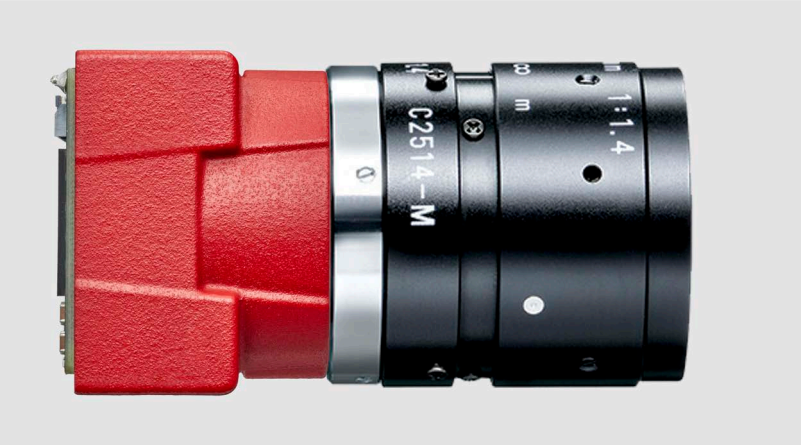
Allied Vision

mipi Direct Register Access



MIPI CSI-2 Cameras

Direct Register Access Controls Reference

V2.4.2

FW 00.12.00.00611a22

Allied Vision Technologies GmbH // Taschenweg 2a, 07646 Stadtroda / Germany

2023-Sep-29

This reference at a glance

This document describes controls for the **Direct Register Access** of Alvium CSI-2 cameras.

CSI-2 access mode	Description
Direct Register Access 	Controls the camera by reading from and writing to registers, using an embedded board or an FPGA.
Video4Linux Access 	Controls the camera by V4L2 controls, using the Allied Vision MIPI CSI-2 V4L2 and GenICam Hybrid Driver directly. Existing PC-based machine vision applications can be scaled down to V4L2 on lean embedded systems, reducing power consumption and costs.

Table 1: CSI-2 Access modes overview

Parameter	Value
Firmware release version	00.12.00.00611a22
CCI Register Layout Version	1.0

Table 2: Supported firmware version and CCI Register Layout Version

What else do you need?

The following downloads provide additional information.

Document	Link
Alvium CSI-2 Cameras User Guide	www.alliedvision.com/en/support/technical-documentation/alvium-csi-2-documentation
Various other documents and downloads	

Table 3: Additional downloads overview

Contact us

Website, email

General
www.alliedvision.com/en/contact
info@alliedvision.com

Distribution partners
www.alliedvision.com/en/avt-locations/avt-distributors

Support
www.alliedvision.com/en/support
www.alliedvision.com/en/about-us/contact-us/technical-support-repair-/-rma

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Contents

Document history and conventions

This chapter includes:

Document history

Version	Date	Remarks
V2.4.2	2023-Sep-29	• Corrected order for ***YUV422 8-bit (UYVY)*** option in 0x0148 | Available MIPI Data Formats on page 47. • Added Write access for 0x0154 | Bayer Pattern on page 48. • Applied editorial changes.
V2.4.1	2023-Jun-15	Corrected numbers in image data flow for Controls processing order on page 22.
V2.4.0	2023-Jun-05	**Firmware version**: 00.12.00.00611a22 • Added register descriptions for Digital binning controls. • Added notes for **`Height Max`** and **`Width Max`** related to binning. • Added digital binning to Controls processing order on page 22. • Changed unit MBps to Mbit/s for 0x0044 and 0x0048 registers. • Adjusted Line IDs in control descriptions to match the convention: Line2 uses GPIO-EXT2 and Line3 uses GPIO-EXT3. • Applied editorial changes.
V2.3.1	2021-Dec-17	• Removed information on Digital Binning because it is not supported by the current camera driver. • Applied editorial changes.
V2.3.0	2021-Dec-07	**Firmware version**: 00.07.00.81db3896 • Added Controls processing order on page 22. • Added register descriptions for **`Camera I2C Address`** controls in CCI registers on page 15. • Added register descriptions for **`Digital Binning`** controls in V4L2 registers on page 24. • Applied editorial changes.

Version	Date	Remarks
V2.2.0	2021-Apr-22	**Firmware version**: 00.04.00.34658 • Added RAW pixel formats for 10-bit and 12-bit Mono in - `MIPI Data Format` - `Available MIPI Data Formats`. • Correct the address for ***`YUV422 8-bit (UYVY)`*** in `MIPI Data Format` • Added register descriptions: - `Exposure Active Output` controls - `Line Configuration` - `Line Status` • Applied editorial changes.

V2.1.0	2020-Dec-08	**Firmware version**: 00.03.00.31919
		• Added register descriptions:
		- `Intensity Auto` controls
		- Controls for value ranges of
		`Exposure Auto`
		`Gain Auto`
		- Controls for
		`Acquisition Frame Rate`
		`Frame Start Trigger`
		• Changed pixel format naming to improve clarity. See Pixel format naming on page 14.
		• Applied editorial changes.

V2.0.1	2020-Feb-14	• Added descriptions for target values used with `Exposure Auto` and `Gain Auto`. • Reworked descriptions for register addresses.
V2.0.0	2020-Jan-06	**Firmware version**: 00.01.02.28100 • Added register descriptions to control `Width`, `Offset X`, `Saturation`, and `Hue`. • Added notes for Improper operation on page 15. • Applied editorial changes.
V1.0.0	2019-Jun-14	**Firmware version**: 00.01.00.26405 Release version

Conventions used in this document

To give this document an easily understood layout and to emphasize important information, the following typographical styles are used:

Typographical styles

Style	Function
`Control`	Control names
Emphasis	Programs, or highlighting important things
`Value`	Control values (modes)
Web links and references	Links to webpages and internal cross references

Table 4: Typographical styles

Symbols and notes

Practical tip

Additional information helps to understand or ease handling the camera.

Avoiding malfunctions

Precautions are described.

Additional information

Web address or reference to an external source with more information is shown.

Controls access

Acronym	Meaning
R/W	Read and write control
R/C	Read-only control that is constant
R	Read-only control that may change
W	Write-only control

Table 5: Controls access

Controls order

The document defines controls listed by register address, grouped in categories.

Reading register descriptions

The following example shows the description for `V4L2 Register Map Version`. Contents highlighted in **red** are explained below.

0x0000 | V4L2 Register Map Version

Displays the version of the V4L2 register map layout. The first version is ***1.0***, where major version = ***1***, minor version = ***0***.

