Ref.: 24489-800-DU004-L

CamSight LS

Interface Control Document
CamSight Low SWaP

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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 §5.3 Add MIPI configuration Add §6.3 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 §0 : Modification of max voltage to 5.5V / add ESD protection warning / add USB C orientation warning USB power supply removed from §4.2.3 and added to §3.8.3 §5.3.3 : add USB orientation warning §6.3.3.31 : Change output selection and 9Hz selection in “RESERVED (DO NOT USE)”	MVI / NGE

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
J	18/12/2025	Update the MIPI table to add the management of the serial number on 32bits	RRI
K	17/03/2026	Update with: - The different lenses - Clarification of the OEM and core concept - Remove SDI board and rear connector interface - Add USB Molex board - For USB: multi frequency, zoom - New firmware 2.3.8 - Remove *triggers* pins on the different interface board - Update of the image processing pipeline - Add of HFlip feature - Add of multi frequency feature - Add of integration guidelines and environmental properties paragraph - Remove Bertin Photonics by Bertin Winlight - Update of the Software interface according to the new firmware 2.3.8 - Add Regulatory Compliance and Integration Responsibility	BKO / ESO & JRA
L	24/08/2026	Update with: - MIPI interface	BKO

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1. SCOPE

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.

1.1. Documentation

AD001	Compagnon software user manual	Upcoming Document
AD002	Updater software user manual	24489-800-DU008-C

1.2. Acronyms

BP	Bad Pixel
CLAE	Contrast-Limited Adaptive Histogram Equalization
CLHE	Contrast-Limited Histogram Equalization
FoV	Field of View
HD	High Definition
MMCX	Micro-Miniature Coaxial
NUC	Non-Uniformity Correction
SDI	Serial Digital Interface
SWaP	Size, Weight and Power
UART	Universal Asynchronous Receiver Transmitter
VFE	Video Front End
WIP	Work In Progress

1.3. Regulatory status and intended use

The CamSight LS is an Original Equipment Manufacturer (OEM) infrared camera module intended exclusively for integration into professional equipment and systems.

The CamSight LS is not intended for direct use by end users and requires integration into a final product providing the necessary mechanical, electrical and environmental protections.

The CamSight LS is an electronic and optoelectronic subassembly and does not constitute machinery or partly completed machinery within the meaning of Regulation (EU) 2023/1230 on machinery.

This document provides the technical data necessary for proper integration of the product. The manufacturer of the final equipment remains solely responsible for ensuring compliance of the complete system with all applicable European legislation or local legislation.

The information contained in this document does not relieve the integrator from performing a complete risk assessment and conformity assessment of the final equipment.

2. OVERVIEW

CamSight LS is an Original Equipment Manufacturer (OEM) digital core camera developed by Bertin Winlight. It has been designed to meet users' requirements of low SWaP cameras offering easy integration within optronic systems while providing thermal infrared.

Figure 1: Picture of CamSight LS OEM version

The CamSight LS camera is based around a thermal infrared sensor detailed in Table 1.

Based on a patented Bertin Winlight's shutterless technology, it allows for low latency and freeze-free image delivery in real time, making it suitable for a wide range of applications.

Sensor/Camera	Thermal IR
Manufacturer	LYNRED
Reference	ATTO640D-02
Spectrum	LWIR
Resolution	640x480
Pixel pitch	12 microns

Table 1: CamSight LS sensor characteristics

CamSight LS is available in 10 different assemblies, each corresponding to a specific Field of View and SWaP requirement, mechanical blueprints and characteristics are given for each module. The camera is available with 9, 25, 30, 50 and 60 Hz framerates.

The CamSight LS OEM version is composed of three main parts:

- At the center, core camera which contains the sensor and the fundamentals printed circuit boards. This component gives you access to the high sensitivity option.
- The lens, located just in front of the core camera. These lenses are specifically designed for the LWIR infrared range. They are integrated and calibrated using a patented method developed by Bertin Technologies, making them highly effective.
- An interface board, located on the back of the camera. They can provide additional connectivity options and allow easier integration with existing systems.

All these components are described in detail in the following section.

3. MECHANICAL INTERFACES

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

3.1. Core camera

3.1.1. Core

The core camera weighs 11g.

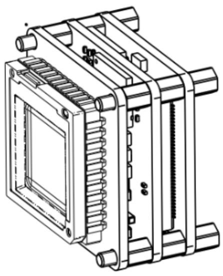

Figure 2: Drawing of the CamSight LS core

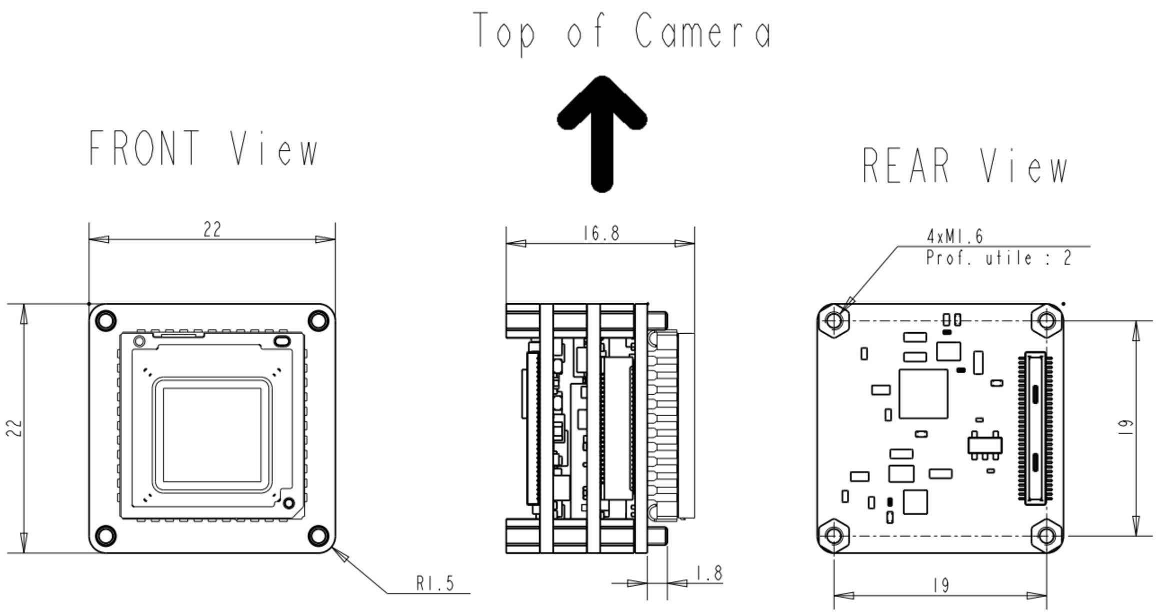

Figure 3: Additional drawing of the CamSight LS core

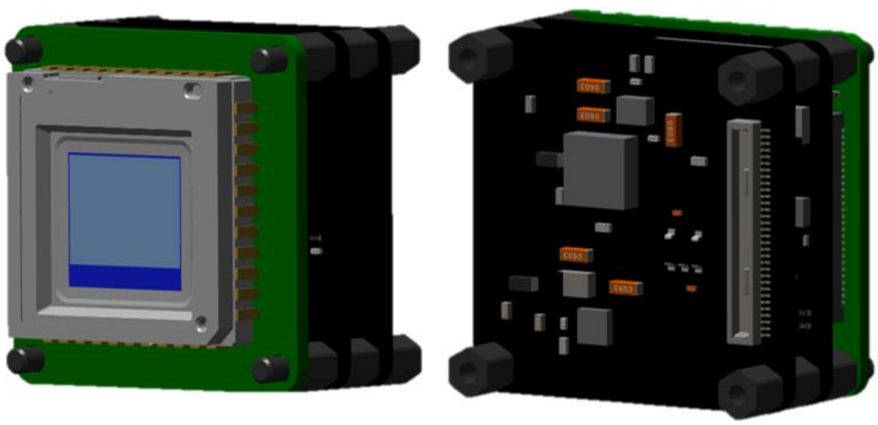

Figure 4: 3D rendering of the CamSight LS core

3.1.2. Shutter

The core 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. The core camera with shutter weighs 22g.

