DIVIINA® LM2
Line Scan Camera

DIVIINA LM2 Camera
User Manual

Summary

1 CAMERA OVERVIEW

1.1 Features

- Sensor: 1024 to 4096 pixels, 10 or 14 µm square
- Data Rate : 40MPixels on two channels
- Line Rate Up to 35,5 KHz
- Bit Depth : 8 bits
- Camera Link® Interface (Base)
- Dimensions: 60 x 60 x 45 (w, h, l)
- Anti-blooming
- Cost effective and easy to use
- Fully configurable with CommCam software.

1.2 Key Specifications

Characteristics	Value			Unit
Sensor Characteristics at Maximum Pixel Rate				
Resolution	1024	2048	4096	Pixels
pixel size (square)	10 or 14	10 or 14	10	µm
Max line rate	35.7	18.1	9.5	kHz
Radiometric Performance at Maximum Pixel Rate and minimum camera gain				
Bit depth		8		Bits
Responsitivity (14µm pixels size)		9		LSB/(nJ/cm²) 8bits
Responsivity (10µm pixels size)		3.5		LSB/(nJ/cm²) 8bits
Response non linearity		< 1		%
PRNU		+/- 10		%
Dynamic range		58		dB
Functionality (Programmable via Control Interface)				
Gain	Up to 36 dB			
Offset	Up to 16 LSB			
Trigger Mode	Free-run, external triggered			

Mechanical and Electrical Interface		
Size (w x h x l)	60 x 60 x 42	mm
Weight	210 g (without mount)	g
Lens Mount	M42 x 1 (by default) F (Nikon) or C optional mounts	
Sensor alignment	±200	µm
Sensor flatness	±30	µm
Power supply	Single 12 to 24	V
Power dissipation	< 5	W
General Features		
Operating temperature	0 to 65 (front face)	°C
Storage temperature	-40 to 70	°C
Regulatory	CE and RoHS compliant	

1.3 Description

DiViiNA is a cost efficient CCD line scan camera family with Camera Link interface. Featuring e2v's own high performance linear CCD sensors from 1024 pixels up to 4096 pixels, as used in the world recognized AViiVA cameras; DiViiNA cameras offer high image quality with user-friendly simplicity. DiViiNA is the perfect candidate for mid range machine vision applications.

1.4 Typical Applications

- Web Inspection (Wood, Paper, Metallurgy)
- Part inspection and sorting (Cotton, Rice, Food)
- General Machine Vision Inspection

1.5 Models & Part numbers

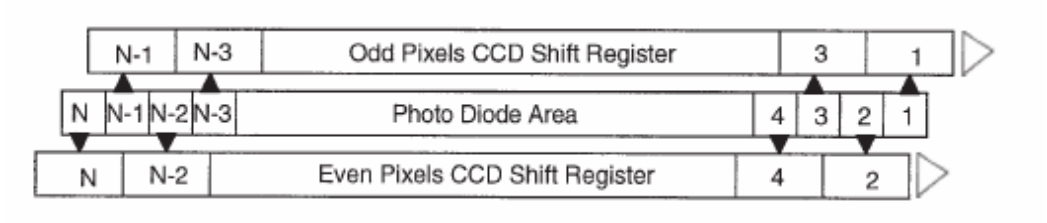
Table 5-1. Ordering Code

Part Number	Sensor type (Resolution, Pixels size)	Description
Camera		
EV50YLM2CL1010-BA0	1024 pixels, 10µm size	DIViiNA LM2 CL 1010
EV50YLM2CL2010-BA0	2048 pixels, 10µm size	DIViiNA LM2 CL 2010
EV50YLM2CL4010-BA0	4096 pixels, 10µm size	DIViiNA LM2 CL 4010
EV50YLM2CL1014-BA0	1024 pixels, 14µm size	DIViiNA LM2 CL 1014
EV50YLM2CL2014-BA0	2048 pixels, 14µm size	DIViiNA LM2 CL 2014
Accessories		
EV50-MOUNT-F		F-Mount (Nikon)
EV50-MOUNT-C		C-Mount

2 IMAGE SENSOR

2.1 Sensor Structure

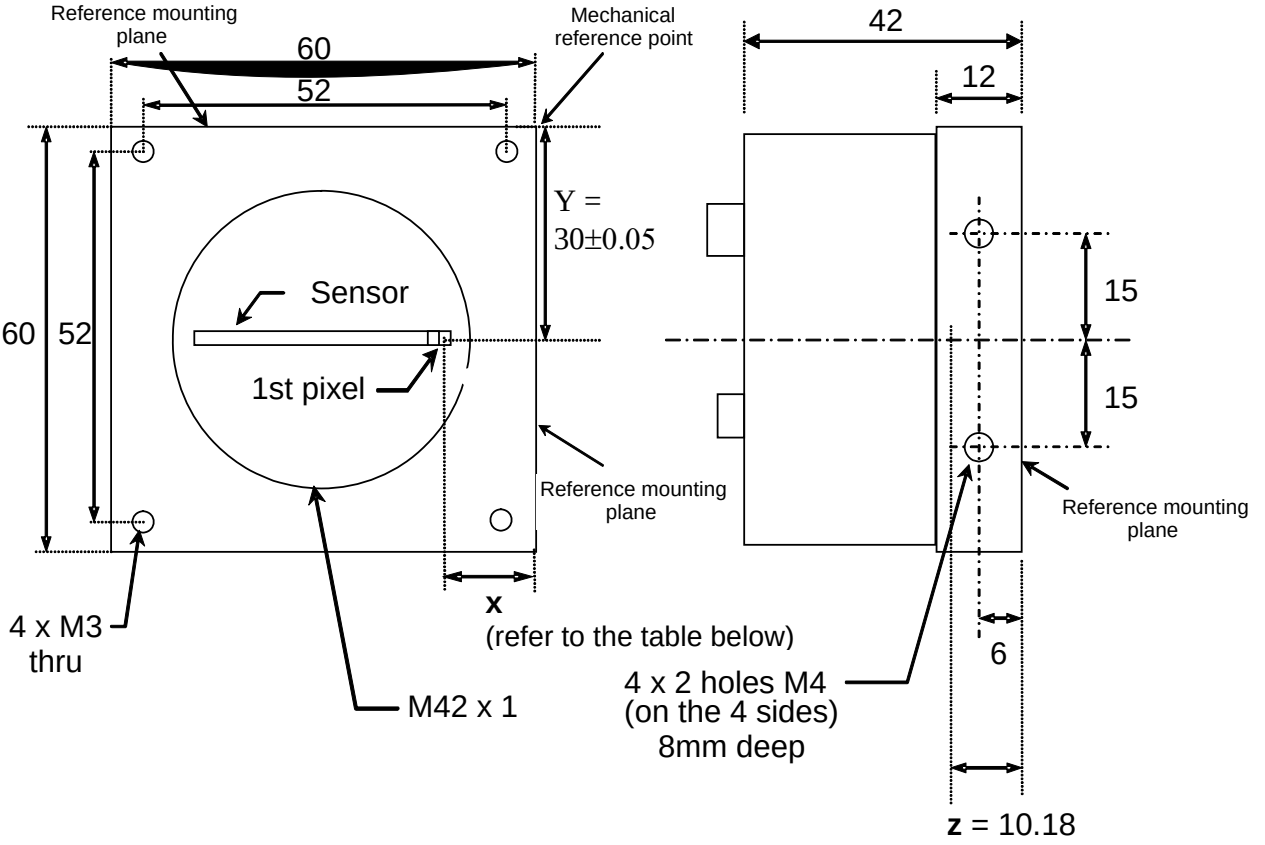
The sensor has a odd/even structure in two taps as following :