Offset	0x0000
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Availability	All camera models

Bit offset (LSB << x)	Width (bits)	Description
0	16	Minor version of the V4L2 register map.
16	16	Major version of the V4L2 register map.

Explanation

Offset: For CCI registers, addresses are absolute; for V4L2 registers, addresses are relative. Because of this, **Offset** is used for register addresses. See Registers and address spaces on page 14.

LSB: The LSB is shifted by the number of bits represented by **x**.
In the example, the LSB is shifted by 16 bit to set the value to ***Major Version***.

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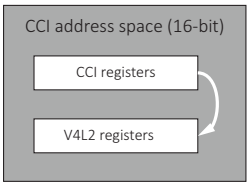
Controls behavior and registers

This chapter informs about writing registers:

Registers and address spaces

Alvium CSI-2 cameras are operated via the Camera Control Interface (CCI) protocol, which requires a 16-bit address space. Within this space, different register maps can be found:

Register map	Function	Reference
CCI register map	Basic information	CCI registers on page 15
V4L2 register map	**Video4Linux Access**	V4L2 registers on page 24



The CCI address space used to operate Alvium CSI-2 cameras contains the CCI register map and the V4L2 register map. To get the absolute address of V4L2 registers, you must consider the offset of the CCI register map.

For the absolute address of V4L2 registers:

1. Read out 0x0014 | V4L2 Register Map Address on page 16.
2. Add this value to the relative address of V4L2 registers in V4L2 registers on page 24.

Pixel format naming

In Direct Register Access, Alvium CSI-2 cameras output pixel formats according to the MIPI CSI-2 standard, **in Video4Linux Access**, according to V4L2 definitions. This document states extended MIPI CSI-2 definitions:

Naming pattern	Examples
MIPI CSI-2 (FOURCC)	RAW8 (GREY)
	RGB888 (RGB3)

Table 6: Pixel format naming convention in specifications

Different names for equivalent formats:

MIPI CSI-2	V4L2	V4L2 FOURCC	PFNC[1]
YUV422 8-bit	V4L2_PIX_FMT_UYVY	UYVY	YCbCr422_8_CbYCrY
RGB888	V4L2_PIX_FMT_RGB24	RGB3	RGB8
RAW8	V4L2_PIX_FMT_GREY	GREY	Mono8
[1]GenICam Pixel Format Naming Convention			

Table 7: Equivalent pixel formats in different standards

Improper operation

If registers are not used properly, the camera may behave unexpectedly, such as changing values or ignoring operations. To avoid malfunctions and camera crashes, we recommend you to:

- Use only documented register addresses
- Keep values in the specified range
- Write only to registers specified for writing access, not to reading registers
- Write to one register at a time
- Ensure that the camera has completed writing to registers.
  Use 0x0018 | Write Done Handshake on page 28 to poll the camera.

As best practice, read written values back from the camera. Should errors occur:

- Verify register access options and adjust your script accordingly.
- Check for conflicts between settings.

CCI registers

0x0000 | CCI Register Layout Version

Displays the version of the CCI register layout. This register is used to check for the compatibility of the register layout with the previous version. The first version is *1.0*, where major version = *1*, minor version = *0*.

Offset	0x0000
Type	UInt32
Access	R
Size [Bytes]	4

Bit offset (LSB << x)	Width (bits)	Description
0	16	Minor version of the CCI register layout.
16	16	Major version of the CCI register layout.

0x0008 | Device Capabilities

Displays information about the camera's capabilities, such as access modes or string encoding.

Offset	0x0008
Type	UInt64
Access	R
Size [Bytes]	8

Bit offset (LSB << x)	Width (bits)	Description
0	1	`User Defined Name` is supported.
1	1	**Video4Linux Access** is supported.
2	2	**Vimba Access** is supported (selected models only).
4	4	String encoding of I2C string registers is supported. • 0x0 -> ASCII
8	1	`Family Name` is supported.
9	55	Reserved.

0x0014 | V4L2 Register Map Address

Displays the address of V4L2 register map. Use as offset to get absolute addresses of V4L2 registers.

Offset	0x0014
Type	UInt16
Access	R
Size [Bytes]	2

0x0018 | Device GUID

Displays the GUID (Globally Unique Identifier) of the camera.

Offset	0x0018
Type	String
Access	R
Size [Bytes]	64

0x0058 | Manufacturer Name

Displays the camera manufacturer name.

Offset	0x0058
Type	String
Access	R
Size [Bytes]	64

0x0098 | Model Name

Displays the camera model name.

Offset	0x0098
Type	String
Access	R
Size [Bytes]	64

0x00D8 | Family Name

Displays the camera family name.

Offset	0x00D8
Type	String
Access	R
Size [Bytes]	64

0x0118 | Device Version

Displays the camera's device version.

Offset	0x0118
Type	String
Access	R
Size [Bytes]	64

0x0158 | Manufacturer Info

Displays the manufacturer information.

Offset	0x0158
Type	String
Access	R
Size [Bytes]	64

0x0198 | Serial Number

Displays the camera's serial number.

Offset	0x0198
Type	String
Access	R
Size [Bytes]	64

0x01D8 | User Defined Name

Controls the user defined name.

Offset	0x01D8
Type	String
Access	R/W
Size [Bytes]	64

0x0218 | Checksum

Displays the checksum which can be used for the register space 0x0000 to 0x0217.

Offset	0x0218
Type	UInt32
Access	R
Size [Bytes]	4

Use this control to check if data was transferred to the host correctly. Make sure that the host calculates the checksum with the following parameters:

Name	JAMCRC
Width	32 bit
Polynomial	0x4C11DB7
Input reflected	Yes
Output reflected	Yes
Output XOR value	0x00000000
Example output for ASCII input string "123456789" (9 bytes)	0x340BC6D9

0x021E | Soft Reset

Performs a soft reset of the camera (Set to 1 to reset the camera).

Offset	0x021E
Type	UInt8
Access	W
Size [Bytes]	1

0x0220 | Camera I2C Address

Controls the I2C address that becomes valid after the next camera reboot.