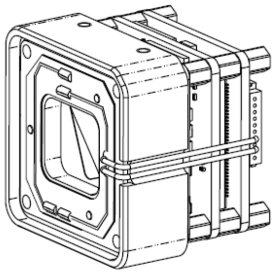

Figure 5: Drawing of the CamSight LS core with shutter

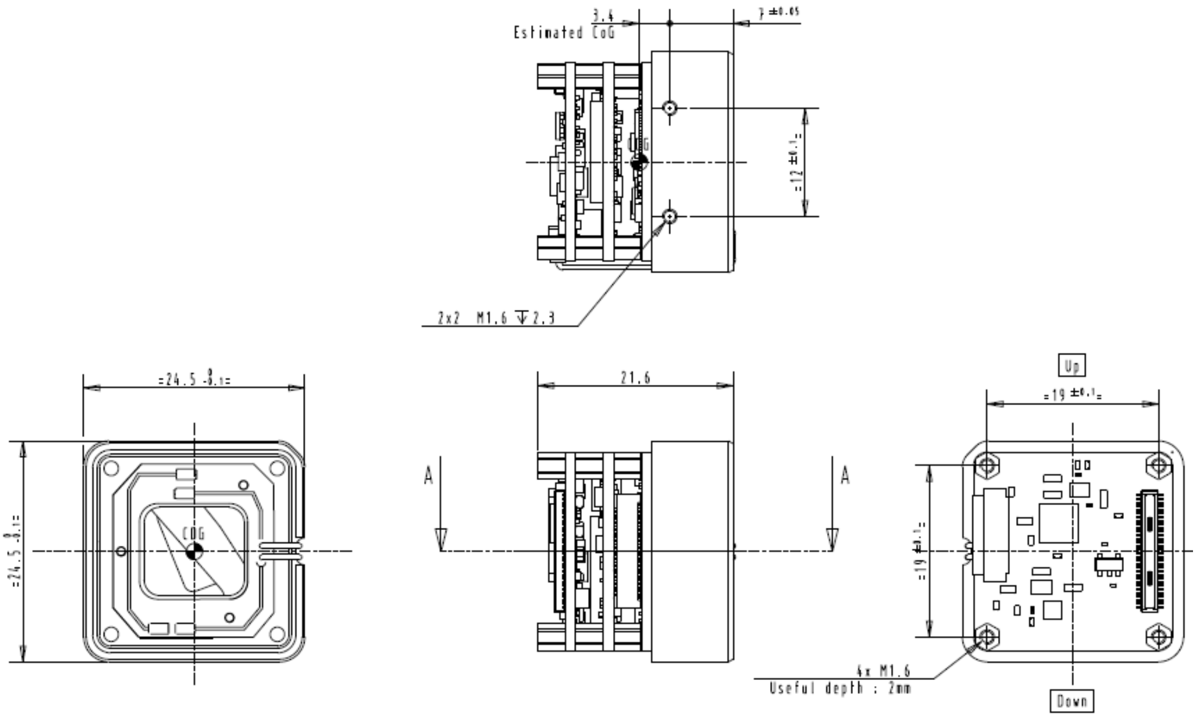

Figure 6: Additional drawing of the CamSight LS core with shutter

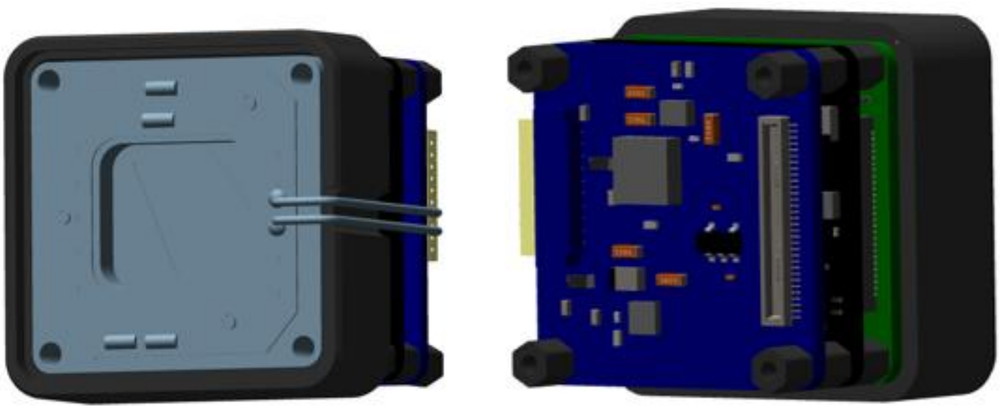

Figure 7: 3D rendering of the CamSight LS core with shutter

3.2. Lens

The OEM version of the CamSight LS camera includes a lens that requires mechanical support to maintain it and hide the parasitic infrared light. It is necessary to ensure proper alignment of the lens and to reduce the impact of parasitic infrared light on the image quality.
This section contains partial information. Other lens configurations are available upon request.

3.2.1. Lens 4.1 mm

The camera supports the following lens:

Figure 8: 3D rendering of the 4.1 mm lens with mechanical support

Dimension	Value
Diameter*	25 mm
Length	34.3 mm
Weight	29 g
Field of view	100° x 75.0°
Mounting screws	M2

Table 2: 4.1 mm Lens characteristics

**Diameter of the thickest ring*

3.2.2. Lens 7.5 mm

The camera supports the following lens:

Figure 9: 3D rendering of the 7.5 mm lens with mechanical support

Dimension	Value
Diameter	30 mm
Length	44 mm
Weight	44 g
Field of view	58.4° x 43.8°
Mounting screws	M2

Table 3: 7.5 mm Lens characteristics

3.2.3. Lens 9.1 mm

The camera supports the following lens:

Figure 10: 3D rendering of the 9.1 mm lens with mechanical support

Dimension	Value
Diameter	25 mm
Length	26.7 mm
Weight	25 g
Field of view	48° x 36°
Mounting screws	M2

Table 4: 9.1 mm Lens characteristics

3.2.4. Lens 13.6 mm

The camera supports the following lens:

Figure 11: 3D rendering of the 13.5 mm lens with mechanical support

Dimension	Value
Diameter	22.5 mm
Length	24.6 mm
Weight	21 g
Field of view	32° x 24°
Mounting screws	M2

Table 5: 13.5 mm Lens characteristics

3.2.5. Lens 18 mm

The camera supports the following lens:

Figure 12: 3D rendering of the 19 mm lens with mechanical support

Dimension	Value
Diameter*	25 mm
Length	28.3 mm
Weight	28 g
Field of view	24.1° x 18.1°
Mounting screws	M2

Table 6: 19 mm Lens characteristics

**Diameter of the thickest ring*

3.2.6. Lens 24 mm

The camera supports the following lens as an optional configuration:

Figure 13: 3D rendering of the 24 mm lens with mechanical support

Dimension	Value
Diameter	34 mm
Length	36.6 mm
Weight	60 g
Field of view	18.0° x 13.5°
Mounting screws	M2

Table 7: 24 mm Lens characteristics

3.2.7. Lens 32.4 mm

Figure 14: 3D rendering of the 32.4 mm lens with mechanical support

Dimension	Value
Diameter*	31 mm
Length	34.6 mm
Weight	40 g
Field of view	13.2° x 10.0°
Mounting screws	M2

Table 8: Lens 32.4 mm characteristics

Diameter of the thickest ring

3.2.8. Lens 40 mm

Figure 15: 3D rendering of the 40 mm lens with mechanical support

Dimension	Value
Diameter	48 mm
Length	54.8 mm
Weight	101 g
Field of view	10.8° x 8.10°
Mounting screws	M2

Table 9: Lens 40 mm characteristics

3.2.9. Lens 55 mm

Figure 16: 3D rendering of the 55 mm lens with mechanical support

Dimension	Value
Diameter	65 mm
Length	69.5 mm
Weight	207 g
Field of view	7.9° x 5.9°
Mounting screws	M2

Table 10: Lens 55 mm characteristics

3.2.10. Lens 75 mm

Figure 17: 3D rendering of the 75 mm lens with mechanical support

Dimension	Value
Diameter*	101 mm
Length	88.9 mm
Weight	554 g
Field of view	5.8° x 4.4°
Mounting screws	M2

Table 11: Lens 75 mm characteristics

**Diameter of the thickest ring*

3.3. Interfaces

Several additional electronic boards are available to adapt the video output and better meet user's needs. As a reminder, interface boards are add-on modules that connect directly to the core camera.

3.3.1. HD-SDI interface board

The HD-SDI interface board provides image output on an MMCX connector. The interface board's thickness shown in the drawings below includes the thickness of the spacer. The core camera with HD-SDI interface board weighs 20 g.

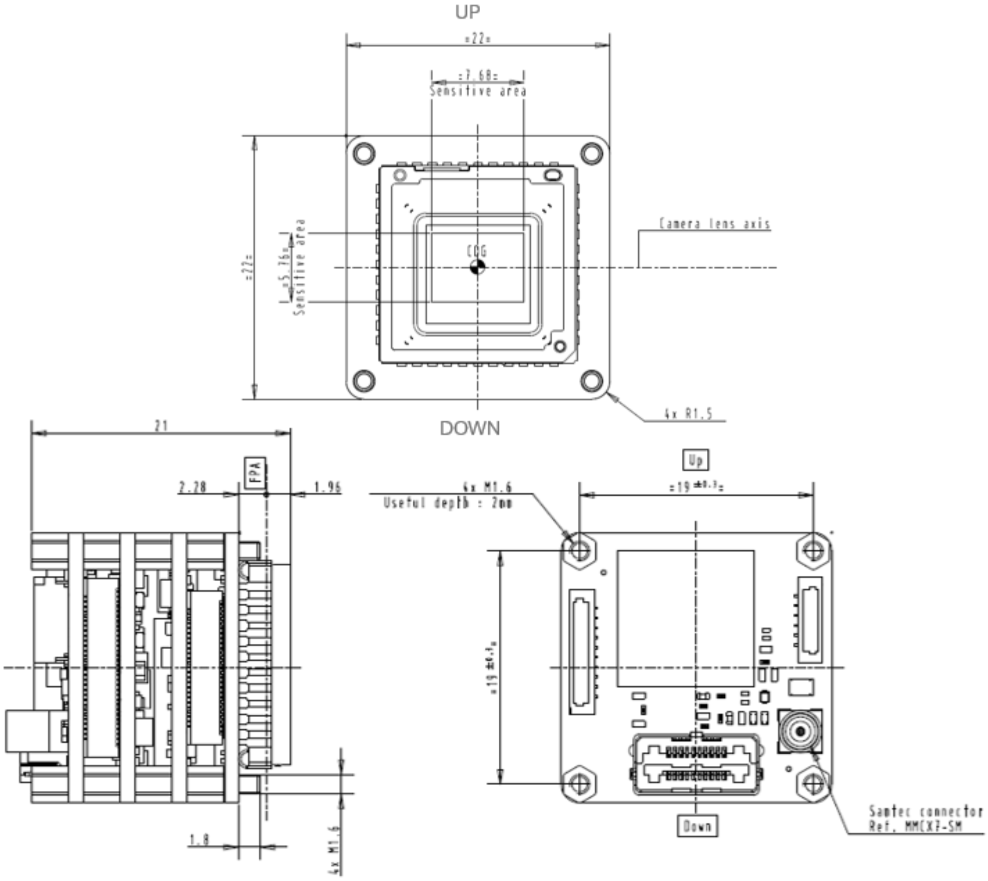

Figure 18: Drawing of HD-SDI interface board

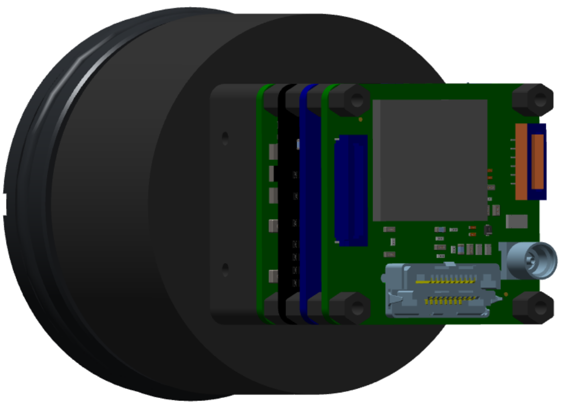

Figure 19: 3D rendering of the CamSight LS with a 25 mm lens and the HD-SDI interface board

3.3.2. USB interface board

The USB interface board provides image output on a Hirose connector. The core camera with USB interface board weighs 19 g.

