Ref.: 24489-800-DU004-I

Interface Control Document

CAMSIGHT LS

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LIST OF REVISIONS

Rev.	Date	Modifications (main reasons, sections and pages affected)	Writer / Checker
A	04/04/2022	First issue	MVi/DOR
B	21/04/2023	Mechanical plans are updated with top up. Mavlink parameters are memorized.	MVI/DOR
C	02/06/2023	Companion description	NGE/DOR
D	12/12/2023	Add Colorlut Update Zoom output resolution Add MAVLINK messages ID 12338 to 12361 Modify column and vignetting correction pictures Pleora NTX GIGE parameters added Add sensor temperature message	MVI / DOR
E	02/29/2024	Correction on serial link voltage on J3 Correction on edge level of parallel output chronogram Update of companion screens Add USB Correct chronogram for parallel video Add AHC gain limitation Add AHC speed temporal filter Update §9 with last update software	MVI / LDe
F	14/05/2024	Dedicated to version 2.2.0. Add PCLK frequencies and pixel delivering previsions in §5.1.1 Add MIPI configuration in §5.1.4 Add §8 I2C interface	MVI / SGE
G	13/02/2025	Minor orthograph and grammar corrections Paragraphs disappeared for Set Gamma Some Get Commands were noted as Set Commands (Get AHC gain limitation, Get LUT temporal filter, Get camera temperature et Get camera information) Get Serial Number: the message returned by the camera has a LEN of 1, not 4. Deleted MIPI information from power board and added MIPI FFC connector board §3.4 : Modification of max voltage to 5.5V / add ESD protection warning / add USB C orientation warning USB power supply removed from §3.8.2 and add to §3.8.3 §5.1.5 : add USB orientation warning §8.2.2.30 : Change output selection and 9Hz selection in “RESERVED (DO NOT USE)”	MVI / NGE

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H	04/04/2025	Added GigE Vision interface §2.6. Optional GigE Vision Interface §3.2.1. Connectors and pinouts suppressed §3.6. GigE Vision Interface board §3.8.4. GigE Vision §5.1.6. Pleora NTX GIGE output §6. PLEORA INTERFACE CONFIGURATION	NGE
I	10/09/2025	Added OEM shutter §2.1.2 OEM shutter Update MIPI Board interface §2.7 Optional MIPI interface board §3.5 MIPI interface board	RRI/JRA

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1. INTRODUCTION

1.1. Purpose of the ICD

This Interface Control Document (ICD) provides detailed information about the electrical and interface for the CamSight LS camera. The purpose of this document is to provide guidance for integrating the camera into other video equipment and systems, by describing the camera's powering requirements, interfaces, and connectors pinouts.

This document is intended for use by engineers and technicians who are responsible for integrating the camera into their systems. It assumes a basic understanding of video signal processing, electrical engineering, and communication protocols. This document should be used as a general guide, and any specific requirements or questions should be addressed to Bertin Technologies.

1.2. Overview of the CamSight LS camera

The CamSight LS is an original equipment manufacturer (OEM) digital core camera developed by Bertin Photonics. It has been designed to meet the needs of users who require a low SWaP camera that can be easily integrated within optronic systems. This uncooled microbolometer infrared camera features a LYNRED ATTO640D-02 sensor with a resolution of 640x480 pixels and a pixel pitch of 12 microns. Based on a patented Bertin Photonics' shutterless technology, it allows for low latency and freeze-free image delivery in real time, making it suitable for a wide range of applications. Available framerates are 9/25/30/60Hz and camera support parallel, SD-SDI and MIPI CSI-2 video output. A progressive PAL output is available on the OEM+ version of the camera.

Figure 1: CamSight LS with casing

Three versions of the CamSight LS are available:

- CamSight LS OEM version is the main core of the camera. It features a circular Hirose output connector, which allows for easy connectivity with other systems. This version supports parallel, SD-SDI, or MIPI CSI-2 video output, with frame rates of 9, 25, 30, or 60Hz. This versatility in video output options allows the camera to be easily integrated into a wide range of optronic systems.
- An optional Interface board can provide additional connectivity options and allows for easier integration with existing systems. One of the key features of this board is the capability to generate progressive PAL video. Another important feature is the different connectors that enable easy interfacing with the OEM.
- An optional Connector board and Casing provide additional protection from external elements. The output connector allows the camera to connect directly to a power supply and a SD-SDI monitor.
- An optional USB driver board offers connectivity support for both USB 2.1 and 3.2. A second additional board provides access to a USB-C port.

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2. MECHANICAL INTERFACES

Mechanical step files are available, please contact Bertin Technologies if needed.

2.1. CamSight LS OEM

2.1.1. Standard OEM

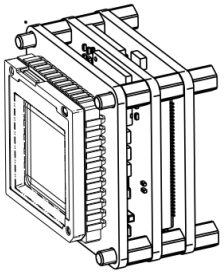

Figure 2: CamSight LS OEM

The OEM version of the CamSight LS camera requires mechanical support to maintain the lens and hide the parasitic infrared light. Mechanical support is necessary to ensure proper alignment of the lens and to reduce the impact of parasitic infrared light on the image quality. Several lenses and support are available. The board stack weight is 9g.

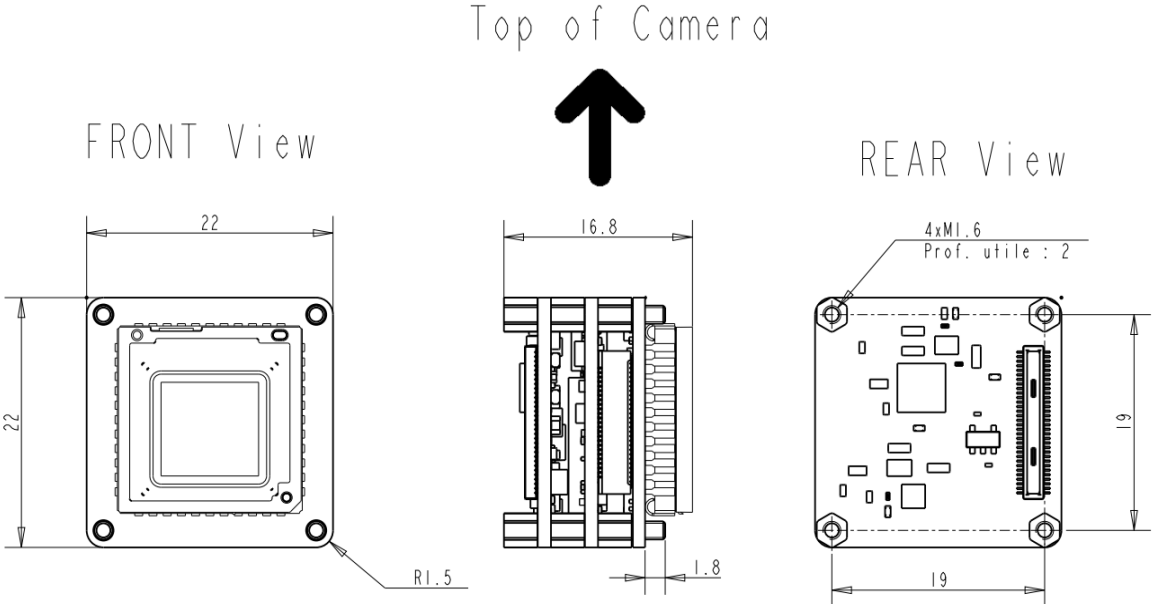

Figure 3: CamSight LS OEM mechanical blueprint

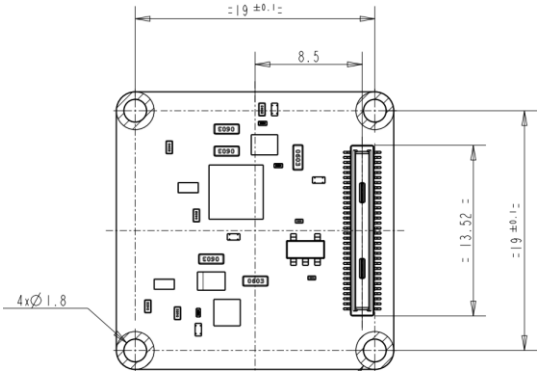

Figure 4: CamSight LS OEM back board

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2.1.2. OEM shutter

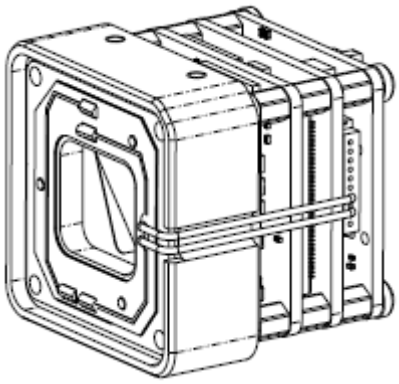

Figure 5: CamSight LS OEM shutter

The OEM shutter version of the CamSight LS camera requires mechanical support to maintain the lens and hide the parasitic infrared light. Mechanical support is necessary to ensure proper alignment of the lens and to reduce the impact of parasitic infrared light on the image quality. Several lenses and support are available. The board stack weight is 25g.

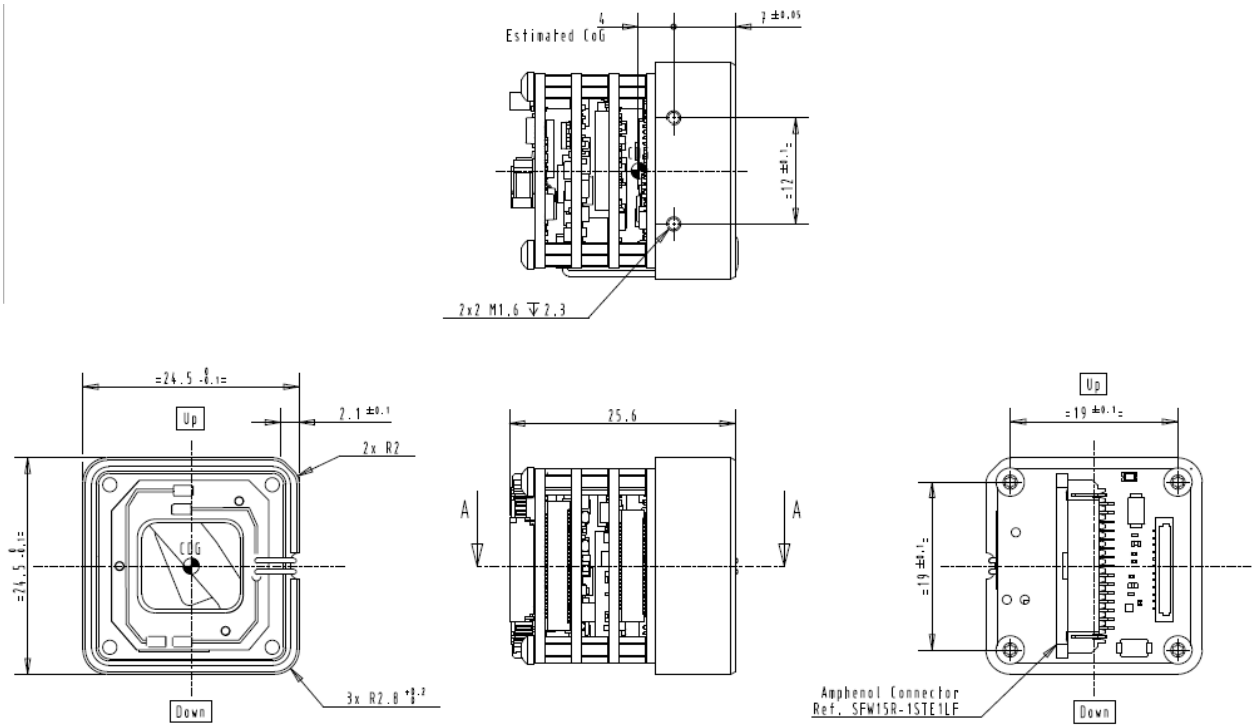

Figure 6: CamSight LS OEM shutter mechanical blueprint

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2.2. Optional Interface board

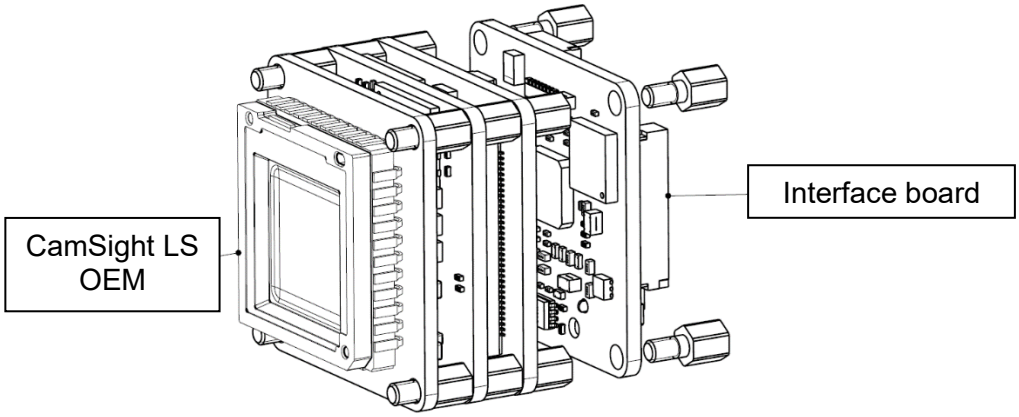

Figure 7: CamSight LS OEM + interface plan

The CamSight LS OEM + Interface is composed of the OEM camera and an interface board.
Dimensions: 22 x 22 x 21.65 mm.
Weight: 12g (boards only)

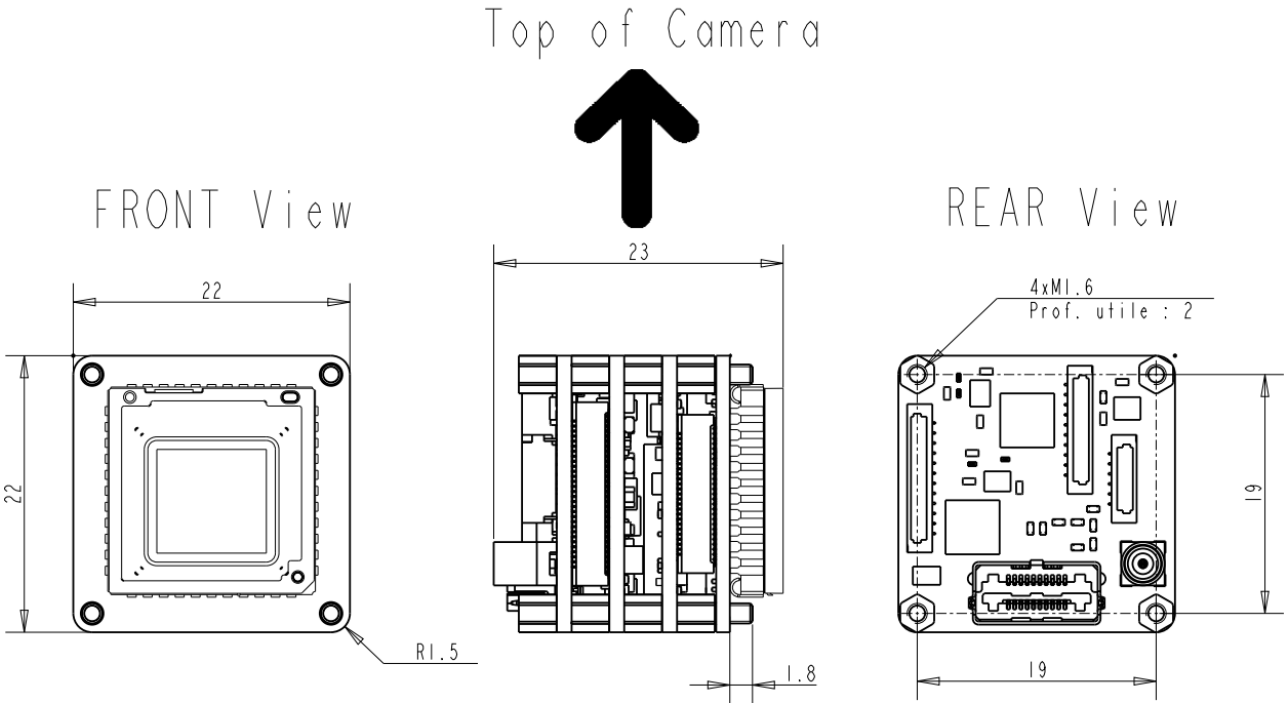

Figure 8: CamSight LS OEM+

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2.3. Optional Connector board and Casing

The CamSighT LS Casing version is composed of:

- The OEM camera
- A connector board
- A mechanical casing

Dimensions: 24 x 24 x 38 mm

Weight: 30g

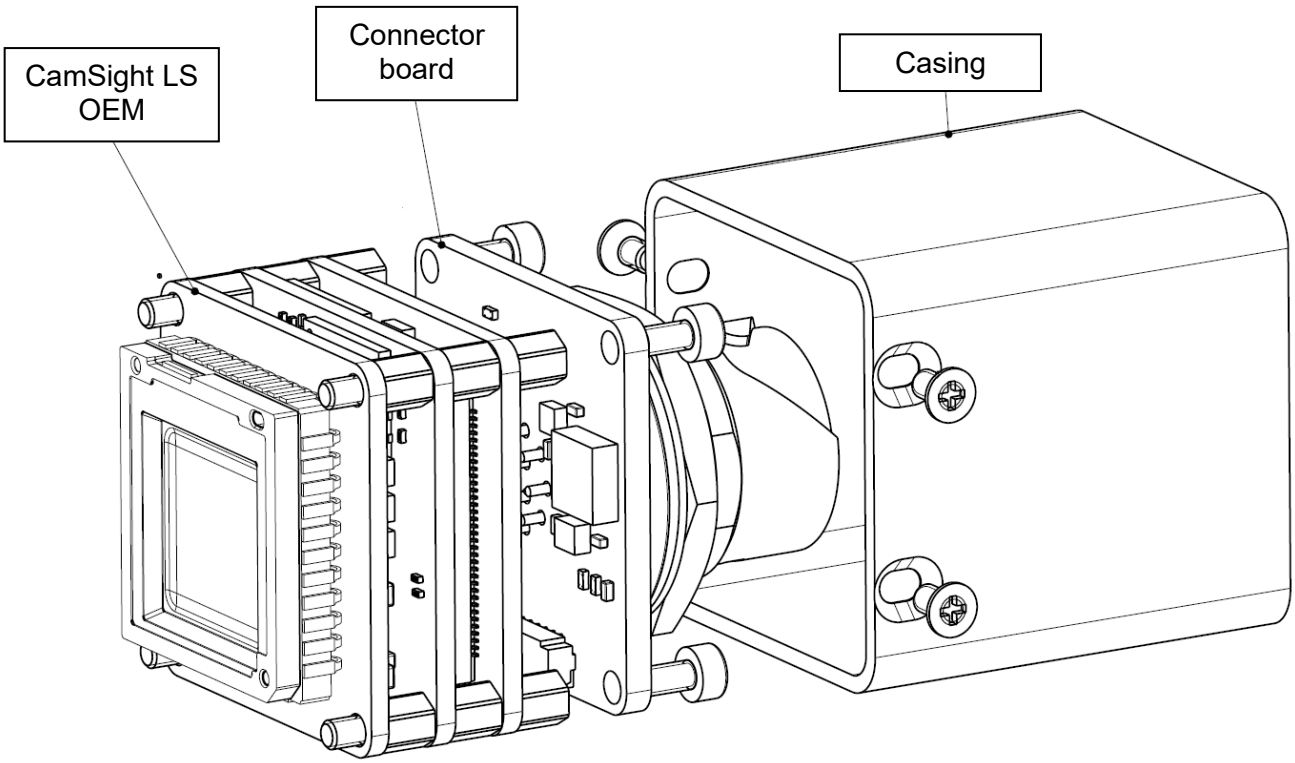

Figure 9: CamSight LS Casing version plan

Figure 10: CamSight LS Casing version (with and without lens)

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2.4. Optional USB driver board

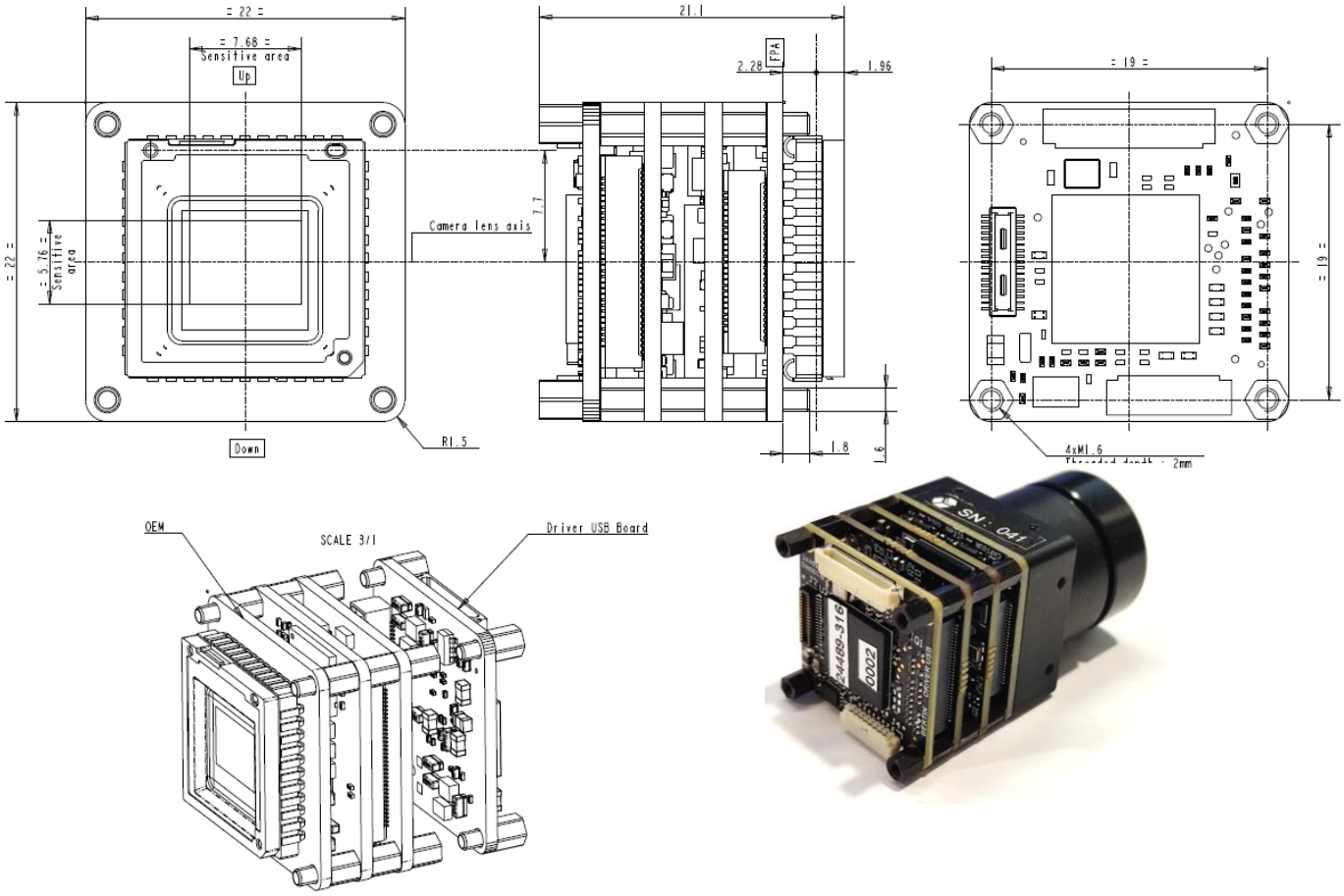

Figure 11: Blueprint CamSight LS OEM + USB driver board

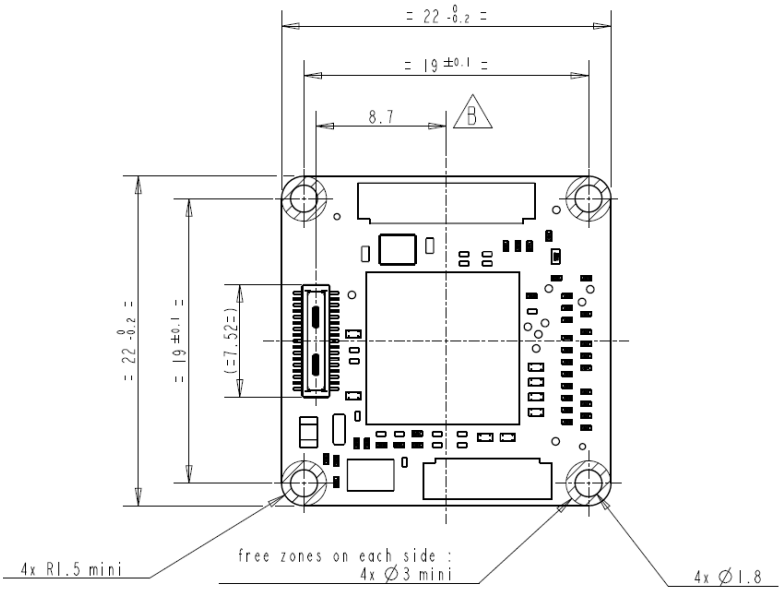

Figure 12: USB driver board

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2.5. Optional USB connector board (USB-C)