Offset	0x0220
Type	UInt8
Access	R/W
Size [Bytes]	1

Value	Description
0x3C	Default value

CSI-2 streaming setup

The following steps must be performed to transfer a lane count and clock frequency for CSI-2 between host and device:

1. The host determines which lane counts are supported by the host (by such as hardware and driver).
2. The host reads the `Supported CSI-2 Lane Count` register from the device. This register contains a bitfield to indicate which lane counts are supported by the device.
3. The host selects a lane count that is compatible to host and device. Potential modes:
   - Automatically select the highest lane count supported by host and device.
   - Manually select one of the lane counts that are supported by host and device.
4. The host determines the CSI clock frequency range supported by host (by hardware, driver etc.) for the selected lane count (from step 3).
5. The host writes the selected lane count (from step 3) into the `CSI-2 Lane Count` register.
6. The host reads `CSI-2 Clock Min Value` and `CSI-2 Clock Max Value` registers to get the range for the clock frequency supported by the device for the selected lane count (from step 3).
7. The host selects a clock frequency that is compatible to host and device. Potential modes:
   - Automatically select the highest clock frequency supported by host and device.
   - Manually select a clock frequency that is supported by host and device.
8. The host writes selected clock frequency (from step 7) to the `CSI-2 Clock` register. The device may not be able to support the exact clock frequency selected. In this case it will use the highest clock frequency that is lower or equal to the clock frequency written to the register.

   Example: The transport layer writes 650 MHz to the register of a device that only supports clock frequencies with a multiple of 100 MHz. In this case the device uses a clock frequency of 600 MHz (6 × 100 MHz).

9. The host reads the actual clock frequency from the `CSI-2 Clock` register.
10. The host checks if the actual clock frequency used in the device (from step 9) lies in the range of clock frequencies supported by the host (from step 4). If not, image acquisition cannot be started, and an error will be issued on the host.

Sometimes, this procedure does not transfer a lane count or it does not select a compatible clock frequency supported by the host. In this case, image acquisition cannot be started and an error is issued on the host.

The host must perform this negotiation during opening the device (for example, so that any frame rate limit calculation in the device can take the result of this negotiation into consideration).

Numeric registers

Most of the numeric controls listed in the next chapter consist of a list of four registers:

1. Value register: Used for reading or writing the current value of the control.
2. Minimum register: The minimal value that can be set to the value register.
3. Maximum register: The maximal value that can be set to the value register.
4. Increment register: The step or increment of values valid for the value register (beginning with minimal value).

For such a control, a valid value must hold the following three conditions true:

1. Value >= minimum
2. Value <= maximum
3. ((Value- minimum) % increment) == 0

If a value is written to such value register that is not valid, the camera will correct the value to the nearest valid value. The updated or corrected value can be read back by the user.

This control behavior is used for the following controls:

- `Acquisition Frame Rate`
- `Black Level`
- `Blue Balance Ratio`
- `Exposure Time`
- `Gain`
- `Gamma`
- `Height`
- `Hue`
- `Intensity Auto Target`
- `Offset X`
- `Offset Y`
- `Red Balance Ratio`
- `Saturation`
- `Width`

Target values for auto controls

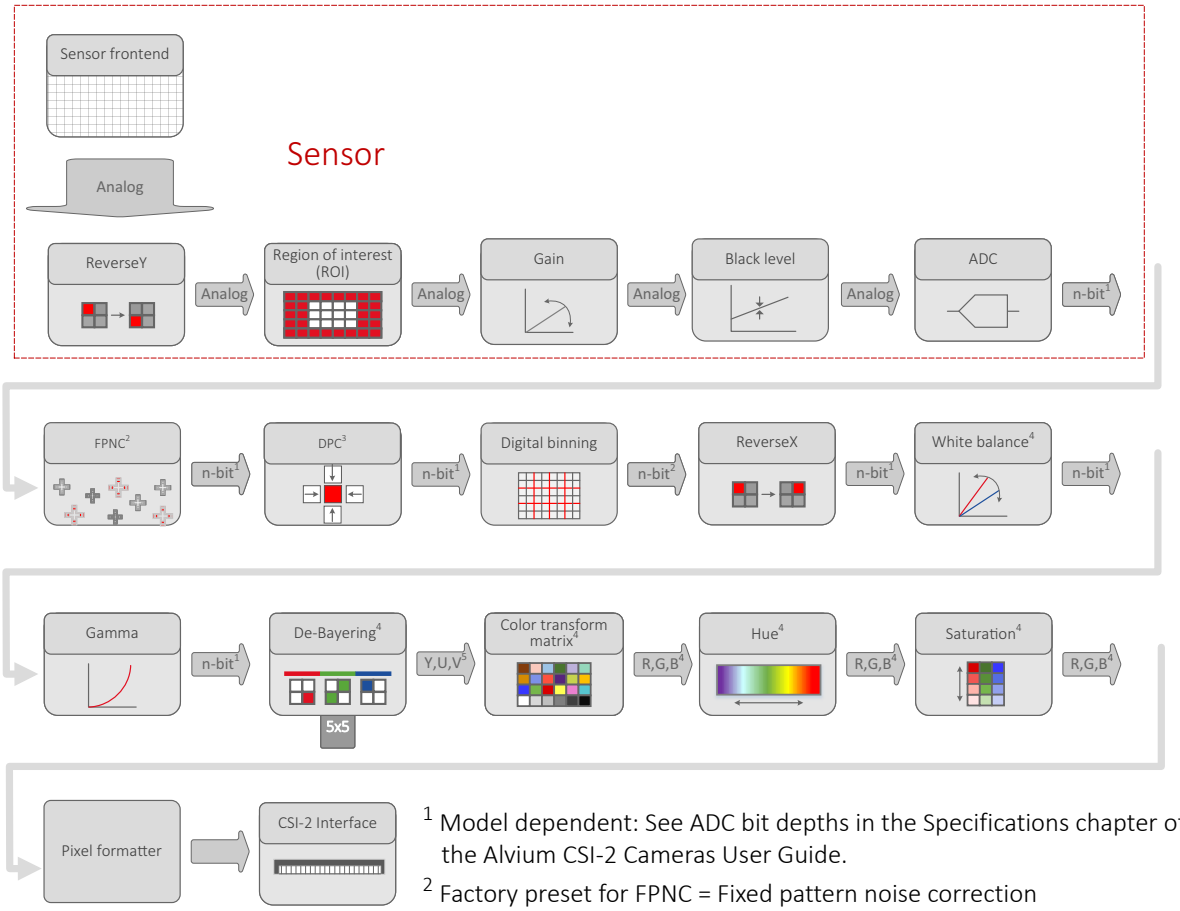
`Exposure Auto` and `Gain Auto` adjust the mean pixel intensity to a target value of 50% between minimum and maximum. Use `Intensity Auto Target` controls to adjust the target value (with a tolerance of 5%). Use `Intensity Auto Precedence` to set the priority between `Exposure Auto` and `Gain Auto`.

Controls processing order

To develop your application effectively, note the order in which the controls are processed in Alvium cameras.

Image data flow

In the Alvium user guides, the image data flow describes the sequence of image processing steps inside the camera. The shown functionalities represent controls or control groups.