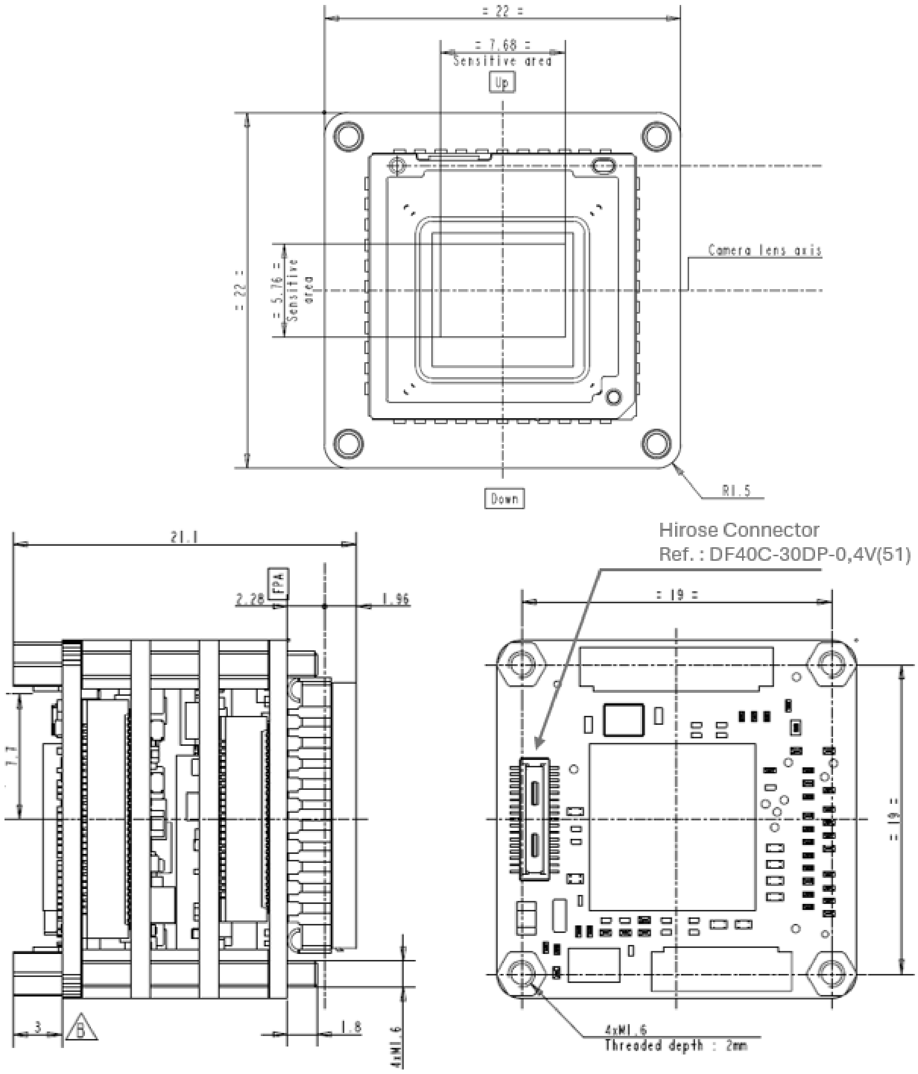

Figure 20: Drawing of USB interface board

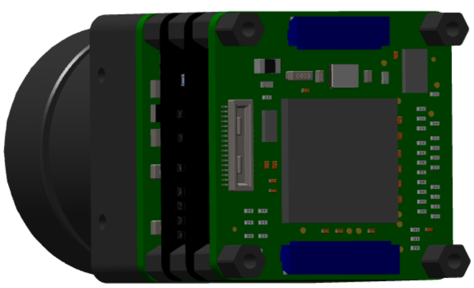

Figure 21: 3D rendering of the CamSight LS with a 13.6 mm lens and the USB interface board

3.3.3. USB-C interface board

The USB-C interface board provides image output on a USB-C connector. It is composed of:

- The USB interface board
- The USB-C connector board.

The core camera with USB-C interface board weighs 27 g.

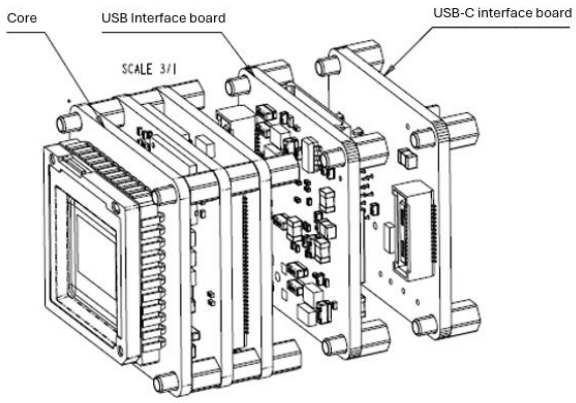

Figure 22: Drawing of the core camera with the USB-C interface board

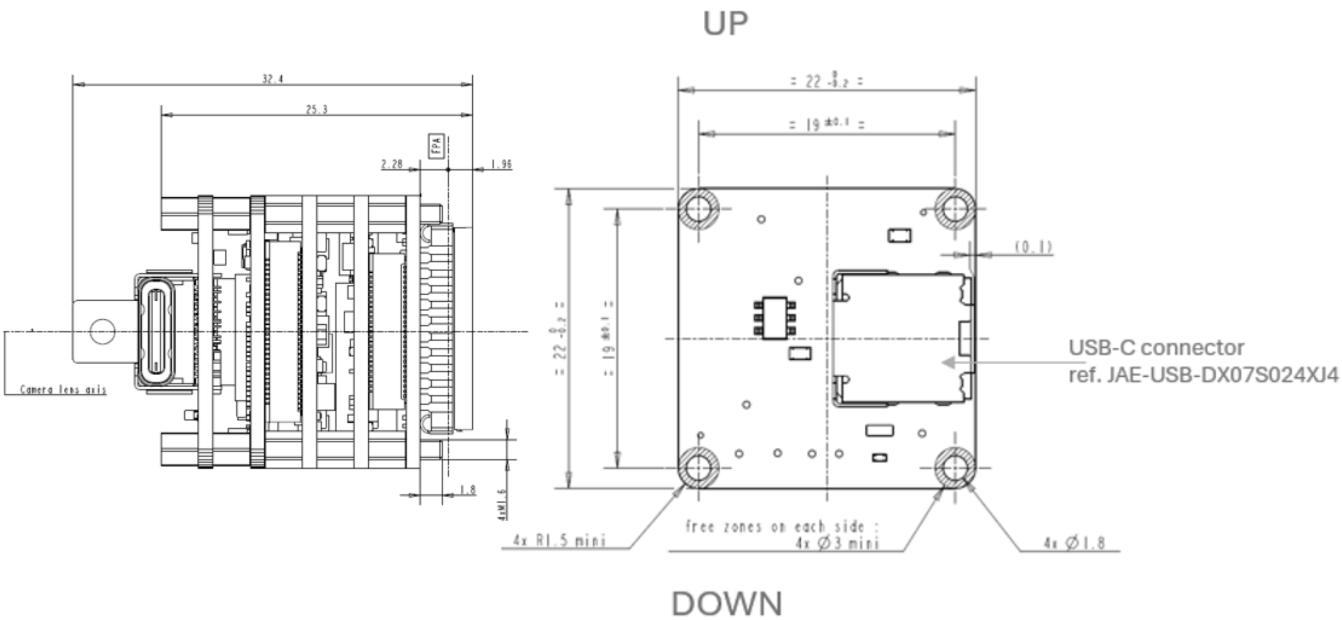

Figure 23: Drawing of the USB-C interface board

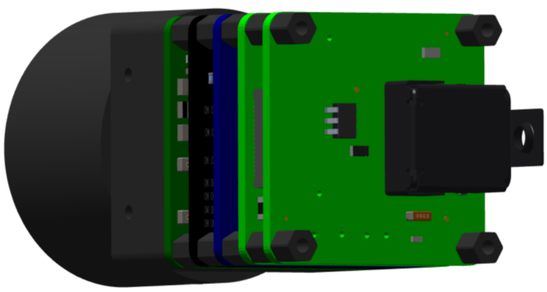

Figure 24: 3D rendering of the CamSight LS with a 4.3 mm lens and the USB-C interface board

3.3.4. USB-M interface board

The USB MOLEX interface board provides image output on a MOLEX connector. The core camera with USB-C interface board weighs 20 g.

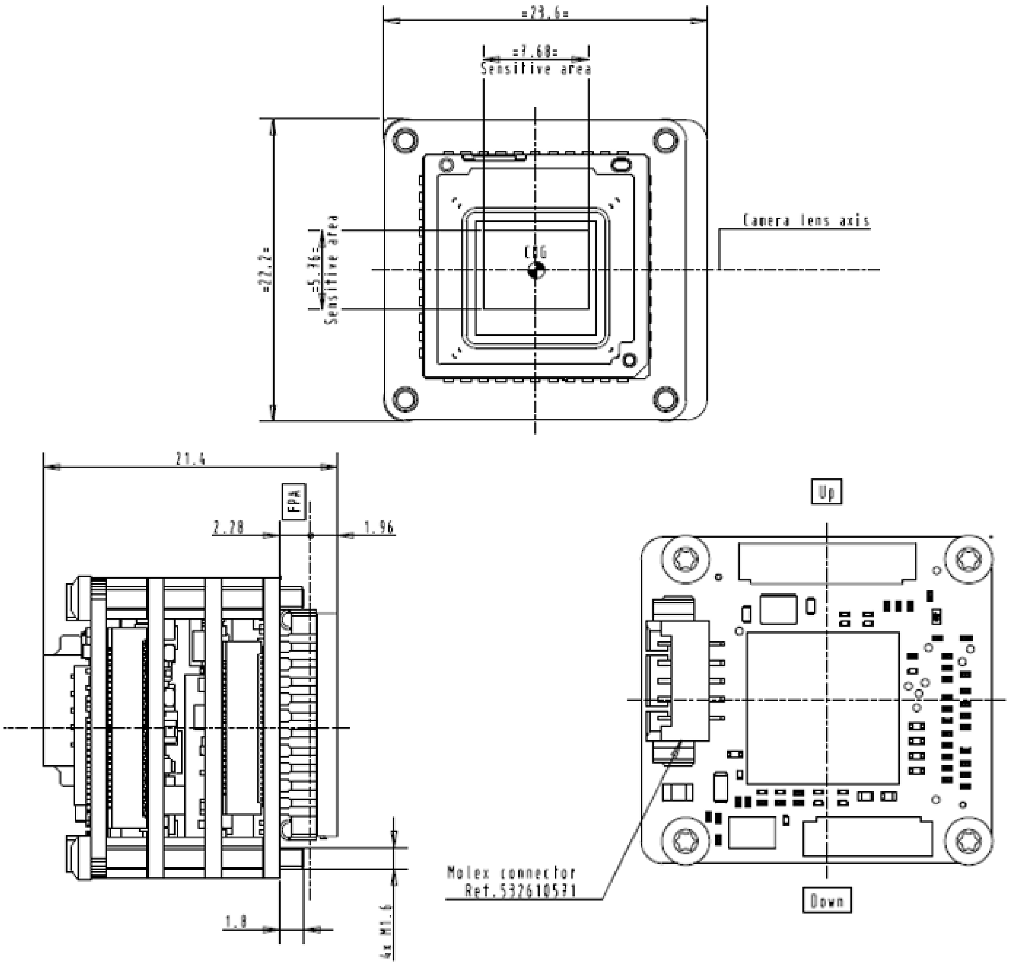

Figure 25: Drawing of USB MOLEX interface board

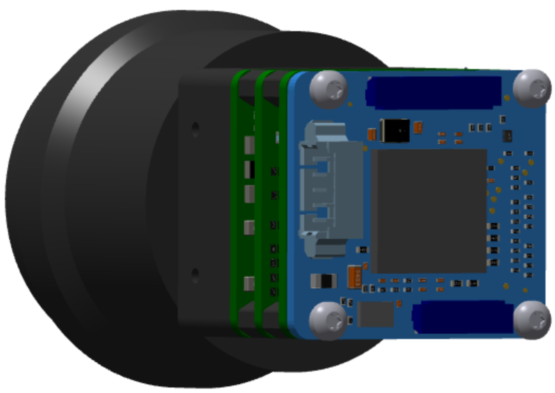

Figure 26: 3D rendering of CamSight LS with 32.4 mm lens and the USB MOLEX interface board

3.3.5. MIPI interface board

The MIPI interface board provides image output on a Amphenol connector. The core camera with MIPI interface board weighs 15 g.