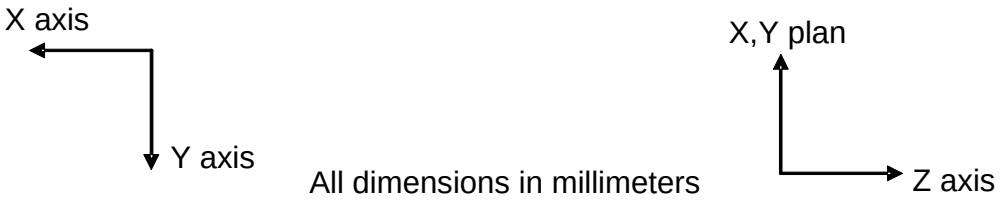


2.2 Response of the sensors

3 CAMERA HARDWARE INTERFACE

3.1 Mechanical Drawings

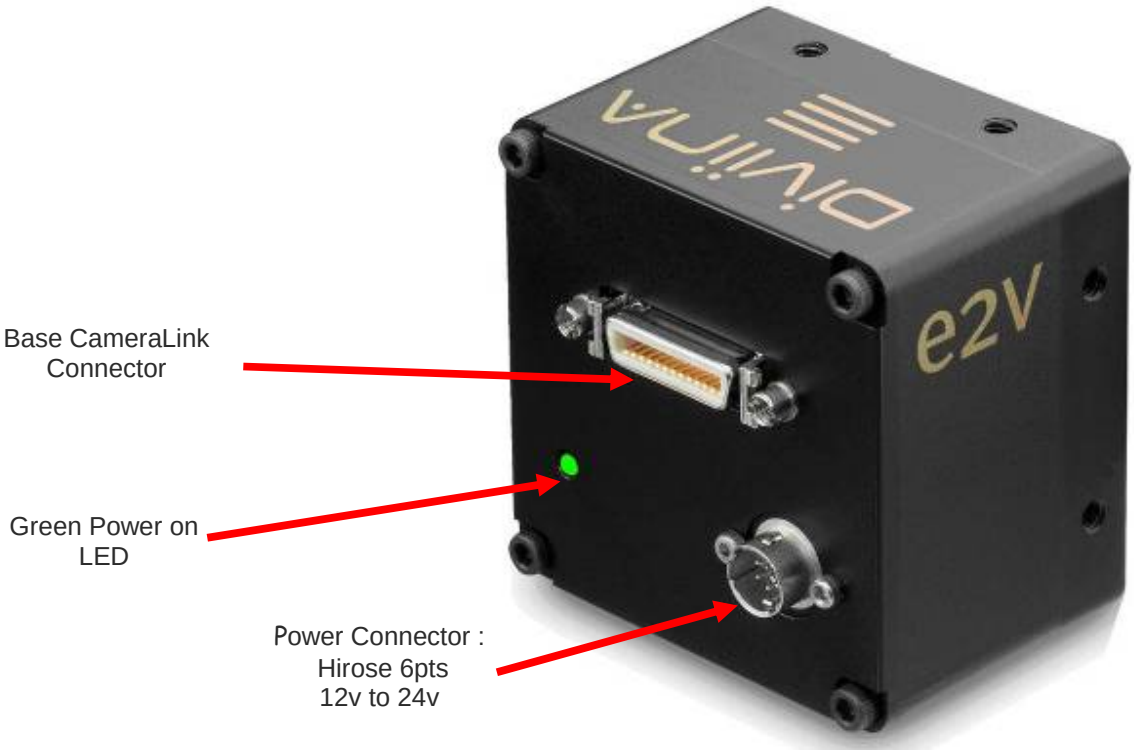




All dimensions in millimeters

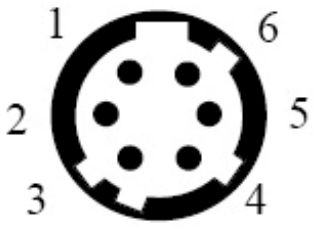
Sensor size (pixels #)	1024	2048	4096
x with 14µm sensor (mm)	20.83	13.66	-
x with 10µm sensor (mm)	22.88	17.76	7.52

3.2 Input/output Connectors and LED



3.2.1 Power Connector

Camera connector type: Hirose HR10A-7R-6PB (male)
Cable connector type: Hirose HR10A-7P-6S (female)



Camera side description

Signal	Pin	Signal	Pin
PWR	1	GND	4
PWR	2	GND	5
PWR	3	GND	6

Power supply from 12v to 24v

3.2.2 Camera Link Output Configuration

Port / Bit	Output data
Port A0	A0
Port A1	A1
Port A2	A2
Port A3	A3
Port A4	A4
Port A5	A5
Port A6	A6
Port A7	A7
Port B0	B0
Port B1	B1
Port B2	B2
Port B3	B3
Port B4	B4
Port B5	B5
Port B6	B6
Port B7	B7

4 STANDARD CONFORMITY

The DIVIINA cameras have been tested using the following equipment:

- A shielded power supply cable
- A Camera Link data transfer cable ref. 14B26-SZLB-500-OLC (3M)

e2v recommends using the same configuration to ensure the compliance with the following standards.

4.1 CE Conformity

The DIVIINA cameras comply with the requirements of the EMC (European) directive 89/336/CEE (EN 50081-2, EN 61000-6-2).

4.2 RoHs Conformity

DIVIINA cameras comply with the requirements of the RoHS directive

Warning: Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

5 GETTING STARTED

5.1 Out of the box

The contains of the Camera box is the following :

There is no CDROM delivered with the Camera : Both User Manual (this document) and CommCam control software have to be downloaded from the web site : This ensure you to have an up-to-date version.

*Main Camera page : **www.e2v.com/cameras***

On the appropriate Camera Page (EM2 or EM4) you'll find a download link first version of CommCam compliant is indicated in the last Chapter

CommCam download requires a login/password :

- *Login : **commcam***
- *Password : **chartreuse***

5.2 *Setting up in the system*

Vocabulary :

w = size of the sensor line (40,96mm for the 4k 10µm)

FOV = Field Of View (width of the web inspected by the sensor line) in mm.

L = Working distance (from the Lens to the Web) in mm.

f = focal distance of the lens in mm.

S = Speed of the web in mm/s

We have : $\frac{w}{FOV} = \frac{f}{L}$

The ratio M = w/FOV is called Magnification.

The FOV is grabbed by 4096 pixels in the width.