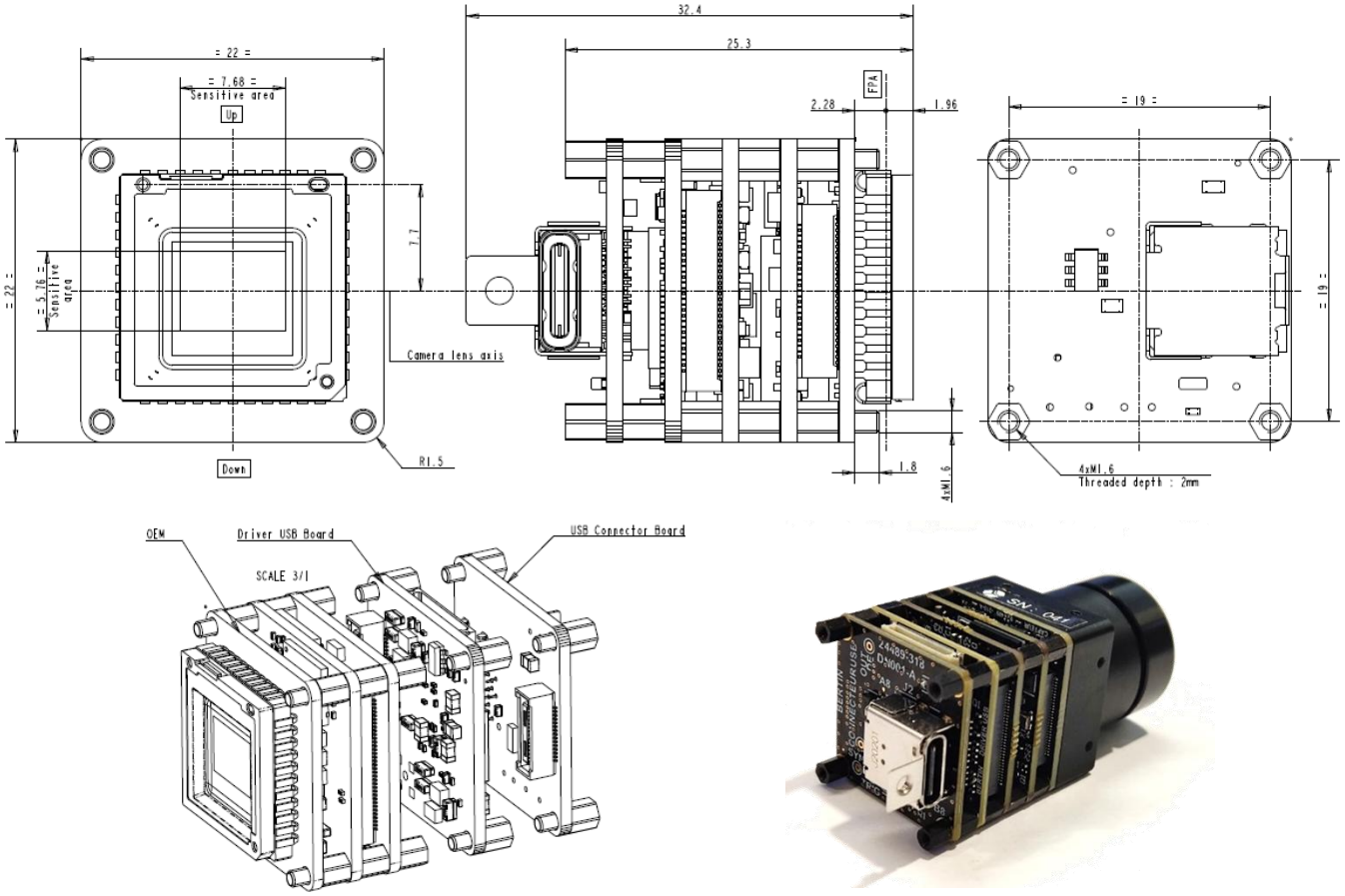

Figure 13: Blueprint CamSight LS OEM + USB driver board + USB connector (USB-C)

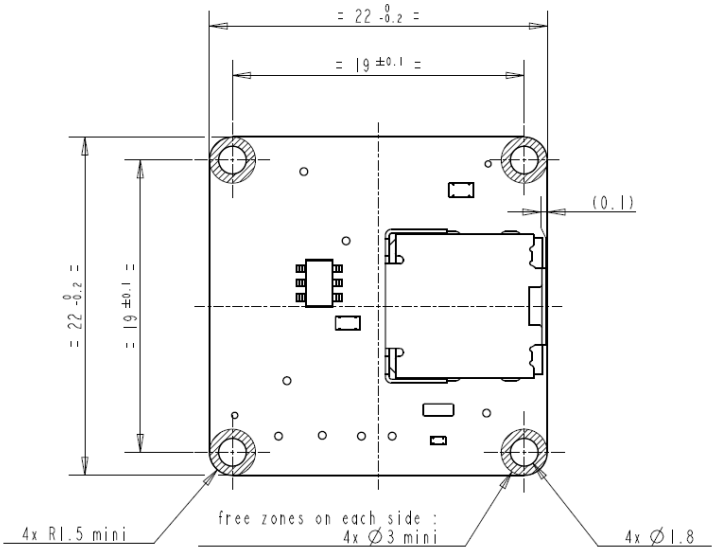

Figure 14: USB connector board

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2.6. Optional GigE Vision Interface

The GigE Vision interface is made of:

- a GigE interface board,
- an NTX board composed of 2 boards
    - a processing board
    - an Ethernet board
- an optional flat flexible connector (recommended) between the two boards to remove NTX board from camera in order to avoid heat emission from NTX board on the sensor.

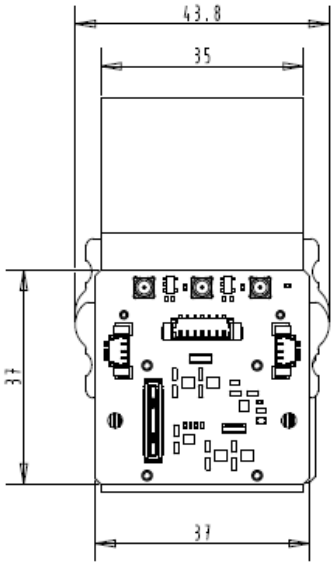

Figure 15: GigE interface board + FFC

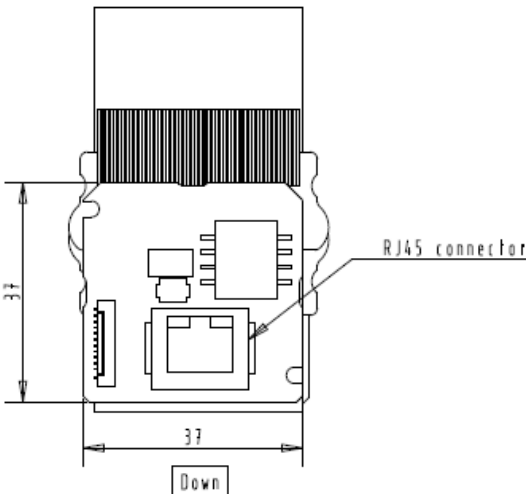

Figure 16: NTX board + FFC

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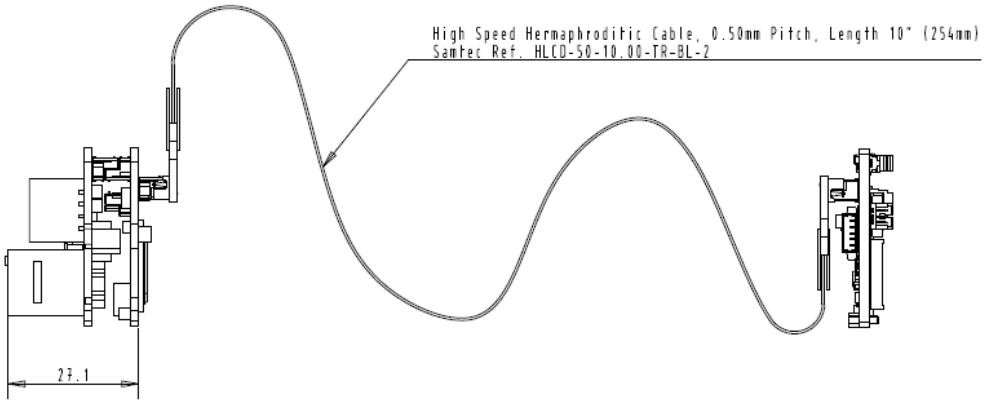

Figure 17: Global GigE Vision Interface side view

Figure 18: Global GigE Vision Interface top view

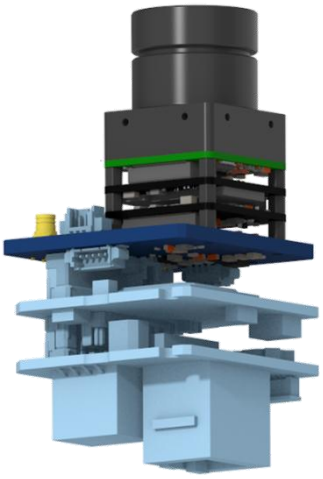

Figure 19: CamSight LS + GigE Interface board (dark blue) + NTX board (light blue)

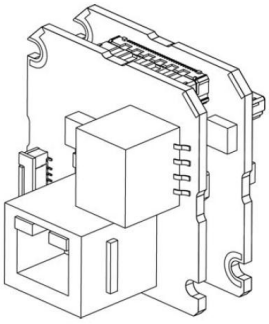

Figure 20: NTX board 3D view

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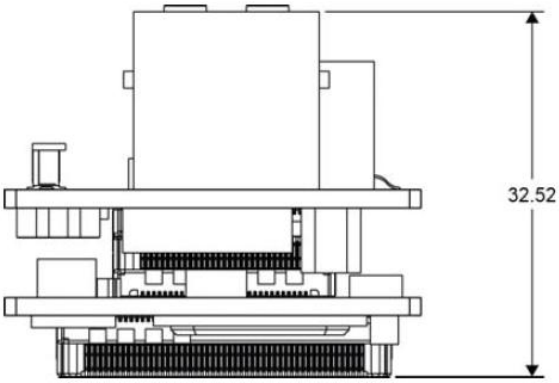

Figure 21: NTX board side view

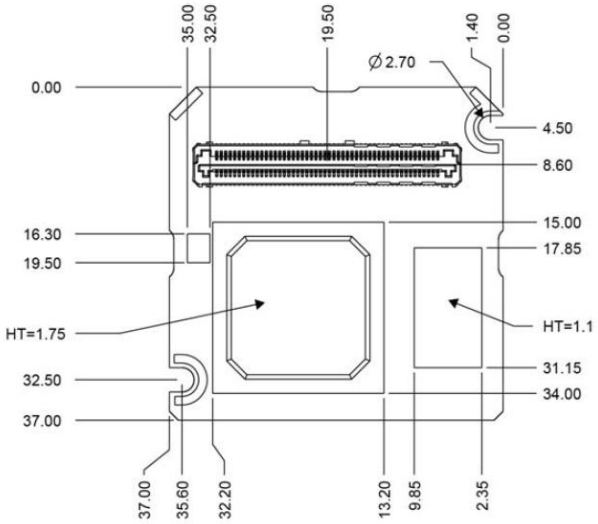

Figure 22: NTX processing board

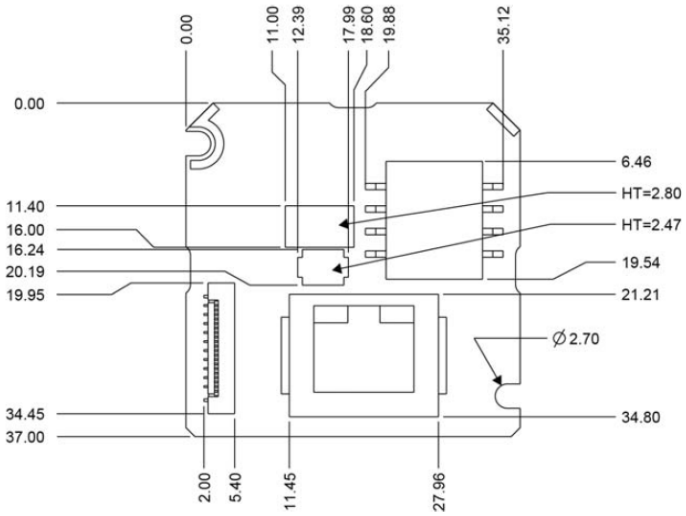

Figure 23: NTX Ethernet board

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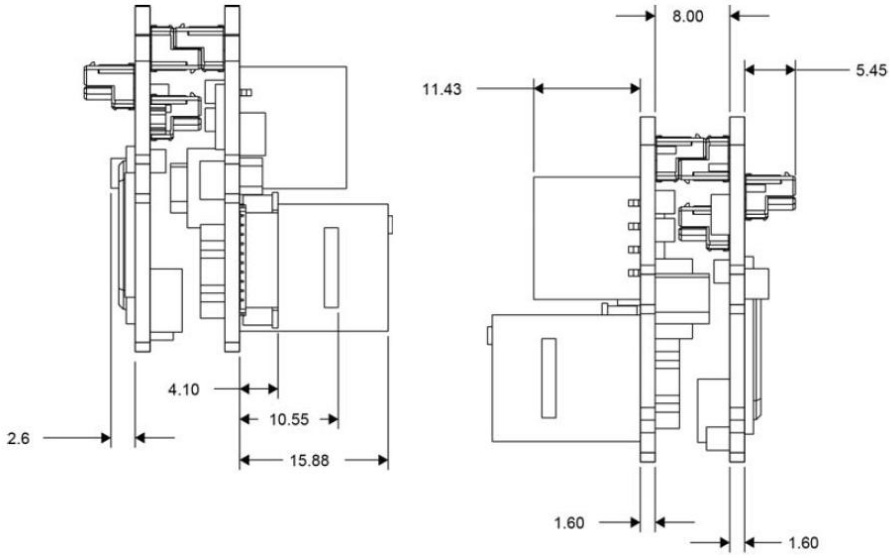

Figure 24: NTX side view

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2.7. Optional MIPI interface board

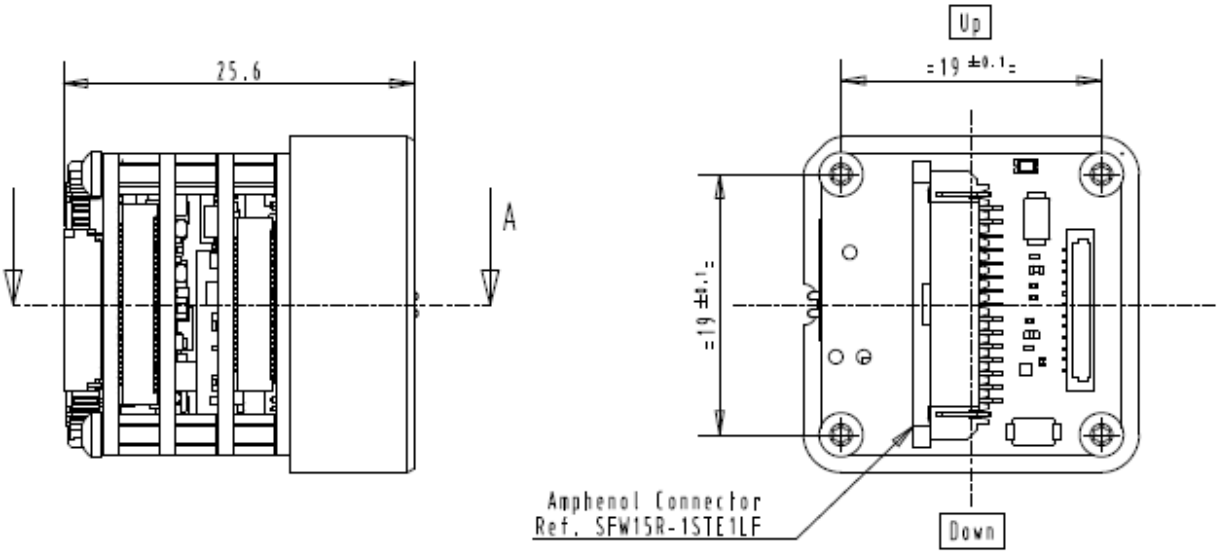

Figure 25: MIPI interface board

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3. ELECTRICAL INTERFACE

3.1. OEM version

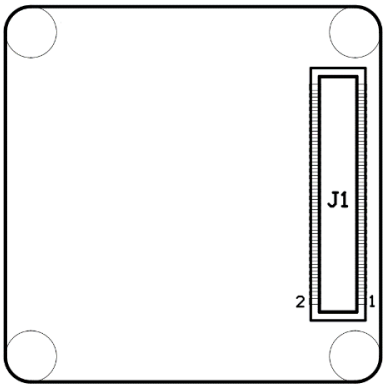

Figure 26: OEM backboard plan

24489-312-J1 (DF40C-60DP-0.4V(51))									
Description	Signal name	Level	I/O	Pin	Pin	I/O	Level	Signal name	Description
Parallel video data	VIDEO_OUT_D0	LVCMOS18	O	1	2	O	SDI level	SD-SDI	SD-SDI video output
Parallel video data	VIDEO_OUT_D1	LVCMOS18	O	3	4	P		GND	
Parallel video data	VIDEO_OUT_D2	LVCMOS18	O	5	6	-		Reserved	Do not connect
Parallel video data	VIDEO_OUT_D3	LVCMOS18	O	7	8	-		Reserved	Do not connect
Parallel video data	VIDEO_OUT_D4	LVCMOS18	O	9	10	P		GND	
Parallel video data	VIDEO_OUT_D5	LVCMOS18	O	11	12	-		Reserved	Do not connect
Parallel video data	VIDEO_OUT_D6	LVCMOS18	O	13	14	-		Reserved	Do not connect
Parallel video data	VIDEO_OUT_D7	LVCMOS18	O	15	16	P		GND	
	GND		P	17	18	I	LVCMOS18	UART0_RX CAM	Serial data receive to cam
Parallel video data	VIDEO_OUT_D8	LVCMOS18	O	19	20	O	LVCMOS18	UART0_TX CAM	Serial data transmit from cam
Parallel video data	VIDEO_OUT_D9	LVCMOS18	O	21	22	-		Reserved	Do not connect
Parallel video data	VIDEO_OUT_D10	LVCMOS18	O	23	24	-		Reserved	Do not connect
Parallel video data	VIDEO_OUT_D11	LVCMOS18	O	25	26	P		GND	
Parallel video data	VIDEO_OUT_D12	LVCMOS18	O	27	28	-	LVDS1V8	VIDEO_CLK_REF_P	Camera ref clock (optional)
Parallel video data	VIDEO_OUT_D13	LVCMOS18	O	29	30	-	LVDS1V8	VIDEO_CLK_REF_N	Camera ref clock (optional)
Parallel video data	VIDEO_OUT_D14	LVCMOS18	O	31	32	P		GND	
Parallel video data	VIDEO_OUT_D15	LVCMOS18	O	33	34	P	LVCMOS18	Reserved	Do not connect
	GND		P	35	36	-	LVCMOS18	Reserved	Do not connect
Parallel video vertical sync	VIDEO_OUT_VSYNC	LVCMOS18	O	37	38	-	LVCMOS18	Reserved	Do not connect
Parallel video horizontal sync	VIDEO_OUT_HSYNC	LVCMOS18	O	39	40	-	LVCMOS18	Reserved	Do not connect
Parallel video data enabled	VIDEO_OUT_DE	LVCMOS18	O	41	42	-	LVCMOS18	Reserved	Do not connect
	GND		P	43	44	P		GND	
Parallel video pixel clock	VIDEO_OUT_PCLK	LVCMOS18	O	45	46	-	LVCMOS18	Reserved	Do not connect
	GND		P	47	48	-	LVCMOS18	Reserved	Do not connect
Cam video trigger (optional)	VIDEO_TRIG_N	LVDS1V8	I	49	50	-	LVCMOS18	Reserved	Do not connect
Cam video trigger (optional)	VIDEO_TRIG_P	LVDS1V8	I	51	52	P		GND	
	GND		P	53	54	-	LVCMOS18	Reserved	Do not connect
Digital Power	Vcc_digital	2.5V-5.1V	P	55	56	P		GND	
Digital Power	Vcc_digital	2.5V-5.1V	P	57	58	P	4.5 to 5.1V	Vcc_analog	Analog Power
	GND		P	59	60	P	4.5 to 5.1V	Vcc_analog	Analog Power

Figure 27: Camera output connector

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3.2. Interface board

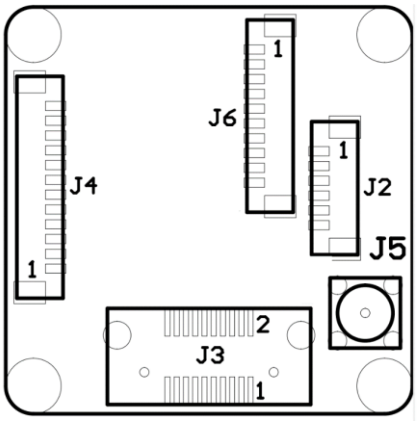

Figure 28: Interface backboard plan

J2 (BM06B-SURS-TF(LF)(SN))		
Pin number	Name	Direction
1	POWER +5V	Input
2	POWER GND	Input
3	UART TX 3.3V	Output
4	UART RX 3.3V	Input
5	PAL GND	Output
6	PAL VIDEO	Input

Figure 29: Camera output connector J2

J5 (MMCX7-SM)	
Center conductor	PAL/SDI SIGNAL
Outer conductor	GND

Figure 30: Camera output connector J5

J4 (BM12B-SURS-TF(LF)(SN))		
Pin number	Name	Direction
1	POWER +3.3V	Output
2	POWER GND	Output
3	GPIO2	Output
4	I2C1_SDA_3V3	Output
5	I2C1_SCL_3V3	Output
6	GND	-
7	GND	-
8	Thermocouple +	Output
9	Thermocouple -	Output
10	GND	-
11	GND	-
12	GND	-

Figure 31: Camera output connector J4

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3.3. Casing version

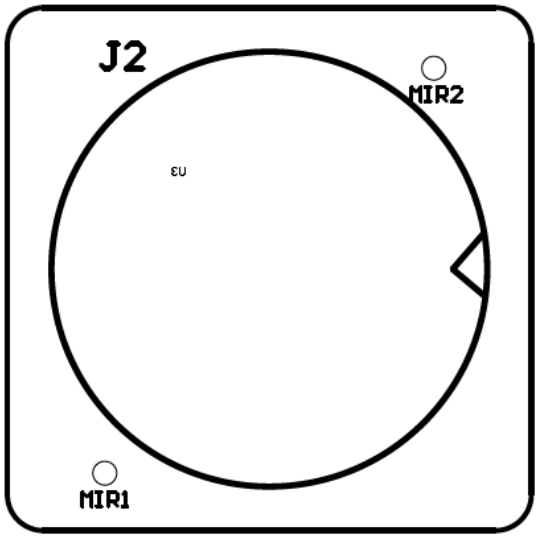

Figure 32: Backboard casing version

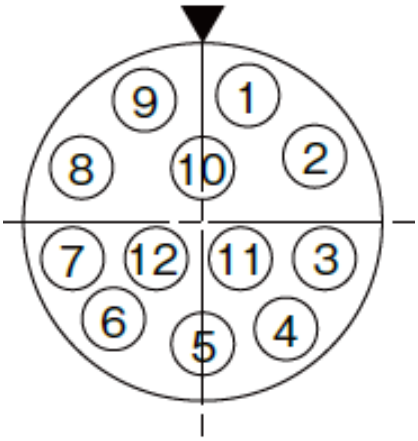

Figure 33: LF10WBRB-12PD pinout (from the view of the female contact connector mating face, the arrow symbol indicates the mating guide position)

J2 (LF10WBRB-12PD)		
Pin number	Name	Direction
1	GND	-
2	+5V	Input
3	UART_RX_3.3V	Input
4	UART_TX_3.3V	Output
5	JTAG_RST	Input
6	JTAG_TCK	Input
7	JTAG_TMS	Input
8	SD-SDI_VIDEO	Output
9	GND	-
10	JTAG_TDI	Input
11	JTAG_TDO	Output
12	JTAG_1.8V	Output

Figure 34: Camera Casing version output connector J2

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3.4. USB driver board

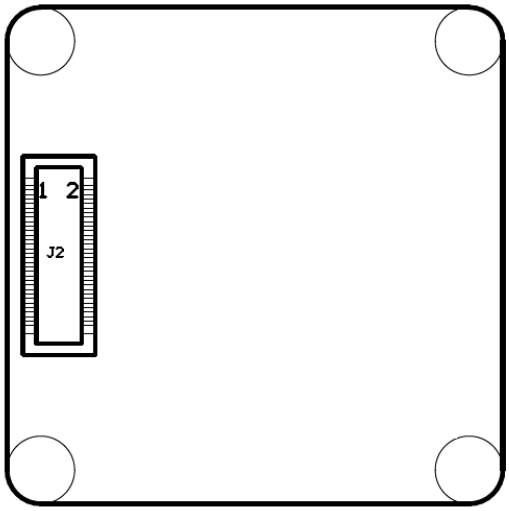

Figure 35: USB driver backboard view

The mechanical position of J2 connector is described in §2.4.

The ESD protections for the various USB lines are not present on this circuit board and must be incorporated by the integrator. These protections should be added if a connector accessible to external users is introduced. Additionally, in the case of using a USB-C connector, the orientation of the connection is not managed by this board and must be handled by the integrator.

