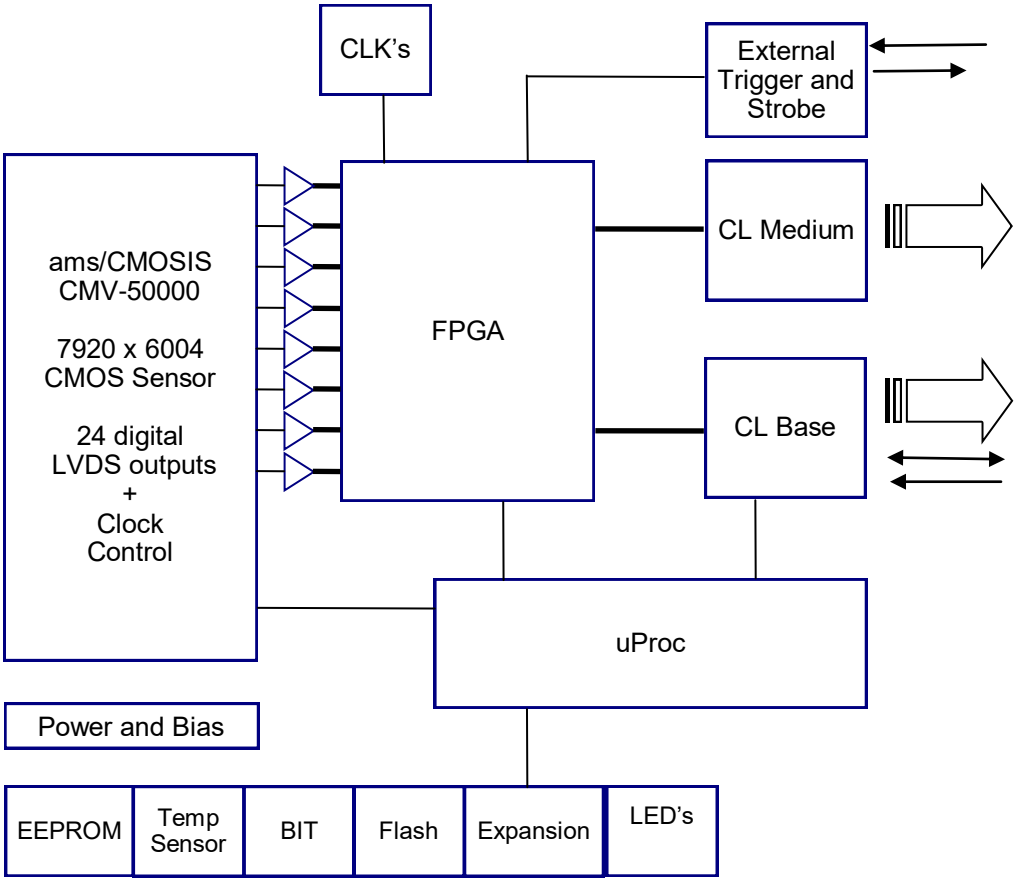


CMV-50 Sensor Pixel Defects:

Name	Limit
Total Defect Columns	0
Total Defect Rows	0
Defect Pixels in dark image	3000
Defect Pixels in grey image	5000
Defect Pixels in saturation image	2000
Total Defect Pixels	6000
Clusters (Size 2 pixels)	15
Clusters (Size 3 pixels)	5
Clusters (Size 4 pixels)	2
Clusters (Size 5 or more pixels)	0

Defects are corrected in the camera hardware as part of the manufacturing process.

CMV-50 Camera Link output block diagram:



The sensor output data is 24 digital taps. Each tap is digitized with an analog to digital converter (ADC) with 12 bit precision. All pixels are optically black clamped and row noise reduced based on the optical black pixel data.

The FPGA reorders the tap data into eight paths of pixels and outputs the pixels onto a one or two Camera Link buses. The output data is formatted to Camera Link. The Camera Link interface includes trigger and serial communications. The camera can output Base, Medium, Full and Dual Full Camera Link configurations.

In addition, an external trigger and strobe are provided on the power connector.

The on-board microprocessor controls the sensor and FPGA operation, as well as monitors the various sensors within the camera.

Note in the case of a USB3/GigE interface the FPGA data is output directly to the USB3/GigE interface board.

Camera Link

Camera Link is a communication interface for visual applications that use digital imaging. The Camera Link (CL) interface is built upon the National Semiconductor Channel Link technology and specifies how image data is formatted and transferred. Channel Link consists of a driver and a receiver pair. The driver accepts 28 single ended data signals and a single ended clock. The data is serialized 7:1 and the four data streams and a dedicated clock are transmitted over five LVDS pairs. The receiver accepts the four data streams and the clock, decodes the data, and drives the 28 bits of data to the capture circuit.

Image data and image enable signals are transmitted on the Camera Link bus. The four Enable signals are:

FVAL: Frame Valid is defined HIGH for valid lines.
LVAL: Line Valid is defined HIGH for valid pixels.
DVAL: Data Valid is defined HIGH for valid data.
SPARE: undefined, for future use.

Four LVDS pairs are reserved for general purpose camera control. They are defined as camera inputs and frame grabber outputs. The signals are CC1, CC2, CC3, CC4. The CMV-50 uses CC1 as the trigger source.

The Camera Link interface has three configurations:

Base:	Single Channel Link chip, single cable connector.
Medium:	Two Channel Link chips, two cable connectors.
Full:	Three Channel Link chips, two cable connectors.

Note: CMV-50 can operate in **Base, Medium, Full or Dual Full** Cameral Link Configurations.

CMV-50 Camera Link Performance:

Camera Link Mode	Cables	Bits/Pixel	Frame Rate
Single Medium	2	10/12	5.9
Dual Medium	4	10/12	12.2
Single Full	2	8	12.2
Dual Full	4	8	24.4