In order to get a ratio of 1 :1 in your image, at the web speed of S, your line rate has to be set :

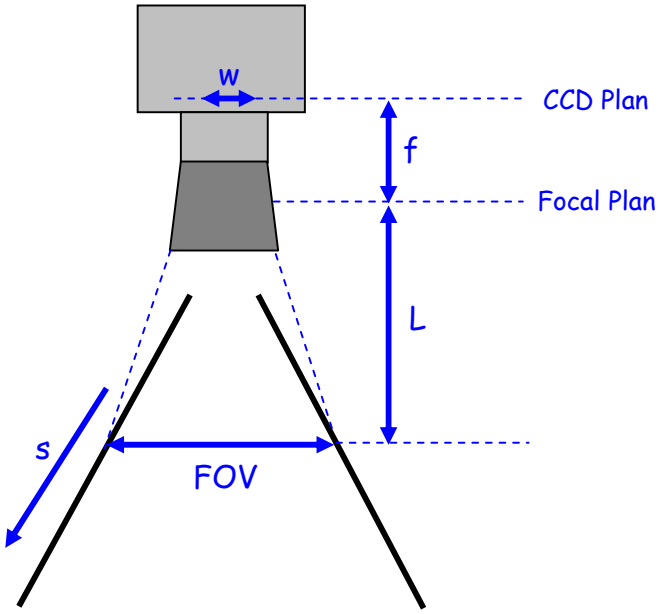
Line Rate = (S/FOV) x 4096

Ex : if the FOV = 11 cm (110mm) and the speed of the web is S= 0,3 m/s (300mm/s) the line rate will be :

Line Rate = (300 /110) x 4096 = 11170 Lines/s.

If you use a 60mm lens, the working distance will be : L = (60 x 110) / 40,96 = 161mm.

This will certainly require a macro lens.



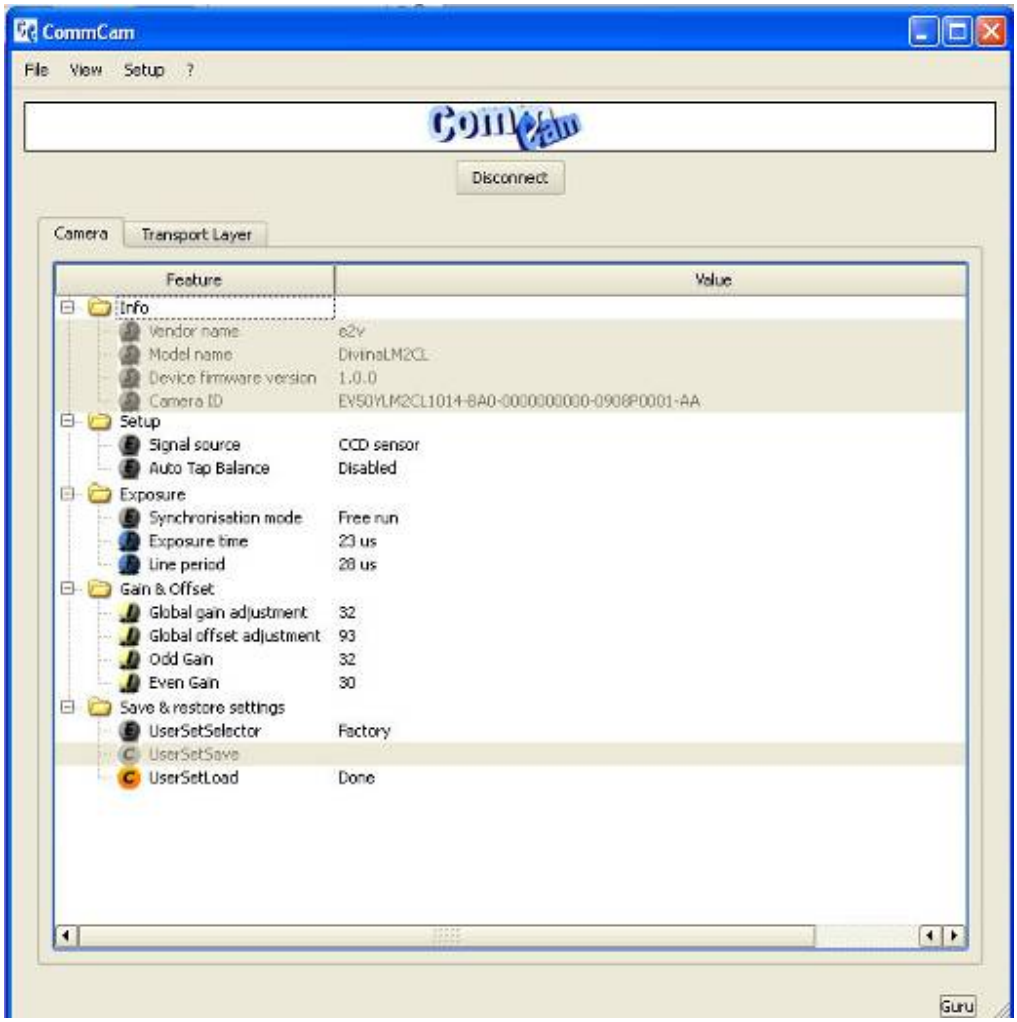
6 CAMERA SOFTWARE INTERFACE

6.1 Control and Interface

As all the e2v Cameras, the DIVIINA is delivered with the friendly interface control software COMMCAM.UCL (as "Ultimate Camera Link") which is based on the GenICam standard

COMMCAM recognizes and detects automatically all the UCL Cameras connected on any transport layers (Camera Link or COM ports) of your system.

Once connected to the Camera you have an easy access to all its features. The visibility of these features can be associated to three types of users: Beginner, Expert or Guru. Then you can make life easy for simple users.



6.2 *Serial Protocol and Command Format*

The Camera Link interface provides two LVDS signal pairs for communication between the camera and the frame grabber. This is an asynchronous serial communication based on RS-232 protocol.
The serial line configuration is:

- Full duplex/without handshaking
- 9600 bauds, 8-bit data, no parity bit, 1 stop bit.

6.2.1 Syntax

Internal camera configurations are activated by write or readout commands.
The command syntax for write operation is:
w <command_name> <command_parameters><CR>
The command syntax for readout operation is:
r <command_name><CR>

6.2.2 Command Processing

Each command received by the camera is processed:

- The setting is implemented (if valid)
- The camera returns ">"<return code><CR>

We recommend to wait for the camera return code before sending a new command.

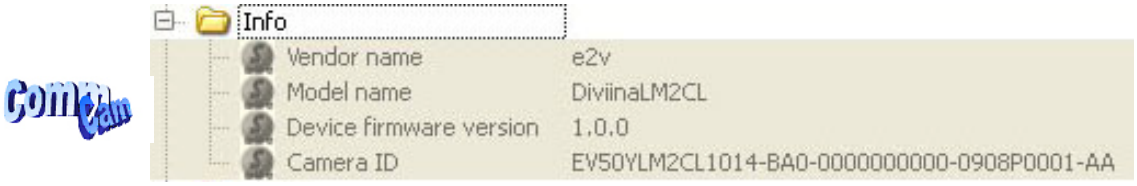
Table 5-1. Camera Returned Code

Returned code	meaning
>0	(or ">OK") : All right, the command will be implemented
>128	Command Error (Command not recognize or doesn't exist)
>129	Error: communication failure.
>130	Error: protocol failure.
>131	Error: parameters are out of range.
>132	Error: access failure.
>133	Error: access denied.
>134	Error: initialization failure.
>135	Error : Parameters conflict.

