Allied Vision

Alecs embedded camera systems have the **Model ID: S1A** that is used in the DoC (EU declaration of conformity) document.

EMBEDDED CAMERA SYSTEMS

Alecs

User Guide

V1.3.0

BSP: V1.0.2

Note: The range of components depends on product configuration.

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

2026-Aug-07

Quick links

- Alecs at a glance on page 15
- Contact us on page 19
- Contents on page 20

Read before use

EN - English

Safety

Before using the product, read these safety instructions. Observe the warnings at all times. Use the product only as stated in the Intended use on page 37.

WARNING

This product can expose you to chemicals including Lead and Lead Compounds, which is known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to: www.P65Warnings.ca.gov.

CAUTION

Risk of burns

The product in operation can reach temperature levels which could cause burns.

CAUTION

Injury by a falling product

The falling product can cause injury.

CAUTION

Risk of cuts by sharp edges

The product 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.

DA - Dansk

Sikkerhed

Læs sikkerhedsanvisningerne, før produkt bruges. Overhold alle advarsler. Brug kun produkt som anført i Intended use på side 37.

FORSIGTIG

Forbrændingsfare

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

FORSIGTIG

Kvæstelser, hvis produkt falder ned

Falder produkt ned, kan dette forårsage kvæstelser.

FORSIGTIG

Fare for skarpe kanter

Produktet 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.

DE - Deutsch

Sicherheit

Bevor Sie das Produkt benutzen, lesen Sie diese Sicherheitshinweise. Beachten Sie diese Hinweise immer. Verwenden Sie das Produkt nur wie beschrieben in Intended use auf Seite 37.

VORSICHT

Gefahr von Verbrennungen

Im Betrieb kann das Produkt Temperaturen erreichen, die zu Verbrennungen führen.

VORSICHT

Verletzung durch das fallende Produkt

Das fallende Produkt kann Verletzungen verursachen.

VORSICHT

Schnitte durch scharfe Kanten

Das Produkt kann 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.

ES - Español

Seguridad

Antes de utilizar el producto lea estas instrucciones de seguridad. Observe las advertencias en todo momento. Utilice el producto solo tal y como se estipula en el Intended use en la página 37.

ADVERTENCIA

Este producto puede exponerle a químicos incluyendo plomo y compuestos de plomo, que son conocidos por el Estado de California como causantes de cáncer y defectos de nacimiento u otros daños reproductivos.
Para mayor información, visite www.P65Warnings.ca.gov.

ATENCIÓN

Riesgo de quemaduras

El producto en funcionamiento puede alcanzar temperaturas que podrían provocar quemaduras.

ATENCIÓN

Lesiones en caso de que el producto se cae

Si el producto se cae puede provocar lesiones.

ATENCIÓN

Riesgo de cortes por bordes afilados

El producto puede 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.

FI - Suomi

Turvallisuus

Lue nämä turvallisuusohjeet ennen tuotteen käyttöä. Noudata tuotetta joka hetki. Käytä tuotteen ainoastaan kohdassa Intended use sivulla 37 kuvatulla tavalla.

HUOMIO

Palovammojen vaara

Käytössä olevan tuotteen saavuttamat lämpötilatasot voivat aiheuttaa palovammoja.

HUOMIO

Putoavan tuotteen aiheuttamat vammat

Putoava tuote voi aiheuttaa vammoja.

HUOMIO

Terävien reunojen aiheuttama viiltovaara

Tuotteessa voi olla teräviä reunoja.

Käyttötarkoitus

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

FR - Français

Sécurité

Veuillez lire ces consignes de sécurité avant d'utiliser le produit. Respectez continuellement les avertissements. Utilisez le produit uniquement comme indiqué sous Intended use, page 37.

ATTENTION

Risque de brûlures

Le produit en service peut atteindre des niveaux de température susceptibles d'entraîner des brûlures.

ATTENTION

Blessures en cas de chute du produit

La chute de la produit peut entraîner des blessures.

ATTENTION

Risque de coupures sur des bords tranchants

Le produit peut 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.

עברית - HE

בטיחות

לפני השימוש במוצר, עליך לקרוא את הוראות הביטחון האלו. עליך לממש הוראות ביטחון אלו תמיד.
השימוש במצלמה הוא רק לפי מה שכתוב ב"כוונת השימוש" (Intended use) בעמוד 37).

זהירות

סכנת כוויה

בזמן הפעלת המוצר עלולות לעלות טמפרטורות גבוהות, שיכולות לגרום לכוויות.

זהירות

פציעה מנפילת המוצר

נפילת המוצר עלולה לגרום לפציעה.

זהירות

סכנת חתכים על ידי קצוות חדים

למוצר יכולים להיות קצוות חדים.

שימוש מיועד

מוצרי AlliedVision מיועדים לשילוב במערכות ממוחשבת לעיבוד צילומים ע"י אנשי מקצוע.
כל מוצרי AlliedVision נמכרים לשימוש בסביבת B2B.

IT - Italiano

Sicurezza

Leggere queste istruzioni per la sicurezza prima di utilizzare il prodotto. Osservare sempre tutte le avvertenze. Utilizzare il prodotto come descritto alla sezione Intended use a pagina 37.

ATTENZIONE

Pericolo di ustioni

Durante il funzionamento, il prodotto può raggiungere temperature elevate che possono essere causa di ustioni.

ATTENZIONE

Lesioni dovute alla caduta del prodotto

Il prodotto può causare delle lesioni.

ATTENZIONE

Pericolo di tagliarsi sui bordi affilati

I bordi del prodotto 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.

JA – 日本語

安全性

本製品を使用する前に、この安全ガイドをお読みください。警告を必ず守ってください。必ず21ページのIntended use 37 ページに従って使用してください。

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

製品の落下によるケガ

本製品が落下すると、けがをするおそれがあります。

注意

な端部で切り傷の危険性

本製品には鋭利な部分がある場合があります。

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。

NL - Nederlands

Veiligheid

Lees deze veiligheidsinstructies voordat u het product gebruikt. Neem deze waarschuwingen altijd in acht. Gebruik het product uitsluitend, zoals aangegeven in het Intended use op pagina 37.

VOORZICHTIG

Risico van verbranding

Het gebruikte product, kan temperatuurwaarden bereiken die brandwonden kunnen veroorzaken.

VOORZICHTIG

Letsel door het vallende product

Het vallende product kan verwondingen veroorzaken.

VOORZICHTIG

Risico van snijwonden door scherpe randen

Het product 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.

NO - Norsk

Sikkerhet

Les disse sikkerhetsinstruksene før du bruker produkt. Følg advarslene til en hver tid. Bruk kun produkt i samsvar med Intended use på side 37.

FORSIKTIG

Risiko for brannskader

Produktet i bruk kan nå temperaturnivåer som kan forårsake brannskader.

FORSIKTIG

Skade ved det fallende produktet

Det fallende produktet kan forårsake skade.

FORSIKTIG

Risiko for kutt fra skarpe kanter

Produktet 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.

SV - Svenska

Säkerhet

Läs igenom säkerhetsinstruktionerna innan du använder produkten. Var hela tiden särskilt uppmärksam på varningarna. Använd enbart produkten på det sätt som anges i Intended use på sida 37.

VARNING

Risk för brännskada

Produkten i drift kan komma upp i temperaturer som kan orsaka brännskador.

VARNING

Risk för skador från fallande produkter

Fallande produkter kan förorsaka skador.

VARNING

Risk för skärsår från vassa kanter

Produkten 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.

ZH - 简体中文版

安全需知

在使用产品之前，请阅读这些安全说明。请务必遵守相关警告 和 Intended use 于第 37 页 .

注意事项

烫伤风险

在产品运行过程中，温度可能会上升，导致烧伤的危险。

注意事项

由坠落的产品造成的伤害

产品可能会坠落并造成伤害。

注意事项

锋利边缘割伤的风险

产品可能有锋利的边缘。

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。

Alecs at a glance

Get an overview of Alecs documentation:

Notes

Read this document carefully

Learn to avoid damage to your Alecs embedded camera system and use it in the most safe and efficient way.

NOTICE

Damage to Alecs and connected hardware by improper handling

Setup and operation for Alecs embedded camera systems is different than for typical machine vision systems. Components can be damaged by improper handling or use.

- Observe the safety notes and warning messages.
- Follow the instructions in Installing your Alecs on page 108.

Consider for Alecs

Alecs is a platform growing continuously with added image sensors and functions. We are collecting experience, such as for daily practice with **eVision** or **HALCON**. Ask for our support for your application.

Alecs product options and naming

You can identify Alecs product options as shown in Alecs model naming on page 31.

Alecs embedded camera system can process image data internally and provide results via the 1000BASE-T interface or the I/O port. This way, PC-based machine vision setups can be replaced, reducing power consumption and costs.

Alecs is delivered with pre-installed BSP for **Vimba Access**. Please read the following to better understand your Alecs embedded camera system and to setup your application smoothly:

V4L2 or GenICam? See Access modes on page 103.

BSP including Vimba X

Alecs is shipped with a preinstalled BSP (board support package) that includes **Vimba X** to enable the full feature range and proper operation.

To update or recover your Alecs embedded camera system, or for the latest BSP, see www.alliedvision.com/en/support/firmware-downloads.

For further information, feel free to contact your Allied Vision Sales representative or visit www.alliedvision.com/en/about-us/contact-us/contact-sales.

See System recovery on page 146 for Instructions.

Shipping contents

Item	Product scope	Basic Alecs embedded camera system
Basic embedded camera system	Mandatory	• Main housing • 3 × Protection cap for Alecs connectors
Lens tube	Mandatory	• Lens tube • 4 × M3-12↓ mounting screw for the lens tube
Ring Light RMX140	Optional	• Camera ring light • 4 × M3-12↓ mounting screw for the ring light • Ring Light mounting plate • 4 × M4-10↓ mounting screw for the mounting plate
Leaflet	Mandatory	Download Instructions for First Camera Operation document

Table 1: Shipping contents

Lens tubes

Product code	Product name	Description[1]	Technical drawing	Instruction
22427	Lens tube LT4632	Lens tube of 32 mm inside length 5 MP C-Mount lenses recommended by Allied Vision	Figure 12 on page 88	Mounting the lens tube on page 120
22432	Lens tube LT4649	Lens tube of 49 mm inside length 5 MP C-Mount lenses recommended by Allied Vision	Figure 13 on page 89	
22433	Lens Tube LT4670	Lens tube of 70 mm inside length for 12 MP Edmund Optics C-Mount lenses recommended by Allied Vision	Figure 14 on page 90	
[1] For use with other lenses, check dimensions. | **You can order lens tubes with your Alecs or separately.**				

Table 2: Lens tubes for Alecs

Ring lights and accessories

Product code	Product name	Description	More information
22428	Ring Light RMX140-WHI	Ring light white	https://www.alliedvision.com/en/products/accessories/lighting-cables
22788	Ring Light RMX140-470	Ring light 470 nm	
22789	Ring Light RMX140-530	Ring light 530 nm	
22790	Ring Light RMX140-625	Ring light 625 nm	
22429	Ring Light RMX140-WHI-MP with mounting plate	Ring light with mounting plate	
22430	Polarizer RMX140-LP for RMX140	Polarizer for RMX ring light	
22431	Ring Light mounting plate	Mounting plate to join Ring Light RMX140 to Alecs	Mounting the mounting plate to the camera ring light on page 121
Various	Y-cables 5-pin M12 A-Coded to 5-pin M12 A-Coded and 3 open ends	Lighting cables to control and power RMX ring lights	https://www.alliedvision.com/en/products/accessories/lighting-cables
You can order these lighting components with your Alecs or separately.			

Table 3: Lighting equipment for Alecs

What else do you need?

This is a selection of helpful links and downloads:

Access mode	Download	Link
Features		
mipi GenICam for CSI-2 Access	Alecs Features Reference	www.alliedvision.com/en/support/alecs-documentation
Software		
mipi Video4Linux Access	Jetpack BSP	www.alliedvision.com/en/support/firmware-downloads
mipi GenICam for CSI-2 Access	Vimba X documentation	www.alliedvision.com/en/products/software/vimba-x-sdk
Get Alecs running		
Any access mode	For first operation, output your first image with Alecs, using **eVision Web Demonstrator**	See eVision Web Demonstrator on page 139.
Any access mode	Application notes and **code examples**	www.alliedvision.com/en/support/camera-documentation/smart-camera-documentation/alecs-documentation https://github.com/alliedvision/Alecs
STEP files		
Any access mode	STEP file downloads	www.alliedvision.com/en/support/alecs-documentation
Accessories		
Any access mode	**Accessories**, such as Network cables, I/O cables, power supplies for first time operation, lens tubes, lenses, as well as camera ring lights and connections	www.alliedvision.com/en/products/accessories

Table 4: Downloads for Alecs embedded camera systems

Contact us

Quick links

Products
www.alliedvision.com/en/products

Distribution partners
www.alliedvision.com/en/company/where-to-buy

Contact
www.alliedvision.com/en/company/contact-us
Info@alliedvision.com

Support
www.alliedvision.com/en/support

Headquarter

Allied Vision Technologies GmbH
Taschenweg 2a
07646 Stadtroda, Germany
T// +49 36428 677-0 (Reception)
T// +49 36428 677-230 (Sales)
F// +49 36428 677-28

Worldwide network

www.alliedvision.com/en/company/about-us/locations/office-locations

Contents

Document history and conventions

This chapter includes:

Document history

Version	Date	Remarks
V1.3.0	2026-Aug-07	**BSP: V1.0.2** (Jetpack V6.2, camera FW V00.14.01.ac2bbcd6) • Added data for Alecs G1-030 VSWIR and G1-530 VSWIR models in: - Alecs model specifications on page 61 - Focal length versus field of view on page 99 - Table 44: Alecs models, lenses, and lens tubes on page 98 - FPNC support on page 138. • Added links to application notes and code examples. • Updated the instruction for the “Most versatile” approach for Acquiring a first image on page 118. • Applied editorial changes.
V1.2.1	2026-Jul-01	**BSP: V1.0.2** (Jetpack V6.2, camera FW V00.14.01.ac2bbcd6) • Added a note for the Model ID on the title page. • Removed notes about the preliminary status of this user guide. • Added the mass value for the lens tube LT4632 and adjusted decimal places for Dimensions and mass on page 85. • Added the technical drawing for Alecs With lens tube LT4632 on page 88. • Applied editorial changes.
V1.2.0	2026-Jun-19 Preliminary document version, for evaluation purposes only.	**BSP: V1.0.2** (Jetpack V6.2, camera FW V00.14.01.ac2bbcd6) • Added data for Alecs G1-130 VSWIR and G1-320 VSWIR models in Alecs model specifications on page 61 and in Focal length versus field of view on page 99. • Added contents for (ADC) bit depth and SensorBitDepth in Specifications on page 48. • Added lens tube LT4632 in Terms and acronyms on page 32 and in Specifications on page 48. • Updated Table 44: Alecs models, lenses, and lens tubes on page 98 for recommended hardware combinations. • Applied editorial changes.