[1] Model dependent: See ADC bit depths in the Specifications chapter of the Alvium CSI-2 Cameras User Guide.

[2] Factory preset for FPNC = Fixed pattern noise correction
See the Alvium CSI-2 Cameras User Guide for model support.

[3] Factory preset for DPC = Defect pixel correction

[4] Color models only

[5] For monochrome models: Y only

Figure 1: Image data flow for Alvium CSI-2 cameras

Control interdependencies

The conversion between time and clock cycles affects control values. Features for pixel format, bandwidth, cropping (ROI), exposure time, and triggering are related to each other. Changing values for one control can change values for another control. For example, frame rates can be reduced when `Mipi Data Format` is changed subsequently. Figure 2 shows the interdependencies.

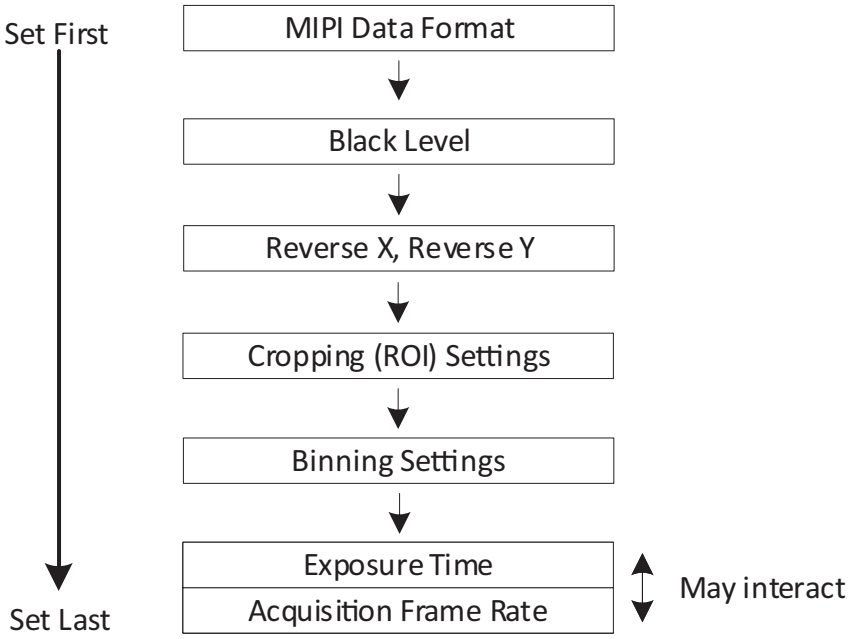


Figure 2: Interdependencies between controls

V4L2 registers

This chapter defines controls listed by register address and grouped in controls categories:

Register offset

The CCI address space used to operate Alvium CSI-2 cameras contains the CCI register map and the V4L2 register map. To get the absolute address of V4L2 registers, you must consider the offset of the CCI register map.

For the absolute address of V4L2 registers:

1. Read out 0x0014 | V4L2 Register Map Address on page 16.
2. Add this value to the relative address of V4L2 registers.

General controls

0x0000 | V4L2 Register Map Version

Displays the version of the V4L2 register map layout. The first version is ***1.0***, where major version = ***1***, minor version = ***0***.

Offset	0x0000
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Availability	All camera models

Bit offset (LSB << x)	Width (bits)	Description
0	16	Minor version of the V4L2 register map.
16	16	Major version of the V4L2 register map.

0x0008 | Register Inquiry

Displays if non-mandatory registers are available.

Note: Availability can change during runtime.

Offset	0x0008
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Availability	All camera models

Bit offset (LSB << x)	Width (bits)	Description
0	1	`Reverse X` is available.
1	1	`Reverse Y` is available.
2	1	`Intensity Auto` controls are available.
3	1	`Black Level` controls are available.
4	1	`Gain` controls are available.
5	1	`Gamma` controls are available.
6	1	Reserved
7	1	`Saturation` controls are available.
8	1	`Hue` controls are available.
9	1	`White Balance` is available.
10	1	Reserved
11	1	`Exposure Auto` controls are available.
12	1	`Gain Auto` controls are available.
13	1	`White Balance Auto` is available.
14	1	`Device Temperature` is available.
15	1	Reserved
16	1	`Acquisition Frame Rate` controls are available.
17	1	`Frame Start Trigger` controls are available.
18	1	`Exposure Active Output Line` is available.
19 to 63	45	Reserved **Set to 0**.

0x0010 | Device Firmware Version

Displays the current firmware version installed on the camera.

Offset	0x0010
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Availability	All camera models

Bit offset (LSB << x)	Width (bits)	Description
0	8	Special firmware version.
8	8	Major firmware version.
16	16	Minor firmware version.
32	32	Patch firmware version.

0x0018 | Write Done Handshake

Read access: The camera confirms that the previous write access to registers has been processed.

Write access: Enables the control and resets the success confirmation.

Offset	0x0018
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	All camera models

Bit offset (LSB << x)	Width (bits)	Description
0	1	***1***: The camera confirms the previous write access has been processed. ***0***: Written by the host to reset this flag.
1	6	Reserved, set to ***0***.
7	1	***1***: The camera outputs if it supports Write Done Handshake.

Streaming Control

0x0040 | Supported CSI-2 Lane Counts

Displays the CSI-2 lane counts supported by the camera.

Offset	0x0040
Origin of control	Camera
Type	UInt8
Access	R
Size [Bytes]	1
Availability	All camera models

Bit offset (LSB << x)	Width (bits)	Description
0	1	1-lane operation is supported.
1	1	2-lane operation is supported.
2	1	3-lane operation is supported.
3	1	4-lane operation is supported.
4	4	Reserved **Set to 0.**

0x0044 | CSI-2 Lane Count

Controls the current CSI-2 lane count.

Note: This control must be set before 0x0050 | CSI-2 Clock. See CSI-2 streaming setup on page 20 for details.

0x0048 | CSI-2 Clock Min Value supports a minimum value of 80 Mbit/s per lane. Select suitable settings so that the resulting data rate is supported by the host.

Offset	0x0044
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	All camera models

0x0048 | CSI-2 Clock Min Value

Displays the minimum CSI-2 clock frequency supported for the current CSI-2 lane count.

Note: The minimum supported value per lane is 80 Mbit/s. Select suitable settings for this control and for 0x0044 | CSI-2 Lane Count, so that the resulting data rate is supported by the host.

Offset	0x0048
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	Hertz
Availability	All camera models

0x004C | CSI-2 Clock Max Value

Displays the maximum CSI-2 clock frequency supported for the current CSI-2 lane count.