6.3 Camera Commands

6.3.1 Information

These values allow to identify the Camera. They can be accessed through the CommCam software in the "Info" section



All these values are fixed in factory except the Camera User ID which can be fixed by the Customer:

- **Vendor name** "e2v"
  - ⇨ Read function: "**r vdnm**";
    Return by the camera: "e2v" (string)
  - ⇨ Can not be written
- **Model Name:** Camera model name
  - ⇨ Read function: "**r mdnm**";
    return by the camera (string) : DiviinaLM2CL
  - ⇨ Can not be written
- **Camera ID :** part number, serial number of the Camera
  - ⇨ Read function : "**r idnb**";
    Return by the camera (string 50 bytes max) :
    ex : EV50YLM2CL1014-BA0-0000000000-0908P0001-AA
    with :
    - EV50YLM2CL1014-BA0 : Part number
    - 0000000000 : Batch number (not used for Cameras)
    - 0908P0001 : Serial number
      - "09" : Year of manufacturing
      - "08" : week in the year
      - "P" as Proto, "M" as Manual, "A" as automatic : type of testing
      - "0001" : Identification number
    - AA: Fab indice.
  - ⇨ Can not be written

- **Firmware Version :** Can be set by the Customer to identify the Camera
  - ⇨ Read function : "**r dfwv**";
    Return M.m.s :
    - M : Major version
    - m : minor version
    - S : sub-minor version.
  - ⇨ Can not be written

6.3.2 Setup

- **Signal source :** Defines if the data comes from the Sensor or the FPGA (test Pattern). This command is available in the CommCam "Setup" section :

⇨ Read function : "**r srce**";
Return by the camera: "0" if Source from the Sensor and "1" if test pattern active

⇨ Write function : "**w srce**" <value> :
- "0" to switch to CCD sensor image
- "1" to switch to Test Pattern.

The Test pattern is a single ramp. The test pattern is generated in the FPGA : It's used to point out any interface problem with the Frame Grabber.

The test pattern is a 8bit width pattern composed with several ramps from 0 to 255 all along the whole Camera definition. Then the number of ramps depends on the number of pixels of the Camera

Test patterns are detailed in Appendix A.

- **Auto Tap Balance :** Enables the Auto Tap balance. This command is available in the CommCam "Setup" section :

⇨ Read function : "**r abal**";
Return by the camera: "0" if Tap balance disabled and "1" if enabled

⇨ Write function : "**w abal**" <value> :
- "0" : Disable the auto Tap Balance
- "1" : Enable the Tap balance.

How works the Automatic Tap Balance ?

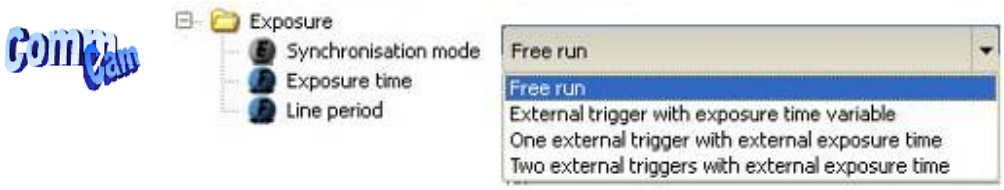
The Auto Tap Balance is a Laplace filter which is applied in the FPGA. It automatically solve any odd/even mismatch that can be visible in the image

- Whatever the action you may have on the Odd/even Tap Gains to increase the mismatch between the Taps, the filter will correct if enabled
- The filter has to be disabled if the inspection is done at **Nyquist** frequency : Then the tap balance has to be performed by using odd and even Tap Gains.

The Camera is delivered with the Auto Tap Balance enabled by default.

6.3.3 Exposure and Synchronization

- **Synchronisation Mode:** Timed or Triggered, it defines how the grabbing is synchronized. This command is available in the CommCam "Exposure" section :



  - ⇨ Read function : "**r sync**";
    Return by the camera:
    - 0 : Free Run or "Timed" mode
    - 1 : Ext Trig with Integration time set in the Camera
    - 2 : Ext ITC (Integration Time Controlled) : The same Trig signal defines the line period and its low level defines the integration time
    - 3 : Ext Trig with two trig signal : CC2 defines the start of the integration and CC1 defines the Stop of the integration.
  - ⇨ Write function : "**w sync**" **<value>**

Timing Specifications

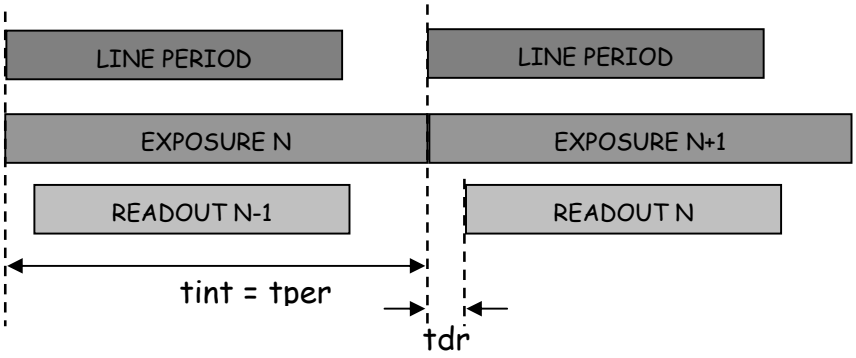
This table is for all the synchronization modes.

Label	Description	Value
td	CC1 rising to integration period start delay	350ns
tdr	Integration period stop to readout	1,8µs
th	CC1 hold time (pulse high duration)	1,1µs
td1	CC1/CC2 falling/rising to integration period start delay	350ns
td2	CC1/CC2 rising to integration period stop delay	1,3µs

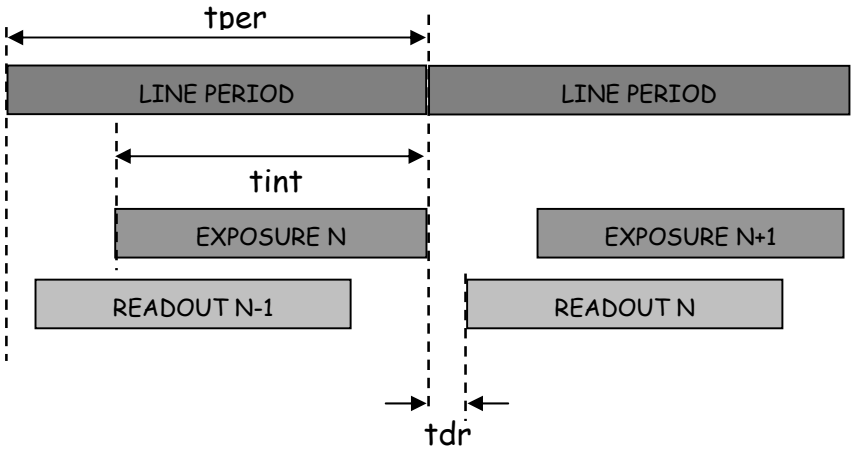
Exposure Mode Timed : Free Run

This mode doesn't require an external trigger.
In this case, the line period (Lp) can be defined in the Camera (see below) but the real line period of the camera depends also on the exposure time (tint) set:

