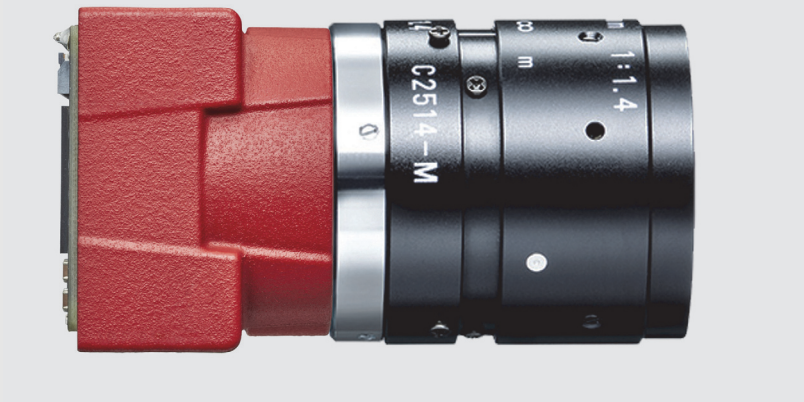
Allied Vision



MIPI CSI-2 Cameras

Alvium CSI-2 Cameras

User Guide

V2.4.0

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

2021-Apr-08

Quick links

- Alvium CSI-2 cameras at a glance on page 14
- Contact us on page 17
- Contents on page 18

Read before use

EN - English

Safety

Before using the camera, read these safety instructions. Observe the warnings at all times. Use the camera only as stated in the Intended use on page 33.

CAUTION

Risk of burns

A camera in operation can reach temperature levels which could cause burns.

CAUTION

Injury by falling cameras or lenses

A falling camera or lens can cause injury.

CAUTION

Risk of cuts by sharp edges of lens mounts

The threads of the lens mount can have sharp edges.

Intended use

Intended use of Allied Vision product is the integration into vision systems by professionals. All Allied Vision product is sold in a B2B setting.

Cameras without closed housings

Cameras without housing or with incomplete housing must be shielded against EMC emission by professionals according to local EMC provisions.

DA - Dansk

Sikkerhed

Læs sikkerhedsanvisningerne, før kameraet bruges. Overhold alle advarsler. Brug kun kameraet som anført i Intended use på side 33.

FORSIGTIG

Forbrændingsfare

Når kameraet bruges, kan det blive meget varmt og forårsage forbrændinger.

FORSIGTIG

Kvæstelser, hvis kameraet eller linser falder ned

Falder kameraet eller linsen ned, kan dette forårsage kvæstelser.

FORSIGTIG

Fare for snitsår på linsemodulets skarpe kanter

Linsemodulets gevind kan have skarpe kanter.

Tilsigtet brug

Allied Vision produktets tilsigtede brug er en indbygning i et visionssystem, udført af fagfolk. Alle Allied Vision produkter sælges i B2B.

Kameraer uden lukket hus

Kameraer uden hus eller uden komplet hus skal beskyttes mod EMC emissioner iht. lokale EMC bestemmelser.

DE - Deutsch

Sicherheit

Bevor Sie die Kamera benutzen, lesen Sie diese Sicherheitshinweise. Beachten Sie diese Hinweise immer. Verwenden Sie die Kamera nur wie beschrieben in Intended use auf Seite 33.

VORSICHT

Gefahr von Verbrennungen

Im Betrieb kann die Kamera Temperaturen erreichen, die zu Verbrennungen führen.

VORSICHT

Verletzung durch fallende Kameras oder Objektive

Eine fallende Kamera oder ein fallendes Objektiv kann Verletzungen verursachen.

VORSICHT

Schnitte durch scharfkantige Objektivgewinde

Objektivgewinde können scharfe Kanten haben.

Bestimmungsgemäßer Gebrauch

Allied Vision Produkte sind bestimmt für die Integration in Bildverarbeitungs-systeme durch Fachpersonal. Alle Allied Vision Produkte werden in einer B2B-Umgebung verkauft.

Kameras ohne geschlossenes Gehäuse

Für Kameras ohne Gehäuse oder mit unvollständigem Gehäuse muss die Abschirmung gegen EMV-Emissionen gemäß den örtlichen EMV-Bestimmungen durchgeführt werden.

ES - Español

Seguridad

Antes de utilizar la cámara lea estas instrucciones de seguridad. Observe las advertencias en todo momento. Utilice la cámara solo tal y como se estipula en el Intended use en la página 33.

ATENCIÓN

Riesgo de quemaduras

Una cámara en funcionamiento puede alcanzar temperaturas que podrían provocar quemaduras.

ATENCIÓN

Lesiones en caso de que las cámaras o las lentes se caigan

Si una cámara o una lente se cae puede provocar lesiones.

ATENCIÓN

Riesgo de cortes debido a los bordes afilados del objetivo

Las roscas de los objetivos pueden tener bordes afilados.

Uso previsto

El uso previsto del producto Allied Vision es la integración en el sistema de visión por parte de profesionales. Todos los productos Allied Vision se venden dentro de una relación B2B.

Cámaras sin carcasa cerrada

Las cámaras sin carcasa o con una carcasa incompleta deben protegerse contra las emisiones CEM por parte de profesionales de acuerdo con las disposiciones locales sobre la CEM.

FI - Suomi

Turvallisuus

Lue nämä turvallisuusohjeet ennen kameran käyttöä. Noudata varoituksia joka hetki. Käytä kameraa ainoastaan kohdassa Intended use sivulla 33 kuvatulla tavalla.

HUOMIO

Palovammojen vaara

Käytössä olevan kameran saavuttamat lämpötilatasot voivat aiheuttaa palovammoja.

HUOMIO

Putoavien kameroiden tai linssien aiheuttamat vammat

Putoava kamera tai linssi voi aiheuttaa vammoja.

HUOMIO

Linssien kiinnikkeiden terävien reunojen aiheuttamien viiltovammojen vaara

Linssin kiinnikkeiden kierteiden reunat voivat olla teräviä.

Käyttötarkoitus

Allied Vision-tuotteen käyttötarkoitus on integrointi kuvajärjestelmiin ammattilaisten toimesta. Kaikki Allied Vision-tuotteet myydään B2B-ympäristössä.

Kamerat, joissa ei ole suljettuja koteloita

Ammattilaisten on suojattava kamerat, joissa ei ole koteloa tai joiden kotelo on epätäydellinen, EMC-päästöiltä paikallisten EMC-määräysten mukaisesti.

FR - Français

Sécurité

Veuillez lire ces consignes de sécurité avant d'utiliser la caméra. Respectez continuellement les avertissements. Utilisez la caméra uniquement comme indiqué sous Intended use, page 33.

ATTENTION

Risque de brûlures

Une caméra en service peut atteindre des niveaux de température susceptibles d'entraîner des brûlures.

ATTENTION

Blessures en cas de chute de caméras ou d'objectifs

La chute d'une caméra ou d'un objectif peut entraîner des blessures.

ATTENTION

Risque de coupures sur les bords tranchants des montures d'objectif

Les filetages des montures d'objectif peuvent présenter des bords tranchants.

Utilisation prévue

L'utilisation prévue du produit Allied Vision est son intégration dans des systèmes de vision par le soin de professionnels. Tout produit Allied Vision est vendu dans un cadre B2B.

Caméras sans boîtier fermé

Les caméras sans boîtier fermé ou à boîtier incomplet doivent être blindées contre les émissions CEM par le soin de professionnels conformément aux dispositions CEM locales.

IT - Italiano

Sicurezza

Leggere queste istruzioni per la sicurezza prima di utilizzare la telecamera. Osservare sempre tutte le avvertenze. Utilizzare la telecamera come descritto alla sezione Intended use a pagina 33.

ATTENZIONE

Pericolo di ustioni

Durante il funzionamento una telecamera può raggiungere temperature elevate che possono essere causa di ustioni.

ATTENZIONE

Lesioni dovute alla caduta di telecamere o lenti

La caduta di una telecamera o di una lente può causare delle lesioni.

ATTENZIONE

Pericolo di tagliarsi sui bordi affilati degli attacchi della lente

I bordi della filettatura dell'attacco della lente possono essere affilati.

Uso previsto

Il prodotto Allied Vision è concepito per essere integrato in sistemi di monitoraggio in campo professionale. Tutti i prodotti Allied Vision sono venduti in uno scenario B2B.

Telecamere senza custodia chiusa

Le telecamere senza custodia o con una custodia incompleta devono essere protette dalle emissioni elettromagnetiche in ambienti professionali in conformità con le norme CEM nazionali.

JA – 日本語

安全性

本カメラを使用する前に、この安全の手引きをお読みください。常に、警告事項を守ってください。必ず、Intended use 33 ページの通りに、本カメラを使用してください。

注意

やけどの危険性

作動中のカメラは、やけどを引き起こす温度まで熱くなる恐れがあります。

注意

カメラまたはレンズの落下によるけが

カメラまたはレンズが落下すると、けがをする恐れがあります。

注意

レンズマウントの鋭利な端部で切り傷の危険性

レンズマウントのギザギザの部分が鋭利である可能性があります。

用途

Allied Vision製品は、専門家が視覚装置に統合することを意図したものです。すべてのAllied Vision製品は、企業間取り引き用に販売されています。

ハウジングで閉じられていないカメラ

ハウジングのないカメラまたはハウジングが不完全なカメラは、現地の電磁両立性（EMC）規定に従い、専門家によって、EMCエミッションから保護される必要があります。

NL - Nederlands

Veiligheid

Lees deze veiligheidsinstructies voordat u de camera gaat gebruiken. Neem deze waarschuwingen altijd in acht. Gebruik de camera uitsluitend, zoals aangegeven in het Intended use op pagina 33.

VOORZICHTIG

Risico van verbranding

Een camera die gebruikt wordt, kan temperatuurwaarden bereiken die brandwonden kunnen veroorzaken.

VOORZICHTIG

Letsel door vallende camera's of lenzen

Een vallende camera of lens kan letsel veroorzaken.

VOORZICHTIG

Risico van snijwonden door scherpe randen van lensbevestigingen

Het schroefdraad van de lensbevestiging kan scherpe randen hebben.

Beoogd gebruik

Het beoogde gebruik van het Allied Vision-product is de integratie in optische systemen door professionals. Alle Allied Vision-producten worden verkocht in de B2B-markt.

Camera's zonder gesloten behuizing

Camera's zonder behuizing of met een onvolledige behuizing moeten door professionals worden beschermd tegen EMC-straling door EMC-beschermingen ter plaatse.

NO - Norsk

Sikkerhet

Les disse sikkerhetsinstruksene før du bruker kameraet. Følg advarslene til en hver tid. Bruk kun kameraet i samsvar med Intended use på side 33.

FORSIKTIG

Risiko for brannskader

Et kamera i bruk kan nå temperaturnivåer som kan forårsake brannskader.

FORSIKTIG

Skade ved fallende kameraer eller linser

Et fallende kamera eller en fallende linse kan forårsake skade.

FORSIKTIG

Risiko for kutt fra skarpe kanter på linsefester

Sporene på linsefestet kan ha skarpe kanter.

Tiltenkt bruk

Den tiltenkte bruken av Allied Vision-produktet er integrering i visjonssystemer av profesjonelle. Alle Allied Vision-produkter selges i en forretning til forretning-situasjon.

Kameraer uten lukkede kamerahus

Kameraer uten kamerahus eller med ufullstendige kamerahus må beskyttes mot EMC-utslipp av fagfolk i henhold til lokale EMC-bestemmelser.

SV - Svenska

Säkerhet

Läs igenom säkerhetsinstruktionerna innan du använder kameran. Var hela tiden särskilt uppmärksam på varningarna. Använd enbart kameran på det sätt som anges i Intended use på sida 33.

VARNING

Risk för brännskada

En kamera i drift kan komma upp i temperaturer som kan orsaka brännskador.

VARNING

Risk för skador från fallande kameror eller objektiv

Fallande kameror eller objektiv kan förorsaka skador.

VARNING

Risk för skärsår från vassa kanter på objektivfattningar

Objektivets gängor kan ha vassa kanter.

Avsedd användning

Den avsedda användningen av Allied Vision-produkter är integrering i visionssystem av fackmän. Samtliga Allied Vision-produkter säljs i en B2B-miljö.

Kameror utan slutna kamerahus

Kameror utan eller med ofullständiga kamerahus måste skyddas mot elektromagnetiska emissioner av fackmän enligt lokala bestämmelser för elektromagnetiska emissioner.

ZH - 英文简体中文版

安全需知

使用本相机前，请阅读本安全说明书。请务必遵守相关警告 和 Intended use 于第 33 页 .

注意事项

烫伤风险

相机操作过程中温度可能上升并导致烫伤风险。

注意事项

相机或者镜头跌落造成伤害

相机或者镜头可能会跌落并造成伤害。

注意事项

镜头接口的锐利边缘划伤风险

镜头接口螺纹边缘可能较为锐利。

预期用途

Allied Vision 产品的预期用途是由专业人士整合到视觉系统中。所有 Allied Vision 的产品均通过 B2B 渠道销售。

无封闭式外壳相机

使用不带外壳或外壳不完整的相机时，必须由专业人员根据当地的 EMC 规定，对其进行 EMC 屏蔽。

Alvium CSI-2 cameras at a glance

Get an overview of Alvium CSI-2 camera documentation.

Read this document carefully

Learn to avoid damage to your Alvium CSI-2 camera and use it in the most safe and efficient way.

NOTICE

Damage to camera and embedded hardware by improper handling

Setup and operation for Alvium CSI-2 cameras in embedded systems is different than for cameras in PC-based systems. Components can easily be damaged.

- If you are unfamiliar with embedded systems, be extremely careful.
- Follow the safety notes.
- Follow the instructions in Installing the hardware on page 138.

Achieved values for your system may not match specified values

Values stated in Specifications on page 42 show the maximum available on an ideal system, supporting a bandwidth of 1.125 Gbps per lane. Your individual setup may affect available values such as for:

- Minimum and maximum exposure times and increments
- Maximum frame rates, including ROI frame rates
- Image resolution steps.

Please consider Value changes by control interdependencies on page 166 when you change settings.

Individual properties of Alvium CSI-2 cameras

Please consider individual properties of Alvium CSI-2 cameras to design applications successfully. See Performance on page 164 for details.

Bare board cameras

If you intend to design an application using bare board cameras, please consider:

- Aligning the sensor to the lens is extremely difficult and expensive. Therefore, we recommend you to do evaluation with housed cameras first.
- Bare board cameras are specialized components. We cannot give all data needed for any application in advance.
- Please let us partner with you for bare board camera applications to ensure a successful design.
- For reference, keep the **sandwich label including the serial numbers** of the Alvium chip and the camera itself with the camera. See Serial numbers of Alvium® chips and bare board cameras on page 140.

Shipping contents

- Alvium CSI-2 camera
- Download Instructions for First Camera Operation document

What else do you need?

This is a selection of helpful downloads:

Document	Link
Direct Register Access Controls Reference	www.alliedvision.com/en/support/technical-documentation/alvium-csi-2-documentation
Alvium Cameras Hardware Options	www.alliedvision.com/en/support/technical-documentation/alvium-csi-2-documentation under Additional documents
Alvium Cameras Accessory Guide	
Optimum Heat Dissipation for Housed Alvium Cameras application note	
Electromagnetic Compatibility for Open Housing Alvium Cameras application note	
Defect Pixel Correction on Alvium Cameras application note	
Avoiding Ground Loops in Vision Systems application note	
Sensor Alignment for Alvium Cameras white paper	

Table 1: Document downloads for Alvium CSI-2 cameras

Download or information	Link
Driver for Alvium CSI-2 cameras, code examples, and more	www.alliedvision.com/en/products/software/embedded-software-and-drivers

Table 2: Embedded software and driver downloads for Alvium CSI-2 cameras

Contact us

Website

General
www.alliedvision.com/en/contact

Distribution partners
www.alliedvision.com/en/about-us/where-we-are

Email

General
info@alliedvision.com

Support
support@alliedvision.com

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Contents

Document history and conventions

This chapter includes:

Document history

Version	Date	Remarks
V2.4.0	2021-Apr-08	• Added RAW pixel formats for 10-bit and 12-bit Mono in Specifications on page 42. • Added 1800 C-2460m/c models in Specifications on page 42. • Updated mass values in Dimensions and mass on page 107. • Updated descriptions in V4L2 controls vs. GenICam features on page 125. • Updated instructions for Mounting the camera on page 144. • Updated graphic in Value changes by control interdependencies on page 166. • Applied minor editorial changes.
V2.3.0	2020-Dec-15	• Updated ROI frame rates and values for minimum and maximum exposure time in Specifications on page 42. • Added content about Pixel format default and naming on page 46. • Added values for White balance default on page 106. • Updated drawings and dimension values for bare board cameras in Technical drawings on page 107. • Updated tables in V4L2 controls vs. GenICam features on page 125. • Added information about Serial numbers of Alvium® chips and bare board cameras on page 140. • Added Non-isolated, programmable GPIOs on page 155. • Added Triggering on page 158. • In Image data flow on page 162, added FPNC support for all models, except for Alvium 1800 C-2050. • Added notes about frame rates for rolling shutter cameras run in triggered mode. • Added content about Limitations for available resolutions on page 171. • Applied minor editorial changes.

Table 3: Document history (sheet 1 of 3)

Version	Date	Remarks
V2.2.0	2020-Jul-22	• Added Alvium 1800 C-240m/c, 1800 C-508m/c, and 1800 C-1240m/c models. • Updated ROI frame rates and pixel formats in Specifications on page 42. • Updated Type for Alvium 1500 C-210m/c on page 58. • Added QE and spectral response to Alvium 1800 C-2050m/c on page 98. • Extended information in Shock and vibration on page 43. • Updated spectral response graphic in IR cut filter on page 113. • Added Sensor position accuracy on page 114. • Added Read before use on page 2. • Corrected minor errors.
V2.1.3	2020-Mar-12	• Corrected maximum exposure times. • DPC: Removed specifications into an application note. • FPNC: Updated note in Image data flow on page 162.
V2.1.2	2020-Mar-04	Applied minor changes.
V2.1.1	2020-Feb-28	Updated content for shutter types.
V2.1.0	2020-Feb-20	• Added Alvium 1800 C-319m/c, 1800 C-507m/c, 1800 C-1236m/c, and 1800 C-2050m/c models. • Added specifications for DPC. • Updated description for sensor shutter types.
V2.0.0	2020-Jan-06	• Added Alvium 1500 C-210m/c, 1800 C-040m/c, and 1800 C-158m/c models. • Added descriptions for Hue and Saturation in V4L2 controls vs. GenICam features on page 125. • Added Dark current compensation on page 168. • Updated technical drawings and dimensions for bare board cameras in Dimensions and mass on page 107. • Updated values for power consumption in Specifications on page 42. • Restructured contents in Performance on page 164. • Applied editorial changes.

Table 3: Document history (sheet 2 of 3)

Version	Date	Remarks
V1.1.0	2019-Jul-01	• Removed separate bit depth for maximum frame rates in Specifications on page 42. • Corrected ADC bit depth for Alvium 1500 C-500m/c in Specifications on page 42 and for all models in Image data flow on page 162.
V1.0.0	2019-Jun-04	Release version

Table 3: Document history (sheet 3 of 3)

Conventions used in this user guide

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

Typographic styles

Style	Function
Emphasis	Programs, or highlighting important things
`Feature and register names`	Names for GenICam features or for camera control registers
`Feature and register options`	Options for GenICam features or for camera control registers
`Input commands`	Text or command to type in by the user, selected menu options, or other selectable options
UIElements	Text that is displayed or output by the system, like parts of the GUI, dialog boxes, buttons, menus, important information, or windows titles
Web addresses and references	Links to webpages and internal cross references

Table 4: Typographic styles

Symbols and notes

CAUTION

Risk of burns

Precautions are described

CAUTION

Injury by falling cameras or lenses

Precautions are described

CAUTION

Risk of cuts by sharp edges of lens mounts

Precautions are described

NOTICE

Material damage

Precautions are described.

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.

Naming and terms

Camera model naming

Alvium cameras are named to identify model properties.
For example, **Alvium 1500 C-500c** is composed of:

	Alvium	**1500**	**C**	**500**	**c**
Content element	Camera series	Camera series detail	Interface	Resolution[1]	Color/ monochrome
Examples	Alvium	1500: Basic feature set 1800: Advanced feature set or high-performance sensors	C: MIPI CSI-2 U: USB	500: 5.0 MP 050: 0.5 MP	c: color m: monochrome
[1]Model resolutions may slightly deviate from model naming.					

Table 5: Camera model naming

Hardware options

Alvium CSI-2 cameras are available as bare board or open housing models with different lens mounts. For ordering, see hardware options and product codes in the Alvium Cameras Hardware Options document at www.alliedvision.com/en/support/technical-documentation/alvium-csi-2-documentation under Additional documents.

Terms and acronyms

Term or acronym	**Description**	**Reference**
adapter board	Printed circuit board (PCB) that connects embedded boards, cameras, and I/Os, dedicated to an individual embedded board	Alvium Cameras Accessory Guide at www.alliedvision.com/en/support/technical-documentation/alvium-csi-2-documentation
bare board	Camera consisting of electronics and sensor on a common printed circuit board (PCB), to be designed into a housing with heat sink and lens mount	Bare Board on page 108
CRA	Chief ray angle	Alvium 1500 C-050m/c on page 50
EMVA	European Machine Vision Association	www.emva.org
ERS	Electronic rolling shutter, see RS	Shutter types affecting image readout on page 170
ESD	Electrostatic discharge	ESD on page 36

Table 6: Terms and acronyms (sheet 1 of 2)

Term or acronym	Description	Reference
FPC cable	(MIPI CSI-2 FPC cable) Flexible printed circuit cable, component that connects embedded boards and cameras via adapter board	Alvium Cameras Accessory Guide at www.alliedvision.com/en/support/technical-documentation/alvium-csi-2-documentation
FPC connector	Hirose FH55-22S-0.5SH connector	www.hirose.com
FPNC	Fixed pattern noise correction	Image data flow on page 162
fps	Frames per second	Alvium 1500 C-050m/c on page 50
GND	Ground (power)	FPC connector pin assignment on page 153
Gbps	Gigabit per second	Alvium 1500 C-050m/c on page 50
GS	Global shutter	Shutter types affecting image readout on page 170
H × V	Horizontal × Vertical (sensor resolution)	Alvium 1500 C-050m/c on page 50
PCB	Printed circuit board	Connecting FPC cable and FPC connectors on page 141
PCBA	Printed circuit board assembly	PCBAs on page 37
open housing	Camera housing that is open at the back side to be designed into an encompassing housing with other components	Open Housing C-Mount on page 111
QE	Quantum efficiency	Absolute QE on page 52
ROI	Region of interest	V4L2 controls vs. GenICam SFNC features on page 128
RS	Rolling shutter, see ERS	Shutter types affecting image readout on page 170
SFNC	Standard Feature Naming Convention (GenICam)	www.emva.org
S-Mount	M12-Mount	Mounting and focusing S-Mount lenses on page 148

Table 6: Terms and acronyms (sheet 2 of 2)

Compliance, safety, and intended use

This chapter includes:

Compliance notifications

National regulations on disposal must be followed.

Bare board and open housing cameras

Bare board and open housing cameras are designed for integration and are delivered without closed housing on customer's request. Housing design is critical for electromagnetic compatibility (EMC) of the camera.

Requirements for EMC housings

See the Electromagnetic Compatibility for Open Housing Alvium Cameras application note at www.alliedvision.com/en/support/technical-documentation/alvium-csi-2-documentation under Additional documents.

Avoid electromagnetic interferences

Interface cables, power cables, and I/O cables are sensitive to electromagnetic interference.

- Use shielded cables only.
- We recommend using cables offered by Allied Vision.
- Avoid coiling.
- We recommend using GPIOs only in environments with low electromagnetic interference.

Moreover, avoid unnecessary bending to prevent damaging the cables.

Intended use

Allied Vision's objective is the development, design, production, maintenance, servicing and distribution of digital cameras and components for image processing. We are offering standard products as well as customized solutions.

Intended use of Allied Vision product is the integration into Vision systems by professionals. All Allied Vision product is sold in a B2B setting.

Allied Vision isn't a legal manufacturer of medical product. Instead, Allied Vision cameras and accessories may be used as components for medical product after design-in by the medical device manufacturer and based on a quality assurance agreement (QAA) between Allied Vision (supplier) and medical device manufacturer (customer). Allied Vision's duties in that respect are defined by ISO 13485, clause 7.2 (customer-related processes, equivalent to ISO 9001, clause 8.2).

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Your safety

This section informs about issues related to your personal safety. Descriptions explain how to avoid hazards and operate Alvium CSI-2 cameras safely.

Handling lens mounts

The lens mount thread has sharp edges. Be careful these edges do not cut your skin when mounting or unmounting lenses.

Housed cameras: handling hot cameras

If the mainboard temperature exceeds the specified maximum for more than two seconds, the camera is powered off automatically. The current value for mainboard temperature is output by `Device Temperature`, using Direct Register Access. You can use this value to control cooling by software, for example, to control a fan.

However, if you hold the camera in your hands during operation, your skin may get hurt. If you touch the camera when it is heated up, we recommend wearing protective gloves.

Providing optimum heat dissipation

Design bare board and open housing cameras into a heat dissipative housing with a high thermal conductivity. For more information, see Mounting bare board cameras on page 144. Keep the operating temperature in the specified range to enable best image quality and to protect the camera from damage. Temperature values apply to a relative humidity of 0 to 80 percent that is non-condensing.

Hardware option	Housing	Components in the cooling areas[1]	Mainboard[2]
Bare board[3]	Not applicable	+5 °C to +85 °C	See model Specifications on page 42.
Open housing[4]	+5 °C to +65 °C		

[1] See Mounting the heat sink on page 143.

[2] Output by `Device Temperature`, using Direct Register Access.

[3] Ensure that the sensor is operated in the temperature range specified by the manufacturer. For any questions, please contact support@alliedvision.com.

[4] Temperature values must be observed for the housing **and** for the cooling areas.

Table 7: Operating temperature ranges for Alvium CSI-2 cameras

For your safety and to improve camera performance, operate the camera:

- Mounted to a base with a high thermal conductivity
- With lens or other optical components mounted
- With a heat sink mounted that has large surface areas (closed housing cameras include a heat sink)
- Using conductive media for camera and heat sink mounting
- With active cooling of camera, mounting base, and heat sink, such as by ventilation.

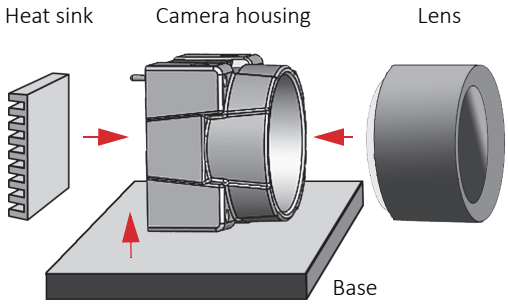


Figure 1: Setup to provide optimum heat dissipation

More information

For more information on heat dissipation, see the Optimum Heat Dissipation for Housed Alvium Cameras application note at www.alliedvision.com/en/support/technical-documentation/alvium-csi-2-documentation under Additional documents.

Camera mounting

Housed cameras must be mounted using the mounting threads. If vibration is higher than specified, cameras can disconnect from the mounting. Falling cameras can hurt you. To avoid personal injury:

- Mount the camera according to the instructions in Mounting open housing cameras on page 145.
- Ensure, shock and vibration do not exceed the specified range, see Shock and vibration on page 43.
- Use a lens support if you want to use Heavy lenses.

Heavy lenses

For non-static applications, use lenses with a mass less than 70 grams and a length less than 38 mm, where the center of gravity is 20 mm, measured from the lens mount front flange. For heavier or longer lenses, use a lens support and apply additional tests. For more information, please contact support@alliedvision.com.

Product safety

To prevent material damage, read the following and understand how to safely handle and operate the camera.

Embedded systems

Setup and operation of Alvium CSI-2 cameras in embedded systems is different than for cameras in PC-based systems. Components can easily be damaged.

If you are unfamiliar with embedded systems, be extremely careful. Follow the instructions in Installing the hardware on page 138.

Supported embedded boards

We have tested that Alvium CSI-2 cameras can be operated properly with the referenced embedded boards. For information on using these components safely, please see the documentation provided by the manufacturers of the embedded boards.

Electrical connections

The MIPI CSI-2 standard does not specify electrical connections as extensively as the USB or GigE standard. Read specifications carefully.

Allied Vision accessories help to avoid damage to the camera and connected components. See the Alvium Cameras Accessory Guide for suitable accessories. See Specifications on page 42 and Installing the hardware on page 138.

Alvium CSI-2 cameras are not protected against damage caused by reverse polarity.

- For specifications, see FPC connector pin assignment on page 153.
- For instructions to avoid electronics damage, see Connecting FPC cable and FPC connectors on page 141.

ESD

ESD is dangerous for electronic devices, especially when tools or hands get in contact with connectors and electronic components. We recommend measures to avoid damage by ESD:

- Unpacking: Remove the camera from its anti-static packaging only when your body is grounded.
- Workplace: Use a static-safe workplace with static-dissipative mat and air ionization.
- Wrist strap: Wear a static-dissipative wrist strap to ground your body.

- Clothing: Wear ESD clothing. Keep components away from your body and clothing. Even if you are wearing a wrist strap, your body is grounded but your clothes are not.
- Housing: use an ESD housing, including the camera, embedded board, adapter board, and MIPI CSI-2 FPC cable.

Cable connections

Provide sufficient strain relief for all cable connections to avoid short circuits and malfunctions.

PCBAs

Alvium CSI-2 cameras enable access to PCBAs. Keep away from camera electronics to avoid damage.

Camera power

Operating cameras beyond the specified range damages cameras. Cameras are powered using the FPC connector at a maximum input of 5.5 VDC with maximum 1.5 A, using a limited power source (LPS), according to IEC62368-1: 2014 (Second Edition). The camera is not intended to be connected to a DC distribution network.

Only use power supplies that meet the insulation requirement according to PELV or SELV. For details, please refer to IEC 61140.

Ground loops

Unsuitable connections can lead to different potentials between the camera system GND and the environmental shield/chassis GND caused by ground loops. This can damage the camera and the connected devices or cause malfunctions.

- Avoid potential differences between the camera housing and GND.
- All wiring must be done by authorized personnel, according to the corresponding technical standards.
- You may mount the camera electrically isolated.
- Read the Avoiding Ground Loops in Vision Systems application note.

More information

See the Avoiding Ground Loops in Vision Systems application note at www.alliedvision.com/en/support/technical-documentation/alvium-csi-2-documentation under Additional documents.

FPC connectors

Hirose FH55-22S-0.5SH FPC connectors enable compact camera design.

The small-sized connectors are sensitive to mechanical stress and are specified for maximum 20 mating and unmating cycles. Especially if you are inexperienced with this connector, be very cautious. If the FPC connector is broken, the camera must be replaced. To install and operate cameras safely, read this section carefully.

Instructions in Installing the hardware on page 138 include helpful information to enable proper installation.

- Avoid stress to FPC connectors.
- Allow only the FPC cable to touch conductors.

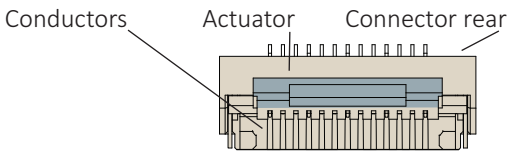


Figure 2: Hirose FH55-22S-0.5SH FPC connector

Additional information

For technical data and more instructions on the Hirose FH55-22S-0.5SH connector, see the manufacturer data sheet at www.hirose.com.

Handling the actuator

- Move the actuator only between 0 degrees (locked position) and 105 degrees (open position).
- Carefully flip the actuator at the middle with your finger nail, see Connecting FPC cable and FPC connectors on page 141.

MIPI CSI-2 FPC cables

Manufacturing FPC cables or embedded boards

If you want to design your own components to connect Alvium CSI-2 cameras to embedded boards, contact your Allied Vision Sales representative or Allied Vision Support at support@alliedvision.com.

FPC cable position

Short circuits of the FPC cable can damage the camera or connected hardware.

- Insert the FPC cable into the connector with cable guiding tabs matching the connector's side guides. See Connecting FPC cable and FPC connectors on page 141.
- Connect the camera and the embedded board (adapter) only as shown by the arrow printed on the FPC cable, see Connecting FPC cable and FPC connectors on page 141.

FPC cables and stress

Over-stressed FPC cables can damage the camera and connected hardware. When camera and embedded board are twisted against each other or pulled apart from each other with too much force, the FPC cable is over-stressed. Spring contacts of FPC connectors are worn out, causing short circuits and unreliable electrical connections.

- Insert the FPC cable into the FPC connector at 12 degrees to the PCB board surface. See Connecting FPC cable and FPC connectors on page 141.
- Allow only slight bending of the FPC cable (minimum bending radius: 10 mm).
- Provide strain relief to avoid short cuts and malfunctions.

No hot-plugging for MIPI CSI-2

Alvium CSI-2 cameras do not support hot-plugging. Hot-plugging can destroy the camera and connected hardware by high inrush current.

Disconnect power supplies before connecting FPC cables.

FPC cable signal quality

Noise and electromagnetic interference can disable camera functions.

- Avoid contact to metal surfaces, causing electromagnetic interference.
- Please use cables recommended by Allied Vision.

Handling bare board cameras

Bare board cameras are an electronic assembly without a protective housing. Therefore, they can easily be damaged.

- Handle bare board cameras with extreme care.
- Avoid any mechanical stress to the sensor area.
- Avoid short circuits by keeping away from electronics components.

Observe for mounting bare board cameras:

- Allow mechanical contact only at the mounting area. (This does not apply to the cooling areas.)
- Enable proper cooling at the cooling areas, see Mounting bare board cameras on page 144.
- Give 2 mm minimum clearance above board components.
- Tighten screws at 0.1 Nm maximum torque.
- Follow the instructions in Mounting bare board cameras on page 144.

Optical components

Provide the following conditions to keep dirt and droplets out of the optical system of camera and lens:

- Dust-free environment
- Low relative humidity
- No condensation.

When camera or lens are stored:

- Cover the lens mount with a protection foil or cap.
- Cover front and back lens with caps.

Damage to optical components by conductive media for heat sinks

See Conductive media for heat sinks on page 41 for details.

Sensor

Sensors are sensitive to excessive radiation: focused sunlight, lasers, and X-rays can damage the sensor. Dirt and scratches can damage the sensor as well.

Alvium CSI-2 cameras do not need additional cleaning. Cameras are cleaned before shipping. Incorrect cleaning can damage the sensor or the filter. Therefore, never clean the sensor or the filter.

Protect the camera filter and the sensor from dirt, because dirt becomes more visible the closer it gets to the sensor. In addition, keep the back lens clean.
Hold the camera with the lens mount facing the ground to keep dirt out of the lens mount. When no lens is mounted, protect the sensor and filter by a dust cap.

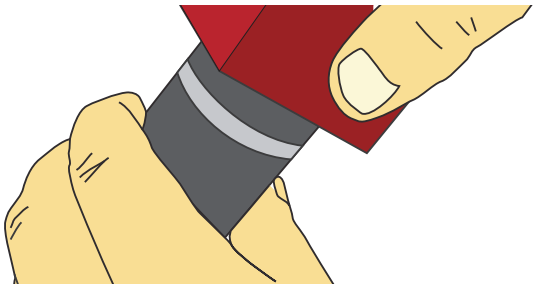


Figure 3: Holding the camera with the lens mount facing the ground

Lenses

Maximum protrusion

The sensor, filter, lens, or camera electronics can be damaged if a lens exceeding maximum protrusion is mounted to the camera. Use lenses with a maximum protrusion within camera specifications. Figure 4 shows maximum protrusion. For details, see Lens mounts and maximum protrusion on page 112.

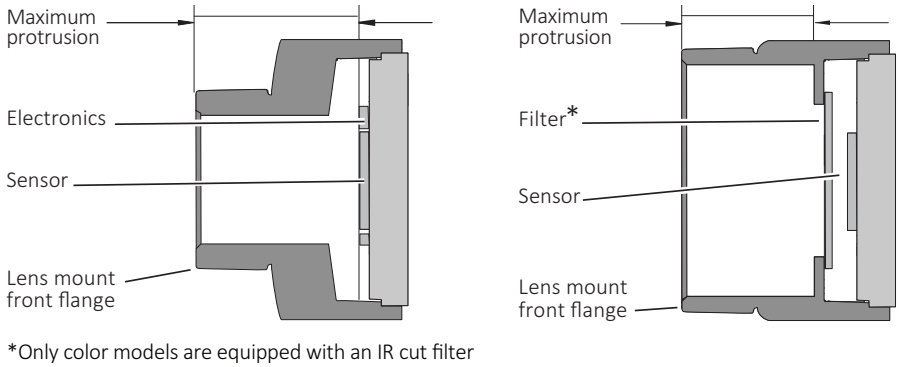


Figure 4: Maximum protrusion; S-Mount (left); CS-Mount and C-Mount (right)

For S-Mount lenses, read Mounting and focusing S-Mount lenses on page 148 to avoid damage to the sensor, electronics, and lens.

Heat sinks and conductive media

The camera can be damaged if heat sink or conductive media are not used properly.