Table 5: Document history (sheet 1 of 2)

Version	Date	Remarks
V1.1.1	2026-Mar-27	**BSP: V1.0.2** (Jetpack V6.2, camera FW V00.14.01.ac2bbcd6) • Updated the title image. • Updated links to download the latest BSP image. • Updated contents in Alecs thermal management on page 46. • Added Alecs SoM specifications on page 59. • Added SoM data to the tables in Alecs model specifications on page 61. • Updated the screenshots for eVision Web Demonstrator on page 139. • Applied editorial changes.
V1.1.0	2026-Mar-12	**Release: BSP: V1.0.2** (Jetpack V6.2, camera FW V00.14.01.ac2bbcd6) • Corrected the information for the supported resolution of lenses in Lens tubes on page 17. • Created a separate table for Ring lights and accessories on page 17 with information for supported ring lights and accessories. • Added Alecs model naming on page 31. • Added warning messages for maximum power supply voltage in Power on page 40 and in I/O connection on page 128. • Updated the diagram for Data flow on page 105. • Applied editorial changes.
V1.0.2	2025-Oct-22	**Release: BSP: V1.0.1** (Jetpack V6.2, camera FW V00.14.01.ac2bbcd6) • Corrected BSP version from V1.0.0 to V1.0.**1**. • Corrected camera FW version from V00.14.01.29922c93 to FW V00.14.01.**ac2bbcd6**. • In What else do you need? on page 18, added a link to contents related to eVision software. • Added a note for supported NVIDIA® SoMs in Acquiring a first image on page 118. • Applied editorial changes.
V1.0.1	2025-Oct-15	**Release: BSP: V1.0.1** (Jetpack V6.2, camera FW V00.14.01.**ac2bbcd6**) Updated draft version
V1.0.0	2025-Apr-10	Draft version

Table 5: Document history (sheet 2 of 2)

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 important things
`Features and registers`	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, selectable options
UIElements	Text displayed or output by the system: GUI, dialog boxes, buttons, menus, important information, or windows titles
Web addresses and references	Links to webpages and internal cross references

Table 6: Typographic styles

Symbols and notes

Warning

Precautions are described.

CAUTION

Risk of burns

Precautions are described.

CAUTION

Injury by falling products

Precautions are described.

CAUTION

Risk of cuts by sharp edges

Precautions are described.

CYBER SECURITY

Hazard by cyber attacks

Precautions are described.

NOTICE

Material damage

Precautions are described.

Practical tip

Additional information helps to understand or ease handling the Alecs embedded camera system.

Avoiding malfunctions

Precautions are described.

Additional information

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

Access modes

Alecs embedded camera systems support can be accessed by V4L2 controls or by GenICam features, see Access modes on page 103.

Data applying to **GenICam for CSI-2 Access** is marked as follows:

Paragraphs and graphics

A gray box with this icon signals that contents apply to **GenICam for CSI-2 Access** only.

Specification tables

Red table boarder lines signal that data applies to **GenICam for CSI-2 Access** only:

Feature	Specification
Feature 1	This specification applies to **all access modes**.
Feature 2	This specification applies to **GenICam for CSI-2 Access** only.

Naming and terms

Alecs model naming

Names identify model properties like this:

The short name **Alecs G1-510c NX16** is used in user documentation and on the website, it represents the main product.

The long name **LXB-G1-510m-VIS-NX16-C-LT4649** is used for ordering and delivery. Information is more detailed and includes the sensor spectrum, lens mount, and lens tube in addition.

	Product series	Interface	Resolution[1]	Chroma	Spectrum	SoM[2]	SoM RAM size	Lens mount	Lens tube[3]
Short name	Alecs	G1	510	c	-	NX	16	-	-
Long name	LXB	G1	510	c	Vis	NX	16	C	LT4649
Examples	Alecs	G1: 1000BASE-T	510: 5.1 MP 1242: 12.4 MP	c: color m: mono	Vis: Visible VSWIR: Visible SWIR	NX: NVIDIA® Jetson Orin™ NX NA: NVIDIA® Jetson Orin™ Nano	16: 16 GByte 8: 8 GByte	C: C-Mount	LT4649: 46 × 49 mm LT4670: 46 × 70 mm

[1] Model resolutions may slightly deviate from model naming. | [2] System on module | [3] See Maximum dimensions for lenses on page 91.

Table 7: Alecs model naming scheme

Terms and acronyms

Term or acronym	Description	Reference
Mounting plate	Metal plate to mount Smart Vision's RMX 140 **camera ring light** (Ring Light RMX140) to **lens tubes**. For ordering, see Lens tubes on page 17.	Mounting the mounting plate to the camera ring light on page 121
Alecs	Used instead of **Alecs embedded camera system** for better reading. Alecs is an embedded camera system based on a CSI-2 camera connected to an **NVIDIA® Jetson Orin™** embedded board. The preinstalled **BSP** includes **Vimba X** for first camera operation and evaluation. You can replace Vimba X by your own or a third-party image processing software.	Alecs mounting on page 39
Alecs embedded camera system	The range of components depends on the needs of your application and can consist of the **main housing**, lens and possibly the **lens tube**, and **camera ring light** in addition.	Consider for Alecs on page 16
BSP	Board support package	Hardware installation on page 110
Camera light	General term for a light source connected to Alecs. See **camera ring light**.	Ring lights and accessories on page 17
Camera ring light	Using the **mounting plate**, Ring Light RMX140 can be mounted to the **lens tube**. See **camera light** and **main housing**.	Ring lights and accessories on page 17
CRA	Chief ray angle	Alecs G1-510m/c on page 73
Cropping	Reduces the size of the output sensor area. See **ROI**.	Internal frame rates with ROI/Cropping on page 56
DoC	Declaration of Conformity. Document proving that Alecs fulfills the requirements by EU legislation for product safety.	Product identification on page 35
Embedded camera system	Device including an embedded board, connected to a camera, general term for Alecs	Title page
EMVA	European Machine Vision Association	www.emva.org
ESD	Electrostatic discharge	ESD on page 40
GByte	Gigabyte	Alecs G1-510m/c on page 73
GND	Ground for electrical connections	Schematics on page 128
H × V	Horizontal × Vertical (sensor resolution)	Alecs G1-510m/c on page 73
IP class	The Ingress Protection class defines how well a device is protected against water or dust penetrating the housing.	IP class on page 50

Table 8: Terms and acronyms (sheet 1 of 2)

Term or acronym	Description	Reference
KByte	Kilobyte	Alecs G1-510m/c on page 73
Lane	The cameras inside **Alecs embedded camera systems** are based on MIPI CSI-2 with 1 to 4 lanes for data transfer.	Alecs G1-510m/c on page 73
Lens tube	Housing part to include lenses on Alecs. With the lens tube mounted and with cables or cable caps attached, Alecs fulfills the requirements for **IP class** 67. See **LT4632**, **LT4649**, **LT4670**, and **main housing**.	Hardware overview on page 111
LT4632	Lens tube (inside diameter × length) 46 × 32 mm for recommended 5 MP lenses For ordering, see Lens tubes on page 17.	Figure 12 on page 88
LT4649	Lens tube (inside diameter × length) 46 × 49 mm for recommended 5 MP lenses For ordering, see Lens tubes on page 17.	Figure 13 on page 89
LT4670	Lens tube (inside diameter × length) 46 × 70 mm for recommended 12 MP lenses For ordering, see Lens tubes on page 17.	Figure 14 on page 90
Main housing	Housing part to include the embedded board and the camera See **lens tube** and **camera ring light**.	Hardware overview on page 111
Model ID	Unique identifier for Alecs embedded camera systems related to the **DoC**.	Product identification on page 35
MP	Megapixels for sensor resolution (see **Px**)	Alecs G1-510m/c on page 73
NIC	Network interface card for the Ethernet connection	Connecting to the Network on page 116
Px	Pixels for sensor resolution (see **MP**)	Alecs G1-510m/c on page 73
ROI	Region of interest: Used to reduce the size of the output sensor area. See **Cropping**.	Internal frame rates with ROI/Cropping on page 56
SSH	Secure Shell Protocol: Cryptographic network protocol to operate network services securely over an unsecured network.	Acquiring a first image on page 118
SoM	System on module: Integrated circuit including all components to input, process, and output data, forming an electronic computer on a single chip.	Handling hot Alecs on page 38
QE	Quantum efficiency	Absolute QE on page 75
Vimba X	Allied Vision's current SDK (software development kit) to control cameras.	www.alliedvision.com/en/products/software/vimba-x-sdk
VSWIR	Visible short-wave infrared	Alecs G1-130 VSWIR on page 65

Table 8: Terms and acronyms (sheet 2 of 2)

Compliance, safety, and intended use

This chapter includes:

Product identification

You can identify your Alecs embedded camera system from the product labels:

Figure 1: Alecs housing labels

Alecs embedded camera systems have the Model ID: **S1A**.

Compliance notifications

National regulations on disposal must be followed.

For customers in the US

FCC Class B digital device

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Supplier Declaration of Conformity

Alecs embedded camera systems comply with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

Party issuing Supplier's Declaration of Conformity

Allied Vision Technologies GmbH
Taschenweg 2a
07646 Stadtroda, Germany
T// +49 (36428) 677-106
quality@alliedvision.com

Responsible party - US contact information

Allied Vision Technologies, Inc.
102 Pickering Way – Suite 502
Exton, PA 19341, USA
T// +1 978 225 2030

Note: changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

For customers in Canada

This apparatus complies with the Class B limits for radio noise emissions set out in the Radio Interference Regulations.
CAN ICES-3 (B) / NMB-3 (B)

Pour utilisateurs au Canada

Cet appareil est conforme aux normes classe B pour bruits radioélectriques, spécifiées dans le Règlement sur le brouillage radioélectrique.
CAN ICES-3 (B) / NMB-3 (B)

Avoid electromagnetic interferences

All cable connections are sensitive to electromagnetic interference.

- Use shielded cables only.
- We recommend using cables offered by Allied Vision.
- Avoid coiling.
- We recommend using I/Os 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.

This product is intended to be used in internal networks that are separated from public networks. For any camera operation, the customer is responsible to enable suitable protection measures. Observe the notes in Ensuring cyber security for Alecs on page 145.

Unless expressly agreed otherwise, we design, manufacture, and supply in accordance with the standards of the machine vision industry.

In the event of requirements going beyond this, the customer must:

- Notify us of the special use for each model before the first order is placed so that the models in question can be separated out from the standard processes using their own part numbers, and
- Conclude a quality assurance agreement with us prior to purchasing, to define its requirements in a legally secure manner.

This may require a surcharge, as our prices are very tightly tailored to standard requirements.

Liability, trademarks, and copyright

Allied Vision has tested the product under the described conditions. The customer assumes all risk of product damage, application compromise or potential failure, and Sales Warranty loss related to deviation from the described conditions. Allied Vision's acknowledgement of such deviations in the customer's modified product or applications does not constitute advice for use. No Warranty is offered or implied by Allied Vision regarding the customer's assumed risk or legal responsibilities with such modified products or applications.

Your safety

This section informs about issues related to your personal safety. Descriptions explain how to avoid hazards and operate Alecs embedded camera systems safely.

Handling lens mounts

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

- Avoid touching these edges with your fingers.
- Wear protective gloves for handling the lens mount of Alecs embedded camera systems.
- Follow the instructions in Mounting the lens on page 112.

Handling hot Alecs

Alecs embedded camera system is throttled or powered off to avoid damage by overtemperature. However, if you hold the Alecs in your hands during operation, your skin may get hurt. If you touch the Alecs embedded camera system when it is heated up, we recommend wearing protective gloves.

For more information, see:

- Alecs thermal management on page 46 on specified temperature values and on using software features to output temperature values.
- Providing optimum heat dissipation on page 47 for general measures.

Alecs mounting

Alecs must be mounted using the mounting threads. If vibration is higher than specified, Alecs embedded camera systems can disconnect from the mounting base. Falling Alecs can hurt you. To avoid personal injury:

- Mount the Alecs embedded camera system according to the instructions in Mounting Alecs on page 125.
- Ensure, shock and vibration do not exceed the specified range, see Shock and vibration on page 50.

Cyber security

Alecs is delivered with a demo image preinstalled on the internal SSD. This image is dedicated for getting started most easily and for flexibility, but **only for evaluation and development purposes**.

Before operating Alecs in final applications and production environments, especially in open networks, take suitable measures as described in Ensuring cyber security for Alecs on page 145.

How to avoid product damage

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

Electrical connections

The camera is connected to the network by an 8-pin M12 X-coded connector following the IEC 61076-2-109 standard for Gigabit Ethernet applications. The other electrical connections are not defined by common standards. Read specifications carefully.

Allied Vision accessories help to avoid damage to the Alecs embedded camera system and connected components. See www.alliedvision.com/en/products/accessories for suitable accessories.

Alecs can be damaged by wrong connections or voltage levels.

- For specifications, see Electrical interfaces and LEDs on page 126.
- For instructions to avoid electronics damage, see Installing your Alecs on page 108.

ESD

Follow these instructions to avoid damage to the Alecs embedded camera system, including possible **damage to the sensor**, see Possible damage to image sensors due to electrostatic discharge on page 43.

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

Power

Operating Alecs embedded camera systems beyond the specified range damages the device. Alecs is powered using the M12 A Coded 12-pin connector with an input of 24 VDC ±10% and minimum 1.5 A without optional light or minimum 7 A with optional light, using a limited power source (LPS), according to IEC 62368-1. The Alecs embedded camera system 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.

Alecs is damaged if the specified maximum power supply voltage is exceeded.

- Power Alecs below 24 VDC ±10%.

Alecs can be damaged if they are powered with reverse polarity.

- Observe polarity in I/O connection on page 128.

Ground loops

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

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

Application note

See the Avoiding Ground Loops in Vision Systems application note at Link www.alliedvision.com/en/support/alecs-documentation.

Cable connections

Alecs embedded camera systems are ingress protected according to IP67 only when all connectors are covered by caps or when connected to cables with screw locks tightened completely. See also Mounting lens tubes on page 44.

- Use cables by Allied Vision for best compatibility and system performance: Allied Vision cables were used for the IP tests as well as for the shock and vibration tests.
- Align Alecs sockets and cable plugs and tighten locking screws at 1.2 to 1.5 Nm maximum torque.

Observe general notes to avoid damage:

- Only connect cables with suitably coded connectors.
- Ensure proper orientation of cables.
- Fit connectors without strength.
- For bending of cables and minimum bending radius, see cable specifications.
- Provide strain relief to avoid damage, such as short circuits and malfunctions.

M12 cables by Allied Vision

We recommend using cables by Allied Vision. All tests for shock and vibration as well as for IP protection were done with these cables.

For cable specifications, see the accessory documentation at www.alliedvision.com/en/products/accessories.

No hot-plugging for all connections

Alecs embedded camera systems do not support hot-plugging because it can destroy the Alecs embedded camera system and connected hardware by high inrush current.

Disconnect power supplies before connecting to Alecs embedded camera systems.

Cable signal quality

Noise and electromagnetic interference can disable functions of Alecs embedded camera systems.

- Avoid contact to metal surfaces, causing electromagnetic interference.
- We recommend using cables by Allied Vision.

Optical components

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

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

When the Alecs embedded camera system or lens are stored:

- Cover the Alecs embedded camera system’s lens mount with a protection foil or cap.
- Cover front and back lens with caps.
- Protect the lens tube’s front glass from dirt and damage.

Sensor

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

Alecs does not need additional cleaning. The included 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. At delivery, the camera's lens mount is protected by a circular foil. Remove the circular foil only when you are about to mount the lens.

Hold the Alecs embedded camera system with the camera’s lens mount facing the ground to keep dirt out of the lens mount. When no lens is mounted, protect the sensor and filter reusing the circular foil or by a dust cap..

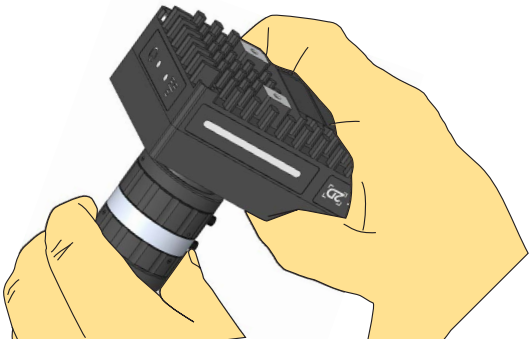


Figure 2: Holding Alecs with the lens mount facing the ground

Possible damage to image sensors due to electrostatic discharge

In some rare cases, electrostatic discharge occurring on the surface of the image sensor may cause damages to particular pixel groups, which may become visible as bubbles or blobs in the image generated by the sensor.

Therefore, it is very important to comply with ESD protection measures in accordance with technical standards. We recommend you to take suitable measures to avoid damage by ESD.