- If tint > tper, the line period is equal to tint

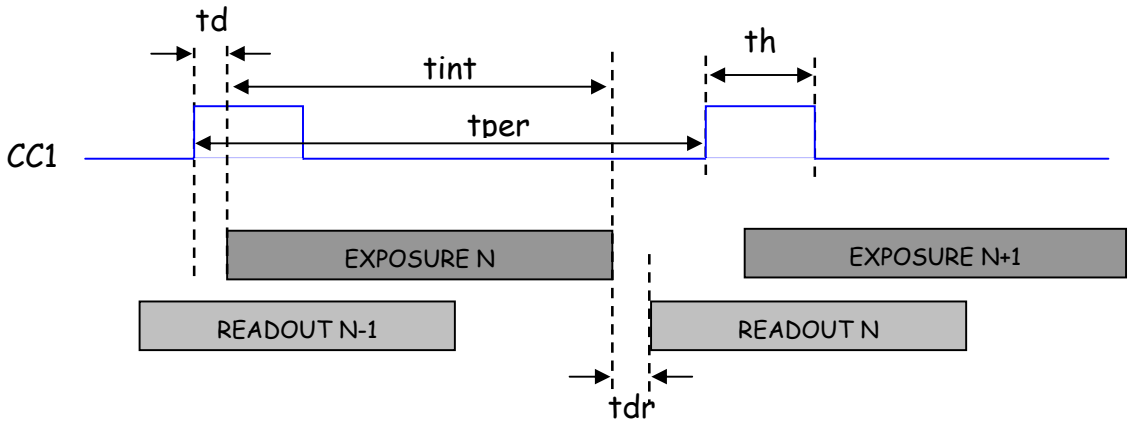


- If tper > tint, the line period is equal to tint



Ext Trig with integration time set in the camera

This mode requires an external trigger (via CC1) but the exposure time is the one defined in the Camera.

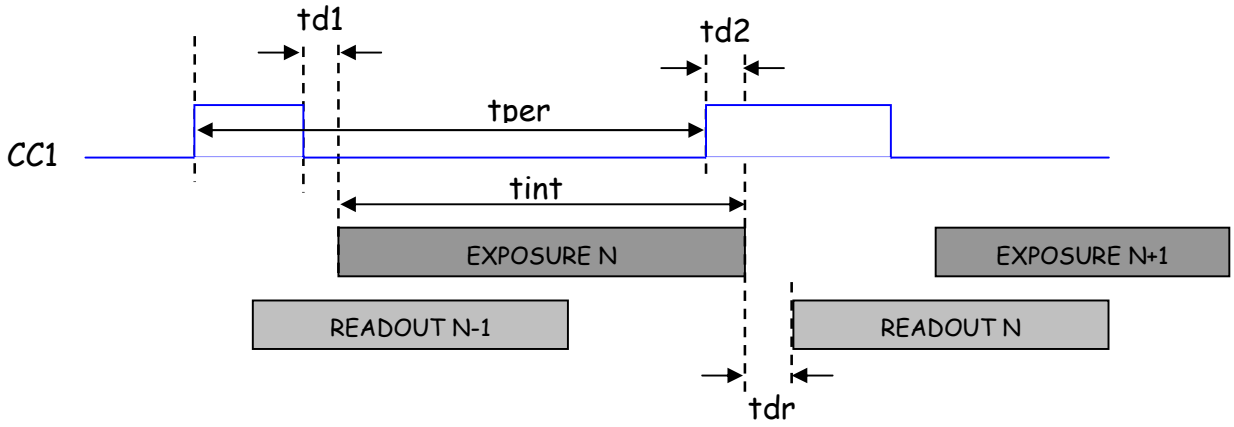


If the line period of the Trig signal provided to the camera is bigger than the exposure time set in the camera, the "short trig pulses" will be ignored : The exposure set in the camera defines the minimum line period possible.

Ext Trig with Integration Time Controlled (ITC) with one Trig

This mode requires an external trigger (via CC1). Both exposure time and line period are defined by this Trig signal :

- The exposure time during the low level of the Trig Signal
- The line period between two rising edges of the Trig Signal

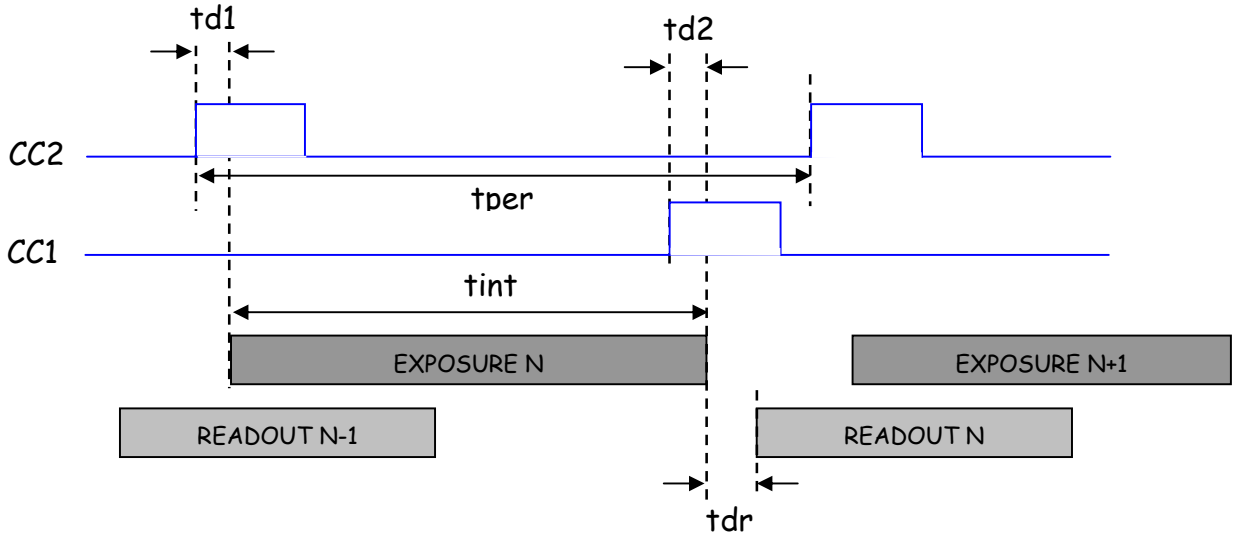


Ext Trig with Integration Time Controlled (ITC) with two Trigs

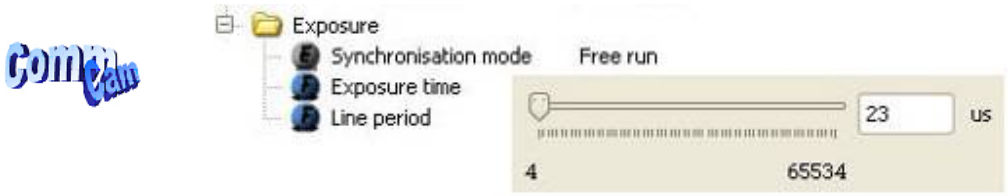
This mode requires two external triggers (via CC1 and CC2):

- CC2 controls the starting of the exposure time
- CC1 controls the end of the exposure time.