Heat sinks

Adhere to the instructions and safety notes provided by the manufacturer of the heat sink.

Conductive media for heat sinks

Some conductive media for heat sinks contain corrosive substances that can damage optical surfaces of the sensor, filter, and lens.

- Cover the optical path of the camera when you apply heat sink compound or adhesive to prevent substances and fumes from damaging optical surfaces.
- Adhere to the instructions and safety notes provided by the manufacturer of the conductive media.
- Ensure that the conductive media is correctly positioned: covering only the **cooling areas**, see Mounting the heat sink on page 143.

Specifications

This chapter includes:

Applied standards

MIPI CSI-2

The MIPI (Mobile Industry Processor Interface) CSI (Camera Serial Interface)-2 standard describes a class of MIPI CSI-2 cameras for still image photography and video streaming. Generically, MIPI CSI-2 cameras are operated by Direct Register Access. Alvium CSI-2 cameras have a MIPI CSI-2 interface. They comply with:

- MIPI CSI-2 V1.1
- D-PHY V1.1.

V4L2

The current V4L2 framework is described at linuxtv.org. Allied Vision provides V4L2 drivers. You can download Allied Vision V4L2 drivers from www.alliedvision.com/en/products/software/embedded-software-and-drivers.

Shock and vibration

Alvium closed and open housing cameras were tested according to the following standards:

- IEC 60068-2-6, sinusoidal vibration testing
- IEC 60068-2-27, shock testing
- IEC 60068-2-64, random vibration testing.

Cameras were inspected before and after the tests. All tests were passed successfully:

Condition	Passed
Mechanics	• The camera housings showed no deformations. • The connections between camera components had not come loose. • The sensor position was within the specified tolerances of a new camera.
Camera behavior	Camera functionalities were not affected, no deviations occurred.
Image streaming	Images were streamed without errors.

Table 8: Conditions for passed tests

The conditions for cameras and lenses were the same for all tests. Solid aluminum tubes were used to represent real lenses:

Parameter	Value
Lens dummy length	38 mm
Lens dummy mass	70 g
Center of gravity (CoG)[1]	20 mm
[1]For camera and lens dummy assemblies, measured from the lens mount front flange	

Table 9: Conditions for lenses

IEC 60068-2-6: Sinusoidal vibration

Frequency	Acceleration	Displacement
10 Hz to 58.1 Hz	Not applicable	1.5 mm
58.1 Hz to 500 Hz	20 *g*	Not applicable

Table 10: Frequency, acceleration, and displacement for IEC 60068-6 tests

Parameter	Value
Axis	x, y, z
Sweep rate	1 oct/min
Sweep duration per axis [hh:mm:ss]	00:11:17
Number of sweeps	20

Table 11: Other parameters for IEC 60068-6 tests

IEC 60068-2-27: Shock

Parameter	Value
Axis	x, y, z
Acceleration	20 *g*
Number of shocks per axis	10
Duration per axis	11 ms
Waveform	Half sine

Table 12: Parameters for IEC 60068-2-27 tests

IEC 60068-2-64: Random vibration

Frequency	Acceleration
15 Hz to 500 Hz	0.05 $g^2/_{Hz}$

Table 13: Frequency and acceleration for IEC 60068-2-64 tests

Parameter	Value
Axis	x, y, z
Acceleration RMS (Sigma)	4.9 *g*
Acceleration peak (Sigma)	14.8 *g*
Duration per axis [hh:mm:ss]	00:30:00

Table 14: Other parameters for IEC 60068-64 tests

Notes on specifications

This section defines the conditions for specifications stated in this chapter.

Sensor

Absolute QE plots

Measurements for color cameras were done with IR cut filter, measurements for monochrome and S-Mount cameras were done without optical filters. With optical filters, QE decreases by approximately 10 percent. The uncertainty in measurement of the QE values is ±10 percent. This is mainly due to uncertainties in the measuring apparatus itself (such as Ulbricht sphere and optometer).

Manufacturing tolerance of the sensor increases overall uncertainty.

Sony sensors

Sony provides relative response curves in their sensor data sheets. To create the absolute QE plots shown in this chapter, the relative response was converted to a normalized QE response and then adjusted as per three measured QE values (at 448 nm, 529 nm, 632 nm) for color sensors and one measured QE value (at 529 nm) for monochrome sensors.

ON Semiconductor sensors

The curve in the absolute QE plots shown in this chapter is from the sensor manufacturer data sheet. The information was correct at the time of publishing.

Wavelength

The wavelength range in the absolute QE plots reflects the information available in the sensor manufacturer data sheet at the time of publishing. For additional wavelength information, contact the sensor manufacturer.

Spectral response plots

The curves in the spectral response plots shown in this chapter were calculated from measured quantum efficiencies at 448 nm, 529 nm, and 632 nm. The shape of the curve is taken from the sensor data sheet but the values have been adjusted based on these measured values. The uncertainty in measurement of the spectral response values is ±10 percent.

Resolution limitations

Different hosts can affect available values for minimum and maximum resolution, and for resolution increments. See Limitations for available resolutions on page 171.

Pixel format default and naming

The **default pixel format** for Alvium cameras is RGB888 (RGB3). Monochrome cameras are included to enable quick access on V4L2 where V4L2_PIX_FMT_UYVY is the default. For monochrome cameras, the 3 bytes for RGB are set to a common value, resulting in gray.

Pixel format naming

- Video4Linux Access: according to V4L2 definitions.
- Direct Register Access: Alvium CSI-2 cameras output pixel formats according to the MIPI CSI-2 standard.

This manual states extended MIPI CSI-2 definitions.

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

Table 15: 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
RAW10	V4L2_PIX_FMT_Y10	Y10	Mono10
RAW12	V4L2_PIX_FMT_Y12	Y12	Mono12
[1]GenICam Pixel Format Naming Convention			

Table 16: Equivalent pixel formats in different standards

Availability of pixel formats

The availability of pixel formats depends on camera models and the abilities of the connected system.

Exposure time, bandwidth, and frame rates

Exposure time values

Interdependencies between controls affect each other. See Value changes by control interdependencies on page 166.

Bandwidth

CSI-2 Lane Count and CSI-2 Clock

Alvium cameras require higher bandwidths than supported by only one CSI-2 lane, especially with low CSI-2 clock frequencies. We recommend you to do extensive testing to find the best setup for maximum frame rates, regarding:

- `CSI-2 lane count`
- `CSI-2 Clock`.

Dropped frames or a viewer issue?

Alvium CSI-2 cameras are designed for a maximum bandwidth that does not exceed board abilities. However, if your setup does not provide sufficient bandwidth, frames are dropped. Even if bandwidth is sufficient, embedded boards may not be able to display all images of an image stream. In this case, only the display is affected but no dropped frames occur.

Frame rates with Cropping/ROI frame rates

Cropping is a functionality similar to ROI. By using a reduced area of the available sensor, the payload is reduced, increasing frame rates. For details, see V4L2 controls vs. GenICam features on page 125.

The maximum frame rate which can be achieved depends on various values, such as bandwidth, pixel format, exposure time, and ROI. Calculation of maximum frame rates for different ROIs for Alvium CSI-2 cameras does not allow to give a formula. Data is calculated for **typical operation**:

- Factory settings (camera after startup)
- Minimum exposure time
- Full resolution
- RAW8 (GREY) pixel format
- Camera operation in freerun mode
- Sensor readout using ADC bit depth
- Without bandwidth limitations.

Achieved values for your system may not match specified values

Values stated in this chapter show the maximum available on an ideal system, supporting a bandwidth of 1.125 Gbps per lane. Your individual setup may affect available values such as for:

- Minimum **exposure times**
- Maximum **frame rates**, including ROI frame rates
- **Image resolution steps**. Due to increments, some standard resolutions are not available. For example, instead of 1,440 × 900 pixels for WXGA+, 1,440 × 904 pixels are available. See Limitations for available resolutions on page 171.

Interdependencies between ROI and Exposure Time values

Changing parameters for ROI can affect values for Exposure Time, such as minimum, maximum, and increments, but Exposure Time itself as well.

We recommend you to **set ROI values before you set values for Exposure Time**.

See Value changes by control interdependencies on page 166 for details.

Delays

For delays, see Trigger latency on page 160.

Triggering

The following table shows how the shutter type impacts available frame rates. Reducing the area for ROI reduces readout time. The relations in Table 17 apply only if exposure time is shorter than readout time.

Sensor type	Shutter type	Trigger mode	Available frame rates	ROI frame rates
Global shutter (GS)	Global shutter (GS)	Freerun	Maximum values	Increased values
	Global shutter (GS)	External trigger	Maximum values	Increased values
Rolling shutter (RS)	Rolling shutter (RS)	Freerun	Maximum values	Increased values
	Rolling shutter (RS)	External trigger	**Halved values**	Increased values

Table 17: Frame rates depending on shutter types and trigger modes

Sensor shutter types

Differences between global shutter (GS), rolling shutter (RS) sensors are explained in Shutter types affecting image readout on page 170. Triggering behavior differs between cameras with global shutter (GS) and rolling shutter (RS). See Triggering on page 158 for details.

Power consumption

The power consumption values in this chapter are for **typical operation**:

- Factory settings (camera after startup)
- Minimum exposure time
- Maximum frame rate
- Full resolution
- RAW8 (GREY) pixel format
- Camera operation in freerun mode
- Sensor readout using ADC bit depth
- Without bandwidth limitations.

Dimensions

For your model's dimensions, see Dimensions and mass on page 107.

In manufacturing, camera board and sensor are moved against each other to adjust flange focal distance. The value range for camera length with open housing cameras reflects in the technical drawings. See Technical drawings on page 107.

Alvium 1500 C model specifications

Alvium 1500 C-050m/c

Feature	Specification	
	1500 C-050m (monochrome)	**1500 C-050c (color)**
Sensor model	ON Semiconductor PYTHON 480	
Resolution	808 (H) × 608 (V); 0.5 MP	
Sensor type	CMOS	
Shutter type	Global shutter (GS)	
Sensor size	Type 1/3.6; 3.9 mm × 2.9 mm; 4.9 mm diagonal	
Pixel size	4.8 µm × 4.8 µm	
CRA	1.65 deg	
ADC	10-bit	
YUV color pixel formats	Not applicable	YUV422 8-bit (UYVY)
RGB color pixel formats	Default: RGB888 (RGB3)	
RAW pixel formats	RAW8 (GREY), RAW10 (Y10)	
Maximum image bit depth	10-bit	
Maximum frame rate	117 fps, using 1 to 4 lanes	
Exposure time	64 µs to 10 s, using 1 lane	
Image buffer (RAM)	256 KB	
Non-volatile memory (Flash)	1024 KB	
Gain	0 dB to 11 dB; 0.1 dB increments	
GPIOs	2 programmable GPIOs As direct inputs (push-pull): 0 to 5.5 VDC As direct outputs (push-pull): 0 to 3.3 VDC at 12 mA	
Power requirements	Power over MIPI CSI-2	
Power consumption (typical, at 5 VDC)	1.3 W	

Table 18: Alvium 1500 C-050m/c specifications (sheet 1 of 2)

Feature	Specification			
	1500 C-050m/c			
Operating temperature	**Hardware option**	**Housing**	**Cooling areas[1]**	**Mainboard[2]**
	Bare board[3]	Not applicable	+5 °C to +85 °C	+5 °C to +85 °C
	Open housing[4]	+5 °C to +65 °C		
Relative humidity	0% to 80% (non-condensing)			
Digital interface	MIPI CSI-2 D-PHY V1.1; 1, 2, or 4 lanes; maximum 1.125 Gbps per lane			
Camera controls	V4L2 controls (Video4Linux Access), Direct Register Access			

[1]See Mounting the heat sink on page 143.

[2]Output by `Device Temperature`

[3]Ensure that the sensor is operated in the temperature range specified by the manufacturer. For any questions, please contact support@alliedvision.com.

[4]Temperature values must be observed for the housing **and** for the cooling areas.

Table 18: Alvium 1500 C-050m/c specifications (sheet 2 of 2)

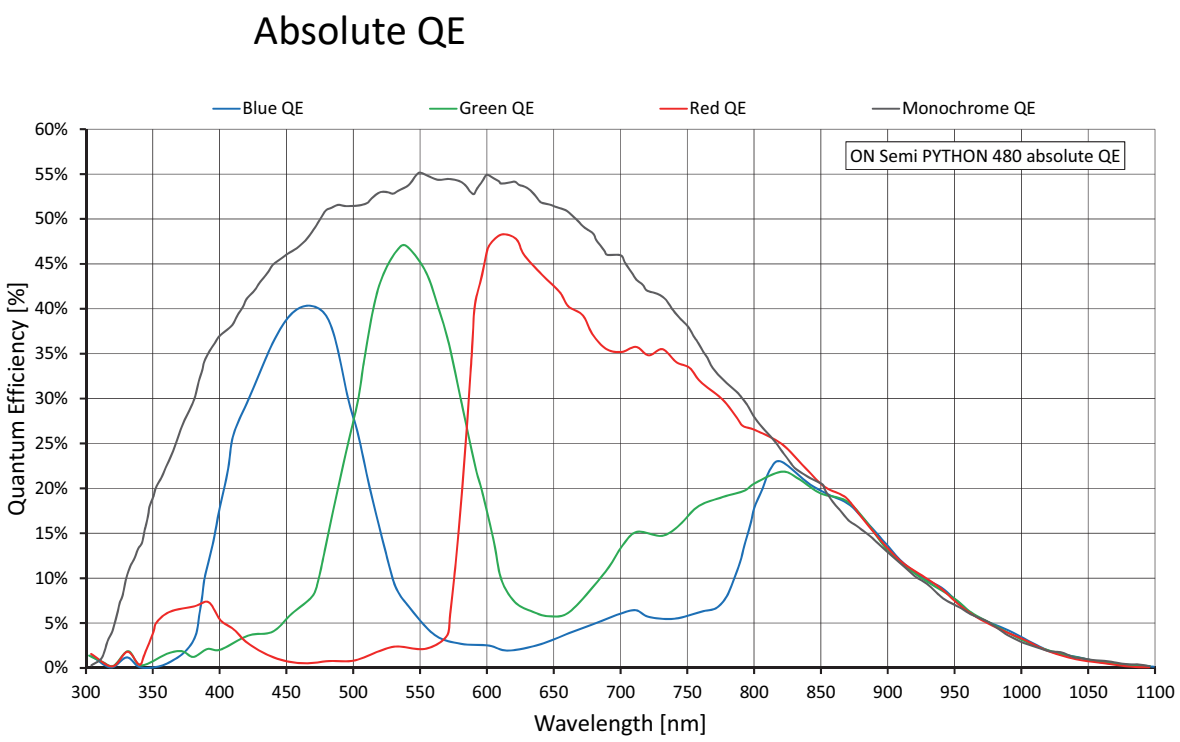


Figure 5: Alvium 1500 C-050m/c (ON Semi PYTHON 480) absolute QE

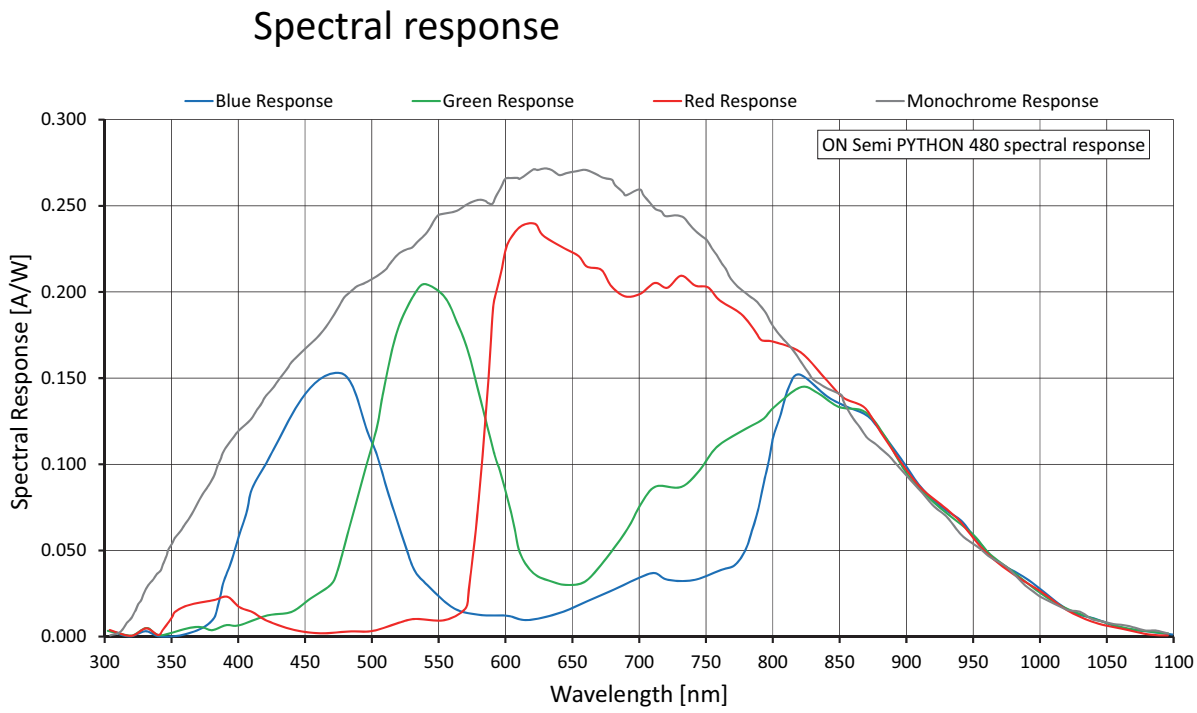


Figure 6: Alvium 1500 C-050m/c (ON Semi PYTHON 480) spectral response

Frame rates with Cropping

Values were calculated for **typical operation** defined in Frame rates with Cropping/ROI frame rates on page 48.

Frame rates at maximum bandwidth calculates for 1.125 Gbps per lane. To reach the maximum frame rate available for typical operation, the bandwidth for image traffic is at 1 lane with 1.125 Gbps. Increasing the `CSI-2 Lane Count` value does not increase frame rates.

Image format	Width [pixels]	Height [pixels]	ROI area [pixels]	Frame rate [fps]		
				1-lane	2-lane	4-lane
				1.125 Gbps	2.25 Gbps	4.5 Gbps
Full resolution	808	608	491,264	117		
VGA	640	480	307,200	176		
HVGA	480	320	153,600	313		
QVGA	320	240	76,800	514		
HQVGA	240	160	38,400	784		
QQVGA	160	120	19,200	1,069		
Maximum × half	808	304	245,632	219		
Maximum × minimum	808	16	12,928	1,278		
Minimum × maximum	16	608	9,728	726		
Minimum × minimum	16	16	256	1,943		

Table 19: Alvium 1500 C-050m/c ROI frame rates at maximum bandwidth

Alvium 1500 C-120m/c

Feature	Specification	
	1500 C-120m (monochrome)	**1500 C-120c (color)**
Sensor model	ON Semiconductor AR0135CS	
Resolution	1280 (H) × 960 (V); 1.2 MP	
Sensor type	CMOS	
Shutter type	Global shutter (GS)	
Sensor size	Type 1/3; 4.8 mm × 3.6 mm; 6.0 mm diagonal	
Pixel size	3.75 µm × 3.75 µm	
CRA	0 deg	
ADC	12-bit	
YUV color pixel formats	Not applicable	YUV422 8-bit (UYVY)
RGB color pixel formats	Default: RGB888 (RGB3)	
RAW pixel formats	RAW8 (GREY), RAW10 (Y10), RAW12 (Y12)	
Maximum image bit depth	12-bit	
Maximum frame rate	52 fps, using 1 to 4 lanes	
Exposure time	57 µs to 12.2 s, using 1 lane	
Image buffer (RAM)	256 KB	
Non-volatile memory (Flash)	1024 KB	
Gain	0 dB to 18 dB; 0.1 dB increments	
GPIOs	2 programmable GPIOs As direct inputs (push-pull): 0 to 5.5 VDC As direct outputs (push-pull): 0 to 3.3 VDC at 12 mA	
Power requirements	Power over MIPI CSI-2	
Power consumption (typical, at 5 VDC)	1.1 W	

Table 20: Alvium 1500 C-120m/c specifications (sheet 1 of 2)

Feature	Specification			
	1500 C-120m/c			
Operating temperature	**Hardware option**	**Housing**	**Cooling areas[1]**	**Mainboard[2]**
	Bare board[3]	Not applicable	+5 °C to +85 °C	+5 °C to +85 °C
	Open housing[4]	+5 °C to +65 °C		
Relative humidity	0% to 80% (non-condensing)			
Digital interface	MIPI CSI-2 D-PHY V1.1; 1, 2, or 4 lanes; maximum 1.125 Gbps per lane			
Camera controls	V4L2 controls (Video4Linux Access), Direct Register Access			

[1]See Mounting the heat sink on page 143.

[2]Output by `Device Temperature`

[3]Ensure that the sensor is operated in the temperature range specified by the manufacturer. For any questions, please contact support@alliedvision.com.

[4]Temperature values must be observed for the housing **and** for the cooling areas.

Table 20: Alvium 1500 C-120m/c specifications (sheet 2 of 2)

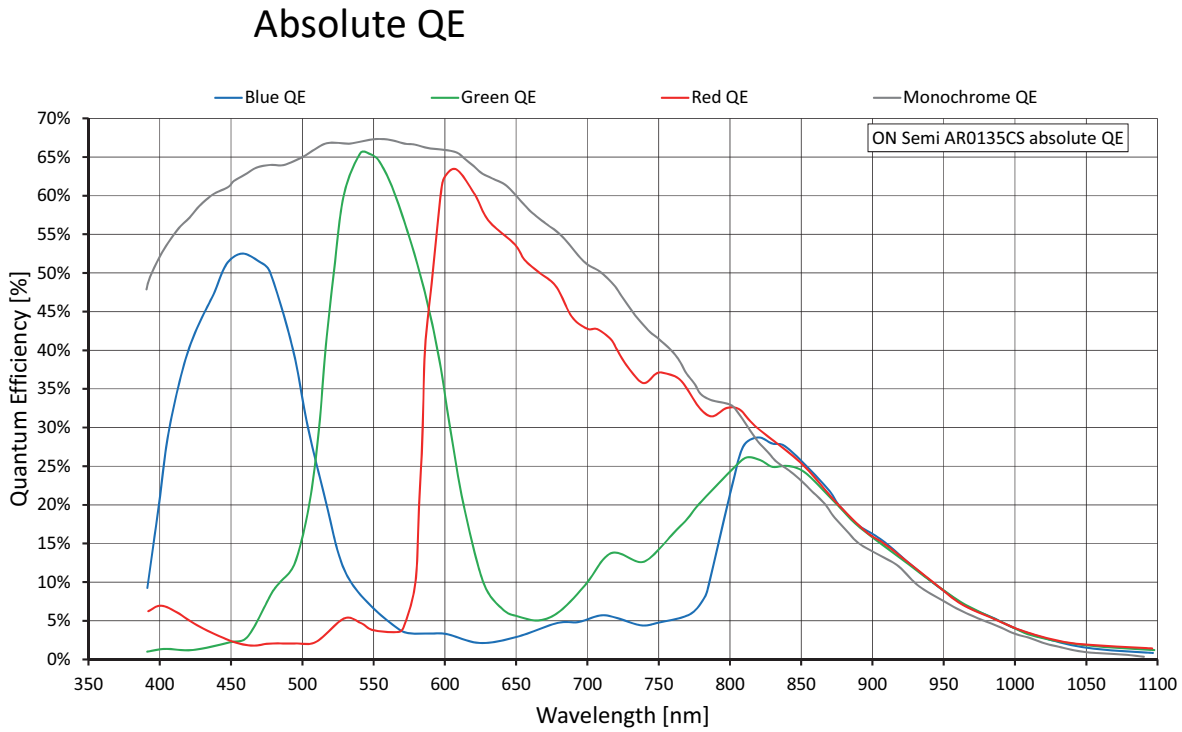


Figure 7: Alvium 1500 C-120m/c (ON Semi AR0135CS) absolute QE

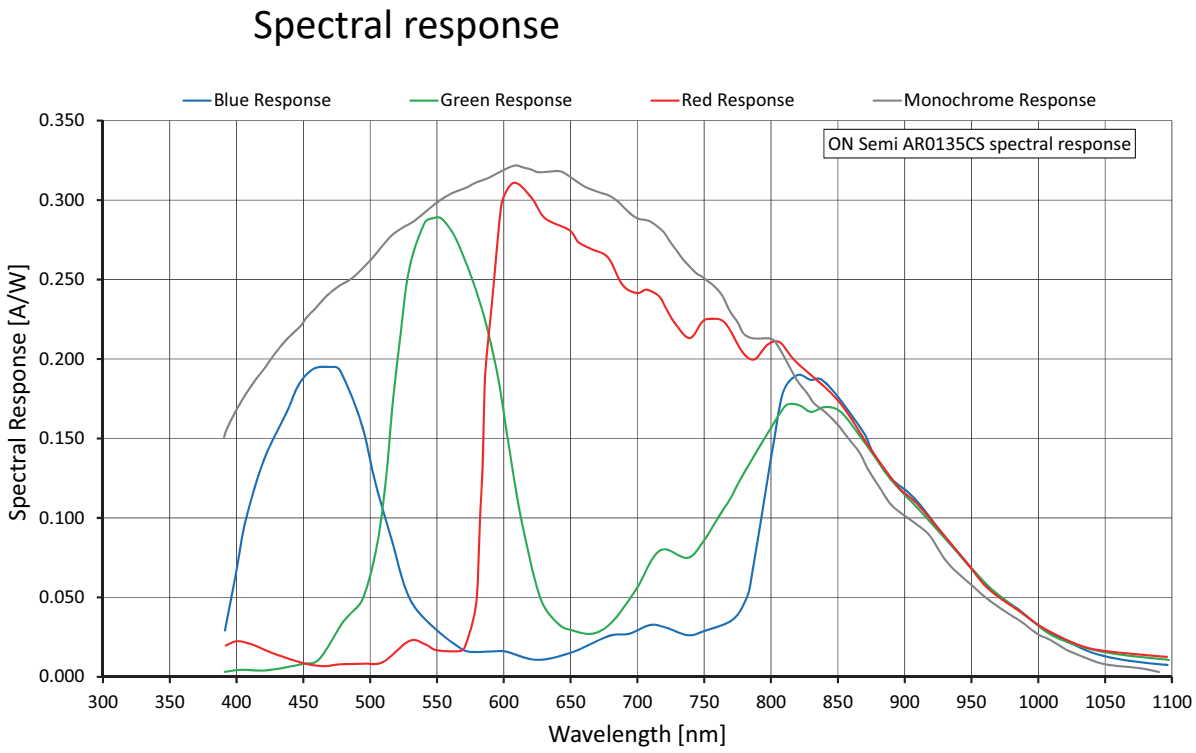


Figure 8: Alvium 1500 C-120m/c (ON Semi AR0135CS) spectral response

Frame rates with Cropping

Values were calculated for **typical operation** defined in Frame rates with Cropping/ROI frame rates on page 48.

Frame rates at maximum bandwidth calculates for 1.125 Gbps per lane. To reach the maximum frame rate available for typical operation, the bandwidth for image traffic is at 1 lane with 1.125 Gbps. Increasing the `CSI-2 Lane Count` value does not increase frame rates.

Image format	Width [pixels]	Height [pixels]	ROI area [pixels]	Frame rate [fps]		
				1-lane	2-lane	4-lane
				1.125 Gbps	2.25 Gbps	4.5 Gbps
Full resolution	1,280	960	1,228,800	52		
HD 720	1,280	720	921,600	69		
XGA	1,024	768	786,432	65		
SVGA	800	600	480,000	81		
VGA	640	480	307,200	100		
QVGA	320	240	76,800	160		
QQVGA	160	120	19,200	160		
Maximum × half	1,280	480	614,400	100		
Maximum × minimum	1,280	16	20,480	160		
Minimum × maximum	16	960	15,360	52		
Minimum × minimum	16	16	256	160		

Table 21: Alvium 1500 C-120m/c ROI frame rates at maximum bandwidth

Alvium 1500 C-210m/c

Feature	Specification	
	1500 C-210m (monochrome)	**1500 C-210c (color)**
Sensor model	ON Semiconductor AR0521SR	
Resolution	1928 (H) × 1088 (V); 2.1 MP	
Sensor type	CMOS	
Shutter type	Rolling shutter (RS)	
Sensor size	Type 1/3.6; 4.2 mm × 2.4 mm; 4.9 mm diagonal	
Pixel size	2.2 µm × 2.2 µm	
CRA	9 deg	
ADC	10-bit	
YUV color pixel formats	Not applicable	YUV422 8-bit (UYVY)
RGB color pixel formats	Default: RGB888 (RGB3)	
RAW pixel formats	RAW8 (GREY), RAW10 (Y10)	
Maximum image bit depth	10-bit	
Maximum frame rate	119 fps[1], using 2 to 4 lanes	
Exposure time	8 µs to 0.48 s, using 2 lanes	
Image buffer (RAM)	256 KB	
Non-volatile memory (Flash)	1024 KB	
Gain	0 dB to 24 dB; 0.1 dB increments	
GPIOs	2 programmable GPIOs As direct inputs (push-pull): 0 to 5.5 VDC As direct outputs (push-pull): 0 to 3.3 VDC at 12 mA	
Power requirements	Power over MIPI CSI-2	
Power consumption (typical, at 5 VDC)	1.9 W	
[1]In triggered mode: 59 fps		

Table 22: Alvium 1500 C-210m/c specifications (sheet 1 of 2)

Feature	Specification			
	1500 C-210m/c			
Operating temperature	**Hardware option**	**Housing**	**Cooling areas[2]**	**Mainboard[3]**
	Bare board[4]	Not applicable	+5 °C to +85 °C	+5 °C to +85 °C
	Open housing[5]	+5 °C to +65 °C		
Relative humidity	0% to 80% (non-condensing)			
Digital interface	MIPI CSI-2 D-PHY V1.1; 1, 2, or 4 lanes; maximum 1.125 Gbps per lane			
Camera controls	V4L2 controls (Video4Linux Access), Direct Register Access			

[2]See Mounting the heat sink on page 143.

[3]Output by `Device Temperature`

[4]Ensure that the sensor is operated in the temperature range specified by the manufacturer. For any questions, please contact support@alliedvision.com.

[5]Temperature values must be observed for the housing **and** for the cooling areas.

Table 22: Alvium 1500 C-210m/c specifications (sheet 2 of 2)

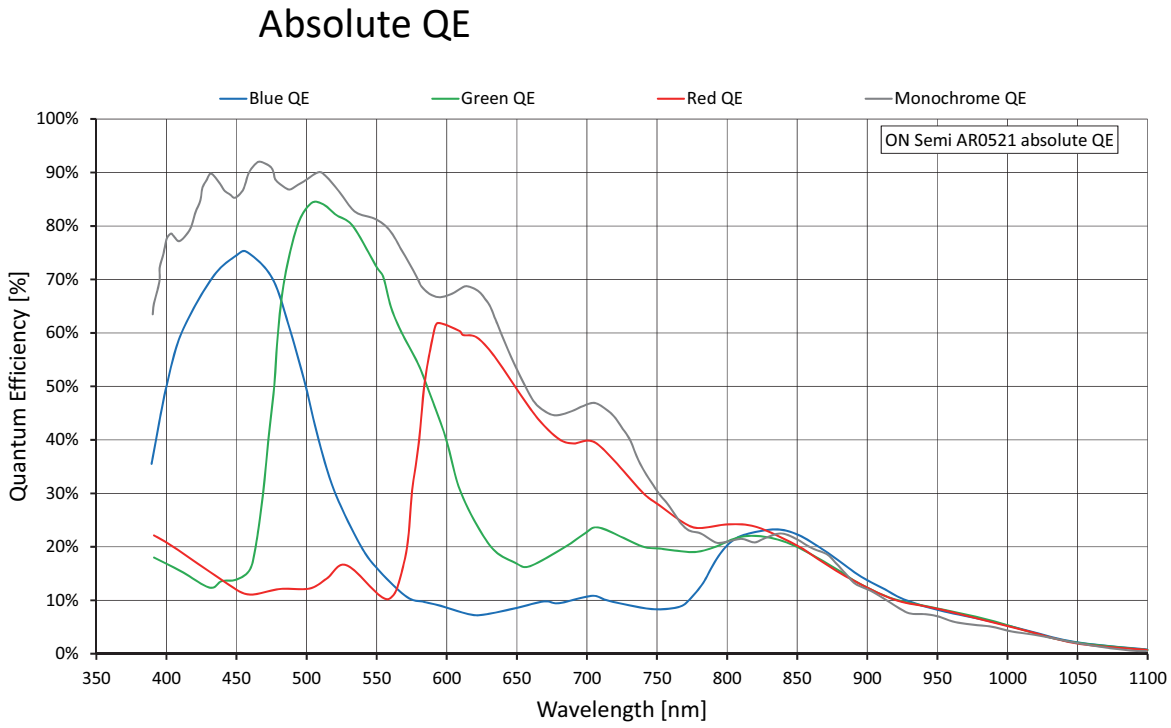


Figure 9: Alvium 1500 C-210m/c (ON Semi AR0521HD) absolute QE

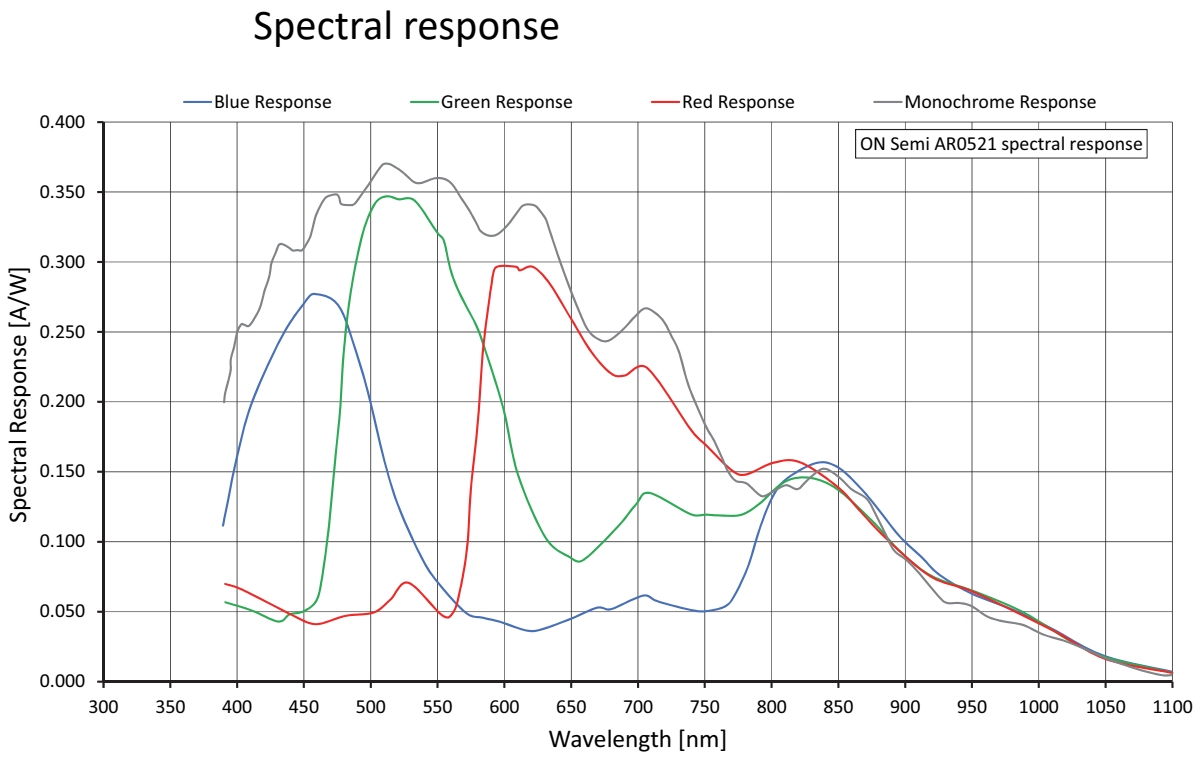


Figure 10: Alvium 1500 C-210m/c (ON Semi AR0521HD) spectral response

Frame rates with Cropping

Values were calculated for **typical operation** defined in Frame rates with Cropping/ROI frame rates on page 48.

Frame rates at maximum bandwidth calculates for 1.125 Gbps per lane. To reach the maximum frame rate available for typical operation, the bandwidth for image traffic is at 2 lanes with 2.25 Gbps. Increasing the `CSI-2 Lane Count` value does not increase frame rates.

Image format	Width [pixels]	Height [pixels]	ROI area [pixels]	Frame rate [fps]		
				1-lane	2-lane	4-lane
				1.125 Gbps	2.25 Gbps	4.5 Gbps
Full resolution	1,928	1,088	2,097,664	64	119	
WXGA+ [1]	1,440	900 [1]	1,296,000	103	143	
SXGA	1,280	1,024	1,310,720	102	127	
HD 720	1,280	720	921,600	143	177	
XGA	1,024	768	786,432	167		
SVGA	800	600	480,000	212		
VGA	640	480	307,200	261		
QVGA	320	240	76,800	488		
QQVGA	160	120	19,200	856		
Maximum × half	1,928	544	1,048,832	124	229	
Maximum × minimum	1,928	16	30,848	1,216	2,062	
Minimum × maximum	16	1,088	17,408	120		
Minimum × minimum	16	16	256	2,474		

[1] 1,440 × 904
Due to increments, some resolutions are not available. In this case, frame rates were calculated for the next available resolution.