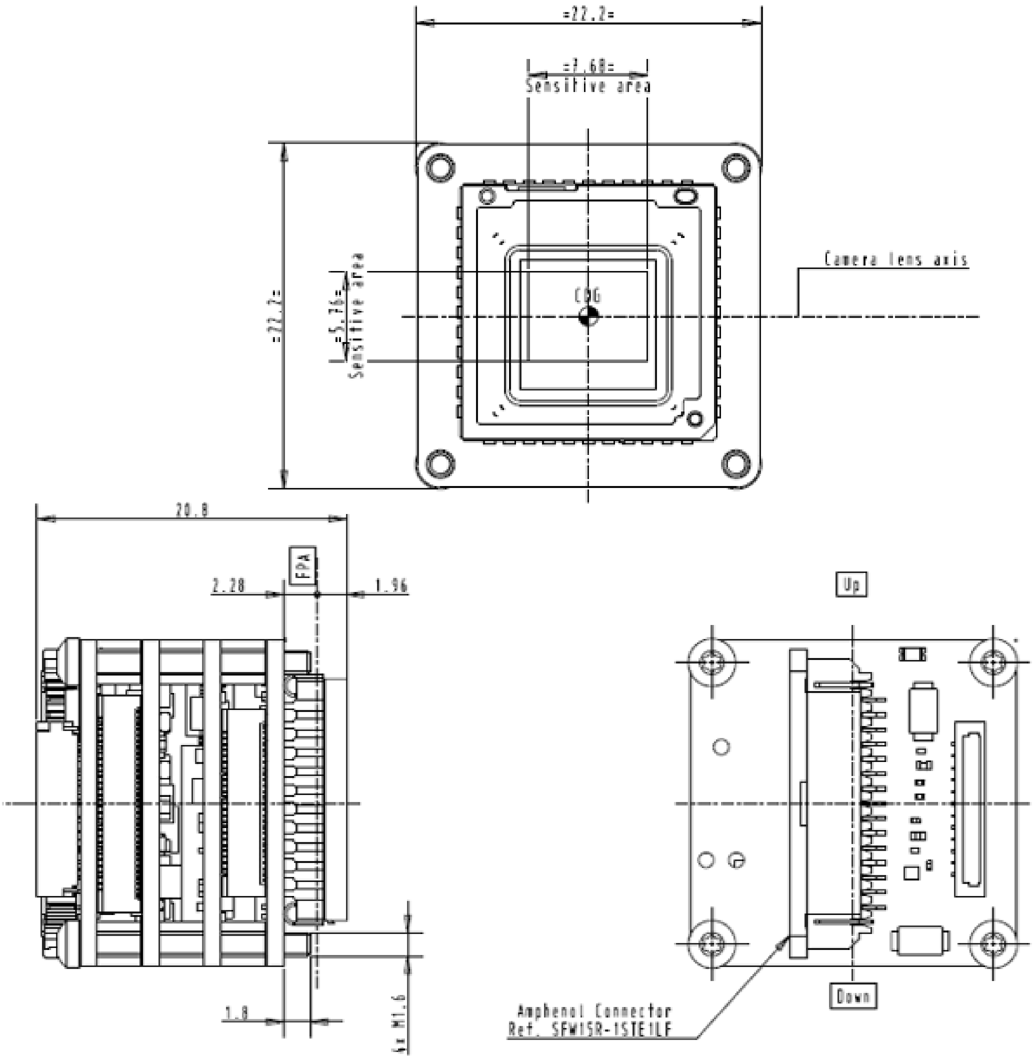

Figure 27: Drawing of the MIPI interface board

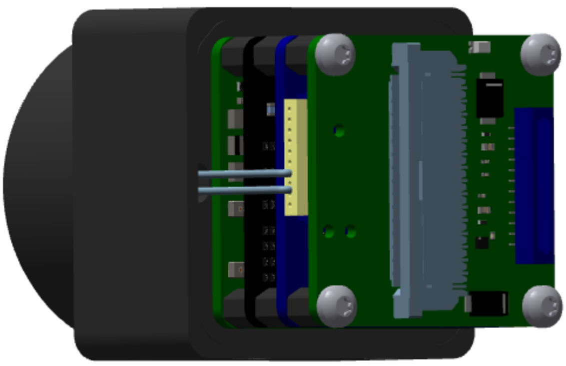

Figure 28: 3D rendering of the CamSight LS with a 4.3 mm lens, a shutter and the MIPI interface board

3.3.6. GigE Vision interface board

The GigE Vision interface board provides image output on an RJ45 connector. It is made of:

- An interface board,
- A Pleora stack (NTx-GigE Vision) composed of
  - An image capture board
  - An Ethernet board
- An optional flat flexible connector (recommended) between the two boards to distance the Pleora boards from the camera to avoid heat emission from Pleora boards on the sensor.

This configuration requires to purchase an SDK from Pleora to fully utilize the camera.

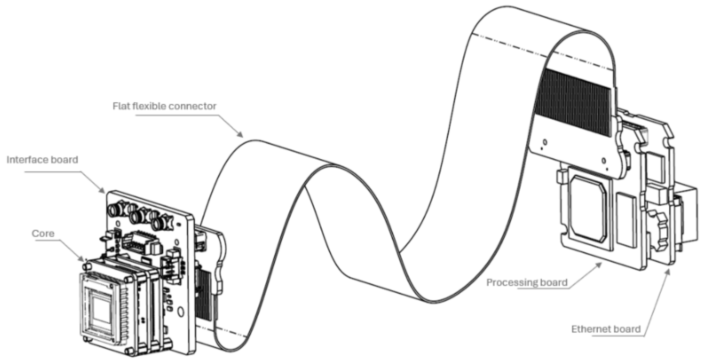

Figure 29: Drawing of the Core camera with GigE Vision interface board

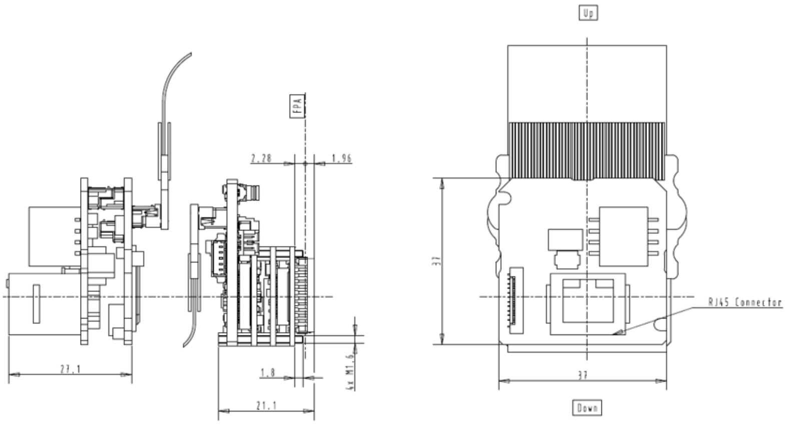

Figure 30: Drawing of the NTX board interface

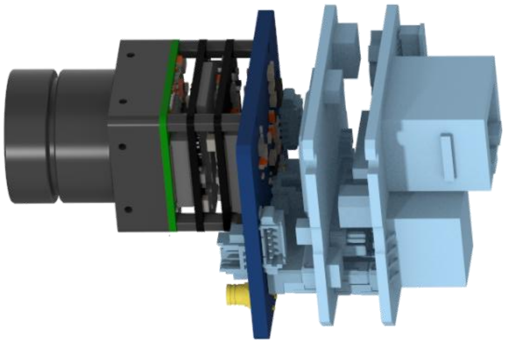

Figure 31: 3D rendering of the CamSight LS with a 9.2 mm lens and the GigE Vision interface

3.3.7. USB-C casing version

The USB-C casing version provides image output on a USB-C connector. It is composed of:

- The USB-C interface board (described in section 3.3.3 USB-C interface board)
- A ruggedized casing to protect the camera

Depending on the lens you choose, the dimensions and weight of the casing will vary.

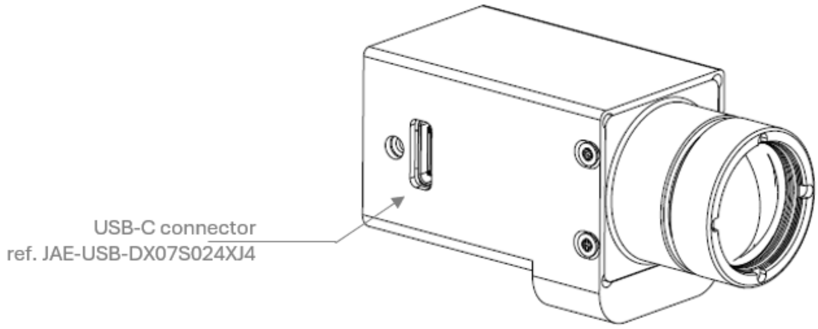

Figure 32: Drawing of the CamSight LS with a 13.6 mm lens and the USB-C casing version

Figure 33: 3D rendering of the CamSight LS with 13.6 mm lens and USB-C casing version

4. ELECTRICAL INTERFACE

4.1. Boards connectors

4.1.1. Core camera

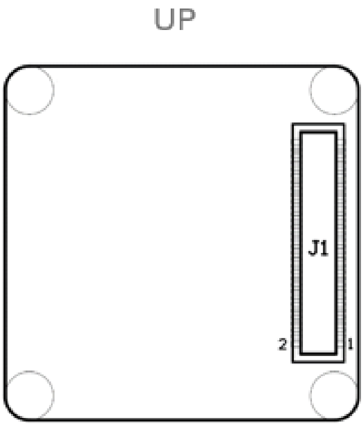

Figure 34: Drawing of the Core camera connector

Connector	Connector reference	Mating connector
J1	HIROSE DF40C-60DP-0.4V (51)	HIROSE DF40HC (3.0)-60DS-0.4V (51)

Table 12: Core board connector reference

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

Table 13: Core camera J1 connector pinout

4.1.2. HD-SDI interface board

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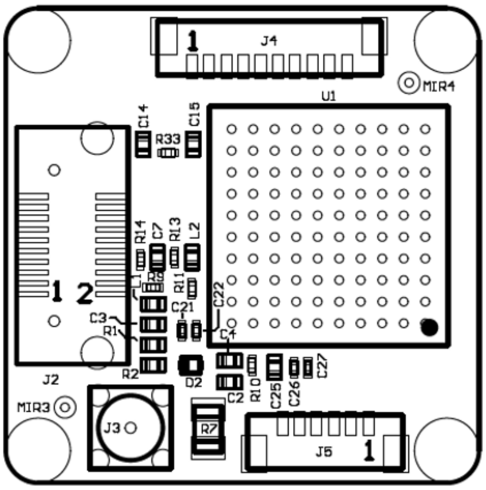


Figure 35: Drawing of the HD-SDI interface board connectors

NOTE: J4 and J5 is factory reserved connector.