The line period is defined by the one of the CC2 Trig signal.



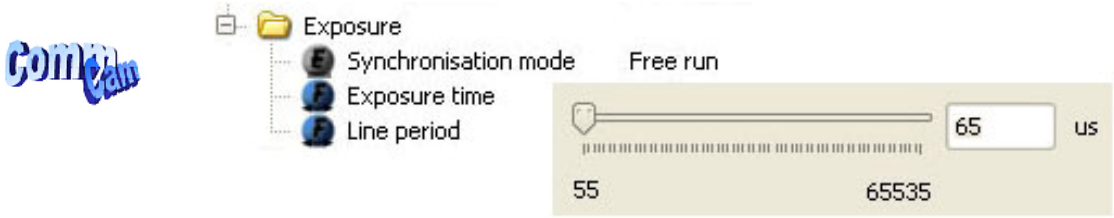
- **Exposure time:** Defines the integration time when set in the Camera. This command is available in the CommCam "Exposure" section :



⇨ Read function : "**r tint**";
Return by the camera : Integer from 4 to 65534µs (by step of 1µs)
⇨ Write function : "**w tint**" <value> ;

This value of integration time is taken in account only when the synchronisation mode is "free run" (0) or "Ext Trig with Integration time set" (1). Otherwise it's ignored.

- **Line Period:** Defines the Line Period of the Camera in Timed mode. This command is available in the CommCam "Exposure" section :



⇨ Read function : "**r tper**";
Return by the camera : Integer from *Tpermin* to 65535 (by step of 1µs)
Tpermin depends on the number of pixels on the sensor :
  - 28µs for the 1K Pixels cameras (35,714kHz)
  - 55µs for the 2K pixels cameras (18,182kHz)
  - 105µs for the 4k pixels cameras (9,523 kHz)

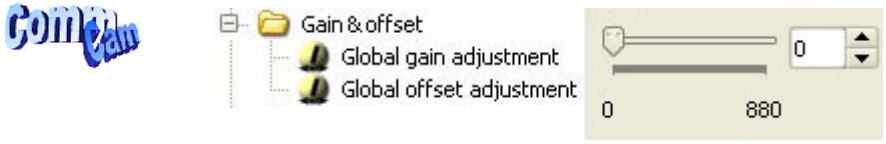
⇨ Write function : "**w tper**" <value> ;

The Tper min value is not displayed in CommCam for each camera but any attempt to set to a lower value then this will be refused by the camera.

In the same way, it's impossible to set the line period at a lower value than the exposure time. Note that if the exposure time is increased and set at a lower value than the line period, this last one will be automatically adjusted at the value of the exposure time : This modification won't appear in CommCam without disconnect/reconnect

6.3.4 Gain and Offset

- **Analog Global Gain:** Set the Amplification Gain. This command is available in the CommCam "Gain & Offset" section :



The Value set is also copied in the both odd and even Gains.

⇨ Read function : "**r gain**";
Return by the camera: Value from 0 to 880 corresponding to a Gain range of 0 to 31dB by step of 0,0351dB

⇨ Write function : "**w gain**" <int> ;

- **Analog odd/even Gains per Tap:** A separate command for each sensor is also available for each sensor Tap. These commands are available in the CommCam "Gain & Offset" section :

Gains Management and Auto Tap Balance

The Global Gain is a "virtual" global command which affects both Odd and Even Gains in the same time. Each value set in the Global Gain erases Odd and Even Gain values.
This gain has to be used when the Auto Tap balance is activated as a "friendly" mode to set quickly the gain level in the Camera without taking care of the Tap balance which is automatically done by the Laplace filter.

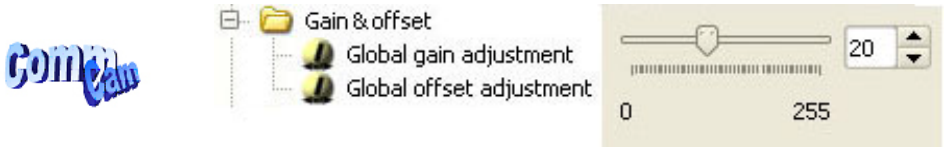
- The Value set for the Global Gain is copied in both Odd and Even Gains
- The value set for the Odd Gain is copied in the Global Gain value
- Whatever the action you may have on the Odd/even Tap Gains to increase the mismatch between the Taps, the filter will correct if enabled. But an individual action on the Odd Gain will increase the global gain in the same way.
- In CommCam the odd/gains Values are not refreshed after the setting of the Global gain command : You have to refresh them individually with a right click on the value.

- **Analog odd Gain:** Set the Amplification Gain on the odd Tap
The value set also copied in the Analog Global Gain parameter.

⇨ Read function : "**r fga1**";
Return by the camera: Value from 0 to 880 corresponding to a Gain range of 0 to 31dB by step of 0,0351dB
⇨ Write function : "**w fga1**" <int> ;

- **Analog even Gain:** Set the Amplification Gain on the even Tap.
  ⇨ Read function : "**r fga2**";
  Return by the camera: Value from 0 to 880 corresponding to a Gain range of 0 to 31dB by step of 0,0351dB
  ⇨ Write function : "**w fga2**" <int> ;

- **Analog Offset:** Set the global Offset. This command is available in the CommCam "Gain & Offset" section :



⇨ Read function : "**r offs**";
Returned by the camera : Value from 0 to 255 which is equivalent to 16 LSB by steps of 0,063 LSB (8 bits)
⇨ Write function : "**w offs**" <int> ;

6.3.5 Save & Restore Settings

The settings of the Camera can be saved in one User bank.
The Factory default settings can be load from its dedicated memory bank.

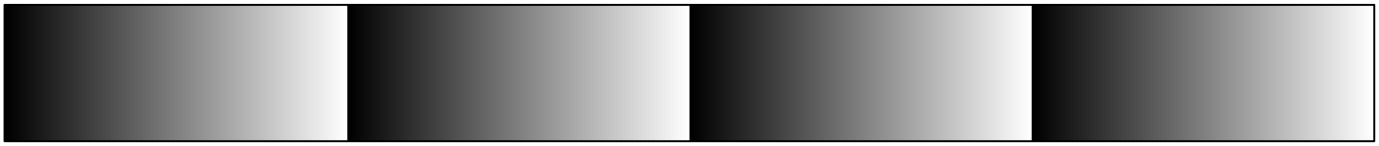
- **Save & restore settings :** Allows to save or restore all the Camera settings : This command is available in the CommCam "Save & Restore Settings" section :

⇨ Write function
  - "**w lcfg 0**" : Load settings from the Factory default settings
  - "**w lcfg 1**" : Load settings from the User Bank
  - "**w scfg 1**" : Save the current settings in the User bank