Table 23: Alvium 1500 C-210m/c ROI frame rates at maximum bandwidth

Values in triggered mode

When rolling shutter cameras are operated in triggered mode, the values for maximum frame rate reached in free run mode are cut in half.

Alvium 1500 C-500m/c

Feature	Specification	
	1500 C-500m (monochrome)	**1500 C-500c (color)**
Sensor model	ON Semiconductor AR0521SR	
Resolution	2592 (H) × 1944 (V); 5.0 MP	
Sensor type	CMOS	
Shutter type	Rolling shutter (RS)	
Sensor size	Type 1/2.5; 5.7 mm × 4.3 mm; 7.1 mm diagonal	
Pixel size	2.2 µm × 2.2 µm	
CRA	9 deg	
ADC	10-bit	
YUV color pixel formats	Not applicable	YUV422 8-bit (UYVY)
RGB color pixel formats	Default: RGB888 (RGB3)	
RAW pixel formats	RAW8 (GREY), RAW10 (Y10)	
Maximum image bit depth	10-bit	
Maximum frame rate	68 fps[1], using 4 lanes	
Exposure time	8 µs to 0.48 s, using 4 lanes	
Image buffer (RAM)	256 KB	
Non-volatile memory (Flash)	1024 KB	
Gain	0 dB to 24 dB; 0.1 dB increments	
GPIOs	2 programmable GPIOs As direct inputs (push-pull): 0 to 5.5 VDC As direct outputs (push-pull): 0 to 3.3 VDC at 12 mA	
Power requirements	Power over MIPI CSI-2	
Power consumption (typical, at 5 VDC)	1.9 W	
[1]In triggered mode: 34 fps		

Table 24: Alvium 1500 C-500m/c specifications (sheet 1 of 2)

Feature	Specification			
	1500 C-500m/c			
Operating temperature	**Hardware option**	**Housing**	**Cooling areas[2]**	**Mainboard[3]**
	Bare board[4]	Not applicable	+5 °C to +85 °C	+5 °C to +85 °C
	Open housing[5]	+5 °C to +65 °C		
Relative humidity	0% to 80% (non-condensing)			
Digital interface	MIPI CSI-2 D-PHY V1.1; 1, 2, or 4 lanes; maximum 1.125 Gbps per lane			
Camera controls	V4L2 controls (Video4Linux Access), Direct Register Access			

[2]See Mounting the heat sink on page 143.

[3]Output by `Device Temperature`

[4]Ensure that the sensor is operated in the temperature range specified by the manufacturer. For any questions, please contact support@alliedvision.com.

[5]Temperature values must be observed for the housing **and** for the cooling areas.

Table 24: Alvium 1500 C-500m/c specifications (sheet 2 of 2)

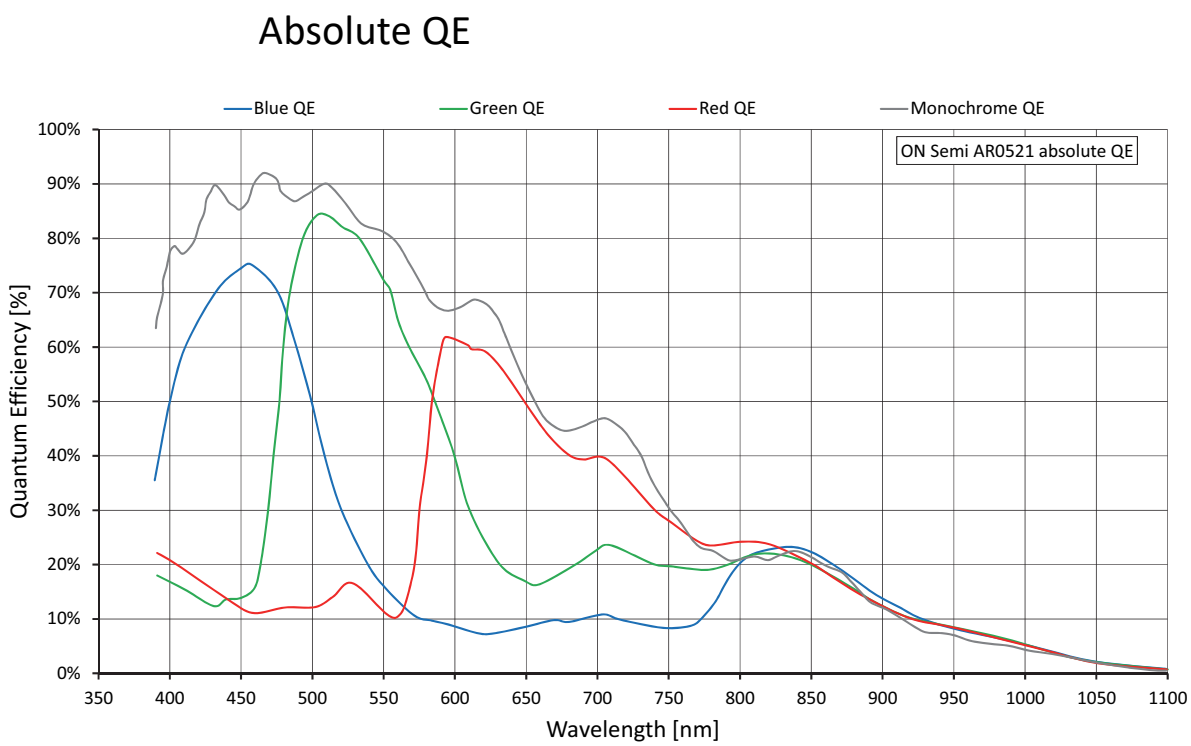


Figure 11: Alvium 1500 C-500m/c (ON Semi AR0521SR) absolute QE

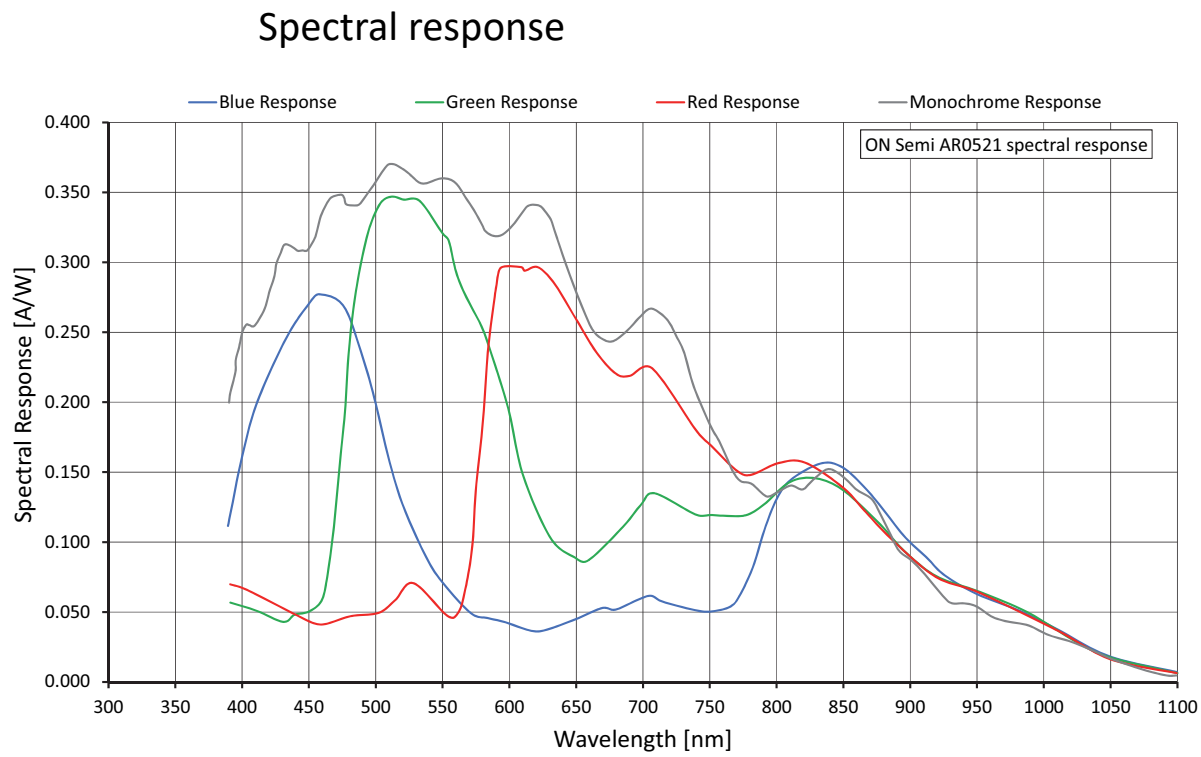


Figure 12: Alvium 1500 C-500m/c (ON Semi AR0521SR) spectral response

Frame rates with Cropping

Values were calculated for **typical operation** defined in Frame rates with Cropping/ROI frame rates on page 48.

Frame rates at maximum bandwidth calculates for 1.125 Gbps per lane. To reach the maximum frame rate available for typical operation, the bandwidth for image traffic is at 4 lanes with 4.5 Gbps.

Image format	Width [pixels]	Height [pixels]	ROI area [pixels]	Frame rate [fps]		
				1-lane	2-lane	4-lane
				1.125 Gbps	2.25 Gbps	4.5 Gbps
Full resolution	2,592	1,944	5,038,848	27	54	68
QXGA	2,048	1,536	3,145,728	43	85	
Full HD	1,920	1,080	2,073,600	65	120	
UXGA	1,600	1,200	1,920,000	70	109	
WXGA+ [1]	1,440	900 [1]	1,296,000	103	143	
SXGA	1,280	1,024	1,310,720	102	127	
HD 720	1,280	720	921,600	143	177	
XGA	1,024	768	786,432	167		
SVGA	800	600	480,000	212		
VGA	640	480	307,200	261		
QVGA	320	240	76,800	488		
QQVGA	160	120	19,200	856		
Maximum × half [2]	2,592	972 [2]	2,519,424	53	105	132
Maximum × minimum	2,592	16	41,472	904	1,618	1,917
Minimum × maximum	16	1,944	31,104	68		
Minimum × minimum	16	16	256	2,474		

[1] 1,440 × 904

[2] 2,592 × 976
Due to increments, some resolutions are not available. In this case, frame rates were calculated for the next available resolution.

Table 25: Alvium 1500 C-500m/c ROI frame rates at maximum bandwidth

Values in triggered mode

When rolling shutter cameras are operated in triggered mode, the values for maximum frame rate reached in free run mode are cut in half.

Alvium 1800 C model specifications

Alvium 1800 C-040m/c

Feature	Specification	
	1800 C-040m (monochrome)	**1800 C-040c (color)**
Sensor model	Sony IMX287	
Resolution	728 (H) × 544 (V); 0.4 MP	
Sensor type	CMOS	
Shutter type	Global shutter (GS)	
Sensor size	Type 1/2.9; 5 mm × 3.8 mm; 6.3 mm diagonal	
Pixel size	6.9 µm × 6.9 µm	
CRA	0 deg	
ADC	12-bit	
YUV color pixel formats	Not applicable	YUV422 8-bit (UYVY)
RGB color pixel formats	Default: RGB888 (RGB3)	
RAW pixel formats	RAW8 (GREY), RAW10 (Y10), RAW12 (Y12)	
Maximum image bit depth	12-bit	
Maximum frame rate	289 fps, using 1 to 4 lanes	
Exposure time	177 µs to 10 s, using 1 lane	
Image buffer (RAM)	256 KB	
Non-volatile memory (Flash)	1024 KB	
Gain	0 dB to 24 dB; 0.1 dB increments	
GPIOs	2 programmable GPIOs As direct inputs (push-pull): 0 to 5.5 VDC As direct outputs (push-pull): 0 to 3.3 VDC at 12 mA	
Power requirements	Power over MIPI CSI-2	
Power consumption (typical, at 5 VDC)	1.7 W	

Table 26: Alvium 1800 C-040m/c specifications (sheet 1 of 2)

Feature	Specification			
	1800 C-040m/c			
Operating temperature	**Hardware option**	**Housing**	**Cooling areas[1]**	**Mainboard[2]**
	Bare board[3]	Not applicable	+5 °C to +85 °C	+5 °C to +85 °C
	Open housing[4]	+5 °C to +65 °C		
Relative humidity	0% to 80% (non-condensing)			
Digital interface	MIPI CSI-2 D-PHY V1.1; 1, 2, or 4 lanes; maximum 1.125 Gbps per lane			
Camera controls	V4L2 controls (Video4Linux Access), Direct Register Access			

[1]See Mounting the heat sink on page 143.

[2]Output by `Device Temperature`

[3]Ensure that the sensor is operated in the temperature range specified by the manufacturer. For any questions, please contact support@alliedvision.com.

[4]Temperature values must be observed for the housing **and** for the cooling areas.

Table 26: Alvium 1800 C-040m/c specifications (sheet 2 of 2)

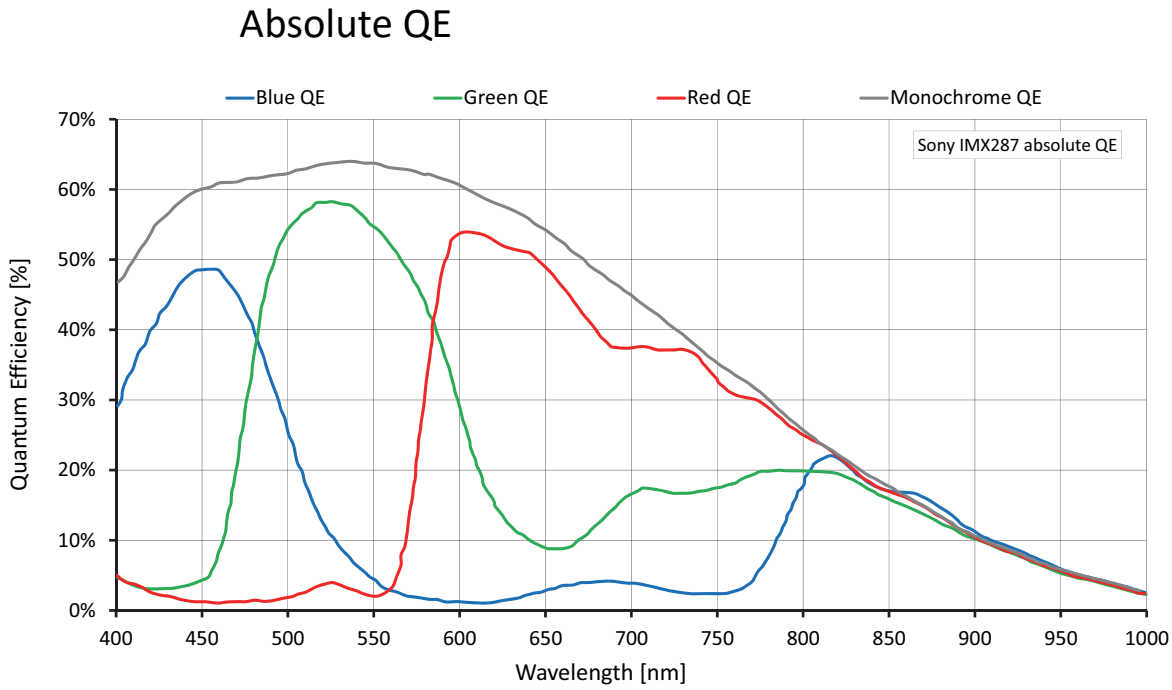


Figure 13: Alvium 1800 C-040m/c (Sony IMX287) absolute QE

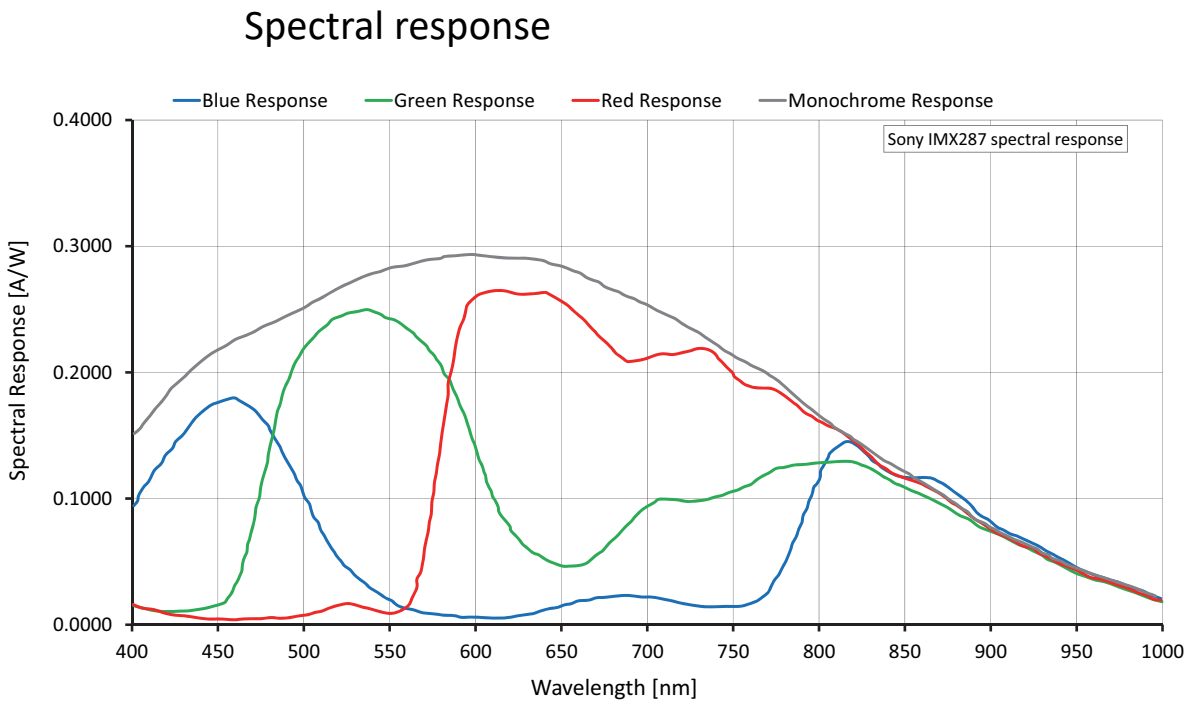


Figure 14: Alvium 1800 C-040m/c (Sony IMX287) spectral response

Frame rates with Cropping

Values were calculated for **typical operation** defined in Frame rates with Cropping/ROI frame rates on page 48.

Frame rates at maximum bandwidth calculates for 1.125 Gbps per lane. To reach the maximum frame rate available for typical operation, the bandwidth for image traffic is below 1.125 Gbps. Increasing the `CSI-2 Lane Count` value does not increase frame rates.

Image format	Width [pixels]	Height [pixels]	ROI area [pixels]	Frame rate [fps]		
				1-lane	2-lane	4-lane
				1.125 Gbps	2.25 Gbps	4.5 Gbps
Full resolution	728	544	396,032	289		
VGA	640	480	307,200	322		
HVGA	480	320	153,600	450		
QVGA	320	240	76,800	564		
HQVGA	240	160	38,400		750	
QQVGA	160	120	19,200		896	
Maximum × half	728	272	198,016	503		
Maximum × minimum	728	16	11,648	1,663		
Minimum × maximum	16	544	8,704	293		
Minimum × minimum	16	16	256	1,810		

Table 27: Alvium 1800 C-040m/c ROI frame rates at maximum bandwidth

Alvium 1800 C-158m/c

Feature	Specification	
	1800 C-158m (monochrome)	**1800 C-158c (color)**
Sensor model	Sony IMX273	
Resolution	1456 (H) × 1088 (V); 1.6 MP	
Sensor type	CMOS	
Shutter type	Global shutter (GS)	
Sensor size	Type 1/2.9; 5 mm × 3.8 mm; 6.3 mm diagonal	
Pixel size	3.45 µm × 3.45 µm	
CRA	0 deg	
ADC	12-bit	
YUV color pixel formats	Not applicable	YUV422 8-bit (UYVY)
RGB color pixel formats	Default: RGB888 (RGB3)	
RAW pixel formats	RAW8 (GREY), RAW10 (Y10), RAW12 (Y12)	
Maximum image bit depth	12-bit	
Maximum frame rate	153 fps, using 2 to 4 lanes	
Exposure time	177 µs to 10 s, using 2 lanes	
Image buffer (RAM)	256 KB	
Non-volatile memory (Flash)	1024 KB	
Gain	0 dB to 24 dB; 0.1 dB increments	
GPIOs	2 programmable GPIOs As direct inputs (push-pull): 0 to 5.5 VDC As direct outputs (push-pull): 0 to 3.3 VDC at 12 mA	
Power requirements	Power over MIPI CSI-2	
Power consumption (typical, at 5 VDC)	2.4 W	

Table 28: Alvium 1800 C-158m/c specifications (sheet 1 of 2)

Feature	Specification			
	1800 C-158m/c			
Operating temperature	**Hardware option**	**Housing**	**Cooling areas[1]**	**Mainboard[2]**
	Bare board[3]	Not applicable	+5 °C to +85 °C	+5 °C to +85 °C
	Open housing[4]	+5 °C to +65 °C		
Relative humidity	0% to 80% (non-condensing)			
Digital interface	MIPI CSI-2 D-PHY V1.1; 1, 2, or 4 lanes; maximum 1.125 Gbps per lane			
Camera controls	V4L2 controls (Video4Linux Access), Direct Register Access			

[1]See Mounting the heat sink on page 143.

[2]Output by `Device Temperature`

[3]Ensure that the sensor is operated in the temperature range specified by the manufacturer. For any questions, please contact support@alliedvision.com.

[4]Temperature values must be observed for the housing **and** for the cooling areas.

Table 28: Alvium 1800 C-158m/c specifications (sheet 2 of 2)

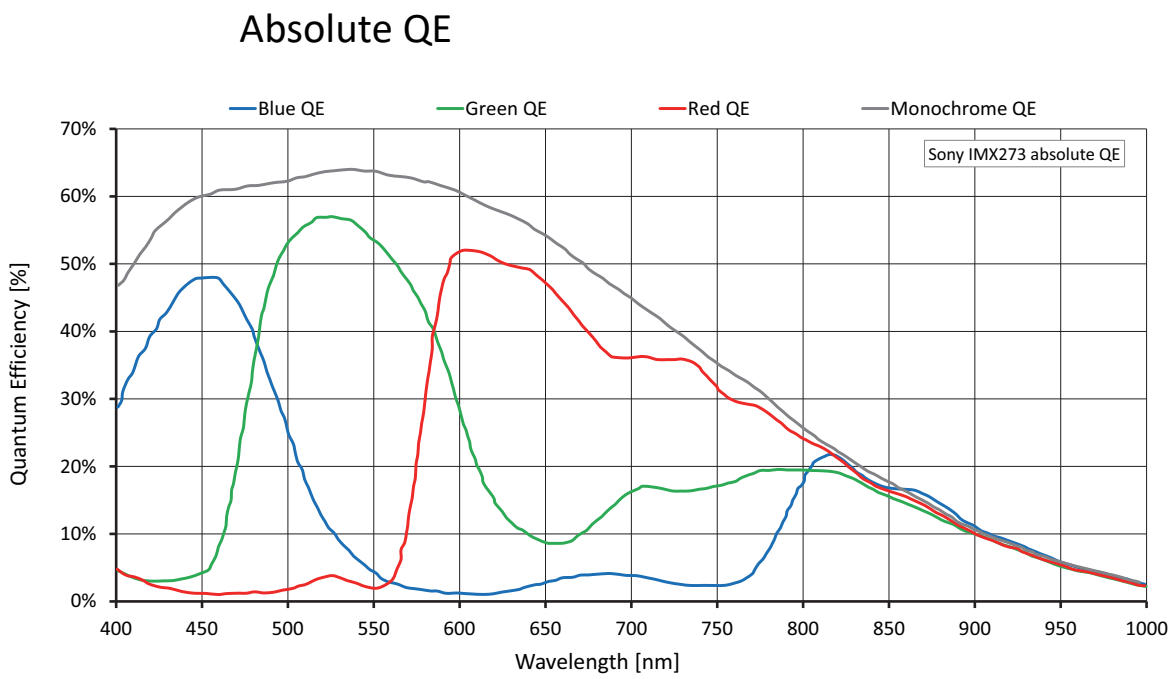


Figure 15: Alvium 1800 C-158m/c (Sony IMX273) absolute QE

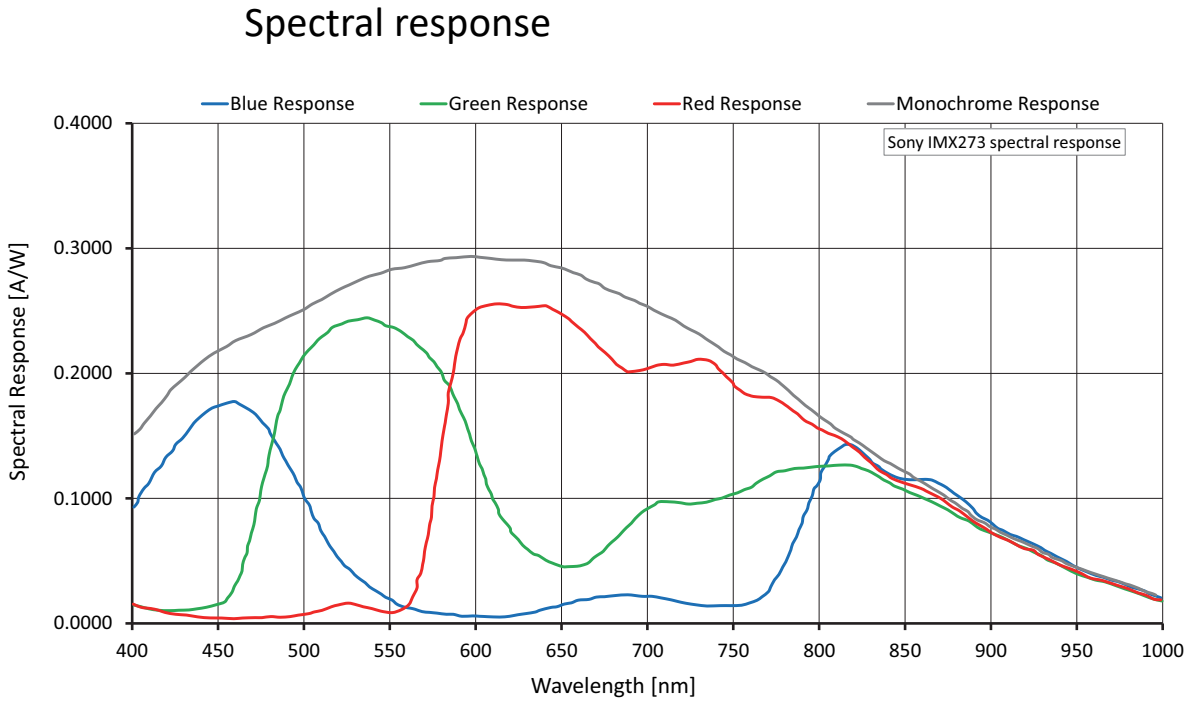


Figure 16: Alvium 1800 C-158m/c (Sony IMX273) spectral response

Frame rates with Cropping

Values were calculated for **typical operation** defined in Frame rates with Cropping/ROI frame rates on page 48.

Frame rates at maximum bandwidth calculates for 1.125 Gbps per lane. To reach the maximum frame rate available for typical operation, the bandwidth for image traffic is at 2 lanes with 2.25 Gbps. Increasing the `CSI-2 Lane Count` value does not increase frame rates.

Image format	Width [pixels]	Height [pixels]	ROI area [pixels]	Frame rate [fps]		
				1-lane	2-lane	4-lane
				1.125 Gbps	2.25 Gbps	4.5 Gbps
Full resolution	1,456	1,088	1,584,128	81	153	
WXGA+ [1]	1,440	900 [1]	1,296,000	98	181	
SXGA	1,280	1,024	1,310,720	98	163	
HD 720	1,280	720	921.600	136	222	
XGA	1,024	768	786,432	158	211	
SVGA	800	600	480,000	250	264	
VGA	640	480	307,200	321	321	
QVGA	320	240	76,800	564	564	
QQVGA	160	120	19,200	896		
Maximum × half	1,456	544	792,064	153	281	
Maximum × minimum	1,456	16	23,296	978	1,431	
Minimum × maximum	16	1,088	17,408	157		
Minimum × minimum	16	16	256	1,810		

[1] 1440 × 904
Due to increments, some resolutions are not available. In this case, frame rates were calculated for the next available resolution.

Table 29: Alvium 1800 C-158m/c ROI frame rates at maximum bandwidth

Alvium 1800 C-240m/c

Feature	Specification	
	1800 C-240m (monochrome)	**1800 C-240c (color)**
Sensor model	Sony IMX392	
Resolution	1936 (H) x 1216 (V); 2.4 MP	
Sensor type	CMOS	
Shutter type	Global shutter (GS)	
Sensor size	Type 1/2.3; 6.7 mm × 4.2 mm; 7.9 mm diagonal	
Pixel size	3.45 µm × 3.45 µm	
CRA	0 deg	
ADC	12-bit	
YUV color pixel formats	Not applicable	YUV422 8-bit (UYVY)
RGB color pixel formats	Default: RGB888 (RGB3)	
RAW pixel formats	RAW8 (GREY), RAW10 (Y10), RAW12 (Y12)	
Maximum image bit depth	12-bit	
Maximum frame rate	126 fps, using 4 lanes	
Exposure time	176 µs to 10 s, using 4 lanes	
Image buffer (RAM)	256 KB	
Non-volatile memory (Flash)	1024 KB	
Gain	0 dB to 24 dB; 0.1 dB increments	
GPIOs	2 programmable GPIOs As direct inputs (push-pull): 0 to 5.5 VDC As direct outputs (push-pull): 0 to 3.3 VDC at 12 mA	
Power requirements	Power over MIPI CSI-2	
Power consumption (typical, at 5 VDC)	2.7 W	

Table 30: Alvium 1800 C-240m/c specifications (sheet 1 of 2)

Feature	Specification			
	1800 C-240m/c			
Operating temperature	**Hardware option**	**Housing**	**Cooling areas[1]**	**Mainboard[2]**
	Bare board[3]	Not applicable	+5 °C to +85 °C	+5 °C to +85 °C
	Open housing[4]	+5 °C to +65 °C		
Relative humidity	0% to 80% (non-condensing)			
Digital interface	MIPI CSI-2 D-PHY V1.1; 1, 2, or 4 lanes; maximum 1.125 Gbps per lane			
Camera controls	V4L2 controls (Video4Linux Access), Direct Register Access			

[1]See Mounting the heat sink on page 143.

[2]Output by `Device Temperature`

[3]Ensure that the sensor is operated in the temperature range specified by the manufacturer. For any questions, please contact support@alliedvision.com.

[4]Temperature values must be observed for the housing **and** for the cooling areas.

Table 30: Alvium 1800 C-240m/c specifications (sheet 2 of 2)

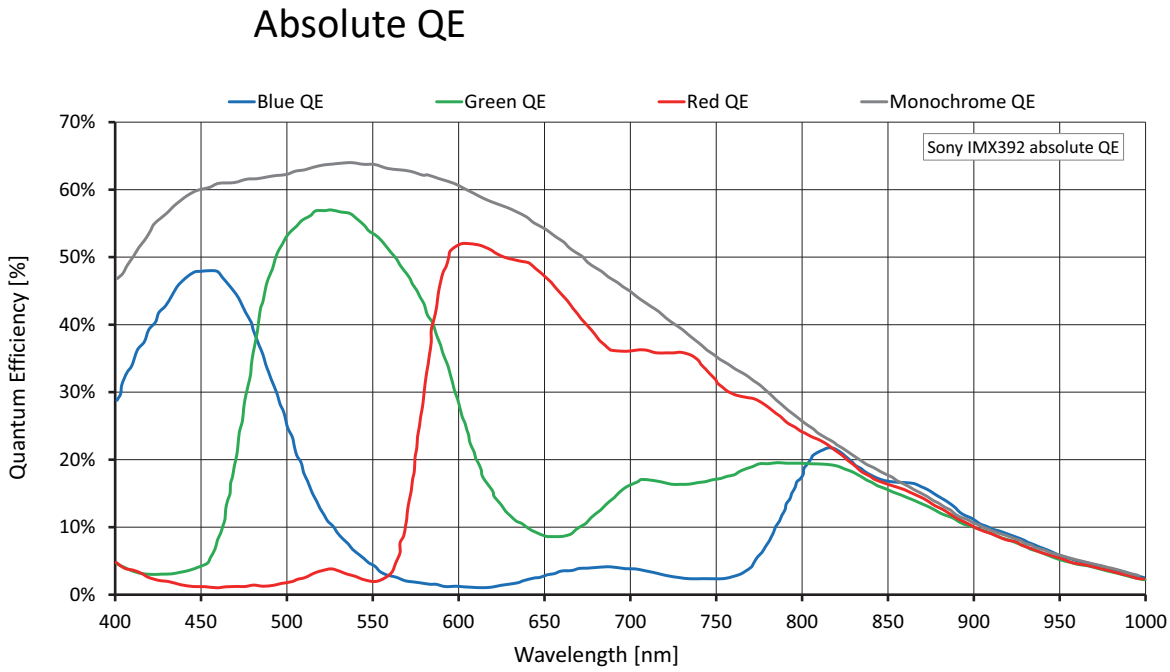


Figure 17: Alvium 1800 C-240m/c (Sony IMX392) absolute QE

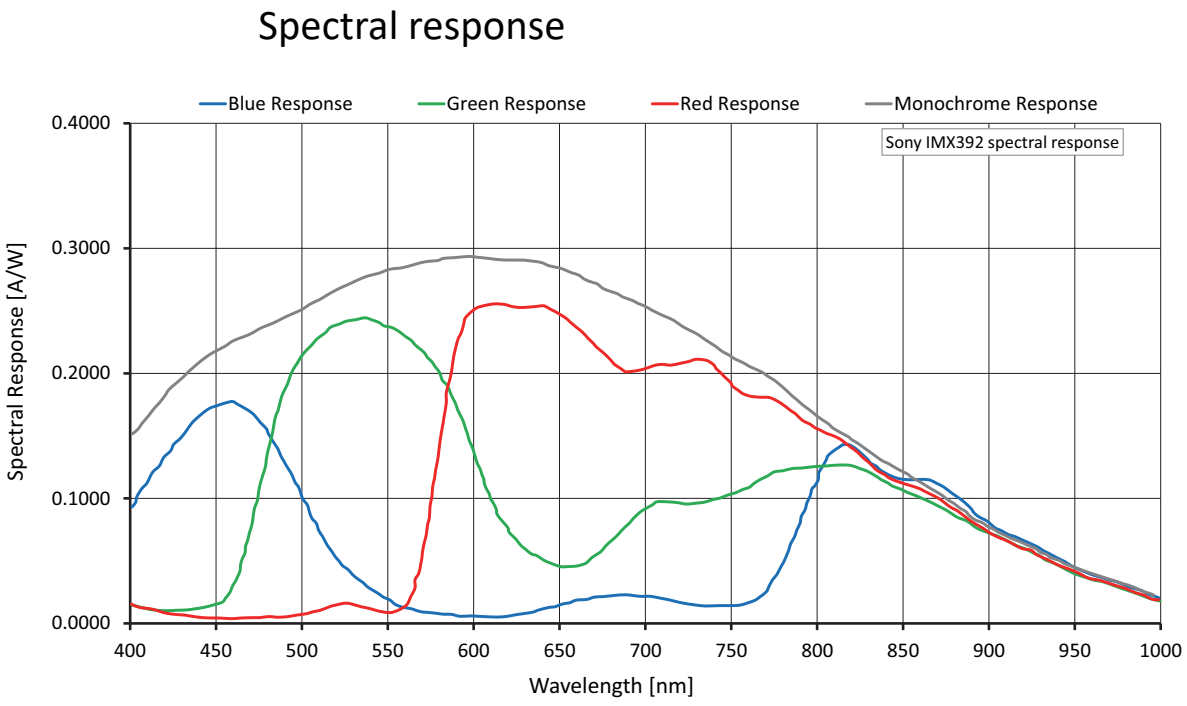


Figure 18: Alvium 1800 C-240m/c (Sony IMX392) spectral response

Frame rates with Cropping

Values were calculated for **typical operation** defined in Frame rates with Cropping/ROI frame rates on page 48.

Frame rates at maximum bandwidth calculates for 1.125 Gbps per lane. To reach the maximum frame rate available for typical operation, the bandwidth for image traffic is at 4 lanes with 4.5 Gbps. Increasing the `CSI-2 Lane Count` value does not increase frame rates.