Connector	Connector reference	Mating connector
J2	SAMTEC LSHM-110-02.5-L-DV-A-S (hermaphroditic connector)	SAMTEC LSHM-110-02.5-L-DV-A-S (hermaphroditic connector)
J3	SAMTEC RSP-229832-02	SAMTEC MCX7-P-C-H-ST-CA3

Table 14: HD-SDI interface board connector reference

J3 – HD-SDI Output (MMCX7 Female)				
Pin	**Name**	**I/O**	**Voltage**	**Description**
1	SDI SIGNAL	O	Video	*HD-SDI video output*
Outer conductor	GND	P		

Table 15: HD-SDI interface board J3 connector pinout

J2 – Camera Control Connector (LSHM-110-02.5-L-DV-A-S)									
Description	**Voltage**	**I/O**	**Name**	**Pin**	**Pin**	**Name**	**I/O**	**Voltage**	**Description**
		P	GND	1	2	GND	P		
MIPI CSI2 line	mipi phyD	O	MIPI_L1_N	3	4	GND	P		
MIPI CSI2 line	mipi phyD	O	MIPI_L1_P	5	6	GND	P		
		P	GND	7	8	UART_TX	O	1.8V or 3.3V	*UART level can be chosen to be either 1.8V or 3.3V depending on HW config*
MIPI CSI2 differential clock	mipi phyD	O	MIPI_CLK_N	9	10	UART_RX	I	1.8V or 3.3V	*UART level can be chosen to be either 1.8V or 3.3V depending on HW config*
MIPI CSI2 differential clock	mipi phyD	O	MIPI_CLK_P	11	12	GND	P		
		P	GND	13	14	VIDEO_CLK_REF_P	I	LVDS	
HD SDI video output	SDI level	O	SDI OUT	15	16	VIDEO_CLK_REF_N	I	LVDS	
CAMERA_POWER	5V	P	CAMERA_POWER	17	18	GND	P		
		P	GND	19	20	Reserved	-		*Do not connect*

Table 16: HD-SDI interface board J5 connector pinout

4.1.3. USB interface board

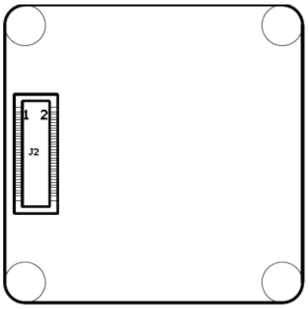


Figure 36: Drawing of the USB interface board connectors

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.

Connector	Connector reference	Mating connector
J2	HIROSE DF40C-30DP-0.4V (51)	DF40C-30DS-0.4V (51)

Table 17: USB interface board connector reference

J2 – CONN PLUG 30POS SMD GOLD (DF40C-30DP-0.4V (51))									
Description	**Voltage**	**I/O**	**Nom**	**Pin Number**	**Pin Number**	**Nom**	**I/O**	**Voltage**	**Description**
*See §**Erreur ! Source du renvoi introuvable.** for electrical specifications*	5V	P	CAMERA_POWER	1	2	CAMERA_POWER	P	5V	*See §**Erreur ! Source du renvoi introuvable.** for electrical specifications*
		P	GND	3	4	GND	P		
Do not connect		-	RESERVED	5	6	GND	P		
		P	GND	7	8	USB_D_N	O		*USB 2.0 differential pair*
Do not connect		-	Reserved	9	10	USB_D_P	O		*USB 2.0 differential pair*
		P	GND	11	12	GND	P		
(Optional) 27MHZ LVDS	LVDS	I	VIDEO_CLK_REF_P	13	14	GND	P		
(Optional) 27MHZ LVDS	LVDS	I	VIDEO_CLK_REF_N	15	16	GND	P		
		P	GND	17	18	GND	P		
		P	GND	19	20	USB3_SSTX_N	O		*USB 3.0 signal transmission line*
		P	GND	21	22	USB3_SSTX_P	O		*USB 3.0 signal transmission line*
Do not connect		-	Reserved	23	24	GND	P		
	1V8	O	VIDEOOUT_VSYNC	25	26	GND	P		
		P	GND	27	28	USB3_SSRX_P	I		*USB 3.0 signal receiving line*
		P	GND	29	30	USB3_SSRX_N	I		*USB 3.0 signal receiving line*

Table 18: USB interface board J2 connector pinout

4.1.4. USB-C interface board

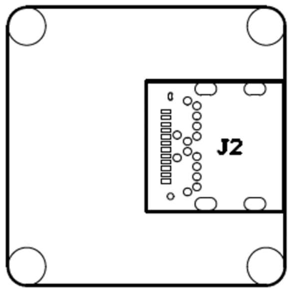


Figure 37: Drawing of the USB-C interface board connectors

Connector	Connector reference	Mating connector
J2	JAE Electronics DX07S024XJ4R250	USB-C male connector

Table 19: USB-C interface board connector reference

J2 – USB-C female (DX07S024XJ4R250)									
Description	**Voltage**	**I/O**	**Nom**	**Pin Number**	**Pin Number**	**Nom**	**I/O**	**Voltage**	**Description**
		P	GND	A1	B1	GND	P		
USB 3.0 signal transmission line		I	USB3_SSTX_P	A2	B2	Reserved			*Do not connect*
USB 3.0 signal transmission line		I	USB3_SSTX_N	A3	B3	Reserved			*Do not connect*
	5V	P	VBUS	A4	B4	V_USB	P	5V	
Configuration channel Pin	0-5V		CC1	A5	B5	CC2		0-5V	*Configuration channel Pin*
		IO	USB3_D_P	A6	B6	USB_D_N	IO		*USB 2.0 differential pair*
		IO	USB3_D_P	A7	B7	USB_D_P	IO		*USB 2.0 differential pair*
Do not connect			Reserved	A8	B8	Reserved			*Do not connect*
	5V	P	V_USB	A9	B9	V_USB	P	5V	
Do not connect			Reserved	A10	B10	USB3_SSTX_N	O		*USB 3.0 signal transmission line*
Do not connect			Reserved	A11	B11	USB3_SSTX_P	O		*USB 3.0 signal transmission line*
		P	GND	A12	B12	GND	P		
		P	Shield GND	SH					

Table 20: USB-C interface board J2 connector pinout

4.1.5. USB-M interface board

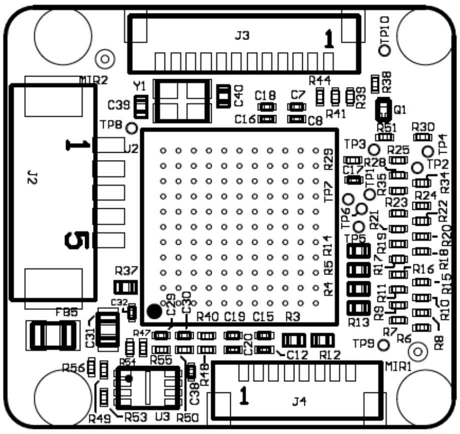


Figure 38: Drawing of the USB-M interface board connectors

NOTE: J3 and J4 is factory reserved connector.

Connector	Connector reference	Mating connector
J2	MOLEX 53261-0571	MOLEX 51021-0500

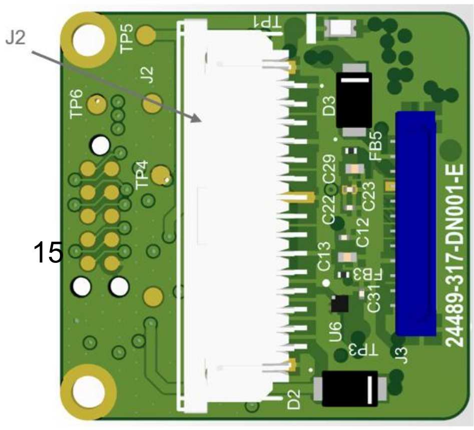
Table 21: USB-M interface board connector reference

J2 – USB MOLEX (MOLEX 53261-0571)				
Pin	**Name**	**I/O**	**Voltage**	**Description**
1	VUSB	P	5 V	*Power*
2	USB3_D_N	IO		*USB 2.0 differential pair*
3	USB3_D_P	IO		*USB 2.0 differential pair*
4	GND	P		*Power*
5	Reserved	-		*Do not connect*

Table 22: USB-M interface board J2 connector pinout

4.1.6. MIPI interface board

UP



DOWN

Figure 39: Drawing of the MIPI interface board connectors

NOTE: J3 is factory reserved connector.

Connector	Connector reference	Mating connector
J2	AMPHENOL SFW15R-1STE1LF	15 pins FFC cable

Table 23: MIPI interface board connector reference

J2 – MIPI CSI-2 (SFW15R-1STE1LF)			
Pin number	**Name**	**I/O**	**Voltage**
1	GND	P	
2	CSI_D0_N	O	MIPI data lane 0 (N)
3	CSI_D0_P	O	MIPI data lane 0 (P)
4	GND	P	
5	CSI_D1_N	O	MIPI data lane 1 (N)
6	CSI_D1_P	O	MIPI data lane 1 (P)
7	GND	P	
8	CSI_CLK_N	O	MIPI clock lane (N)
9	CSI_CLK_P	O	MIPI clock lane (P)
10	GND	P	
11	Reserved	-	Do not connect
12	Reserved	-	Do not connect
13	CSI_I2C_SCL	IO	I2C clock lane – 3v3 - 4.7kΩ pull-up on board
14	CSI_I2C_SDA	IO	I2C data lane – 3v3 - 4.7kΩ pull-up on board
15	POWER +3.3V	P	+3.3V

Table 24: MIPI interface board J2 connector pinout

4.1.7. GigE Vision interface

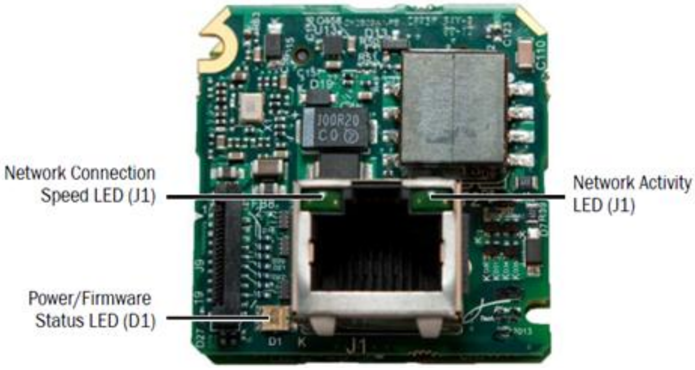


Figure 40: GigE Vision NTX backboard view

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 25 Hz to 60 Hz).