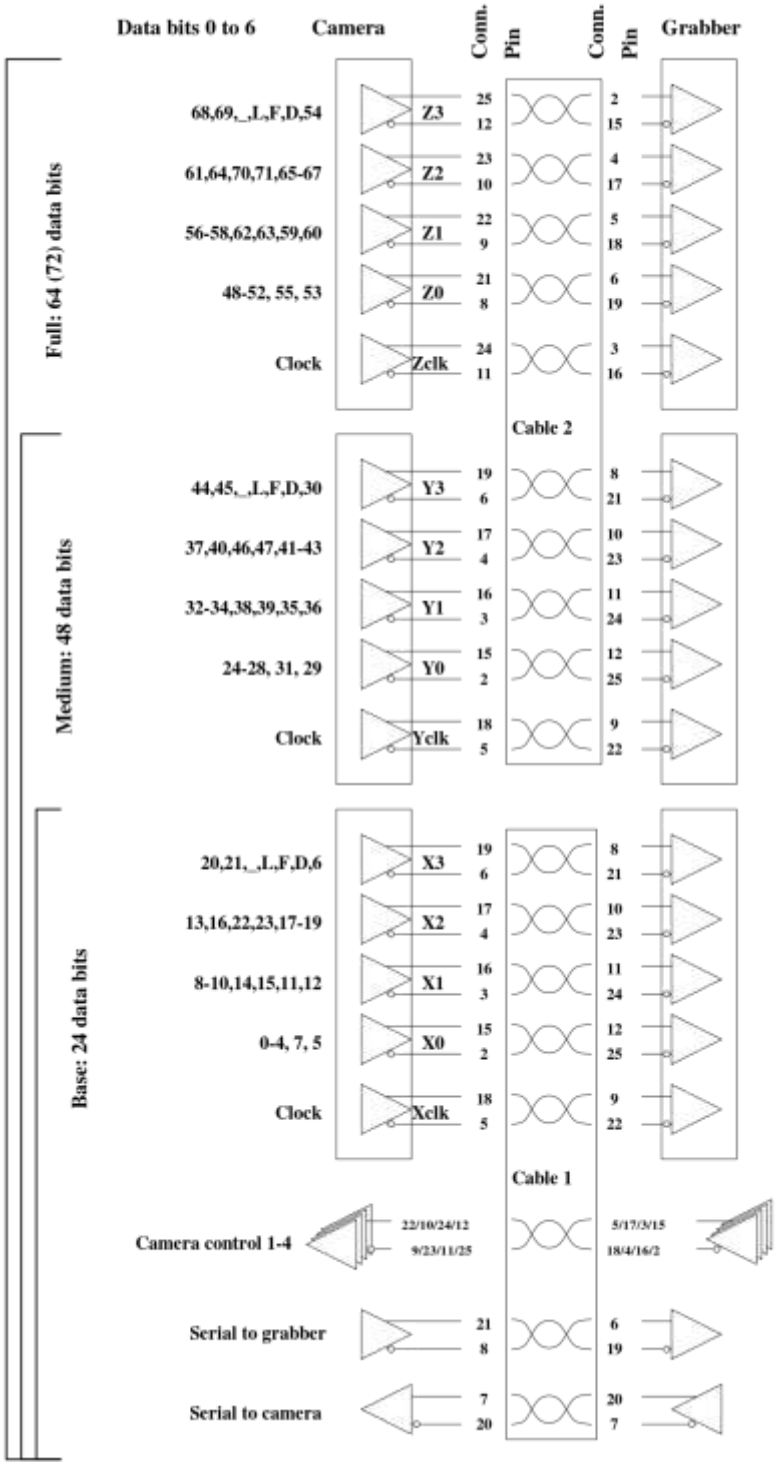
CMV-50 UB3 Performance:

Bits/Pixel	Frame Rate
8	6.8
10	3.3
12	3.3

CMV-50 GigE Performance:

Bits/Pixel	Frame Rate
8	2.6
10	1.7
12	1.7

Camera Link


Data bits 0 to 6
Camera
Conn.
Pin
Conn.
Pin
Grabber
Full: 64 (72) data bits
68,69,_,L,F,D,54
Z3
25
12
2
15
61,64,70,71,65-67
Z2
23
10
4
17
56-58,62,63,59,60
Z1
22
9
5
18
48-52, 55, 53
Z0
21
8
6
19
Clock
Zclk
24
11
3
16
Cable 2
Medium: 48 data bits
44,45,_,L,F,D,30
Y3
19
6
8
21
37,40,46,47,41-43
Y2
17
4
10
23
32-34,38,39,35,36
Y1
16
3
11
24
24-28, 31, 29
Y0
15
2
12
25
Clock
Yclk
18
5
9
22
Base: 24 data bits
20,21,_,L,F,D,6
X3
19
6
8
21
13,16,22,23,17-19
X2
17
4
10
23
8-10,14,15,11,12
X1
16
3
11
24
0-4, 7, 5
X0
15
2
12
25
Clock
Xclk
18
5
9
22
Cable 1
Camera control 1-4
22/10/24/12
9/23/11/25
5/17/3/15
18/4/16/2
Serial to grabber
21
8
6
19
Serial to camera
7
20
20
7

Pixel Format

The CMV-50 camera samples the sensor with 12 bit precision and processes the data throughout the FPGA at 12 bits.

During the data format stage, the 12 bit image data can be down sampled to 10 or 8 bits. In addition, the bottom 8 bit data can be output as the top 8 (msb) of the 12 bit image sample.

Sensor ADC pixel sample to Camera Link mapping			
ADC bits	12 bit CL	10 bit CL	8 bit CL
11	11>11	11>9	11>7
10	10>10	10>8	10>6
9	9>9	9>7	9>5
8	8>8	8>6	8>4
7	7>7	7>5	7>3
6	6>6	6>4	6>2
5	5>5	5>3	5>1
4	4>4	4>2	4>0
3	3>3	3>1	
2	2>2	2>0	
1	1>1		
0	0>0		

Target	Index	Command	R/W	Description
0x00	0x00	Bit Depth	R/W	0 = 12 bit 1 = 10 bit 2 = 8 bit

Channel Format

The Camera Link Base Mode used on the CMV-50 camera, can transfer pixel data in 8, 10, 12 bit depths.

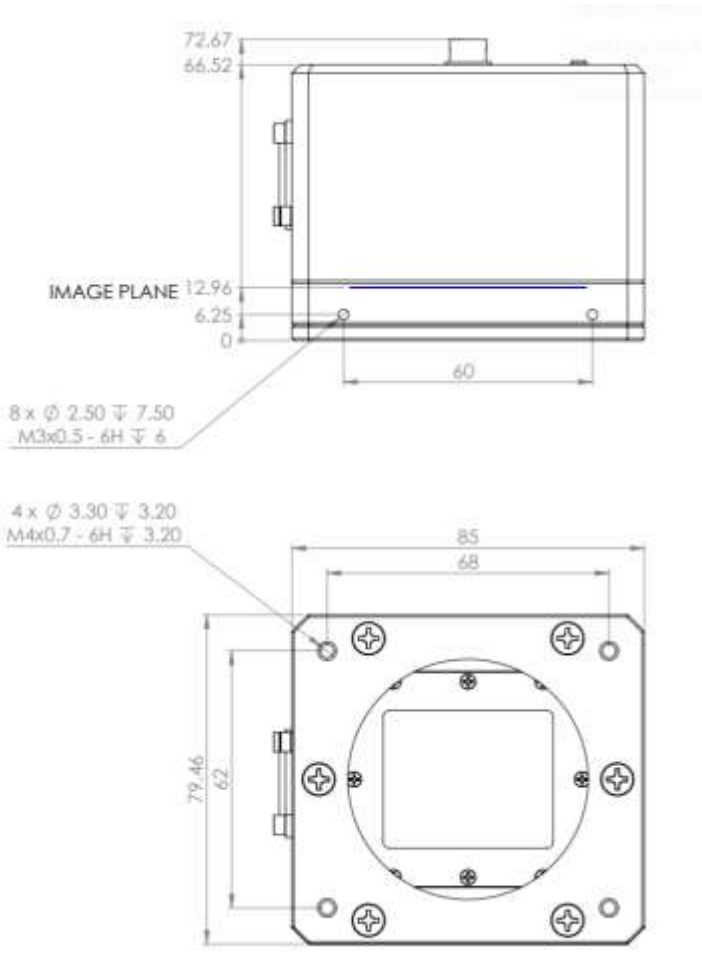
Target	Index	Command	R/W	Description
0x00	0x02	Camera Link Output	W	0 = Single Medium 8bit 1 = Single Medium 10bit 2 = Single Medium 12bit 3 = Single Full 8bit 4 = Dual Medium 8bit 5 = Dual Medium 10bit 6 = Dual Medium 12bit 7 = Dual Full 8bit