Image format	Width [pixels]	Height [pixels]	ROI area [pixels]	Frame rate [fps]		
				1-lane	2-lane	4-lane
				1.125 Gbps	2.25 Gbps	4.5 Gbps
Full resolution	1,936	1,216	2,354,176	56	109	126
Full HD	1,920	1,080	2,073,600	63	123	140
UXGA	1,600	1,200	1,920,000	68	128	
WXGA+ [1]	1,440	900 [1]	1,296,000	99	166	
SXGA	1,280	1,024	1,310,720	99	149	
HD 720	1,280	720	921,600	137	204	
XGA	1,024	768	786,432	160	194	
SVGA	800	600	480,000	243	243	
VGA	640	480	307,200	297		
QVGA	320	240	76,800	529		
QQVGA	160	120	19,200	862		
Maximum × half	1,936	608	1,177,088	106	203	233
Maximum × minimum	1,936	16	30,976	841	1,251	1,337
Minimum × maximum	16	1,216	19,456	129		
Minimum × minimum	16	16	256	1,858		

[1] 1,440 × 904
Due to increments, some resolutions are not available. In this case, frame rates were calculated for the next available resolution.

Table 31: Alvium 1800 C-240m/c ROI frame rates at maximum bandwidth

Alvium 1800 C-319m/c

Feature	Specification	
	1800 C-319m (monochrome)	**1800 C-319c (color)**
Sensor model	Sony IMX265	
Resolution	2064 (H) × 1544 (V); 3.2 MP	
Sensor type	CMOS	
Shutter type	Global shutter (GS)	
Sensor size	Type 1/1.8; 7.1 mm × 5.3 mm; 8.9 mm diagonal	
Pixel size	3.45 µm × 3.45 µm	
CRA	0 deg	
ADC	12-bit	
YUV color pixel formats	Not applicable	YUV422 8-bit (UYVY)
RGB color pixel formats	Default: RGB888 (RGB3)	
RAW pixel formats	RAW8 (GREY), RAW10 (Y10), RAW12 (Y12)	
Maximum image bit depth	12-bit	
Maximum frame rate	53 fps, using 2 to 4 lanes	
Exposure time	175 µs to 10 s, using 2 lanes	
Image buffer (RAM)	256 KB	
Non-volatile memory (Flash)	1024 KB	
Gain	0 dB to 24 dB; 0.1 dB increments	
GPIOs	2 programmable GPIOs As direct inputs (push-pull): 0 to 5.5 VDC As direct outputs (push-pull): 0 to 3.3 VDC at 12 mA	
Power requirements	Power over MIPI CSI-2	
Power consumption (typical, at 5 VDC)	1.9 W	

Table 32: Alvium 1800 C-319m/c specifications (sheet 1 of 2)

Feature	Specification			
	1800 C-319m/c			
Operating temperature	**Hardware option**	**Housing**	**Cooling areas[1]**	**Mainboard[2]**
	Bare board[3]	Not applicable	+5 °C to +85 °C	+5 °C to +85 °C
	Open housing[4]	+5 °C to +65 °C		
Relative humidity	0% to 80% (non-condensing)			
Digital interface	MIPI CSI-2 D-PHY V1.1; 1, 2, or 4 lanes; maximum 1.125 Gbps per lane			
Camera controls	V4L2 controls (Video4Linux Access), Direct Register Access			

[1]See Mounting the heat sink on page 143.

[2]Output by `Device Temperature`

[3]Ensure that the sensor is operated in the temperature range specified by the manufacturer. For any questions, please contact support@alliedvision.com.

[4]Temperature values must be observed for the housing **and** for the cooling areas.

Table 32: Alvium 1800 C-319m/c specifications (sheet 2 of 2)

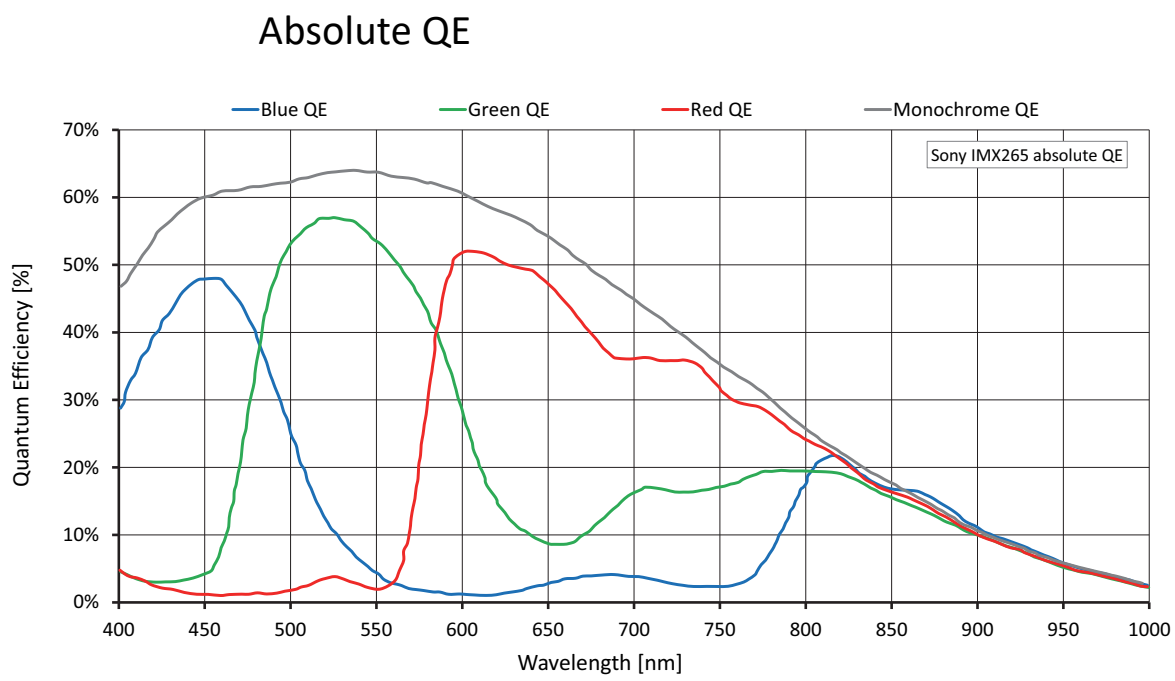


Figure 19: Alvium 1800 C-319m/c (Sony IMX265) absolute QE

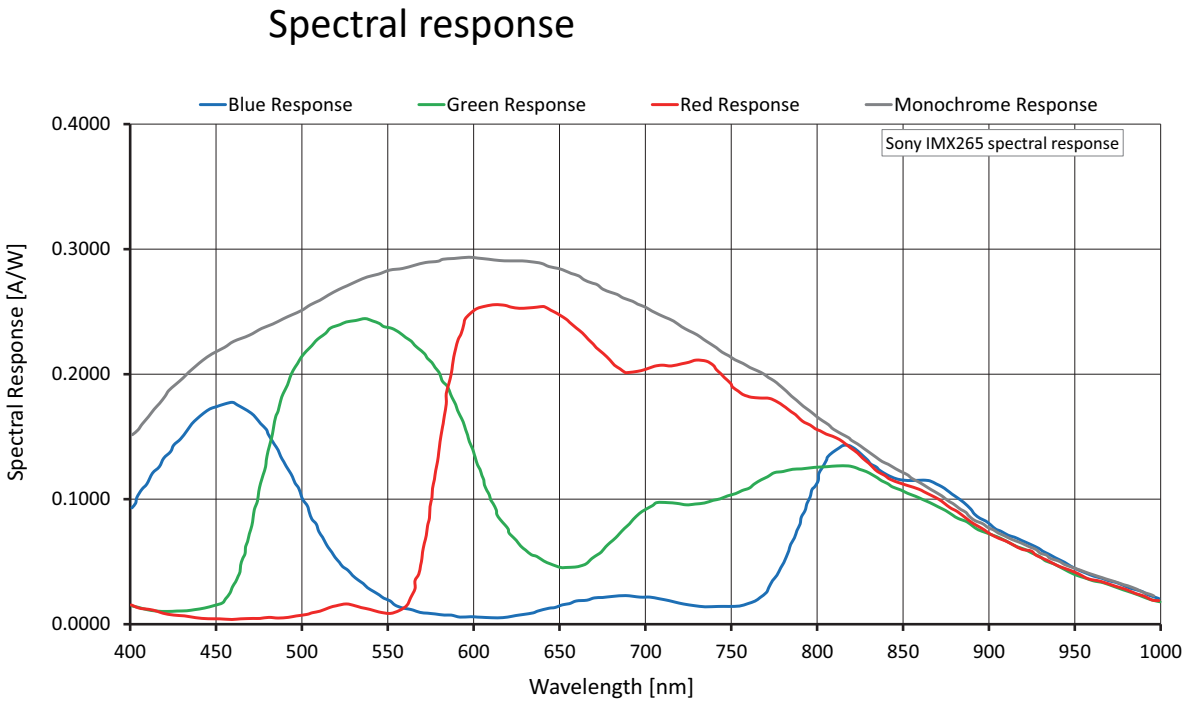


Figure 20: Alvium 1800 C-319m/c (Sony IMX265) spectral response

Frame rates with Cropping

Values were calculated for **typical operation** defined in Frame rates with Cropping/ROI frame rates on page 48.

Frame rates at maximum bandwidth calculates for 1.125 Gbps per lane. To reach the maximum frame rate available for typical operation, the bandwidth for image traffic is at 2 lanes with 2.25 Gbps.

Image format	Width [pixels]	Height [pixels]	ROI area [pixels]	Frame rate [fps]		
				1-lane	2-lane	4-lane
				1.125 Gbps	2.25 Gbps	4.5 Gbps
Full resolution	2,064	1,544	3,186,816	42	53	
QXGA	2,048	1,536	3,145,728	42	54	
Full HD	1,920	1,080	2,073,600	63	75	
UXGA	1,600	1,200	1,920,000	68		
WXGA+ [1]	1,440	900 [1]	1,296,000	89		
SXGA	1,280	1,024	1,310,720	79		
HD 720	1,280	720	921,600	110		
XGA	1,024	768	786,432	104		
SVGA	800	600	480,000	131		
VGA	640	480	307,200	160		
QVGA	320	240	76,800	289		
QQVGA	160	120	19,200	484		
Maximum × half [2]	2,064	772 [2]	1,593,408	80	102	
Maximum × minimum	2,064	16	33,024	790	937	
Minimum × maximum	16	1,544	24,704	54		
Minimum × minimum	16	16	256	1,146		

[1] 1,440 × 904

[2] 2,064 × 776
Due to increments, some resolutions are not available. In this case, frame rates were calculated for the next available resolution.

Table 33: Alvium 1800 C-319m/c ROI frame rates at maximum bandwidth

Alvium 1800 C-507m/c

Feature	Specification	
	1800 C-507m (monochrome)	**1800 C-507c (color)**
Sensor model	Sony IMX264	
Resolution	2464 (H) × 2056 (V); 5.1 MP	
Sensor type	CMOS	
Shutter type	Global shutter (GS)	
Sensor size	Type 2/3; 8.5 mm × 7.1 mm; 11.1 mm diagonal	
Pixel size	3.45 µm × 3.45 µm	
CRA	0 deg	
ADC	12-bit	
YUV color pixel formats	Not applicable	YUV422 8-bit (UYVY)
RGB color pixel formats	Default: RGB888 (RGB3)	
RAW pixel formats	RAW8 (GREY), RAW10 (Y10), RAW12 (Y12)	
Maximum image bit depth	12-bit	
Maximum frame rate	34 fps, using 2 to 4 lanes	
Exposure time	176 µs to 10 s, using 2 lanes	
Image buffer (RAM)	256 KB	
Non-volatile memory (Flash)	1024 KB	
Gain	0 dB to 24 dB; 0.1 dB increments	
GPIOs	2 programmable GPIOs As direct inputs (push-pull): 0 to 5.5 VDC As direct outputs (push-pull): 0 to 3.3 VDC at 12 mA	
Power requirements	Power over MIPI CSI-2	
Power consumption (typical, at 5 VDC)	1.9 W	

Table 34: Alvium 1800 C-507m/c specifications (sheet 1 of 2)

Feature	Specification			
	1800 C-507m/c			
Operating temperature	**Hardware option**	**Housing**	**Cooling areas[1]**	**Mainboard[2]**
	Bare board[3]	Not applicable	+5 °C to +85 °C	+5 °C to +85 °C
	Open housing[4]	+5 °C to +65 °C		
Relative humidity	0% to 80% (non-condensing)			
Digital interface	MIPI CSI-2 D-PHY V1.1; 1, 2, or 4 lanes; maximum 1.125 Gbps per lane			
Camera controls	V4L2 controls (Video4Linux Access), Direct Register Access			

[1]See Mounting the heat sink on page 143.

[2]Output by `Device Temperature`

[3]Ensure that the sensor is operated in the temperature range specified by the manufacturer. For any questions, please contact support@alliedvision.com.

[4]Temperature values must be observed for the housing **and** for the cooling areas.

Table 34: Alvium 1800 C-507m/c specifications (sheet 2 of 2)

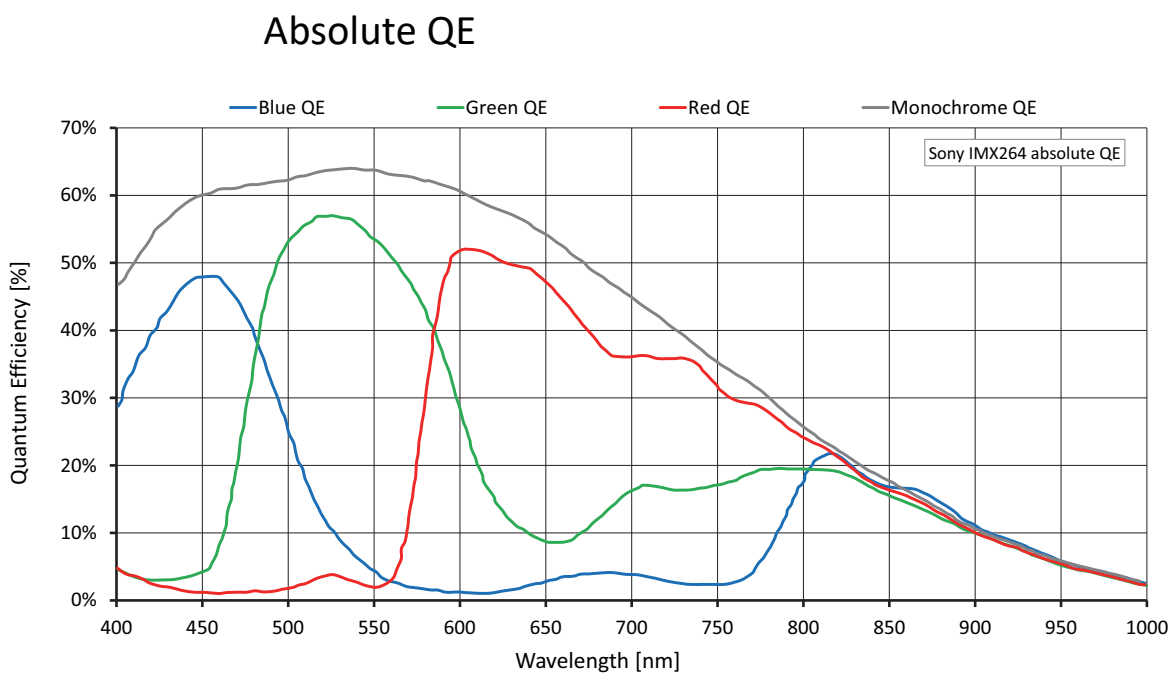


Figure 21: Alvium 1800 C-507m/c (Sony IMX264) absolute QE

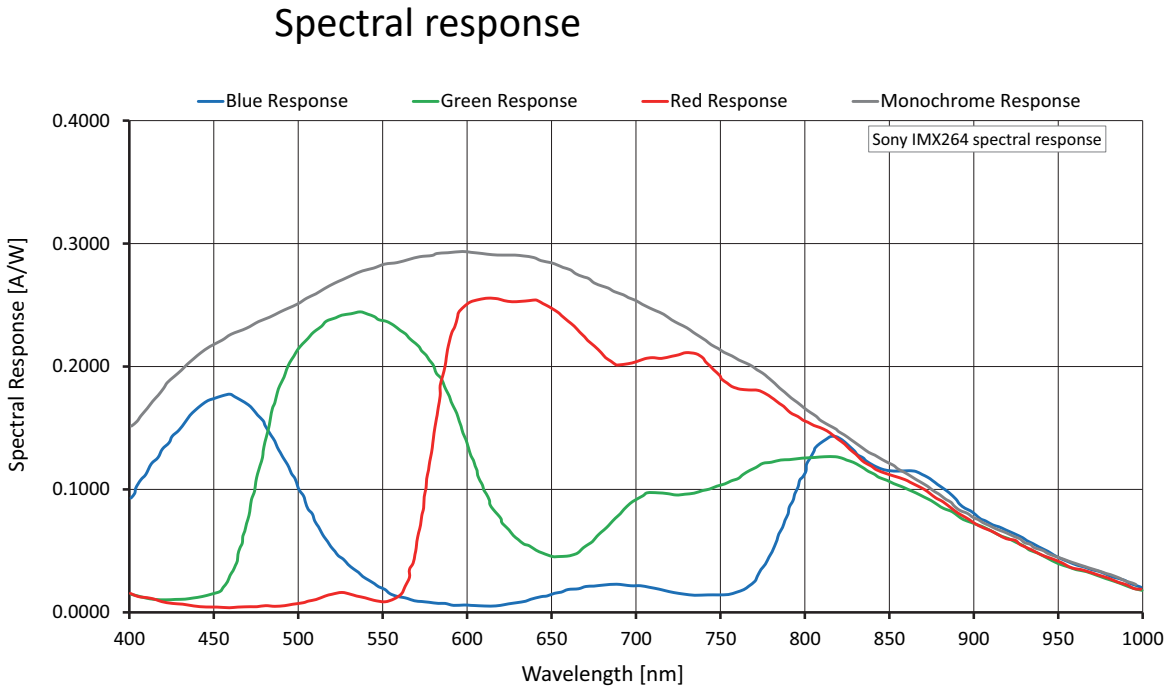


Figure 22: Alvium 1800 C-507m/c (Sony IMX264) spectral response

Frame rates with Cropping

Values were calculated for **typical operation** defined in Frame rates with Cropping/ROI frame rates on page 48.

Frame rates at maximum bandwidth calculates for 1.125 Gbps per lane. To reach the maximum frame rate available for typical operation, the bandwidth for image traffic is at 2 lanes with 2.25 Gbps.

Image format	Width [pixels]	Height [pixels]	ROI area [pixels]	Frame rate [fps]		
				1-lane	2-lane	4-lane
				1.125 Gbps	2.25 Gbps	4.5 Gbps
Full resolution	2,464	2,056	5,065,984	26	34	
QXGA	2,048	1,536	3,145,728	42	46	
Full HD	1,920	1,080	2,073,600	63	64	
UXGA	1,600	1,200	1,920,000	58		
WXGA+ [1]	1,440	900 [1]	1,296,000	76		
SXGA	1,280	1,024	1,310,720	67		
HD 720	1,280	720	921,600	94		
XGA	1,024	768	786,432	89		
SVGA	800	600	480,000	111		
VGA	640	480	307,200	136		
QVGA	320	240	76,800	248		
QQVGA	160	120	19,200	416		
Maximum × half [2]	2,464	1,028 [2]	2,532,992	51	66	
Maximum × minimum	2,464	16	39,424	678	814	
Minimum × maximum	16	2,056	32,896	35		
Minimum × minimum	16	16	256	1,001		

[1] 1,440 × 904

[2] 2,464 × 1,032
Due to increments, some resolutions are not available. In this case, frame rates were calculated for the next available resolution.

Table 35: Alvium 1800 C-507m/c ROI frame rates at maximum bandwidth

Alvium 1800 C-508m/c

Feature	Specification	
	1800 C-508m (monochrome)	**1800 C-508c (color)**
Sensor model	Sony IMX250LLR	Sony IMX250LQR
Resolution	2464 (H) x 2056 (V); 5.1 MP	
Sensor type	CMOS	
Shutter type	Global shutter (GS)	
Sensor size	Type 2/3; 8.5 mm × 7.1 mm; 11.1 mm diagonal	
Pixel size	3.45 µm × 3.45 µm	
CRA	0 deg	
ADC	12-bit	
YUV color pixel formats	Not applicable	YUV422 8-bit (UYVY)
RGB color pixel formats	Default: RGB888 (RGB3)	
RAW pixel formats	RAW8 (GREY), RAW10 (Y10), RAW12 (Y12)	
Maximum image bit depth	12-bit	
Maximum frame rate	65 fps, using 4 lanes	
Exposure time	176 µs to 10 s, using 4 lanes	
Image buffer (RAM)	256 KB	
Non-volatile memory (Flash)	1024 KB	
Gain	0 dB to 24 dB; 0.1 dB increments	
GPIOs	2 programmable GPIOs As direct inputs (push-pull): 0 to 5.5 VDC As direct outputs (push-pull): 0 to 3.3 VDC at 12 mA	
Power requirements	Power over MIPI CSI-2	
Power consumption (typical, at 5 VDC)	2.8 W	

Table 36: Alvium 1800 C-508m/c specifications (sheet 1 of 2)

Feature	Specification			
	1800 C-508m/C			
Operating temperature	**Hardware option**	**Housing**	**Cooling areas[1]**	**Mainboard[2]**
	Bare board[3]	Not applicable	+5 °C to +85 °C	+5 °C to +85 °C
	Open housing[4]	+5 °C to +65 °C		
Relative humidity	0% to 80% (non-condensing)			
Digital interface	MIPI CSI-2 D-PHY V1.1; 1, 2, or 4 lanes; maximum 1.125 Gbps per lane			
Camera controls	V4L2 controls (Video4Linux Access), Direct Register Access			

[1]See Mounting the heat sink on page 143.

[2]Output by `Device Temperature`

[3]Ensure that the sensor is operated in the temperature range specified by the manufacturer. For any questions, please contact support@alliedvision.com.

[4]Temperature values must be observed for the housing **and** for the cooling areas.

Table 36: Alvium 1800 C-508m/c specifications (sheet 2 of 2)

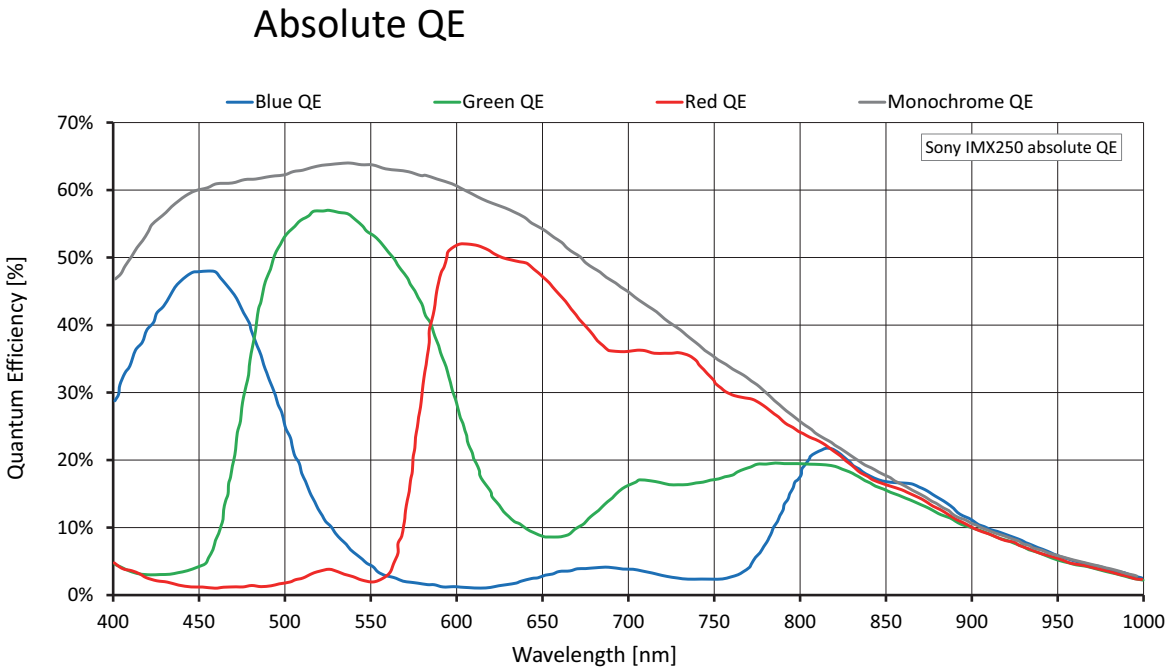


Figure 23: Alvium 1800 C-508m/c (Sony IMX250) absolute QE

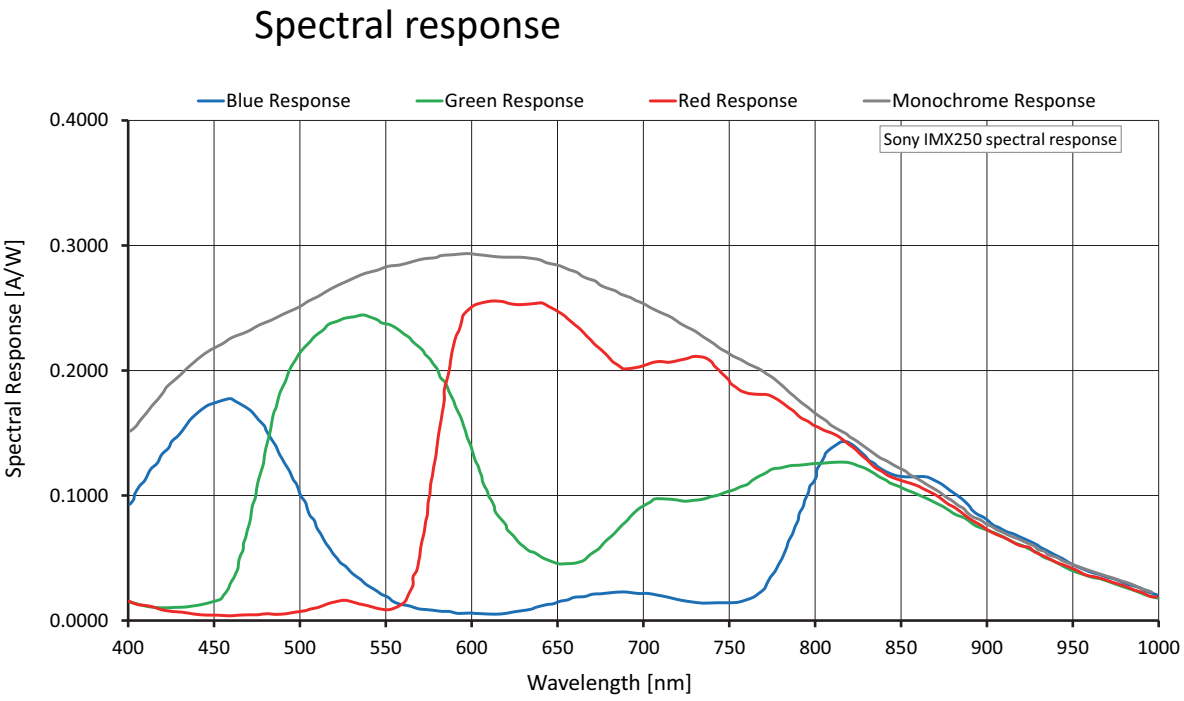


Figure 24: Alvium 1800 C-508m/c (Sony IMX250) spectral response

Frame rates with Cropping

Values were calculated for **typical operation** defined in Frame rates with Cropping/ROI frame rates on page 48.

Frame rates at maximum bandwidth calculates for 1.125 Gbps per lane. To reach the maximum frame rate available for typical operation, the bandwidth for image traffic is at 4 lanes with 4.5 Gbps.

Image format	Width [pixels]	Height [pixels]	ROI area [pixels]	Frame rate [fps]		
				1-lane	2-lane	4-lane
				1.125 Gbps	2.25 Gbps	4.5 Gbps
Full resolution	2,464	2,056	5,065,984	26	52	65
QXGA	2,048	1,536	3,145,728	42	83	86
Full HD	1,920	1,080	2,073,600	63	120	
UXGA	1,600	1,200	1,920,000	68	109	
WXGA+ [1]	1,440	900 [1]	1,296,000	99	142	
SXGA	1,280	1,024	1,310,720	99	127	
HD 720	1,280	720	921,600	136	175	
XGA	1,024	768	786,432	159	166	
SVGA	800	600	480,000	208	208	
VGA	640	480	307,200	254		
QVGA	320	240	76,800	447		
QQVGA	160	120	19,200	718		
Maximum × half [2]	2,464	1,028 [2]	2,532,992	51	100	124
Maximum × minimum	2,464	16	39,424	648	995	1,111
Minimum × maximum	16	2,056	32,896		66	
Minimum × minimum	16	16	256	1,513		

[1] 1,440 × 904

[2] 2,464 × 1,032
Due to increments, some resolutions are not available. In this case, frame rates were calculated for the next available resolution.

Table 37: Alvium 1800 C-508m/c ROI frame rates at maximum bandwidth

Alvium 1800 C-1236m/c

Feature	Specification	
	1800 C-1236m (monochrome)	**1800 C-1236c (color)**
Sensor model	Sony IMX304	
Resolution	4112 (H) × 3008 (V); 12.4 MP	
Sensor type	CMOS	
Shutter type	Global shutter (GS)	
Sensor size	Type 1.1; 14.2 mm × 10.4 mm; 17.6 mm diagonal	
Pixel size	3.45 µm × 3.45 µm	
CRA	0 deg	
ADC	12-bit	
YUV color pixel formats	Not applicable	YUV422 8-bit (UYVY)
RGB color pixel formats	Default: RGB888 (RGB3)	
RAW pixel formats	RAW8 (GREY), RAW10 (Y10), RAW12 (Y12)	
Maximum image bit depth	12-bit	
Maximum frame rate	22 fps, using 2 to 4 lanes	
Exposure time	176 µs to 10 s, using 2 lanes	
Image buffer (RAM)	256 KB	
Non-volatile memory (Flash)	1024 KB	
Gain	0 dB to 24 dB; 0.1 dB increments	
GPIOs	2 programmable GPIOs As direct inputs (push-pull): 0 to 5.5 VDC As direct outputs (push-pull): 0 to 3.3 VDC at 12 mA	
Power requirements	Power over MIPI CSI-2	
Power consumption (typical, at 5 VDC)	2.6 W	

Table 38: Alvium 1800 C-1236m/c specifications (sheet 1 of 2)

Feature	Specification			
	1800 C-1236m/c			
Operating temperature	**Hardware option**	**Housing**	**Cooling areas[1]**	**Mainboard[2]**
	Bare board[3]	Not applicable	+5 °C to +85 °C	+5 °C to +88 °C
	Open housing[4]	+5 °C to +65 °C		
Relative humidity	0% to 80% (non-condensing)			
Digital interface	MIPI CSI-2 D-PHY V1.1; 1, 2, or 4 lanes; maximum 1.125 Gbps per lane			
Camera controls	V4L2 controls (Video4Linux Access), Direct Register Access			

[1]See Mounting the heat sink on page 143.

[2]Output by `Device Temperature`

[3]Ensure that the sensor is operated in the temperature range specified by the manufacturer. For any questions, please contact support@alliedvision.com.

[4]Temperature values must be observed for the housing **and** for the cooling areas.

Table 38: Alvium 1800 C-1236m/c specifications (sheet 2 of 2)

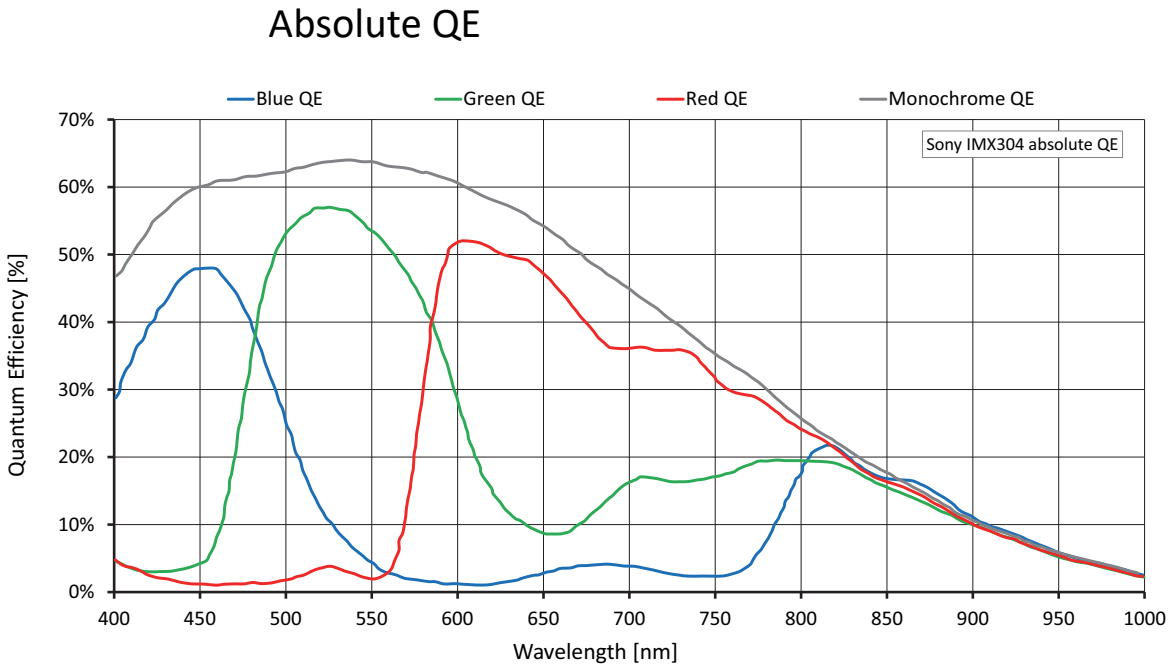


Figure 25: Alvium 1800 C-1236m/c (Sony IMX304) absolute QE

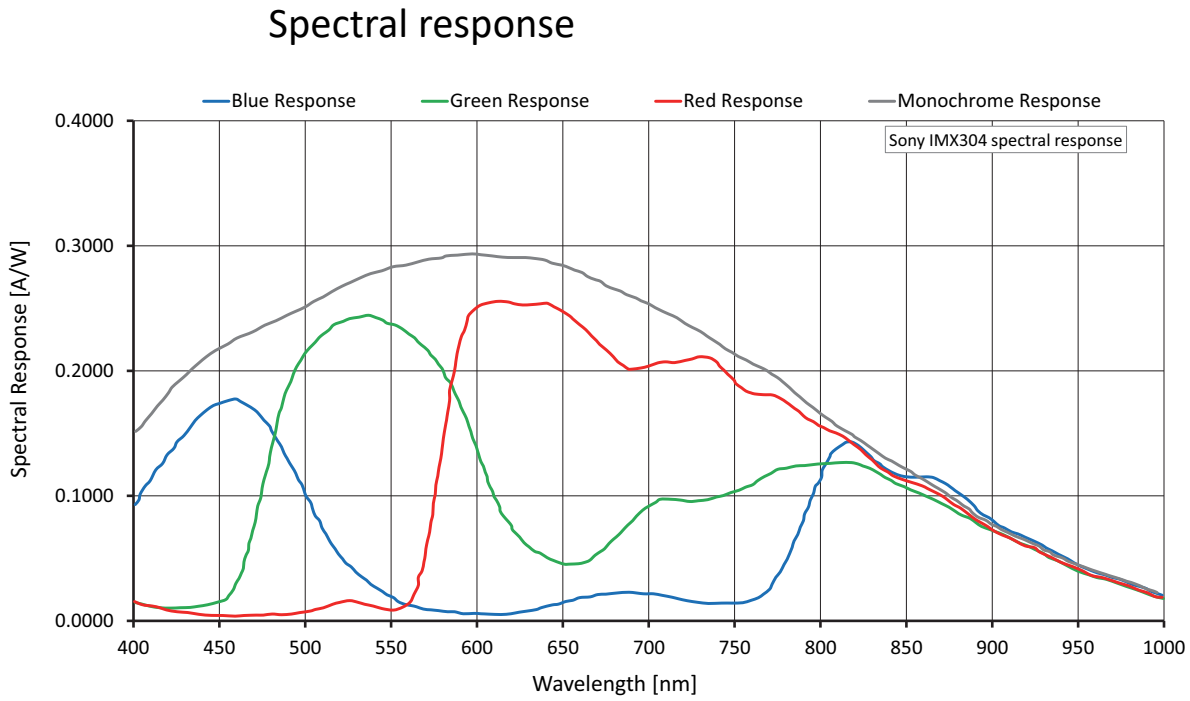


Figure 26: Alvium 1800 C-1236m/c (Sony IMX304) spectral response

Frame rates with Cropping

Values were calculated for **typical operation** defined in Frame rates with Cropping/ROI frame rates on page 48.

Frame rates at maximum bandwidth calculates for 1.125 Gbps per lane. To reach the maximum frame rate available for typical operation, the bandwidth for image traffic is at 2 lanes with 2.25 Gbps.