Offset	0x004C
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	Hertz
Availability	All camera models

0x0050 | CSI-2 Clock

Controls the current CSI-2 clock frequency.

Note: Set 0x0044 | CSI-2 Lane Count before this control. See CSI-2 streaming setup on page 20 for details.

Offset	0x0050
Origin of control	Camera
Type	UInt32
Access	R/W
Size [Bytes]	4
Unit	Hertz
Availability	All camera models

0x0054 | Buffer Size

Displays the size of the streaming buffer (payload).

Offset	0x0054
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	Bytes
Availability	All camera models

0x0078 | CSI-2 Phy Reset

Controls the Phy (physical layer) reset state.

Offset	0x0078
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	All camera models

Value	Description
0	CSI-2 Phy is operated normally.
1	CSI-2 Phy is held in reset state.

Acquisition Control

0x0080 | Acquisition Start

Starts the acquisition. Reading the register returns the command value until the acquisition is stopped or aborted. Otherwise *0* is returned.

Read access: The register returns *1* if acquisition is active and *0* if acquisition has been stopped.

Offset	0x0080
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	All camera models

Value	Description
1	Starts the acquisition.

0x0084 | Acquisition Stop

Stops the acquisition **after the current frame has been acquired**.

Read access: The register returns *1* if acquisition is active and *0* if acquisition has been stopped.

Offset	0x0084
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	All camera models

Value	Description
1	Stops the acquisition.

0x008C | Acquisition Status

Displays if the camera is acquiring images.

Offset	0x008C
Origin of control	Camera
Type	UInt8
Access	R
Size [Bytes]	1
Availability	All camera models

Value	Description
0	Acquisition has been stopped.
1	Acquisition has been started or is running.

0x0090 | Acquisition Frame Rate

Controls the frequency at which the frames are captured.

Offset	0x0090
Origin of control	Camera
Type	UInt64
Access	R/W
Size [Bytes]	8
Unit	Micro Hertz [µHz]
Availability	All camera models

0x0098 | Acquisition Frame Rate Min Value

Displays the minimum value for `Acquisition Frame Rate`.

Offset	0x0098
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Unit	Micro Hertz [µHz]
Availability	All camera models

0x00A0 | Acquisition Frame Rate Max Value

Displays the maximum value for `Acquisition Frame Rate`.

Offset	0x00A0
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Unit	Micro Hertz [µHz]
Availability	All camera models

0x00B0 | Acquisition Frame Rate Enable

Enables or disables `Acquisition Frame Rate`.

Note: `Acquisition Frame Rate` is used only if `Frame Start Trigger Mode` is set to *`Off`*.

Offset	0x00B0
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	All camera models

Value	Description
0	`Acquisition Frame Rate` is disabled.
1	`Acquisition Frame Rate` is enabled.

0x00B4 | Frame Start Trigger Mode

Enables or disables the `Frame Start Trigger`.

Offset	0x00B4
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	All camera models

Value	Description
0	The `Frame Start Trigger` is disabled.
1	The `Frame Start Trigger` is enabled.

0x00B8 | Frame Start Trigger Source

Selects the internal signal or physical input line to use as trigger source.

Notes:

- To use this control, the `Frame Start Trigger Mode` must be set to *`On`*.
- Line 2 and line 3 are used for I2C.

Offset	0x00B8
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	All camera models

Value	Description
`0`	Line2 is selected.
`1`	Line3 is selected.
`4`	Software is selected.

0x00BC | Frame Start Trigger Activation

Selects how signals activate the `Frame Start Trigger`.

Offset	0x00BC
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	All camera models

Value	Description
`0`	The trigger is enabled on the rising edge of the signal.
`1`	The trigger is enabled on the falling edge of the signal.
`2`	The trigger is enabled on the any edge of the signal.
`3`	The trigger is enabled by a high-level signal.
`4`	The trigger is enabled by a low-level signal.

0x00C0 | Frame Start Trigger Software

Generates a software trigger.

Note: `Trigger Source` must be set to *`Software`*.

Offset	0x00C0
Origin of control	Camera
Type	UInt8
Access	W
Size [Bytes]	1
Availability	All camera models

Value	Description
1	A trigger is generated.

Recommended workflow for using the exposure active output controls

1. Disable the signal by `Exposure Active Output Line Mode` for the selected output line.
2. Select the desired line for exposure active output signal by `Exposure Active Output Line`.
3. Set the selected line to output (option: enable *`Invert`* to invert exposure active output signal) by `Line Configuration`.
3. Enable the exposure active output signal by `Exposure Active Output Line Mode`.
4. Read the signal level from the oscilloscope (option: use `Line Status`).

0x00C8 | Exposure Active Output Line Mode

Enables or disables the exposure active output signal on the line selected by `Exposure Active Output Line`.

Offset	0x00C8
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	All camera models

Value	Description
0	**Off**: The signal is disabled.
1	**On**: The signal is enabled.

0x00CC | Exposure Active Output Line

Selects the physical output line for the exposure active output signal.

Note: `Exposure Active Output Line Mode` must be set to *`Off`* before output lines can be changed.

Offset	0x00CC
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	All camera models

Value	Description
`0`	Line2 is selected.
`1`	Line3 is selected.

0x00D0 | Line Configuration

Configures the line as input or output and inverted or not-inverted.

Note: To get **constant low** on a line, please set the line to output mode with invert bit set to 0. For **constant high**, please set the invert bit to 1.

Offset	0x00D0
Origin of control	Camera
Type	UInt32
Access	R/W
Size [Bytes]	4
Availability	All camera models

Bit offset (lsb << X)	Width (bits)	Description
0	1	Line2 is set to input or output.
1	1	Line2 is set to inverted or not inverted.
2 to 7	6	Reserved
8	1	Line3 is set to input or output.
9	1	Line3 is set to inverted or not inverted.
10 to 31	22	Reserved

To switch between input or output, set bits as follows:

Value	Description
0	**False**: The selected line is set to input.
1	**True**: The selected line is set to output.

To switch between inverted and not inverted, set bits as follows:

Value	Description
0	**False**: The selected line is set to not inverted.
1	**True**: The selected line is set to inverted.

0x00D4 | Line Status

Returns the logical state (high or low) of the selected line.

Offset	0x00D4
Origin of control	Camera
Type	UInt8
Access	R
Size [Bytes]	1
Availability	All camera models

Bit offset (lsb << X)	Width (bits)	Description
0	1	The logical state (high or low) of Line2 is returned
1	1	The logical state (high or low) of Line3 is returned

The logical state of the selected line is displayed as follows:

Value	Description
0	**False**: The logical state is low.
1	**True**: The logical state is high.