Sensor cleanliness

Definitions for Alecs embedded camera systems are shown in Table 9. The incident beam is not related to the lens' angle of view.

Sensor family	Aperture*	Incident beam	Visible particles quantity
Sony	f1/8.0	≥7°	0

Table 9: Sensor cleanliness definitions

Alecs embedded camera systems are manufactured to match the requirements of typical machine vision applications. This enables a clean image for typical monitor view. Particles may become visible when the image is viewed critically, such as with contrast enhancement or edge detection.

Optical cleaning at Allied Vision

Before being shipped, each Alecs is tested for cleanliness in order to meet the requirements of machine vision applications. For more information, see the Optical Cleaning for Allied Vision Cameras competence showcase document at www.alliedvision.com/en/support/alecs-documentation.

Advanced sensor cleanliness

If definitions for Alecs embedded camera systems do not fulfill the requirements of your application, please contact your Allied Vision Sales representative or visit www.alliedvision.com/en/about-us/contact-us/contact-sales.

Lenses

Lens dimensions

If lenses are mounted that exceed the specified dimensions, the lens or the Alecs embedded camera system can be damaged.

- To avoid damage to the lens and to the lens tube's front glass, use only lenses that suit the dimensions of the lens tube.
- To avoid damage mainly to the sensor and filter of the camera, use only lenses that suit the dimensions of the lens mount.
- See Maximum dimensions for lenses on page 91.

Mechanical components

Mounting lens tubes

Alecs embedded camera systems are ingress protected according to IP67 only when a lens tube is mounted. See also Cable connections on page 41.

Observe for mounting lens tubes:

- Tighten screws at 1.0 Nm maximum torque.
- Follow the instructions in Mounting the lens tube on page 120.

Lens dimensions

- Maximum dimensions for lenses apply only with lens tube. Without lens tube, there are no limitations by the Alecs design.
- Filters and extension tubes, fastening screws for adjustment rings, or other lens accessories increase the dimensions of the lens.
- For some lenses, the length increases by focusing or when the focal length is adjusted.
- Lens tubes can cause vignetting, especially with wide angle lenses.

Lens tubes for larger lenses

Current lens tubes can be used with lenses up to 70 mm length and 46 mm width.

If you want to use lenses exceeding these dimensions, please contact your Allied Vision Sales representative or visit www.alliedvision.com/en/about-us/contact-us/contact-sales.

Camera light

General information

We recommend you to use the third-party camera light we have tested with Alecs, see: Ring Light RMX140 on page 45.

Please observe for any connected camera light: If the power output is used beyond the specified limits, Alecs can be damaged.

- Observe the specifications in Camera light connection on page 132.
- This includes keeping the maximum output for **VCC-Light** below 5.9 A.
- Observe that above 700 mA, Strobe-PNP is limited to 50 ms and 10% duty cycle.
- If the SoM is operated in another power mode than default 15 W, power lighting externally, **not** by Alecs. Otherwise, Alecs and connected peripherals can be damaged.

Connections for external lighting

Allied Vision offers compatible Y-cables at different lengths allowing to separate electrical lines for lighting control by Alecs from lighting power by external power supplies, see www.alliedvision.com/en/support/accessory-documentation.

- To ensure proper and safe operation of the strobe output, use the preinstalled **leds-rmx140** driver. This driver is used automatically if the dedicated V4L2 controls and Vimba X features are used.

Ring Light RMX140

You can easily use Alecs with Ring Light RMX140. It can be mounted using the mounting plate by Allied Vision, and power consumption is exactly in the range of the lighting output specification of Alecs. See the product data sheet for technical data and the safety notes for eye safety.

Documentation

See the product data sheet at https://www.alliedvision.com/en/products/accessories/lighting-cables.

Alecs thermal management

Though Alecs embedded camera systems have a heat dissipative housing, the cooling may not be sufficient for some applications. It depends on the environmental conditions if additional thermal management is required. Keep the housing temperature in the specified range of -20 °C to +65 °C, see Alecs model specifications on page 61. You can inquire values by using firmware features:

Alecs system

Housing: Temperature output

`Transport Layer` (module) > `SystemInformation` (category), for
> `Device Temperature Selector` (feature) > ***`Housing`*** (option), output by
> `Device Temperature` (feature).

NVIDIA® Jetson Orin™ SoM

CPU: Temperature output

`Transport Layer` (module) > `SystemInformation` (category), for
> `Device Temperature Selector` (feature) > ***`CPU`*** (option), output by
> `Device Temperature` (feature).

Output on Linux systems: /sys/class/thermal/thermal_zone0/temp

Shutdown temperature

When the value for CPU temperature reaches 99 °C, the system is throttled. When 105 °C is reached, the SoM is shut down to avoid material damage.

NVIDIA Jetson Orin specifications

For details, see the documentation for NVIDIA Jetson Orin SoMs at: https://developer.nvidia.com/embedded/downloads.

Camera module

Mainboard: Temperature output

`Camera` (module) > `DeviceControl` (category) for
> `DeviceTemperatureSelector` (feature) > ***`Mainboard`*** (option), output by
> `DeviceTemperature` (feature)

Shutdown temperature

When 85 °C is reached, the camera module is shut down to avoid material damage.

Image sensor: Temperature output

This value is available with selected sensor models only:
`Camera` (module) > `DeviceControl` (category) for
> `DeviceTemperatureSelector` (feature) > *`Sensor`* (option), output by
> `DeviceTemperature` (feature)

Providing optimum heat dissipation

To avoid that Alecs is shut down for overtemperature:

- Operate Alecs mounted to a base with a high thermal conductivity and large surface area.
- Use heat sinks to maximize heat dissipation.
- Provide ventilation or other active cooling of Alecs and mounted hardware. You can use the different values for `DeviceTemperature` to control cooling by software, for example, to control a fan.
- Use default 15 W power mode if possible. When 25 W power mode is used, heat increases. If the SoM is operated in another power mode than default 15 W, power lighting externally, **not** by Alecs. Otherwise, Alecs and connected peripherals can be damaged.
  See Alecs thermal management on page 46 for details.

Connections for external lighting

Allied Vision offers compatible Y-cables at different lengths allowing to separate electrical lines for lighting control by Alecs from lighting power by external power supplies, see www.alliedvision.com/en/support/accessory-documentation.

Switching between power modes

You can find NVIDIA® documentation on how to switch between power modes at https://docs.nvidia.com/jetson/archives/r36.4.3/DeveloperGuide/SD/PlatformPowerAndPerformance/JetsonOrinNanoSeriesJetsonOrinNxSeriesAndJetsonAgxOrinSeries.html#power-mode-controls.

Specifications

This chapter includes:

Applied standards

GenICam

GenICam provides a generic access for cameras and devices that is independent of the digital interface. This enables operating cameras with USB3 Vision, GigE Vision, or CoaXPress interfaces with a common software. With the CSI-2 transport layer for Alecs, MIPI CSI-2 is added.

GenICam consists of multiple modules for different tasks. Allied Vision cameras and software use these modules, like the SFNC that standardizes feature names and types via an XML file or the transport layer interface (GenTL) used to grab images.

Alecs complies with:

- GenICam Standard Document Version 2.1.1
- GenAPI Schema Version 1.1
- GenAPI Version 3.1
- GenICam Standard Features Naming Convention (SFNC) Version 2.7
- GenICam Pixel Format Naming Convention (PFNC) Version 2.2

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. Alecs has 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.

IP class

Ingress protection for Alecs complies with IP67 class according to IEC 60529 when used as intended, with:

- Lens tube mounted properly, see Mounting the lens on page 112.
- Connector caps or cables connected properly. Tests for the support of IP67 have been applied with cables by Allied Vision.

NOTICE

Damage to Alecs...

...if cable connections are not sealed against water or dust

- Attach connector caps or connect cables with locking sleeves tightened at 1.2 to 2.5 Nm maximum torque.
- Before using third-party cables, apply tests for IP67 compliance.

Shock and vibration

Alecs embedded camera systems 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.

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

Condition	Passed
Mechanics	• The Alecs housing showed no deformations. • The connections between Alecs and connected peripherals did not come loose. • The sensor position was within the specified tolerances of a new Alecs.
Alecs behavior	Functionalities were not affected, no deviations occurred.
Image streaming	Images were streamed without errors.

Table 10: Conditions for passed tests

The conditions for included 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	140 g
Center of gravity (CoG)[1]	20 mm
[1] For camera and lens dummy assemblies, measured from the lens mount front flange	

Table 11: Conditions for lenses

IEC 60068-2-6: Sinusoidal vibration

Frequency	Acceleration	Displacement
10 Hz to 55 Hz	Not applicable	1.5 mm
55 Hz to 500 Hz	10 $g^{(1)}$	Not applicable
[1] g = Gravity of earth		

Table 12: Frequency, acceleration, and displacement for IEC 60068-2-6 tests

Parameter	Value
Axis	x, y, z
Sweep rate	1 oct/min
Number of sweeps	10

Table 13: Other parameters for IEC 60068-2-6 tests

IEC 60068-2-27: Non repetitive shock

Parameter	Value
Axis	x, y, z
Acceleration	50 $g^{(1)}$
Number of shocks per axis	10
Duration per axis	11 ms
Waveform	Half sine
[1] g = Gravity of earth	

Table 14: Parameters for IEC 60068-2-27, tests part 1

IEC 60068-2-27: Repetitive shock

Parameter	Value
Axis	x, y, z
Acceleration	25 $g^{(1)}$
Number of shocks per axis	1000
Duration per axis	6 ms
Waveform	Half sine
[1] g = Gravity of earth	

Table 15: Parameters for IEC 60068-2-27, tests part 2

IEC 60068-2-64: Random vibration

Frequency	Acceleration[1]
5 Hz to 500 Hz	0.05 $g^2/_{Hz}$

Table 16: Frequency and acceleration for IEC 60068-2-64 tests

Parameter	Value
Axis	x, y, z
Acceleration RMS (Sigma)	4.9 $g^{(1)}$
Acceleration peak (Sigma)	14.8 $g^{(1)}$
[1] g = Gravity of earth	

Table 17: Other parameters for IEC 60068-2-64 tests

Notes on specifications

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

Not every data may apply to your application

Data in this chapter mostly relate to the CSI-2 camera included in Alecs. Because Alecs is intended to process image data internally and provide results via the 1000BASE-T interface or the I/O port, not every data may apply to your application. For example, frame rates relate to the CSI-2 interface with 5.7 Gbit/s while the Alecs' 1000BASE-T interface supports maximum 1 Gbit/s.

Sensor

Measurements for QE and spectral response

Curves for quantum efficiency and for relative response show manufacturer data that has been adapted by Allied Vision's measurements according to EMVA 1288. In some cases, no such measurements may be available. This is signaled by table captions saying **According to manufacturer data**. Please feel free to ask your Allied Vision Sales representative if you have any questions.

Absolute QE plots

All measurements were done without lens or lens tube's front glass.
Measurements for color cameras were done with IR cut filter, measurements for monochrome cameras were done without optical filters. With optical filters, QE decreases by approximately 10%. The uncertainty in measurement of the QE values is ±10%. 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.

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%.

Pixel format default and naming

GenICam for CSI-2 Access

The **default pixel format** for Alecs embedded camera systems is RGB8 for color models and Mono8 for monochrome models.

Pixel formats are named according to the PFNC (Pixel Format Naming Convention), see GenICam on page 49.

Other access modes

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

Pixel formats are named as extended MIPI CSI-2 definitions.

- Video4Linux Access: According to V4L2 definitions.
- Direct Register Access: Alecs embedded camera systems output pixel formats according to the MIPI CSI-2 standard.

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

Table 18: Extended MIPI CSI-2 definitions for pixel format naming

Media Bus Format describes the string output by the Allied Vision MIPI CSI-2 driver to be received by the MIPI CSI-2 driver installed on the embedded board included in the Alecs embedded camera system. Every Media Bus Format is assigned to a single MIPI CSI-2 pixel format.

More than one V4L2 format for a Media Bus Format

Sometimes, host drivers offer more than one V4L2 format for Media Bus Formats. Use `media-ctl -p command` to query which Media Bus Format (and the corresponding CSI format) is currently used by the host driver.

Pixel formats for various standards

MIPI CSI-2	Media Bus Format	V4L2	V4L2 FOURCC	PFNC
YUV422 8-bit	MEDIA_BUS_FMT_UYVY8_2X8	V4L2_PIX_FMT_UYVY	UYVY	YCbCr422_8_CbYCrY
RGB888	MEDIA_BUS_FMT_RGB888_1X32	V4L2_PIX_FMT_XRGB32	BX24	RGB8
RGB888	MEDIA_BUS_FMT_RGB888_1X32	V4L2_PIX_FMT_XRGB32	XR24	RGB8
RAW8	MEDIA_BUS_FMT_Y8_1X8	V4L2_PIX_FMT_GREY	GREY	Mono8
RAW8	MEDIA_BUS_FMT_SRGGB8_1X8	V4L2_PIX_FMT_SRGGB8	RGGB	BayerRG8*
RAW8	MEDIA_BUS_FMT_SGRGB8_1X8	V4L2_PIX_FMT_SGRBG8	GRBG	BayerGR8*
RAW8	MEDIA_BUS_FMT_SGBRG8_1X8	V4L2_PIX_FMT_SGBRG8	GBRG	BayerGB8*
RAW8	MEDIA_BUS_FMT_SBGGR8_1X8	V4L2_PIX_FMT_SBGGR8	BA81	BayerBG8*
RAW10	MEDIA_BUS_FMT_Y10_1X10	V4L2_PIX_FMT_Y10	Y10	Mono10
RAW10	MEDIA_BUS_FMT_SRGGB10_1X10	V4L2_PIX_FMT_SRGGB10	RG10	BayerRG10*
RAW10	MEDIA_BUS_FMT_SGRGB10_1X10	V4L2_PIX_FMT_SGRBG10	BA10	BayerGR10*
RAW10	MEDIA_BUS_FMT_SGBRG10_1X10	V4L2_PIX_FMT_SGBRG10	GB10	BayerGB10*
RAW10	MEDIA_BUS_FMT_SBGGR10_1X10	V4L2_PIX_FMT_SBGGR10	BG10	BayerBG10*
RAW12	MEDIA_BUS_FMT_Y12_1X12	V4L2_PIX_FMT_Y12	Y12	Mono12
RAW12	MEDIA_BUS_FMT_SRGGB12_1X12	V4L2_PIX_FMT_SRGGB12	RG12	BayerRG12*
RAW12	MEDIA_BUS_FMT_SGRGB12_1X12	V4L2_PIX_FMT_SGRBG12	BA12	BayerGR12*
RAW12	MEDIA_BUS_FMT_SGBRG12_1X12	V4L2_PIX_FMT_SGBRG12	GB12	BayerGB12*
RAW12	MEDIA_BUS_FMT_SBGGR12_1X12	V4L2_PIX_FMT_SBGGR12	BG12	BayerBG12*

* Depending on Alecs model and Bayer pattern

Table 19: Equivalent pixel formats in various standards

Exposure time and frame rates

Internal and external frame rates

Frame rates are internal values of the CSI-2 interface with 5.7 Gbit/s. External values are limited to maximum 1 Gbit/s.

Achieved values deviating from specified values

Values stated in the model specifications show the maximum available on an ideal system, supporting a bandwidth of 5.7 Gbit/s. 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.
- **Image resolution steps**. Depending on the available increments, some standard resolutions are not supported. For example, instead of 1,440 × 900 pixels for WXGA+, 1,440 × 904 pixels are available.
- We recommend you to set ROI values before you set values for Exposure Time, because interdependencies between controls affect each other. See Value changes by control interdependencies on page 147.
- **Deviations from stated frame rates** can occur, especially when:
  - Alecs is operated in triggered mode.
  - Small ROIs are used.

Dropped frames in streaming mode

Alecs embedded camera system is intended to process image data internally and provide results via the 1000BASE-T interface or the I/O port. In this case, dropped frames are not an issue.