Image format	Width [pixels]	Height [pixels]	ROI area [pixels]	Frame rate [fps]		
				1-lane	2-lane	4-lane
				1.125 Gbps	2.25 Gbps	4.5 Gbps
Full resolution	4,112	3,008	12,368,896	11	22	
UHD 4K	3,840	2,160	8,294,400	16	31	
QSXGA	2,560	2,048	5,242,880	25	33	
WQHD	2,560	1,440	3,686,400	36	46	
QXGA	2,048	1,536	3,145,728	42	44	
Full HD	1,920	1,080	2,073,600	61		
UXGA	1,600	1,200	1,920,000	55		
WXGA+ [1]	1,440	900 [1]	1,296,000	72		
SXGA	1,280	1,024	1,310,720	65		
HD 720	1,280	720	921,600	90		
XGA	1,024	768	786,432	85		
SVGA	800	600	480,000	106		
VGA	640	480	307,200	130		
QVGA	320	240	76,800	235		
QQVGA	160	120	19,200	392		
Maximum × half	4,112	1,504	6,184,448	21	42	44
Maximum × minimum	4,112	16	65,792	397	621	640
Minimum × maximum	16	3,008	48,128	23		
Minimum × minimum	16	16	256	923		

[1] 1,440 × 904
Due to increments, some resolutions are not available. In this case, frame rates were calculated for the next available resolution.

Table 39: Alvium 1800 C-1236m/c ROI frame rates at maximum bandwidth

Alvium 1800 C-1240m/c

Feature	Specification	
	1800 C-1240m (monochrome)	**1800 C-1240c (color)**
Sensor model	Sony IMX226	
Resolution	4024 (H) x 3036 (V); 12.2 MP	
Sensor type	CMOS	
Shutter type	Rolling shutter (RS)	
Sensor size	Type 1/1.7; 7.4 mm × 5.6 mm; 9.33 mm diagonal	
Pixel size	1.85 µm × 1.85 µm	
CRA	0 deg	
ADC	10-bit	
YUV color pixel formats	Not applicable	YUV422 8-bit (UYVY)
RGB color pixel formats	Default: RGB888 (RGB3)	
RAW pixel formats	RAW8 (GREY), RAW10 (Y10)	
Maximum image bit depth	10-bit	
Maximum frame rate	41 fps, using 4 lanes	
Exposure time	10 µs to 10 s, using 4 lanes	
Image buffer (RAM)	256 KB	
Non-volatile memory (Flash)	1024 KB	
Gain	0 dB to 27 dB; 0.1 dB increments	
GPIOs	2 programmable GPIOs As direct inputs (push-pull): 0 to 5.5 VDC As direct outputs (push-pull): 0 to 3.3 VDC at 12 mA	
Power requirements	Power over MIPI CSI-2	
Power consumption (typical, at 5 VDC)	2.9 W	

Table 40: Alvium 1800 C-1240m/c specifications (sheet 1 of 2)

Feature	Specification			
	1800 C-1240m/c			
Operating temperature	**Hardware option**	**Housing**	**Cooling areas[2]**	**Mainboard[3]**
	Bare board[4]	Not applicable	+5 °C to +85 °C	+5 °C to +88 °C
	Open housing[5]	+5 °C to +65 °C		
Relative humidity	0% to 80% (non-condensing)			
Digital interface	MIPI CSI-2 D-PHY V1.1; 1, 2, or 4 lanes; maximum 1.125 Gbps per lane			
Camera controls	V4L2 controls (Video4Linux Access), Direct Register Access			

[2]See Mounting the heat sink on page 143.

[3]Output by `Device Temperature`

[4]Ensure that the sensor is operated in the temperature range specified by the manufacturer. For any questions, please contact support@alliedvision.com.

[5]Temperature values must be observed for the housing **and** for the cooling areas.

Table 40: Alvium 1800 C-1240m/c specifications (sheet 2 of 2)

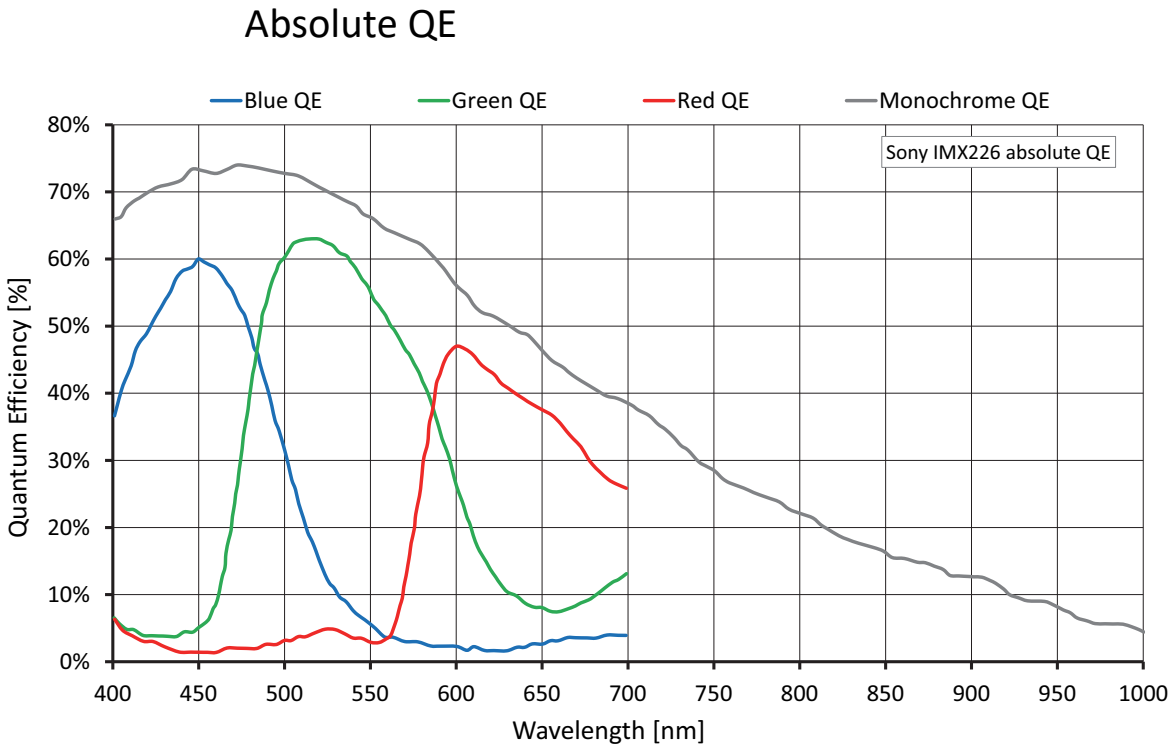


Figure 27: Alvium 1800 C-1240m/c (Sony IMX226) absolute QE

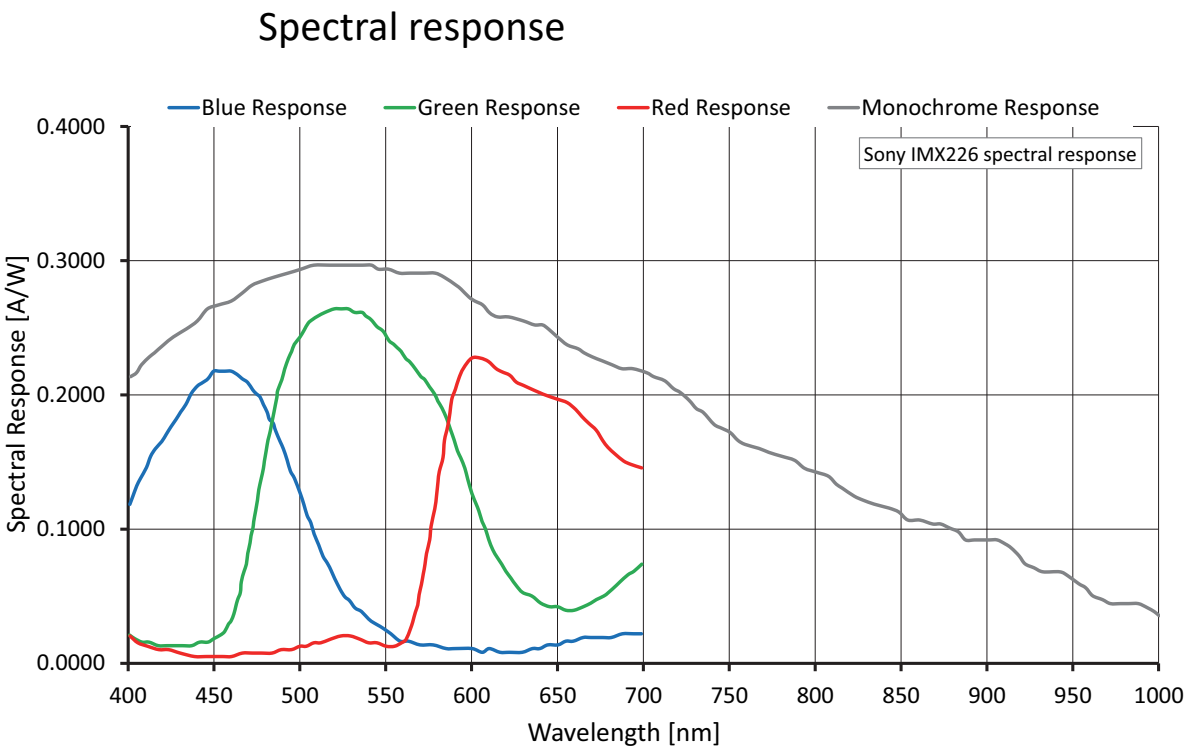


Figure 28: Alvium 1800 C-1240m/c (Sony IMX226) spectral response

Frame rates with Cropping

Values were calculated for **typical operation** defined in Frame rates with Cropping/ROI frame rates on page 48.

Frame rates at maximum bandwidth calculates for 1.125 Gbps per lane. To reach the maximum frame rate available for typical operation, the bandwidth for image traffic is at 4 lanes with 4.5 Gbps.

Image format	Width [pixels]	Height [pixels]	ROI area [pixels]	Frame rate [fps]		
				1-lane	2-lane	4-lane
				1.125 Gbps	2.25 Gbps	4.5 Gbps
Full resolution	4,024	3,036	12,216,864	11	22	41
UHD 4K	3,840	2,160	8,294,400			
QSXGA	2,560	2,048	5,242,880			
WQHD	2560	1440	3,686,400			
QXGA	2,048	1,536	3,145,728			
Full HD	1,920	1,080	2,073,600			
UXGA	1,600	1,200	1,920,000			
WXGA+	1,440	900	1,296,000			
SXGA	1,280	1,024	1,310,720			
HD 720	1,280	720	921,600			
XGA	1,024	768	786,432			
SVGA	800	600	480,000			
VGA	640	480	307,200			
QVGA	320	240	76,800			
QQVGA	160	120	19,200			
Maximum × half [1]	4,024	1,518 [1]	6,108,432			
Maximum × minimum	4,024	16	64,384			
Minimum × maximum	16	3,036	48,576			
Minimum × minimum	16	16	256			

[1] 4,024 × 1,520
Due to increments, some resolutions are not available. In this case, frame rates were calculated for the next available resolution.

Table 41: Alvium 1800 C-1240m/c ROI frame rates at maximum bandwidth

Values in triggered mode

When rolling shutter cameras are operated in triggered mode, the values for maximum frame rate reached in free run mode are cut in half.

Alvium 1800 C-2050m/c

Feature	Specification	
	1800 C-2050m (monochrome)	**1800 C-2050c (color)**
Sensor model	Sony IMX183	
Resolution	5376 (H) × 3672 (V); 19.7 MP	
Sensor type	CMOS	
Shutter type	Rolling shutter (RS)	
Sensor size	Type 1; 13.1 mm × 8.8 mm; 15.86 mm diagonal	
Pixel size	2.4 µm × 2.4 µm	
CRA	3 deg	
ADC	10-bit	
YUV color pixel formats	Not applicable	YUV422 8-bit (UYVY)
RGB color pixel formats	Default: RGB888 (RGB3)	
RAW pixel formats	RAW8 (GREY), RAW10 (Y10)	
Maximum image bit depth	10-bit	
Maximum frame rate	26 fps[1], using 4 lanes	
Exposure time	13 µs to 10 s, using 4 lanes	
Image buffer (RAM)	256 KB	
Non-volatile memory (Flash)	1024 KB	
Gain	0 dB to 27 dB; 0.1 dB increments	
GPIOs	2 programmable GPIOs As direct inputs (push-pull): 0 to 5.5 VDC As direct outputs (push-pull): 0 to 3.3 VDC at 12 mA	
Power requirements	Power over MIPI CSI-2	
Power consumption (typical, at 5 VDC)	2.9 W	
[1]In triggered mode: 13 fps		

Table 42: Alvium 1800 C-2050m/c specifications (sheet 1 of 2)

Feature	Specification			
	1800 C-2050m/c			
Operating temperature	**Hardware option**	**Housing**	**Cooling areas[2]**	**Mainboard[3]**
	Bare board[4]	Not applicable	+5 °C to +85 °C	+5 °C to +88 °C
	Open housing[5]	+5 °C to +65 °C		
Relative humidity	0% to 80% (non-condensing)			
Digital interface	MIPI CSI-2 D-PHY V1.1; 1, 2, or 4 lanes; maximum 1.125 Gbps per lane			
Camera controls	V4L2 controls (Video4Linux Access), Direct Register Access			

[2]See Mounting the heat sink on page 143.

[3]Output by `Device Temperature`

[4]Ensure that the sensor is operated in the temperature range specified by the manufacturer. For any questions, please contact support@alliedvision.com.

[5]Temperature values must be observed for the housing **and** for the cooling areas.

Table 42: Alvium 1800 C-2050m/c specifications (sheet 2 of 2)

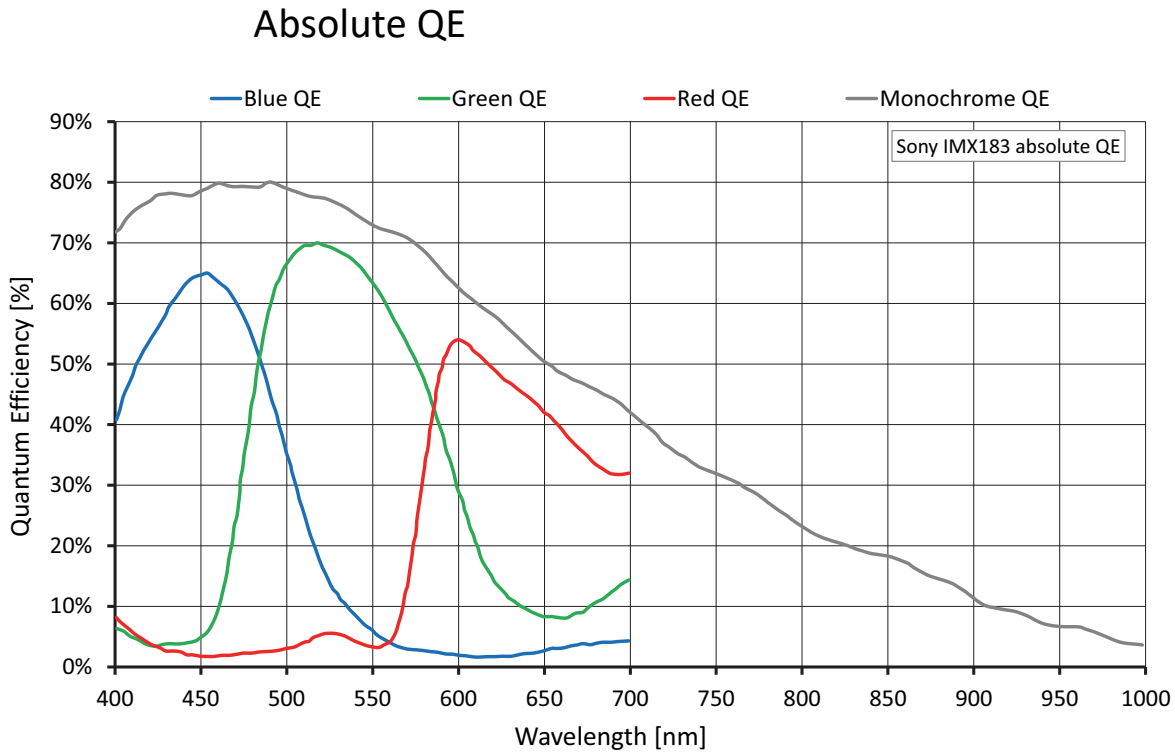


Figure 29: Alvium 1800 C-2050m/c (Sony IMX183) absolute QE

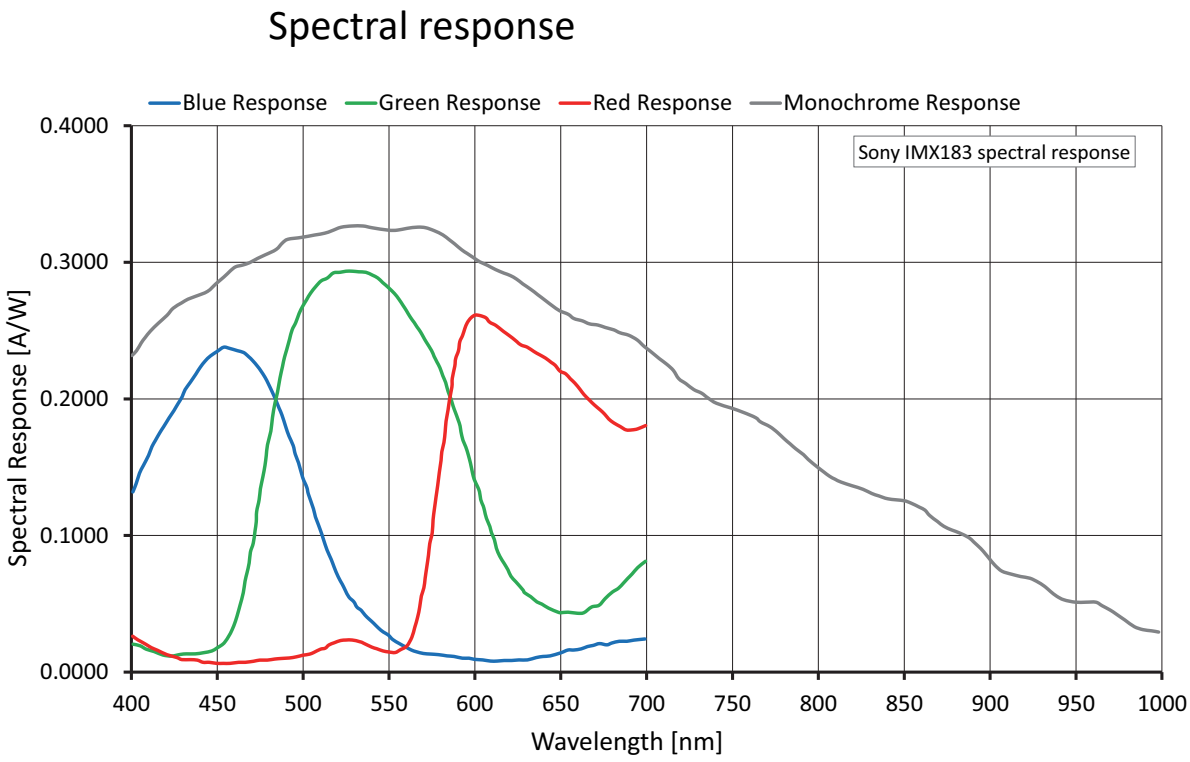


Figure 30: Alvium 1800 C-2050m/c (Sony IMX183) spectral response

Frame rates with Cropping

Values were calculated for **typical operation** in rolling shutter (RS) mode, as defined in Frame rates with Cropping/ROI frame rates on page 48.

Frame rates at maximum bandwidth calculates for 1.125 Gbps per lane. To reach the maximum frame rate available for typical operation, the bandwidth for image traffic is at 4 lanes with 4.5 Gbps.

Image format	Width [pixels]	Height [pixels]	ROI area [pixels]	Frame rate [fps], in RS mode		
				1-lane	2-lane	4-lane
				1.125 Gbps	2.25 Gbps	4.5 Gbps
Full resolution	5,376	3,672	19,740,672	6	13	26
HXGA	4,096	3,072	12,582,912	8	16	31
UHD 4K	3,840	2,160	8,294,400	11	22	43
QSXGA	2,560	2,048	5,242,880	12	23	45
WQHD	2560	1440	3,686,400	13	26	50
QXGA	2,048	1,536	3,145,728			
Full HD	1,920	1,080	2,073,600			
UXGA	1,600	1,200	1,920,000			
WXGA+ [1]	1,440	900 [1]	1,296,000			
SXGA	1,280	1,024	1,310,720			
HD 720	1,280	720	921,600			
XGA	1,024	768	786,432			
SVGA	800	600	480,000			
VGA	640	480	307,200			
QVGA	320	240	76,800			
QQVGA	160	120	19,200			
Maximum × half [2]	5,376	1,836 [2]	9,870,336			
Maximum × minimum	5,376	16	86,016			
Minimum × maximum	16	3,672	58,752	6	13	26
Minimum × minimum	16	16	256	13	26	50

[1] 1,440 × 904

[2] 5,376 × 1,840
Due to increments, some resolutions are not available. In this case, frame rates were calculated for the next available resolution.

Table 43: Alvium 1800 C-2050m/c ROI frame rates at maximum bandwidth

Values in triggered mode

When rolling shutter cameras are operated in triggered mode, the values for maximum frame rate reached in free run mode are cut in half.

Alvium 1800 C-2460m/c

Feature	Specification	
	1800 C-2460m (monochrome)	**1800 C-2460c (color)**
Sensor model	Sony IMX540-AAMJ	Sony IMX540-AAQJ
Resolution	5328 (H) × 4608 (V); 24.6 MP	
Sensor type	CMOS	
Shutter type	Global shutter (GS)	
Sensor size	Type 1.2; 14.60 mm × 12.63 mm; 19.3 mm diagonal	
Pixel size	2.74 µm × 2.74 µm	
CRA	0 deg	
ADC	12-bit	
YUV color pixel formats	Not applicable	YUV422 8-bit (UYVY)
RGB color pixel formats	Default: RGB888 (RGB3)	
RAW pixel formats	RAW8 (GREY), RAW10 (Y10), RAW12 (Y12)	
Maximum image bit depth	10-bit	
Maximum frame rate	21 fps, using 4 lanes	
Exposure time	168 µs to 10 s, using 4 lanes	
Image buffer (RAM)	256 KB	
Non-volatile memory (Flash)	1024 KB	
Gain	0 dB to 24 dB; 0.1 dB increments	
GPIOs	2 programmable GPIOs As direct inputs (push-pull): 0 to 5.5 VDC As direct outputs (push-pull): 0 to 3.3 VDC at 12 mA	
Power requirements	Power over MIPI CSI-2	
Power consumption (typical, at 5 VDC)	3.8 W	

Table 44: Alvium 1800 C-2460m/c specifications (sheet 1 of 2)

Feature	Specification			
	1800 C-2460m/c			
Operating temperature	**Hardware option**	**Housing**	**Cooling areas[1]**	**Mainboard[2]**
	Bare board[3]	Not applicable	+5 °C to +85 °C	+5 °C to +85 °C
	Open housing[4]	+5 °C to +65 °C		
Relative humidity	0% to 80% (non-condensing)			
Digital interface	MIPI CSI-2 D-PHY V1.1; 1, 2, or 4 lanes; maximum 1.125 Gbps per lane			
Camera controls	V4L2 controls (Video4Linux Access), Direct Register Access			

[1]See Mounting the heat sink on page 143.

[2]Output by `Device Temperature`

[3]Ensure that the sensor is operated in the temperature range specified by the manufacturer. For any questions, please contact support@alliedvision.com.

[4]Temperature values must be observed for the housing **and** for the cooling areas.

Table 44: Alvium 1800 C-2460m/c specifications (sheet 2 of 2)

Absolute QE

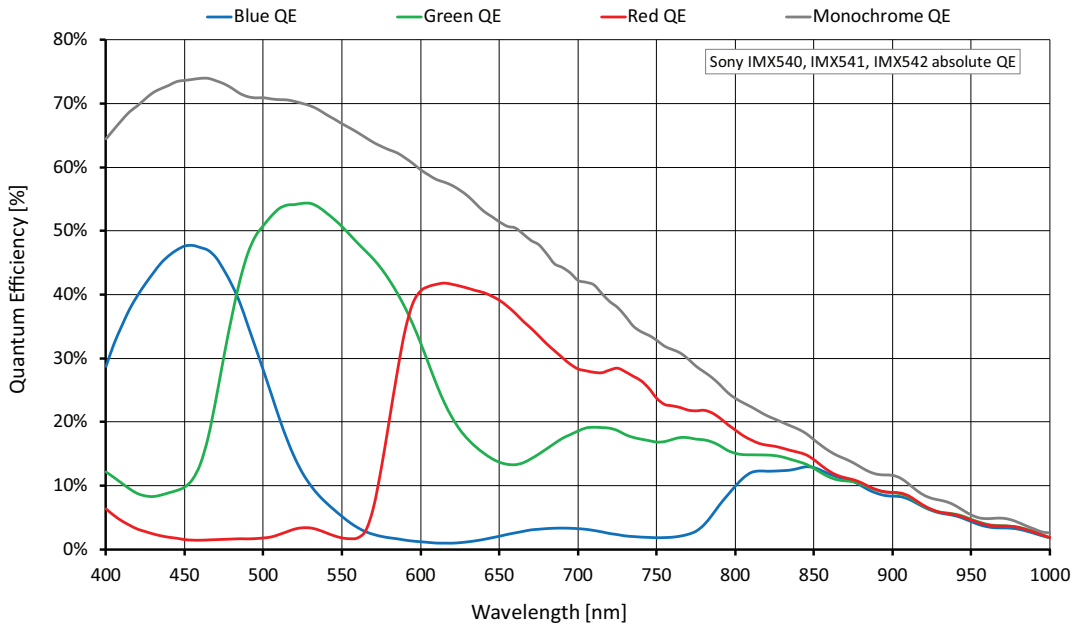


Figure 31: Alvium 1800 C-2460m/c (Sony IMX540) absolute QE

Spectral response

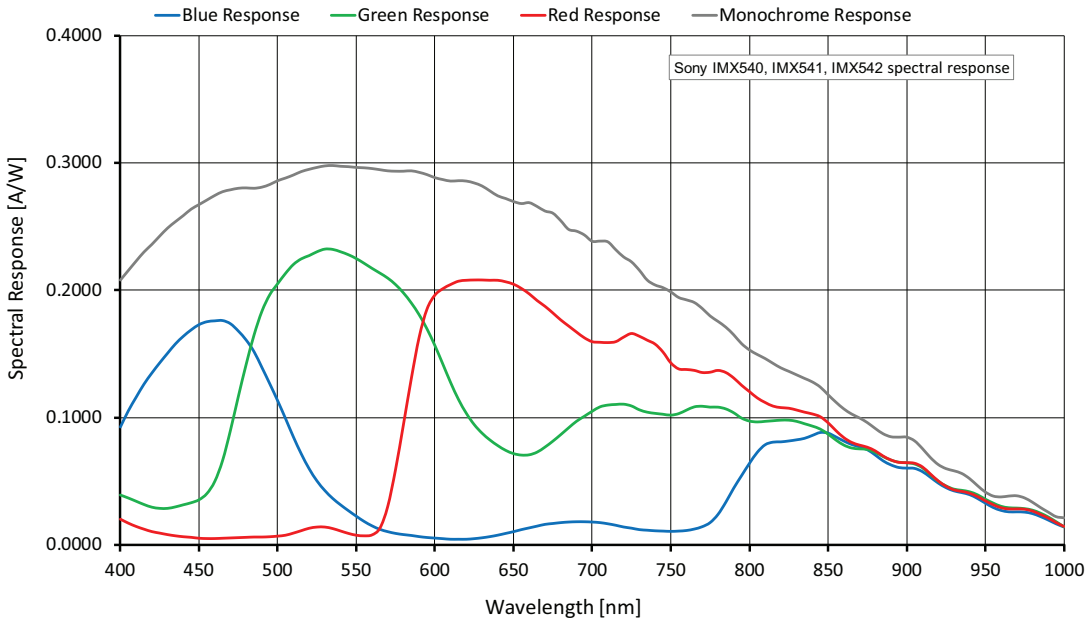


Figure 32: Alvium 1800 C-2460m/c (Sony IMX540) spectral response

Frame rates with Cropping

Values were calculated for **typical operation** defined in Frame rates with Cropping/ROI frame rates on page 48.

Frame rates at maximum bandwidth calculates for 1.125 Gbps per lane. To reach the maximum frame rate available for typical operation, the bandwidth for image traffic is at 4 lanes with 4.5 Gbps. Increasing the `CSI-2 Lane Count` value does not increase frame rates.

Image format	Width [pixels]	Height [pixels]	ROI area [pixels]	Frame rate [fps]		
				1-lane	2-lane	4-lane
				1.125 Gbps	2.25 Gbps	4.5 Gbps
Full resolution	5,328	4,608	24,551,424	5	11	21
HSXGA	5,120	4,096	20,971,520	6	12	24
HXGA	4,096	3,072	12,582,912	10	21	31
UHD 4K	3,840	2,160	8,294,400	15	31	44
QSXGA	2,560	2,048	5,242,880	25	46	46
WQHD	2,560	1,440	3,686,400	34	64	64
QXGA	2,048	1,536	3,145,728	40	61	61
Full HD	1,920	1,080	2,073,600	59	83	83
UXGA	1,600	1,200	1,920,000	65	76	
WXGA+	1,440	900[1]	1,296,000	92	98	
SXGA	1,280	1,024	1,310,720	88		
HD 720	1,280	720	921,600	119		
XGA	1,024	768	786,432	113		
SVGA	800	600	480,000	139		
VGA	640	480	307,200	166		
QVGA	320	240	76,800	272		
QQVGA	160	120	19,200	399		
Maximum × half	5,328	2,304	12,275,712	10	21	41
Maximum × minimum	5,328	16	85,248	179	323	531
Minimum × maximum	16	4,608	73,728	21		
Minimum × minimum	16	16	256	669		

[1] 1440 × 904

Table 45: Alvium 1800 C-2460m/c ROI frame rates at maximum bandwidth

White balance default

Alvium color cameras are balanced for neutral color reproduction with an illumination of 5000 °K (warm daylight). Table 46 shows default values for the red and blue channel by model.

For different illuminations, use auto white balance or adapt the color channel values manually. See the descriptions in V4L2 controls vs. GenICam features on page 125 for details.

Alvium model	Sensor model	Red channel value	Blue channel value
1500 C-050c	ON Semiconductor PYTHON 480	1.930	1.500
1500 C-120c	ON Semiconductor AR0135CS	1.760	1.650
1500 C-210c	ON Semiconductor AR0521SR	2.120	1.520
1500 C-500c	ON Semiconductor AR0521SR	2.120	1.520
1800 C-040c	Sony IMX287	2.360	2.030
1800 C-158c	Sony IMX273	2.355	2.100
1800 C-240c	Sony IMX392	2.355	2.100
1800 C-319c	Sony IMX265	2.355	2.100
1800 C-507c	Sony IMX264	2.355	2.100
1800 C-508c	Sony IMX250	2.355	2.100
1800 C-1236c	Sony IMX304	2.355	2.100
1800 C-1240c	Sony IMX226	2.620	1.810
1800 C-2050c	Sony IMX183	2.660	1.830
1800 C-2460c	Sony IMX540	2.870	2.000

Table 46: Alvium default values for color channels

Dimensions and mass

Bare board cameras	Specification
Dimensions (L × W × H [mm])	[Model specific] × 26 × 26
Mass [g]	10 g

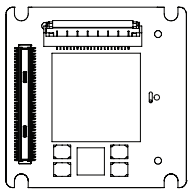
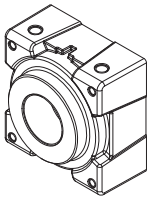
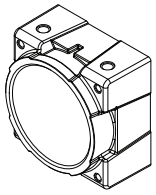
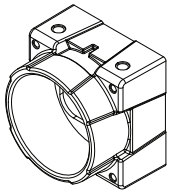
Table 47: Bare board dimensions and mass

Open housing cameras	S-Mount	CS-Mount	C-Mount
Flange focal distance, optical [mm]	12.63	12.526	17.526
Thread	M12 mm × 0.5 mm	1“-32tpi UNS-2B	1“-32tpi UNS-2B
Maximum protrusion[1] [mm]	11.0	8.6	13.6
Body dimensions (L × W × H [mm])	20 × 29 × 29	21 × 29 × 29	26 × 29 × 29
Mass	40 g	40 g	40 g
[1]For details, see Lens mounts and maximum protrusion.			

Table 48: Housing dimensions and mass

Technical drawings

Alvium CSI-2 cameras are available with the following housing options:

				
Option	Bare Board	Open Housing S-Mount	Open Housing CS-Mount	Open Housing C-Mount
Page	108	109	110	111

Bare Board

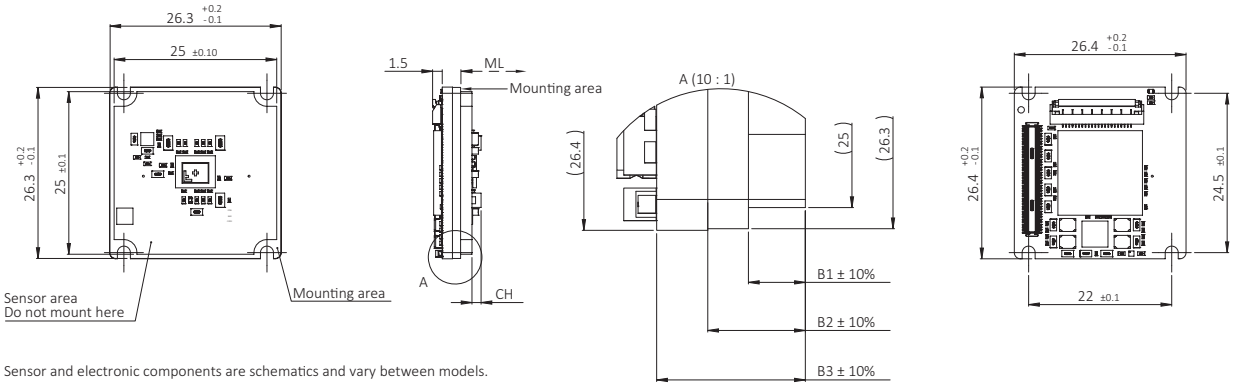


Figure 33: Bare Board dimensions

Dimensions that are common between different models are shown in Figure 33, model specific dimensions are listed in Table 49. **Mechanical length** (ML) defines the mechanical distance from the mounting area to the lens mount front flange, without optical filter. **Components height** (CH) relates to the electronic components with maximum height, sometimes the sensor.

Mechanical length for S-Mount and CS-Mount

Mechanical length for other mounts is:

- CS-Mount: [C-Mount value] – 5 mm
- S-Mount: depending on your design.