Drawings and CAD Models:

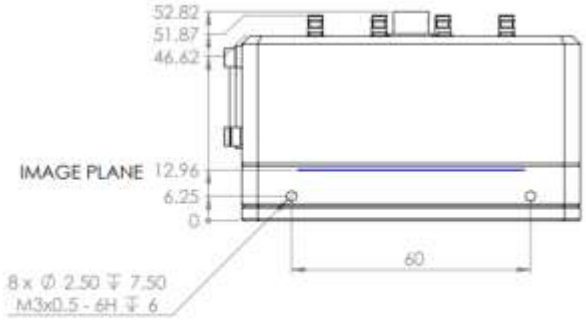
The CMV-50 case dimensions are available on the illunis web site under the camera and interface of interest. See the web page for the most current mechanical drawings.

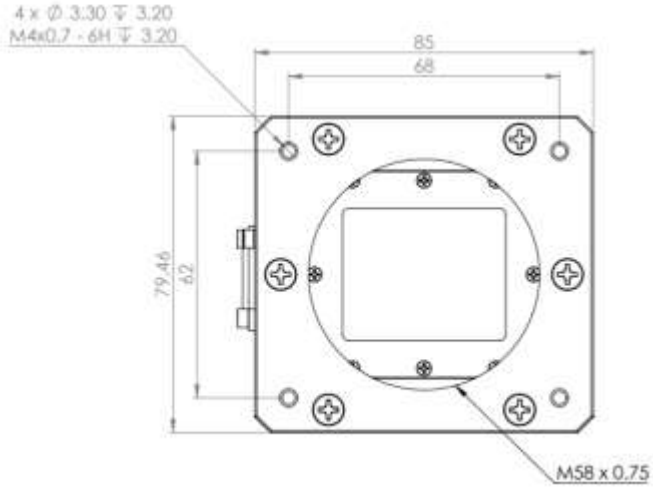
CAD Models are available by request to info@illunis.com.