			DF40C-30DP-0.4V(51)						
Description	Nom	Level	I/O	Pin NB	Pin NB	I/O	Level	Nom	Description
See §3.8.3 for electrical specifications	CAMERA_POWER	5V	P	1	2	P	5V	CAMERA_POWER	See §3.8.3 for electrical specifications
	GND		P	3	4	P		GND	
	RESERVED			5	6	P		GND	
	GND		P	7	8	O		USB_D_N	USB 2.0 differential pair
	DNC			9	10	O		USB_D_P	USB 2.0 differential pair
	GND		P	11	12	P		GND	
(Optional) 27MHZ LVDS	VIDEO_CLK_REF_P	LVDS	I	13	14	P		GND	
(Optional) 27MHZ LVDS	VIDEO_CLK_REF_N	LVDS	I	15	16	P		GND	
	GND		P	17	18	P		GND	
	GND		P	19	20	O		USB3_SSTX_N	USB 3.0 signal transmission line
	GND		P	21	22	O		USB3_SSTX_P	USB 3.0 signal transmission line
(Optional)	VIDEO_TRIG_P	1V8	I	23	24	P		GND	
	VIDEOOUT_VSYNC	1V8	O	25	26	P		GND	
	GND		P	27	28	I		USB3_SSRX_P	USB 3.0 signal receiving line
	GND		P	29	30	I		USB3_SSRX_N	USB 3.0 signal receiving line

Figure 36: Camera driver USB J2 pinout

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3.5. MIPI interface board

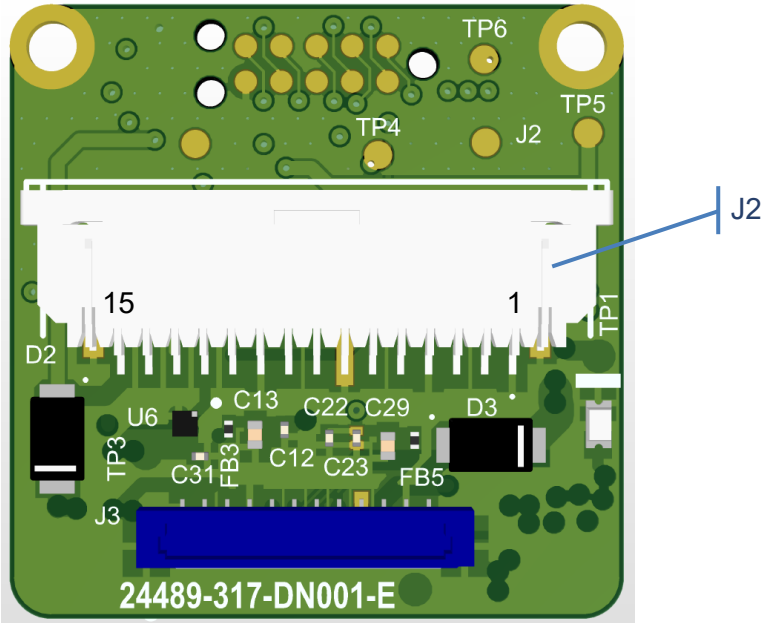

Figure 37: MIPI FFC backboard view

J2 – MIPI CSI-2 (SFW15R-1STE1LF)			
Pin number	**Name**	**Direction**	**Voltage**
1	GND	Input	
2	CSI_D0_N	Output	MIPI data lane 0 (N)
3	CSI_D0_P	Output	MIPI data lane 0 (P)
4	GND	Input	
5	CSI_D1_N	Output	MIPI data lane 1 (N)
6	CSI_D1_P	Output	MIPI data lane 1 (P)
7	GND	Input	
8	CSI_CLK_N	Output	MIPI clock lane (N)
9	CSI_CLK_P	Output	MIPI clock lane (P)
10	GND	Input	
11	Not connected	Not connected	
12	VIDEO_TRIG (optional)	Input	Vmin=0V – Vmax=+5V Vih_{min} = +1.5V
13	CSI_I2C_SCL		I2C clock lane – 3v3 - 4.7kΩ pull-up on board
14	CSI_I2C_SDA		I2C data lane – 3v3 - 4.7kΩ pull-up on board
15	POWER +3.3V	Input	+3.3V

Figure 38: MIPI FFC board J2 pinout

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3.6. GigE Vision interface board

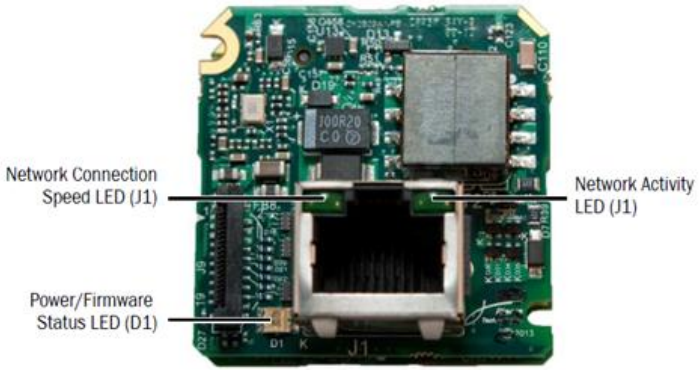

Figure 39: GigE Vision NTX backboard view

RJ45 connector for Ethernet Network connection, as specified in IEEE 802.3 standard.

The Ethernet interface can operate at 100 or 1000 Mbps and supports Internet Protocol Version 4 (IPv4). Bitrate to be chosen depending on video flow from the camera (8 or 14 bits, frequency from 9Hz to 60Hz).

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3.7. Signals levels

I/O standard	VDDI Min (V)	VDDI Max (V)	VIL Max (V)	VIH Min (V)	VIH Max (V)
LVCMOS18	1.71	1.89	0.60	1.17	1.89

Figure 40: 1.8V CMOS DC input levels

I/O standard	VDDI Min (V)	VDDI Max (V)	VOL Max (V)	VOH Min (V)
LVCMOS18	1.71	1.89	0.45	1.35

Figure 41: 1.8V CMOS DC output levels

I/O standard	VICM Min(V)	VICM Max(V)	VID Min(V)	VID Max(V)
LVDS18	0.6	1.25	0.1	0.6

Figure 42: Differential DC input levels

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3.8. Power supply

3.8.1. OEM

Supply voltage:

- Vcc_Digital:
  - 2.5V to 5.1V
  - Current < 280mA.
  - Ripple < 60mV. Avoid SMPS with operating frequency lower than 1MHz for better image quality
- Vcc_Analog:
  - 4.5V to 5.1V
  - Current < 100mA.
  - Ripple < 30mV. Avoid SMPS with operating frequency lower than 1MHz for better image quality. Prefer linear regulators with high PSRR.

3.8.2. Interface and casing versions

Supply voltage:

- POWER +5V:
  - 4.5V to 5.1V
  - Current < 200mA.
  - Ripple < 60mV. Avoid SMPS with operating frequency lower than 1MHz for better image quality. Prefer linear regulators with high PSRR.
  -

3.8.3. USB

Supply voltage:

- POWER +5V:
  - 4.5V to 5.5V (USB voltage compliance)
  - Current < 300mA.
  - Ripple < 60mV. Avoid SMPS with operating frequency lower than 1MHz for better image quality.

3.8.4. GigE Vision

Supply voltage:

This is a PoE Ethernet powered interface in accordance with IEEE 802.3af standard, up to 7 Watts.

3.8.5. MIPI

Supply voltage:

- POWER +3.3V:
  - Current : < 400mA.
  - Input ripple: < 60mV. Avoid SMPS with operating frequency lower than 1MHz for better image quality.

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4. SOFTWARE AND IMAGE PROCESSING

4.1. Framerate

The camera is designed to handle different framerates, including 25, 30, and 60Hz. A command is available to switch between the different framerates in real-time, allowing users to adapt the camera's output to their specific needs. At 30 and 60Hz, SDI and PAL outputs are disabled to reduce power consumption.

However, it is important to note that the PAL and SDI video outputs are limited to a maximum framerate of 25Hz. This is due to the limitations of these specific video output standards, which cannot handle higher framerates. Users who require higher framerates will need to use the parallel or MIPI CSI-2 video outputs instead.

Please note that framerates over 9Hz are subject to export-control and thus the 9Hz version (for civilian applications) is a factory hard-wired configuration and cannot be changed by settings.

Video format	9Hz	25Hz	30Hz	60Hz
Parallel	X	X	X	X
SD-SDI	X	X		
MIPI				X
PAL	X	X		
USB		X		

Figure 43: Framerate depending of video format

4.2. Shutterless operation

The CamSight LS camera features shutterless technology that allows for low-latency and freeze-free image delivery without a mechanical shutter. This technology compensates for thermal drift and other sources of noise that can affect image quality in traditional shuttered cameras.

In addition to the shutterless technology, the CamSight LS camera is designed to operate optimally over a wide temperature range, from -40°C to +70°C. To achieve this, the camera has several operating points, each optimized for a specific temperature range. When transition occurs between two temperature operating points some artifacts can be observed on the image during typically less than half a second.

The shutterless operation of the CamSight LS camera offers many advantages, such as low latency and freeze-free image delivery in real-time. To improve the image quality, several post processing algorithms are integrated into the camera such as column noise correction and vignetting correction.

By incorporating these image processing algorithms, the CamSight LS camera can effectively mitigate some of encountered non-uniformities in infrared images, resulting in high-quality improved overall uniformity.

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4.3. Column noise correction

The column noise is a type of non-uniformity that can be induced by the variation in the response of the reference bolometers in the sensor. However, this noise can be effectively reduced by using the “Column noise correction” algorithm available in the camera. This algorithm works by estimating the amount of noise present in each column of the image and then removing it. However, it is important to note that this algorithm may sometimes create artefacts on vertical structures when they are too big in the image. Nonetheless, the Column noise correction algorithm is an important tool for improving the overall image quality of the camera.

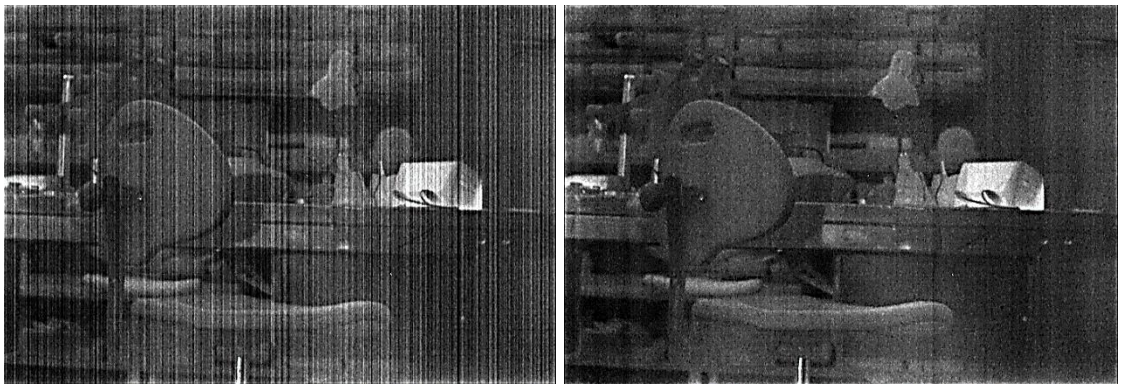

Figure 44: Left: column noise correction off / Right: column noise correction ON (Sharpness is increased by 75% on both images to better observe the effect on thumbnails.)

4.4. Vignetting correction (flattening filter)

The Vignetting correction algorithm is a powerful tool to reduce non-uniformities induced by temperature gradients on the sensor, also called vignetting. This non-uniformity is a common issue with shutterless cameras and can significantly degrade the image quality. The algorithm works by analyzing the image to detect areas with different temperature gradients and applying a correction factor to each pixel based on its location. This correction factor compensates for the non-uniformities and restores the uniformity of the image.

However, it is important to note that the Vignetting correction algorithm can sometimes create artefacts on temperature uniform surfaces, such as the sky. This is because the algorithm may interpret the uniform temperature as a temperature gradient and apply a correction factor that is not needed. Overall, the Vignetting correction algorithm is a valuable tool for improving the image quality.

Figure 45: Left: vignetting correction off / Right: vignetting correction on (brightness is increased by 30% on both images to better observe the effect on thumbnails.)

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4.5. Edge enhancement: sharpening or contouring

The camera is equipped with an edge enhancement algorithm which can improve the image quality by enhancing the edges. There are three modes available for this algorithm: disable, sharpening, and contouring. In sharpening mode, the edges of the objects in the image are enhanced, resulting in a sharper image. In contouring mode, an edge detection algorithm is applied to the image, which can be particularly useful when aiming with a holographic thermal aiming sight.

Figure 46: Left: sharpening off / Right: Sharpening on

Figure 47: Left: contouring off / Right: contouring on

During contouring mode, it is recommended that image polarity is inverted, to have contours in white over black instead of black over white.

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4.6. Histogram dynamic range enhancement

The camera includes two dynamic range correction algorithms that optimize the histogram processing of the scene. There are two algorithms: CLHE (Contrast-Limited Histogram Equalization) and CLAHE (Contrast-Limited Adaptive Histogram Equalization). A parameter allows adjusting these algorithms to be more linear or more histogram equalization. The algorithms also include a gamma correction and an inversion of the image polarity. While the CLHE algorithm works on the histogram computed over a single ROI (Region of Interest) defined by the user, CLAHE divides the image into multiple ROI and processes the histogram of each part of the image.

Depending on the scenes encountered of the final application, CLHE or CLAHE should be selected for best results.

Figure 48: Left: CLHE / Right: CLAHE

4.7. Zoom

The camera includes a digital zoom algorithm that allows for linear zooming up to a factor of x8. The zoom center can be moved within a 50x50 pixel square around the center of the image. The resolution of the zoomed output is forced at 720x576 pixels when BT656/SDI output is enabled. The output zoom resolution can be configured for parallel output. When changing the resolution be careful to disable BT656/SDI output. Two methods are available for the zooming algorithm: nearest neighbor or interpolation. For DRI (Detection, Recognition and Identification) applications it is recommended to use the nearest neighbor method to avoid any interpolation artifacts. If the zoom factor is too low, black bars will appear on the edges of the image. By default, the zoom is centered on pixel (320, 240) with a magnification factor of x1.0. Zoom center is limited to a 50-pixel square at the center of the image.

Figure 49: Left: Zoom x1.0 / Right: Zoom x 2.0

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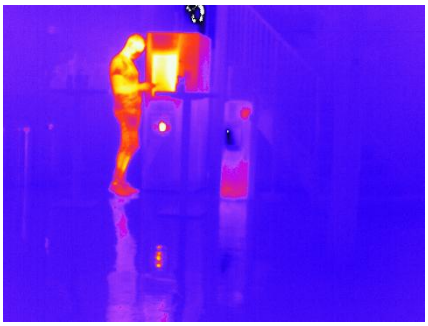
4.8. False-color LUT

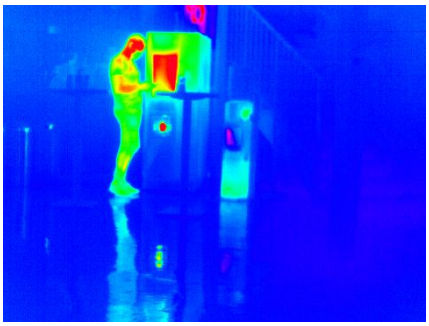
The camera includes a false-color LUT (Look-Up Table) algorithm, enabling the display of videos in color. It's designed to enhance visualization and analysis of captured images. This technique allows users to interpret image data in a unique and customizable way by mapping different pixel intensity values to a wide range of selectable colors. Six different LUTs are available:

GREYSCALE

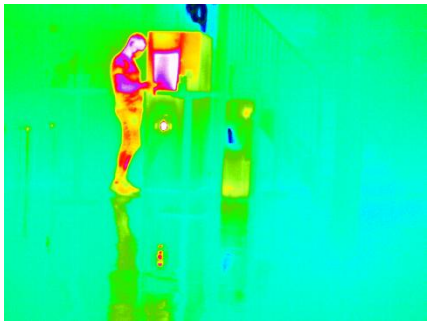


IRON

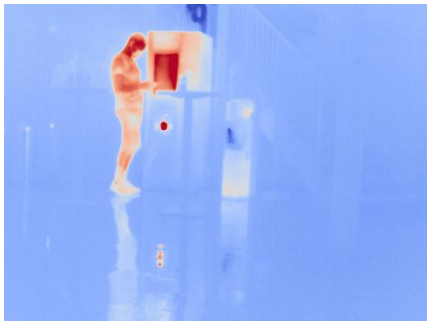
HOT



RAINBOW



NCAR



COOLWARM

CUBEHELIX

False color LUT is available for 8 bits outputs parallel, SDI, PAL and MIPI. It's not available for 14 bits data.

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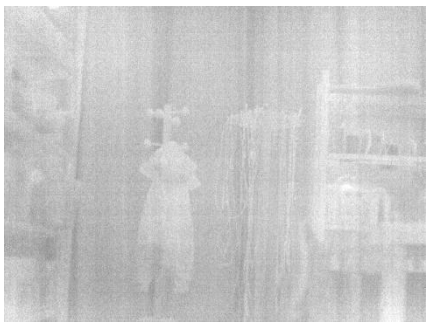
4.9. AHC gain limitation

The camera is equipped with a function to restrict AHC (Automatic Histogram Control) gain amplification. This functionality serves to diminish noise amplification in situations of low contrast. Users can employ two parameters, namely AHC black limit and AHC white limit, to confine the histogram to either black or white values, or both. The interplay of these parameters can result in a grey limitation as well.

Figure 50 : Original image with low contrast and high noise (limit black = 0, limit white = 0)

limit black = 10, limit white = 0

limit black = 10, limit white = 10



limit black = 0, limit white = 10

In scenes with higher contrast, the effects of limitation will become noticeable only when employing higher values for the limitations:

limit black = 0, limit white = 0

limit black = 20, limit white = 20

limit black = 40, limit white = 40

4.10. AHC speed temporal filter

A parameter is provided for adjusting the speed of the Automatic Histogram Control (AHC). A recursive filter is employed to restrict the AHC speed, where the filter coefficient is represented as alpha = $1/2^{AHC_speed_filter}$. This parameter can be adjusted within a range from 0 (indicating no temporal filter) to 8 (reflecting a very slow AHC response). Iterations time is typically 50ms.

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5. VIDEO INTERFACES

5.1. Video outputs

Different outputs are available depending on the CamSight LS version (see table below).

Camera version	Parallel	SD-SDI	MIPI	PAL	USB
OEM	X	X			
Interface board		X		X	
Connector board		X			
Driver USB					X
MIPI Interface board			X		

Figure 51: CamSight LS video capabilities.

5.1.1. Parallel video output

The parallel video output of the CamSight LS camera is a 14-bit video greyscale bus that transmits pixel data for each frame. This video output is available at 9/25/30/60 Hz.

VIDEO_OUT_PCLK: Pixel clock. Synchronization and data signals are set on falling edge of PCLK.

VIDEO_OUT_HSYNC: Horizontal sync. Syncs the data for the horizontal columns of pixels.

VIDEO_OUT_VSYNC: Horizontal sync. Syncs the data for the vertical rows of pixels.

VIDEO_OUT_DE: Data enable. Confirms valid data is transmitted. Prior to software version 2.1.1, the DE signal can fall to '0' at any time during a line. Starting from version 2.1.1, the DE signal remains at '1' throughout the entire line.

VIDEO_OUT_D0 to VIDEO_OUT_D15: Video bus (16 bits).

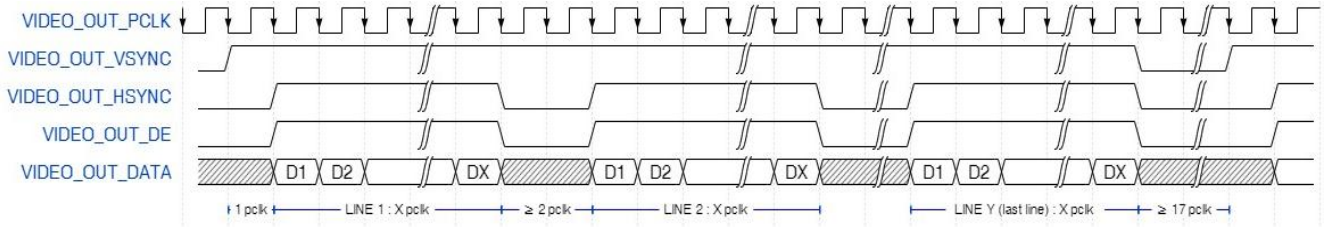

Figure 52 : Parallel video framing with resolution X Y (software version ≥ 2.1.1)

When False Color LUT is activated, the data bus becomes a YCbCr 4:2:2 16 bits:

- VIDEO_OUT_D0 to D7 ➔ CbCr (4:2:2, Cb first)
- VIDEO_OUT_D8 to D15 ➔ Y

Generic Firmware (versions ≤ v2.2.0):

The parallel video bus can be configured to stream:

- RAW_OUTPUT; raw mode, 640x480, 14-bit pixels. PCLK = 9MHz (25Hz), 10MHz (30Hz), 20MHz (60Hz).
- NUC_OUTPUT; after NUC, 640x480, 14-bit pixels. PCLK = 9MHz (25Hz), 10MHz (30Hz), 20MHz (60Hz).
- COLUMN_OUTPUT; after column correction, 640x480, 14-bit pixels. PCLK = 9MHz (25Hz), 10MHz (30Hz), 20MHz (60Hz).
- VIGNETTING_OUTPUT; after vignetting correction, 640x480, 14-bit pixels. PCLK = 9MHz (25Hz), 10MHz (30Hz), 20MHz (60Hz).

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- EDGE_OUTPUT; after edge correction, 640x480, 14-bit pixels. PCLK = 9MHz (25Hz), 10MHz (30Hz), 20MHz (60Hz).
- LUT_OUTPUT; after LUT correction, 640x480, Mono 8-bit or YCbCr 4:2:2 16-bits pixels. Compatible with false color LUT. PCLK = 9MHz (25Hz), 10MHz (30Hz), 20MHz (60Hz).
- RFU_OUTPUT; reserved for future use.
- ZOOM_OUTPUT; Zoom mode, 720x576 by default, parallel format, Mono 8-bit or YCbCr 4:2:2 16-bits pixels. Compatible with false color LUT. Default setting for customer usage. PCLK = 44MHz.
- BT656_OUTPUT; BT656 format. **(Must be selected for PAL output)**. PCLK = 27MHz.

The framing of the pixel output is not fixed. The pixels are delivered when they are available. When high zoom values are applied, bursts of successive lines can be observed.

MIPI 60Hz Firmware (versions ≥ v2.3.0):

- ZOOM_OUTPUT; Zoom mode, 640x480 by default, parallel format, Mono 8-bit or YCbCr 4:2:2 16-bits pixels. Compatible with false color LUT. Default setting for customer usage. PCLK = 44MHz. Zoom factor may be limited.

Other stream and frame rates will be implemented in a later version.

5.1.2. PAL video signal

CamSight LS proposes a PAL video output in which the represented video data is in progressive form, say the odd field and the even field are time related. This video presentation method is less prone-to-artifacts picture than regular PAL video.

The PAL video interface provides a frame rate of 25 frames per second and a resolution of 720x576 pixels. The output impedance is 75ohm. The PAL driver uses the parallel bus to transmit video to the PAL video encoder chip. When PAL output is used, the parallel video bus needs to be set to “BT656_OUTPUT”.

5.1.3. SD-SDI video signal

CamSight LS proposes a SD-SDI video output in which the represented video data is in progressive form, say the odd field and the even field are time related. This video presentation method is less prone-to-artifacts picture than regular SD-SDI video.

The progressive SD-SDI interface transmits video signals with a resolution of 720x576 pixels. The interface is 75ohm and transmits a digital signal at a rate of 270 Mbps. The video signal is encoded using 8-bit digital coding and is transmitted in a serial format.

5.1.4. MIPI CSI-2 D-PHY

CamSight LS proposes a MIPI-CSI2 output using D-PHY version 1.1:

- 1 clock lane + 2 data lanes (176Mbps per lane, may vary across FW versions)
- Mono 8 greyscale pixel format.

Camera settings (*) :

- Colorlut: Only “GREYSCALE”.
- Zoom resolution: 640x480.
- Parallel Output: enabled.
- Output type: “LUT CORRECTION” or “ZOOM”

*The MIPI outputs share the same video stream as the parallel video bus.

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5.1.5. USB

The CamSight LS camera is equipped with a USB interface. Recognized as a UVC V1.1 (USB Video Class) device, it allows effortless plug-and-play functionality across multiple platforms. Additionally, a virtual serial port is emulated via the USB connection (USB CDC), to communicate with the camera for configuration and control purposes. Users have the flexibility to choose between two interfaces: either a Hirose DF40 connector or a USB Type-C connector with a second additional board.

The camera manages USB2.1 and USB 3.2 protocols. The resolution and framerate are limited to 640x480@25Hz. While operating under USB2.1 protocol, the camera exhibits a maximum zoom factor of x2.

Camera parameters to set while using USB:

- Framerate: 25Hz.
- BT-656/SDI Output: disabled.
- Parallel Output: enabled.
- Colorlut: from “IRON” to “GREYSCALE YCbCr”. Do not use “GREYSCALE”.
- Zoom resolution: 640x480.
- Zoom factor: x2 maximum while using USB2.1 protocol.

The USB-C connector board does not include a switch, and as a result, the orientation of the connector is critical for achieving either USB 3.0 or USB 2.0 functionality. Proper alignment is essential to ensure the correct communication standard is used, as reversing the connector may lead to an incorrect or degraded performance.

5.1.6. Pleora NTX-GIGE output

When a Pleora NTX-GIGE is connected to the parallel output, the following parameters must be set with eBUS Player (version 5.1):

- Width:
  - 640 for all outputs but zoom
  - 720 for zoomed stage output (by default)
- Height:
  - 480 for all outputs but zoom
  - 576 in zoomed stage output (by default)
- PixelFormat:
  - Mono8 for 8 bits output selection (camera standard mode with Bertin image processing)
  - Mono14 for 14 bits output selection (reserved for RAW data mode)
  - YCbCr422_8_CbYCrY for color palette LUT selection (camera standard mode with Bertin image processing with color palette LUT activated)
- TestPattern: Off
- PixelBusDataValidEnabled: True (for camera software version below 2.1.1)

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6. PLEORA INTERFACE CONFIGURATION

In case of GigE Vision Interface board, eBUS Player software is necessary to communicate with Pleora device (version 5.1). eBUS Player is software developed by PLEORA. The following instructions are for indication only and are not a User Manual.

6.1. Pleora configuration

Plug Pleora device to Power Over Ethernet (PoE) switch.