If Alecs is used for streaming: Observe that frames will be dropped for high resolutions and frame rates because MIPI CSI-2 on the included camera supports much higher bandwidths than the 1000BASE-T interface of Alecs.

Internal frame rates with ROI/Cropping

Internal and external frame rates

Frame rates in this chapter are internal values of the CSI-2 interface for 5.7 Gbit/s. External values are limited to maximum 1 Gbit/s.

ROI and Cropping work similarly: While ROI is typically used for **GenICam for CSI-2 Access**, Cropping is typically used for the **other access modes**. By using a reduced area of the available sensor, the payload is reduced, increasing frame rates. This user guide uses the term ROI.

The maximum available frame rate depends on values, such as bandwidth, pixel format, exposure time, and ROI. Calculation of maximum frame rates for different ROIs for Alecs embedded camera systems does not allow to give a formula. Data is calculated for Conditions for internal frame rate values on page 58.

Sensor ADC readout modes for maximum frame rates

Selected Alecs models support various readout modes. This is stated in the tables for ROI frame rates.

If you are using pixel formats that do not require 12-bit sensor readout and you want to achieve higher frame rates, you can select between readout modes for 12-bit, 10-bit, and 8-bit with some Alecs models. See your model's specifications.

By default, Alecs models use the maximum (ADC) bit depth for `SensorBitDepth`. For selected models, ***`Adaptive`*** mode switches automatically between 12-bit and 10-bit sensor readout, depending on the bit depth of the selected pixel format. This allows to reduce bandwidth and increase frame rates when only 10-bit is required.

To enable the 8-bit sensor readout mode, you must switch manually, using `SensorBitDepth`. Please observe that the image brightness changes when you switch between 8-bit sensor readout mode and the other sensor readout modes.

Keep in mind that changing the output bit depth of the sensor also affects the minimum available exposure time of the camera.

Maximum frame rates at different values for SensorBitDepth

When the maximum bandwidth supported by your system is reached, reducing the value for `SensorBitDepth` does not increase the available maximum frame rate.

Exposure time behavior regarding ExposureMode

This section shows how exposure time behaves in the different exposure modes.

Alecs has an exposure time offset. The exposure time offset and the exposure time increment depend on sensor and camera characteristics. Both, the exposure time offset and the exposure time increment, can change if `Width`, `PixelFormat`, or values for `CSI-2LaneCount`, or `CSI-2 ClockFrequency` are changed. See Value changes by control interdependencies on page 147.

ExposureMode = Timed

For Alecs, exposure time can be set by `ExposureTime` or `ExposureAuto`. For this, `ExposureMode` is set to *`Timed`*.

The selected exposure time is extended automatically:

- If the selected exposure time does not match the available increment, Alecs automatically extends the exposure time to the next increment.
- The **exposure time offset is included** in the selected exposure time.

ExposureMode = TriggerWidth or TriggerControlled

In addition, some Alecs models can control exposure time by the trigger signal, with the `ExposureMode` set to *`TriggerWidth`* or *`TriggerControlled`* (using *`ExposureStart`* and *`ExposureStop`*).

The trigger controlled exposure time is extended automatically:

- If the trigger controlled exposure time does not match the available increment, Alecs automatically extends the exposure time to the next increment.
- Subsequently, the **exposure time offset is added**.

You can use *`ExposureActive`* to determine the duration of the exposure time offset.

Conditions for internal frame rate values

Internal and external frame rates

Frame rates in this chapter are internal values of the CSI-2 interface with 5.7 Gbit/s. External values are limited to maximum 1 Gbit/s.

Values for maximum frame rates and for minimum and maximum exposure time in the specification tables were measured based on following parameters:

- Factory settings (Alecs after power up)
- Minimum exposure time
- Full resolution
- **GenICam for CSI-2 Access**
- Mono8 or Bayer8 pixel format
- Alecs operation in freerun mode
- Without bandwidth limitations.

Digital binning

Alecs embedded camera systems combine digital horizontal binning and digital vertical binning for integer values 1 to 8. In **GenICam for CSI-2 Access**, horizontal and vertical binning values can be combined freely. In other access modes, horizontal and vertical values can be combined commonly only.

Alecs models ≥12 MP resolution

If digital horizontal and digital vertical binning are set to 1× and the digital vertical binning value is increased, digital horizontal binning is automatically set to 2×.

Sensor binning

Monochrome Alecs supports ***Sum*** mode for sensor binning in addition to digital binning.
See the specifications tables in Alecs model specifications on page 61.

Please observe

- Only digital binning or sensor binning can be used at a a time.
- You must revert binning values to ***1*** before you can switch between these binning modes.

Operating power consumption

The actual power consumption of your Alecs embedded camera system depends on the requirements of your application. Therefore, only rough values can be given.
Total values are divided between different consumers:

SoM

The main share of Alecs' power consumption is drawn by the SoM. The Alecs embedded camera system has been designed for default maximum 15 W SoM power. If you consider using 25 W, see Alecs thermal management on page 46.

Other consumers

Carrier board electronics draw approximately 2.0 W. Depending on the sensor model, the camera contributes far below 5.0 W.

Dimensions and mass

For your model's dimensions, see Dimensions and mass on page 85. For technical drawings, see Technical drawings on page 86.

Alecs SoM specifications

Alecs consists of an industrial camera controlled by a system on modules (SoM). Alecs characteristics are defined by the combination of these components.

Memory, DLA, and PVA

Property	NVIDIA® Jetson Orin™ NX16	NVIDIA® Jetson Orin™ Nano8
RAM	16 GByte	8 GByte
DLA[1] included	✓	–
PVA[2] included	✓	–
[1]Deep learning Accelerator | [2]Programmable Vision Accelerator		

Table 20: Alecs SoM specifications

Advanced AI models and compute-intensive edge detection benefit from:

- Deep Learning Accelerator (DLA) with dedicated cores offloading the hosts' CPU and GPU
- Programmable Vision Accelerator (PVA) with dedicated cores to extend the Alvium BSP feature set by NVIDIA vision libraries.

Power modes

NX16

Name	Id	Target Power	Active CPUs	Max CPU clock	Active GPUs	Max GPU clock	Active PVA	Active DLA
ALECS_15W	0	15 W	4	1420.8 MHz	2	612 MHz	0	1
ALECS_25W	1	25 W	6	1497.6 MHz	4	408 MHz	1	2

Table 21: Power modes with Alecs NX16 models

NA8

Name	Id	Target Power	Active CPUs	Max CPU clock	Active GPUs	Max GPU clock	Active PVA	Active DLA
ALECS_15W	0	15 W	6	1510.4 MHz	4	624.75 MHz	N.a.	N.a.
ALECS_7W	1	7 W	4	960 MHz	2	408 MHz	N.a.	N.a.

Table 22: Power modes with Alecs NA8 models

Switching between power modes

You can find NVIDIA® documentation on how to switch between power modes at https://docs.nvidia.com/jetson/archives/r36.4.3/DeveloperGuide/SD/PlatformPowerAndPerformance/JetsonOrinNanoSeriesJetsonOrinNxSeriesAndJetsonAgxOrinSeries.html#power-mode-controls.

Thermal management

Using high power modes increases heat.
For details, see Alecs thermal management on page 46.

Alecs model specifications

Alecs G1-030 VSWIR

Feature	Specification
	Alecs G1-030 VSWIR
SoM (system on module)	NVIDIA® Jetson Orin™ NX16
Extended memory (non-volatile)	128 GByte (NVME SSD)
RAM (volatile)	16 GByte (NX16)
Sensor model	Sony IMX991
Resolution	656 (H) × 520 (V); 0.3 MP
Sensor type	InGaAs
Shutter type	Global shutter (GS)
Sensor size	Type 1/4; 3.3 mm × 2.6 mm; 4.1 mm diagonal
Pixel size	5 µm × 5 µm
CRA	0 deg
Sensor bit depth (ADC)	8-bit, 10-bit, 12-bit; Adaptive (10-bit, 12-bit)
Sensor bit depth (ADC)	12-bit
	Pixel formats, GenICam for CSI-2 Access
Monochrome pixel formats	Mono8 (default), Mono10, Mono10p, Mono12, Mono12p
	Pixel formats, other access modes
RAW pixel formats	RAW8 (GREY), RAW10 (Y10), RAW12 (Y12)
	Camera speed, gain, and binning
Maximum frame rate (internal)	249 fps, using 1 to 4 lanes
Maximum frame rate (internal)	132 fps, using 1 to 4 lanes
Exposure time	15 µs to 10 s (1 lane)
Exposure modes	Timed, TriggerControlled, TriggerWidth
Gain	0 dB to 42 dB; 0.1 dB increments
Digital binning	Horizontal: 1 to 8 columns; Vertical: 1 to 8 rows

Red table boarder lines signal that data applies to **GenICam for CSI-2 Access** only.

Table 23: Alecs G1-030 VSWIR specifications (sheet 1 of 2)

Feature	Specification
	Alecs G1-030 VSWIR
	Memory
Camera: Image buffer (RAM)	256 KByte
Camera: Non-volatile memory (Flash)	1024 KByte
SoM: Non-volatile memory (Flash)	128 GByte (NVME SSD)
	Power and I/Os
I/Os (opto-isolated)	2 inputs, 2 outputs, 1 trigger input, 1 strobe output
Power requirements	24 VDC
Power consumption, typical operation (without camera light, at 24 VDC)	SoM: Max. 10 W to 25 W (depending on the power mode)[1] Carrier board electronics: 2.0 W Camera module: 1.8 W
Power consumption, idle state (without camera light, at 24 VDC)	8.5 W
	Storage and operating conditions
Storage temperature	-20 °C to +85 °C (ambient temperature)
Operating temperature[2]	-20 °C to +55 °C housing temperature
Relative humidity	0% to 95% (non-condensing)
	Network
Digital interface	1000BASE-T
Camera controls	GenICam (GenICam for CSI-2 Access)
	V4L2 controls (Video4Linux Access), Direct Register Access

[1] SoM default power setting is 15 W for Alecs to reach the temperature specifications in this user guide. If you consider using 25 W, see Alecs thermal management on page 46.
The SoM's power consumption varies depending on the processing power. Alecs has been tested with power modes up to 25 W using passive cooling.

[2] Output by `DeviceTemperature`, see Handling hot Alecs on page 38.

Red table boarder lines signal that data applies to **GenICam for CSI-2 Access** only.

Table 23: Alecs G1-030 VSWIR specifications (sheet 2 of 2)

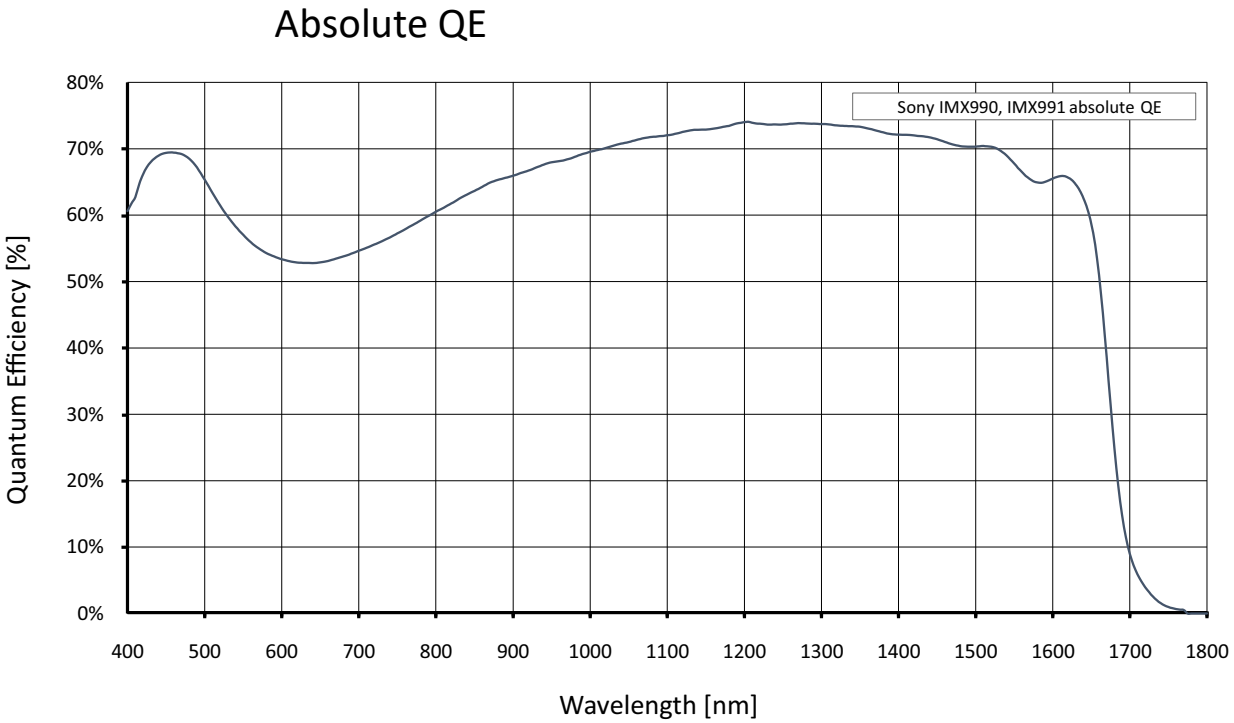


Figure 3: Alecs G1-030 VSWIR (Sony IMX991) absolute QE

Frame rates with Cropping

Values were calculated as defined in Internal frame rates with ROI/Cropping on page 56 and in Conditions for internal frame rate values on page 58.

Frame rates at maximum bandwidth calculates for 1.425 Gbit/s per lane. Table 26 shows the maximum frame rate available for typical operation, using 4 lanes with a bandwidth of 5.700 Gbit/s.

Image format	Width [pixels]	Height [pixels]	ROI area [MP]	Frame rate [fps][1]
Full resolution	656	520	0.341	249.1
VGA	640	480	0.307	268.4
HVGA	480	320	0.154	384.8
QVGA	320	240	0.077	494.0
HQVGA	240	160	0.038	686.4
QQVGA	160	120	0.019	849.9
Max. × half [2]	656	264	0.173	450.4
Max. × min.	656	16	0.010	2069.4
Min. × max.	16	520	0.008	252.2
Min. × min.[3]	16	16	256 Px	2303.0

[1] Mono8 at `SensorBitDepth` = 8-Bit

[2] Instead of 656 × 260
If resolutions were not available due to increments, frame rates relate to the next available resolution.

[3] **GenICam for CSI-2 Access** (Vimba X): 16 × 16 | Other access modes: 16 × 32

Table 24: Alecs G1-030 VSWIR ROI frame rates

Alecs G1-130 VSWIR

Feature	Specification
	Alecs G1-130 VSWIR
SoM (system on module)	NVIDIA® Jetson Orin™ NX16
Extended memory (non-volatile)	128 GByte (NVME SSD)
RAM (volatile)	16 GByte (NX16)
Sensor model	Sony IMX990
Resolution	1296 (H) × 1032 (V); 1.3 MP
Sensor type	InGaAs
Shutter type	Global shutter (GS)
Sensor size	Type 1/2; 6.4 mm × 5.1 mm; 8.2 mm diagonal
Pixel size	5 µm × 5 µm
CRA	0 deg
Sensor bit depth (ADC)	8-bit, 10-bit, 12-bit; Adaptive (10-bit, 12-bit)
Sensor bit depth (ADC)	12-bit
	Pixel formats, GenICam for CSI-2 Access
Monochrome pixel formats	Mono8 (default), Mono10, Mono10p, Mono12, Mono12p
	Pixel formats, other access modes
RAW pixel formats	RAW8 (GREY), RAW10 (Y10), RAW12 (Y12)
	Camera speed, gain, and binning
Maximum frame rate (internal)	130 fps, using 2 to 4 lanes
Maximum frame rate (internal)	69 fps, using 1 to 4 lanes
Exposure time	15 µs to 10 s (1 lane)
Exposure modes	Timed, TriggerControlled, TriggerWidth
Gain	0 dB to 42 dB; 0.1 dB increments
Digital binning	Horizontal: 1 to 8 columns; Vertical: 1 to 8 rows
	Memory
Camera: Image buffer (RAM)	256 KByte
Camera: Non-volatile memory (Flash)	1024 KByte
SoM: Non-volatile memory (Flash)	128 GByte (NVME SSD)

Red table boarder lines signal that data applies to **GenICam for CSI-2 Access** only.