USB3

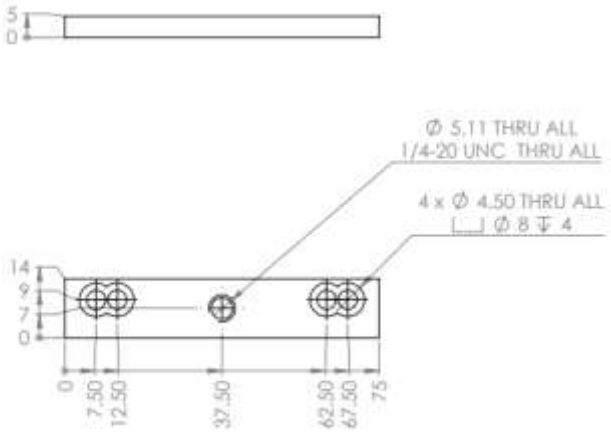


Camera Link

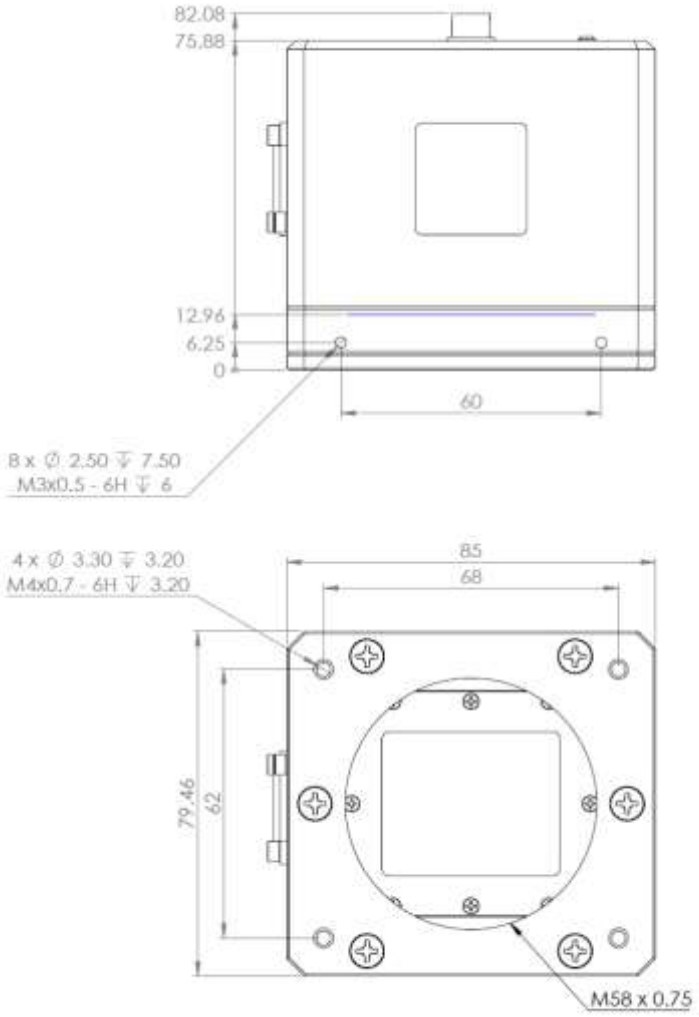




Tripod Adapter



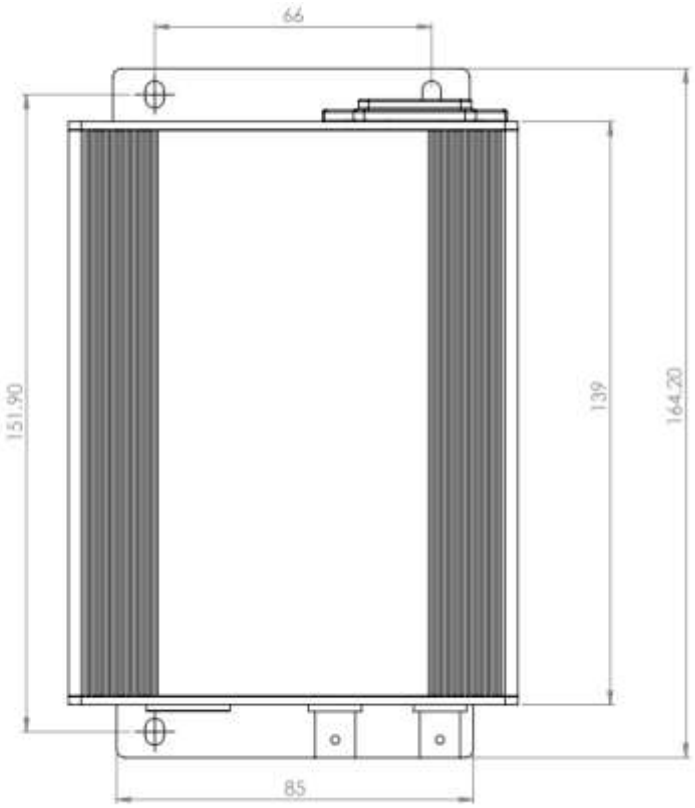
GigE

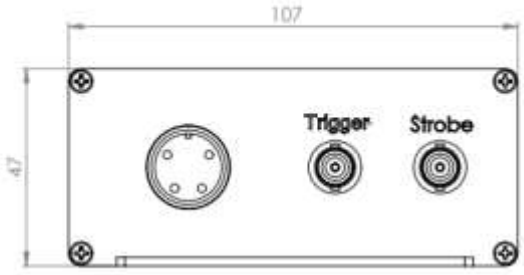


Lens Interfaces:

The CMV-50 base configuration for all data interfaces is an M58/OEM mount. Optional mounts include Nikon F, M72 and Canon EF.

12V Universal Power Supply (UPS-12)





The CMV-50 serial interface was developed for high reliability applications. The interface incorporates error checking and a handshake protocol, which responds with either a positive or negative acknowledge signal. The communication path from the frame grabber to the CMV-50 is through the Camera Link cable.

The CMV-50 microprocessor is a flash programmable device with many features vital to the operation of the camera. Some of these features include:

- Hardware UART used for serial communications.
- A watchdog timer used to monitor communication errors and system faults.
- Onboard RAM and EEPROM for saving camera settings.
- Parallel data bus for high speed interfaces to the FPGA and NAND FLASH memories.
- Brown out detection and reset.

SERIAL INTERFACE PROTOCOL

Implementation

Camera communication is accomplished via asynchronous serial communication according to EIA Standard RS 232 C through the Camera Link cable.

Data rate: Full Duplex, 115200 baud.

- 1 START bit.
- 8 DATA bits – The LSB (D0) is transfered first.
- 1 STOP bit.
- No parity.

Protocol

The CMV-50 camera is controlled through command packets. The CMV-50 camera is considered a slave device and never generates data without a read request. The data packet formatting is described in detail below. ***Note:*** the checksum is calculated only on the 4 ascii characters comprising the Data.

Data Packets

Data packets are of either ‘read’ or ‘write’ types. For example: to read the camera serial number, the packet sent to the camera would be {r07000002fe}. The camera would respond by issuing an acknowledge character ! followed by the response {r0700sssscc}, where ssss is the camera serial number and cc is the checksum calculated in hex as 0x0100 – (ss (high byte hex) + ss (low byte).

Packet Format							
1 Char	2 Char	2 Char	2 Char	4 Char	2 Char	1 Char	1 Char
Start	**Command**	**Target**	**Index**	**Data**	**Checksum**	**End**	**Ack/ Nack**

Start:

Indicates the Start of the frame
Size = 1 ascii character
Value = 123 Decimal (ascii {)

Command:

Command descriptor
Size = 1 ascii character
Value = 114 Decimal (ascii r) for Read
Value = 119 Decimal (ascii w) for Write

Target:

Command descriptor
Size = 2 ascii characters

Index:

Command descriptor
Size = 2 ascii characters

Data:

The data transferred
Size = 4 ascii characters

Checksum of Data

Size = 2 ascii characters - Intel-Standard - two's compliment of sum of data.

Example 1: Data = 2002, checksum = lower byte of (0x100 – (0x20 + 0x02)) = 0xde
Example 2: Data = 0000, checksum = lower byte of (0x100 – (0x00 + 0x00)) = 0x00
Example 3: Data = fef0, checksum = lower byte of (0x100 – (0xfe + 0xf0)) = 0x12

End:

Indicates the End of the frame
Size = 1 ascii character
Value = 125 Decimal (ascii })

Ack/Nack:

Positive **Ack**nowledge - **N**egative **ack**nowledge
Size = 1 ascii character
Ack Value = 33 Decimal (ascii !)
Nack Value = 63 Decimal (ascii ?)

COMMAND DESCRIPTIONS

Read Command Structure

The CMV-50 camera parses the sequence byte by byte. An invalid read command, target , or index will cause the camera to issue a NACK. The Host (the user) will generate dummy data with a valid checksum then an end. The camera will respond with an ACK and re-send the command with valid data and checksum. If the Host detects an error, it will re-issue the command.

Host {r tt ii 0 0 0 0 cc}, camera issues !
Camera issues {r tt ii data data data data cc} (NOTE no ACK).

Write Command Structure

The CMV-50 camera parses the sequence byte by byte. An invalid write command, target, index, or checksum will cause the camera to issue a NACK; otherwise, the write sequence will complete and the camera will issue an ACK after the command has been executed. The camera receives the checksum from the Host.

Host {w tt ii data data data data cc} camera issues !

Error Checking

The CMV-50 camera parser is character by character and will respond with an immediate NACK if any unrecognized command, target, index, or checksum occurs.

Communication Timeouts

The CMV-50 camera micro-controller uses a hardware watchdog timer that will time out if the time between bytes are longer than 500ms. When sending command frames to the camera, the host must not have significant delays between bytes sent.

Camera Control

Target	Index	Description	Read Write	Modes
0x00	0x00	Set Bit Depth	R/W	0 = 12 bit 1 = 10 bit 2 = 8 bit
0x00	0x01	Set Exposure Time ms	R/W	Exposure is limited to 0xFFFF = 65535ms
0x00	0x02	Camera link output	R/W	0 = 12 bit Med Single 1 = 10 bit Med Single 3 = 8 bit Full Single 4 = 12 bit Med Dual 5 = 10 bit Med Dual 7 = 8 bit Full Dual
0x00	0x03	Readout Mode	R/W	0 = Free Run, 1=TPE, 2=TME
0x00	0x05	Exposure time us	R/W	Exposure is limited to 0xFFFF = 65535us
0x00	0x06	Trigger Polarity	R/W	0=Active Low, 1=Active High
0x00	0x07	Test Pattern	R/W	0=off, 1=input, 2=output, 3 = sensor
0x00	0x09	Black Clamp Value	R/W	Sets OB in dn, Saves to EEPROM
0x00	0x0A	Pre Emphasis	R/W	Requires special hardware for 10M CL Cable
0x00	0x0B	Trigger Source	R/W	0 = CLA CC1, 1 = CLB CC1, 2 = External Power Connector
0x02	0x05	Software Trigger	W	Software trigger in ms 1—65535
0x00	0x11	EOB Target	R/W	Target black level in DN
0x00	0x20	Color Mode	R/W	0 = Mono, 1 = Color
0x00	0x24	Binning Mode	R/W	0 = Disable, 1 = Enable
0x00	0x25	Sub Sample Mode	R/W	0 = Disable, 1 = Enable
0x00	0x30	RE_CE Gain	R/W	Row Even, Column Even Digital Gain
0x00	0x31	RE_CO Gain	R/W	Row Even, Column Odd Digital Gain
0x00	0x32	RO_CE Gain	R/W	Row Odd, Column Even Digital Gain
0x00	0x33	RO_CO Gain	R/W	Row Odd, Column Odd Digital Gain
0x00	0x40	YWin Subs Blk Enable	R/W	
0x00	0x41	YWin Start	R/W	
0x00	0x42	YWin Size	R/W	
0x00	0x43	YWindow	R/W	