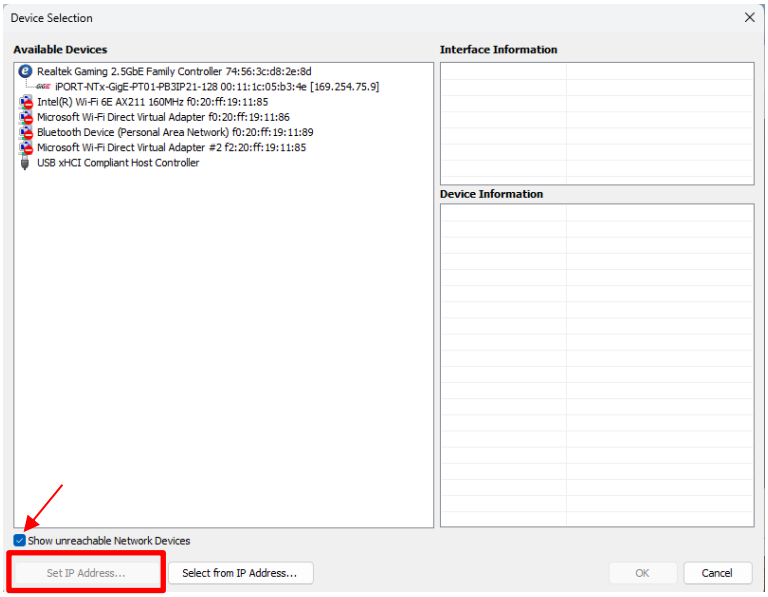
Connect computer to PoE Switch.

Run eBUS Player.

Select Pleora IP address.

If Pleora IP address is not on the same range as computer IP address, check box “show unreachable Network Device”.

Select detected IP address. Click on “Set IP address” and enter a number. Click on OK.



On new eBUS Player window, click on “Device control” to setup parameters.

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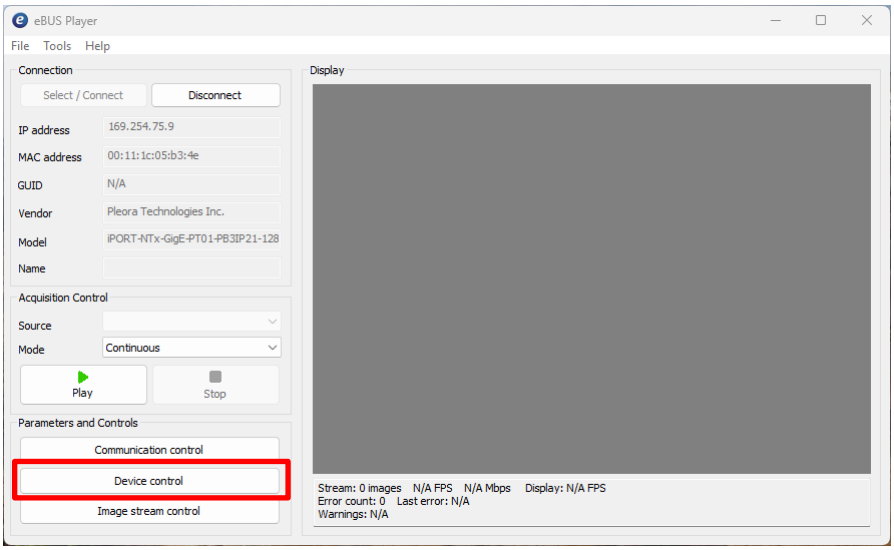
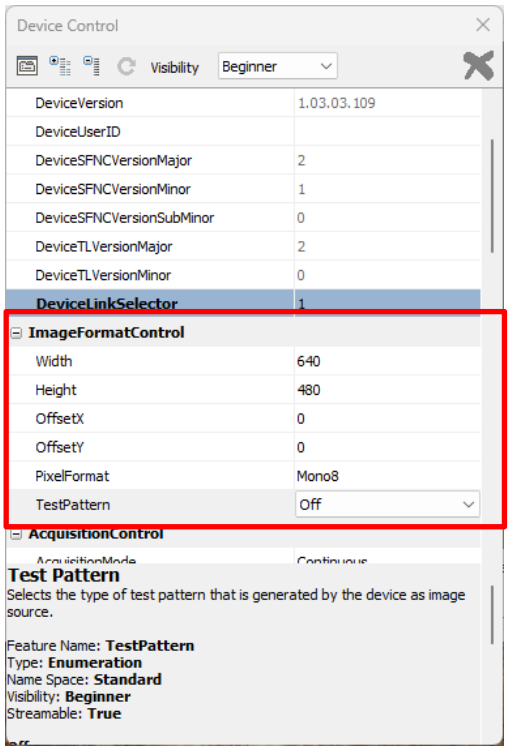


In “Device control” window, in “Image Format Control” section, enter format parameters:
Width: 640
Height: 480
PixelFormat: Mono8
TestPattern: Off



In “Device control” window, in “PixelBusInterfaceControl” section, change parameter:
PixelBusDataValidEnabled: True

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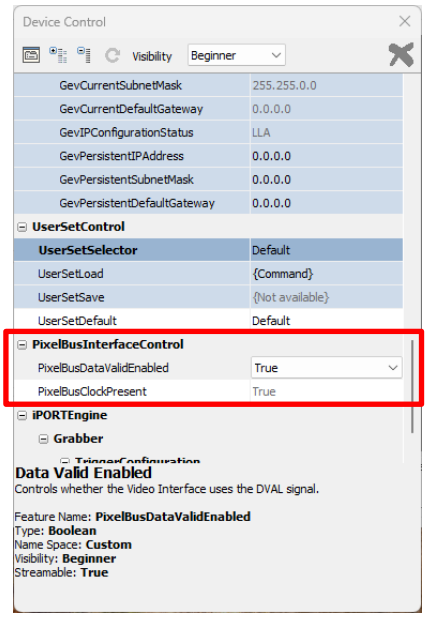
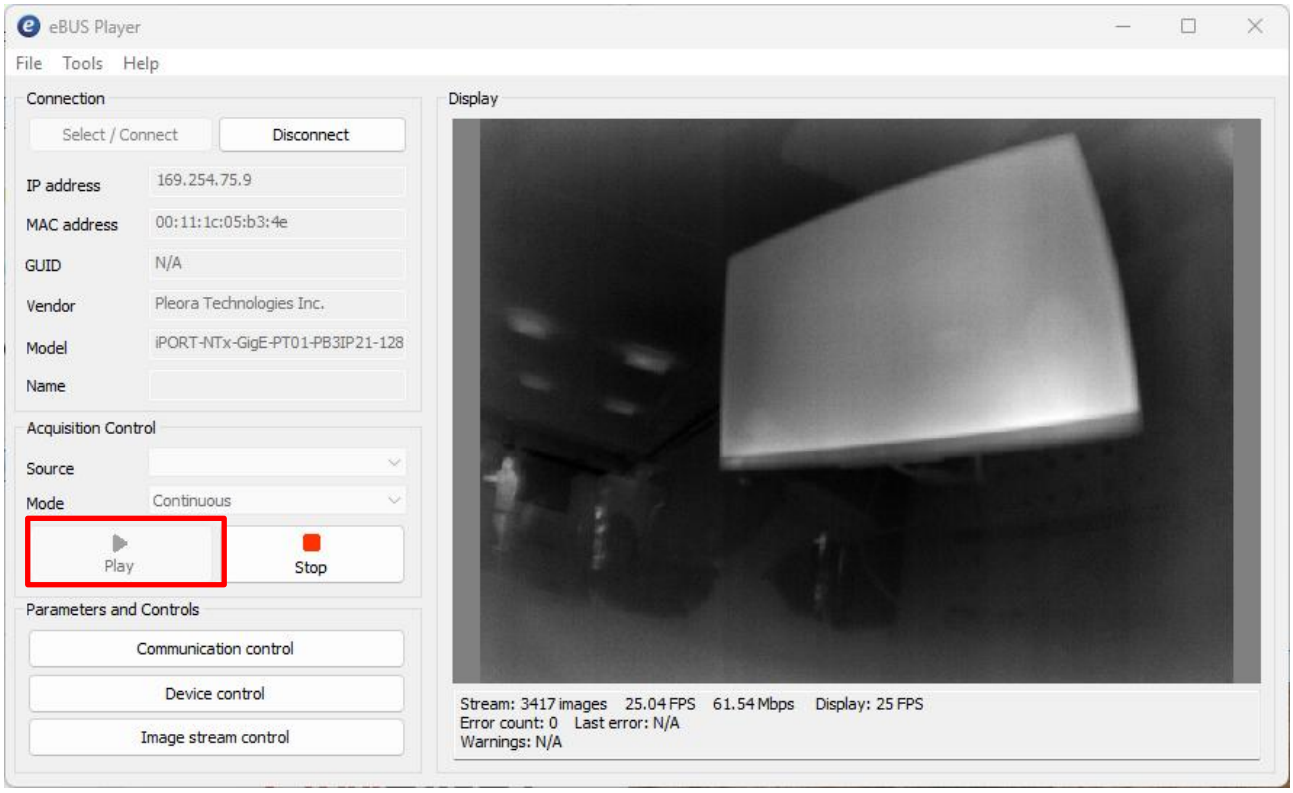


Close “Device control” window.
In ebus Player window, click on Play.



Pleora configuration can be saved.
In “File” menu, click on “Save as”. Enter a location where to save and a name.

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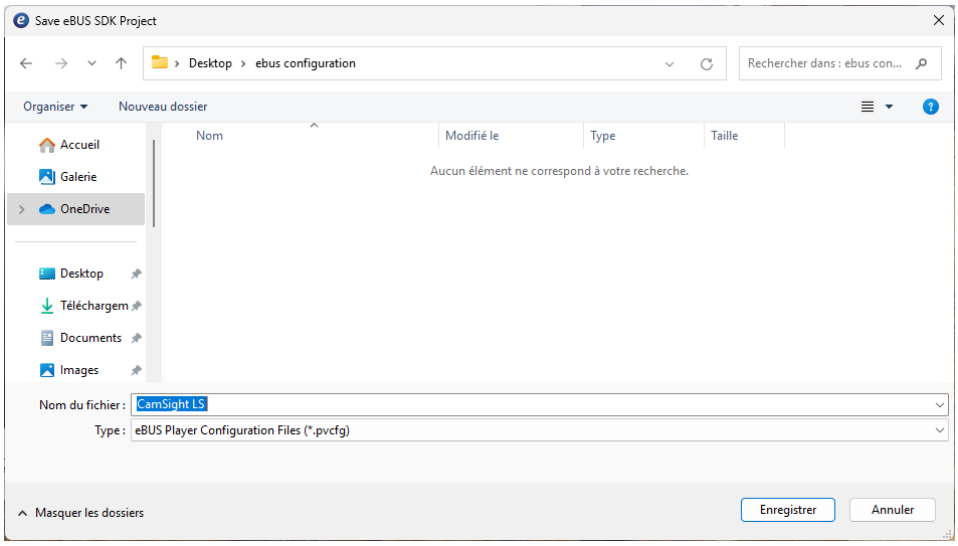

At the next power on and connection, select Pleora IP address.

When connected, in “File” menu, click on “Open” and select the configuration previously saved (.pvcfg).

All parameters saved will be loaded.

If video output is not correct or not complete, tune camera parameters with Companion application (video output type or resolution, for example).

6.2. Pleora serial communication bridge

Serial communication is needed to use Companion with CamSight LS.

eBUS Player can emulate serial communication.

First, setup serial bridge with an application such as “Com0com” v3.0.0.0 (2012-06-04).

Com0Com is Open-Source software. The following instructions are for indication only and are not a User Manual.

Install Com0com executable file.

Run “setup com0com” and setup 2 PortCOM names. For example, COM98 and COM99 (choose portCOM numbers that are not used by other applications).

Other pairs can be removed if not used.

Click on “Apply”.

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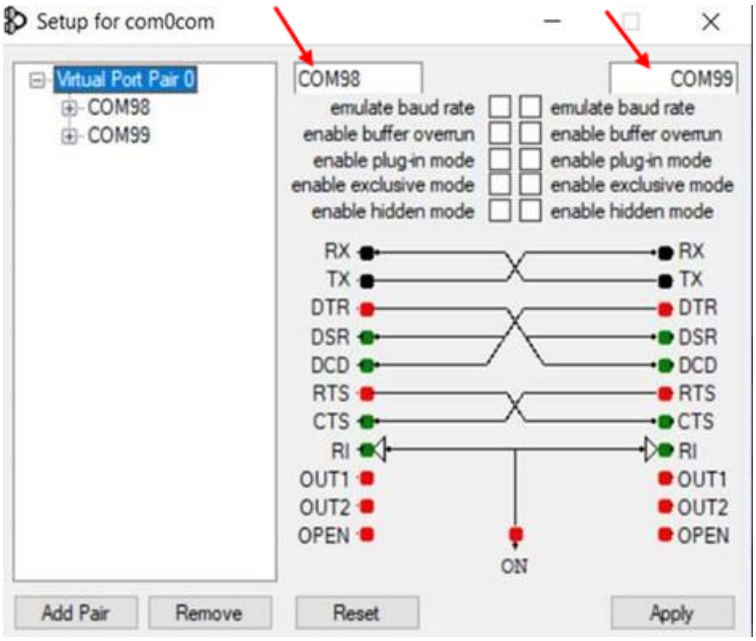
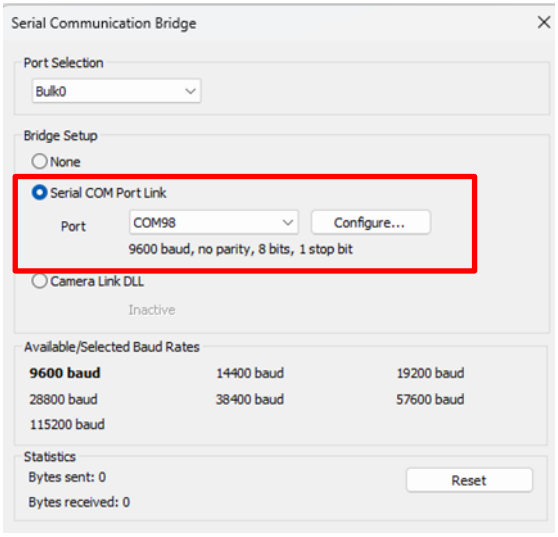


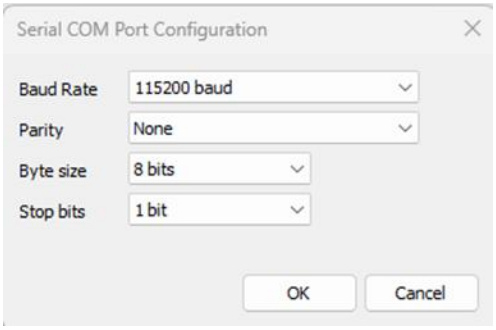
Run eBUS Player and select IP address to connect.

In “Tools” menu, select “Serial communication bridge”.



Click on “Serial COM Port Link” and select one of the two portCOM setup in com0com (COM98, for example) and click on the right on “Configure”.

In the new window, set speed at 115200 Baud and click on OK.



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It’s possible to save configuration (menu “File” and “Save”).

To save a complete configuration (image format + serial bridge), when connected to camera, open configuration previously saved (File menu, “Open”), setup serial communication bridge and save new configuration (File menu, Save as).

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7. SERIAL COMMUNICATION INTERFACE

7.1. Hardware

A UART serial port allows communication with the camera. The characteristics are:

- Pin 18 and 20 on the output connector, 1.8V LVCMOS electrical levels (see §3.1).
- Main UART parameters: 115200 / 8-N-1
- Baudrate: 115200 bps (default value)
- Start bit: 1
- Data bit: 8 bits data
- Parity: None

7.2. MAVLINK

MAVLINK sources files (.xml) are available, please contact Bertin Technologies if needed.

The CamSight® camera is always configured as a slave device in the system. A master device must be connected to the camera to initiate communication, so the camera will never initiate a transaction by its own.

The CamSight MavLink Protocol is versioned. All devices implementing this protocol must ensure the protocol compatibility by respecting the command implementation guideline (see corresponding table: Command list, in this document).

7.2.1. Mavlink implementation

The CamSight MavLink Protocol is based on the MavLink v2 protocol. Moreover, all transactions are composed of 1 command packet sent by the master device and 1 response packet sent by the slave device.

7.2.2. Mavlink versioning

The list of available commands and corresponding responses is defined in the Command List Table. Depending on the version of the CamSight MavLink Protocol, the commands can be mandatory, optional, or deprecated (not to be implemented even if existing in previous versions).

Historical version of the CamSight MavLink Protocol is not versioned (it doesn't implement the `MAVLINK_MSG_ID_GET_CAMERA_PROTOCOL_VERSION` command) and is identified in this document as version 0.

The `MAVLINK_MSG_ID_GET_CAMERA_PROTOCOL_VERSION` command is used by the master device to identify the available camera command set.

7.2.3. Mavlink generator

7.2.3.1. GitHub tool

The following GitHub repository is used to generate automatically the MavLink code libraries to be implemented in the Camera firmware as well as in the master device that communicate with it: https://github.com/mavlink/mavlink

The python program 'mavgenerate.py' is used for this purpose. It needs an XML file describing the command set as input.

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7.2.3.2. XML file description

The library generator program 'mavgenerate.py' takes, as input information, an XML file describing the command set to be implemented in the library.

One XML file is the reference for each version of CamSight MavLink Protocol.

The format of XML is described in the web site:

https://mavlink.io/en/

Basically, 2 kinds of field are used:

- enum: list of possible values for a specific field of a message.
- message: command or response definition.

'enum' example:

```
<enum name="CONTRAST_TYPE">
  <description>Type of contrast to be applied</description>
  <entry value="0" name="CONTRAST_CLHE">
    <description>Process contrast limited histogram equalization</description>
  </entry>
  <entry value="1" name="CONTRAST_CLAHE">
    <description>Process contrast limited adaptative histogram equalization</description>
  </entry>
</enum>
```

'message' examples:

```
<message id="12320" name="GET_CONTRAST_TYPE">
  <description>Get IR sensor contrast type</description>
  <field type="uint8_t" name="type" enum="CONTRAST_TYPE">Type of contrast</field>
</message>
```

```
<message id="12297" name="ROI_CONTROL">
  <description>Set Region of Interest size and position</description>
  <field type="uint16_t" name="x_start">X start position</field>
  <field type="uint16_t" name="x_end">X end position</field>
  <field type="uint16_t" name="y_start">Y start position</field>
  <field type="uint16_t" name="y_end">Y end position</field>
</message>
```

7.3. Protocol packet description

In MavLink packets, all words are coded in little endian format.

7.3.1. Command packet format

Two kinds of command are defined:

- Set commands: the master device sends data to the slave; no data is sent back by the slave, who responds with an ACK message.
- Get commands: the master device sends some optional parameters to the slave; data are expected to be sent by the slave into the response, which consists in the same message than command.

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7.3.1.1. Set command type

B0	B1	B2-B3	B4	B5-B6	B7-B9	n=LEN bytes	B(n+10)-B(n+11)
0xFD	LEN	unused	SEQ	unused	MID	PAYLOAD	CRC16

0xFD is the magic number for MavLink v2.

LEN: length of the payload, expressed in bytes; can be from 0 to 255 bytes.

SEQ: sequence number, incremented at each command.

MID: Message ID (24 bits).

PAYLOAD: command data of LEN bytes.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B(n+9) bytes.

Unused: must be kept 0.

7.3.1.2. Get command type

B0	B1	B2-B3	B4	B5-B6	B7-B9	n=LEN bytes	B(n+10)-B(n+11)
0xFD	LEN	unused	SEQ	unused	MID	PAYLOAD	CRC16

0xFD is the magic number for MavLink v2.

LEN: length of the payload, expressed in bytes; can be from 0 to 255 bytes.

SEQ: sequence number, incremented at each command.

MID: Message ID (24 bits).

PAYLOAD: contains some parameters, generally empty for a Get command.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B(n+9) bytes.

Unused: must be kept 0.

7.3.2. Response format

7.3.2.1. Acknowledge response type

In case of no data answer to a command, this ACK message is used to send the command result. It is used in 2 different cases:

- Set command type after correct completion; in this case, RESULT field is ACK.
- Any command type with error status after execution, in this case, RESULT field is NACK.

See the message description chapter for more details.

7.3.2.2. Data response type

In case of data expected by the master device, the slave response is the same message as the command, containing the data in the payload.

B0	B1	B2-B3	B4	B5-B6	B7-B9	n=LEN bytes	B(n+10)-B(n+11)
0xFD	LEN	unused	SEQ	unused	MID	PAYLOAD	CRC16

0xFD is the magic number for MavLink v2.

LEN: length of the payload, expressed in bytes; can be from 0 to 255 bytes.

SEQ: sequence number, must be the same as corresponding command.

MID: Message ID (24 bits). Same value as command MID.

PAYLOAD: contains requested data.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B(n+9) bytes.

Unused: must be kept 0.

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7.3.3. Noticeable specificities

In Mavlink v2 protocol specification, a payload truncation is defined.

If last bytes of any payload are equal to 0x00, they are removed from the payload, the LEN byte of the header is reduced. It is up to the message receiver to analyse the content and recover missing zeros.

This feature is used in this document to reduce the packet size in specific circumstances. This improves system performance.

7.4. Commands

All command parameters sent to the camera are stored in non-volatile memory, which means that they will be retained even when the camera is powered off. The camera loads with the stored parameters at startup.

Command	MID	Description
Administrator commands		
MESSAGE_ACK	8192	This message is used to respond to Set commands when only few data are sent back to the master or to any message to return an error
GET_SERIAL_NUMBER	8194	This message requests the camera serial number stored in non-volatile memory.
SET_MAVLINK_SERIAL_SPEED	8217	This command switches the Mavlink UART baud rate between all possible values. Following standard values must be available for all slave devices: 9600, 115200, 230400, 460800 and 921600
GET_FPA_TEMPERATURE	8199	This command returns the sensor temperature.
SET_TEST_PATTERN	8207	This command enables Test pattern video output
GET_TEST_PATTERN	8208	This command gets the Test pattern video output state.
GET_SENSOR_SERIALNUMBER	8209	This command requests the sensor serial number
User commands		
GET_CAMERA_PROT_VERS	12287	This command requests the mavlink protocol version.
SET_GAMMA	12290	The Gamma parameter adjusts the contrast curve of the image in order to compensate the restitution of the final display.
SET_CONTRAST	12292	This command sets the CLHE value for image processing. This permits to adjust the dynamic of the LUT (more linear or more histogram equalization).
INVERT_POLARITY	12294	This command enables or disables the IR image polarity. Standard polarity means hot points are white and cold points are black
ROI_CONTROL	12297	This command defines the Region of Interest for the CLHE LUT algorithm. Note that this setting is used in CLHE mode only (not used in CLAHE mode).
CONTRAST_CONTROL	12300	Selects the LUT mode: CLHE (global LUT) or CLAHE (local LUT)
CAMERA_STATUS	12303	This command gets parameters information from the camera (contrast, gamma, polarity)
SET_CUSTOM_SPEED	12308	This command switches the Mavlink UART baud rate between default and custom values. Note that default value is always 115200 and custom value depends on the camera model
SET_ZOOM_PARAMS	12310	Set parameters for the zoom algorithm
SET_ZOOM_METHOD	12311	Set the zoom method
GET_ROI	12315	This command gets the Region of Interest for the CLHE LUT algorithm. Note that this setting is used in CLHE mode only (not used in CLAHE mode).

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GET_ZOOM_CONFIG	12316	This command gets the zoom configuration parameters.
GET_CONTRAST_TYPE	12320	This command reads the type of contrast processing applied: CLHE or CLAHE.
GET_FIRMWARE_ID	12321	This command reads both FPGA and RISC-V firmware IDs.
GET_FLIP_H	12322	This message reads the horizontal flip state.
SET_FLIP_H	12323	This message sets the horizontal flip state.
SET_COLUMN_CORRECTION	12326	This message enables or disables the column correction processing
GET_COLUMN_CORRECTION	12327	This message gets the column correction status
SET_VIGNETTING_CORRECTION	12328	This message enables or disables the vignetting correction processing
GET_VIGNETTING_CORRECTION	12329	This message reads the vignetting correction processing state
SET_FRAMERATE	12330	This command sets the video output frame rate. This information is stored in non-volatile memory. It is applied immediately and at next start-up
GET_FRAMERATE	12331	This command reads the video output frame rate currently in use.
SET_VIDEO_SELECT	12332	This command selects the video source to use as output for parallel and MIPI.
GET_VIDEO_SELECT	12333	This command gets the video source to use as output for parallel and MIPI.
SET_EDGE_PARAMS	12334	This command enables or disables the video edge processing (sharpening or contouring) and sets the corresponding parameters.
GET_EDGE_PARAMS	12335	This command reads the video edge processing settings currently in use in the camera
SET_ZOOM_OUTPUT_RESOLUTION	12338	This command sets the output resolution of the zoom. Only available when SDI output is disable
GET_ZOOM_OUTPUT_RESOLUTION	12339	This command reads the output resolution of the zoom.
SET_COLORLUT	12340	This command sets the false color LUT
GET_COLORLUT	12341	This command reads the false color LUT
SET_SDI_OUTPUT	12342	This command enables or disables the SDI output
GET_SDI_OUTPUT	12343	This command reads the SDI output status
SET_PARALLEL_OUTPUT	12344	This command enables or disables the PARALLEL output
GET_PARALLEL_OUTPUT	12345	This command reads the PARALLEL output status
SET_MIPI_OUTPUT	12346	This command enables or disables the MIPI output
GET_MIPI_OUTPUT	12347	This command reads the MIPI output status
SET_ROI1_inclusive	12348	This command defines the Region of Interest inclusive 1 for the CLHE LUT algorithm. Note that this setting is used in CLHE mode only (not used in CLAHE mode).
GET_ROI1_inclusive	12349	This command gets the Region of Interest inclusive 1 for the CLHE LUT algorithm.
SET_ROI0_exclusive	12350	This command defines the Region of Interest exclusive 0 for the CLHE LUT algorithm. Note that this setting is used in CLHE mode only (not used in CLAHE mode).
GET_ROI0_exclusive	12351	This command gets the Region of Interest exclusive 0 for the CLHE LUT algorithm.
SET_ROI1_exclusive	12352	This command defines the Region of Interest exclusive 1 for the CLHE LUT algorithm. Note that this setting is used in CLHE mode only (not used in CLAHE mode).