Camera model	ML: Mechanical length* for C-Mount	CH: Components height, incl. the sensor	B1: Board thickness	B2: Board thickness	B3: Board thickness
Alvium 1500 C-050m/c	19.604 mm	1.40 mm	1.75 mm	3.00 mm	4.55 mm
Alvium 1500 C-120m/c	19.689 mm	1.44 mm	1.25 mm	2.40 mm	3.95 mm
Alvium 1500 C-210m/c	19.739 mm	1.67 mm	1.30 mm	2.40 mm	3.95 mm
Alvium 1500 C-500m/c	19.739 mm	1.67 mm	1.30 mm	2.40 mm	3.95 mm
Alvium 1800 C-040m/c	19.897 mm	2.27 mm	1.20 mm	2.20 mm	3.75 mm
Alvium 1800 C-158m/c	19.897 mm	2.27 mm	1.20 mm	2.20 mm	3.75 mm
Alvium 1800 C-240m/c	19.929 mm	2.27 mm	1.25 mm	2.20 mm	3.75 mm
Alvium 1800 C-319m/c	19.929 mm	2.27 mm	1.25 mm	2.20 mm	3.75 mm
Alvium 1800 C-507m/c	19.929 mm	2.27 mm	1.25 mm	2.20 mm	3.75 mm
Alvium 1800 C-508m/c	19.929 mm	2.27 mm	1.25 mm	2.20 mm	3.75 mm
Alvium 1800 C-1236m/c	19.829 mm	2.27 mm	1.15 mm	2.20 mm	3.75 mm
*Theoretical values					

Table 49: Bare Board model specific dimensions and nominal values (sheet 1 of 2)

Camera model	ML: Mechanical length* for C-Mount	CH: Components height, incl. the sensor	B1: Board thickness	B2: Board thickness	B3: Board thickness
Alvium 1800 C-1240m/c	19.763 mm	2.20 mm	1.15 mm	2.20 mm	3.75 mm
Alvium 1800 C-2050m/c	19.663 mm	2.87 mm	1.05 mm	2.20 mm	3.75 mm
Alvium 1800 C-2460m/c	19.613 mm	2.88 mm	1.00 mm	2.20 mm	3.75 mm
*Theoretical values					

Table 49: Bare Board model specific dimensions and nominal values (sheet 2 of 2)

Open Housing S-Mount

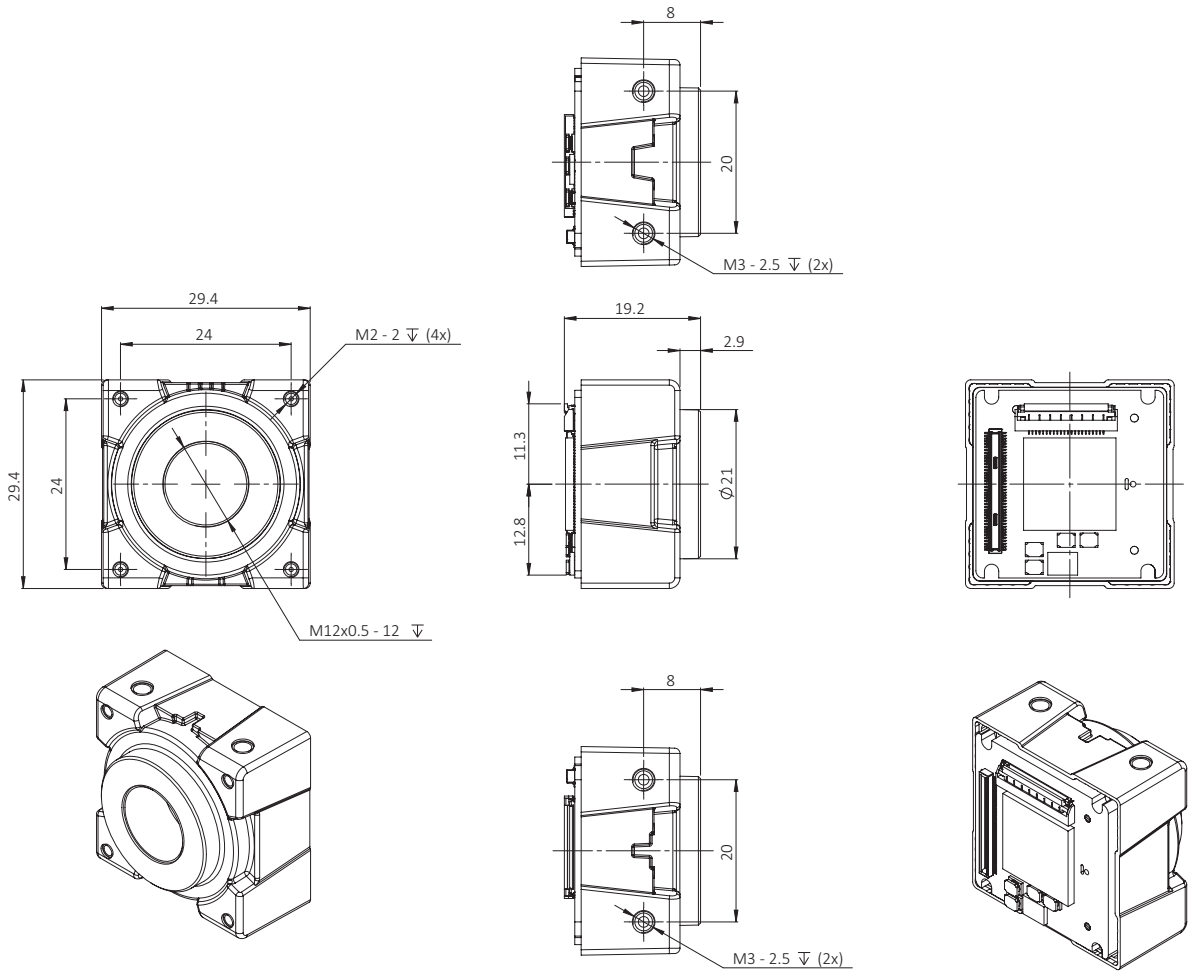


Figure 34: Open Housing S-Mount dimensions

Open Housing CS-Mount

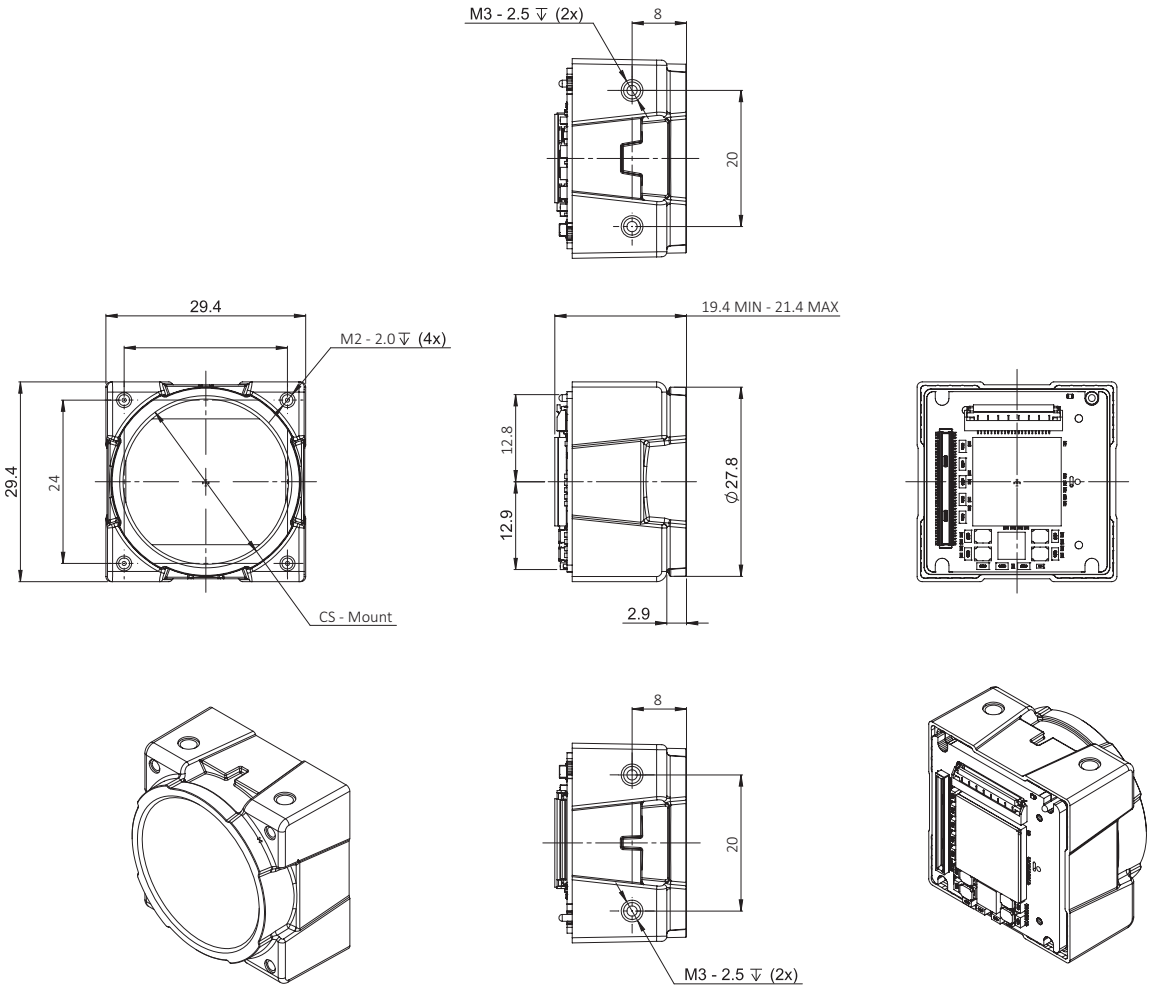


Figure 35: Open Housing CS-Mount dimensions

Open Housing C-Mount

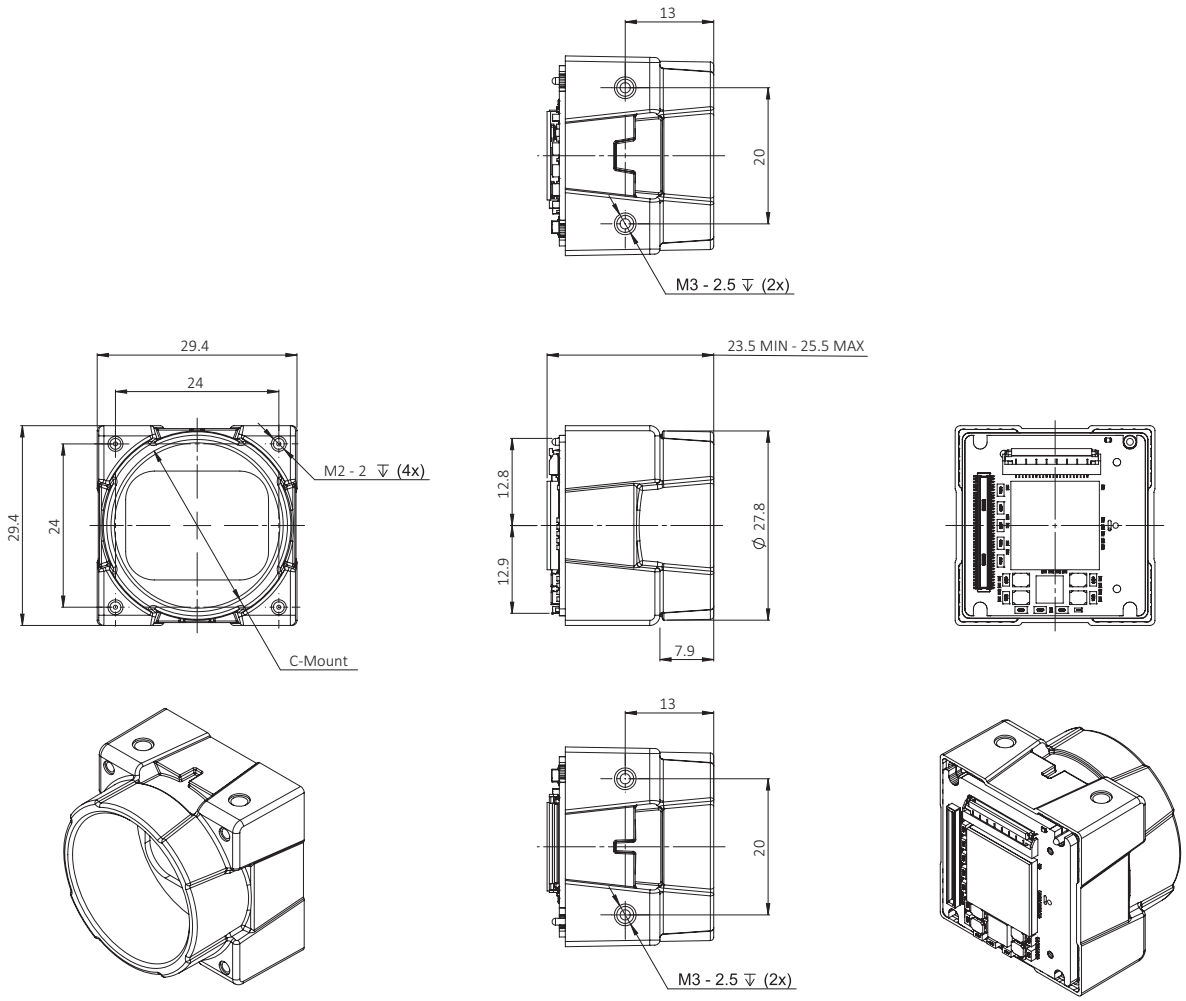
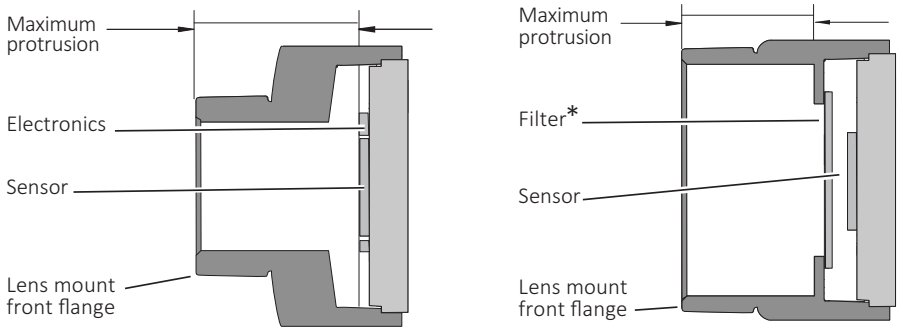


Figure 36: Open Housing C-Mount dimensions

Lens mounts and maximum protrusion

No need to readjust lens mounts

Alvium CSI-2 camera mounts are adjusted with high precision during manufacturing. Construction ensures permanent accuracy without need to readjust.



*Only color models are equipped with an IR cut filter

Figure 37: Maximum protrusion S-Mount (left); CS-Mount and C-Mount (right)

Figure 37 shows schematics for maximum protrusion of lenses, Table 50 shows values for maximum protrusion.

NOTICE

Damage to sensor, optics, or electronics by unsuitable lenses

The sensor, filter, lens, or electronics can be damaged if a lens exceeding maximum protrusion is mounted to the camera.

- Use lenses with less than the allowed maximum protrusion, see Table 50.
- See Mounting the lens on page 147.
- For S-Mount lenses, see Mounting and focusing S-Mount lenses on page 148.

Mount	Maximum protrusion
S-Mount	11.0 mm
CS-Mount	8.6 mm
C-Mount	13.6 mm

Table 50: Alvium CSI-2 cameras maximum protrusion

IR cut filter

Table 51 shows which Alvium models are equipped with an IR cut filter. The filter is permanently installed and cannot be removed.

Color or monochrome model	Bare Board	S-Mount	CS-Mount	C-Mount
Color	No filter		Type Hoya C-5000 IR cut filter	
Monochrome	No filter			

Table 51: Optical filter availability

Cameras **without** IR cut filter have a higher sensitivity for low-light imaging. Moreover, spectral sensitivity is increased.

Cameras **with** IR cut filter are more accurate in reproduction of color, contrast, and sharpness, as the filter absorbs near-IR wavelengths. See Figure 38 for filter transmission.

Spectral transmission values

The following curve shows typical transmission for type Hoya C-5000 IR cut filter. Values may vary slightly by filter lot.

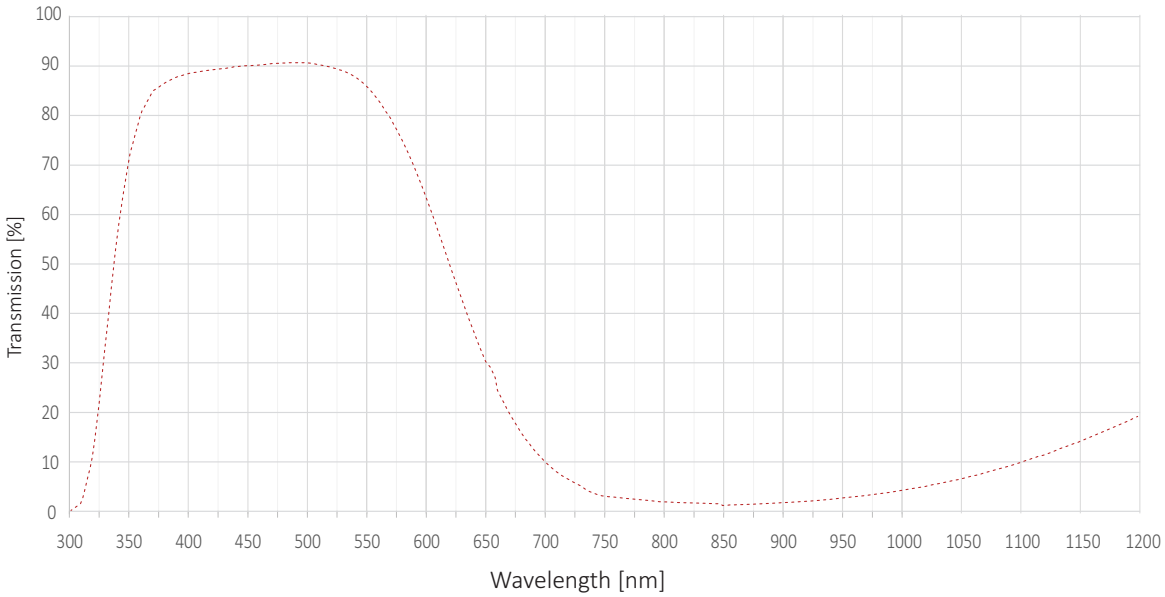


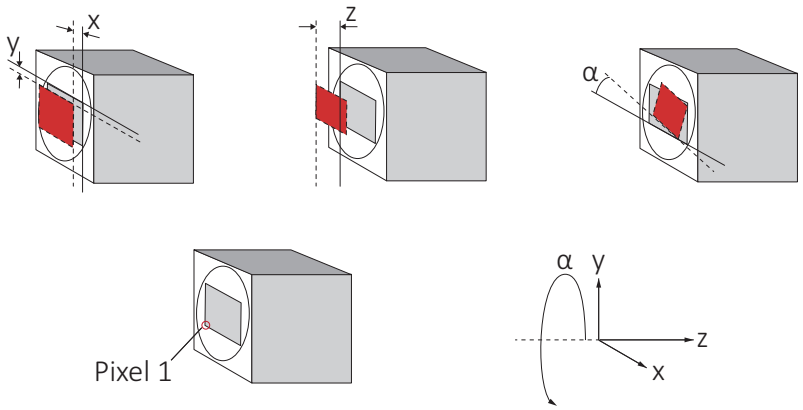
Figure 38: Type Hoya C-5000 IR cut filter spectral transmission

S-Mount lenses with IR cut design

For improved image quality, we recommend using S-Mount lenses that are IR-optimized or that have IR cut coating. See the S-Mount Lenses User Guide at www.alliedvision.com/en/support/technical-documentation/accessory-documentation under Lenses.

Sensor position accuracy

Sensor shift and rotation



Gray rectangle: Reference sensor position **Red rectangle**: Current position
Straight line: Reference edge **Dotted line**: Current reference edge

The orientation of the z-axis deviates from scientific conventions to define tolerances of the flange focal distance.

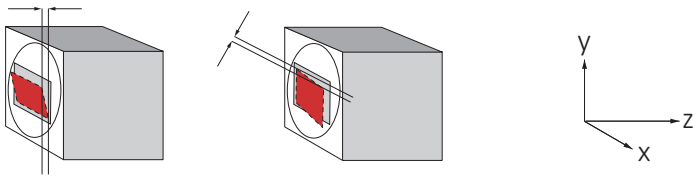
Figure 39: Sensor shift and rotation

The following table defines the manufacturing accuracy for sensor shift.

Criteria	Subject	Properties
Alignment method		Optical alignment of the photosensitive sensor area into the camera front module (lens mount front flange)
Reference Points	Sensor	Center of the pixel area (photo sensitive cells)
	Camera	Center of the lens mount
Accuracy	x/y-axis	±150 µm[1] (sensor shift)
	z	0 to -100 µm (optical back focal length)
	α	±0.5 deg (sensor rotation as the deviation from the parallel to the camera bottom)
[1]For Alvium 1800 C-2050 models, the complete offset is ±200 µm, common tolerances do not have to be added.		

Table 52: Alvium CSI-2 cameras, criteria of sensor position accuracy

Sensor tilt



Gray rectangle: Reference sensor position **Red rectangle**: Current position

Figure 40: Sensor tilt

The following table defines sensor tilt as the variance between highest and lowest pixel of a sensor along the z-axis, measured in micrometers.

Alvium model	Pixel size	Maximum tilt
Alvium 1500 C-050m/c	4.8 µm × 4.8 µm	47 µm
Alvium 1500 C-120m/c	3.75 µm × 3.75 µm	29 µm
Alvium 1500 C-210m/c	2.2 µm × 2.2 µm	15 µm
Alvium 1500 C-500m/c	2.2 µm × 2.2 µm	15 µm
Alvium 1800 C-040m/c	6.9 µm × 6.9 µm	95 µm
Alvium 1800 C-158m/c	3.45 µm × 3.45 µm	24 µm
Alvium 1800 C-240m/c	3.45 µm × 3.45 µm	24 µm
Alvium 1800 C-319m/c	3.45 µm × 3.45 µm	24 µm
Alvium 1800 C-507m/c	3.45 µm × 3.45 µm	24 µm
Alvium 1800 C-508m/c	3.45 µm × 3.45 µm	24 µm
Alvium 1800 C-1236m/c	3.45 µm × 3.45 µm	24 µm
Alvium 1800 C-1240m/c	1.85 µm × 1.85 µm	12 µm
Alvium 1800 C-2050m/c	2.4 µm × 2.4 µm	12 µm
Alvium 1800 C-2460m/c	2.74 µm × 2.74 µm	18 µm

Table 53: Sensor tilt

Lenses: Focal length vs. field of view

This chapter includes:

About this chapter

This section presents tables that list selected fields of view (FOV) depending on sensor size, distance, and focal length of the lens.

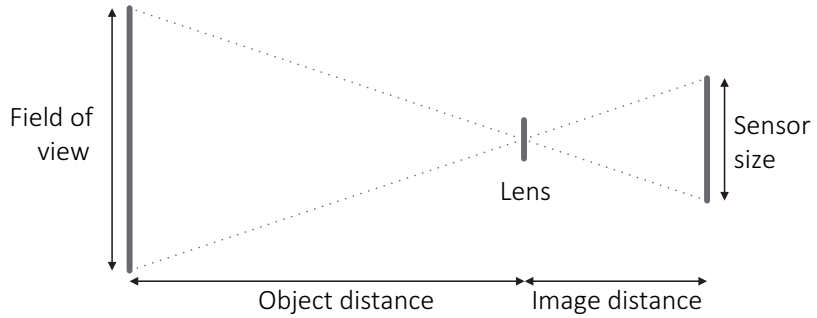


Figure 41: Parameters used in tables for focal length versus FOV

Allied Vision S-Mount lenses

For technical data of Allied Vision S-Mount lenses with dedicated operating instructions, see the S-Mount Lenses User Guide at www.alliedvision.com/en/support/technical-documentation/accessory-documentation under Lenses.

Parameters in tables

The distance to the object is measured from the first principal the plane of the lens to the object. For some lenses, manufacturers do not define the principal plane position. Production spread causes tolerances for all values, including actual focal lengths. Calculations apply for image reproduction without distortion. Therefore, values do not apply for fisheye lenses.

Please ask your Allied Vision Sales representative in case you need more information.

Optical vignetting with certain lenses

Lenses with short focal lengths may show optical vignetting at the edges of the image. Microlenses on the sensor pixels can increase the effect.

For demanding applications, we suggest testing camera and lens to find a suitable setup. If you have questions, please contact your Allied Vision Sales representative.

About S-Mount lenses

Alvium CSI-2 models with S-Mount have no filter. For typical applications, we recommend using S-Mount lenses with an integrated IR cut filter for a better image quality.

Read Mounting and focusing S-Mount lenses on page 148 to avoid damage when using S-Mount lenses.

Focal length vs. field of view

Alvium 1500 C-050m/c

Values apply to 1500 C-050m/c cameras (aspect ratio 1:1.34) with Type 1/3.6 (4.9 mm diagonal) sensors.

Focal length [mm]	Field of view (H × V [mm])	
	Object distance = 500 mm	Object distance = 1000 mm
2.8	689 × 517	1381 × 1036
3.6	535 × 401	1073 × 805
4.8	400 × 300	804 × 603
6	319 × 239	643 × 482
8	239 × 179	481 × 361
12	158 × 118	319 × 239
16	117 × 88	239 × 179
25	74 × 55	151 × 113

Table 54: Focal length versus field of view for Alvium 1500 C-050m/c

Alvium 1500 C-120m/c

Values apply to 1500 C-120m/c cameras with Type 1/3 (6.0 mm diagonal) sensors.

Focal length [mm]	Field of view (H × V [mm])	
	Object distance = 500 mm	Object distance = 1000 mm
2.8	852 × 639	1709 × 1282
3.6	662 × 496	1329 × 996
4.8	495 × 371	995 × 746
6	395 × 296	795 × 596
8	295 × 221	595 × 446
12	195 × 146	395 × 296
16	145 × 109	295 × 221
25	91 × 68	187 × 140

Table 55: Focal length versus field of view for Alvium 1500 C-120m/c

Alvium 1500 C-210m/c

Values apply to 1500 C-210m/c cameras (aspect ratio 1:1.75) with Type 1/3.6 (4.9 mm diagonal) sensors.

Focal length [mm]	Field of view (H × V in [mm])	
	Object distance = 500 mm	Object distance = 1000 mm
2.8	746 × 426	1496 × 855
3.6	579 × 331	1162 × 664
4.8	433 × 248	871 × 498
6	346 × 198	696 × 398
8	258 × 148	521 × 298
12	171 × 98	346 × 198
16	127 × 73	258 × 148
25	80 × 46	164 × 94

Table 56: Focal length versus field of view for Alvium 1500 C-210m/c

Alvium 1500 C-500m/c

Values apply to 1500 C-500m/c cameras with Type 1/2.5 (7.1 mm diagonal) sensors.

Focal length [mm]	Field of view (H × V in [mm])	
	Object distance = 500 mm	Object distance = 1000 mm
2.8	1013 × 759	2031 × 1523
3.6	786 × 590	1578 × 1184
4.8	588 × 441	1182 × 887
6	469 × 352	945 × 709
8	351 × 263	707 × 530
12	232 × 174	469 × 352
16	172 × 129	351 × 263
25	108 × 81	222 × 167

Table 57: Focal length versus field of view for Alvium 1500 C-500m/c

Alvium 1800 C-040m/c, 1800 C-158m/c

Values apply to 1800 C-040m/c and C-158m/c cameras with Type 1/2.9 (6.3 mm diagonal) sensors.

Focal length [mm]	Field of view (H × V [mm])	
	Object distance = 500 mm	Object distance = 1000 mm
2.8	892 × 667	1789 × 1337
3.6	693 × 518	1390 × 1039
4.8	518 × 387	1041 × 778
6	414 × 309	832 × 622
8	309 × 231	623 × 465
12	204 × 153	414 × 309
16	152 × 114	309 × 231
25	95 × 71	196 × 146

Table 58: Focal length versus field of view for Alvium 1800 C-040m/c and 1800 C-158m/c

Alvium 1800 C-240m/c

Values apply to 1800 C-240m/c cameras with Type 1/2.3 (7.9 mm diagonal) sensors.

Focal length [mm]	Field of view (H × V in [mm])	
	Object distance = 500 mm	Object distance = 1000 mm
4.8	691 × 433	1389 × 871
6	552 × 346	1110 × 696
8	412 × 258	831 × 521
12	272 × 171	552 × 346
16	203 × 127	412 × 258
25	127 × 80	261 × 164
35	89 × 56	185 × 116
50	60 × 38	127 × 80

Table 59: Focal length versus field of view for Alvium 1800 C-240m/c

Alvium 1800 C-319m/c

Values apply to 1800 C-319m/c cameras with Type 1/1.8 (8.9 mm diagonal) sensors.

Focal length [mm]	Field of view (H × V in [mm])	
	Object distance = 500 mm	Object distance = 1000 mm
4.8	735 × 550	1476 × 1104
6	586 × 439	1180 × 882
8	438 × 328	883 × 661
12	290 × 217	586 × 439
16	215 × 161	438 × 328
25	135 × 101	278 × 208
35	95 × 71	196 × 147
50	64 × 48	135 × 101

Table 60: Focal length versus field of view for Alvium 1800 C-319m/c

Alvium 1800 C-507m/c, 1800 C-508m/c

Values apply to 1800 C-507m/c and 1800 C-508 cameras with Type 2/3 (11.1 mm diagonal) sensors.

Focal length [mm]	Field of view (H × V in [mm])	
	Object distance = 500 mm	Object distance = 1000 mm
6	700 × 584	1408 × 1175
8	523 × 436	1054 × 880
12	346 × 288	700 × 584
16	257 × 215	523 × 436
25	162 × 135	332 × 277
35	113 × 94	234 × 196
50	77 × 64	162 × 135

Table 61: Focal length versus field of view for Alvium 1800 C-507m/c and 1800 C-508m/c

Alvium 1800 C-1236m/c

Values apply to 1800 C-1236m/c cameras with Type 1.1 (17.6 mm diagonal) sensors.

Focal length [mm]	Field of view (H × V in [mm])	
	Object distance = 500 mm	Object distance = 1000 mm
8	872 × 638	1759 × 1287
12	577 × 422	1168 × 854
16	429 × 314	872 × 638
25	270 × 197	553 × 405
35	188 × 138	391 × 286
50	128 × 93	270 × 197
75	80 × 59	175 × 128

Table 62: Focal length versus field of view for Alvium 1800 C-1236m/c

Alvium 1800 C-1240m/c

Values apply to 1800 C-1240m/c cameras with Type 1/1.7 (9.33 mm diagonal) sensors.

Focal length [mm]	Field of view (H × V in [mm])	
	Object distance = 500 mm	Object distance = 1000 mm
4.8	763 × 578	1534 × 1161
6	609 × 461	1226 × 928
8	455 × 344	918 × 694
12	301 × 228	609 × 461
16	224 × 169	455 × 344
25	141 × 106	289 ×218
35	98 × 74	204 × 154
50	67 × 50	141 × 106

Table 63: Focal length versus field of view for Alvium 1800 C-1240m/c

Alvium 1800 C-2050m/c

Values apply to 1800 C-2050m/c cameras with Type 1 (15.8 mm diagonal) sensors.

Focal length [mm]	Field of view (H × V in [mm])	
	Object distance = 500 mm	Object distance = 1000 mm
8	811 × 542	1636 × 1093
12	536 × 358	1086 × 726
16	399 × 267	811 × 542
25	251 × 167	514 × 344
35	175 × 117	364 × 243
50	119 × 79	251 × 167
75	75 × 50	163 × 109
85	64 × 43	142 × 95
100	53 × 35	119 × 79

Table 64: Focal length versus field of view for Alvium 1800 C-2050m/c

Alvium 1800 C-2460m/c

Values apply to 1800 C-2460m/c cameras with Type 1.2 (19.3 mm diagonal) sensors.

Focal length [mm]	Field of view (H × V in [mm])	
	Object distance = 500 mm	Object distance = 1000 mm
8	898 × 776	1810 × 1566
12	594 × 513	1202 × 1040
16	442 × 382	898 × 776
25	277 × 240	569 × 492
35	194 × 168	403 × 348
50	131 × 114	277 × 240
75	83 × 72	180 × 156

Table 65: Focal length versus field of view for Alvium 1800 C-2460m/c

V4L2 controls vs. GenICam features

This chapter includes:

Access modes

The driver for Alvium CSI-2 cameras supports two different access modes to suit the various requirements of individual applications:

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. See the Direct Register Access Controls Reference document at www.alliedvision.com/en/support/technical-documentation/alvium-csi-2-documentation.
Video4Linux Access	Controls the camera by V4L2 controls, using the Allied Vision driver for CSI-2 cameras directly. Existing PC-based machine vision applications can be scaled down to V4L2 on lean embedded systems, reducing power consumption and costs.

Table 66: Access modes overview

Figure 42 on page 127 shows how cameras are controlled using the different access modes.

Access modes data flow

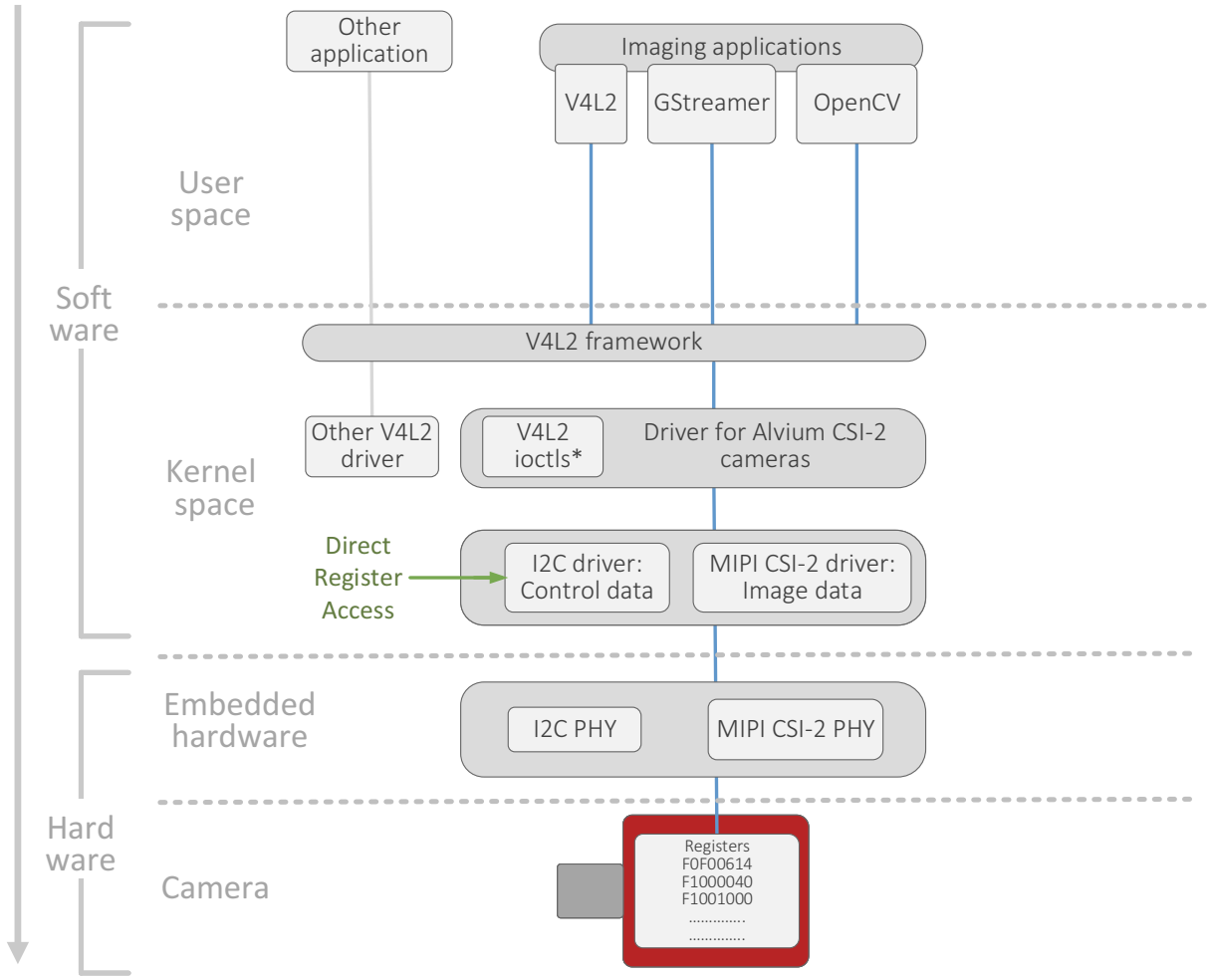


Figure 42: Camera control using the different access modes

Direct Register Access: Data is read from and written to registers directly.

Video4Linux Access: V4L2 controls registers.

V4L2 controls vs. GenICam SFNC features

V4L2 controls

Consider that V4L2 controls change through the Linux kernel development. The driver for Alvium CSI-2 cameras currently supports kernel 4.9.140. For embedded board adapters, see CSI-2 accessories at www.alliedvision.com/en/support/technical-documentation/accessory-documentation.

For a description of V4L2 controls related to the **current kernel version**, see https://linuxtv.org.

GenICam Standard Features Naming Convention (SFNC) features

The SFNC is defined by the EMVA. See www.emva.org.

Embedded applications often use V4L2 controls provided with the Linux kernel to operate and configure the camera. Machine vision applications typically use GenICam SFNC features enabled by a transport layer communicating between a software development kit (SDK) and the interface driver. Current Alvium CSI-2 cameras do not support GenICam.

This section compares functionalities provided by V4L2 controls and SFNC features. Using controls and features on page 134 explains different handling of functionalities for both sides.

Using register controls instead of V4L2 controls

Some controls require **Direct Register Access** because no equivalent V4L2 controls are available. See the Direct Register Access Controls Reference document at www.alliedvision.com/en/support/technical-documentation/alvium-csi-2-documentation.

Functionalities comparison

Functionalities represent controls and features in a simplified way. The following functionalities are organized under category and subcategory. Properties that apply to some functionalities only are set in parentheses. Sometimes, more than one V4L2 control or GenICam feature is used.

The standards define all available controls or features and options. This section describes only features and options that are available with Alvium CSI-2 cameras.

Image control > Auto control

Functionality	**V4L2 controls (Control IDs);** Data type: Options; [Unit]; Control type	**SFNC features or *non-SFNC*** (Selector Feature)/Feature; Data type: Options; [Unit]	**Remarks**
Auto exposure	V4L2_CID_EXPOSURE_AUTO; Enumeration: V4L2_EXPOSURE_AUTO, V4L2_EXPOSURE_MANUAL; Extended control	ExposureAuto; Enumeration: Continuous, Off	Disables V4L2_CID_EXPOSURE and V4L2_CID_EXPOSURE_ABSOLUTE
Auto exposure minimum values	Not applicable	*ExposureAutoMin*; Float	See descriptions in Exposure time on page 134.
Auto exposure maximum value	Not applicable	*ExposureAutoMax*; Float	
Auto gain	V4L2_CID_AUTOGAIN; Boolean: True/False; User control	GainAuto; Enumeration: Continuous, Off	Not applicable
Auto gain minimum value	Not applicable	*GainAutoMin*; Float	See descriptions in Gain on page 135.
Auto gain maximum value	Not applicable	*GainAutoMax*; Float	
Auto white balance	V4L2_CID_AUTO_WHITE_BALANCE;Boolean: True/False; User control	BalanceWhiteAuto; Enumeration: Continuous, Off	Not applicable
Intensity auto precedence	Not applicable	*IntensityAutoPrecedence*; Enumeration: Minimizenoise, Minimizeblur	
Intensity auto target value	Not applicable	*IntensityControllerTarget*; Float	For the related controls, see descriptions in Intensity auto on page 136.