Target	Index	Description	Read Write	Modes
0x00	0x50	Dual Exposure Mode	R/W	HDR 1=Enable, 0 = Disable
0x00	0x51	Dual Exposure Group	R/W	0 = Mono, 1 = Color (Two Column)
0x00	0x52	Dual Exposure Time L	R/W	Long exposure for HDR
0x00	0x53	Dual Exposure Time S	R/W	Short exposure for HDR
0x03	0x00	Save to EEPROM	W	Save state to EEPROM including UART
0x03	0x03	Copy USER to Factory	W	
0x03	0x05	Reset Factory	W	
0x03	0x06	Copy USER to USER	W	
0x03	0x07	USER	R/W	
0x03	0x22	Copy USER to USER	W	
0x04	0x09	UART Initialize	W	0=9600, 1=19200, 2=38400,3=57600, 4=115200
0x04	0xFF	Base Reset		Resets camera to base mode UART=9600
0x04	0x07	Read Temperature	R	Read PCB Temp
0x04	0x08	Read Temperature	R	Read PCB Temp
0x07	0x00	Read Camera Info	R	0x0003 = Micro-firmware Rev 0x0004 = FPGA Major Revi-sion 0x0006 = Clock Rate 0x0007 = FPGA Sub/Minor Revision 0x0008 = Micro Sub/Minor Revision

Baud Rate

NOTE: The CMV-50 default baud rate is 115200.

The CMV-50 camera allows for the setting of the baud rate to one of five rates. This setting can be made for only the current power cycle or for the boot cycle.

The CMV-50 camera allows the user the option of saving the communication speed in the camera EEPROM. This can cause communication with the camera to be lost if the command is not used carefully. ***Note:*** only one of the baud rates will be used so that if communication is lost it can be restored by trying the other baud rates.

Once the EEPROM baud rate is set, the camera must be re-powered to set the rate.

Target	Index	Description	Read Write	Modes
0x04	0x09	Set Current Baud Rate	W	0x0000 = 9600 0x0001 = 19200 0x0002 = 38400 0x0003 = 57600 0x0004 = 115200 Save the state to EEPROM to retain baud rate
0x04	0xD2	Set Camera Link Boot Baud Rate (Requires reboot)	R/W	0x0000 = 9600 0x0001 = 19200 0x0002 = 38400 0x0003 = 57600 0x0004 = 115200
0x04	0xD0	Power Up	W	Resets camera and powers up circuits

Readout Control

The exposure type is either Free Run Mode or Trigger Mode.

In Free Run Mode, the camera outputs continuous images in a global shutter mode.

In Trigger Mode, the camera receives the trigger, erases the pixels, exposes the image, and then reads it out.

Target	Index	Description	Read Write	Modes
0x00	0x03	Readout Mode	R/W	0 = Free Run 1 = Trigger Program Exposure 2 = Trigger Manual Exposure

Exposure Time

The exposure time is set in either milliseconds or microseconds. The resolution of the exposure is in horizontal line times. Two commands are provided for calculating the Free Run time from a specified time variable (milliseconds or microseconds). **The closest available time is selected and set in the internal time variable.**

Target	Index	Description	Read Write	Modes
0x00	0x01	Exposure ms	R/W	Exposure time in milliseconds, max is 0xFFFF = 65.535 seconds
0x00	0x05	Exposure us	R/W	Exposure time in Microseconds, max is 0xFFFF = 0.065 seconds

Strobe Signal

The CMV-50 Strobe Signal is a 3.3V LVTTL signal that is active when the sensor is triggered and exposing an image. The Strobe Signal is useful for analyzing and optimizing imaging applications. The strobe can be used to activate an illumination source. If used in this fashion, the Strobe Signal cannot drive significant current and should be buffered.

Target	Index	Description	Read Write	Modes
0x04	0x0e	Strobe Control	Write	0x0000 = negative strobe polarity 0x0001 = positive strobe polarity

Windowed Readout

Target	Index	Description	Read Write	Modes
	0x40	YWin Subs Blk Enable	R/W	
	0x41	YWin Start	R/W	
	0x42	YWin Size	R/W	
	0x43	YWindow	R/W	

Software Trigger

The Software Controlled Trigger command forces an internal trigger from a software command. The software trigger pulse has a width in ms as specified in the data field. The range is 1 to 65535 ms (65sec) where 10ms is typical usage.

Target	Index	Description	Read Write	Modes
0x02	0x05	Soft Trigger	W	Software trigger in ms 1-65535

Gain and Black Level

The CMV-50 camera has 24 digital taps. Each tap is processed by an analog front end (AFE). Each AFE has a gain stage and a 12 bit analog to digital converter.

Digital Gain is set as a fixed point number:

DG = (Val + 1) / 16

1.0X = 0x0F
16X = 0xFF
1/16X = 0x00

.

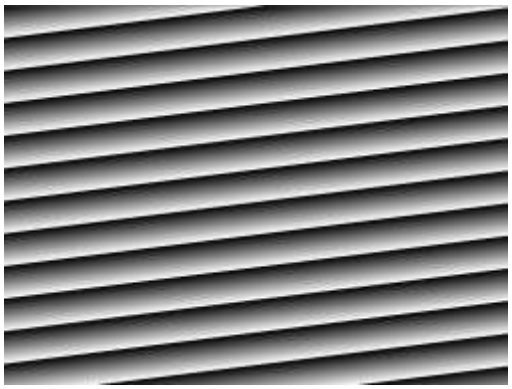
Target	Index	Description	Read Write	Modes
0x00	0x30	RE_CE Gain	R/W	Row Even, Column Even Digital Gain
0x00	0x31	RE_CO Gain	R/W	Row Even, Column Odd Digital Gain
0x00	0x32	RO_CE Gain	R/W	Row Odd, Column Even Digital Gain
0x00	0x33	RO_CO Gain	R/W	Row Odd, Column Odd Digital Gain

Test Patterns

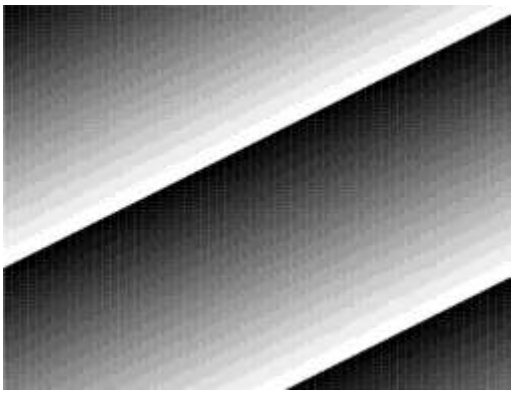
The CMV-50 camera has two synthetic test patterns that can be used for testing both the digital path and Camera Link communications.