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GET_ROI1_exclusive	12353	This command gets the Region of Interest exclusive 1 for the CLHE LUT algorithm.
SET_AHC_GAIN_LIMITATION	12354	This command defines AHC (Automatic Histogram Control) gain limit to CLHE and CLAHE algorithm. It is used to limit the maximum amplification of the histogram in case of low contrast.
GET_AHC_GAIN_LIMITATION	12355	This command gets AHC (Automatic Histogram Control) gain limit from CLHE and CLAHE algorithm.
SET_LUT_TEMPORAL_FILTER	12356	This command defines AHC (Automatic Histogram Control) speed for CLHE and CLAHE algorithm.
GET_LUT_TEMPORAL_FILTER	12357	This command gets AHC (Automatic Histogram Control) speed for CLHE and CLAHE algorithm.
GET_CAMERA_TEMPERATURE	12359	This command gets camera internal temperatures.
GET_CAMERA_INFO	12361	This command gets number of startup and operating time from the camera.

Figure 53 : Command list

7.4.1. Message ACK

This message is used to respond to Set commands when only few data are sent back to the master or to any message to return an error.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B13	B14-B17	B18	B19-B20
0xFD	LEN	unused	SEQ	unused	MID	CID	VALUE	RESULT	CRC16

LEN: length of the payload, expressed in bytes; can be from 2 to 9 bytes.

MID = `MAVLINK_MSG_ID_MESSAGE_ACK` = 8192 (0x2000)

SEQ: sequence number, must be the same as corresponding command.

ACK_PAYLOAD (B10-B18) contains the corresponding command ID, an optional value and the result. Zeros terminating of the payload are removed from the sent message. In practice, it can be reduced to 2 bytes containing non-zero bytes of the command ID (all CID are greater than 256).

CID: Command ID. It contains the Message ID of the command to which this message responds.

VALUE: generally unused (filled at 0).

Result: 0 for ACK, 1 for NACK.

Unused: must be kept 0.

7.4.2. Set Test Pattern

This command enables Test pattern video output.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B11-B12
0xFD	1	unused	SEQ	unused	MID	ENABLE	CRC16

0xFD is the magic number for MavLink v2.

MID = `MAVLINK_MSG_ID_SET_TEST_PATTERN` = 8207 (0x200F). This is a Set Command type.

PAYLOAD: ENABLE; can be:

- =0: Test pattern disabled.
- =1: Test pattern enabled.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.

Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.4.3. Get Test Pattern

This command gets the Test pattern video output state.

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B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B11-B12
0xFD	1	unused	SEQ	unused	MID	ENABLE	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_GET_TEST_PATTERN` = 8208 (0x2010). This is a Get Command type.
PAYLOAD: used for both command and response:

- Command: empty.
- Response: ENABLE; see Set Test Pattern command.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.
Unused: must be kept 0.
Note: if the camera doesn't implement this command, it responds with NACK packet.

7.4.4. Get Serial Number

This message requests the camera serial number stored in non-volatile memory.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B13	B14-B15
0xFD	1	unused	SEQ	unused	MID	SERIAL_NUMBER	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_GET_SERIALNUMBER` = 8194 (0x2002). This is a Get Command type.
PAYLOAD: used for both command and response:

- Command: empty.
- Response: SERIAL_NUMBER.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B13 bytes.
Unused: must be kept 0.

7.4.5. Shutter control

This message is used to control the shutter, open it and close it.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B11-B12
0xFD	1	unused	SEQ	unused	MID	COMMAND	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_GET_SHUTTER_CONTROL` = 8206 (0x200E). This is a Set Command type.
PAYLOAD: COMMAND:

- SHUTTER_CONTROL_CMD_OPEN = 0
- SHUTTER_CONTROL_CMD_CLOSE = 1

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.
Unused: must be kept 0.

7.4.6. Set Mavlink Serial Speed

This command switches the Mavlink UART baudrate between all possible values. Following standard values must be available for all slave devices: 9600, 115200, 230400, 460800 and 921600. In addition, dedicated specific values can be implemented and depend on the camera model.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B13	B14	B15-B16
0xFD	5	unused	SEQ	unused	MID	BAUDRATE	PERMANENT	CRC16

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0xFD is the magic number for MavLink v2.

MID = `MAVLINK_MSG_ID_SET_MAVLINK_SERIAL_SPEED` = 8217 (0x2019). This is a Set Command type.

PAYLOAD: 5 bytes.

- BAUDRATE, unit is bit/sec.
- PERMANENT: Boolean, if = 1, value is stored in non-volatile memory and used at next start-up. If = 0, new baudrate is valid until next reset only.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B14 bytes.

Unused: must be kept 0.

7.5. Get FPA Temperature

This command reads the Focal Plan Array Temperature from the image sensor. It returns a raw value that must be interpreted with dedicated formula.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B13	B14-B15
0xFD	4	unused	SEQ	unused	MID	TEMPERATURE	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_GET_FPA_TEMPERATURE` = 8199 (0x2007). This is a Get Command type.

PAYLOAD: used for both command and response:

- Command: empty.
- Response: TEMPERATURE, raw value.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B13 bytes.

Unused: must be kept 0.

Formula to convert temperature from raw value to °C:

⇨ **TFPA (°C) = -188.65 × (1.5 – [((RAW_VALUE / 2^18) - 8192) / 8192] × 499 / 402) + 415.48**

7.5.1. Get Camera Protocol Version

This command is mandatory to identify the CamSight MavLink Protocol version implemented in the camera. This allows the PC to choose the right command set for next transactions.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B13	B14-B15
0xFD	4	unused	SEQ	unused	MID	PAYLOAD	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_GET_CAMERA_PROT_VERS` = 12287 (0x2FFF). This is a Get Command type.

PAYLOAD: used for both commands and response:

- Command: Most recent Protocol version implemented by the master.
- Response: Protocol version implanted in the slave (= 1 for the version described in this document).

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B13 bytes.

Unused: must be kept 0.

7.5.2. Set Gamma

The Gamma parameter adjusts the contrast curve of the image in order to compensate the restitution of the final display. The nominal range for the Gamma value is between 0.5 and 2.5.

The Gamma value is encoded in 16-bit fixed point over 32-bit unsigned integer.

Example: Gamma = 0.5 → Encoded value = 0.5*65536 = 32768 (0x08000)

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B13	B14-B15

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0xFD	4	unused	SEQ	unused	MID	GAMMA	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_SET_GAMMA` = 12290 (0x3002). This is a Set Command type.

PAYLOAD: GAMMA: uint32_t, 16-bit fixed point; Gamma value to set.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B13 bytes.

Unused: must be kept 0.

7.5.3. Set Contrast

The CLHE algorithm is a mix between a linear LUT and a histogram equalization. The lower the value applied to this parameter, the more linear the behavior is, and in turn, the higher the value applied to this parameter is, the more equalized the histogram will be.

The CLAHE Algorithm handles the histogram processing locally, say, the image is split into sub images that are processed separately, and the result is interpolated. The CLAHE algorithm is a mix between a linear LUT and a histogram equalization. The lower the applied value to this parameter, the more linear the behavior is, and in turn, the highest the value applied to this parameter is, the more equalized the histogram will be.

This command sets the CLHE value for image processing.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B13	B14-B15
0xFD	4	unused	SEQ	unused	MID	CONTRAST	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_SET_CONTRAST` = 12292 (0x3004). This is a Set Command type.

PAYLOAD: CONTRAST, contrast value to set, between 0 and 30000.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B13 bytes.

Unused: must be kept 0.

7.5.4. NUC_REQUEST

This command processes a new NUC. This NUC will be automatically applied to the output image at the end of the processing if everything goes well.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B14-B15
0xFD	1	unused	SEQ	unused	MID	OPTION	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_NUC_REQUEST`= 12296 (0x3008). This is a Set Command type.

PAYLOAD: OPTION:

- NUC_REQUEST_OPTION_NONE = 0
- NUC_REQUEST_OPTION_WITH_SHUTTER = 1. Manage automatically the shutter before and after the nuc processing

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.

Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.5. Invert Polarity

This command enables or disables the IR image polarity. Standard polarity means hot points are white and cold points are black.

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B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B14-B15
0xFD	1	unused	SEQ	unused	MID	ENABLE	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_INVERT_POLARITY` = 12294 (0x3006). This is a Set Command type.
PAYLOAD: ENABLE, if =1, image polarity inverted; if =0, standard image polarity.
CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.
Unused: must be kept 0.
Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.6. Camera Status

This command gets parameters information from the camera (contrast, gamma, polarity)
This command reads the camera status information.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B28	B29-B30
0xFD	19	unused	SEQ	unused	MID	PAYLOAD	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_CAMERA_STATUS` = 12303 (0x300F). This is a Get Command type.
PAYLOAD: used for both commands and response:

- Command: empty (0x00 that are removed by library).
- Response:
  - Contrast: uint32_t, value set by 'Set Contrast' command.
  - Gamma: uint32_t, value set by 'Set Gamma' command.
  - Reserved: uint8_t.
  - Reserved: uint8_t.
  - Reserved: uint8_t.
  - Reserved: uint8_t.
  - Reserved ion: uint32_t.
  - Reserved: uint8_t.
  - Reserved: uint8_t.
  - IR polarity: uint8_t, value set by 'Invert Polarity' command.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B28 bytes.
Unused: must be kept 0.

7.5.7. Set Zoom Parameters

This command defines the zoom parameters. X_CENTER and Y_CENTER are the pixel count between zoom center and picture left-up corner. X_FACTOR and Y_FACTOR must be between 1.0 and 8.0, expressed in 16-bit fixed point format.
Example: Factor = 2.4 is encoded: 2.4 * 65536 = 157286 (0x26666)

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B13	B14-B17	B18-B21	B22-B25	B26-B27
0xFD	16	unused	SEQ	unused	MID	X_FACTOR	Y_FACTOR	X_CENTER	Y_CENTER	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_SET_ZOOM_PARAMS` = 12310 (0x3016). This is a Set Command type.

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PAYLOAD: center and zoom factor:

- X_FACTOR: uint32_t, 16-bit fixed point; Zoom ratio to be used horizontally.
- Y_FACTOR: uint32_t, 16-bit fixed point; Zoom ratio to be used vertically.
- X_CENTER: uint32_t, pixel count from left side, Zoom center.
- Y_CENTER: uint32_t, pixel count from top side, Zoom center.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B25 bytes.

Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.8. Set Zoom Method

This command defines the zoom algorithm used for pixel interpolation. It can be nearest neighbors or bilinear method.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B11-B12
0xFD	1	unused	SEQ	unused	MID	METHOD	CRC16

0xFD is the magic number for MavLink v2.

MID = `MAVLINK_MSG_SET_ZOOM_METHOD` = 12311 (0x3017). This is a Set Command type.

PAYLOAD: METHOD; can be:

- =0: Nearest method used.
- =1: Bilinear method used.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.

Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.9. Get Zoom Configuration

This command reads the Zoom settings currently in use in the camera. See 'Set Zoom Parameters' and 'Set Zoom Method' for more details.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B26	B27-B28
0xFD	17	unused	SEQ	unused	MID	PAYLOAD	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_GET_ZOOM_CONFIG` = 12316 (0x301C). This is a Get Command type.

PAYLOAD: used for both commands and response:

- Command: empty (0x00 that are removed by library).
- Response: zoom parameters:
  - X_FACTOR: uint32_t, 16-bit fixed point; Zoom ratio to be used horizontally.
  - Y_FACTOR: uint32_t, 16-bit fixed point; Zoom ratio to be used vertically.
  - X_CENTER: uint32_t, pixel count from left side, Zoom center.
  - Y_CENTER: uint32_t, pixel count from top side, Zoom center.
  - METHOD: uint8_t; =0: Nearest method used; =1: Bilinear method used.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B26 bytes.

Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

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7.5.10. Set Contrast Type

Two types of histogram processing are available on CamSight cameras:

- CLHE (Contrast Limited Histogram equalization)
- CLAHE (Contrast Limited Adaptative Histogram Equalization).

Only one method can be selected at a time.

When using CLHE method, the ROI (Region of Interest) must be defined with 'ROI Control' command. The image processing algorithm uses this portion of image as processing reference.

When using CLAHE, ROI (Region of Interest) is not used as the full image is analyzed by the algorithm.

This command sets the type of contrast processing to apply: CLHE or CLAHE.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B11-B12
0xFD	1	unused	SEQ	unused	MID	TYPE	CRC16

0xFD is the magic number for MavLink v2.

MID = `MAVLINK_MSG_ID_CONTRAST_CONTROL` = 12300 (0x300C). This is a Set Command type.

PAYLOAD: TYPE; can be:

- =0: CLHE processing applied.
- =1: CLAHE processing applied.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.

Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.11. Get Contrast Type

This command reads the type of contrast processing applied: CLHE or CLAHE.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B11-B12
0xFD	1	unused	SEQ	unused	MID	TYPE	CRC16

0xFD is the magic number for MavLink v2.

MID = `MAVLINK_MSG_ID_GET_CONTRAST_TYPE` = 12320 (0x3020). This is a Get Command type.

PAYLOAD: used for both commands and response:

- Command: empty (0x00 that is removed by library).
- Response: TYPE; can be:
  - =0: CLHE processing applied.
  - =1: CLAHE processing applied.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.

Unused: must be kept 0.

7.5.12. Get Firmware ID

This command reads both FPGA and RISC-V firmware IDs.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B11	B12-B13	B14-B15
0xFD	4	unused	SEQ	unused	MID	FPGA_V	RISCV_V	CRC16

0xFD is the magic number for MavLink v2.

MID = `MAVLINK_MSG_ID_GET_FIRMWARE_ID` = 12321 (0x3021). This is a Get Command type.

PAYLOAD: used for both commands and response:

- Command: empty (0x00 that is removed by library).
- Response: versions:

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- FPGA_V: (uint16_t)
  - Bit 13: (1) MIPI enable / (0) MIPI disable
  - Bit 12: (1) 9Hz Hz locked version / (0) 9/25/30/60 Hz version
  - Bits 0 to 11: FPGA firmware version. Format is hexadecimal 0x211 for 2.1.1.
- RISCV_V : uint16_t, RISC-V firmware version.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B13 bytes.
Unused: must be kept 0.

7.5.13. Get Flip Horizontal

This message reads the horizontal flip state.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B11-B12
0xFD	1	unused	SEQ	unused	MID	ENABLE	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_GET_FLIP_H` = 12322 (0x3022). This is a Get Command type.
PAYLOAD: used for both command and response:

- Command: empty.
- Response: ENABLE, =1 horizontal flip enabled; =0 horizontal flip disabled.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.
Unused: must be kept 0.
Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.14. Set Flip Horizontal

This message enables or disables the horizontal flip (rear mirror effect).

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B11-B12
0xFD	1	unused	SEQ	unused	MID	ENABLE	CRC16

0xFD is the magic number for MavLink v2.
MID = `MAVLINK_MSG_ID_SET_FLIP_H` = 12323 (0x3023). This is a Set Command type.
PAYLOAD: ENABLE, =1 to enable horizontal flip; =0 to disable horizontal flip.
CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.
Unused: must be kept 0.
Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.15. Set Column Noise Correction

This message enables or disables the column correction processing.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B11-B12
0xFD	1	unused	SEQ	unused	MID	ENABLE	CRC16

0xFD is the magic number for MavLink v2.
MID = `MAVLINK_MSG_ID_SET_COLUMN_CORRECTION` = 12326 (0x3026). This is a Set Command type.
PAYLOAD: ENABLE, =1 to enable column correction; =0 to disable column correction.
CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.
Unused: must be kept 0.
Note: if the camera doesn't implement this command, it responds with NACK packet.

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7.5.16. Get Column Noise Correction

This message reads the column correction processing state.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B11-B12
0xFD	1	unused	SEQ	unused	MID	ENABLE	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_GET_COLUMN_CORRECTION` = 12327 (0x3027). This is a Get Command type.

PAYLOAD: used for both command and response:

- Command: empty.
- Response: ENABLE, =1 column correction enabled; =0 column correction disabled.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.

Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.17. Set Vignetting Correction

This message enables or disables the vignetting correction processing.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B11-B12
0xFD	1	unused	SEQ	unused	MID	ENABLE	CRC16

0xFD is the magic number for MavLink v2.

MID = `MAVLINK_MSG_ID_SET_VIGNETTING_CORRECTION` = 12328 (0x3028). This is a Set Command type.

PAYLOAD: ENABLE, =1 to enable vignetting correction; =0 to disable vignetting correction.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.

Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.18. Get Vignetting Correction

This message reads the vignetting correction processing state.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B11-B12
0xFD	1	unused	SEQ	unused	MID	ENABLE	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_GET_VIGNETTING_CORRECTION` = 12329 (0x3029). This is a Get Command type.

PAYLOAD: used for both command and response:

- Command: empty.
- Response: ENABLE, =1 vignetting correction enabled; =0 vignetting correction disabled.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.

Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

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7.5.19. Set Frame Rate

This command sets the video output frame rate. This information is stored in non-volatile memory. It is applied immediately and at next start-up.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B13	B14-B15
0xFD	4	unused	SEQ	unused	MID	FRAMERATE	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_SET_FRAMERATE` = 12330 (0x302A). This is a Set Command type.

PAYLOAD: VALUE, uint32_t, frame rate to apply, unit is frame per second.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B13 bytes.

Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.20. Get Frame Rate

This command reads the video output frame rate currently in use.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B13	B14-B15
0xFD	4	unused	SEQ	unused	MID	FRAMERATE	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_GET_FRAMERATE` = 12331 (0x302B). This is a Get Command type.

PAYLOAD: used for both commands and response:

- Command: empty (0x00 that are removed by library).
- Response: uint32_t, 8-bit fixed point, sharpening value.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B13 bytes.

Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.21. Set Video Select

This command selects the video source to use as output for parallel and MIPI.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B11-B12
0xFD	1	unused	SEQ	unused	MID	VALUE	CRC16

0xFD is the magic number for MavLink v2.

MID = `MAVLINK_MSG_ID_SET_VIDEO_SELECT` = 12332 (0x302C). This is a Set Command type.

PAYLOAD: VALUE; can be:

- 0: RAW_OUTPUT; raw mode, 640x480, 14-bit pixels
- 1: NUC_OUTPUT; NUC mode, 640x480, 14-bit pixels
- 2: COLUMN_OUTPUT; column correction, 640x480, 14-bit pixels
- 3: VIGNETTING_OUTPUT; vignetting correction, 640x480, 14-bit pixels
- 4: EDGE_OUTPUT; edge correction, 640x480, 14-bit pixels
- 5: LUT_OUTPUT; LUT correction, 640x480, 8-bit pixels. Default setting for customer usage.
- 6: RFU_OUTPUT; reserved for future use.
- 7: ZOOM_OUTPUT; Zoom mode, 720x576, parallel format, 8-bit pixels.
- 8: BT656_OUTPUT; BT656 format. **(Must be selected for PAL output)**

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CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.
Unused: must be kept 0.
Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.22. Get Video Select

This command reads the video source currently in use as output.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B11-B12
0xFD	1	unused	SEQ	unused	MID	VALUE	CRC16

0xFD is the magic number for MavLink v2.
MID = `MAVLINK_MSG_ID_GET_VIDEO_SELECT` = 12333 (0x302D). This is a Get Command type.
PAYLOAD: used for both commands and response:

- Command: empty (0x00 that is removed by library).
- Response: VALUE; see 'Set Video Select' command description.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.
Unused: must be kept 0.
Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.23. Set Edge Parameters

This command enables or disables the video edge processing (sharpening or contouring) and sets the corresponding parameters.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B22	B23-B24
0xFD	17	unused	SEQ	unused	MID	PAYLOAD	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_SET_EDGE_PARAMS` = 12334 (0x302E). This is a Set Command type.
PAYLOAD: linear description:

- MODE: uint8_t; Video edge processing mode, can be:
  - =0: disabled.
  - =1: Sharpening mode.
  - =2: Contouring mode.
- GAIN: uint32_t, 8-bit fixed point; used in sharpening mode only.
- THRESHOLD_1: uint32_t; between 0 and 255.
- THRESHOLD_2: uint32_t; between 0 and 255, must be higher than THRESHOLD_1.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B22 bytes.
Unused: must be kept 0.
Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.24. Get Edge Parameters

This command reads the video edge processing settings currently in use in the camera.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B22	B23-B24
0xFD	17	unused	SEQ	unused	MID	PAYLOAD	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.

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MID = `MAVLINK_MSG_ID_GET_EDGE_PARAMS` = 12335 (0x302F). This is a Get Command type.
PAYLOAD: used for both commands and response:

- Command: empty (0x00 that are removed by library).
- Response: VALUE; see 'Set Edge Parameters' command description.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B22 bytes.
Unused: must be kept 0.
Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.25. Set ZOOM output resolution

This command set the output zoom resolution.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B17	B18-B19
0xFD	8	unused	SEQ	unused	MID	PAYLOAD	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_SET_ZOOM_OUTPUT_RESOLUTION`= 12338 (0x3032). This is a Set Command type.
PAYLOAD: linear description:

- x_resolution: uint32_t; resolution axis X (CamSight LS Default = 720)
- y_resolution: uint32_t; resolution axis Y (CamSight LS Default = 576)

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B17 bytes.
Unused: must be kept 0.
Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.26. Get ZOOM output resolution

This command set the output zoom resolution.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B17	B18-B19
0xFD	8	unused	SEQ	unused	MID	PAYLOAD	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_GET_ZOOM_OUTPUT_RESOLUTION`= 12339 (0x3033). This is a Get Command type.
PAYLOAD: used for both commands and response:

- Command: empty (0x00 that are removed by library).
- Response: VALUE; see 'Set ZOOM output resolution' command description.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B17 bytes.
Unused: must be kept 0.
Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.27. Set colorlut

This command set the false colorlut type.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B13	B14-B15
0xFD	8	unused	SEQ	unused	MID	PAYLOAD	CRC16

0xFD is the magic number for MavLink v2.

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SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_SET_COLORLUT`= 12340 (0x3034). This is a Set Command type.
PAYLOAD: linear description:

- x_ colorlut_sel: uint32_t; can be:
  - 0: GREYSCALE (no colors)
  - 1: IRON
  - 2: HOT
  - 3: RAINBOW
  - 4: NCAR
  - 5: COOLWARM
  - 6: CUBEHELIX

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B13 bytes.
Unused: must be kept 0.
Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.28. Get colorlut

This command sets the colorlut type.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B13	B14-B15
0xFD	8	unused	SEQ	unused	MID	PAYLOAD	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_GET_COLORLUT`= 12341 (0x3035). This is a Get Command type.
PAYLOAD: linear description:
PAYLOAD: used for both commands and response:

- Command: empty (0x00 that are removed by library).
- Response: VALUE; see 'Set colorlut' command description.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B13 bytes.
Unused: must be kept 0.
Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.29. Set SDI Output

This command enables or disables the SDI output.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B14-B15
0xFD	8	unused	SEQ	unused	MID	Value	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_SET_SDI_OUTPUT`= 12342 (0x3036). This is a Set Command type.
PAYLOAD: linear description:

- Value: Enable = 1/disable = 0

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.
Unused: must be kept 0.
Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.30. Get SDI Output

This command gets the status of the SDI Output.

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B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B14-B15
0xFD	8	unused	SEQ	unused	MID	Value	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_GET_SDI_OUTPUT`= 12343 (0x3037). This is a Get Command type.
PAYLOAD: used for both commands and response:

- Command: empty (0x00 that are removed by library).
- Response: VALUE; see 'Set SDI Output' command description.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.
Unused: must be kept 0.
Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.31. Set parallel Output

This command enables or disables the parallel output.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B14-B15
0xFD	8	unused	SEQ	unused	MID	Value	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_SET_PARALLEL_OUTPUT`= 12344 (0x3038). This is a Set Command type.
PAYLOAD: linear description:

- Value: Enable = 1/disable = 0

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.
Unused: must be kept 0.
Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.32. Get parallel Output

This command gets the status of the parallel Output.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B14-B15
0xFD	8	unused	SEQ	unused	MID	Value	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_GET_PARALLEL_OUTPUT`= 12345 (0x3039). This is a Get Command type.
PAYLOAD: used for both commands and response:

- Command: empty (0x00 that are removed by library).
- Response: VALUE; see 'Set parallel Output' command description.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.
Unused: must be kept 0.
Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.33. Set MIPI CSI-2 Output

This command enables or disables the MIPI CSI-2 output.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B14-B15
0xFD	8	unused	SEQ	unused	MID	Value	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_SET_MIPI_OUTPUT` = 12346 (0x303A). This is a Set Command type.

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PAYLOAD: linear description:

- Value: Enable = 1/disable = 0

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.

Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.34. Get MIPI CSI-2 Output

This command gets the status of the MIPI CSI-2 output.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B14-B15
0xFD	8	unused	SEQ	unused	MID	Value	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_GET_MIPI_OUTPUT`= 12347 (0x303B). This is a Get Command type.

PAYLOAD: used for both commands and response:

- Command: empty (0x00 that are removed by library).
- Response: VALUE; see 'Set MIPI CSI-2 Output' command description.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B10 bytes.

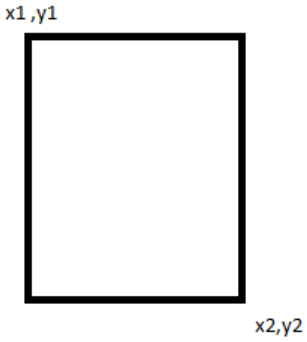
Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.35. Set ROI 0 inclusive

This command defines the Region of Interest inside current image. Note that this setting is used in CLHE mode only (not used in CLAHE mode).