Table 67: Image control > Auto control comparison

Image control > Basic control

Functionality	V4L2 controls (Control IDs); Data type: Options; [Unit]; Control type	SFNC features or *non-SFNC* (Selector Feature)/Feature; Data type: Options; [Unit]	Remarks
Black level / Brightness	V4L2_CID_BRIGHTNESS; Integer; User control	BlackLevel; Float	Not applicable
Exposure time	V4L2_CID_EXPOSURE; Integer; [ns] | User control	ExposureTime; Float; [µs]	Disables V4L2_EXPOSURE_AUTO and V4L2_CID_EXPOSURE_ABSOLUTE
Exposure time	V4L2_CID_EXPOSURE_ABSOLUTE; Integer; [100 µs]; Extended control	*Universal Video Class (UVC): Exposure Time (Absolute) Control*; Integer; [100 µs]	Disables V4L2_EXPOSURE_AUTO and V4L2_CID_EXPOSURE
Frame rate	VIDIOC_S_PARM; Float [Hz] (rational number)	AcquisitionFrameRate; Float [Hz]	Not applicable
Gain	V4L2_CID_GAIN; Integer; User control	Gain; Float	Not applicable
Gamma	V4L2_CID_GAMMA; Integer; User control	Gamma; Float	Not applicable
Hue	V4L2_CID_HUE; Integer; User control	*Universal Video Class (UVC): Hue Control*; Float	UVC feature values are multiplied by 100 to change float to integer.
Saturation	V4L2_CID_SATURATION; Integer; User control	*Universal Video Class (UVC): Saturation Control*; Float	UVC feature values are multiplied by 100 to change float to integer.
White balance	V4L2_CID_DO_WHITE_BALANCE; Button (= Command); User control	BalanceWhiteAuto; Enumeration: Once	Not applicable
Balance ratio: blue	V4L2_CID_BLUE_BALANCE; Integer; User control	BalanceRatioSelector; Enumeration: Blue BalanceRatio; Float	Alternative to White balance
Balance ratio: red	V4L2_CID_RED_BALANCE Integer User control	BalanceRatioSelector; Enumeration: Red BalanceRatio; Float	Alternative to White balance

Table 68: Image control > Basic control comparison

Image control > Image size

Functionality	V4L2 controls (Control IDs); Data type: (Options); [Unit]; Control type	SFNC features	Remarks
ROI / Cropping	See ROI / Cropping on page 137.		

Table 69: Image control > Image size comparison

Image control > Image correction

Functionality	V4L2 controls (= Control IDs); Data type: (Options); [Unit]; Control type	SFNC features (Selector Feature)/Feature; Data type: (Options); [Unit]	Remarks
Mirror image X	V4L2_CID_HFLIP; Boolean: True/False; User control	ReverseX; Boolean: True/False	The control changes the Bayer pattern.
Mirror image Y	V4L2_CID_VFLIP Boolean: True/False User control	ReverseY Boolean: True/False	The control changes the Bayer pattern.

Table 70: Image control > Image correction comparison

Camera control > Triggering

While GenICam features use enumerations for different values, IOCTLs use commands and queries for separate values.

Functionality	IOCTLs; Data type: (Options); [Unit]; Control type	SFNC features (Selector Feature)/Feature; Data type: (Options); [Unit]	Remarks
Trigger mode	VIDIOC_TRIGGER_MODE_ON; Command; IO control	TriggerMode; Enumeration: On	Not applicable
Trigger mode	VIDIOC_TRIGGER_MODE_OFF; Command; IO control	TriggerMode; Enumeration: Off	Not applicable
Trigger activation	VIDIOC_TRIGGER_ ACTIVATION_RISING_EDGE; Command; IO control	TriggerActivation; Enumeration: RisingEdge	Not applicable

Table 71: Image control > Triggering comparison

Functionality	IOCTLs; Data type: (Options); [Unit]; Control type	SFNC features (Selector Feature)/Feature; Data type: (Options); [Unit]	Remarks
Trigger activation	VIDIOC_TRIGGER_ ACTIVATION_FALLING_EDGE; Command; IO control	TriggerActivation; Enumeration: FallingEdge,	Not applicable
Trigger activation	VIDIOC_TRIGGER_ ACTIVATION_ANY_EDGE; Command; IO control	TriggerActivation; Enumeration: AnyEdge	Not applicable
Trigger activation	VIDIOC_TRIGGER_ ACTIVATION_LEVEL_HIGH; Command; IO control	TriggerActivation; Enumeration: LevelHigh	Not applicable
Trigger activation	VIDIOC_TRIGGER_ ACTIVATION_LEVEL_LOW; Command; IO control	TriggerActivation; Enumeration: LevelLow	Not applicable
Trigger source set	VIDIOC_S_TRIGGER_SOURCE; Command; IO control	TriggerSource; Enumeration: Software, Line0, Line1	Not applicable
Trigger source get	VIDIOC_G_TRIGGER_SOURCE; Command; IO control	TriggerSource; Enumeration: Software, Line0, Line1	Not applicable
Trigger software	VIDIOC_TRIGGER_SOFTWARE; Command; IO control	TriggerSoftware; Command	Not applicable

Table 71: Image control > Triggering comparison

Camera control > Advanced triggering

The following controls are used to output signals to trigger other devices by the camera.

Functionality	**IOCTLs;** Data type: (Options); [Unit]; Control type	**SFNC features** (Selector Feature)/Feature; Data type: (Options); [Unit]	**Remarks**
Exposure Active Output Line	Not applicable	LineMode; Enumeration: Output	Exposure Active Output Line selects a line to output the **Exposure Active** signal, LineMode selects a line to output **any** signal.
Exposure Active Line Mode	Not applicable	TriggerSelector; Enumeration: ExposureActive	Not applicable
Line Configuration	Not applicable	LineMode; Enumeration: Out LineInverter; Boolean: True	Line Status includes the functions of both SFNC features.
Line Status	Not applicable	Not applicable	Not applicable

Table 72: Image control > Advanced triggering comparison

Using controls and features

Many V4L2 controls have GenICam feature equivalents. The differences are described in the following table. Standards define functionalities in general, value ranges and available options may differ between different cameras.

Exposure time

Description	**V4L2 controls (Control IDs)**	**SFNC features or *non-SFNC*** Feature; Data type: Options
Exposure is set manually	V4L2_CID_EXPOSURE	ExposureAuto; Enumeration: Off ExposureMode; Enumeration: Timed ExposureTime; Float [µs]
Exposure is set manually	V4L2_CID_EXPOSURE_ABSOLUTE	Derived from *Universal Video Class (UVC): Exposure Time (Absolute) Control*; Integer
Auto exposure is disabled.	V4L2_EXPOSURE_MANUAL	ExposureAuto; Enumeration: Off ExposureMode; Enumeration: Timed ExposureTime; Float [µs]
V4L2 controls only: Auto exposure is set in general.[1]	V4L2_CID_EXPOSURE_AUTO	ExposureAuto; Enumeration: On ExposureMode; Enumeration: Timed
Minimum value for auto exposure time is set.	Not applicable	*ExposureAutoMin*; Float
Maximum value for auto exposure time is set.	Not applicable	*ExposureAutoMax*; Float

[1]By default, the pixel intensity is adjusted to a target value of 50% of the mean. Use `Intensity Auto` register control to adjust the target value or to set the priority between `Exposure Auto` and `Gain Auto`. See the Direct Register Access Controls Reference for details.

Table 73: Using Exposure time

Gain

Analog gain equals digital gain for Alvium CSI-2 cameras.

Description	V4L2 controls (Control IDs)	SFNC features Feature; Data type: Options
Gain is set manually.	V4L2_CID_GAIN	Gain; Float
Gain is set automatically.[1]	V4L2_CID_AUTOGAIN (Active continuously)	GainAuto; Enumeration: Continuous
Minimum value for auto gain is set.	Not applicable	*GainAutoMin*; Float
Maximum value for auto gain is set.	Not applicable	*GainAutoMax*; Float
[1]By default, the pixel intensity is adjusted to a target value of 50% of the mean. Use `Intensity Auto` register control to adjust the target value or to set the priority between `Exposure Auto` and `Gain Auto`. See the Direct Register Access Controls Reference for details.		

Table 74: Using Gain

White balance and balance ratio

V4L2 and GenICam offer different concepts for color balance: white balance and separate balance for blue and red.

Description	V4L2 controls (Control IDs)	SFNC features or *non-SFNC* Feature; Data type: Options
White balance is set once automatically. Afterwards, settings are maintained.	V4L2_CID_DO_WHITE_BALANCE Action control	BalanceWhiteAuto; Enumeration: Once
White balance is adjusted continuously.	V4L2_CID_AUTO_WHITE_BALANCE	BalanceWhiteAuto Enumeration: Continuous
According to the HSV/HSL color model, values rotate from-180° × 100 = -18000 to 180° × 100 = 18000. For example, 0 represents cyan and 18000 =-18000 represents red.	V4L2_CID_HUE	*Universal Video Class (UVC): Hue Control*

Table 75: Using Balance ratio and Hue (sheet 1 of 2)

Description	V4L2 controls (Control IDs)	SFNC features or *non-SFNC* Feature; Data type: Options
The blue color channel is balanced.	V4L2_CID_BLUE_BALANCE	BalanceRatioSelector: Enumeration: Blue BalanceRatio: The value is set
The red color channel is balanced.	V4L2_CID_RED_BALANCE	BalanceRatioSelector: Enumeration: Red BalanceRatio: The value is set

Table 75: Using Balance ratio and Hue (sheet 2 of 2)

Intensity auto

The following control group is used to select the priority between auto controls and target values for auto controls.

Description	V4L2 controls (Control IDs)	SFNC features or *non-SFNC* Feature; Data type: Options
The priority between auto controls is selected.	Not applicable	*IntensityAutoPrecedence*; Enumeration: Minimize noise, Minimize blur
The target value for pixel intensity with auto controls is set. The default value is 50%.	Not applicable	*Intensity Auto Target Value*[1]
The minimum available value for pixel intensity with auto controls is displayed.	Not applicable	*Intensity Auto Target Minimum Value*[1]
The maximum available value for pixel intensity with auto controls is displayed.	Not applicable	*Intensity Auto Target Maximum Value*[1]
The increment value for pixel intensity with auto controls is displayed.	Not applicable	*Intensity Auto Target Increment*[1]
[1]Register control, unavailable as SFNC feature.		

Table 76: Using Intensity auto

ROI / Cropping

For ROI (SFNC) or Cropping (V4L2), a set of features or controls is used. When width and height are set with Alvium cameras, the image is not scaled. Instead, a section or ROI of the image is acquired.

Description	**V4L2 IOCTLs**	**SFNC features** Feature; Data type; [Unit]
Limits for cropping are displayed.	VIDIOC_CROPCAP; I/O control	Not applicable
The pixel format is set.	VIDIOC_S_FMT	PixelFormat; Enumeration
The pixel format is displayed.	VIDIOC_G_FMT	PixelFormat; Enumeration
The available width is displayed.	VIDIO_G_FMT struct v4l2_format .v4l2_pix_format.width; Integer; [pixels]; I/O control	WidthMax; Integer; [pixels]
The available height is displayed.	VIDIO_G_FMT struct v4l2_format .v4l2_pix_format.height; Integer; [pixels]; I/O control	HeightMax; Integer; [pixels]
The width is set. Setting values requires the VIDIOC_S_CROP I/O control.	VIDIOC_S_CROP struct v4l2_crop .v4l2_rect.width; Integer; [Pixel]; I/O control	Width; Integer; [Pixel] Width, height and offsets are set simultaneously.
The height is set. Setting values requires the VIDIOC_S_CROP I/O control.	VIDIOC_S_CROP struct v4l2_crop .v4l2_rect.height; Integer; [pixels]; I/O control	Height; Integer; [pixels] Width, height and offsets are set simultaneously.
The horizontal offset is set. Setting values requires the VIDIOC_S_CROP I/O control.	VIDIOC_S_CROP struct v4l2_crop .v4l2_rect.left Integer; [Pixel]; I/O control	OffsetX; Integer; [Pixel] Width, height and offsets are set simultaneously.
The vertical offset is set. Setting values requires the VIDIOC_S_CROP I/O control.	VIDIOC_S_CROP struct v4l2_crop .v4l2_rect.top; Integer; [pixels]; I/O control	OffsetY; Integer; [pixels] Width, height and offsets are set simultaneously.

Table 77: Using ROI and Cropping

Installing the hardware

This chapter includes:

Touching hot cameras

CAUTION

Risk of burns

A camera in operation can reach temperature levels which could cause burns.

- Wear protective gloves when you touch a camera that is heated up.
- Ensure proper cooling of the camera.

Scope of instructions

Software installation

Software downloads and documentation

This chapter describes hardware installation only. For information on supported Linux distributions and embedded boards, drivers, libraries, and programming examples, see www.alliedvision.com/en/products/software/embedded-software-and-drivers.

Hardware installation

This chapter instructs on using Alvium CSI-2 cameras safely and effectively. However, we cannot provide complete information. The MIPI CSI-2 standard does not specify electrical connections as extensively as USB or GigE standard. Therefore, instructions on camera connections can be general only.

Bare board cameras

If you intend to design an application using bare board cameras, please consider:

- Aligning the sensor to the lens is extremely difficult and expensive. Therefore, we recommend you to do evaluation with housed cameras first.
- Bare board cameras are specialized components. We cannot give all data needed for any application in advance.
- Please let us partner with you for bare board camera applications to ensure a successful design.

Serial numbers of Alvium® chips and bare board cameras

Bare board cameras do not have enough space for a label with all the required information. Therefore, they are shipped with a 25 mm × 25 mm sandwich label on the blister pack. This label shows, for example:

- Product code: 11500 for a 1500 C-210c Bare Board camera
- Alvium® chip SN (serial number): 183603543
- Camera SN (serial number): R7QW5 as digits and 2D code.

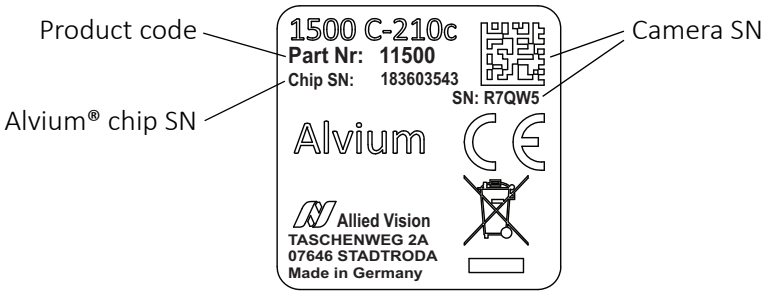


Figure 43: Sandwich label on blister packs shipped for bare board cameras

Before operating the camera, we recommend you to pull the sandwich label off the blister pack and stick it close to the camera.

If the label is lost, please read out with your smart phone the serial number of the Alvium® chip from the 2D code (a). With this number, we can look up the serial number of the camera in our database.

If your smart phone cannot read the 2D code: Combine the four digits (b) with the five digits (c). In the example, the serial number is 183603543.

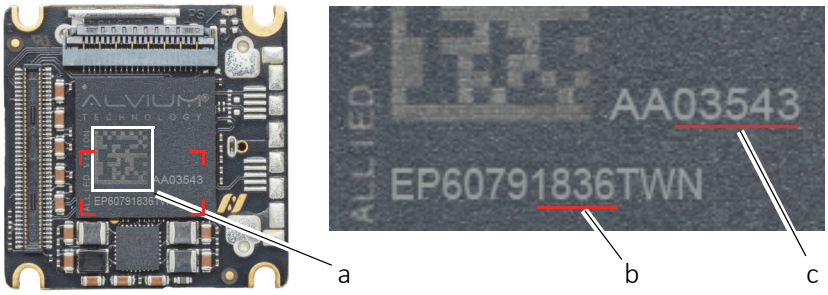


Figure 44: Alvium® chip imprint version 1 with detail view (right)

Future bare board cameras follow the convention shown in Figure 45. String (d) is the serial number, in the example, it is 205203543.

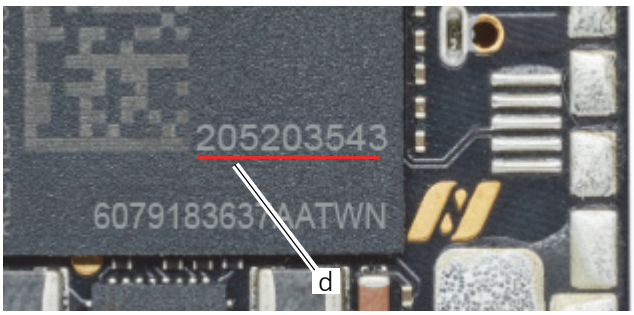


Figure 45: Alvium® chip imprint version 2

Connecting FPC cable and FPC connectors

Connecting Alvium CSI-2 cameras to embedded boards

- For evaluation, Allied Vision offers components to connect Alvium CSI-2 cameras to embedded boards. **Adapter boards** provide common pinning and voltage for connections to the camera using **FPC cables**.
  See the Alvium Cameras Accessory Guide at www.alliedvision.com/en/support/technical-documentation/alvium-csi-2-documentation under Additional documents.
- If you want to design your own components to connect Alvium CSI-2 cameras to embedded boards, contact your Allied Vision Sales representative or Allied Vision Support at support@alliedvision.com.

Figure 46 shows how the FPC cable connects to the FPC connector.

Follow the instructions to connect the FPC cable to the camera and to the embedded board.

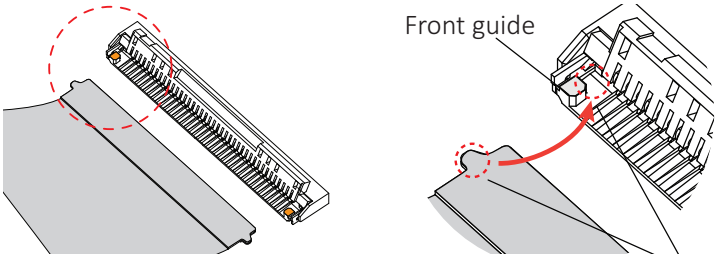


Figure 46: FPC cable and FPC connector (open position)

1. Opening the FPC connector:
   With your fingernail*, flip the actuator to open position at 105 degrees to the PCB surface, see Figure 47.

   *Or a plastic tool, because metal tools can damage the actuator.

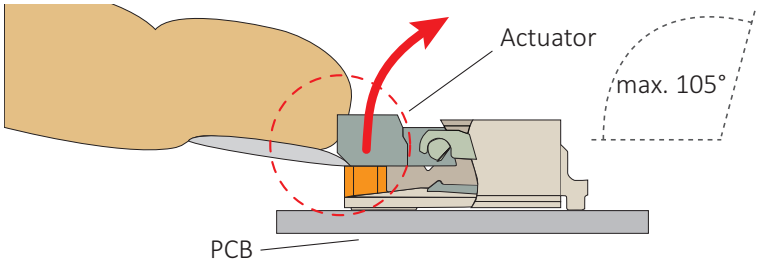


Figure 47: Opening the FPC connector

NOTICE

Damage to the camera by reverse polarity

If Alvium CSI-2 cameras are powered with reverse polarity, camera electronics is damaged.

- Before connecting camera power and I/O power, carefully read FPC connector pin assignment on page 153.
- Connect the cable as shown in this section.

Embedded board or adapter board

Camera

Figure 48: FPC cable and image data direction

2. **Ensuring proper cable direction between host and camera**, take the FPC cable with conductors facing the FPC connector conductors (see Figure 49).

3. Inserting the FPC cable:
At a horizontal angle of 90 degrees to the connector's rear (see Figure 49) and at a vertical angle of 12 degrees to the PCB (see Figure), slowly insert the FPC cable into the actuator...

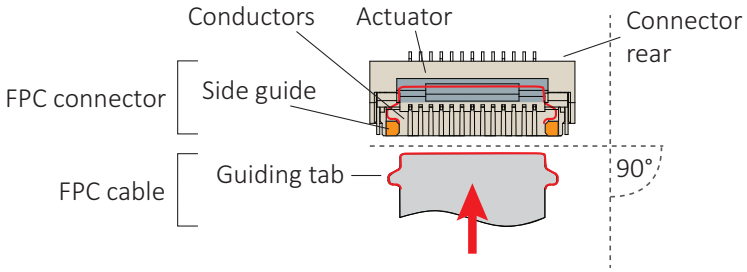


Figure 49: FPC cable and FPC connector

4. ...until cable guiding tabs are caught between connector rear and side guides (see Figure 49). Pull the cable slightly to ensure guiding tabs are properly engaged.

5. Holding the FPC cable in position, flap down the actuator to closed position (see Figure).

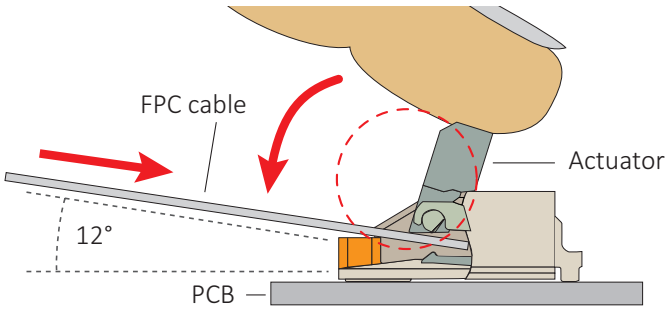


Figure 50: Engaging the FPC cable in the FPC connector

NOTICE

Damage to FPC connectors

A bended FPC cable can break the FPC connector's actuator.

Provide sufficient strain relief at both ends of the cable.

Mounting the heat sink

Keep the operating temperature in the specified range to enable best image quality and to protect the camera from damage. We recommend you to equip Alvium bare board and open housing cameras with heat sinks.

Optimizing heat dissipation

For details, see the Optimum Heat Dissipation for Housed Alvium Cameras application note at www.alliedvision.com/en/support/technical-documentation/alvium-csi-2-documentation under Additional documents.

NOTICE

Damage to the camera by heat sinks mounted improperly

- Allow mechanical contact only at the cooling areas.
- Avoid any mechanical stress to the sensor and electronics area.
- Avoid short circuits of the electronics components.

NOTICE

Damage to the sensor, filter, and lens by corrosive substances

Some conductive media for heat sinks contain corrosive substances that can damage optical surfaces of the sensor, filter, and lens.

- Cover the optical path of the camera when you apply heat sink compound or adhesive to prevent substances and fumes from damaging optical surfaces.
- Adhere to the instructions and safety notes provided by the manufacturer of the conductive media.

NOTICE

Damage to camera electronics

Heat sinks can cause short circuits if they are not electrically isolated.

Avoid electrical contact between electronic components by unsuitable heat sinks and thermal conductive media.

Connect components in the **cooling areas** (blue areas in Figure 51) to a heat sink, following the instructions of the manufacturer of the heat sink and the thermal conductive media.

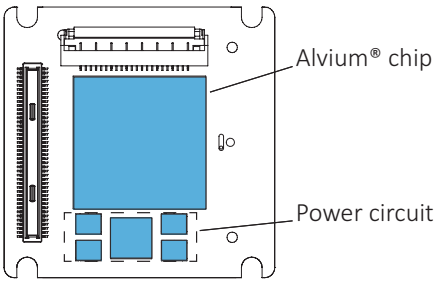


Figure 51: Cooling areas for Alvium CSI-2 bare board cameras

Mounting the camera

CAUTION

Injury by falling cameras or lenses

A falling camera or lens can cause injury.

- Ensure proper mounting of cameras and lenses, especially for dynamic applications.
- Mount cameras as described in the instructions.
- Always make sure the mounting threads are intact.
- Fasten screws with maximum torque, using the entire thread engagement. For less thread engagement, see Adapting maximum torque values on page 146.
- We recommend you to apply thread locking.
- Use a lens support for heavy lenses.

Mounting bare board cameras

Heat dissipation and electromagnetic compatibility for bare board cameras

For heat dissipation, see the Optimum Heat Dissipation for Housed Alvium Cameras application note.

For electromagnetic compatibility, see the Electromagnetic Compatibility for Open Housing Alvium Cameras application note.

See www.alliedvision.com/en/support/technical-documentation/alvium-csi-2-documentation under **Additional documents**.

NOTICE

Damage to the camera by improper mounting

- Allow mechanical contact only at the mounting area.
- Avoid any mechanical stress to the sensor and the electronics area.
- Avoid short circuits of the electronics components.
- Give 2 mm minimum clearance above board components.
- Tighten screws at 0.1 Nm maximum torque.

Schematic drawings in Figure 52 show the Alvium CSI-2 bare board camera. Only the mounting area (gray) can be used for mounting. The sensor and electronics area (red) must not be touched nor put at mechanical stress.
a = Mounting hole | b = Mounting hole and chassis ground

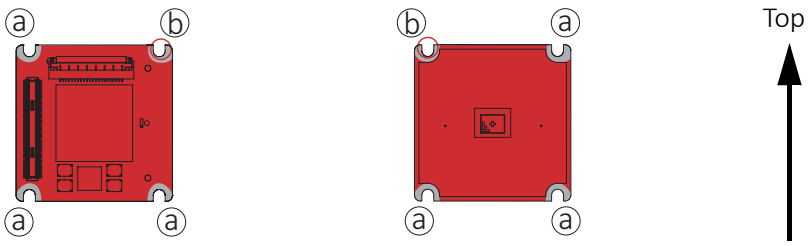


Figure 52: Mounting area of Alvium CSI-2 bare board cameras connector side (left); sensor side (right)

Mount the bare board with four M2 screws at 0.1 Nm maximum torque.

Mounting open housing cameras

Bottom or top mounting

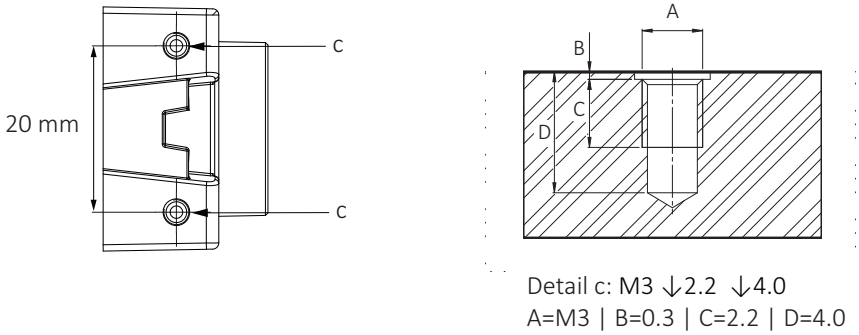


Figure 53: Top and bottom and mounting threads (c)

The maximum torque value applies only if the entire thread engagement is used. For other values, see Adapting maximum torque values on page 146.

1. Mount the camera to the base using suitable M3 screws at 0.51 Nm maximum torque for a thread engagement (C) of 2.2 mm between screws and mounting threads, see Figure 53. For technical drawings, see Dimensions and mass on page 107.
2. Continue with Mounting the lens on page 147.

Front mounting

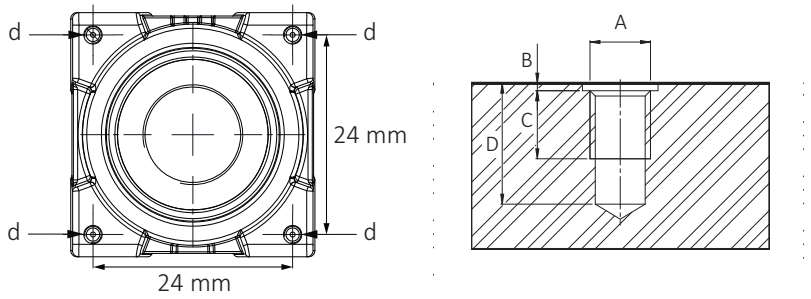


Figure 54: Camera front with mounting threads (d)

The maximum torque value applies only if the entire thread engagement is used. For other values, see Adapting maximum torque values on page 146.

1. Mount the camera to the base using suitable M2 screws at 0.17 Nm maximum torque for a thread engagement (C) of 1.7 mm between screws and mounting threads, see Figure 54. For technical drawings, see Dimensions and mass on page 107.
   We recommend you to additionally use bottom and top mounting threads for a more solid connection.
2. Continue with Mounting the lens on page 147.

Adapting maximum torque values

The total bolt length composes of the mounting holes length and the height of your mounting base.

For using less than the stated length of thread engagement, calculate maximum torque as follows:

$$\frac{\textbf{Current length of thread engagement}}{\text{Length of thread engagement in table}} \times \text{Torque in table} = \textbf{Current torque}$$

Example for a length of thread engagement of **1.4 mm** instead of 1.7 mm:
1.4 mm / 1.7 mm × 0.17 Nm = **0.14 Nm**

Thread group	Thread position	Thread type	Total protrusion	Length of thread engagement	Maximum torque
d	Front mounting	M2	2 mm	1.7 mm	0.17 Nm
d	Front mounting	M2	2 mm	**1.4 mm**	**0.14 Nm**

Table 78: Adjusting maximum torque values

To ensure that the bolts do not become loose over time, we recommend you to use means for securing bolts, such as screw locking varnish.

Tripod adapter

For more information, see the Alvium Cameras Accessory Guide at www.alliedvision.com/en/support/technical-documentation/alvium-csi-2-documentation under Additional documents.

Mounting the lens

Observe the following notes before you mount lenses to Alvium CSI-2 cameras.

CAUTION

Injury by falling cameras or lenses

A falling camera or lens can cause injury.

- Ensure proper mounting of cameras and lenses, especially for dynamic applications.
- Mount cameras as described in the instructions.
- Use a lens support for heavy lenses.

CAUTION

Risk of cuts by sharp edges of lens mounts

The threads of the lens mount can have sharp edges.

Be careful when mounting or unmounting lenses.

NOTICE

Damage to sensor, optics, or electronics by unsuitable lenses

The sensor, filter, lens, or electronics can be damaged if a lens exceeding maximum protrusion is mounted to the camera.

- Use lenses only up to the specified maximum protrusion, see Lens mounts and maximum protrusion on page 112.
- S-Mount lenses must be screwed into the camera at less than maximum protrusion (11.0 mm), see Mounting and focusing S-Mount lenses on page 148.
- Avoid short S-Mount lenses falling into the camera.

Mounting and focusing S-Mount lenses

Allied Vision S-Mount lenses

For technical data of Allied Vision S-Mount lenses with dedicated operating instructions, see the S-Mount Lenses User Guide at www.alliedvision.com/en/support/technical-documentation/accessory-documentation under Lenses.

This section instructs how to use S-Mount lenses with your camera safely.

S-Mount lenses are screwed into the mount to adjust focus. Vibration moves lenses out of position. Several techniques can be used to fasten S-Mount lenses in focus. We recommend using fixing nuts. See instructions in this section.

Drawings and fixing nuts

Drawings in the instructions are schematic.

Several manufacturers offer various types of S-Mount fixing nuts. The type shown in the instructions drawings is an example.

We recommend using pinch nose pliers to tighten fixing nuts.

Figure 55 shows how fixing nuts lock S-Mount lenses.

Follow the instructions to lock the lens in focus position.

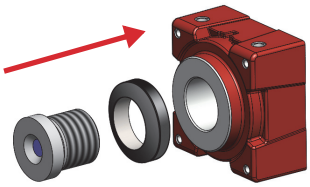


Figure 55: Fixing nut locking an S-Mount lens

NOTICE

Damage to sensor, optics, or electronics by improper handling

If an S-Mount lens is screwed against the sensor or electronics, sensor, lens, or electronics can be damaged.

- Screw in the lens at less than 11.0 mm maximum protrusion.
- Follow the instructions carefully.

Determining the allowed range for the position of the lens

1. Measure the length of the lens.
2. Calculate: **a = c – b**
   a: length of the mounted lens, measured from lens mount front flange
   b: maximum protrusion (11.0mm)
   c: length of the lens

   See Lens mounts and maximum protrusion on page 112.
3. Set a gauge to the length of (a).

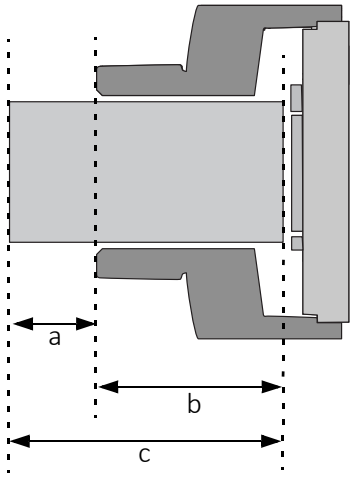


Figure 56: S-Mount lens and protrusion

Mounting the fixing nut to the lens

4. Screw the fixing nut clockwise onto the lens until you can hold the front part (d) of the lens with your finger tips.

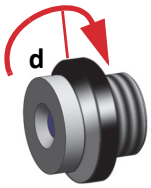


Figure 57: Lens and fixing nut

Focusing the lens

5. **Checking (a) with a gauge**, slowly screw the lens clockwise into the lens mount until the image is roughly in focus.
6. Slowly screw in and unscrew the lens until you have found the most accurate focus.

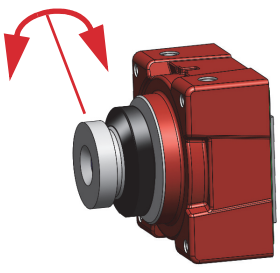


Figure 58: Adjusting focus

NOTICE

Damage to lens threads and fixing nut by excessive force

If the fixing nut is screwed with too much force, threads are worn out and the lens cannot be locked anymore.

Screw fixing nuts hand tight to keep the lens in a fixed position.

Locking focus

Pinch nose pliers are used to screw the fixing nut:

7. Holding the lens in position with one hand, screw the fixing nut clockwise against the lens mount until you feel the lens is locked.

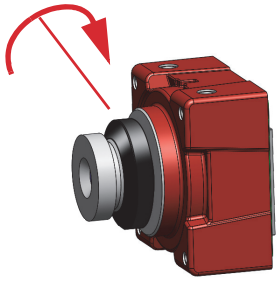


Figure 59: Tightening the fixing nut

Checking focus is set and locked properly

8. Check No.1: Try to rotate the lens with little force in both directions to ensure the lens is safely locked in position.

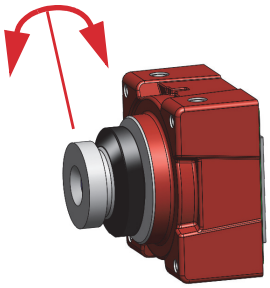


Figure 60: Checking lens is safely locked

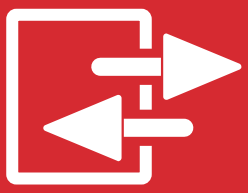
9. Check No. 2: S-Mount thread allows a slightly tilted lens position. In this case, focus for a common object plane varies over the image plane.
   If focus is constant over the image plane, you are done.
   If focus varies over the image plane, the lens is tilted. Continue with 10.

10. Loosen the fixing nut.

11. Continue with 6.

    The lens is locked in focus and ready for operation.

Camera interfaces



This chapter includes:

Recommended accessories

Compatible electronics accessories

For more information, see the Alvium Cameras Accessory Guide at www.alliedvision.com/en/support/technical-documentation/alvium-csi-2-documentation under Additional documents.

Back panel

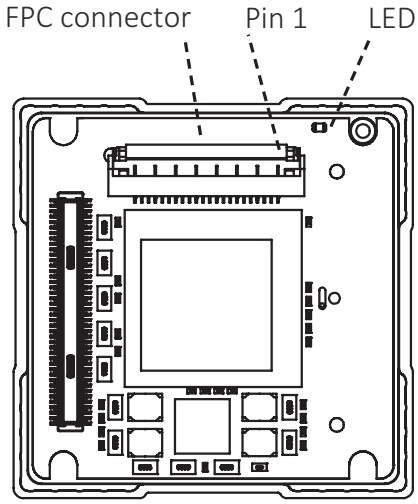


Figure 61: Camera back panel

For connector pin assignment, see FPC connector pin assignment on page 153.

FPC connector pin assignment

Alvium CSI-2 cameras have a 22-pin Hirose FH55-22S-0.5SH connector.

NOTICE

Damage to the camera by reverse polarity

If Alvium CSI-2 cameras or camera I/Os are powered with reverse polarity, camera electronics can be damaged.

Observe polarity for camera and I/O power.

More information on Hirose FH55-22S-0.5SH connector

For technical data and more instructions on the Hirose FH55-22S-0.5SH connector, see the manufacturer data sheet at www.hirose.com.