The Input Test Pattern can be used to test the internal data path of the CMV-50 FPGA. The Output Test Pattern can be used to test the Camera Link digital communication path.

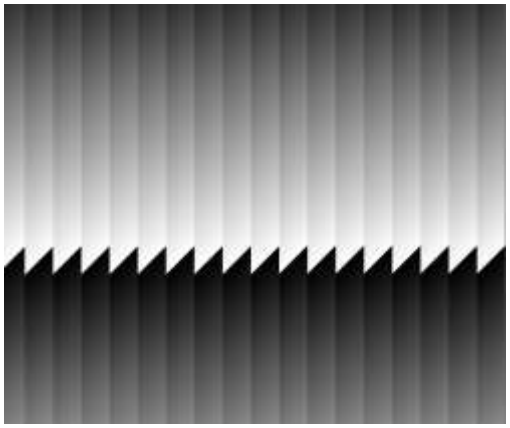
Target	Index	Command	R/W	Description
0x00	0x07	Test Pattern	W	0x0000 = Normal Video 0x0001 = Input (CCD) Test Pattern 0x0002 = Output Test Pattern 0x0003 = Sensor Test Pattern



Input (CCD) Test Pattern



Output Test Pattern



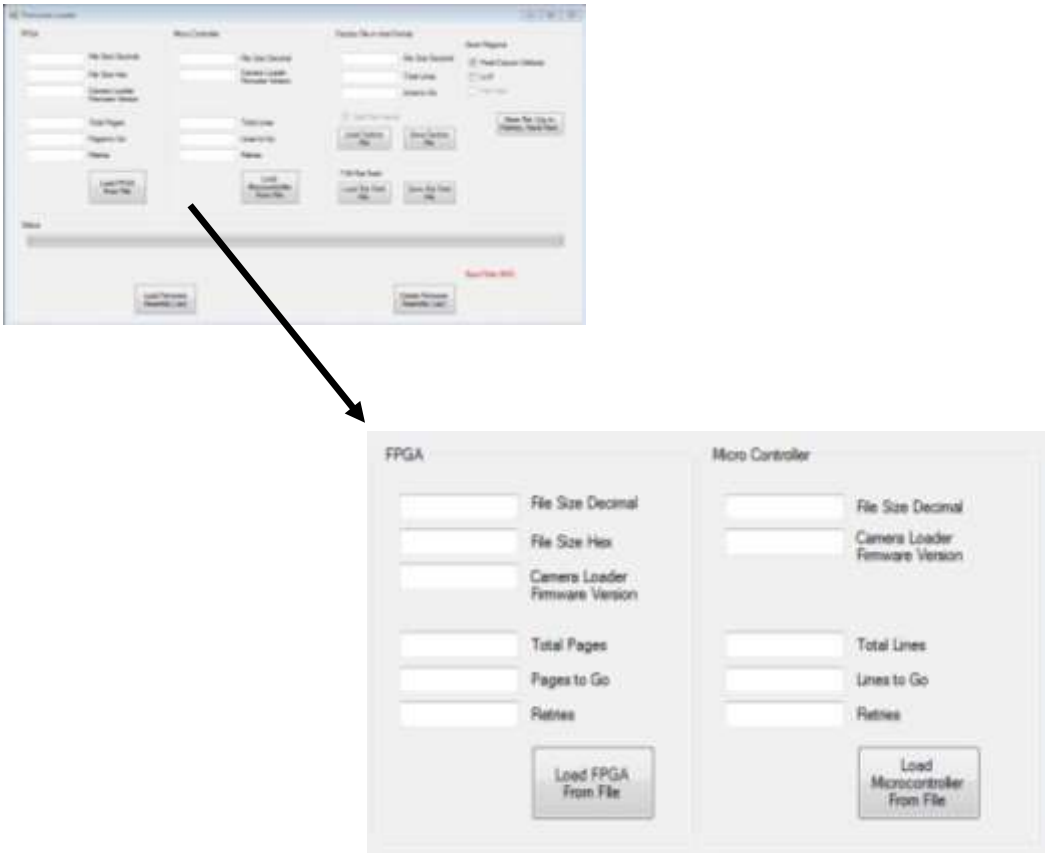
Sensor Test Pattern

Manufacturing->Firmware Loader

The camera firmware is field upgradeable.

Load FPGA from file: Loads the FPGA configuration data. The camera must be repowered to enable the new configuration.

Load Microcontroller from file: Loads the Micro configuration data. The camera must be repowered to enable the new configuration.