Image Format Control

0x0100 | Width

Controls the current image width.

Offset	0x0100
Origin of control	Camera
Type	UInt32
Access	R/W
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x0104 | Width Min Value

Displays the minimum image width available.

Offset	0x0104
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x0108 | Width Max Value

Displays the maximum image width available.

Offset	0x0108
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x010C | Width Increment

Displays the increment value available for `Width`.

Offset	0x010C
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x0110 | Height

Controls the current image height.

Offset	0x0110
Origin of control	Camera
Type	UInt32
Access	R/W
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x0114 | Height Min Value

Displays the minimum image height available.

Offset	0x0114
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x0118 | Height Max Value

Displays the maximum image height available.

Note: This excludes region of interest, as known from GenICam SFNC features.

Offset	0x0118
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x011C | Height Increment

Displays the increment value available for `Height`.

Offset	0x011C
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x0120 | Offset X

Controls the horizontal offset from the origin to the region of interest (ROI).

Offset	0x0120
Origin of control	Camera
Type	UInt32
Access	R/W
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x0124 | Offset X Min Value

Displays the minimum value available for `Offset X`.

Offset	0x0124
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x0128 | Offset X Max Value

Displays the maximum value available for `Offset X`.

Offset	0x0128
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x012C | Offset X Increment

Displays the increment value available for `Offset X`.

Offset	0x012C
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x0130 | Offset Y

Controls the vertical offset from the origin to the region of interest (ROI).

Offset	0x0130
Origin of control	Camera
Type	UInt32
Access	R/W
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x0134 | Offset Y Min Value

Displays the minimum value available for `Offset Y`.

Offset	0x0134
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x0138 | Offset Y Max Value

Displays the maximum value available for `Offset Y`.

Offset	0x0138
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x013C | Offset Y Increment

Displays the increment value available for `Offset Y`.

Offset	0x013C
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x0140 | MIPI Data Format

Controls the (pixel) data format provided by the camera.

Offset	0x0140
Origin of control	Camera
Type	UInt32
Access	R/W
Size [Bytes]	4
Availability	Sensor model dependent

Name	Value	Description
YUV422 8-bit (UYVY)	0x1E	Selects YUV422 8-bit (UYVY).
RGB888 (RGB3)	0x24	Selects RGB888 (RGB3).
RAW8 (GREY)	0x2A	Selects RAW8 (GREY) data.
RAW10 (Y10)	0x2B	Selects RAW10 (Y10) data.
RAW12 (Y12)	0x2C	Selects RAW12 (Y12) data.

Pixel format availability and naming

- The **availability** of pixel formats depends on camera models and the abilities of the connected system.
- For the **naming**, see Pixel format naming on page 14.

0x0148 | Available MIPI Data Formats

Displays a bitmap with the representation of the available MIPI (pixel) data formats.

Offset	0x0148
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Availability	Sensor model dependent

Bit offset (LSB << x)	Width (bits)	Description
0 to 4	5	Reserved
5	1	YUV422 8-bit (UYVY) is available.
6	1	Reserved.
7	1	RGB888 (RGB3) is available.
8 to 13	6	Reserved
14	1	RAW8 (GREY) is available.
15	1	RAW10 (Y10) is available.
16	1	RAW12 (Y12) is available.
17 to 63	47	Reserved **Set to 0.**

Pixel format availability and naming

- The **availability** of pixel formats depends on camera models and the abilities of the connected system.
- For the **naming**, see Pixel format naming on page 14.

0x0150 | Bayer Pattern Inquiry

Displays the Bayer pattern availability for RAW formats, independent of the currently selected MIPI Data Format.

Offset	0x0150
Origin of control	Camera
Type	UInt8
Access	R
Size [Bytes]	1
Availability	All camera models

Bit offset (LSB << x)	Width (bits)	Description
0	1	Monochrome format is available.
1	1	Bayer GR is available.
2	1	Bayer RG is available.
3	1	Bayer GB is available.
4	1	Bayer BG is available.
5 to 7	3	Reserved. **Set to 0.**

0x0154 | Bayer Pattern

Controls the Bayer pattern for RAW formats. If the current MIPI Data Format is not a RAW format, this register value is ignored.

Offset	0x0154
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	All camera models

Bit offset (LSB << x)	Width (bits)	Description
0	1	Selects monochrome format.
1	1	Selects Bayer GR.
2	1	Selects Bayer RG.
3	1	Selects Bayer GB.
4	1	Selects Bayer BG.

0x0158 | Reverse X

Flips the image horizontally.

Note: Region of interest is applied after this control.

Offset	0x0158
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	All camera models

Bit offset (LSB << x)	Width (bits)	Description
0	1	Image remains unchanged.
1	1	The image is flipped horizontally.

0x015C | Reverse Y

Flips the image vertically.

Note: Cropping is applied after this control.

Offset	0x015C
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	All camera models

Bit offset (LSB << x)	Width (bits)	Description
0	1	Image remains unchanged.
1	1	The image is flipped vertically.

0x0160 | Sensor Width

Displays the number of horizontal pixels of the image sensor.

Offset	0x0160
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x0164 | Sensor Height

Displays the number of vertical pixels of the image sensor.

Offset	0x0164
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x0168 | Width Max

Displays the number of horizontal pixels of the image sensor available, after binning and before region of interest has been applied.

Offset	0x0168
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x016C | Height Max

Displays the number of vertical pixels of the image sensor available, after binning and before region of interest has been applied.

Offset	0x016C
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	Pixel
Availability	All camera models

0x0170 | Digital Binning Inquiry

Displays the availability of binning factors.

Note: This control is available with NVIDIA Driver 5.1 or higher.

Offset	0x0170
Origin of control	Camera
Type	UInt16
Access	R
Size [Bytes]	2
Availability	All camera models

Bit offset (LSB << x)	Width (bits)	Description
0	1	2 × 2 Digital
1	1	3 × 3 Digital
2	1	4 × 4 Digital
3	1	5 × 5 Digital
4	1	6 × 6 Digital
5	1	7 × 7 Digital
6	1	8 × 8 Digital
7	9	Reserved

0x0174 | Digital Binning Setting

Controls the binning factor.

Note: This control is available with NVIDIA Driver 5.1 or higher.

Offset	0x0174
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	All camera models

Value	Description
0	Off (1 × 1) (Default)
1	2 × 2
2	3 × 3
3	4 × 4
4	5 × 5
5	6 × 6
6	7 × 7
7	8 × 8

0x0178 | Digital Binning Mode

Controls whether the result of binned pixels is averaged or summed up.

Note: This control is available with NVIDIA Driver 5.1 or higher.