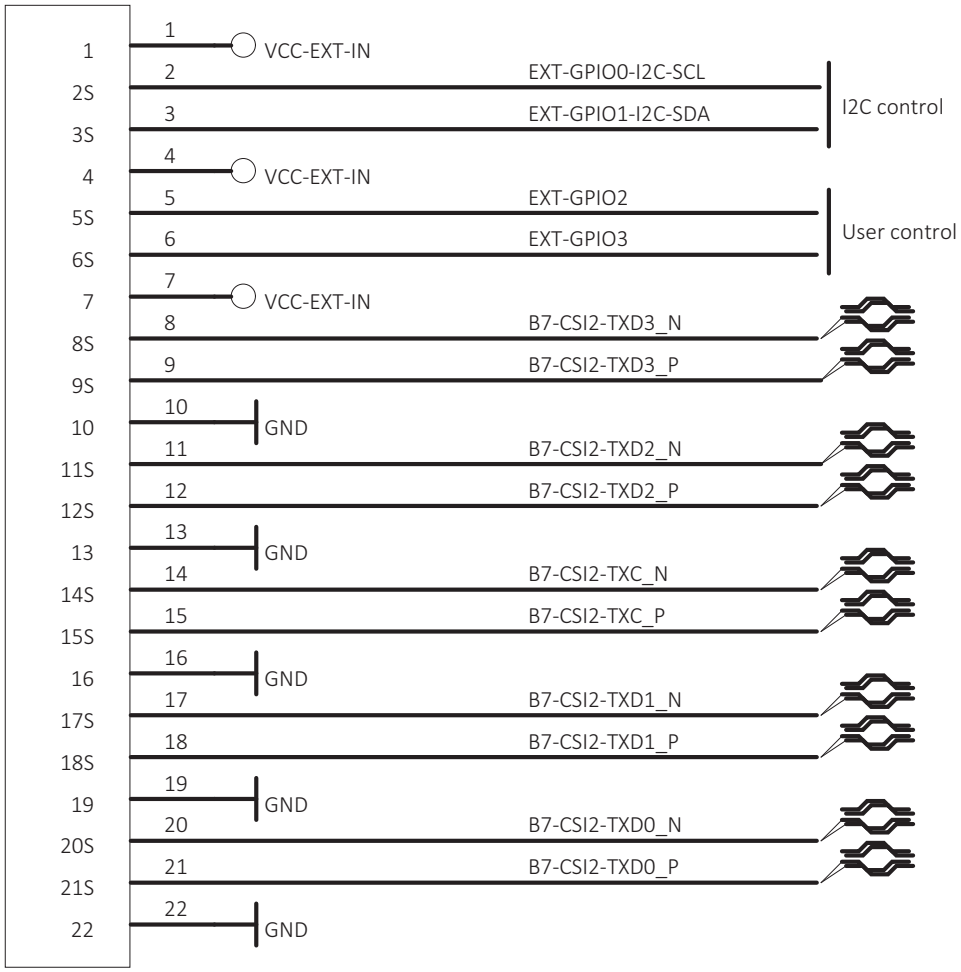


Figure 62: Camera Hirose FH55-22S-0.5SH connector pin assignment

Pin	Signal	Direction	Level	Description
1	VCC-EXT-IN	PWR IN	4.5 to 5.5 VDC	Power supply voltage Maximum input current: 1.5 A
2	EXT-GPIO 0	IN/OUT	U_{in} (low) = -0.3 to 0.8 VDC U_{in} (high) = 2.0 to 5.5 VDC U_{out} (low) = 0 to 0.4 VDC U_{out} (high) = 2.4 to 3.3 VDC at 12 mA	I2C Control Internal pull-up resistor: 33 to 63 kΩ
3	EXT-GPIO 1	IN/OUT	See Pin 2, EXT-GPIO 0	
4	VCC-EXT-IN	PWR IN	4.5 to 5.5 VDC	Power supply voltage Maximum input current: 1.5 A
5	EXT-GPIO 2	IN/OUT	U_{in} (low) = -0.3 to 0.8 VDC U_{in} (high) = 2.0 to 5.5 VDC U_{out} (low) = 0 to 0.4 VDC U_{out} (high) = 2.4 to 3.3 VDC at 12 mA	GPIO Internal pull-up resistor: 33 to 63 kΩ
6	EXT-GPIO 3	IN/OUT	See Pin 5, EXT-GPIO 2	
7	VCC-EXT-IN	PWR IN	4.5 to 5.5 VDC	Power supply voltage Maximum input current: 1.5 A
8	CSI2-TXD3_N	OUT	According to MIPI CSI-2 D-PHY V1.1	CSI-2 TX data lane 3 negative rail
9	CSI2-TXD3_P	OUT	According to MIPI CSI-2 D-PHY V1.1	CSI-2 TX data lane 3 positive rail
10	GND	PWR	0 VDC	Power supply ground
11	CSI2-TXD2_N	OUT	According to MIPI CSI-2 D-PHY V1.1	CSI-2 TX data lane 2 negative rail
12	CSI2-TXD2_P	OUT	According to MIPI CSI-2 D-PHY V1.1	CSI-2 TX data lane 2 positive rail
13	GND	PWR	0 VDC	Power supply ground
14	CSI2-TXC_N	OUT	According to MIPI CSI-2 D-PHY V1.1	CSI-2 TX clock lane negative rail
15	CSI2-TXC_P	OUT	According to MIPI CSI-2 D-PHY V1.1	CSI-2 TX clock lane positive rail
16	GND	PWR	0 VDC	Power supply ground
17	CSI2-TXD1_N	OUT	According to MIPI CSI-2 D-PHY V1.1	CSI-2 TX data lane 1 negative rail
18	CSI2-TXD1_P	OUT	According to MIPI CSI-2 D-PHY V1.1	CSI-2 TX data lane 1 positive rail
19	GND	PWR	0 VDC	Power supply ground
20	CSI2-TXD0_N	OUT	According to MIPI CSI-2 D-PHY V1.1	CSI-2 TX data lane 0 negative rail
21	CSI2-TXD0_P	OUT	According to MIPI CSI-2 D-PHY V1.1	CSI-2 TX data lane 0 positive rail
22	GND	PWR	0 VDC	Power supply ground

Table 79: Camera FPC connector pin assignment

Non-isolated, programmable GPIOs

Available GPIOs

From four GPIOs, I2C uses two GPIOs for control traffic. Therefore, only two GPIOs are available for user control of the camera.

I/O cables maximum length

The maximum length for I/O cables must not exceed 30 m.

GPIOs description

The camera has four non-isolated GPIOs that can be configured by software to act as inputs or outputs.

Alvium GPIOs use the push-pull technology to switch the signal level between low and high. For low levels, the signal is "pulled" down towards ground level. For high levels, the signal is "pushed" up towards VCC level.

Alvium GPIOs feature the CMOS push-pull output drivers and Schmitt trigger inputs with an internal pull-up resistor and a filter circuit, shown in Figure 63. The push-pull GPIOs are able to source or sink current from an external pin.

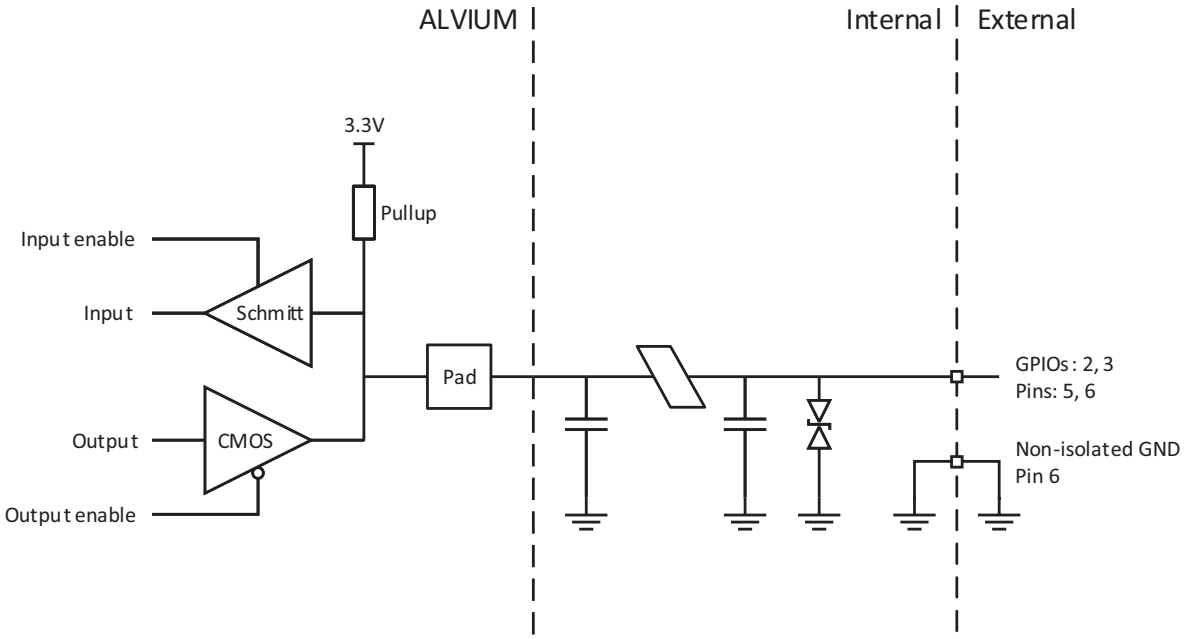


Figure 63: GPIOs block diagram

Input levels

The GPIOs can be connected directly to the system controlling the camera for voltages up to 5.5 VDC. An external resistor is not necessary.

NOTICE

Damage to the camera by high input voltage

Exceeding maximum input voltage can damage the camera.

Keep maximum input voltage below 5.5 VDC.

Parameter	Value
U_{in} (low)	-0.3 to 0.8 VDC
U_{in} (high)	2.0 to 5.5 VDC
Undefined levels	0.8 to 2.0 VDC

Table 80: GPIOs as input, voltage levels

Output levels

NOTICE

Damage to the camera by high output current or voltage

The camera can be damaged when connected to a device that exceeds the specified maximum current or voltage. Consider maximum values:

- Max. current = 12 mA per output
- Max. Out VCC = 3.3 VDC

Parameter	Value
External output voltage U_{out} (low)	0 to 0.4 VDC
External output voltage U_{out} (high)	2.4 to 3.3 VDC
Undefined levels	0.4 to 2.4 VDC
Maximum external output voltage	3.3 VDC
Maximum output current	12 mA

Table 81: GPIOs as output, current and voltage levels

Output voltage for U_{Out} (high) = On state

The voltage level in the On state depends on the load current. Higher currents yield lower voltage.

Status LED

Alvium CSI-2 cameras have a green status LED. The following table describes the flashing pattern indicating different events. Inverse flashing: If the LED is already on, it is switched off for a short time.

Normal operation

LED codes	Behavior	Status
	Continuously active	Power on or idle state
	Irregular flashing	Command or image traffic, such as for camera startup
	Four short flashes and code sequence	Error state

Table 82: LED codes for normal operation

Error conditions

Four short flashes followed by another sequence indicate errors. In this case, try the following to get the camera back to normal operation:

1. Restart the camera.
2. If the LED again indicates error state after restart, please contact support@alliedvision.com

Triggering

This chapter includes:

Availability of triggering controls

Alvium CSI-2 cameras can be triggered by the following boards:

- NVIDIA Jetson AGX Xavier Developer Kit
- NVIDIA Jetson Nano Developer Kit
- NVIDIA Jetson TX2 Developer Kit
- NVIDIA Jetson Xavier NX Developer Kit.

Downloads

Some boards have restrictions. For more information, go to the examples repository on https://github.com/alliedvision.

Use the NVIDIA Jetson driver provided at https://github.com/alliedvision/linux_nvidia_jetson

Trigger controls description

For more information on triggering controls, see the Direct Register Access Controls Reference at www.alliedvision.com/en/support/technical-documentation/alvium-csi-2-documentation.

The current firmware supports Frame Start Trigger controls by software or external line signals. Other trigger controls known from GenICam features are not supported.

Some controls may not be supported by all camera models.

Trigger signal flow

Figure 64 shows an ideal diagram for the trigger signal flow for Alvium CSI-2 cameras. The external signal can be a physical source, such as light barrier as hardware trigger or a software trigger. This external signal starts the exposure of a frame. The end of exposure starts the readout. High levels show the active state of a signal. The different **signals display the workflow**, not user controls.

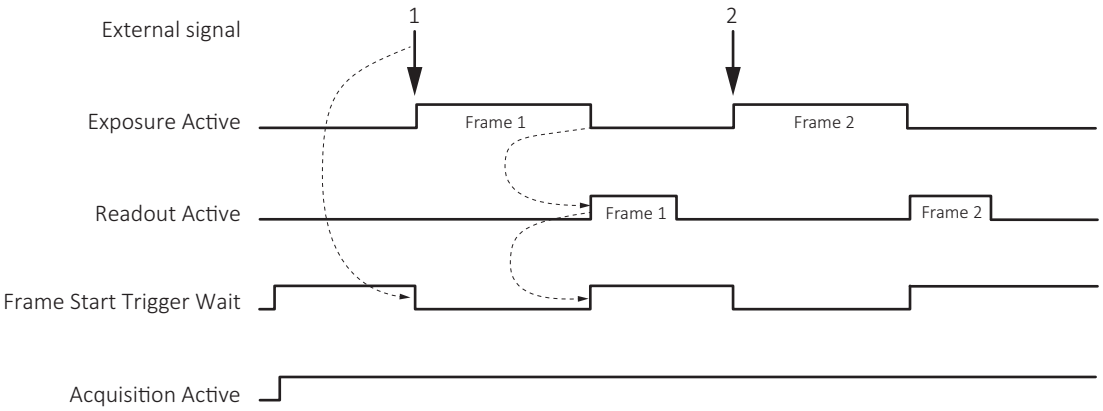


Figure 64: Trigger signal flow

Term	Description
External signal	Electrical trigger signal starting the signal flow
Exposure Active	Exposing a frame
Readout Active	Reading out a frame
Frame Start Trigger Wait	Waiting for a trigger
Acquisition Active	Enables frame acquisition: Expose, read out data, or wait for triggers.

Table 83: Trigger signal flow, legend

Trigger latency

In theory, a trigger creates an immediate response of the camera, depending on the cable length. In practice, the computer may add a delay that is mostly unpredictable. In addition, camera electronics and sensors have a delay.

Rolling shutter (RS) cameras in this document also have exposure delay, depending on camera settings, see Triggering with rolling shutter cameras on page 160.

Triggering with rolling shutter cameras

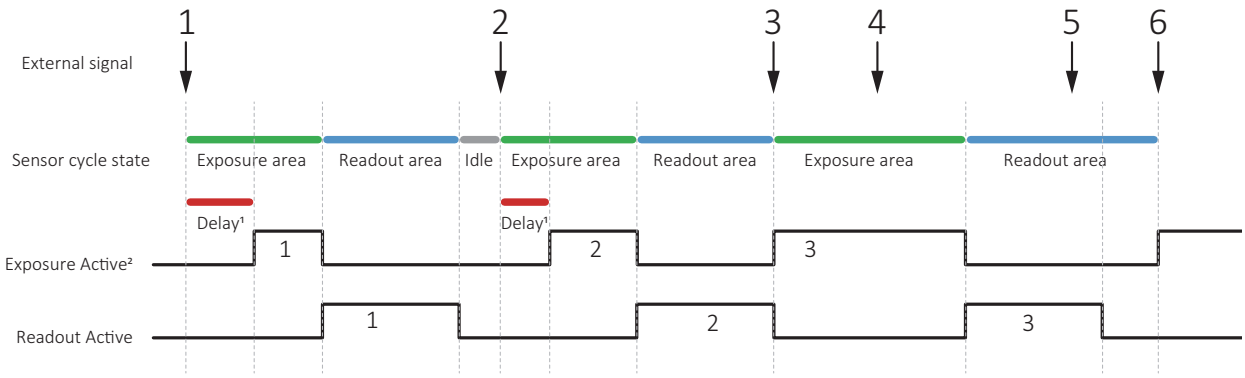
This section describes triggering behavior for **1500 C-210m/c** and **C-500m/c,** and for **1800 C-1240m/c** and **C-2050m/c**. Figure 65 shows how an external signal triggers exposure and readout for cameras with rolling shutter (RS) sensors. Like for global shutter (GS) sensors, readout has a constant duration, acquisition must be active to enable exposure, the end of exposure starts readout.

Rolling shutter (RS) sensors run in cycles where readout area equals exposure area. Overlapping triggering is not supported. If exposure time is shorter than readout time, exposure starts with a delay:

Exposure start delay = exposure area – exposure time.

Signals and controls

The signals displayed in Figure 65 represent logical states, not user controls.



¹Exposure start delay
²Active when all lines are exposing simultaneously. Therefore, Exposure Active is shorter than Exposure Time.

Figure 65: Triggering rolling shutter (RS) cameras

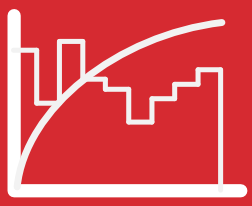
No	Conditions	Results
1	Exposure time is shorter than readout time.	Trigger 1 starts exposure 1 with a delay
2	Exposure time is shorter than readout time, but **longer** than for exposure 1.	Trigger 2 starts exposure 2 with a delay **shorter** than for exposure 1.
3	Exposure time is longer than readout time	Trigger 3 starts exposure time without a delay. Because the exposure area is longer, also the readout area is longer than for triggers 1 and 2
4	Exposure area is ongoing.	Trigger 4 is ignored.
5	Readout area is ongoing	Trigger 5 is ignored.
6	Readout area is finished. Exposure time is longer than readout time.	Trigger 6 starts exposure 6 without a delay

Table 84: Triggering conditions and results

Frame rates in triggered mode

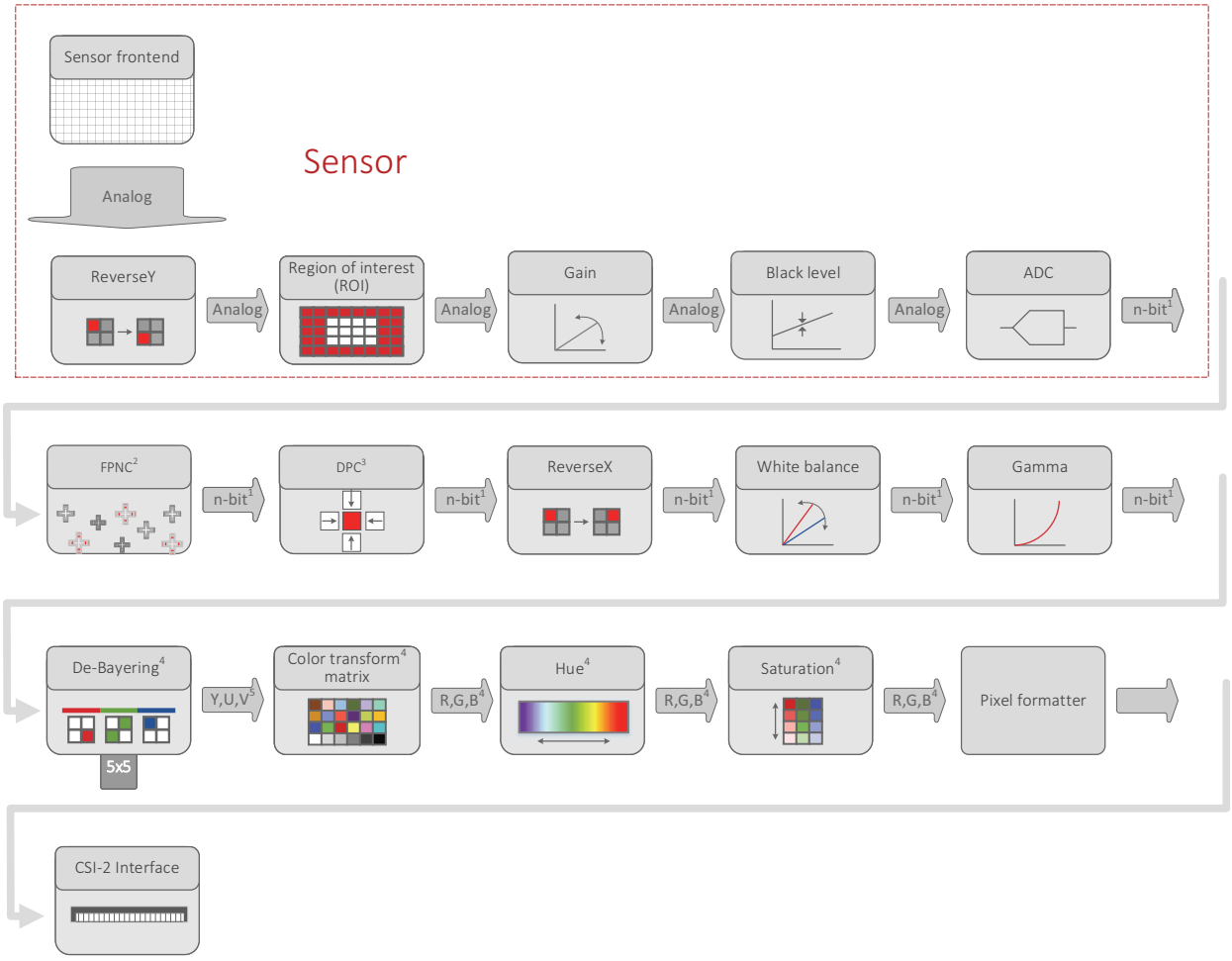
When rolling shutter cameras are operated in triggered mode, the values for maximum frame rate reached in free run mode are cut in half.

Image data flow



This chapter includes an image data flow of Alvium CSI-2 cameras.

Figure 66 shows image data processing in Alvium CSI-2 cameras in general.



[1] Model dependent: See ADC bit depths in Specifications on page 42.

[2] Factory preset for FPNC = Fixed pattern noise correction
The current firmware version does not support FPNC for Alvium 1800 C-2050.

[3] Factory preset for DPC = Defect pixel correction

[4] Color models only

[5] For monochrome models: Y only

Figure 66: Image data flow of Alvium CSI-2 cameras

Control descriptions

The shown functionalities represent controls or groups of controls:

- For V4L2 controls, see www.linuxtv.org.
- For register controls, see the Direct Register Access Controls Reference. See www.alliedvision.com/en/support/technical-documentation/alvium-CSI-2-documentation for details.

Performance

This chapter includes:

Image transfer with rolling shutter cameras

Affected models: **Alvium 1500 C-210m/c, C-500m/c, 1800 C-1240m/c,** and **1800 C-2050m/c**

If acquisition is started and stopped in a short sequence, no image is transferred to the host. The duration cannot be predicted, because it depends on various factors.

Frame rate jitter

Affected models: **Alvium 1500 C-210m/c, C-500m/c, 1800 C-1240m/c,** and **1800 C-2050m/c**

Generally, some parameters can be changed during exposure without affecting the timing. When the camera is operated in freerun mode, changing parameters during exposure leads to a frame rate jitter.

When parameters are entered, the next frame starts only after readout and sensor reconfiguration delay are finished. When the camera is run in `Exposure Auto` mode, the actual frame rate is less than the calculated value for the corresponding exposure time. Consider frame rate jitter for your application.

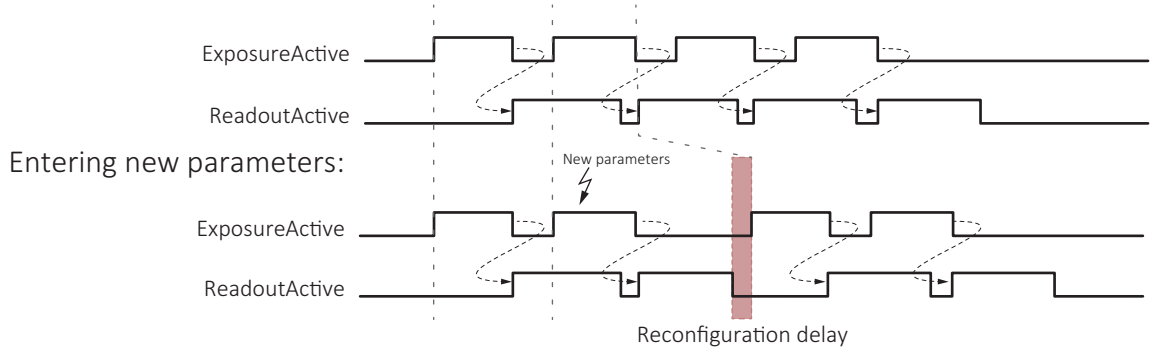


Figure 67: Delayed exposure due to parameter changes

Feature value changes on a streaming camera

Only some controls can be adjusted while the camera is streaming, these include:

`Black Level`	`Gain`	`OffsetY`
`Exposure Auto`	`Gain Auto`	`White Balance Auto`
`Exposure Time`	`OffsetX`	

This list is not complete and will be updated in future document versions.

Latencies

Consider that value changes become effective with latencies based on the sensor and its operation mode (triggered or free run, frame rate).

Value changes by control interdependencies

The conversion between time and clock cycles affects control values. Controls for pixel format, bandwidth, cropping (ROI), and exposure time 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 68 shows the interdependencies.

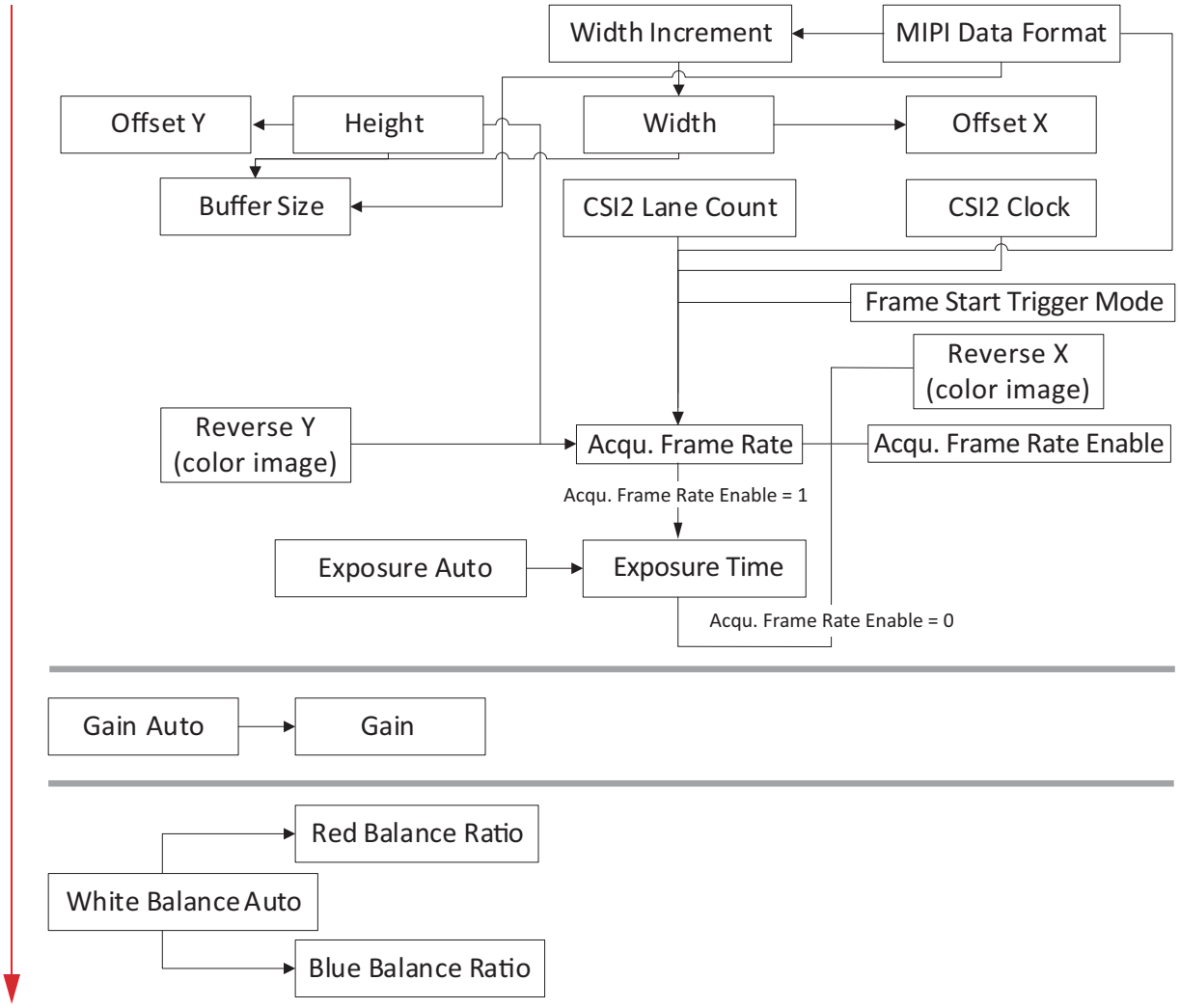


Figure 68: Interdependencies between controls

Effects for the interdependent controls

Changing one control's value affects other control's values, such as:

If: `Height` value is changed.
Then: Other values may be affected, such as for `Exposure Time`.

We recommend you to consider:

- The more controls you adjust, the more current values deviate from previously set values.
- The same effects that apply to `Exposure Time`, also apply to `Exposure Auto`.
- To avoid readjustments, apply settings in the order shown in Figure 68.

Impact by other controls

Input	Output	
	Exposure time values	**Frame rate**
`Exposure Time`	Affected as expected	Affected
`CSI-2 Lane Count`	Affected	Affected
`Height`	Not affected	Affected
`Width`	May be affected	May be affected

Table 85: Impact by other controls

Exposure times and frame rates with rolling shutter cameras

Affected models: **Alvium 1800 C-1240 m/c and C-2050m/c**

Generally, long exposure times result in low frame rates because one is roughly the inverse of the other. With Alvium IMX RS cameras

- The range of available frame rates depends on the exposure time.
- The exposure time must be increased when low frame rates are used.
- The available range for frame rate values depends on the exposure time. If by changing the exposure time, the previous frame rate is moved out of the available range, the frame rate is adjusted automatically.

Dark current compensation

All sensors accumulate dark current in the pixels. Dark current increases the signal level and black level. Most sensors in Alvium CSI-2 cameras compensate for this.

For **Alvium 1500 C-050m/c** with the ON Semi PYTHON 480 sensor, see Black level compensation for 1500 C-050m/c on page 169.

If cameras are operated at high temperatures or exposure times, compensation reaches its limits. The typical compensation mechanism uses a **margin** to compensate for dark current. This works only until dark current reaches the size of the margin. The following table shows the relation of the margin and accumulated dark current for a pixel in 8-bit mode with a maximum value of 255.

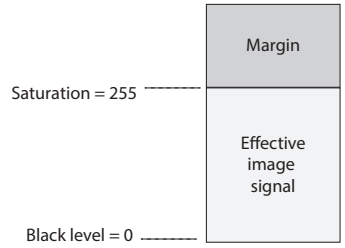
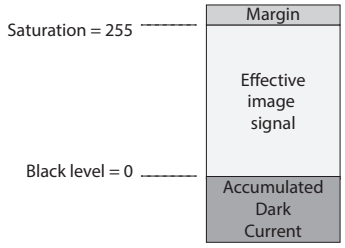
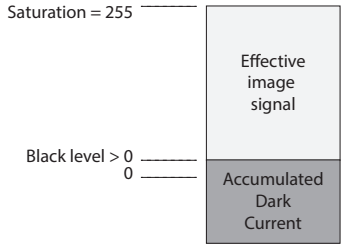
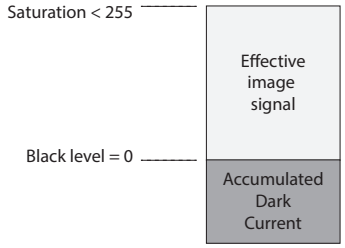
Effective signal versus noise	Description
	The pixel has accumulated no dark current, the margin has maximum size.
	The pixel has accumulated some dark current, reducing the size of the margin.
The following images show a pixel that has accumulated a higher dark current than the margin.	
	The pixel has accumulated dark current, the margin reduces to 0. **Type 1 compensation** • Dark current compensation is stopped. • Dark current increases the black level. • Fixed pattern noise increases.
	The pixel has accumulated dark current, the margin reduces to 0. **Type 2 compensation** (Typically used for sensor-internal compensation, often in the analog domain.) • Dark current compensation stays active. • Maximum saturation signal decreases. • Fixed pattern noise increases.

Table 86: Accumulated dark current affecting the effective image signal

Additional compensation

If compensation limits are reached and you cannot decrease operating temperature or exposure time, what can you do to keep signal quality high?

Measures for type 1 compensation

Alvium 1500 C-050m/c supports compensation type 1. For additional compensation, see Black level compensation for 1500 C-050m/c on page 169.

Typically, there is no measure to improve the image signal.
The rising black level shifts black and dark gray values to gray.

Measures for type 2 compensation

All other Alvium camera models support compensation type 2.

You can increase the margin size by using gain, with the following side effects:

- To give space to a larger margin, the effective pixel capacity decreases.
- White and light gray values are shifted down to gray.

Black level compensation for 1500 C-050m/c

Because the ON Semi PYTHON 480 sensor does not have a dark current compensation, **Alvium 1500 C-050m/c** cameras have a typical black level value drift, depending on exposure time and `Device Temperature` (measured at the mainboard). The black level compensation adjusts this effect as shown in Table 87.

	ExposureTime [ms]							
Temperature [°C]	**1**	**10**	**50**	**100**	**250**	**500**	**750**	**1,000**
35								
40								
45								
50								
55								
60								
65								
70								
75								
Full compensation								
Partial compensation								

Table 87: Exposure time and temperature affecting black level compensation

Should additional compensation be needed, we recommend cooling the camera.

Shutter types affecting image readout

Some Alvium CSI-2 camera models are operated using global shutter (GS), other models use rolling shutter (RS):

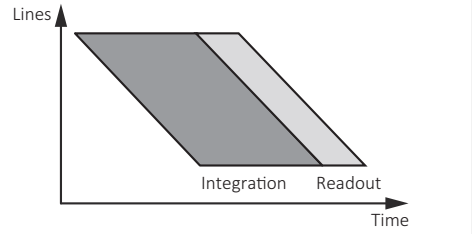
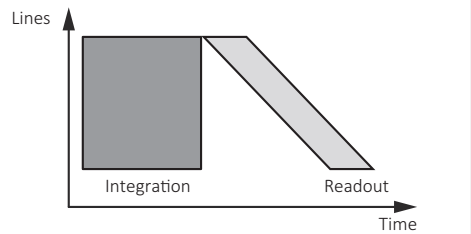
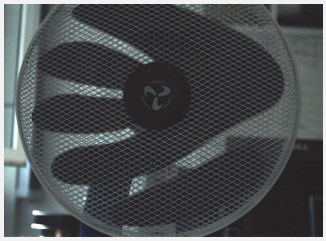
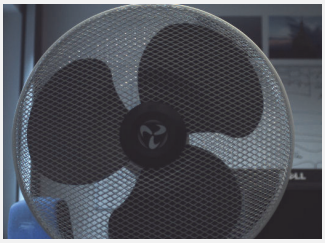
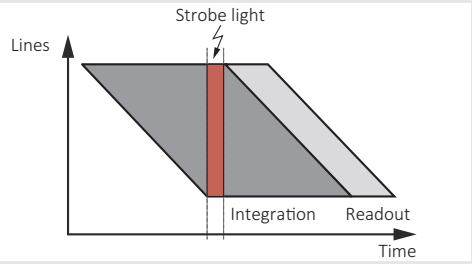
Property	Rolling shutter (RS)	Global shutter (GS)
Line readout		
Line exposure start	Deferred from line to line	Common for all lines
Image acquisition of moving objects		
Moving objects	Distorted shape	Shape without distortion
Typical application	Static objects	Moving objects
Compensation	Use an additional mechanical or use a strobe light in the Strobe area: 	No compensation required.

Table 88: Shutter types affecting image readout

Limitations for available resolutions

Resolutions stated in this manual refer to camera output. However, the individual setup affects the available minimum and maximum values and increments of your vision system.

The embedded board CSI-2 receiver chip is subject to certain restrictions, limiting the values for:

- Packet size minimum
- Packet size maximum
- Packet size increment
- Packets per image.

Table 89 defines limitations for NXP i.MX6 and NVIDIA Tegra boards. For other boards, see the manufacturer's manual.

Specification	NXP i.MX 6	NVIDIA Tegra
Min. packet size [Bytes]	16	32
Max. packet size [Bytes]	8192	32768
Packet size increment [Bytes]	16	1
Min. number of packets	16	32
Max. number of packets	4096	32768
Packet number increment	16	1
Max. frame size [Bytes]	33,554,432	1,073,741,824

Table 89: Limitations for NXP i.MX 6 and NVIDIA Tegra

Dependencies between camera and host

The resulting minimum value is defined as:
minimum = max(camera_minimum, host_minimum)

The resulting maximum value is defined as:
maximum = min(camera_maximum, host_maximum)

The resulting increment value is defined as:
increment = max(camera_increment, host_increment)

Example

The following example shows how values from Table 89 on page 171 are applied to define available resolutions depending on the camera model and the pixel format. How do host restrictions affect the available maximum resolution?

Specification	Value
Camera model	Alvium 1800 C-2050m/c
Sensor model	Sony IMX183
Camera resolution	19,740,672 pixels
Max. frame size NXP i.MX6	33,554,432 Bytes
Bytes per pixel for RAW8 (GREY)	1
Bytes per pixel for RGB888 (RGB3)	3
RAW8 (GREY) maximum image size [Bytes]	19,740,672--> image transfer is possible
RGB888 (RGB3) maximum image size [Bytes]	59,222,016--> image transfer is not possible

Table 90: Example values for maximum resolution for a camera-host setup

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