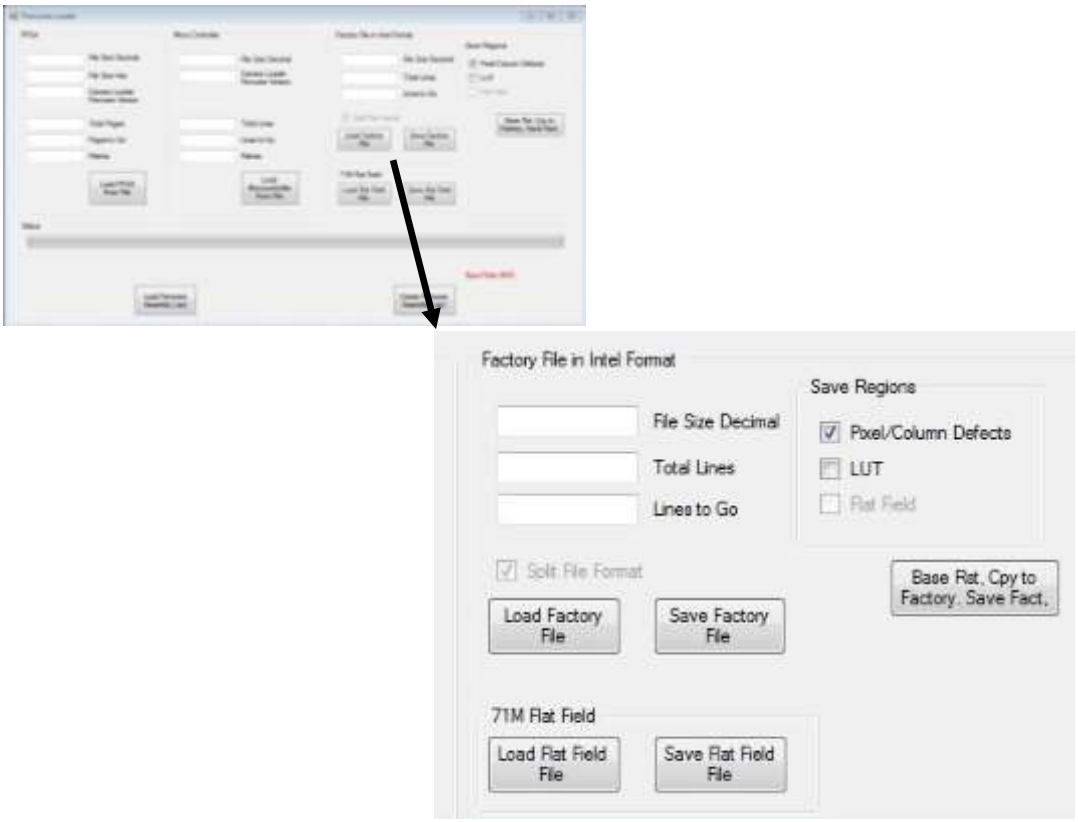
Backup/Restore

The CMV-50 camera control program provides features for saving and restoring the camera state. Please save the camera state before changing the default state of the camera by choosing the Save Factory File button.

State data can be saved and restored (from files) for the following:

1) Camera state with optional defect tables.

Note: The camera control program may change the communication rate during this operation.



Camera Save/Restore

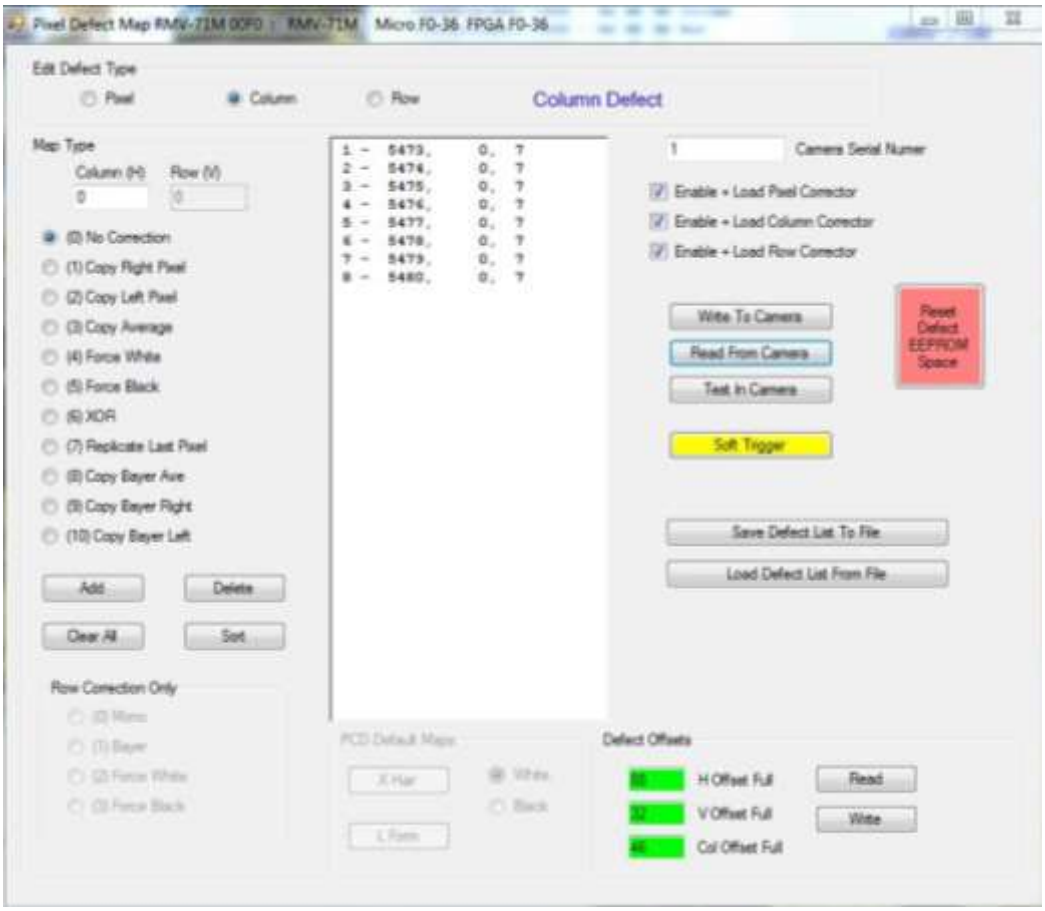
Save Factory File: Saves the camera state to a file for future restores. Options include defect table.

Load Factory File: Restores camera state from a file. The camera state is saved in manufacturing and can be emailed to the user.

Pixel, Column and Row Defects

Defect correction is used to “map out “ defective pixels in the camera and substitute synthesized pixel values. The illunis Camera Control Application provides a defect editor to simplify the editing of defect mapping.

Target	In-dex	Description	Read Write	Modes
0x04	0x1c	Defect Correction (DC)	Write	0x0000 = Load/Enable Pixel DC 0x0001 = Load/Enable Column DC 0x000A = Load/Enable Row DC 0x0005 = Disable Pixel DC 0x0004 = Disable Column DC 0x000B = Disable Row DC



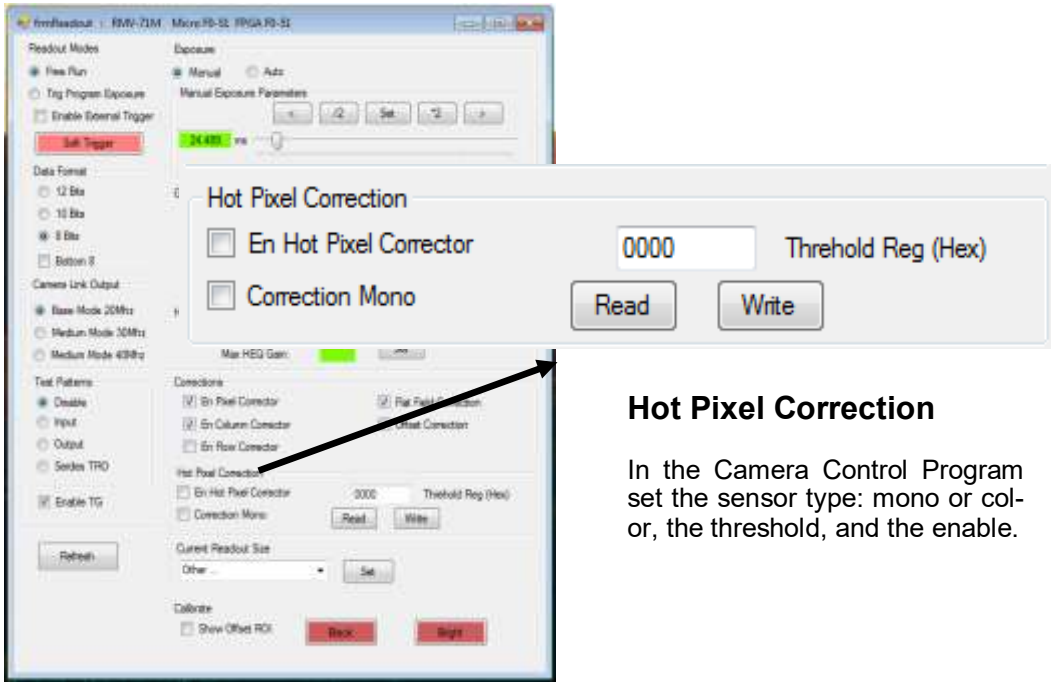
Hot Pixel Correction

The Hot Pixel Correction (HPC) algorithm dynamically analyzes the video data for single bright (hot) pixels.