The message contains 2 coordinates (x1, y1) et (x2, y2) that define the ROI rectangle as depicted in the picture below:



The reference of these values is the picture left-up corner.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B11	B12-B13	B14-B15	B16-B17	B18-B19
0xFD	8	unused	SEQ	unused	MID	X1	X2	Y1	Y2	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_ROI_CONTROL` = 12297 (0x3009). This is a Set Command type.

PAYLOAD: image positions defining the ROI:

- X1: X start: left limit of the ROI.
- X2: X end: right limit of the ROI.
- Y1: Y start: up limit of the ROI.
- Y2: Y end: bottom limit of the ROI.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B17 bytes.

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Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.36. Get ROI 0 inclusive

This command reads the Region Of Interest currently in use in the camera. Note that this setting is used in CLHE mode only (not used in CLAHE mode).

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B11	B12-B13	B14-B15	B16-B17	B18-B19
0xFD	8	unused	SEQ	unused	MID	X1	X2	Y1	Y2	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_GET_ROI` = 12315 (0x301B). This is a Get Command type.

PAYLOAD: used for both commands and response:

- Command: empty (0x00 that are removed by library).
- Response: image positions defining the ROI:
  - X1: X start: left limit of the ROI.
  - X2: X end: right limit of the ROI.
  - Y1: Y start: up limit of the ROI.
  - Y2: Y end: bottom limit of the ROI.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B17 bytes.

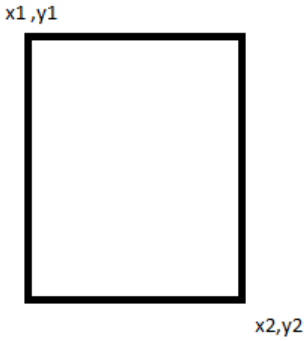
Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.37. Set ROI 1 inclusive

This command defines the optional Region of Interest 1 inside current image. It is used to include another rectangle to the ROI. Note that this setting is used in CLHE mode only (not used in CLAHE mode).

The message contains 2 coordinates (x1, y1) et (x2, y2) that define the ROI rectangle as depicted in the picture below:



The reference of these values is the picture left-up corner.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B11	B12-B13	B14-B15	B16-B17	B18-B19
0xFD	8	unused	SEQ	unused	MID	X1	X2	Y1	Y2	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_SET_ROI1_inclusive`= 12348 (0x303C). This is a Set Command type.

PAYLOAD: image positions defining the ROI:

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- X1: X start: left limit of the ROI. Unused = 0.
- X2: X end: right limit of the ROI. Unused = 0.
- Y1: Y start: up limit of the ROI. Unused = 0.
- Y2: Y end: bottom limit of the ROI. Unused = 0.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B17 bytes.

Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.38. Get ROI 1 inclusive

This command reads the Region of Interest 1 currently in use in the camera. Note that this setting is used in CLHE mode only (not used in CLAHE mode).

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B11	B12-B13	B14-B15	B16-B17	B18-B19
0xFD	8	unused	SEQ	unused	MID	X1	X2	Y1	Y2	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_GET_ROI1_inclusive` = 12349 (0x303D). This is a Get Command type.

PAYLOAD: used for both commands and response:

- Command: empty (0x00 that are removed by library).
- Response: image positions defining the ROI:
  - X1: X start: left limit of the ROI.
  - X2: X end: right limit of the ROI.
  - Y1: Y start: up limit of the ROI.
  - Y2: Y end: bottom limit of the ROI.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B17 bytes.

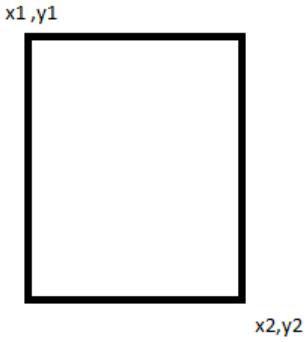
Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.39. Set ROI 0 exclusive

This command defines the optional Region of Interest 0 exclusive inside current image. It is used to exclude a rectangle from the ROI. Note that this setting is used in CLHE mode only (not used in CLAHE mode).

The message contains 2 coordinates (x1, y1) et (x2, y2) that define the ROI rectangle as depicted in the picture below:



The reference of these values is the picture left-up corner.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B11	B12-B13	B14-B15	B16-B17	B18-B19

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0xFD	8	unused	SEQ	unused	MID	X1	X2	Y1	Y2	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_SET_ROI0_exclusive`= 12350 (0x303E). This is a Set Command type.

PAYLOAD: image positions defining the ROI:

- X1: X start: left limit of the ROI. Unused = 0.
- X2: X end: right limit of the ROI. Unused = 0.
- Y1: Y start: up limit of the ROI. Unused = 0.
- Y2: Y end: bottom limit of the ROI. Unused = 0.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B17 bytes.

Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.40. Get ROI 0 exclusive

This command reads the Region Of Interest 0 exclusive currently in use in the camera. Note that this setting is used in CLHE mode only (not used in CLAHE mode).

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B11	B12-B13	B14-B15	B16-B17	B18-B19
0xFD	8	unused	SEQ	unused	MID	X1	X2	Y1	Y2	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_GET_ROI0_exclusive` = 12351 (0x303F). This is a Get Command type.

PAYLOAD: used for both commands and response:

- Command: empty (0x00 that are removed by library).
- Response: image positions defining the ROI:
  - X1: X start: left limit of the ROI.
  - X2: X end: right limit of the ROI.
  - Y1: Y start: up limit of the ROI.
  - Y2: Y end: bottom limit of the ROI.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B17 bytes.

Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.41. Set ROI 1 exclusive

This command defines the optional Region of Interest 1 exclusive inside current image. It is used to exclude a rectangle from the ROI. Note that this setting is used in CLHE mode only (not used in CLAHE mode).

The message contains 2 coordinates (x1, y1) et (x2, y2) that define the ROI rectangle as depicted in the picture below:

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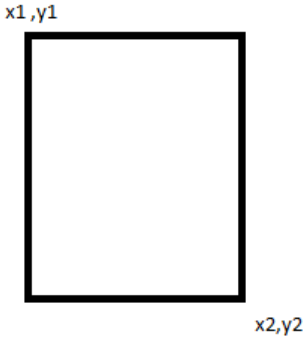

The reference of these values is the picture left-up corner.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B11	B12-B13	B14-B15	B16-B17	B18-B19
0xFD	8	unused	SEQ	unused	MID	X1	X2	Y1	Y2	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_SET_ROI1_exclusive`= 12352 (0x3040). This is a Set Command type.

PAYLOAD: image positions defining the ROI:

- X1: X start: left limit of the ROI. Unused = 0.
- X2: X end: right limit of the ROI. Unused = 0.
- Y1: Y start: up limit of the ROI. Unused = 0.
- Y2: Y end: bottom limit of the ROI. Unused = 0.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B17 bytes.

Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.42. Get ROI 1 exclusive

This command reads the Region of Interest 1 exclusive currently in use in the camera. Note that this setting is used in CLHE mode only (not used in CLAHE mode).

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B11	B12-B13	B14-B15	B16-B17	B18-B19
0xFD	8	unused	SEQ	unused	MID	X1	X2	Y1	Y2	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_GET_ROI0_exclusive` = 12353 (0x3041). This is a Get Command type.

PAYLOAD: used for both commands and response:

- Command: empty (0x00 that are removed by library).
- Response: image positions defining the ROI:
  - X1: X start: left limit of the ROI.
  - X2: X end: right limit of the ROI.
  - Y1: Y start: up limit of the ROI.
  - Y2: Y end: bottom limit of the ROI.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B17 bytes.

Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

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7.5.43. Set AHC gain limitation

This command defines AHC (Automatic Histogram Control) gain limit to CLHE and CLAHE algorithm. It is used to limit the maximum amplification of the histogram in case of low contrast.

The message contains 2 parameters (BLACK_LIMITATION, WHITE_LIMITATION) to choose the behavior of the limitation. For example, by setting BLACK_LIMITATION = 20 and WHITE_LIMITATION = 0, the image will be limited in the dark. By setting BLACK_LIMITATION = WHITE_LIMITATION = 20 the image will be limited in grey.

The AHC will be limited to $BLACK_LIMITATION^2 + WHITE_LIMITATION^2$. SITF is usually around 40 DL/°C, if BLACK_LIMITATION = WHITE_LIMITATION = 10, so AHC limit will be $10^2+10^2 = 200$, 200/40 = 5°C. If contrast is below 5°C, the gain will be limited.

The reference of these values is the picture left-up corner.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B11	B12-B13
0xFD	8	unused	SEQ	unused	MID	PAYLOAD	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_SET_AHC_GAIN_LIMITATION` = 12354 (0x3042). This is a Set Command type.

PAYLOAD:

- BLACK_LIMITATION: from 0 to 100, limit the AHC to black.
- WHITE_LIMITATION: from 0 to 100, limit the AHC to white.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B17 bytes.

Unused: must be kept 0.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.44. Get AHC gain limitation

This command gets AHC (Automatic Histogram Control) gain limit to CLHE and CLAHE algorithm.

The reference of these values is the picture left-up corner.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B12	B13-B14
0xFD	8	unused	SEQ	unused	MID	PAYLOAD	CRC16

0xFD is the magic number for MavLink v2.

SEQ: sequence number, incremented at each command.

MID = `MAVLINK_MSG_ID_GET_AHC_GAIN_LIMITATION` = 12355 (0x3043). This is a Get Command type.

PAYLOAD:

- BLACK_LIMITATION: from 0 to 100, limit the AHC to black.
- WHITE_LIMITATION: from 0 to 100, limit the AHC to white.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B17 bytes.

Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.45. Set LUT Temporal filter

This command defines AHC (Automatic Histogram Control) speed for CLHE and CLAHE algorithm. A recursive filter limits the AHC speed. alpha = $1/2^{N_filter}$

The reference of these values is the picture left-up corner.

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B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B11-B12
0xFD	8	unused	SEQ	unused	MID	PAYLOAD	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_SET_LUT_TEMPORAL_FILTER`= 12356 (0x3044). This is a Set Command type.
PAYLOAD:

- N_Filter: from 0 to 8

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B17 bytes.
Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.46. Get LUT Temporal filter

This command defines AHC (Automatic Histogram Control) speed for CLHE and CLAHE algorithm. A recursive filter limits the AHC speed. alpha = $1/2^{N_filter}$

The reference of these values is the picture left-up corner.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10	B11-B12
0xFD	8	unused	SEQ	unused	MID	PAYLOAD	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_GET_LUT_TEMPORAL_FILTER`= 12357 (0x3045). This is a Get Command type.
PAYLOAD:

- N_Filter: from 0 to 8

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B17 bytes.
Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.47. Get camera temperatures

This command gets camera internal temperatures. The unit is mK (millikelvin).

The reference of these values is the picture left-up corner.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B17	B18-B19
0xFD	8	unused	SEQ	unused	MID	PAYLOAD	CRC16

0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_GET_CAMERA_TEMPERATURE`= 12359 (0x3047). This is a Get Command type.
PAYLOAD:

- FPGA_TEMPERATURE: (uint32_t)
- SENSOR_TEMPERATURE: (uint32_t)

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B17 bytes.
Note: if the camera doesn't implement this command, it responds with NACK packet.

7.5.48. Get camera informations

This command gets number of startups and operating time from the camera.
The reference of these values is the picture left-up corner.

B0	B1	B2-B3	B4	B5-B6	B7-B9	B10-B17	B18-B19
0xFD	8	unused	SEQ	unused	MID	PAYLOAD	CRC16

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0xFD is the magic number for MavLink v2.
SEQ: sequence number, incremented at each command.
MID = `MAVLINK_MSG_ID_GET_CAMERA_INFO`= 12361 (0x3049). This is a Get Command type.
PAYLOAD:

- STARTUP_NUMBER: (uint32_t). Number of camera startups
- OPERATING_TIME: (uint32_t). Minutes of operations.

CRC16: 16-bit CRC (MCRF4XX) computed over B1 to B17 bytes.
Note: if the camera doesn't implement this command, it responds with NACK packet.

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8. MIPI CSI I2C COMMUNICATION INTERFACE

Available for version superior to 2.2.0.

8.1. Overview

The control part of the MIPI-CSI standard relies on a I2C (Inter-Integrated Circuit) link, allowing processors to configure and control the camera during MIPI operation.

The camera, accessible via the I2C bus at address 0x30, offers compatibility with frequencies of 100kHz and 400kHz. Presently, the I2C address of the camera is fixed and cannot be modified.

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8.2. I²C Register Map

8.2.1. I²C Register Summary

ADDRESS	REGISTER	R / W	DESCRIPTION
0x00	DEVICE_INFO	R	Device type and register map version.
0x01	FPGA_VERSION_LSB	R	Version of the FPGA (LSB).
0x02	FPGA_VERSION_MSB	R	Version of the FPGA (MSB).
0x03	RISCV_VERSION_LSB	R	Version of the RISCV (LSB).
0x04	RISCV_VERSION_MSB	R	Version of the RISCV (MSB).
0x05	CAMERA_SN_LSB	R	Serial number of the camera (LSB).
0x06	CAMERA_SN_MSB	R	Serial number of the camera (MSB).
0x07	SENSOR_SN_PART1	R	Serial number of the sensor.
0x08	SENSOR_SN_PART2	R	Serial number of the sensor.
0x09	SENSOR_SN_PART3	R	Serial number of the sensor.
0x0A	SENSOR_SN_PART4	R	Serial number of the sensor.
0x0B	FPGA_TEMP_LSB	R	FPGA Temperature.
0x0C	FPGA_TEMP_MSB	R	FPGA Temperature.
0x0D	CAMERA_TEMP_LSB	R	Camera temperature
0x0E	CAMERA_TEMP_MSB	R	Camera temperature
0x0F	CONTRAST_CFG	RW	Contrast configuration register
0x10	GAMMA_FACTOR	RW	Configure the gamma correction factor
0x11	CONTRAST_VAL_LSB	RW	Set histogram limit for CLAHE algorithm. (LSB)
0x12	CONTRAST_VAL_MSB	RW	Set histogram limit for CLAHE algorithm. (MSB)
0x13	GAIN_BLACK_LIMIT	RW	Set the limit for the black gain.
0x14	GAIN_WHIETE_LIMIT	RW	Set the limit for the white gain.
0x15	TEMPORAL_FILTER	RW	Set temporal filter value
0x16	ROI0_INC_X1_LSB	RW	Define ROI 0 inclusive X1 (LSB)
0x17	ROI0_INC_X1_MSB	RW	Define ROI 0 inclusive X1(MSB)
0x18	ROI0_INC_X2_LSB	RW	Define ROI 0 inclusive X2 (LSB)
0x19	ROI0_INC_X2_MSB	RW	Define ROI 0 inclusive X2 (MSB)
0x1A	ROI0_INC_Y1_LSB	RW	Define ROI 0 inclusive Y1 (LSB)
0x1B	ROI0_INC_Y1_MSB	RW	Define ROI 0 inclusive Y1 (MSB)
0x1C	ROI0_INC_Y2_LSB	RW	Define ROI 0 inclusive Y2 (LSB)
0x1D	ROI0_INC_Y2_MSB	RW	Define ROI 0 inclusive Y2 (MSB)
0x1E	ROI1_INC_X1_LSB	RW	Define ROI 1 inclusive X1 (LSB)
0x1F	ROI1_INC_X1_MSB	RW	Define ROI 1 inclusive X1 (MSB)
0x20	ROI1_INC_X2_LSB	RW	Define ROI 1 inclusive X2 (LSB)
0x21	ROI1_INC_X2_MSB	RW	Define ROI 1 inclusive X2 (MSB)
0x22	ROI1_INC_Y1_LSB	RW	Define ROI 1 inclusive Y1 (LSB)

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0x23	ROI1_INC_Y1_MSB	RW	Define ROI 1 inclusive Y1(MSB)
0x24	ROI1_INC_Y2_LSB	RW	Define ROI 1 inclusive Y2 (LSB)
0x25	ROI1_INC_Y2_MSB	RW	Define ROI 1 inclusive Y2 (MSB)
0x26	ROI0_EXCL_X1_LSB	RW	Define ROI 0 exclusive X1 (LSB)
0x27	ROI0_EXCL_X1_MSB	RW	Define ROI 0 exclusive X1 (MSB)
0x28	ROI0_EXCL_X2_LSB	RW	Define ROI 0 exclusive X2 (LSB)
0x29	ROI0_EXCL_X2_MSB	RW	Define ROI 0 exclusive X2 (MSB)
0x2A	ROI0_EXCL_Y1_LSB	RW	Define ROI 0 exclusive Y1 (LSB)
0x2B	ROI0_EXCL_Y1_MSB	RW	Define ROI 0 exclusive Y1 (MSB)
0x2C	ROI0_EXCL_Y2_LSB	RW	Define ROI 0 exclusive Y2 (LSB)
0x2D	ROI0_EXCL_Y2_MSB	RW	Define ROI 0 exclusive Y2 (MSB)
0x2E	ROI1_EXCL_X1_LSB	RW	Define ROI 1 exclusive X1 (LSB)
0x2F	ROI1_EXCL_X1_MSB	RW	Define ROI 1 exclusive X1 (MSB)
0x30	ROI1_EXCL_X2_LSB	RW	Define ROI 1 exclusive X2 (LSB)
0x31	ROI1_EXCL_X2_MSB	RW	Define ROI 1 exclusive X2 (MSB)
0x32	ROI1_EXCL_Y1_LSB	RW	Define ROI 1 exclusive Y1 (LSB)
0x33	ROI1_EXCL_Y1_MSB	RW	Define ROI 1 exclusive Y1 (MSB)
0x34	ROI1_EXCL_Y2_LSB	RW	Define ROI 1 exclusive Y2 (LSB)
0x35	ROI1_EXCL_Y2_MSB	RW	Define ROI 1 exclusive Y2 (MSB)
0x36	OUTPUT_CFG_1	RW	Configure output type and frame rate.
0x37	OUTPUT_CFG_2	RW	Configure hardware output and correction type.
0x38	OUTPUT_X_RES_LSB	RW	Configure X axis output resolution (LSB).
0x39	OUTPUT_X_RES_MSB	RW	Configure X axis output resolution (MSB).
0x3A	OUTPUT_Y_RES_LSB	RW	Configure Y axis output resolution (LSB).
0x3B	OUTPUT_Y_RES_MSB	RW	Configure Y axis output resolution (MSB).
0x3C	ZOOM_CENTER_X_LSB	RW	Configure zoom center for axis X (LSB).
0x3D	ZOOM_CENTER_X_MSB	RW	Configure zoom center for axis X (MSB).
0x3E	ZOOM_CENTER_Y_LSB	RW	Configure zoom center for axis Y (LSB).
0x3F	ZOOM_CENTER_Y_MSB	RW	Configure zoom center for axis Y (MSB).
0x40	ZOOM_FACTOR_X_LSB	RW	Configure zoom factor for axis X (LSB).
0x41	ZOOM_FACTOR_X_MSB	RW	Configure zoom factor for axis X (MSB).
0x42	ZOOM_FACTOR_Y_LSB	RW	Configure zoom factor for axis Y (LSB).
0x43	ZOOM_FACTOR_Y_MSB	RW	Configure zoom factor for axis Y (MSB).
0x44	ZOOM_CFG	RW	Configure image flip and zoom method.
0x45	EDGE_CFG	RW	Configure the EDGE mode
0x46	EDGE_GAIN_LSB	RW	Sharpening filter gain (LSB)
0x47	EDGE_GAIN_MSB	RW	Sharpening filter gain (MSB)
0x48	EDGE_THRESHOLD_1	RW	Sharpening filter threshold 1
0x49	EDGE_THRESHOLD_2	RW	Sharpening filter threshold 2
0x50	SHUTTER	RW	Open and Close shutter

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0x51	NUC_1POINT_RQST	RW	Set NUC 1 point reference

8.2.2. Registers description

8.2.2.1. DEVICE_INFO Register (address = 0x00)

This register contains the type of the device and the version of this register map. This version can be used to check driver compatibility.

7	6	5	4	3	2	1	0
DEVICE_ID				MAP_VERSION			
R				R			

Bit	Field	Type	Reset	Description
7-4	DEVICE_ID	R	TBD	The device ID. 0x02 = CamSight LS TBD => Add other device ID
3-0	MAP_VERSION	R	1h	The version of this register map. The current version is 0x01.

8.2.2.2. FPGA_VERSION Registers (address = 0x01 & 0x02)

These registers contain the FPGA's version. The most significant bit (MSB) value is available at address 0x02, and the least significant bit (LSB) at address 0x01.

7	6	5	4	3	2	1	0
FPGA_VERSION_LSB							
R							

7	6	5	4	3	2	1	0
FPGA_VERSION_MSB							
R							

8.2.2.3. RISCV_VERSION Registers (address = 0x03 & 0x04)

These registers contain the RISCV's version. The most significant bit (MSB) value is available at address 0x04, and the least significant bit (LSB) at address 0x03.

7	6	5	4	3	2	1	0
RSCV_VERSION_LSB							
R							

7	6	5	4	3	2	1	0
RISCV_VERSION_MSB							
R							

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8.2.2.4. CAMERA_SN Registers (address = 0x05 & 0x06)

These registers contain the serial number of the camera. The most significant bit (MSB) value is available at address 0x04, and the least significant bit (LSB) at address 0x06.

7	6	5	4	3	2	1	0
CAMERA_SN_LSB							
R							

7	6	5	4	3	2	1	0
CAMERA_SN_MSB							
R							

8.2.2.5. SENSOR_SN Registers (address = 0x07 & 0x08 & 0x09 & 0x0A)

These registers contain the serial number of the sensor. The most significant bit (MSB) value is available at address 0x04, and the least significant bit (LSB) at address 0x06.

7	6	5	4	3	2	1	0
SENSOR_SN_PART1							
R							

7	6	5	4	3	2	1	0
SENSOR_SN_PART2							
R							

7	6	5	4	3	2	1	0
SENSOR_SN_PART3							
R							

7	6	5	4	3	2	1	0
SENSOR_SN_PART4							
R							

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8.2.2.6. FPGA_TEMPERATURE Register (address = 0x0B & 0x0C)

These registers contain the temperature of the FPGA. The MSB value is available at address 0x0C and the LSB at the address 0x0B.

The value unit is 10 m°.

Example

- Registers value = 0x157C => 5500 * 10 = 55 000m° = 55°
- Registers value = 0x2BC0 => 11200 * 10 = 112 000m° = 112°
- Registers value = 0xF060 => -4000 * 10 = -40 000m° = -40°

7	6	5	4	3	2	1	0
FPGA_TEMPERATURE_LSB							
R							

7	6	5	4	3	2	1	0
FPGA_TEMPERATURE_MSB							
R							

8.2.2.7. CAM_TEMPERATURE Register (address = 0x0D & 0x0E)

These registers contain the temperature of the camera. The MSB value is available at the address 0x0E and the LSB at the address 0x0D.

The value unit is 10 mC°.

Example

- Registers value = 0x157C => 5500 * 10 = 55 000m° = 55°
- Registers value = 0x2BC0 => 11200 * 10 = 112 000m° = 112°
- Registers value = 0xF060 => -4000 * 10 = -40 000m° = -40°

7	6	5	4	3	2	1	0
CAM_TEMPERATURE_LSB							
R							

7	6	5	4	3	2	1	0
CAM_TEMPERATURE_MSB							
R							

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8.2.2.8. CONTRAST_CFG Register (address = 0x0F)

This register configures the contrast and several LUT settings.

7	6	5	4	3	2	1	0
LUT_COLOR				Reserved	Reserved	POLARITY	CONTRAT_MODE
R/W				R	R	R/W	R/W

Bit	Field	Type	Reset	Description
7-4	LUT_COLOR	R/W	0h	LUT color selection. 0d = GREYSCALE 1d = IRON 2d = HOT 3d = RAINBOW 4d = NCAR 5d = COOLWARM 6d = CUBEHELIX 7d =GRAYSCALE YCBCR
3	Reserved	R	0h	Reserved
2	Reserved	R	0h	Reserved
1	POLARITY	R/W	0h	Invert polarity. 0d = Normal 1d = Inverted
0	CONTRAT_MODE	R/W	0h	Select the contrast mode. 0d = ROI mode (CLHE) 1d = Locale mode (CLAHE)

8.2.2.9. GAMMA_FACTOR Register (address = 0x10)

This register configures the gamma correction factor.

Gamma factor is equal at:
GAMMA_FACTOR Gamma = (GAMMA_FACTOR * 10) + 0,5

7	6	5	4	3	2	1	0
GAMMA_FACTOR							
R/W							

Bit	Field	Type	Reset	Description
7-0	GAMMA_FACTOR	R/W	0h	1 is equal to a factor of 0.1

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8.2.2.10. CONTRAST_VALUE Registers (address = 0x11 & 0x12)

These registers contain the histogram limit value used in the CLAHE algorithm. The most significant bit (MSB) value is available at address 0x12, and the least significant bit (LSB) at address 0x11. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed.

The value must be within the range [0:10000].

7	6	5	4	3	2	1	0
CONTRAST_VAL_LSB							
R/W							

7	6	5	4	3	2	1	0
CONTRAST_VAL_MSB							
R/W							

8.2.2.11. GAIN_BLACK_LIMIT Register (address = 0x13)

This register configures the black limit value used in the CLAHE algorithm.

The value must be within the range [0:100].

7	6	5	4	3	2	1	0
CONTRAST_VAL_LSB							
R/W							

8.2.2.12. GAIN_WHITE_LIMIT Register (address = 0x14)

This register configures the white limit value used in the CLAHE algorithm.

The value must be within the range [0:100].

7	6	5	4	3	2	1	0
CONTRAST_VAL_LSB							
R/W							

8.2.2.13. TEMPORAL_FILTER Register (address = 0x15)

This register configures the temporal filter which is used in the CLAHE algorithm.

The value must be within the range [0:8].