4.2. Power supply

4.2.1. 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

Table 25: 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

Table 26: 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

Table 27: Differential DC input levels

4.2.2. Core camera

Input pin	Requirement	Min	Max
58: “VCC Analog” 60: “VCC Analog”	Voltage	4.5 V	5.1 V
	Current	-	100 mA
	Ripple*	-	30 mV
55: “VCC Digital” 57: “VCC Digital”	Voltage	2.5 V	5.1 V
	Current	-	280 mA
	Ripple*	-	60 mV

Table 28: Core camera power supplies requirements

**Avoid SMPS with operating frequency lower than 1MHz for better image quality. Prefer linear regulators with high PSRR.*

4.2.3. HD-SDI interface

Input pin	Requirement	Min	Max
J2: 17 J5: 1	Voltage	4.5 V	5.5 V
	Current	-	300 mA
	Ripple*	-	60 mV

Table 29: HD-SDI interface power supply requirements

**Avoid SMPS with operating frequency lower than 1MHz for better image quality. Prefer linear regulators with high PSRR.*

4.2.4. USB interface

Input pin	Requirement	Min	Max
1,2: “Camera Power”	Voltage*	4.5 V	5.5 V
	Current	-	300 mA
	Ripple**	-	60 mV

Table 30: USB interface power supply requirements

**USB voltage compliance*

***Avoid SMPS with operating frequency lower than 1MHz for better image quality.*

4.2.5. USB-C interface

Input pin	Requirement	Min	Max
A4, B4,A9,B9: “VUSB”	Voltage*	4.5 V	5.5 V
	Current	-	300 mA
	Ripple*	-	60 mV

Table 31: USB-C interface power supply requirements

**USB-C voltage compliance*

4.2.6. USB Molex interface

Input pin	Requirement	Min	Max
1: “VUSB”’	Voltage*	4.5 V	5.5 V
	Current	-	300 mA
	Ripple*	-	60 mV

Table 32: USB MOLEX interface power supply requirements

4.2.7. MIPI interface

Input pin	Requirement	Min	Max
15: “POWER 3,3”	Voltage	3.3 V	
	Current	-	400 mA
	Ripple*	-	60 mV

Table 33: MIPI interface power supply requirements

**Avoid SMPS with operating frequency lower than 1MHz for better image quality.*

4.2.8. GigE Vision interface

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

4.3. Interface configurations

4.3.1. Serial electrical interface

To configure and communicate with CamSight LS cameras, a serial UART interface is available on all electronic boards and extension boards.

WARNING: Depending on the electronic board you are connecting to, the logic levels can be either 1.8V or 3.3V, refer to your board electrical interface for the specific line voltage to use.

UART Parameter	Value
Default baud rate	115200 baud/s
Start bit	1
Stop bit	1
Number of data bits	8
Parity bit	None

Table 34: UART Serial interface parameters

4.3.2. I2C MIPI interface

To configure and communicate with CamSight LS cameras with a MIPI CSI-2 output, an I2C interface is available on the MIPI electronics boards.

I2C Parameter	Value
Clock speed	400kHz
Camera address	0x30

Table 35: I2C MIPI interface parameters

5. IMAGE PROCESSING

5.1. Camera Pipeline overview

5.1.1. CamSight LS pipeline

CamSight LS image processing pipeline is the following:

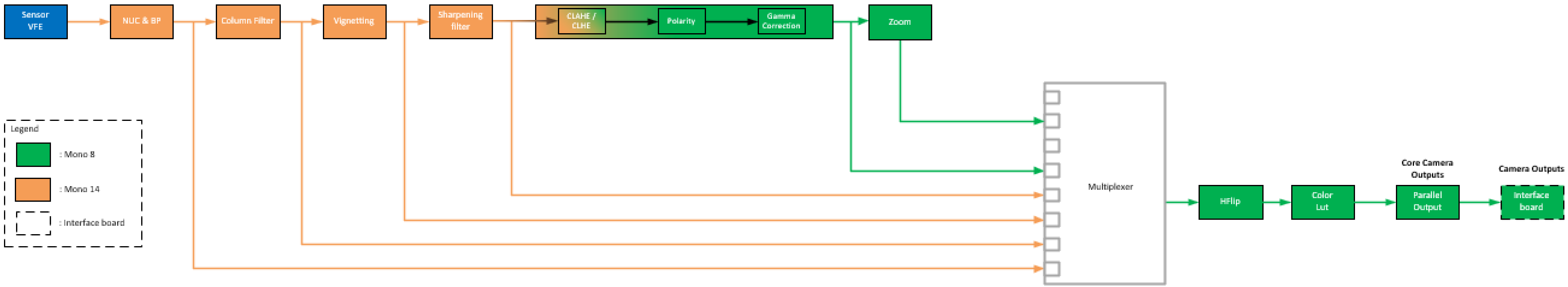


Figure 41: Video stream pipeline of the CamSight LS with 8 bits

The functionalities associated with each processing stage of the image processing pipeline are detailed in Section 5.2. A multiplexer is implemented to allow access to the video stream at each intermediate stage of the pipeline for monitoring or debugging, thereby providing flexibility to accommodate a wide range of operational and integration needs.

5.1.2. Video interfaces

The different interfaces you can choose from only affect the camera's output. The camera's processing pipeline remains the same regardless of the interface you use. You can find more information about the outputs of the different interfaces in the paragraph 4. The table below summarizes the various possible configurations. M8 and M14 means Mono8 and Mono14 format output data.

	9 Hz	25 Hz	30 Hz	50 Hz	60 Hz
Parallel	*Forthcoming*	M8/M14	M8/M14	M8/M14	M8/M14
HD-SDI	X	*Forthcoming*	*Forthcoming*	*Forthcoming*	*Forthcoming*
USB	*Forthcoming*	M8	M8	M8	M8
USB-C	*Forthcoming*	M8	M8	M8	M8
USB-M	*Forthcoming*	M8	M8	M8	M8
MIPI CSI-2	*Forthcoming*	M8	M8	M8	M8
GigE	*Forthcoming*	M8/M14	M8/M14	M8/M14	M8/M14

Table 36: CamSight LS interfaces and frequencies

5.2. Features overview

5.2.1. Framerate

The camera is designed to handle different framerates (up to three frequencies), including 9, 25, 30, 50, and 60Hz. The 9Hz version (for civilian applications) is a factory hard-wired configuration and cannot be changed by settings. For higher framerates than 9 Hz, you can use your cameras with three different frequencies (25 Hz, 30 Hz, 50Hz and 60 Hz). You'll be able to switch between frequencies without making any changes. Cameras with a frequency higher than 9 Hz are subject to export control.

5.2.2. Bad pixels

The CamSight LS integrates the factory list of bad pixels and corrects them in real time with each frame.

5.2.3. Shutterless operation

The CamSight LS camera features shutterless technology that allows for low-latency and freeze-free image delivery in real-time 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.

5.2.4. Less shutter operation

The CamSight LS camera can perform a 1-point Non-Uniformity Correction (NUC1pt). This correction can be carried out either using the camera's internal shutter or by applying an external reference. This operation is performed manually at the operator's request.

5.2.5. 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.

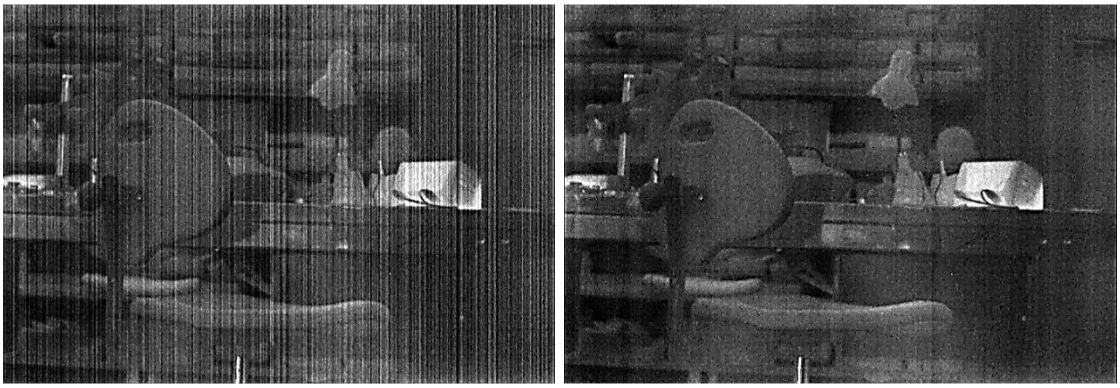


Figure 42: Left picture-column noise correction OFF/Right picture-column noise correction ON

5.2.6. 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 43: Left picture - vignetting correction OFF / Right picture - vignetting correction ON

5.2.7. 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 44: Left: sharpening off / Right: Sharpening on

Figure 45: 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.

5.2.8. 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)
- CLAHE (Contrast-Limited Adaptive Histogram Equalization).

A parameter allows adjusting these algorithms to be more linear or more histogram equalization. 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 equalization 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 46: Left picture - CLHE / Right picture - CLAHE

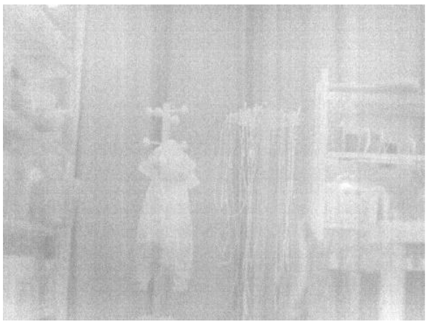
5.2.9. AHC gain limitation

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 gray limitation as well.

Figure 47: 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

Figure 48: CamSight LS AHC gains variations

5.2.10. 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.

5.2.11. Polarity

The camera features an image algorithm to invert image polarity (White Hot vs Black Hot).

Figure 49: Left picture - Black Hot / Right picture - White Hot

5.2.12. Gamma correction

A gamma correction can be applied to the image to modify its luminosity and contrast. Gamma values higher than 1 result in an overall darkening of the image while a gamma value less than 1 results in an overall lightening of the image.

The gamma correction value can be set by the user depending on the imaged scene.

NOTE: The gamma computation is approximated, resulting in a lack of brightness boosting for low values of gamma (3rd order approximation of $(1+x)^{\gamma}$).

Figure 50: Low gamma correction / Right picture – High gamma correction

5.2.13. 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 51: CamSight LS with 13.6 mm lens: Left: Zoom x1.0 / Right: Zoom x 4.0

5.2.14. Horizontal Flip

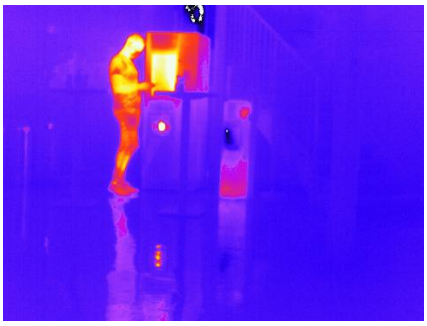
The camera includes a horizontal flip function that allows the image to be mirrored along the vertical axis in real time. This feature is designed to adapt the image orientation to the installation configuration and simplify system integration. By reversing the left and right sides of the image, users can ensure consistent visualization regardless of camera mounting position, such as in inverted or reflected optical setups.

Figure 52: CamSight LS with 7.5 mm lens: Left: HFlip deactivated / Right: HFlip activated

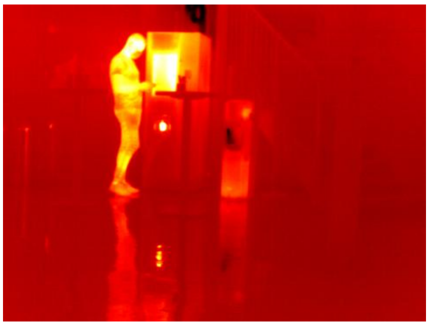
5.2.15. False-color LUT

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.