Table 25: Alecs G1-130 VSWIR specifications (sheet 1 of 2)

Feature	Specification
	Alecs G1-130 VSWIR
	Memory
Camera: Image buffer (RAM)	256 KByte
Camera: Non-volatile memory (Flash)	1024 KByte
SoM: Non-volatile memory (Flash)	128 GByte (NVME SSD)
	Power and I/Os
I/Os (opto-isolated)	2 inputs, 2 outputs, 1 trigger input, 1 strobe output
Power requirements	24 VDC
Power consumption, typical operation (without camera light, at 24 VDC)	SoM: Max. 10 W to 25 W (depending on the power mode)[1] Carrier board electronics: 2.0 W Camera module: 2.8 W
Power consumption, idle state (without camera light, at 24 VDC)	8.5 W
	Storage and operating conditions
Storage temperature	-20 °C to +85 °C (ambient temperature)
Operating temperature[2]	-20 °C to +55 °C housing temperature
Relative humidity	0% to 95% (non-condensing)
	Network
Digital interface	1000BASE-T
Camera controls	GenICam (GenICam for CSI-2 Access)
	V4L2 controls (Video4Linux Access), Direct Register Access

[1] SoM default power setting is 15 W for Alecs to reach the temperature specifications in this user guide. If you consider using 25 W, see Alecs thermal management on page 46.
The SoM's power consumption varies depending on the processing power. Alecs has been tested with power modes up to 25 W using passive cooling.

[2] Output by `DeviceTemperature`, see Handling hot Alecs on page 38.

Red table boarder lines signal that data applies to **GenICam for CSI-2 Access** only.

Table 25: Alecs G1-130 VSWIR specifications (sheet 2 of 2)

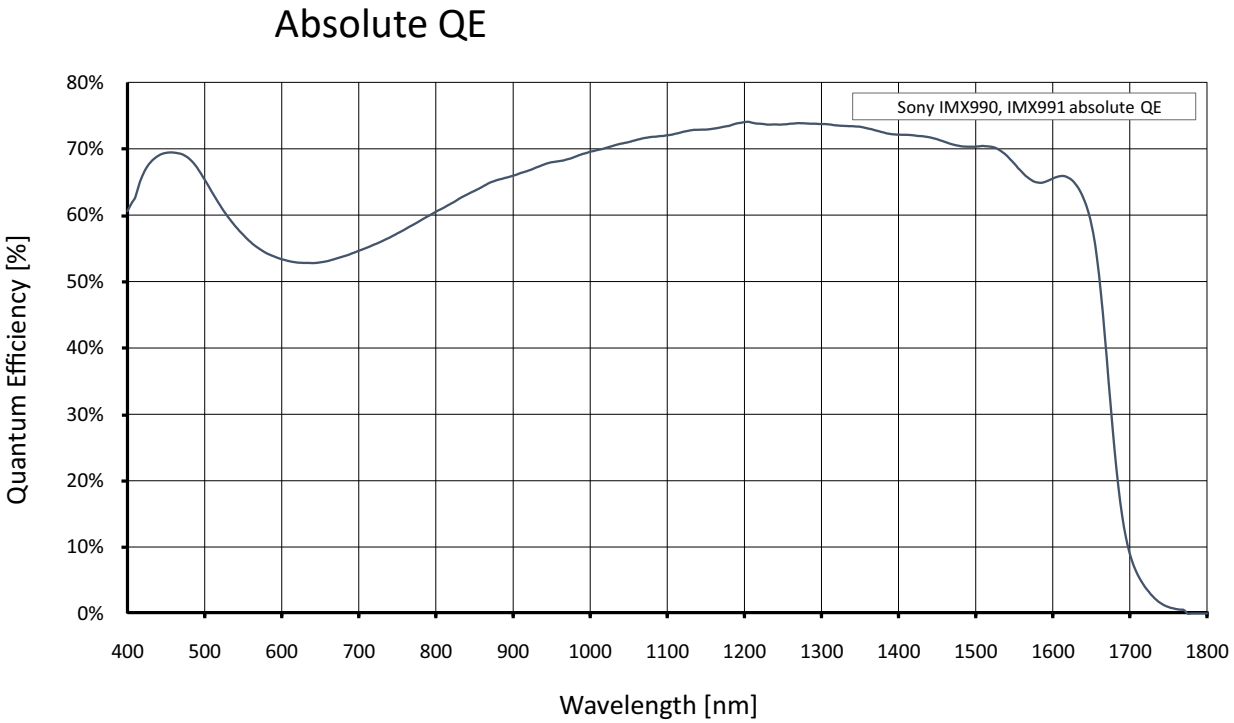


Figure 4: Alecs G1-130 VSWIR (Sony IMX990) absolute QE

Frame rates with Cropping

Values were calculated as defined in Internal frame rates with ROI/Cropping on page 56 and in Conditions for internal frame rate values on page 58.

Frame rates at maximum bandwidth calculates for 1.425 Gbit/s per lane. Table 26 shows the maximum frame rate available for typical operation, using 4 lanes with a bandwidth of 5.700 Gbit/s.

Image format	Width [pixels]	Height [pixels]	ROI area [MP]	Frame rate [fps][1]
Full resolution	1296	1032	1.337	130.8
SXGA	1280	1024	1.311	131.8
HD 720	1280	720	0.922	183.3
XGA	1024	768	0.786	173.2
SVGA	800	600	0.480	218.3
VGA	640	480	0.307	268.4
HVGA	480	320	0.154	384.8
QVGA	320	240	0.077	494.0
HQVGA	240	160	0.038	686.4
QQVGA	160	120	0.019	849.9
Max. × half [2]	1296	520	0.674	246.6
Max. × min.	1296	16	0.021	1903.8
Min. × max.	16	1032	0.017	132.4
Min. × min. [(3)]	16	16	256 Px	2303.0

[1] Mono8 at `SensorBitDepth` = 8-Bit

[2] Instead of 1440 × 900
If resolutions were not available due to increments, frame rates relate to the next available resolution.

[3] **GenICam for CSI-2 Access** (Vimba X): 16 × 16 | Other access modes: 16 × 32

Table 26: Alecs G1-130 VSWIR ROI frame rates

Alecs G1-320 VSWIR

Feature	Specification
	Alecs G1-320 VSWIR
SoM (system on module)	NVIDIA® Jetson Orin™ NX16
Extended memory (non-volatile)	128 GByte (NVME SSD)
RAM (volatile)	16 GByte (NX16)
Sensor model	Sony IMX993
Resolution	2080(H) × 1544 (V); 3.2 MP
Sensor type	InGaAs
Shutter type	Global shutter (GS)
Sensor size	Type 1/1.8; 7.2 mm × 5.3 mm; 8.9 mm diagonal
Pixel size	3.45 µm × 3.45 µm
CRA	0 deg
Sensor bit depth (ADC)	8-bit, 10-bit, 12-bit; Adaptive (10-bit, 12-bit)
Sensor bit depth (ADC)	12-bit
	Pixel formats, GenICam for CSI-2 Access
Monochrome pixel formats	Mono8 (default), Mono10, Mono10p, Mono12, Mono12p
	Pixel formats, other access modes
RAW pixel formats	RAW8 (GREY), RAW10 (Y10), RAW12 (Y12)
	Camera speed, gain, and binning
Maximum frame rate (internal)	131 fps, using 4 lanes
Maximum frame rate (internal)	87 fps, using 4 lanes
Exposure time	33 µs to 10 s (4 lanes)
Exposure modes	Timed, TriggerControlled, TriggerWidth
Gain	0 dB to 42 dB; 0.1 dB increments
Digital binning	Horizontal: 1 to 8 columns; Vertical: 1 to 8 rows
	Memory
Camera: Image buffer (RAM)	256 KByte
Camera: Non-volatile memory (Flash)	1024 KByte
SoM: Non-volatile memory (Flash)	128 GByte (NVME SSD)

Red table boarder lines signal that data applies to **GenICam for CSI-2 Access** only.

Table 27: Alecs G1-320 VSWIR specifications (sheet 1 of 2)

Feature	Specification
	Alecs G1-320 VSWIR
	Memory
Camera: Image buffer (RAM)	256 KByte
Camera: Non-volatile memory (Flash)	1024 KByte
SoM: Non-volatile memory (Flash)	128 GByte (NVME SSD)
	Power and I/Os
I/Os (opto-isolated)	2 inputs, 2 outputs, 1 trigger input, 1 strobe output
Power requirements	24 VDC
Power consumption, typical operation (without camera light, at 24 VDC)	SoM: Max. 10 W to 25 W (depending on the power mode)[1] Carrier board electronics: 2.0 W Camera module: 2.8 W
Power consumption, idle state (without camera light, at 24 VDC)	8.5 W
	Storage and operating conditions
Storage temperature	-20 °C to +85 °C (ambient temperature)
Operating temperature[2]	-20 °C to +55 °C housing temperature
Relative humidity	0% to 95% (non-condensing)
	Network
Digital interface	1000BASE-T
Camera controls	GenICam (GenICam for CSI-2 Access)
	V4L2 controls (Video4Linux Access), Direct Register Access

[1] SoM default power setting is 15 W for Alecs to reach the temperature specifications in this user guide. If you consider using 25 W, see Alecs thermal management on page 46.
The SoM's power consumption varies depending on the processing power. Alecs has been tested with power modes up to 25 W using passive cooling.

[2] Output by `DeviceTemperature`, see Handling hot Alecs on page 38.

Red table boarder lines signal that data applies to **GenICam for CSI-2 Access** only.

Table 27: Alecs G1-320 VSWIR specifications (sheet 2 of 2)

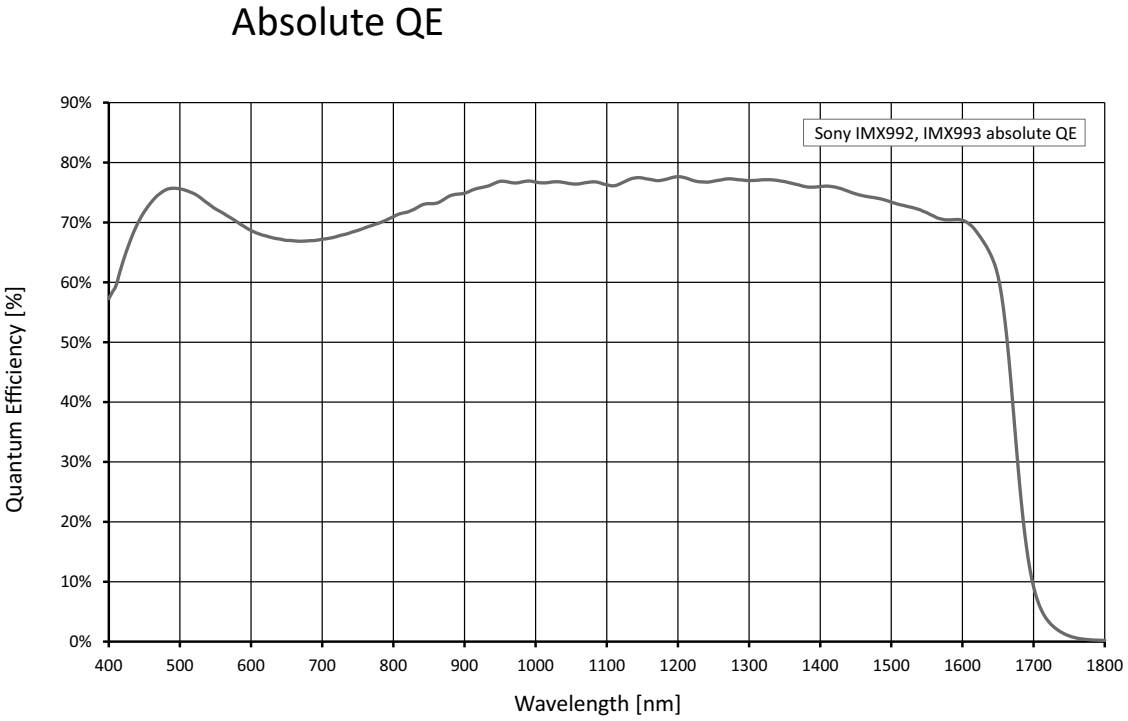


Figure 5: Alecs G1-320 VSWIR (Sony IMX993) absolute QE
According to manufacturer data

Frame rates with Cropping

Values were calculated as defined in Internal frame rates with ROI/Cropping on page 56 and in Conditions for internal frame rate values on page 58.

Frame rates at maximum bandwidth calculates for 1.425 Gbit/s per lane. Table 26 shows the maximum frame rate available for typical operation, using 4 lanes with a bandwidth of 5.700 Gbit/s.

Image format	Width [pixels]	Height [pixels]	ROI area [MP]	Frame rate [fps][1]
Full resolution	2080	1544	3.212	131.3
QXGA	2048	1536	3.146	132.0
Full HD	1920	1080	2.074	180.0
UXGA	1600	1200	1.920	165.1
WXGA+[3]	1440	904	1.302	211.1
SXGA	1280	1024	1.311	190.3
HD 720	1280	720	0.922	255.7
XGA	1024	768	0.786	243.9
SVGA	800	600	0.480	299.4
VGA	640	480	0.307	357.6
HVGA	480	320	0.154	481.6
QVGA	320	240	0.077	584.9
HQVGA	240	160	0.038	739.7
QQVGA	160	120	0.019	857.4
Max. × half [2]	2080	776	1.614	236.7
Max. × min.	2080	16	0.033	1154.9
Min. × max.	16	1544	0.025	134.3
Min. × min. (3)	16	16	256 Px	1441.8

[1] Mono8 at `SensorBitDepth` = 8-Bit

[2] Instead of 1440 × 900
If resolutions were not available due to increments, frame rates relate to the next available resolution.

[3] **GenICam for CSI-2 Access** (Vimba X): 16 × 16 | Other access modes: 16 × 32

Table 28: Alecs G1-320 VSWIR ROI frame rates

Alecs G1-510m/c

Feature	Specification	
	Alecs G1-510m (monochrome)	**Alecs G1-510c (color)**
SoM (system on module)	NVIDIA® Jetson Orin™ NX16 / Nano8	
Extended memory (non-volatile)	128 GByte (NVME SSD)	
RAM (volatile)	16 GByte (NX16) | 8 GByte (Nano8)	
Sensor model	Sony IMX548	
Resolution	2464 (H) × 2064 (V); 5.1 MP	
Sensor type	CMOS	
Shutter type	Global shutter (GS)	
Sensor size	Type 1/1.8; 6.8 mm × 5.7 mm; 8.8 mm diagonal	
Pixel size	2.74 µm × 2.74 µm	
CRA	0 deg	
Sensor bit depth (ADC)	12-bit	
	Pixel formats, GenICam for CSI-2 Access	
Monochrome pixel formats	Mono8 (default), Mono10, Mono10p, Mono12, Mono12p	Mono8, Mono10, Mono10p, Mono12, Mono12p
YUV color pixel formats	Not applicable	YCbCr411_8_CbYYCrYY, YCbCr422_8_CbYCrY, YCbCr8_CbYCr
RGB color pixel formats	Not applicable	BGR8, RGB8 (default)
Raw color pixel formats	Not applicable	BayerRG8, BayerRG10, BayerRG10p, BayerRG12, BayerRG12p
	Pixel formats, other access formats	
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)	
	Camera speed, gain, and binning	
Maximum frame rate (internal)	81 fps, using 4 lanes	
Exposure time	8 µs to 10 s (4 lanes)	
Exposure modes	Timed	
Gain	0 dB to 48 dB; 0.1 dB increments	
Digital binning	Horizontal: 1 to 8 columns; Vertical: 1 to 8 rows	
Sensor binning (H × V)	2 × 2 (*Sum*)	Not applicable

Red table boarder lines signal that data applies to **GenICam for CSI-2 Access** only.