Hot pixels are generated by thermal noise in the photo diode of the sensor. Long exposures will create more hot pixels than short exposures.

The HPC does not require calibration. It compares a target pixel with its horizontally adjacent pixels. The difference of left/right neighbor and the pixel is calculated. If the difference is greater than the set **Threshold,** then the pixel is replaced with the average of the adjacent pixels.

Target	Index	Description	Read Write	Modes
0x04	0xA0	Hot Pixel Corrector	R/W	0x0000 = Disabled 0x0001 = Enabled
0x04	0xA1	Hot Pixel Correction Type	R/W	0x0000 = Monochrome 0x0001 = Color Bayer
0x04	0xA2	Hot Pixel Threshold	R/W	Threshold in dn Recommended > 0x0010



Hot Pixel Correction

In the Camera Control Program set the sensor type: mono or color, the threshold, and the enable.

Hot Pixel Correction

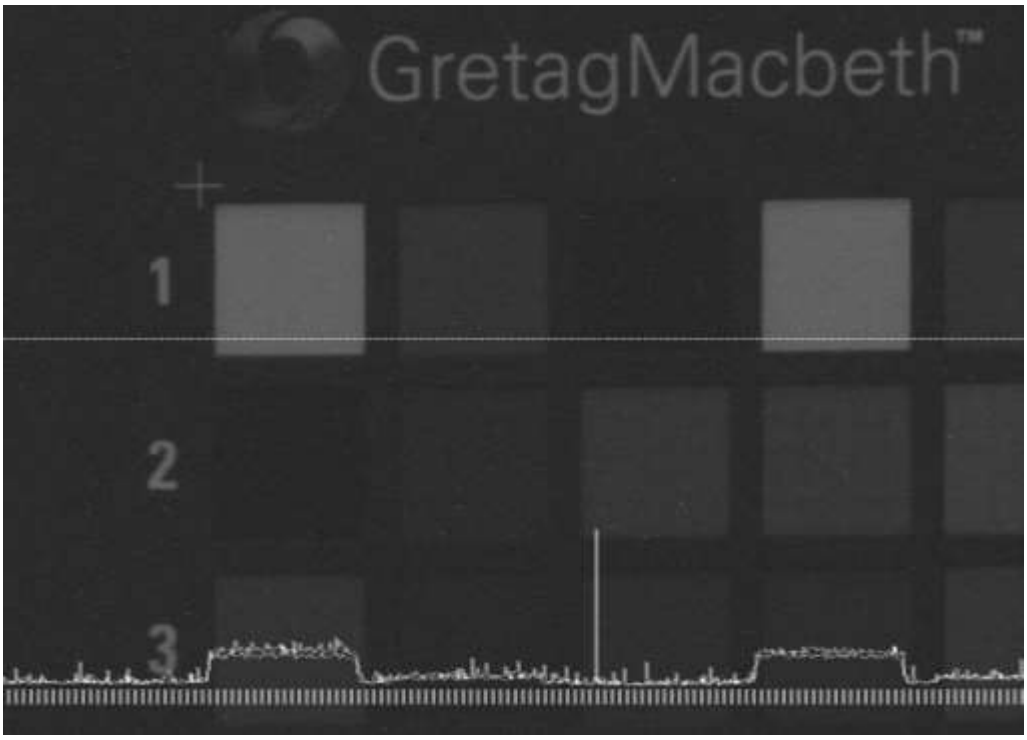


Image with Hot pixels

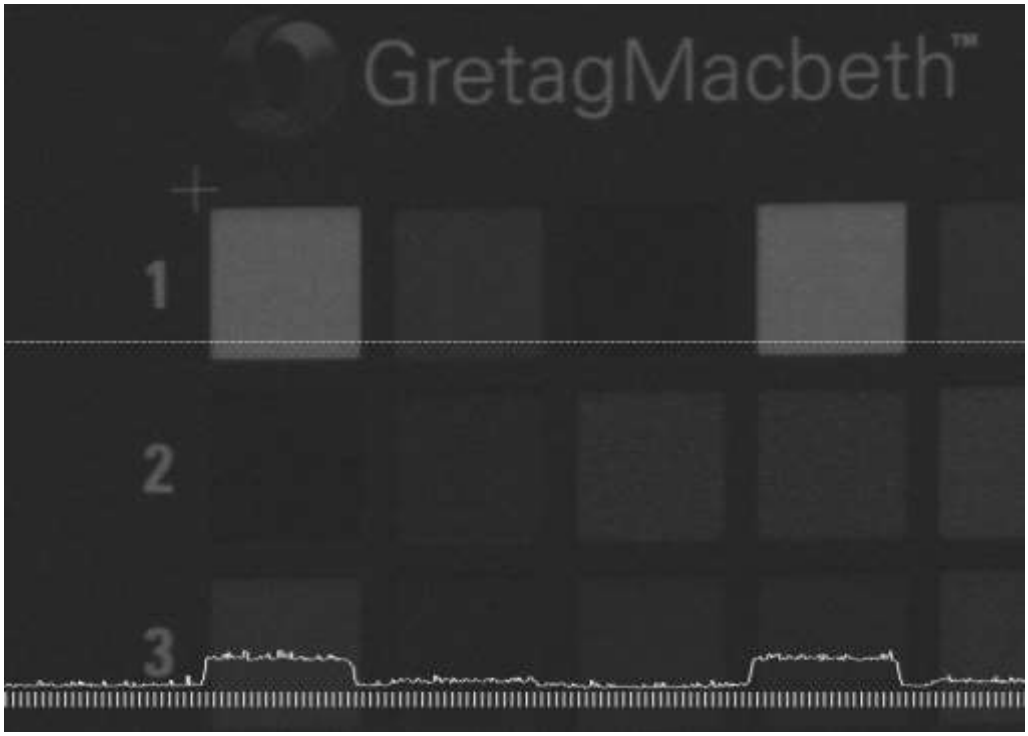


Image with Corrected Hot pixels