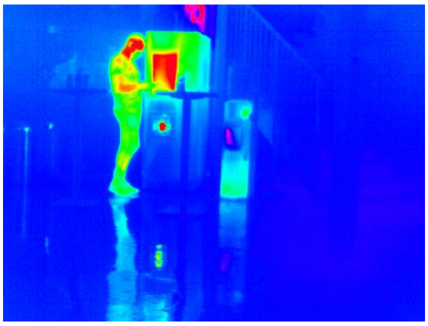
GRAYSCALE



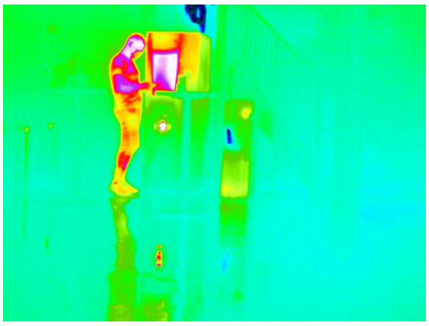
IRON



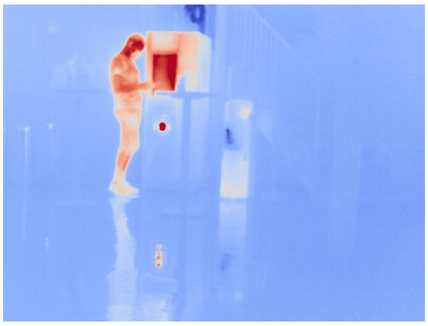
HOT



RAINBOW



NCAR



COOLWARM

CUBEHELIX

Figure 53: Available LUTs of the CamSight LS

False color LUT is available for 8 bits video outputs. It's not available for 14 bits data.

5.3. Video output

5.3.1. Parallel output

The parallel video output of the CamSight LS camera is a 8-bit/14-bit/16-bit video bus that transmits pixel data for each frame. This video output is available at 9/25/30/50/60 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 pixels are 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).

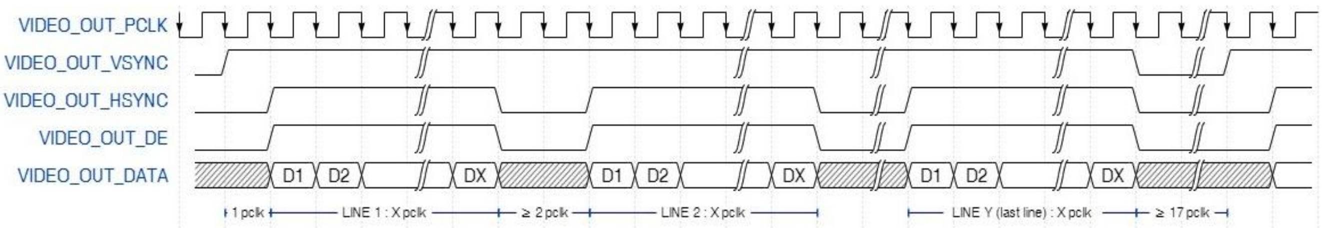


Figure 54: Parallel video framing with resolution X Y (software version ≥ 2.1.1)

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

The parallel video bus can be configured to stream:

Output selection	Resolution	Pixel depth	PCLK frequency	Description
RAW	640x480	14 bits	44MHz	Raw sensor output
NUC	640x480	14 bits	44MHz	NUC output
COLUMN	640x480	14 bits	44MHz	Column correction output
VIGNETTING	640x480	14 bits	44MHz	Vignetting correction output
EDGE	640x480	14 bits	44MHz	Edge correction output
LUT	640x480	8 bits / 16 bits	44MHz	CLHE/CLAHE output
RFU	N/A	N/A	N/A	Reserved
ZOOM (default)	640x480	8 bits / 16 bits	44MHz	Zoom output
BT656	640x480	N/A	N/A	Unavailable

Table 37: Video output configuration

5.3.2. MIPI CSI-2 D-PHY

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

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

Camera settings (*) :

- ColorLUT: Only “GRAYSCALE”.
- 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.

5.3.3. 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 “GRAYSCALE YCbCr”. Do not use “GRAYSCALE”.
- 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.

5.3.4. 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) under “Device Control” section the following Genicam Parameters :

- Width:
  - 640 for all outputs
- Height:
  - 480 for all outputs
- 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

6. SOFTWARE INTERFACE

6.1. SERIAL communication interface

6.1.1. Hardware

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

- Pin 18 and 20 on the output connector, 3.3V or 1.8V LVCMOS electrical levels (see §3.1).
- Main UART parameters: 115200
- Baudrate: 115200 bps (default value)
- Start bit: 1
- Stop bit: 1
- Data bit: 8 bits data
- Parity: None

6.1.2. MAVLINK protocol

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).

6.1.2.1. 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.

6.1.2.2. 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_PROT_VERS` command) and is identified in this document as version 0.

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

6.1.2.3. MAVLink generator

6.1.2.3.1. 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.

6.1.2.3.2. 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/

6.1.3. CamSight MAVLink description

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

6.1.3.1. Command packet format

Two kinds of command are defined:

- Set commands: the master device sends data to the slave; the slave responds with an ACK message indicating success or failure.
- Get commands: the master device sends a request to the slave, the slave sends back the same message with the data/payload filled with the requested data.

6.1.3.2. 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.

6.1.3.3. 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.

6.1.3.4. Response format

6.1.3.4.1. 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.

6.1.3.4.2. 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.

*

6.1.3.5. Noticeable specificities

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

If the 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 (MAVLink decoder) to analyze the content and recover missing zeros based on the message ID.

6.2. 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
CAMERA_STATUS	12303	This command gets parameters information from the camera (contrast, gamma, polarity)
CONTRAST_CONTROL	12300	Selects the LUT mode: CLHE (global LUT) or CLAHE (local LUT)
GET_AHC_GAIN_LIMITATION	12355	This command gets AHC (Automatic Histogram Control) gain limit from CLHE and CLAHE algorithm.
GET_CAMERA_INFO	12361	This command gets number of startup and operating time from the camera.
GET_CAMERA_PROT_VERS	12287	This command requests the mavlink protocol version.
GET_CAMERA_TEMPERATURE	12359	This command gets camera internal temperatures.
GET_COLORLUT	12341	This command reads the false color LUT
GET_COLUMN_CORRECTION	12327	This message gets the column correction status
GET_CONTRAST_TYPE	12320	This command reads the type of contrast processing applied: CLHE or CLAHE.
GET_EDGE_PARAMS	12335	This command reads the video edge processing settings currently in use in the camera
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.
GET_FPA_TEMPERATURE	8199	This command returns the sensor temperature.
GET_FRAMERATE	12331	This command reads the video output frame rate currently in use.
GET_LUT_TEMPORAL_FILTER	12357	This command gets AHC (Automatic Histogram Control) speed for CLHE and CLAHE algorithm.
GET_MIPI_OUTPUT	12347	This command reads the MIPI output status
GET_PARALLEL_OUTPUT	12345	This command reads the PARALLEL output status
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).
GET_ROI0_exclusive	12351	This command gets the Region of Interest exclusive 0 for the CLHE LUT algorithm.
GET_ROI1_exclusive	12353	This command gets the Region of Interest exclusive 1 for the CLHE LUT algorithm.
GET_ROI1_inclusive	12349	This command gets the Region of Interest inclusive 1 for the CLHE LUT algorithm.
GET_SDI_OUTPUT	12343	This command reads the SDI output status
GET_SENSOR_SERIALNUMBER	8209	This command requests the sensor serial number
GET_SERIALNUMBER	8194	This message requests the camera serial number stored in non-volatile memory.
GET_TEST_PATTERN	8208	This command gets the Test pattern video output state.
GET_VIDEO_SELECT	12333	This command gets the video source to use as output for parallel and MIPI.
GET_VIGNETTING_CORRECTION	12329	This message reads the vignetting correction processing state
GET_ZOOM_CONFIG	12316	This command gets the zoom configuration parameters.
GET_ZOOM_OUTPUT_RESOLUTION	12339	This command reads the output resolution of the zoom.
INVERT_POLARITY	12294	This command enables or disables the IR image polarity. Standard polarity means hot points are white and cold points are black
MESSAGE_ACK	8192	This message is only used to respond to Set commands.
NUC_REQUEST	12296	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.
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).
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.
SET_COLORLUT	12340	This command sets the false color LUT
SET_COLUMN_CORRECTION	12326	This message enables or disables the column correction processing
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).
SET_EDGE_PARAMS	12334	This command enables or disables the video edge processing (sharpening or contouring) and sets the corresponding parameters.

SET_FLIP_H	12323	This message sets the horizontal flip 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
SET_GAMMA	12290	The Gamma parameter adjusts the contrast curve of the image in order to compensate the restitution of the final display.
SET_LUT_TEMPORAL_FILTER	12356	This command defines AHC (Automatic Histogram Control) speed for CLHE and CLAHE algorithm.
SET_MAVLINK_SERIAL_SPEED	8217	This command switches the MAVLink UART baud rate between all possible values. Supported standard value: 9600, 115200, 230400, 460800 and 921600
SET_MIPI_OUTPUT	12346	This command enables or disables the MIPI output
SET_PARALLEL_OUTPUT	12344	This command enables or disables the PARALLEL output
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).
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).
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).
SET_SDI_OUTPUT	12342	This command enables or disables the SDI output
SET_TEST_PATTERN	8207	This command enables Test pattern video output
SET_VIDEO_SELECT	12332	This command selects the video source to use as output for parallel and MIPI.
SET_VIGNETTING_CORRECTION	12328	This message enables or disables the vignetting correction processing
SET_ZOOM_METHOD	12311	Set the zoom method
SET_ZOOM_OUTPUT_RESOLUTION	12338	This command sets the output resolution of the zoom. Only available when SDI output is disable
SET_ZOOM_PARAMS	12310	Set parameters for the zoom algorithm
SHUTTER_CONTROL	8206	This message is used to control the shutter, open it and close it.

Table 37 : Command list

6.2.1. Message ACK

This message is used to respond to Set commands.

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.

6.2.2. 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.

6.2.3. Invert Polarity

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

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.

6.2.4. 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_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.

6.2.5. 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

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.

6.2.6. 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**

6.2.7. 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.

6.2.8. Get Sensor Serial Number

This message requests the sensor 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_SENSOR_SERIALNUMBER` = 8209 (0x 2011). This is a Get Command type.
PAYLOAD: used for both command and response:

- Command: empty.
- Response: SENSOR_SERIAL_NUMBER.

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

6.2.9. 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.

6.2.10. Get Test Pattern

This command gets the Test pattern video output 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_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.

6.2.11. 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.

6.2.12. 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.

6.2.13. 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.

6.2.14. 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.
- 6: RFU_OUTPUT; reserved for future use.
- 7: ZOOM_OUTPUT; Zoom mode, 640x480, parallel format, 8-bit pixels. (default)
- 8: BT656_OUTPUT; BT656 format.

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.

6.2.15. 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.

6.2.16. 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
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.

6.2.17. Contrast Control

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.

6.2.18. 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.

6.2.19. 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.

6.2.20. 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.

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.

6.2.21. 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_ID_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.

6.2.22. 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.

6.2.23. 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.

6.2.24. 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:
    - 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.

6.2.25. 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.

6.2.26. 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

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.

6.2.27. 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.

6.2.28. 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.

6.2.29. 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.

6.2.30. 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.

6.2.31. 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.

6.2.32. 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.

6.2.33. 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.