Table 29: Alecs G1-510m/c specifications (sheet 1 of 2)

Feature	Specification	
	Alecs G1-510m (monochrome)	**Alecs G1-510c (color)**
	Memory	
Camera: Image buffer (RAM)	256 KByte	
Camera: Non-volatile memory (Flash)	1024 KByte	
SoM: Non-volatile memory (Flash)	128 GByte (NVME SSD)	
	Power and I/Os	
I/Os (opto-isolated)	2 inputs, 2 outputs, 1 trigger input, 1 strobe output	
Power requirements	24 VDC	
Power consumption, typical operation (without camera light, at 24 VDC)	SoM: Max. 10 W to 25 W (depending on the power mode)[1] Carrier board electronics: 2.0 W Camera module: 2.8 W	
Power consumption, idle state (without camera light, at 24 VDC)	8.5 W	
	Storage and operating conditions	
Storage temperature	-20 °C to +85 °C ambient temperature	
Operating temperature[2]	-20 °C to +65 °C housing temperature	
Relative humidity	0% to 95% (non-condensing)	
	Network	
Digital interface	1000BASE-T	
Camera controls	GenICam (GenICam for CSI-2 Access)	
	V4L2 controls (Video4Linux Access), Direct Register Access	

[1] SoM default power setting is 15 W for Alecs to reach the temperature specifications in this user guide. If you consider using 25 W, see Alecs thermal management on page 46.
The SoM's power consumption varies depending on the processing power. Alecs has been tested with power modes up to 25 W using passive cooling.

[2] Output by `DeviceTemperature`, see Handling hot Alecs on page 38.

Red table boarder lines signal that data applies to **GenICam for CSI-2 Access** only.

Table 29: Alecs G1-510m/c specifications (sheet 2 of 2)

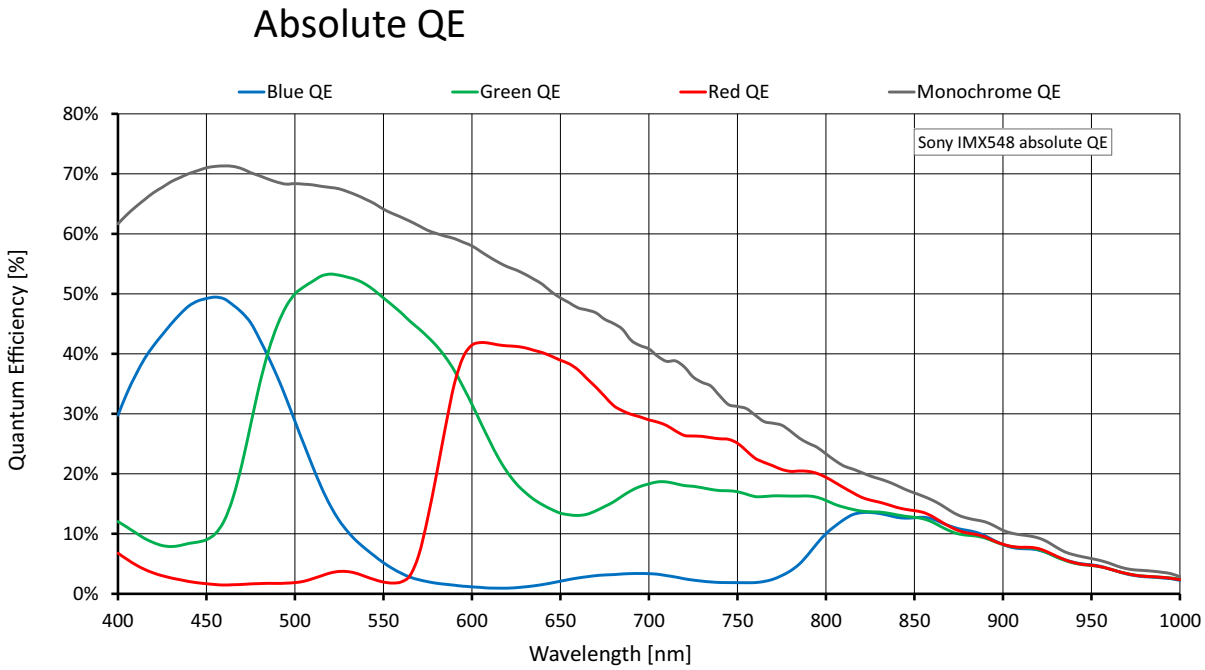


Figure 6: Alecs G1-510m/c (Sony IMX548) absolute QE

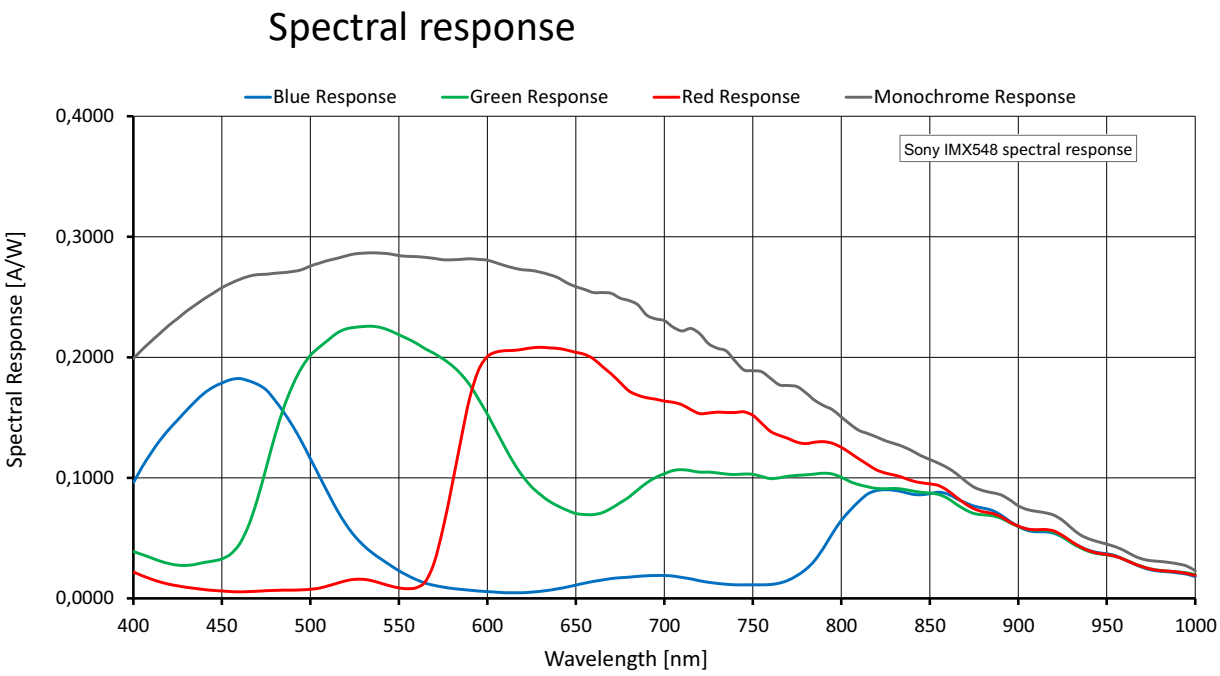


Figure 7: Alecs G1-510m/c (Sony IMX548) spectral response

Internal frame rates with Cropping

Values were calculated as defined in Internal frame rates with ROI/Cropping on page 56 and in Conditions for internal frame rate values on page 58.

Frame rates at maximum bandwidth calculates for 1.425 Gbit/s per lane. Table 30 shows the maximum frame rate available for typical operation, using 4 lanes with a bandwidth of 5.700 Gbit/s.

Image format	Width [pixels]	Height [pixels]	ROI area [MP]	Frame rate [fps][1]
Full resolution	2464	2064	5.086	81.5
QXGA	2048	1536	3.146	106.6
Full HD	1920	1080	2.074	145.4
UXGA	1600	1200	1.920	133.3
WXGA+ [2]	1440	904	1.302	170.1
SXGA	1280	1024	1.311	153.5
HD 720	1280	720	0.922	205.3
XGA	1024	768	0.786	195.8
SVGA	800	600	0.480	239.7
VGA	640	480	0.307	284.7
HVGA	480	320	0.154	379.2
QVGA	320	240	0.077	455.0
HQVGA	240	160	0.038	567.4
QQVGA	160	120	0.019	645.3
Max. × half	2464	1032	2.543	150.0
Max. × min.	2464	16	0.039	884.1
Min. × max.	16	2064	0.033	82.5
Min. × min. [4]	16	16	256 Px	1009.9

[1] Mono8 or Bayer...8[(2)] at `SensorBitDepth` = 8-Bit

[2] The three dots**...** represent the colors of a Bayer pixel format, such as in Bayer**RG**8.

[3] Instead of 1440 × 900
If resolutions were not available due to increments, frame rates relate to the next available resolution.

[4] **GenICam for CSI-2 Access** (Vimba X): 16 × 16 | Other access modes: 16 × 32

Table 30: Alecs G1-510m/c ROI frame rates (internal)

Alecs G1-530 VSWIR

Feature	Specification
	Alecs G1-530 VSWIR
SoM (system on module)	NVIDIA® Jetson Orin™ NX16
Extended memory (non-volatile)	128 GByte (NVME SSD)
RAM (volatile)	16 GByte (NX16)
Sensor model	Sony IMX992
Resolution	2592(H) × 2056(V); 5.3 MP
Sensor type	InGaAs
Shutter type	Global shutter (GS)
Sensor size	Type 1/1.4; 8.9 mm × 7.1 mm; 11.4 mm diagonal
Pixel size	3.45 µm × 3.45 µm
CRA	0 deg
Sensor bit depth (ADC)	8-bit, 10-bit, 12-bit; Adaptive (10-bit, 12-bit)
Sensor bit depth (ADC)	12-bit
	Pixel formats, GenICam for CSI-2 Access
Monochrome pixel formats	Mono8 (default), Mono10, Mono10p, Mono12, Mono12p
	Pixel formats, other access modes
RAW pixel formats	RAW8 (GREY), RAW10 (Y10), RAW12 (Y12)
	Camera speed, gain, and binning
Maximum frame rate (internal)	84 fps, using 4 lanes
Maximum frame rate (internal)	58 fps, using 4 lanes
Exposure time	36 µs to 10 s (4 lanes)
Exposure modes	Timed, TriggerControlled, TriggerWidth
Gain	0 dB to 42 dB; 0.1 dB increments
Digital binning	Horizontal: 1 to 8 columns; Vertical: 1 to 8 rows
	Memory
Camera: Image buffer (RAM)	256 KByte
Camera: Non-volatile memory (Flash)	1024 KByte
SoM: Non-volatile memory (Flash)	128 GByte (NVME SSD)

Red table boarder lines signal that data applies to **GenICam for CSI-2 Access** only.

Table 31: Alecs G1-530 VSWIR specifications (sheet 1 of 2)

Feature	Specification
	Alecs G1-530 VSWIR
	Power and I/Os
I/Os (opto-isolated)	2 inputs, 2 outputs, 1 trigger input, 1 strobe output
Power requirements	24 VDC
Power consumption, typical operation (without camera light, at 24 VDC)	SoM: Max. 10 W to 25 W (depending on the power mode)[1] Carrier board electronics: 2.0 W Camera module: 2.7 W
Power consumption, idle state (without camera light, at 24 VDC)	8.5 W
	Storage and operating conditions
Storage temperature	-20 °C to +85 °C ambient temperature
Operating temperature[2]	-20 °C to +55 °C housing temperature
Relative humidity	0% to 95% (non-condensing)
	Network
Digital interface	1000BASE-T
Camera controls	GenICam (GenICam for CSI-2 Access)
	V4L2 controls (Video4Linux Access), Direct Register Access

[1] SoM default power setting is 15 W for Alecs to reach the temperature specifications in this user guide. If you consider using 25 W, see Alecs thermal management on page 46.
The SoM's power consumption varies depending on the processing power. Alecs has been tested with power modes up to 25 W using passive cooling.

[2] Output by `DeviceTemperature`, see Handling hot Alecs on page 38.

Red table boarder lines signal that data applies to **GenICam for CSI-2 Access** only.

Table 31: Alecs G1-530 VSWIR specifications (sheet 2 of 2)

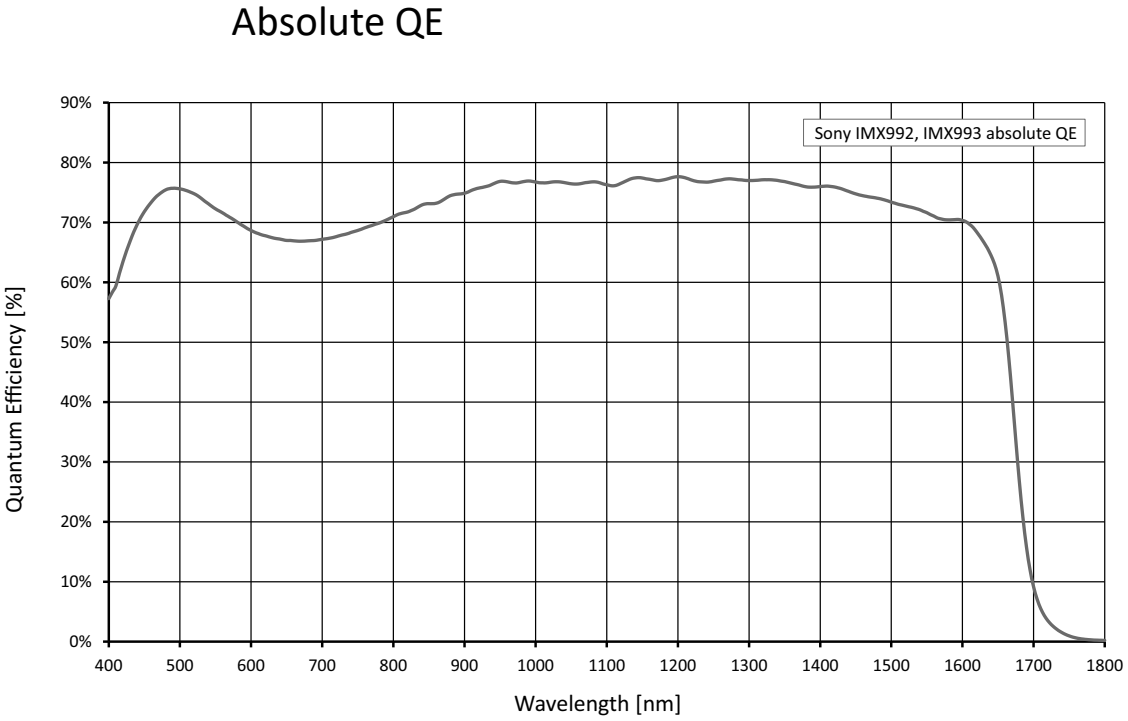


Figure 8: Alecs G1-530 VSWIR (Sony IMX992) absolute QE
According to manufacturer data

Internal frame rates with Cropping

Values were calculated as defined in Internal frame rates with ROI/Cropping on page 56 and in Conditions for internal frame rate values on page 58.

Frame rates at maximum bandwidth calculates for 1.425 Gbit/s per lane. Table 30 shows the maximum frame rate available for typical operation, using 4 lanes with a bandwidth of 5.700 Gbit/s.