Offset	0x0178
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	All camera models

Value	Description
0	Average: The charge or gray value of adjacent pixels is averaged.
1	Sum: The charge or gray value of adjacent pixels is summed up.

Brightness Control

0x0180 | Exposure Time

Sets the exposure time when `Exposure Auto` is *`Off`*. This controls the duration during which the photosensitive cells are exposed to light.

Offset	0x0180
Origin of control	Camera
Type	UInt64
Access	R/W
Size [Bytes]	8
Unit	Nanoseconds [ns]
Availability	All camera models

0x0188 | Exposure Time Min Value

Displays the minimum value available for `Exposure Time`.

Offset	0x0188
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Unit	Nanoseconds [ns]
Availability	All camera models

0x0190 | Exposure Time Max Value

Displays the maximum value available for `Exposure Time`.

Offset	0x0190
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Unit	Nanoseconds [ns]
Availability	All camera models

0x0198 | Exposure Time Increment

Displays the increment value available for `Exposure Time`.

Offset	0x0198
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Unit	Nanoseconds [ns]
Availability	All camera models

0x01A0 | Exposure Auto

Sets the auto exposure mode. The output of the auto exposure function affects the whole image. `Exposure Time` is disabled.

Note: The pixel intensity is set to a target value of 50% of the mean. Use `Intensity Auto Target` controls to adjust the target value or use `Intensity Auto Precedence` to set the priority between `Exposure Auto` and `Gain Auto`.

Offset	0x01A0
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	Camera model dependent

Value	Description
0	*Off*: Exposure duration is user controlled using `Exposure Time`.
1	*Once*: Exposure duration is adapted once by the device. After it has converged, it returns to the *Off* state.
2	*Continuous*: Exposure duration is constantly adapted by the device according to scene illumination.

0x0330 | Exposure Auto Min Value

Controls the minimum value for auto exposure time. The range of this register is:

- `Exposure Auto Min` >= `Exposure Time Min`
- `Exposure Auto Min` <= `Exposure Time Max`
- `Exposure Auto Min` <= `Exposure Auto Max`

Notes:

- This control is not supported by CSI-2 driver versions up to V1.0.4.
- This control must be displayed as available in `Register Inquiry` and `Exposure Auto Max` value must not be ***0***.

Offset	0x0330
Origin of control	Camera
Type	Int64
Access	R/W
Size [Bytes]	8
Unit	Nanoseconds [ns]
Availability	Camera model dependent

0x0338 | Exposure Auto Max Value

Controls the maximum value for auto exposure time. The range of this register is:

- `Exposure Auto Max` >= `Exposure Time Min`
- `Exposure Auto Max` <= `Exposure Time Max`
- `Exposure Auto Max` >= `Exposure Auto Min`

Notes:

- This control is not supported by CSI-2 driver versions up to V1.0.4.
- This control must be displayed as available in `Register Inquiry` and `Exposure Auto Max` value must not be ***0***.

Offset	0x0338
Origin of control	Camera
Type	Int64
Access	R/W
Size [Bytes]	8
Unit	Nanoseconds [ns]
Availability	Camera model dependent

0x01A4 | Intensity Auto Precedence

Selects the priority between exposure and gain control loops for auto intensity.
Note: This parameter is used only if both `Exposure Auto` and `Gain Auto` are available and set to *`Once`* or *`Continuous`*.

Offset	0x01A4
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	All camera models

Value	Description
`0`	*`Minimize noise`*: Loops for `Exposure Time` are applied before loops for `Gain`.
`1`	*`Minimize blur`*: Loops for `Gain` are applied before loops for `Exposure Time`.

0x01A8 | Intensity Auto Target Value

Controls the target value for pixel intensity with auto controls.

Note: This control has a tolerance of 5%.

Offset	0x01A8
Origin of control	Camera
Type	UInt32
Access	R/W
Size [Bytes]	4
Unit	0.1%
Availability	All camera models

0x01AC | Intensity Auto Target Min Value

Displays the minimum target value available for pixel intensity with auto controls.

Offset	0x01AC
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	0.1%
Availability	All camera models

0x01B0 | Intensity Auto Target Max Value

Displays the maximum target value available for pixel intensity with auto controls.

Offset	0x01B0
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	0.1%
Availability	All camera models

0x01B4 | Intensity Auto Target Increment

Displays the increment for target values available for pixel intensity with auto controls.

Offset	0x01B4
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Unit	0.1%
Availability	All camera models

0x01B8 | Black Level

Controls the analog black level as DC offset applied to the video signal.

Offset	0x01B8
Origin of control	Camera
Type	Int32
Access	R/W
Size [Bytes]	4
Availability	Camera model dependent

0x01BC | Black Level Min Value

Displays the minimum value available for `Black Level`.

Offset	0x01BC
Origin of control	Camera
Type	Int32
Access	R
Size [Bytes]	4
Availability	Camera model dependent

0x01C0 | Black Level Max Value

Displays the maximum value available for `Black Level`.

Offset	0x01C0
Origin of control	Camera
Type	Int32
Access	R
Size [Bytes]	4
Availability	Camera model dependent

0x01C4 | Black Level Increment

Displays the increment value available for `Black Level`.

Offset	0x01C4
Origin of control	Camera
Type	Int32
Access	R
Size [Bytes]	4
Availability	Camera model dependent

0x01C8 | Gain

Controls the amplification factor applied to the video signal.

Offset	0x01C8
Origin of control	Camera
Type	UInt64
Access	R/W
Size [Bytes]	8
Unit	Millibel ($1/_{100}$ Decibel)
Availability	Camera model dependent

0x01D0 | Gain Min Value

Displays the minimum value available for `Gain`.

Offset	0x01D0
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Unit	Millibel ($1/_{100}$ Decibel)
Availability	Camera model dependent

0x01D8 | Gain Max Value

Displays the maximum value available for `Gain`.

Offset	0x01D8
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Unit	Millibel ($1/_{100}$ Decibel)
Availability	Camera model dependent

0x01E0 | Gain Increment

Displays the increment value available for `Gain`.

Offset	0x01E0
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Unit	Millibel ($1/_{100}$ Decibel)
Availability	Camera model dependent

0x01E8 | Gain Auto

Controls the automatic gain control (AGC) mode. The output of the auto gain function affects the whole image.

Note: The pixel intensity is set to a target value of 50% of the mean. Use `Intensity Auto Target` controls to adjust the target value or use `Intensity Auto Precedence` to set the priority between `Exposure Auto` and `Gain Auto`.

Offset	0x01E8
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	Camera model dependent

Value	Description
0	*Off*: Gain is User-controlled using `Gain`.
1	*Continuous*: Gain is constantly adjusted by the camera.