6.2.34. 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.

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.

6.2.35. 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 = 640)
- y_resolution: uint32_t; resolution axis Y (CamSight LS Default = 480)

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.

6.2.36. 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.

6.2.37. 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.
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: GRAYSCALE (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.

6.2.38. 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.

6.2.39. 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.

6.2.40. Get SDI Output

This command gets the status of 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_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.

6.2.41. 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.

6.2.42. 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.

6.2.43. 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.

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.

6.2.44. 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.

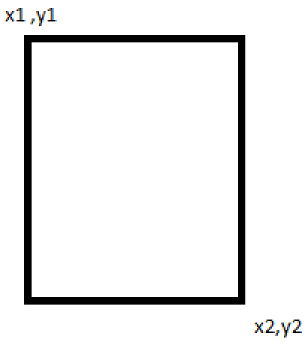
Unused: must be kept 0.

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

6.2.45. 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.

Unused: must be kept 0.

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

6.2.46. 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.

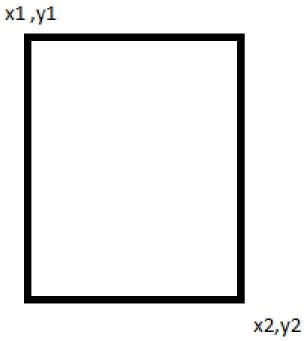
Unused: must be kept 0.

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

6.2.47. 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:

- 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.

6.2.48. 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.

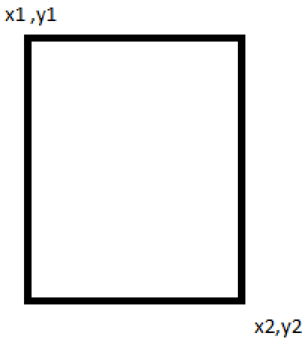
Unused: must be kept 0.

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

6.2.49. 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
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.

6.2.50. 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.

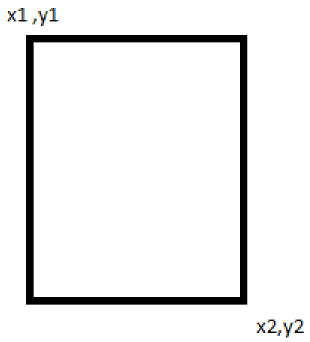
Unused: must be kept 0.

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

6.2.51. 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:



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.

6.2.52. 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_ROI1_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.

6.2.53. 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 gray.

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.

6.2.54. 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.

6.2.55. 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.

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.

6.2.56. 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.

6.3. MIPI CSI I2C communication interface

Available for firmware version above v2.2.0.

6.3.1. MIPI

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.

6.3.2. I²C Register Map

6.3.2.1. 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_BYTE_0	R	Serial number of the camera (Byte 0: LSB).
0x06	CAMERA_SN_BYTE_1	R	Serial number of the camera (Byte 1).
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_WHITE_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)

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
0x4E	CAMERA_SN_BYTE_2	R	Serial number of the camera (Byte 2).
0x4F	CAMERA_SN_BYTE_3	R	Serial number of the camera (Byte 3).

0x50	SHUTTER	**RW**	Open and Close shutter
0x51	**NUC_1POINT_RQST**	**RW**	Set NUC 1 point reference

Table 38: MIPI command list

6.3.3. Registers description

6.3.3.1. 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.

6.3.3.2. 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							

6.3.3.3. 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							

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

These registers contain the first two bytes of the serial number of the camera. The first byte (LSB) is at address 0x05, the second byte is at the address 0x06.

7	6	5	4	3	2	1	0
CAMERA_SN_BYTE_0							
R							

7	6	5	4	3	2	1	0
CAMERA_SN_BYTE_1							
R							

6.3.3.5. CAMERA_SN_EXTENDED Registers (address = 0x4E & 0x4F)

These registers contain the final two bytes of the serial number of the camera. The third byte is at the address 0x4E and the last byte (MSB) at the address 0x4F.

7	6	5	4	3	2	1	0
CAMERA_SN_BYTE_2							
R							

7	6	5	4	3	2	1	0
CAMERA_SN_BYTE_3							
R							

6.3.3.6. 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							

6.3.3.7. 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°C.

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							

6.3.3.8. 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 m°C.

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							

6.3.3.9. 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 = GRAYSCALE 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)

6.3.3.10. 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

6.3.3.11. 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							

6.3.3.12. 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							

6.3.3.13. 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							

6.3.3.14. 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							

6.3.3.15. 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							

6.3.3.16. 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							

6.3.3.17. 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							

6.3.3.18. 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							

6.3.3.19. 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							

6.3.3.20. 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							

6.3.3.21. 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							

6.3.3.22. 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							

6.3.3.23. 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							

6.3.3.24. 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							

6.3.3.25. 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							

6.3.3.26. 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							

6.3.3.27. 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							

6.3.3.28. 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							

6.3.3.29. 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							

6.3.3.30. 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							

6.3.3.31. 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

6.3.3.32. 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

6.3.3.33. 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							

6.3.3.34. 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							

6.3.3.35. 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							

6.3.3.36. 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							

6.3.3.37. 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							

6.3.3.38. 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							

6.3.3.39. 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

6.3.3.40. 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

6.3.3.41. 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							

6.3.3.42. 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							

6.3.3.43. 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							

6.3.3.44. 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

6.3.3.45. 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.

7. ADDITIONAL SOFTWARE

7.1. Compagnon Software

CamSight LS cameras are supplied with a companion software tool to set the camera parameters in factory.

See AD001 for full documentation.

7.2. Updater Software

CamSight LS cameras are supplied with an updater tool to download new firmware or update the existing camera firmware.

See AD002 for full documentation.

8. SAFETY AND INTEGRATION GUIDELINES

The CamSight LS shall be integrated in accordance with the requirements described in this document.

The integrator shall ensure that the final equipment provides the appropriate level of protection against electrical, mechanical, environmental and electromagnetic hazards.

Failure to comply with the integration requirements described herein may affect performance, safety and regulatory compliance.

8.1. Electrostatic Discharge (ESD) precaution

The CamSight LS contains electrostatic discharge sensitive components.

Particular attention shall be paid to:

- USB interfaces;
- MIPI interfaces;
- parallel digital interfaces;
- communication interfaces;
- exposed connectors.

The integrator shall implement appropriate ESD protection measures whenever external interfaces are accessible during installation, maintenance or operation.

In order to ensure the safe and reliable operation of the module during assembly and maintenance operations, 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.

8.2. 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. 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.

8.4. Optical Precautions

The camera incorporates sensitive infrared imaging components.

Direct observation or long-term exposure to intense radiation sources, including the sun, may degrade imaging performance or permanently damage the detector.

Appropriate protective measures shall be implemented by the system designer when required by the application.

8.4.1. Precaution regarding direct sun view

Direct exposure to sunlight may cause temporary marks on the camera sensor. It is therefore recommended to avoid pointing the camera directly at the sun whenever possible. If such marks appear, they typically fade over time; however, the recovery process may take several hours, and in the case of more significant marks, even several days. During storage, the camera should be kept away from direct sunlight to prevent any risk of sensor marking.

Figure 55: Pictures of the temporary marks caused by an excessive pointing to the sun

8.5. Mechanical Integration

The CamSight LS OEM module requires appropriate mechanical support.
The integrator shall ensure:

- adequate fixation of the camera module;
- adequate fixation of the lens assembly;
- protection against excessive vibration;
- protection against mechanical shock.

Mechanical stresses applied to the PCB, sensor package or optical assembly may result in performance degradation or permanent damage.

8.6. Electrical Integration

The camera shall only be powered within the voltage limits specified in this ICD.
The integrator shall implement:

- overvoltage protection;
- reverse polarity protection;
- current limitation protection;
- protection against power supply transients.

Any use outside the specified electrical limits may permanently damage the module and invalidate declared performances.

8.7. Electromagnetic Compatibility

Compliance of the final product with EMC requirements remains under the responsibility of the integrator.
The integrator shall implement:

- an adequate grounding architecture;
- appropriate cable shielding;
- proper routing of high-speed digital signals;
- protection against conducted and radiated disturbances.

System-level EMC validation shall be performed on the final equipment.

8.8. Environmental Conditions

The integrator shall ensure compliance with the environmental conditions specified in this ICD.
The OEM module does not provide environmental protection against:

- dust ingress;
- water ingress;
- corrosive atmospheres;
- condensation.

The final equipment shall provide the necessary environmental protection according to the intended operating conditions.

8.9. Thermal Management

The integrator shall ensure that the operating temperature range specified for the product is respected under all operating conditions.

Appropriate thermal management measures shall be implemented when required by the application.

Operation outside the specified temperature range may affect image quality, reliability and equipment lifetime.

8.10. Residual Risks

The following residual risks remain associated with the OEM module and shall be assessed by the integrator at system level:

- electrostatic discharge damage;
- electrical overstress;
- power supply faults;
- mechanical stress applied to the module or lens assembly;
- environmental exposure beyond specified limits;
- thermal overstress;
- degradation resulting from improper integration.

These risks shall be addressed during the risk assessment of the final equipment.

9. ENVIRONMENTAL PROPERTIES

As mentioned previously, the CamSight camera is an OEM product intended to be integrated into a higher-level system by the customer. It is delivered as a pre-compliant module, meaning that although it has been designed and tested following key environmental and EMC guidelines, the final responsibility for full certification lies with the system integrator once the camera is embedded in its operational platform.

9.1. Climatic

Pre-compliance AECTP300 ed3

- 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)

9.2. Shock & Vibration

Pre-compliance AECTP400 ed3 (Compliant with Casing version).

- Shock : Amplitude 30g RMS / Duration 18ms on 3 axis
- Vibration: 4.3g RMS 10-500Hz on 3 axis

9.3. EMC

Standards Tests Results (with CamSight LS casing version):

- Pre-compliance to AECTP500 ed. E 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.

  - 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

10. REGULATORY COMPLIANCE AND INTEGRATION RESPONSIBILITY

The CamSight LS has been designed in accordance with applicable regulatory requirements relevant to the module level.

The product complies with:

- Directive 2014/30/EU (Electromagnetic Compatibility), when integrated according to the recommendations provided in this document;
- Directive 2011/65/EU and Directive (EU) 2015/863 (RoHS);
- Regulation (EC) No 1907/2006 (REACH).

As an OEM module, the CamSight LS is intended solely for integration into a final product.

Compliance of the final equipment with applicable legislation, including but not limited to Regulation (EU) 2023/1230, EMC Directive 2014/30/EU, Low Voltage Directive 2014/35/EU, Radio Equipment Directive 2014/53/EU or any other applicable legislation remains the responsibility of the manufacturer placing the final product on the market.

Any modification of the product or any use outside the conditions described in this ICD shall be assessed by the integrator for its potential impact on safety, performance and regulatory compliance.

10.1. EU Declaration of Conformity

The EU Declaration of Conformity applicable to the CamSight LS module is available as a separate controlled document.

The Declaration of Conformity applies exclusively to the camera module and shall not be interpreted as a declaration covering the final equipment integrating the product.
The manufacturer of the final equipment remains responsible for the conformity assessment of the complete system.