Image format	Width [pixels]	Height [pixels]	ROI area [MP]	Frame rate [fps][1]
Full resolution	2592	2056	5.329	84.7
QSXGA	2560	2048	5.243	85.0
WQHD	2560	1440	3.686	116.9
QXGA	2048	1536	3.146	110.9
Full HD	1920	1080	2.074	151.5
UXGA	1600	1200	1.920	138.7
WXGA+ [2]	1440	904	1.302	177.6
SXGA	1280	1024	1.311	159.9
HD 720	1280	720	0.922	215.2
XGA	1024	768	0.786	204.9
SVGA	800	600	0.480	251.8
VGA	640	480	0.307	300.6
HVGA	480	320	0.154	405.6
QVGA	320	240	0.077	491.9
HQVGA	240	160	0.038	623.0
QQVGA	160	120	0.019	722.9
Max. × half [3]	2592	1032	2.675	156.2
Max. × min.	2592	16	0.041	966.3
Min. × max.	16	2056	0.033	86.2
Min. × min.[4]	16	16	256 Px	1214.1

[1] Mono8 at `SensorBitDepth` = 8-Bit

[2] Instead of 1440 × 900 | [3] Instead of 2592 × 1028
If resolutions were not available due to increments, frame rates relate to the next available resolution.

[4] **GenICam for CSI-2 Access** (Vimba X): 16 × 16 | Other access modes: 16 × 32

Table 32: Alecs G1-530 VSWIR ROI frame rates (internal)

Alecs G1-1242m/c

Feature	Specification	
	Alecs G1-1242m (monochrome)	**Alecs G1-1242c(color)**
SoM (system on module)	NVIDIA® Jetson Orin™ NX16 / Nano8	
Extended memory (non-volatile)	128 GByte (NVME SSD)	
RAM (volatile)	16 GByte (NX16) | 8 GByte (Nano8)	
Sensor model	Sony IMX545	
Resolution	4128 (H) × 3008 (V); 12.4 MP	
Sensor type	CMOS	
Shutter type	Global shutter (GS)	
Sensor size	Type 1/1.1; 11.3 mm × 8.2 mm; 14.0 mm diagonal	
Pixel size	2.74 µm × 2.74 µm	
CRA	0 deg	
Sensor bit depth (ADC)	12-bit	
	Pixel formats, GenICam for CSI-2 Access	
Monochrome pixel formats	Mono8 (default), Mono10, Mono10p, Mono12, Mono12p	Mono8, Mono10, Mono10p, Mono12, Mono12p
YUV color pixel formats	Not applicable	YCbCr411_8_CbYYCrYY, YCbCr422_8_CbYCrY, YCbCr8_CbYCr
RGB color pixel formats	Not applicable	BGR8, RGB8 (default)
Raw color pixel formats	Not applicable	BayerRG8, BayerRG10, BayerRG10p, BayerRG12, BayerRG12p
	Pixel formats, other access modes	
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)	
	Camera speed, gain, and binning	
Maximum frame rate (internal)	40 fps, using 4 lanes	
Exposure time	11 µs to 10 s (4 lanes)	
Exposure modes	Timed, TriggerControlled, TriggerWidth	
Gain	0 dB to 48 dB; 0.1 dB increments	
Digital binning[1]	Horizontal: 1 to 8 columns; Vertical: 1 to 8 rows	
Sensor binning (H × V)	2 × 2 (*Sum*)	Not applicable

Red table boarder lines signal that data applies to **GenICam for CSI-2 Access** only.

Table 33: Alecs G1-1242m/c specifications (sheet 1 of 2)

Feature	Specification	
	Alecs G1-1242m (monochrome)	**Alecs G1-1242c(color)**
	Memory	
Camera: Image buffer (RAM)	256 KByte	
Camera: Non-volatile memory (Flash)	1024 KByte	
SoM: Non-volatile memory (Flash)	128 GByte (NVME SSD)	
	Power and I/Os	
I/Os (opto-isolated)	2 inputs, 2 outputs, 1 trigger input, 1 strobe output	
Power requirements	24 VDC	
Power consumption, typical operation (without camera light, at 24 VDC)	SoM: Max. 10 W to 25 W (depending on the power mode)[1] Carrier board electronics: 2.0 W Camera module: 3.2 W	
Power consumption, idle state (without camera light, at 24 VDC)	8.5 W	
	Storage and operating conditions	
Storage temperature	-20 °C to +85 °C ambient temperature	
Operating temperature[2]	-20 °C to +65 °C housing temperature	
Relative humidity	0% to 95% (non-condensing)	
	Network	
Digital interface	1000BASE-T	
Camera controls	GenICam (GenICam for CSI-2 Access)	
	V4L2 controls (Video4Linux Access), Direct Register Access	

[1] SoM default power setting is 15 W for Alecs to reach the temperature specifications in this user guide. If you consider using 25 W, see Alecs thermal management on page 46.
The SoM's power consumption varies depending on the processing power. Alecs has been tested with power modes up to 25 W using passive cooling.

[2] Output by `DeviceTemperature`, see Handling hot Alecs on page 38.

Red table boarder lines signal that data applies to **GenICam for CSI-2 Access** only.

Table 33: Alecs G1-1242m/c specifications (sheet 2 of 2)

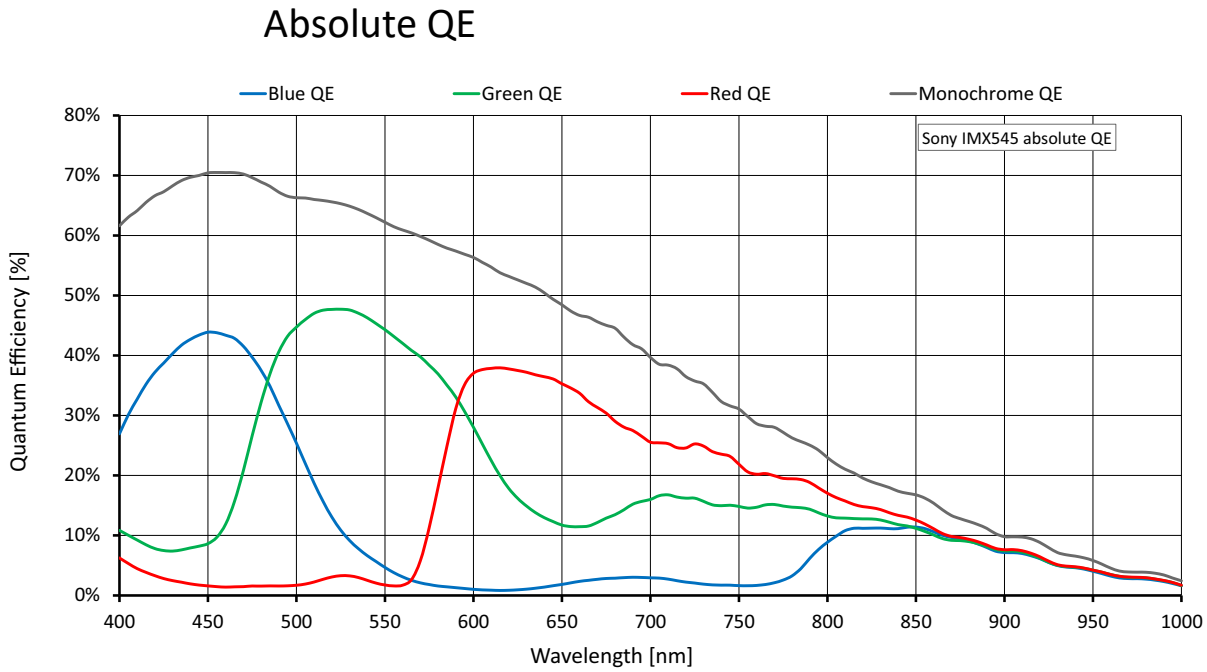


Figure 9: Alecs G1-1242m/c (Sony IMX545) absolute QE

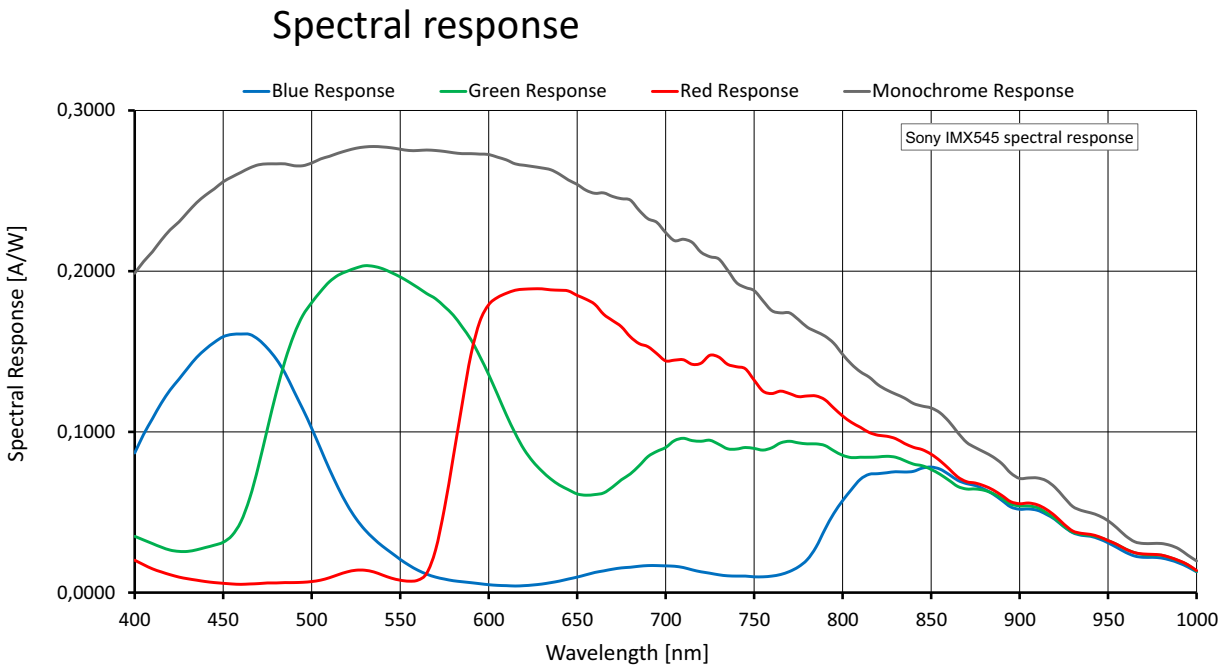


Figure 10: Alecs G1-1242m/c (Sony IMX545) spectral response

Internal frame rates with Cropping

Values were calculated as defined in Internal frame rates with ROI/Cropping on page 56 and in Conditions for internal frame rate values on page 58.

Frame rates at maximum bandwidth calculates for 1.425 Gbit/s per lane. Table 34 shows the maximum frame rate available for typical operation, using 4 lanes with a bandwidth of 5.700 Gbit/s.

Image format	Width [pixels]	Height [pixels]	ROI area [MP]	Frame rate [fps][1]
Full resolution	4128	3008	12.417	40.9
UHD 4K	3840	2160	8.294	55.8
QSXGA	2560	2048	5.243	59.0
WQHD	2560	1440	3.686	81.4
QXGA	2048	1536	3.146	77.0
Full HD	1920	1080	2.074	105.4
UXGA	1600	1200	1.920	96.4
WXGA+ [3]	1440	904	1.302	123.6
SXGA	1280	1024	1.311	111.2
HD 720	1280	720	0.922	149.8
XGA	1024	768	0.786	142.4
SVGA	800	600	0.480	175.1
VGA	640	480	0.307	208.9
HVGA	480	320	0.154	280.7
QVGA	320	240	0.077	339.6
HQVGA	240	160	0.038	428.7
QQVGA	160	120	0.019	493.5
Max. × half	4128	1504	6.209	77.5
Max. × min.	4128	16	0.066	657.3
Min. × max.	16	3008	0.048	41.4
Min. × min. [4]	16	16	256 Px	802.1

[1] Mono8 or Bayer...8[(2)] at `SensorBitDepth` = 8-Bit

[2] The three dots**...** represent the colors of a Bayer pixel format, such as in Bayer**RG**8.

[3] Instead of 1440 × 900
If resolutions were not available due to increments, frame rates relate to the next available resolution.

[4] **GenICam for CSI-2 Access** (Vimba X): 16 × 16 | Other access modes: 16 × 32

Table 34: Alecs G1-1242m/c ROI frame rates (internal)

Dimensions and mass

Dimension	Main housing	With LT4632	With LT4649	With LT4670, camera ring light[1]
Flange focal distance, optical	17.526 mm	17.526 mm	17.526 mm	17.526 mm
Thread	1“-32tpi UNS-2B	1“-32tpi UNS-2B	1“-32tpi UNS-2B	1“-32tpi UNS-2B
Maximum protrusion	13.6 mm	13.6 mm	13.6 mm	13.6 mm
Max. length of lens[2]	N.a.	32 mm	49 mm	70 mm
Max. width of lens	N.a.	46 mm	46 mm	46 mm
Body dimensions (L × W × H) in [mm] Without connectors	49.6 × 72 × 111.75	85.2 × 72 × 111.75	102.3 × 72 × 111.75	122.7 × 140 × 149
Mass, without lens	650 g	805 g	810 g	1270 g

[1] Ring Light RMX140, see Ring lights and accessories on page 17.

[2] Distance from the C-Mount front flange to the lens’ front surface, including needed front filters. Observe that some lenses increase in length when focus or zoom are used.

Table 35: Dimensions and mass

Lens dimensions

- Maximum dimensions for lenses apply only with lens tube. Without lens tube, there are no limitations by the Alecs design.
- Filters and extension tubes, fastening screws for adjustment rings, or other lens accessories increase the dimensions of the lens.
- For some lenses, the length increases by focusing or when the focal length is adjusted.
- Lens tubes can cause vignetting, especially with wide angle lenses.

Lens tubes for larger lenses

Current lens tubes can be used with lenses up to 70 mm length and 46 mm width.

If you want to use lenses exceeding these dimensions, please contact your Allied Vision Sales representative or visit www.alliedvision.com/en/about-us/contact-us/contact-sales.