0x0340 | Gain Auto Min Value

Controls the minimum value for auto gain. The range of this register is:

- `Gain Auto Min` >= `Gain Min`
- `Gain Auto Min` <= `Gain Max`
- `Gain Auto Min` <= `Gain Auto Max`

Notes:

- This control is not supported by CSI-2 driver versions up to V1.0.4.
- This control must be displayed as available in `Register Inquiry` and `Gain Auto Max` value must not be `0`.

Offset	0x0340
Origin of control	Camera
Type	Int64
Access	R/W
Size [Bytes]	8
Unit	Millibel ($1/_{100}$ Decibel)
Availability	All camera models

0x0348 | Gain Auto Max Value

Controls the maximum value for auto gain. The range of this register is:

- `Gain Auto Max` >= `Gain Min`
- `Gain Auto Max` <= `Gain Max`
- `Gain Auto Max` >= `Gain Auto Min`

Notes:

- This control is not supported by CSI-2 driver versions up to V1.0.4.
- This control must be displayed as available in `Register Inquiry` and `Gain Auto Max` value must not be `0`.

Offset	0x0348
Origin of control	Camera
Type	Int64
Access	R/W
Size [Bytes]	8
Unit	Millibel ($1/_{100}$ Decibel)
Availability	All camera models

0x01F0 | Gamma

Controls the correction of pixel intensity.

$Y' = ((Y / Y_{max})^{(Gamma \times 0.01)}) \times Y_{max}$

where
Y' is the new pixel intensity
Y is the original pixel intensity
Y_{max} is the maximum pixel value (for example, 255 for RAW8)
Gamma is the hundredfold correction factor.

Offset	0x01F0
Origin of control	Camera
Type	UInt64
Access	R/W
Size [Bytes]	8
Availability	Camera model dependent

0x01F8 | Gamma Min Value

Displays the minimum value available for `Gamma`.

Offset	0x01F8
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Availability	Camera model dependent

0x0200 | Gamma Max Value

Displays the maximum value available for `Gamma`.

Offset	0x0200
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Availability	Camera model dependent

0x0208 | Gamma Increment

Displays the increment value available for `Gamma`.

Offset	0x0208
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Availability	Camera model dependent

Color Management

0x0240 | Saturation

Controls the amplification of the chrominance signal as 100 × factor.

Offset	0x0240
Origin of control	Camera
Type	UInt32
Access	R/W
Size [Bytes]	4
Availability	All color models

0x0244 | Saturation Min Value

Displays the minimum value available for `Saturation`.

Offset	0x0244
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Availability	All color models

0x0248 | Saturation Max Value

Displays the maximum value available for `Saturation`.

Offset	0x0248
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Availability	All color models

0x024C | Saturation Increment

Displays the increment value available for `Saturation`.

Offset	0x024C
Origin of control	Camera
Type	UInt32
Access	R
Size [Bytes]	4
Availability	All color models

0x0250 | Hue

Controls the color tone by rotating the chrominance field clockwise with values > 0 and counter clockwise with values < 0. Values are 100 × factor.

Offset	0x0250
Origin of control	Camera
Type	Int32
Access	R/W
Size [Bytes]	4
Unit	$^{1}/_{100}$ degrees [°]
Availability	All color models

0x0254 | Hue Min Value

Displays the minimum value available for `Hue`.

Offset	0x0254
Origin of control	Camera
Type	Int32
Access	R
Size [Bytes]	4
Availability	All color models

0x0258 | Hue Max Value

Displays the maximum value available for **Hue**.

Offset	0x0258
Origin of control	Camera
Type	Int32
Access	R
Size [Bytes]	4
Availability	All color models

0x025C | Hue Increment

Displays the increment value available for **Hue**.

Offset	0x025C
Origin of control	Camera
Type	Int32
Access	R
Size [Bytes]	4
Availability	All color models

0x0280 | Red Balance Ratio

Controls the ratio of the red color component to the green color component (variable C). It is used for white balancing. The color balance is realized by the following formula:

C_W = `Red Balance Ratio` × C

C_W: Intensity of selected color component after white balancing
`Red Balance Ratio`: White balance coefficient
C: Intensity of the color component before white balancing.

Offset	0x0280
Origin of control	Camera
Type	UInt64
Access	R/W
Size [Bytes]	8
Availability	All color models

0x0288 | Red Balance Ratio Min Value

Displays the minimum value available for `Red Balance Ratio`.

Offset	0x0288
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Availability	All color models

0x0290 | Red Balance Ratio Max Value

Displays the maximum value available for `Red Balance Ratio`.

Offset	0x0290
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Availability	All color models

0x0298 | Red Balance Ratio Increment

Displays the increment value available for `Red Balance Ratio`.

Offset	0x0298
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Availability	All color models

0x02C0 | Blue Balance Ratio

Controls the ratio of the blue color component to the green color component (variable C). It is used for white balancing. The color balance is realized by the following formula:

C_w = `Blue Balance Ratio` × C

C_w: Intensity of selected color component after white balancing
`Blue Balance Ratio`: White balance coefficient
C: Intensity of the color component before white balancing.

Offset	0x02C0
Origin of control	Camera
Type	UInt64
Access	R/W
Size [Bytes]	8
Availability	All color models

0x02C8 | Blue Balance Ratio Min Value

Displays the minimum value available for `Blue Balance Ratio`.

Offset	0x02C8
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Availability	All color models

0x02D0 | Blue Balance Ratio Max Value

Displays the maximum value available for `Blue Balance Ratio`.

Offset	0x02D0
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Availability	All color models

0x02D8 | Blue Balance Ratio Increment

Displays the increment value available for `Blue Balance Ratio`.

Offset	0x02D8
Origin of control	Camera
Type	UInt64
Access	R
Size [Bytes]	8
Availability	All color models

0x02E0 | White Balance Auto

Controls the mode for automatic white balancing between the color channels. The white balancing ratios are adjusted automatically.

Offset	0x02E0
Origin of control	Camera
Type	UInt8
Access	R/W
Size [Bytes]	1
Availability	All color models

Value	Description
0	*Off*: The automatic adjustment of white balance is turned off.
1	*Once*: White balance is adjusted once by the device. Once it has converged, it returns to the *Off* state.
2	*Continuous*: White balance is constantly adjusted by the device.

Other

0x0310 | Device Temperature

Displays the temperature of the camera.

Offset	0x0310
Origin of control	Camera
Type	Int32
Access	R
Size [Bytes]	4
Unit	$^{1}/_{10}$ °C = d°C
Availability	Camera model dependent

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