7 APPENDIX A: Test Patterns

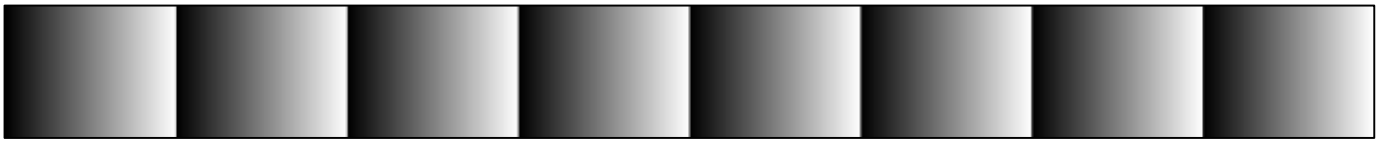
7.1 1024 Pixels Camera

The test pattern is composed of 4 successive ramps from 0 to 255 LSB gray values :



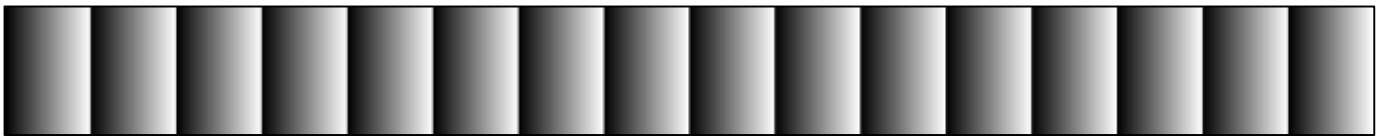
7.2 2048 Pixels Camera

The test pattern is composed of 8 successive ramps from 0 to 255 LSB gray values :



7.3 4096 Pixels Camera

The test pattern is composed of 16 successive ramps from 0 to 255 LSB gray values :

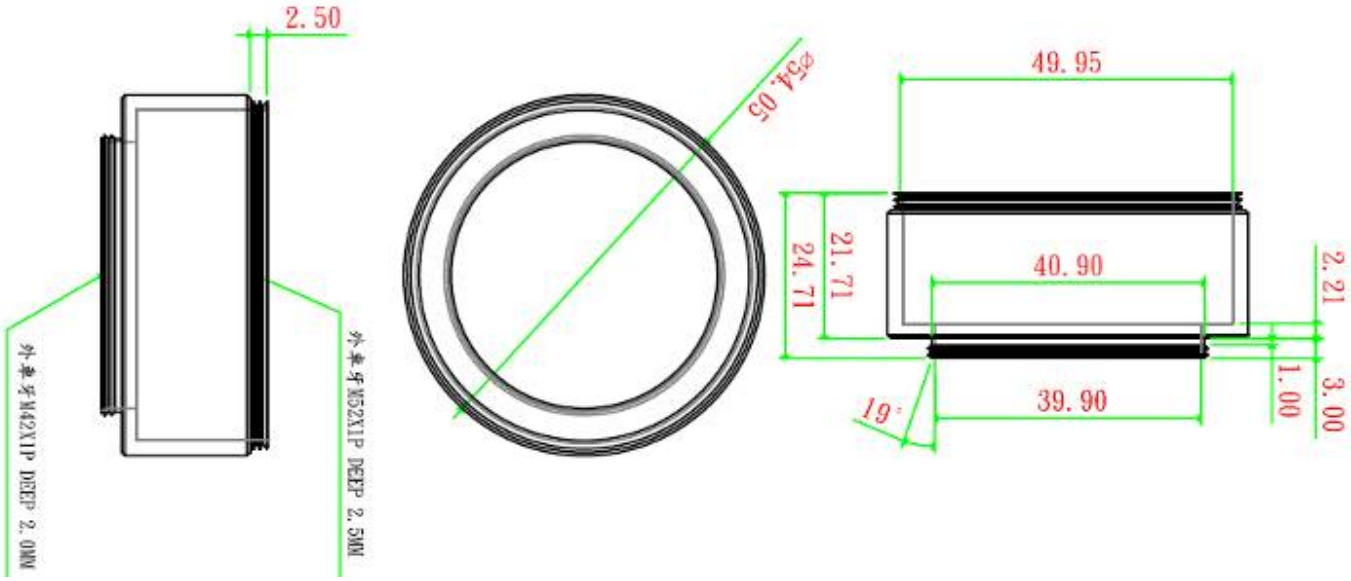


8 APPENDIX B: Optical Mounts available

8.1 F-Mount

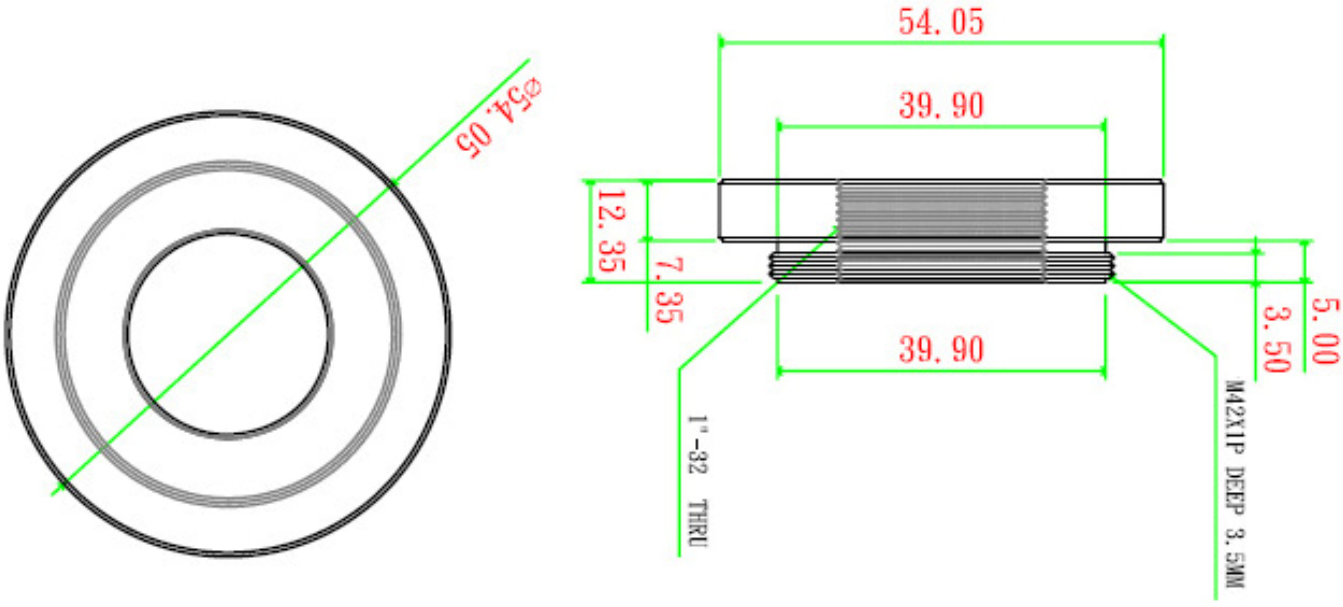
F Mount: (Part number EV50-MOUNT-F)

Drawing for the additional part (except Nikon BR3) :