7	6	5	4	3	2	1	0
CONTRAST_VAL_LSB							
R/W							

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8.2.2.14. ROI0_INC_X1 Registers (address = 0x16 & 0x17)

These registers contain the position of X1 used by the ROI 0 inclusive. The most significant bit (MSB) value is available at address 0x17, and the least significant bit (LSB) at address 0x16. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed. The ROI is considered only when the coordinates (X1, Y1) and (X2, Y2) are either both equal to 0 or if they are both different from 0. In the case where all coordinates are 0, then the ROI is disabled.

The value must be within the range [5:675].

7	6	5	4	3	2	1	0
ROI0_INC_X1_LSB							
R/W							

7	6	5	4	3	2	1	0
ROI0_INC_X1_MSB							
R/W							

8.2.2.15. ROI0_INC_X2 Registers (address = 0x18 & 0x19)

These registers contain the position of X2 used by the ROI 0 inclusive. The most significant bit (MSB) value is available at address 0x19, and the least significant bit (LSB) at address 0x18. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed. The ROI is considered only when the coordinates (X1, Y1) and (X2, Y2) are either both equal to 0 or if they are both different from 0. In the case where all coordinates are 0, then the ROI is disabled.

The value must be within the range [5:675].

7	6	5	4	3	2	1	0
ROI0_INC_X2_LSB							
R/W							

7	6	5	4	3	2	1	0
ROI0_INC_X2_MSB							
R/W							

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8.2.2.16. ROI0_INC_Y1 Registers (address = 0x1A & 0x1B)

These registers contain the position of Y1 used by the ROI 0 inclusive. The most significant bit (MSB) value is available at address 0x1B, and the least significant bit (LSB) at address 0x1A. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed. The ROI is considered only when the coordinates (X1, Y1) and (X2, Y2) are either both equal to 0 or if they are both different from 0. In the case where all coordinates are 0, then the ROI is disabled.

The value must be within the range [5:475].

7	6	5	4	3	2	1	0
ROI0_INC_Y1_LSB							
R/W							

7	6	5	4	3	2	1	0
ROI0_INC_Y1_MSB							
R/W							

8.2.2.17. ROI0_INC_Y2 Registers (address = 0x1C & 0x1D)

These registers contain the position of Y2 used by the ROI 0 inclusive. The most significant bit (MSB) value is available at address 0x1D, and the least significant bit (LSB) at address 0x1C. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed. The ROI is considered only when the coordinates (X1, Y1) and (X2, Y2) are either both equal to 0 or if they are both different from 0. In the case where all coordinates are 0, then the ROI is disabled.

The value must be within the range [5:475].

7	6	5	4	3	2	1	0
ROI0_INC_Y2_LSB							
R/W							

7	6	5	4	3	2	1	0
ROI0_INC_Y2_MSB							
R/W							

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8.2.2.18. ROI1_INC_X1 Registers (address = 0x1E & 0x1F)

These registers contain the position of X1 used by the ROI 1 inclusive. The most significant bit (MSB) value is available at address 0x1F, and the least significant bit (LSB) at address 0x1D. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed. The ROI is considered only when the coordinates (X1, Y1) and (X2, Y2) are either both equal to 0 or if they are both different from 0. In the case where all coordinates are 0, then the ROI is disabled.

The value must be within the range [5:675].

7	6	5	4	3	2	1	0
ROI1_INC_X1_LSB							
R/W							

7	6	5	4	3	2	1	0
ROI1_INC_X1_MSB							
R/W							

8.2.2.19. ROI1_INC_X2 Registers (address = 0x20 & 0x21)

These registers contain the position of X2 used by the ROI 1 inclusive. The most significant bit (MSB) value is available at address 0x21, and the least significant bit (LSB) at address 0x20. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed. The ROI is considered only when the coordinates (X1, Y1) and (X2, Y2) are either both equal to 0 or if they are both different from 0. In the case where all coordinates are 0, then the ROI is disabled.

The value must be within the range [5:675].

7	6	5	4	3	2	1	0
ROI1_INC_X2_LSB							
R/W							

7	6	5	4	3	2	1	0
ROI1_INC_X2_MSB							
R/W							

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8.2.2.20. ROI1_INC_Y1 Registers (address = 0x22 & 0x23)

These registers contain the position of Y1 used by the ROI 1 inclusive. The most significant bit (MSB) value is available at address 0x23, and the least significant bit (LSB) at address 0x22. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed. The ROI is considered only when the coordinates (X1, Y1) and (X2, Y2) are either both equal to 0 or if they are both different from 0. In the case where all coordinates are 0, then the ROI is disabled.

The value must be within the range [5:475].

7	6	5	4	3	2	1	0
ROI1_INC_Y1_LSB							
R/W							

7	6	5	4	3	2	1	0
ROI1_INC_Y1_MSB							
R/W							

8.2.2.21. ROI1_INC_Y2 Registers (address = 0x24 & 0x25)

These registers contain the position of Y2 used by the ROI 1 inclusive. The most significant bit (MSB) value is available at address 0x25, and the least significant bit (LSB) at address 0x24. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed. The ROI is considered only when the coordinates (X1, Y1) and (X2, Y2) are either both equal to 0 or if they are both different from 0. In the case where all coordinates are 0, then the ROI is disabled.

The value must be within the range [5:475].

7	6	5	4	3	2	1	0
ROI1_INC_Y2_LSB							
R/W							

7	6	5	4	3	2	1	0
ROI1_INC_Y2_MSB							
R/W							

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8.2.2.22. ROI0_EXCL_X1 Registers (address = 0x26 & 0x27)

These registers contain the position of X1 used by the ROI 0 exclusive. The most significant bit (MSB) value is available at address 0x27, and the least significant bit (LSB) at address 0x26. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed. The ROI is considered only when the coordinates (X1, Y1) and (X2, Y2) are either both equal to 0 or if they are both different from 0. In the case where all coordinates are 0, then the ROI is disabled.

The value must be within the range [5:675].

7	6	5	4	3	2	1	0
ROI0_EXCL_X1_LSB							
R/W							

7	6	5	4	3	2	1	0
ROI0_INC_X1_MSB							
R/W							

8.2.2.23. ROI0_EXCL_X2 Registers (address = 0x28 & 0x29)

These registers contain the position of X2 used by the ROI 0 exclusive. The most significant bit (MSB) value is available at address 0x29, and the least significant bit (LSB) at address 0x28. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed. The ROI is considered only when the coordinates (X1, Y1) and (X2, Y2) are either both equal to 0 or if they are both different from 0. In the case where all coordinates are 0, then the ROI is disabled.

The value must be within the range [5:675].

7	6	5	4	3	2	1	0
ROI0_EXCL_X2_LSB							
R/W							

7	6	5	4	3	2	1	0
ROI0_EXCL_X2_MSB							
R/W							

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8.2.2.24. ROI0_EXCL_Y1 Registers (address = 0x2A & 0x2B)

These registers contain the position of Y1 used by the ROI 0 exclusive. The most significant bit (MSB) value is available at address 0x2B, and the least significant bit (LSB) at address 0x2A. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed. The ROI is considered only when the coordinates (X1, Y1) and (X2, Y2) are either both equal to 0 or if they are both different from 0. In the case where all coordinates are 0, then the ROI is disabled.

The value must be within the range [5:475].

7	6	5	4	3	2	1	0
ROI0_EXCL_Y1_LSB							
R/W							

7	6	5	4	3	2	1	0
ROI0_EXCL_Y1_MSB							
R/W							

8.2.2.25. ROI0_EXCL_Y2 Registers (address = 0x2C & 0x2D)

These registers contain the position of Y2 used by the ROI 0 exclusive. The most significant bit (MSB) value is available at address 0x2D, and the least significant bit (LSB) at address 0x2C. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed. The ROI is considered only when the coordinates (X1, Y1) and (X2, Y2) are either both equal to 0 or if they are both different from 0. In the case where all coordinates are 0, then the ROI is disabled.

The value must be within the range [5:475].

7	6	5	4	3	2	1	0
ROI0_EXCL_Y2_LSB							
R/W							

7	6	5	4	3	2	1	0
ROI0_EXCL_Y2_MSB							
R/W							

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8.2.2.26. ROI1_EXCL_X1 Registers (address = 0x2E & 0x2F)

These registers contain the position of X1 used by the ROI 1 exclusive. The most significant bit (MSB) value is available at address 0x2F, and the least significant bit (LSB) at address 0x2E. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed. The ROI is considered only when the coordinates (X1, Y1) and (X2, Y2) are either both equal to 0 or if they are both different from 0. In the case where all coordinates are 0, then the ROI is disabled.

The value must be within the range [5:675].

7	6	5	4	3	2	1	0
ROI1_EXCL_X1_LSB							
R/W							

7	6	5	4	3	2	1	0
ROI1_INC_X1_MSB							
R/W							

8.2.2.27. ROI1_EXCL_X2 Registers (address = 0x30 & 0x31)

These registers contain the position of X2 used by the ROI 0 exclusive. The most significant bit (MSB) value is available at address 0x31, and the least significant bit (LSB) at address 0x30. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed. The ROI is considered only when the coordinates (X1, Y1) and (X2, Y2) are either both equal to 0 or if they are both different from 0. In the case where all coordinates are 0, then the ROI is disabled.

The value must be within the range [5:675].

7	6	5	4	3	2	1	0
ROI0_EXCL_X2_LSB							
R/W							

7	6	5	4	3	2	1	0
ROI0_EXCL_X2_MSB							
R/W							

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8.2.2.28. ROI1_EXCL_Y1 Registers (address = 0x32 & 0x33)

These registers contain the position of Y1 used by the ROI 1 exclusive. The most significant bit (MSB) value is available at address 0x33, and the least significant bit (LSB) at address 0x32. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed. The ROI is considered only when the coordinates (X1, Y1) and (X2, Y2) are either both equal to 0 or if they are both different from 0. In the case where all coordinates are 0, then the ROI is disabled.

The value must be within the range [5:475].

7	6	5	4	3	2	1	0
ROI1_EXCL_Y1_LSB							
R/W							

7	6	5	4	3	2	1	0
ROI1_EXCL_Y1_MSB							
R/W							

8.2.2.29. ROI1_EXCL_Y2 Registers (address = 0x34 & 0x35)

These registers contain the position of Y2 used by the ROI 1 exclusive. The most significant bit (MSB) value is available at address 0x35, and the least significant bit (LSB) at address 0x34. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed. The ROI is considered only when the coordinates (X1, Y1) and (X2, Y2) are either both equal to 0 or if they are both different from 0. In the case where all coordinates are 0, then the ROI is disabled.

The value must be within the range [5:475].

7	6	5	4	3	2	1	0
ROI1_EXCL_Y2_LSB							
R/W							

7	6	5	4	3	2	1	0
ROI1_EXCL_Y2_MSB							
R/W							

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8.2.2.30. OUTPUT_CFG_1 Register (address = 0x36)

This register configures the type of output and the frame rate.

7	6	5	4	3	2	1	0
OUTPUT_TYPE				FRAME_RATE			
R/W				R/W			

Bit	Field	Type	Reset	Description
7-4	OUTPUT_TYPE	R/W	7h	RESERVED (DO NOT USE)
3-0	FRAME_RATE	R/W	1h	Frame rate selection. Available values are: 0d = RESERVED (DO NOT USE) 1d = 25 Hz 2d = 30 Hz 3d = 50 Hz 4d = 60 Hz

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8.2.2.31. OUTPUT_CFG_2 Register (address = 0x37)

This register configures the selected hardware output and corrections to apply.

WARNING:

If you enable the SDI output, the camera's resolution switch automatically to 720:576. To apply the resolution presents in registers OUTPUT_X_RES and OUTPUT_Y_RES, the SDI output must be disabled.

7	6	5	4	3	2	1	0
COLUMN	VIGNETTING	TEST_PATTERN	R	R	MIPI_ON	PARALLEL_ON	SDI_ON
R/W	R/W	R	R	R	RW	R/W	R/W

Bit	Field	Type	Reset	Description
7	COLUNM	R/W	1h	Enable / Disable the column correction. 0d = disable 1d = enable
6	VIGNETTING	R/W	1h	Enable / Disable the vignetting correction. 0d = disable 1d = enable
5	TEST_PATTERN	R/W	0	Enable / Disable the test pattern. 0d = disable 1d = enable
4	Reserved	R	0h	Reserved
3	Reserved	R	0h	Reserved
2	MIPI_ON	R	1h	Enable / Disable the MIPI output. 0d = disable 1d = enable
1	PARALLEL_ON	R/W	1h	Enable / Disable the parallel output. 0d = disable 1d = enable
0	SDI_ON	R/W	1h	Enable / Disable the SDI output. 0d = disable 1d = enable

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8.2.2.32. OUTPUT_X_RES Registers (address = 0x38 & 0x39)

These registers contain the X axis resolution of the output frame. The most significant bit (MSB) value is available at address 0x2F, and the least significant bit (LSB) at address 0x2E. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed.

The value must be within the range [0:1024].

WARNING: This value is applied only if the SDI output is disabled.

7	6	5	4	3	2	1	0
OUTPUT_X_RES_LSB							
R/W							

7	6	5	4	3	2	1	0
OUTPUT_X_RES_MSB							
R/W							

8.2.2.33. OUTPUT_Y_RES Registers (address = 0x3A & 0x3B)

These registers contain the Y axis resolution of the output frame. The most significant bit (MSB) value is available at address 0x3B, and the least significant bit (LSB) at address 0x3A. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed.

The value must be within the range [0:768].

WARNING: This value is applied only if the SDI output is disabled.

7	6	5	4	3	2	1	0
OUTPUT_Y_RES_LSB							
R/W							

7	6	5	4	3	2	1	0
OUTPUT_Y_RES_MSB							
R/W							

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8.2.2.34. ZOOM_CENTER_X Registers (address = 0x3C & 0x3D)

These registers contain the X component of the coordinates used to center the zoom on an image. The most significant bit (MSB) value is available at address 0x3D, and the least significant bit (LSB) at address 0x3C. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed.

The value must be within the range [0:640].

7	6	5	4	3	2	1	0
ZOOM_CENTER_X_LSB							
R/W							

7	6	5	4	3	2	1	0
ZOOM_CENTER_X_MSB							
R/W							

8.2.2.35. ZOOM_CENTER_Y Registers (address = 0x3E & 0x3F)

These registers contain the Y component of the coordinates used to center the zoom on an image. The most significant bit (MSB) value is available at address 0x3F, and the least significant bit (LSB) at address 0x3E. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed.

The value must be within the range [0:480].

7	6	5	4	3	2	1	0
ZOOM_CENTER_y_LSB							
R/W							

7	6	5	4	3	2	1	0
ZOOM_CENTER_y_MSB							
R/W							

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8.2.2.36. ZOOM_FACTOR_X Registers (address = 0x40 & 0x41)

These registers contain the zoom factor applied to the X axis. The most significant bit (MSB) value is available at address 0x41, and the least significant bit (LSB) at address 0x40. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed.

The value must be within the range [0:8000].

Example:

- 1059 = A factor of 1.059
- 502 = A factor of 0.502

7	6	5	4	3	2	1	0
ZOOM_FACTOR_X_LSB							
R/W							

7	6	5	4	3	2	1	0
ZOOM_FACTOR_X_MSB							
R/W							

8.2.2.37. ZOOM_FACTOR_Y Registers (address = 0x42 & 0x43)

These registers contain the zoom factor applied to the Y axis. The most significant bit (MSB) value is available at address 0x43, and the least significant bit (LSB) at address 0x42. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed.

The value must be within the range [1000:8000].

Example:

- 1059 = A factor of 1.059
- 502 = A factor of 0.502

7	6	5	4	3	2	1	0
ZOOM_FACTOR_Y_LSB							
R/W							

7	6	5	4	3	2	1	0
ZOOM_FACTOR_Y_MSB							
R/W							

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8.2.2.38. ZOOM_CFG Register (address = 0x44)

This register configures the zoom method and the wished image flip.

7	6	5	4	3	2	1	0
R	R	ZOOM_METHOD		R	R	Y_FLIP	X_FLIP
R	R	R/W		R	R	R/W	R/W

Bit	Field	Type	Reset	Description
7	Reserved	R	0h	Reserved
6	Reserved	R	0h	Reserved
5	Reserved	R	0h	Reserved
4	ZOOM_METHOD	R/W	0h	Select zoom method. 0d = Nearest 1d = Bilinear
3	Reserved	R	0h	Reserved
2	Reserved	R	0h	Reserved
1	Y_FLIP	R/W	0h	Enable / Disable image flip on Y axis. 0d = disable 1d = enable
0	X_FLIP	R/W	0h	Enable / Disable image flip on X axis. 0d = disable 1d = enable

8.2.2.39. EDGE_CFG Register (address = 0x45)

This register configures the edge correction type.

7	6	5	4	3	2	1	0
R	R	R	R	R	R	EDGE_CORRECTION	
R	R	R	R	R	R	R/W	

Bit	Field	Type	Reset	Description
7	Reserved	R	0h	Reserved
6	Reserved	R	0h	Reserved
5	Reserved	R	0h	Reserved
4	Reserved	R	0h	Reserved
3	Reserved	R	0h	Reserved
2	Reserved	R	0h	Reserved
1-0	EDGE_CORRECTION	R/W	0h	Select edge correction type. 0d = None 1d = Sharpening 2d = Contouring

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8.2.2.40. EDGE_GAIN Registers (address = 0x46 & 0x47)

These registers contain the Sharpening filter gain. The most significant bit (MSB) value is available at address 0x47, and the least significant bit (LSB) at address 0x46. No conversion is required; we use the raw value directly. To apply the new value, you must write the Most Significant Bit (MSB) even if it has not changed.

The value must be within the range [0:1024].

7	6	5	4	3	2	1	0
EDGE_GAIN_LSB							
R/W							

7	6	5	4	3	2	1	0
EDGE_GAIN_MSB							
R/W							

8.2.2.41. EDGE_THESHOLD_1 Register (address = 0x48)

This register configures the first threshold used by the sharpening filter.
The value must be within the range [0:200].

7	6	5	4	3	2	1	0
EDGE_THRESHOLD_1							
R/W							

8.2.2.42. EDGE_THESHOLD_2 Register (address = 0x49)

This register configures the second threshold used by the sharpening filter.
The value must be within the range [0:255].

7	6	5	4	3	2	1	0
EDGE_THRESHOLD_2							
R/W							

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8.2.2.43. SHUTTER (address = 0x50)

This register controls shutter position.

7	6	5	4	3	2	1	0
Reserved							CONTROL_SHUTTER
-							R/W

Bit	Field	Type	Reset	Description
7 - 1	Reserved	R	0h	Reserved
0	CONTROL_SHUTTER	R/W	0h	Get and set the shutter position. 0 = Open 1 = Close

8.2.2.44. NUC_1POINT_RQST (address = 0x51)

This register controls the NUC 1 point function.

7	6	5	4	3	2	1	0
Reserved				REQUEST_AUTO	REQUEST	STATUS	
-				W	W	R	

Bit	Field	Type	Reset	Description
7-4	Reserved	R	0h	Reserved
3	REQUEST_AUTO	W	0h	Write 1 to request an automatic NUC (with an automatic shutter management)
2	REQUEST	W	0h	Write 1 to request a NUC (without shutter management)
0-1	STATUS	R	0h	NUC processing status. 0 = Ok 1 = NUC is processing 2 = An error occurred

The fields REQUEST_AUTO and REQUEST shall not be set to ‘1’ in the same command.

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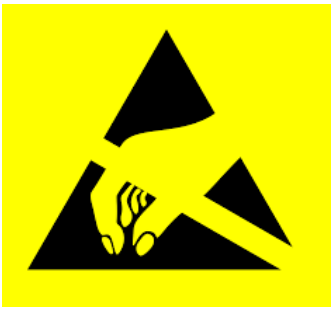
8.3. Integration guidelines

8.3.1. ESD caution



In order to ensure the safe and reliable operation of the module, it is imperative that it be handled with Electrostatic Discharge (ESD) care. Electrostatic discharge can potentially damage sensitive electronic components and circuits within the module, leading to malfunctions or permanent impairment of its functionality. To mitigate this risk, it is essential to implement ESD-safe handling procedures, including the use of grounded wrist straps, antistatic mats, and ESD-safe tools, as well as working in ESD-protected environments. By adhering to these precautions, the integrity of the electronic module can be preserved, ensuring its optimal performance and longevity.

8.3.2. Precaution regarding dust on the sensor

Precautions regarding dust on the sensor are important to ensure high-quality image capture. Dust particles can accumulate on the sensor and cause visible spots on captured images. To prevent this, it is recommended to keep the camera lens clean and to store the camera in a protective case.

It's important to note that on ATTO640 sensors, the distance between pixels and the sensor window is shorter than on PICO640 sensors. Because of this, it's especially important to take precautions to minimize dust buildup on the sensor when using ATTO640 sensors.

Do not unmount the lens out of dust free clean room.

8.3.3. Lens support

If the customer needs to design their own lens support, it is important to follow some guidelines to ensure the optimal performance of the camera. Firstly, the mechanical part facing the sensor must be as emissive as possible, such as using matte anodized aluminum, to minimize stray light entering the sensor and causing unwanted noise or flare. Secondly, it is crucial that the mechanical part is completely sealed to prevent dust or debris from entering the camera and onto the sensor, which can affect image quality and potentially damage the sensor. Therefore, we highly recommend that the customer designs a fully enclosed lens support that meets these requirements.

To align the lens correctly with the sensor, the plastic package of the sensor must be used as a mechanical reference. This ensures that the mounting is aligned and repeatable for the assembler. It is also preferable to have a keying feature that prevents the sensor from being mounted in the wrong orientation.

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8.3.4. Precaution regarding direct sun view

Direct sunlight exposure can cause marks on the camera sensor. It is therefore preferable to avoid direct sun view when possible. If the sensor is marked by the sun, these marks should disappear with time. However, this process can take several hours or even several days for more significant marks. During storage, it is recommended to completely avoid direct sunlight exposure to prevent marking of the sensor.

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9. COMPANION

CamSight LS companion is a software tool that enables factory configuration and testing. Graphic user interface uses MavLink interface and allows to read parameters from camera and write parameters to the camera.

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9.1. Connection Panel

1	Scan devices on port	4	Connect device	7	Write Parameters
2	Detected devices	5	Disconnect device	8	Read Parameters
3	Baud Rate	6	Reset Parameters	9	Command tab

The top panel is dedicated to connection and commands.

9.1.1. Scan devices on port

On clicking this button, CamSight LS Companion will search for devices on USB port of the computer.

9.1.2. Detected devices

When Scan devices button is clicked, recognized devices will be displayed in this list. Select in the list the device you want to connect to.

9.1.3. Baud Rate

Standard Baud Rate for communication is 115200 but you can change it to 9600 if the camera is configured to that Baud Rate.

9.1.4. Connect device

This button will connect CamSight LS Companion to the selected camera.

9.1.5. Disconnect device

This button will disconnect CamSight LS Companion from the actual connected camera.

9.1.6. Reset parameters

This button will automatically reset the camera parameters to factory parameters.

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9.1.7. Write parameters

This button will set the parameters defined in the graphic user interface of the CamSight LS Companion to the camera.

9.1.8. Read parameters

This button will read the parameters from the camera and set them into the graphic user interface of the CamSight LS Companion.

9.1.9. Command tab

This tab selector will allow to navigate in the different parameter screens of CamSight LS Companion.

9.2. Information panel

1	BIT	2	Log info
3	FPGA temperature	4	Sensor temperature
5	About…	6	Clear Log

9.2.1. BIT

This panel shows the BIT result.

It is not handled for the moment.

9.2.2. Log Info

This panel lists the information from the camera.

At the connection, information on the camera is given (serial number, software version…).

When camera is read, all parameters are displayed in this panel.

When camera is written, all writes are displayed with write status.

9.2.3. FPGA temperature

This panel shows the FPGA temperature.

The value is updated at the connection and each time the read button is pressed.

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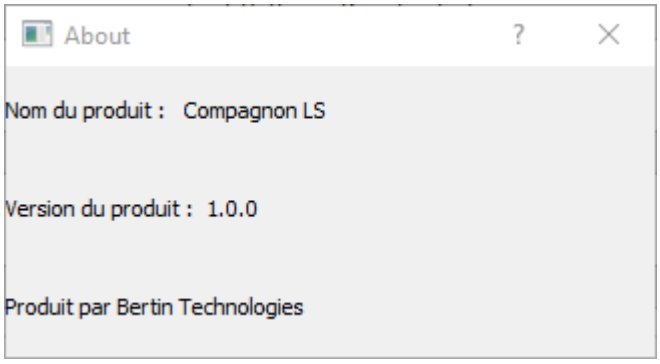
9.2.4. Sensor temperature

This panel shows the sensor temperature.
The value is updated at the connection and each time the read button is pressed.