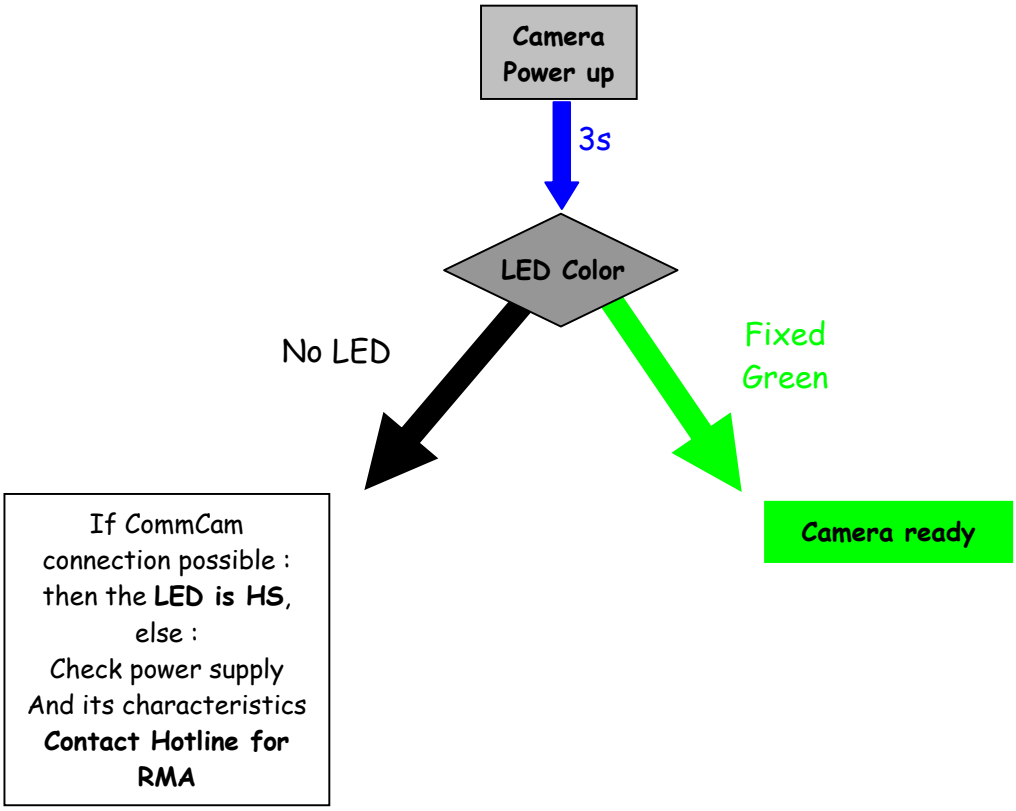
8.2 C-Mount

C Mount : (Part number EV50-MOUNT-C)



9 APPENDIX C : TROUBLESHOOTING

9.1 Camera



9.2 CommCam Connection

Defect	Detail	Solutions
CommCam Can't find the Camera : After launching CommCam, the Icon of the Camera is not visible.		• The Camera is not powered up or the boot sequence is not finished. • The CameraLink cable is not connected or connected on the bad connector. • Check if the CameraLink libraries (clallserial.dll and clserXXX.dll) are in the same directory (either *system32* or *program files/cameralink/serial*) • The Frame Grabber is compliant with CameraLink standard 1.1 ➢ Contact the hotline : hotline-cam@e2v.com
An e2v Camera is detected but not identified : A "question Mark" icon appears in place of the one of the AVIIVA2		• The version of CommCam used is too old : You have to use the version **1.2.x** and after.
Impossible to connect to the identified Camera : The message "Impossible to open device" is displayed		• There is a possible mismatch between the major version of xml file used by CommCam and the firmware version of the Camera • Possible Hardware error or Camera disconnected after being listed. ➢ Contact the hotline : hotline-cam@e2v.com
Error message is displayed just after the connection :		• There is a possible mismatch between the minor version of xml file used by CommCam and the firmware version of the Camera • Default values of the Camera out of range ➢ Contact the hotline : hotline-cam@e2v.com

10 APPENDIX D : Command Summary

10.1 Information

Title	Command	Features
VendorName	r vdnm	Get camera vendor name Return string e2v
ModelName	r mdnm	Get camera model name Return string
Camera ID	r idnb	Get camera ID. Return <idstr> Max 50 bytes
Firmware version	r dfwv	Get the camera software version Return M.m.s as : • M : Major version • m : minor version • S : sub-minor version.

10.2 Signal Source

Title	Command	Features
Signal Source	w srce 0	Set signal source to CCD sensor
	w srce 1	Set signal source to test pattern
	r srce	Get current signal source
Auto Tap Balance	w abal 0	Disable the Auto Tap balance
	w abal 1	Enable the Auto Tap balance
	r abal	Get current auto balance status

10.3 Exposure & Synchronisation

Title	Command	Features
Synchronisation Mode	w sync 0	Set free run mode, with integration time and line period programmable
	w sync 1	Set line period synchronisation with integration time programmable
	w sync 2	Set line period synchronisation (start and period) and integration time controlled by 1 signal (ITC)
	w sync 3	Set line period synchronisation (start and period) and integration time controlled by 2 signals
	r sync	Get current synchronisation mode

Title	Command	Features
Integration time	w tint <val>	Set integration time to <val> in µs, from 1 to 65535
	r tint	Get current integration time
Line Period	w tper <val>	Set line period to <val> in µs, from *Tpermin* to 65535 If tint > tper, tper is set to tint
	r tper	Get current line period

10.4 Gains & Offset

Title	Command	Features
Gain (global command)	w gain <val>	Set the global gain form 0dB (0) to 31dB (880) step of 0.0351dB. Affects both odd and even Tap gains
	r gain	Get current global gain
Gain Odd Tap	w fga1 <val>	Set gain of the odd tap from 0dB (0) to 31dB (880) by step of 0,0351dB
	r fga1	Get gain of the odd tap
Gain Even Tap	w fga2 <val>	Set gain of the even tap from 0dB (0) to 31dB (880) by step of 0,0351dB
	r fga2	Get gain of the even tap
Offset	w offs <val>	Set global offset from 0 LSB (0) to 16 LSB in 8bits (255)
	r offs	Get global offset

10.5 Save & Restore settings

Title	Command	Features
Save & Restore	w lcfg 0	Load current configuration from factory bank
	w lcfg 1	Load current configuration from User bank
	w scfg 1	Save current configuration into User bank

11 APPENDIX E: Revision History

Doc. Revision	Comments / Details	Camera Ref	CommCam
Rev A	Preliminary release	Firmware 1.0.0	1.1.14.x
Rev B	Synchronization modes Pattern test	Firmware 1.0.1 (rev A)	1.1.16.x
Rev C	Enable/Disable Auto-Tap Balance GainTap1/GainTap2 Relook documentation	Firmware 1.1.0 (rev B)	1.2.4.x
Rev D	Gain range change for 0-880 Increase response from 5dB	Firmware 2.0.0 (rev C)	1.2.6.x
Rev E	Drawings complements	Firmware 2.0.0 (rev C)	1.2.6.x
Rev F	Mounts Drawing corrections	Firmware 3.0.0 (rev C)	1.2.7.x
Rev G	"Out of the Box" chapter	Firmware 3.0.0 (rev C)	1.2.7.x

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