9.2.5. About

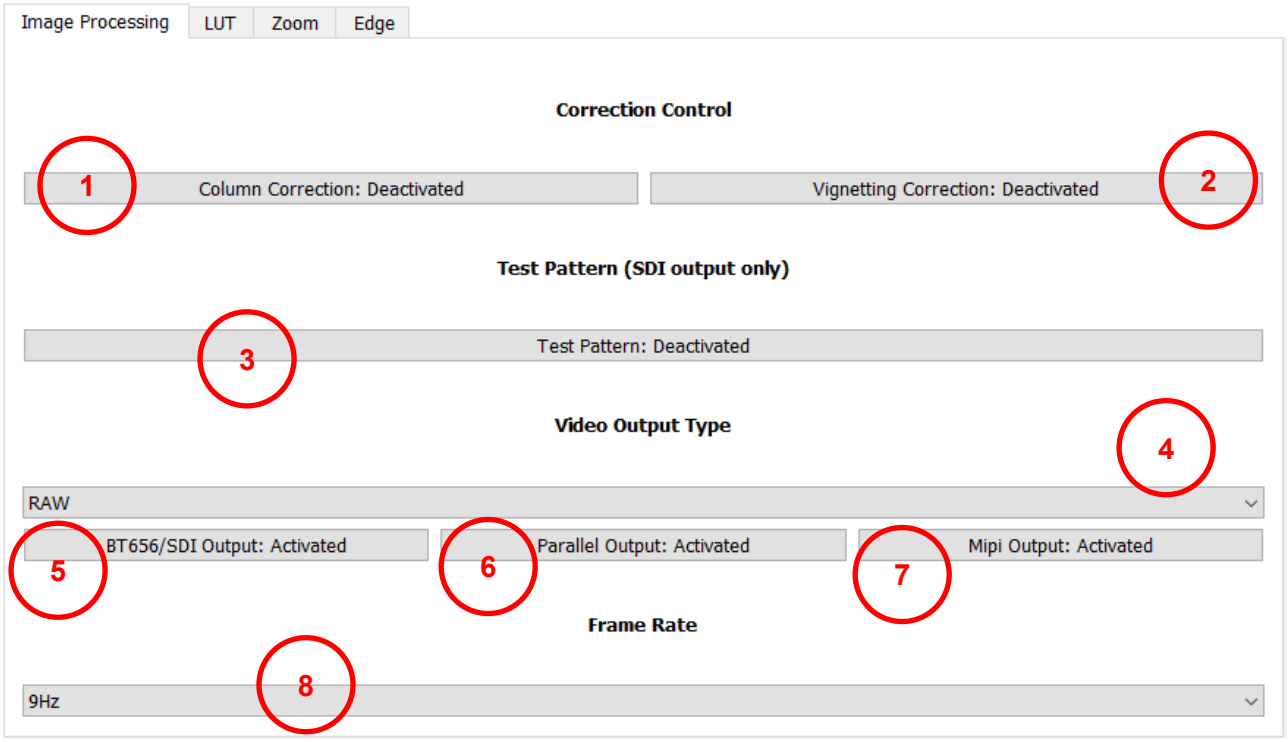
This button displays the about window with information on CamSight LS Companion version.



9.2.6. Clear Log

This button erases completely the log panel.

9.3. Image Processing tab



1	Column Correction	4	Video Output	7	Mipi output
2	Vignetting Correction	5	BT656/SDI output	8	Frame Rate
3	Test Pattern	6	Parallel output		

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9.3.1. Column correction

This bi-state button will allow to activate or deactivate the column noise correction algorithm.

9.3.2. Vignetting correction

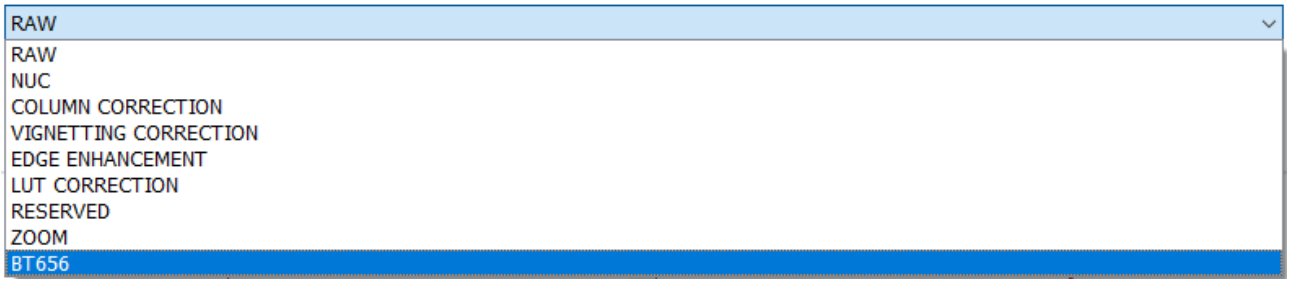
This bi-state button will allow to activate or deactivate the vignetting noise correction algorithm.

9.3.3. Test pattern

This bi-state button will allow to activate or deactivate a test pattern mode on the camera. When activated, the camera will then send an image composed of color pattern for test purpose.

9.3.4. Video output

This parameter is available only in parallel port mode. It allows to select the type of video output that will be displayed. Video output can be selected in a list of stages from RAW image to BT656.



9.3.5. BT656/SDI output

This bi-state button will allow to activate or deactivate the BT656/SDI output. Depending on the output you use it will stop the video or not.

9.3.6. Parallel output

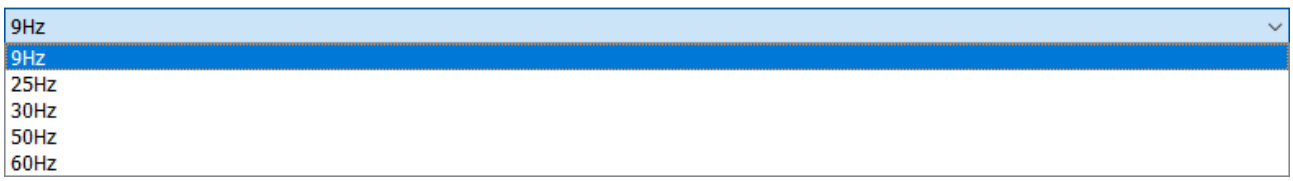
This bi-state button will allow to activate or deactivate the parallel output. Depending on the output you use it will stop the video or not.

9.3.7. Mipi output

This bi-state button will allow to activate or deactivate the MIPI output. Depending on the output you use it will stop the video or not.

9.3.8. Frame rate

This parameter is available only in parallel mode. It allows to select the frequency of the video between 9Hz and 60Hz.



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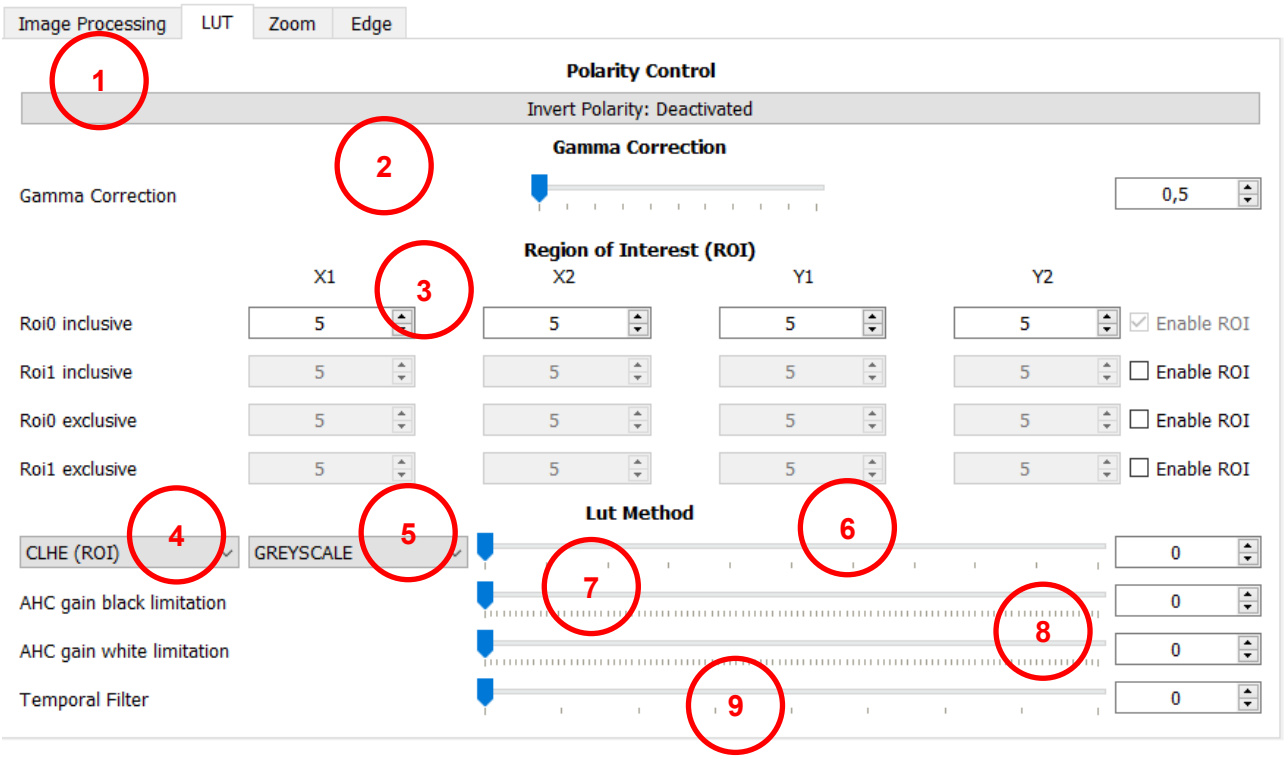
9.4. LUT tab



1	Polarity	4	LUT Method	7	AHC gain black limitation
2	Gamma correction	5	LUT color	8	AHC gain white limitation
3	Region of Interest	6	LUT dynamism	9	Temporal filter

9.4.1. Polarity

This bi-state button allows to invert the polarity from White Hot to Black Hot.

9.4.2. Gamma correction

This parameter allows to change gamma correction to adapt brightness of the video to the screen and ambient luminosity. Increasing gamma correction value decrease luminosity.

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9.4.3. Region of Interest

Note that the system of ROI is only used in CLHE mode.

9.4.3.1. ROI0 inclusive

This ROI is mandatory.

These 4 parameters allow to define the upper left corner and the lower right corner of a rectangle in the image. This rectangle will be the region of interest for calculation of the LUT (look-up table) in CLHE (Contrast Local Histogram Equalization) algorithm method. (X1, Y1) is the top left corner of the region, (X2, Y2) is the bottom right corner of the region. This allows for example to avoid the cold part of the image from the sky in the calculation to avoid the flattening of the image due to non-useful cold parts. Default value is 50 pixels from any border ((50,50), (590,430)). This value has effect only in CLHE mode.

9.4.3.2. ROI1 inclusive

ROI1 inclusive is a second and optional ROI that will be considered for calculation of the LUT if activated.

(X1, Y1) and (X2, Y2) are used the same way described in 9.4.3.1.

9.4.3.3. ROI0 exclusive

ROI0 exclusive is an optional ROI that will not be taken into consideration for calculation of the LUT if activated.

(X1, Y1) and (X2, Y2) are used the same way described in 9.4.3.1.

9.4.3.4. ROI1 exclusive

ROI1 exclusive is a second optional ROI that will not be considered for calculation of the LUT if activated.

(X1, Y1) and (X2, Y2) are used the same way described in 9.4.3.1.

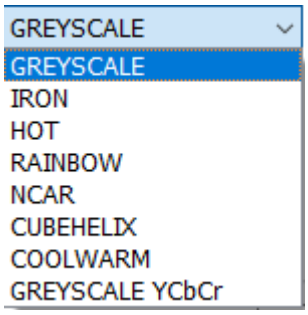
9.4.4. LUT Method

This parameter can be selected between CLHE (Contrast Local Histogram Equalization) method and CLAHE (Contrast Local Adaptative Histogram Equalization).

CLHE uses region of interest to calculate the LUT depending on histogram in the RoI only. It allows to enhance contrast on part of the image.

CLAHE divides the window in tiles and calculates the LUT for each tile. It allows to enhance the contrast in each part of the image.

9.4.5. LUT color



Refer to 4.8 to see the effect of the parameter chosen.

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9.4.6. LUT dynamism

This parameter allows to adapt the dynamism of the histogram in the calculation of the LUT. It allows to be more linear to have better stability of the image on the move or to be more dynamic to have more contrast in the image even with hot or cold points.

9.4.7. AHC black gain limitation

The effect of this parameter is linked to AHC white gain limitation parameter.

Its range is limited from 0% to 100%.

For more information refer to 7.5.43.

9.4.8. AHC white gain limitation

The effect of this parameter is linked to AHC black gain limitation parameter.

Its range is limited from 0% to 100%.

For more information refer to 7.5.43.

9.4.9. Temporal filter

This parameter allows to adapt the time the camera takes to consider the changes that happen in the ROI. The higher the parameter is, the slower the camera is to adapt its calculation for the LUT.

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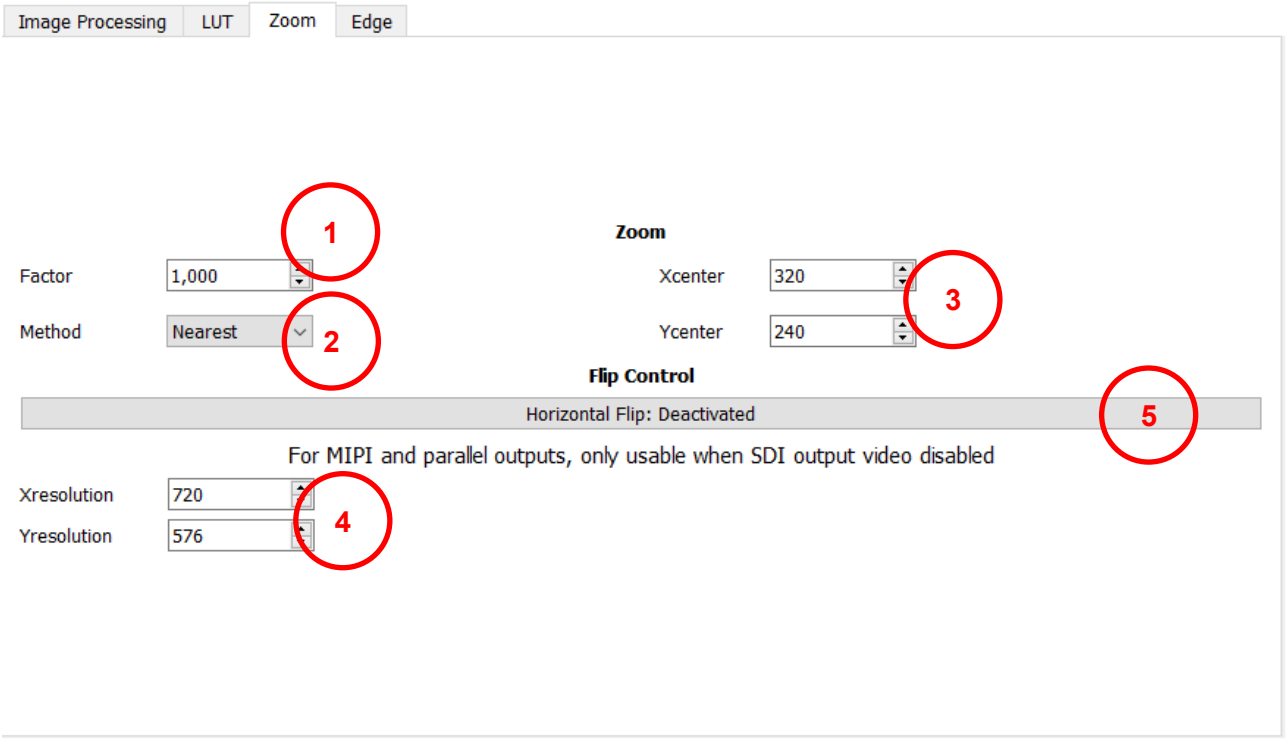
9.5. Zoom tab



1	Zoom factor	3	Zoom Center
2	Zoom Method	4	Zoom resolution
5	Horizontal Flip		

9.5.1. Zoom factor

This parameter allows to set a float zoom factor between 1 and 8. When value is 1, no zoom is applied on the image. When a zoom factor is applied, the useful image will be zoomed to fulfill SD definition (720×576).

9.5.2. Zoom method

This parameter allows to select the method for zoom calculation. It can be selected between Nearest neighbor and Bilinear algorithm.

Nearest neighbor is better for DRI and algorithms (if you use an algorithm on the image, you will prefer this method).

Bilinear method is smoother to the eye, avoiding pixelization.

9.5.3. Zoom Center

This parameter allows to set the center of the zoom. You can set the (X, Y) zoom center to move the zoom in the image. Center can be set to any point of the image.

9.5.4. Zoom resolution

These parameters set the zoom resolution.

The output zoom resolution can be changed for parallel and MIPI output only.

9.5.5. Horizontal flip

This bi-state button activates or deactivates horizontal flip.

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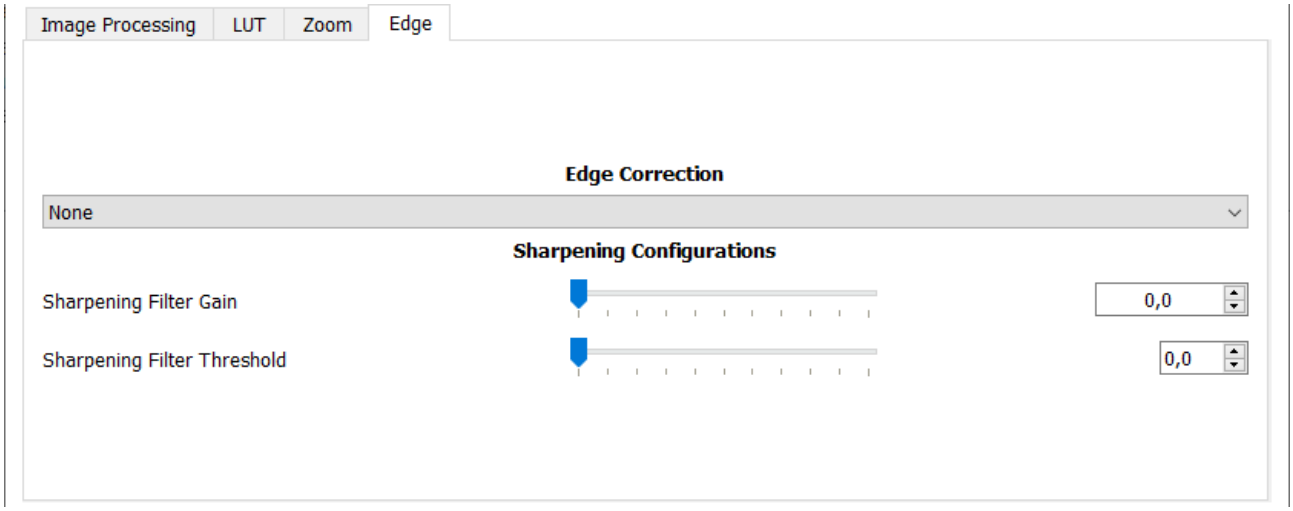
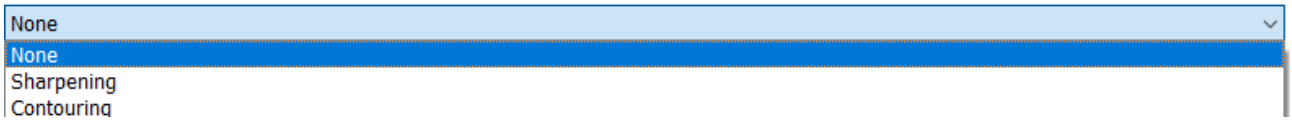
9.6. Edge tab



1	Edge correction	3	Sharpening Filter Threshold
2	Sharpening Filter Gain	4	

9.6.1. Edge correction

This allows to select the type of edge correction to apply.



Sharpening will enhance the sharpening algorithm and make the edges of objects more sharpen.

Contouring will apply a contouring algorithm that will enhance targets.

9.6.2. Sharpening Filter Gain

This parameter allows to increase the gain of the Sharpening filter algorithm. It enhances the edges of objects.

9.6.3. Sharpening Filter Threshold

This parameter allows to increase the threshold of the Sharpening filter algorithm. It lowers the effect of the algorithm on objects with low edge.

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9.7. Default settings

Image processing section			
Parameters	State	Value	USB interface exception
Column Correction	Activated		
Vignetting correction	Activated		
Test pattern	Deactivated		
Video output type		Zoom output	
BT656/SDI output	Activated		Deactivated
Parallel output	Activated		
Mipi output	Activated		Deactivated
Framerate		9Hz	
LUT section			
Parameters	State	Value	USB interface exception
Invert polarity	Deactivated	White hot	
Gamma correction		1.3	
ROI0 inclusive	Activated	(50;50),(590;430)	
ROI1 inclusive	Deactivated	(0;0)(0;0)	
ROI0 exclusive	Deactivated	(0;0)(0;0)	
ROI1 exclusive	Deactivated	(0;0)(0;0)	
LUT method		CLHE	
LUT color		Greyscale	Greyscale YCbCr
LUT dynamism		500	
AHC black gain		10	
AHC white gain		10	
Temporal filter		2	
Zoom section			
Parameters	State	Value	USB interface exception
Factor		1.000	
Zoom method		Nearest	
Zoom center		(320;240)	
Horizontal flip	Deactivated		
Zoom resolution		(720;576)	(640;480)
Edge section			
Parameters	State	Value	USB interface exception
Edge correction		Sharpening	
Sharpening filter gain		255	
Sharpening filter threshold		60	

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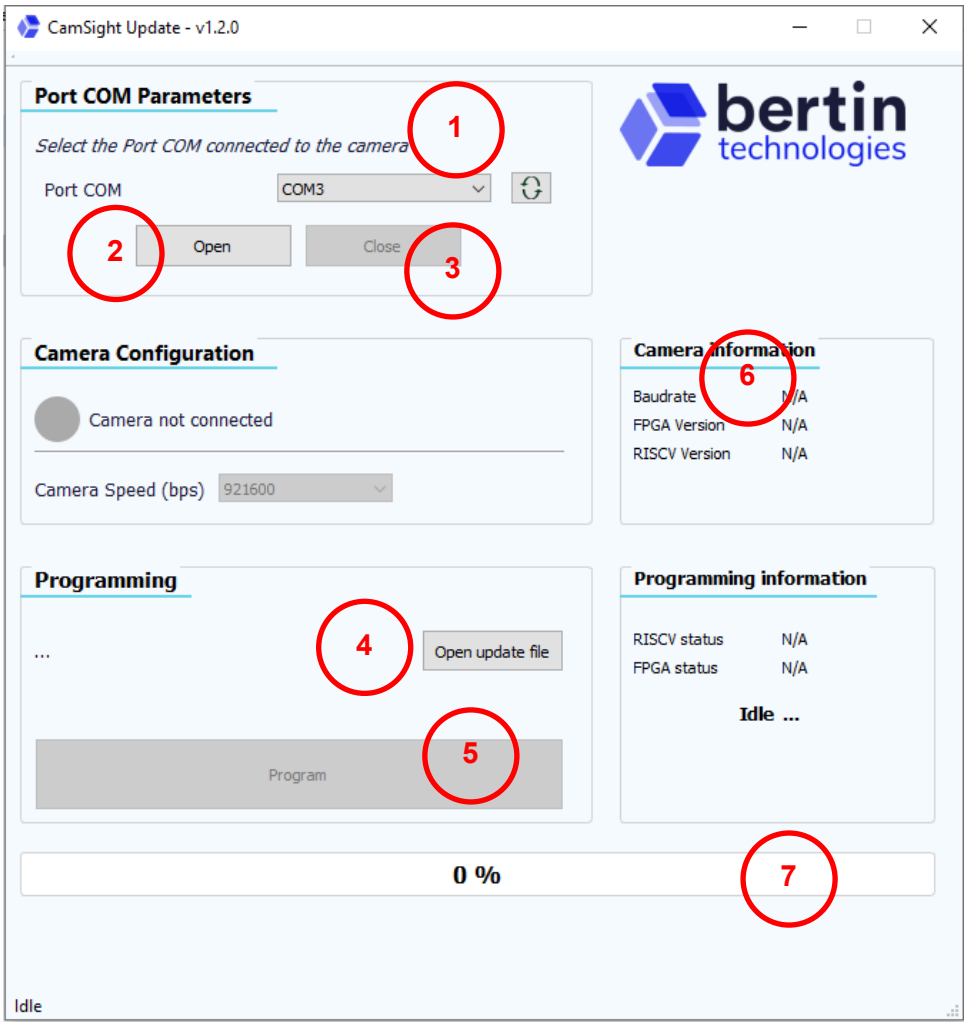
10. UPDATE TOOL



1: Port COM
2: Open
3: Close
4: Open update File
5: Program
6: Information
7: Progression Bar

10.1. Caution for use

Never shut down the power of the camera, nor disconnect the serial link during the update process. In case of disconnection, camera could be damaged, and factory reset should be required.

10.2. General description

The update tool is a software that allows to update the internal camera software. This can be done to add function to the camera, to implement corrections, and so on.

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10.2.1. Port COM

Selection of the detected com port on which is the camera.
Com port parameters have to be let to default value.

10.2.2. Open and Close buttons

Open the port com to allow communication and close the port com to free up resources.

10.2.3. Open update file

Open a browser to select the RISCV file to use for upgrading the camera. RISCV file extension is .upd.

10.2.4. Program button & Progression bar

Start to upload new camera software. Wait until the progression bar is at 100%. Don't stop upgrade while in process.

11. ENVIRONMENTAL PROPERTIES

11.1. Climatic

- Climatic conditions: the camera can operate in the following conditions:
- Storage temperature: - 40°C to + 70°C
- Operating temperature: -40°C to + 70°C
- Humidity: up to 95% (non-condensing)

11.2. Shock

Pre-compliance to MIL STD 883 K (Compliant with Casing version).

11.3. EMC

It is the responsibly of the integrator to verify the final compliance of the overall system with the camera integrated.

Standards Tests Results (with CamSight LS casing version):

- Pre-compliance to AECTP500 ed4 Ground army
  - Conducted Susceptibility
    - NCS02 control and signals, 20Hz-50 kHz Radiated Susceptibility
    - NCS07 BCI
    - NCS08 BCI Impulse excitation
    - NCS09 Damped sinusoidal transients
  - Radiated Susceptibility
    - NRS01 magnetic field, 30 Hz – 100 KHz
    - NRS02 electrical field of 50 kHz to 3 GHz.

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- Radiated Emissions
  - NRE01 Magnetic field 30Hz to 100 KHz.
  - NRE02 Electric field, 10 kHz to 3 GHz.

- Conducted Emissions
  - NCE02 10kHz-10 MHz
  - NCE04 transient measurement.
  - NCE05 30Hz-150 MHz

11.4. CE, RoHS, REACH

Compliant

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