Mass for Alecs accessories

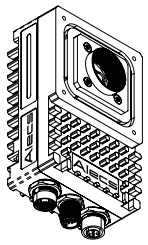
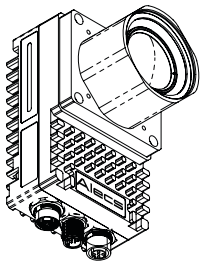
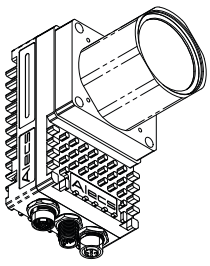
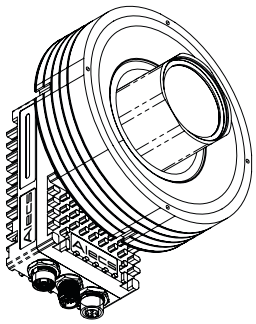
Values in Table 35 apply to assembled components. Table 36 shows values for accessories:

Component	Mass[1]
Lens tube LT4632 [1]	155 g
Lens tube LT4649 [1]	160 g
Lens tube LT4670 [1]	170 g
Ring Light mounting plate [1]	60 g
Ring Light RMX140	370 g
[1] Including screws	

Table 36: Mass for Alecs accessories

Technical drawings

Alecs is available with the following housing options:

				
Option	Main housing	With lens tube LT4632	With lens tube LT4649	With lens tube LT4670 and camera ring light
Page	87	88	89	90

Main housing

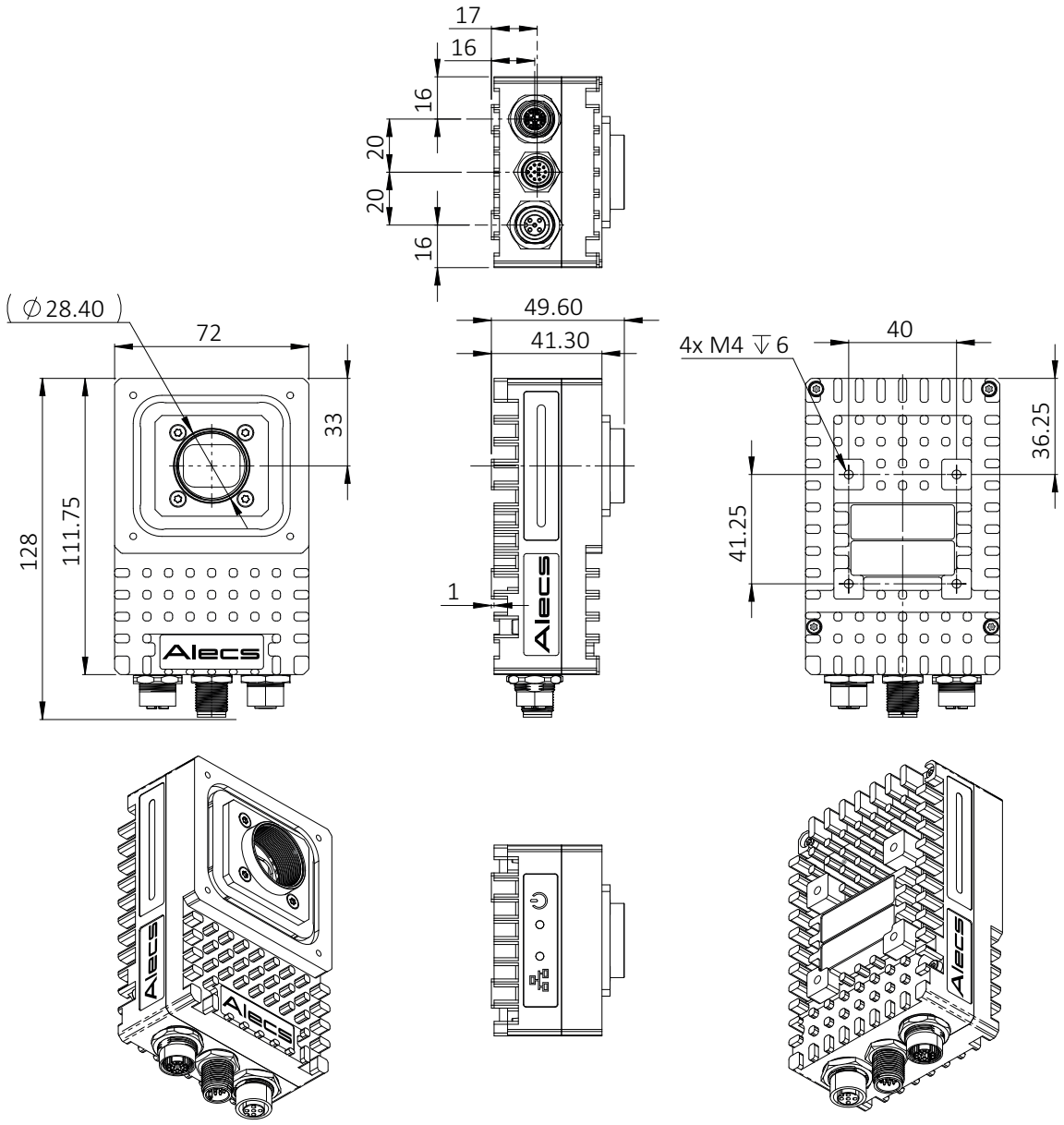


Figure 11: Main housing drawing

With lens tube LT4632

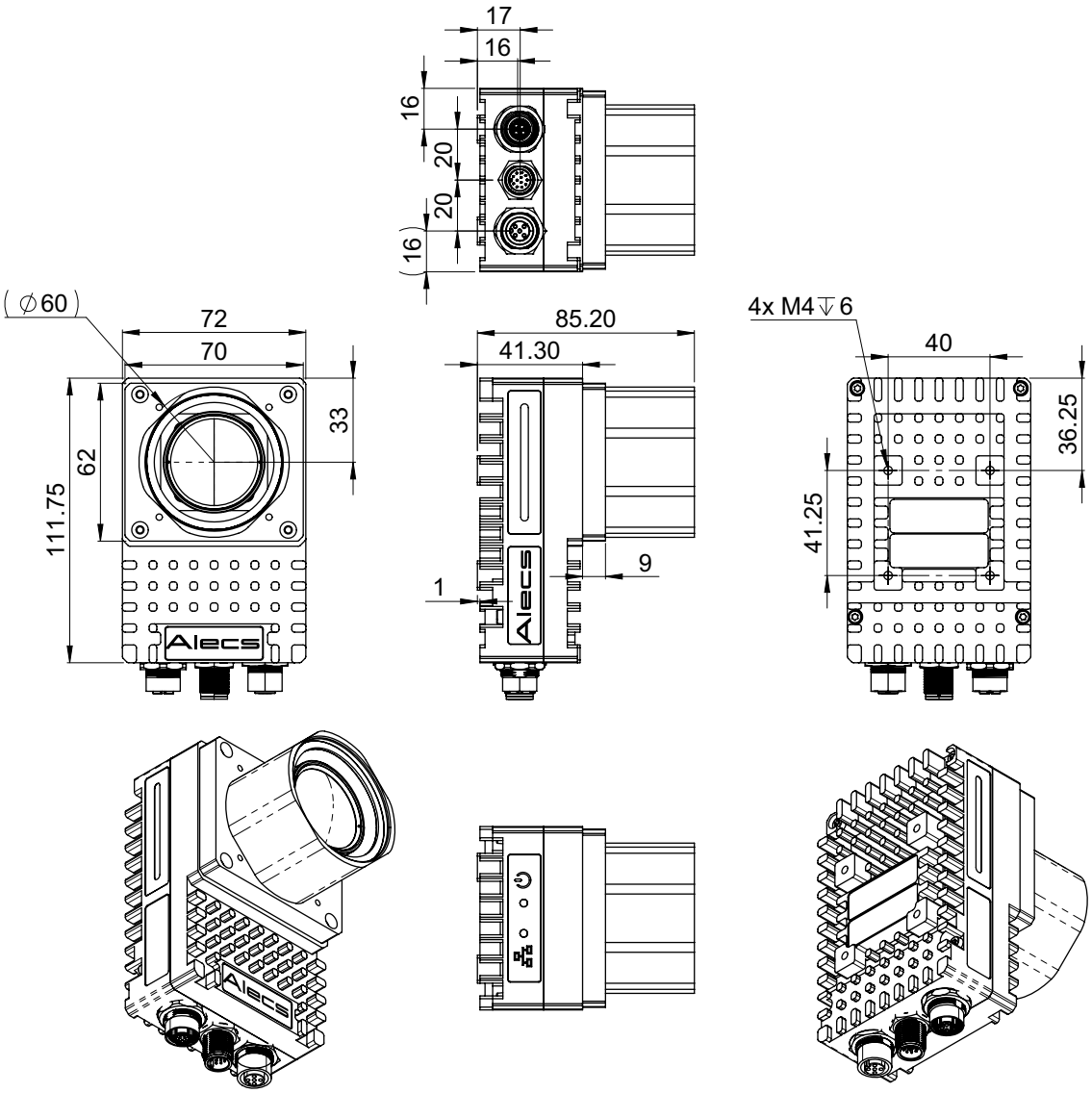


Figure 12: With lens tube LT4632 drawing

With lens tube LT4649

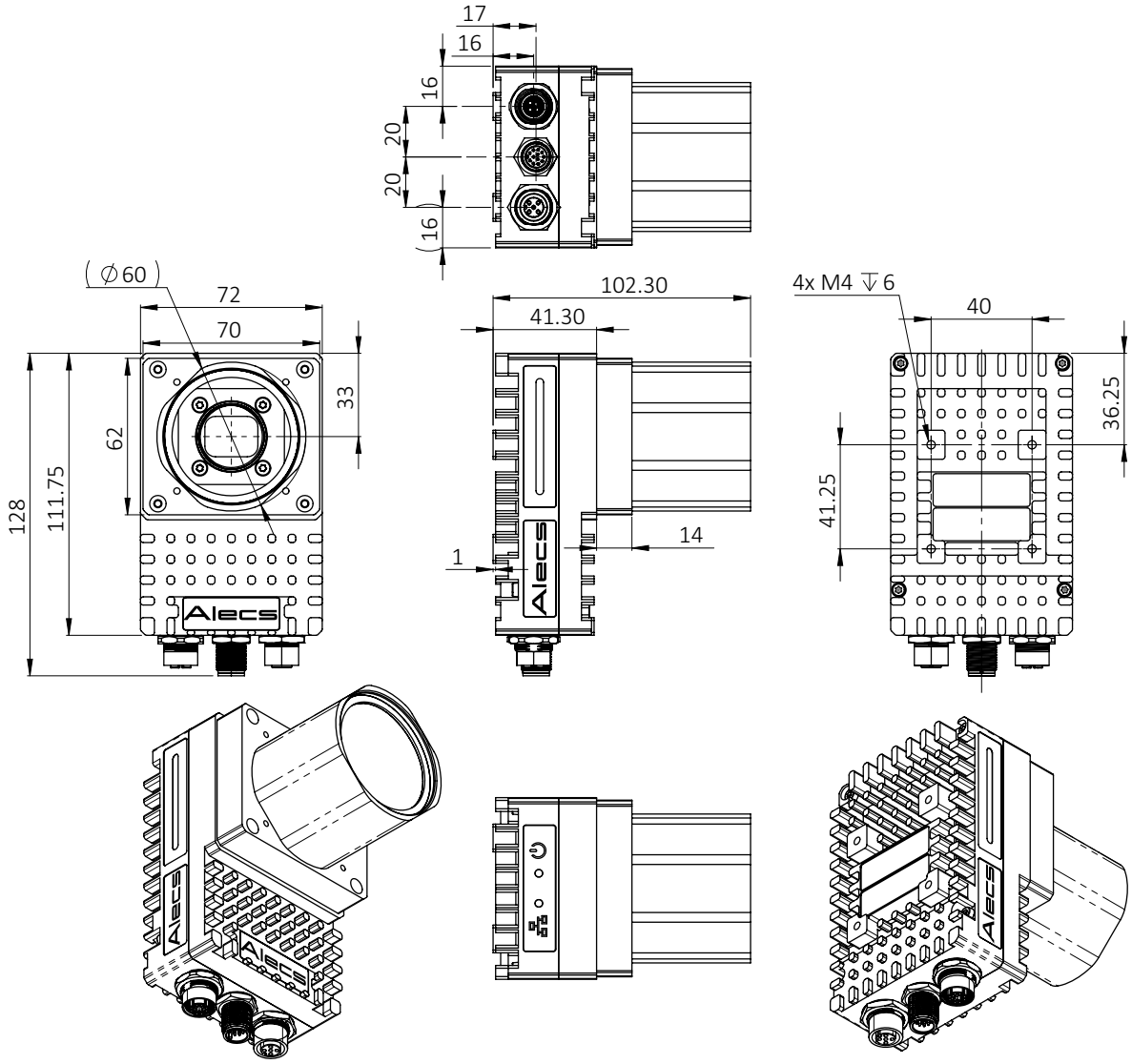


Figure 13: With lens tube LT4649 drawing

With lens tube LT4670 and camera ring light

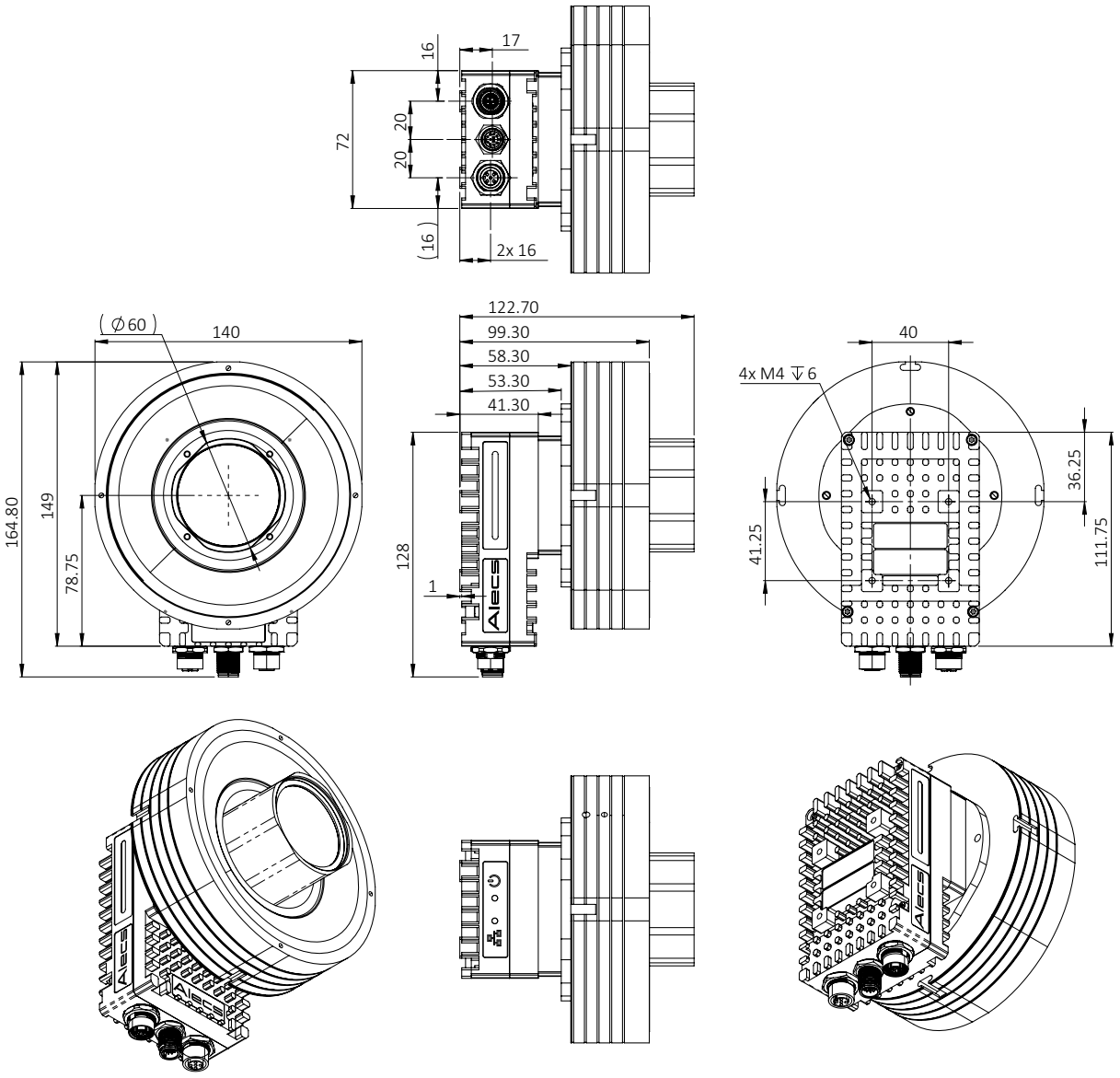


Figure 14: With lens tube LT4670 and camera ring light drawing

Alecs is offered as a bundle with Ring Light RMX140, including the mounting plate. The ring light is available with white or color LEDs, see Lens tubes on page 17.

Technical data and ordering

Information for Ring Light RMX140, including mounting plates:

- Technical data: www.alliedvision.com/en/products/accessories/lighting
- Ordering: www.alliedvision.com/en/about-us/contact-us/contact-sales

Maximum dimensions for lenses

NOTICE

Damage to cameras by unsuitable lenses

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

- Use lenses with less than 13.6 mm maximum protrusion.
- See Mounting the lens on page 112.

NOTICE

Damage to lenses or the lens tube

Lenses or the lens tube's front glass can be damaged if lenses are used that exceed the dimensions of the lens tube.

- Use only lenses within the dimensions of the lens tube.
- Observe that some lenses change in length when focus or zoom are used.

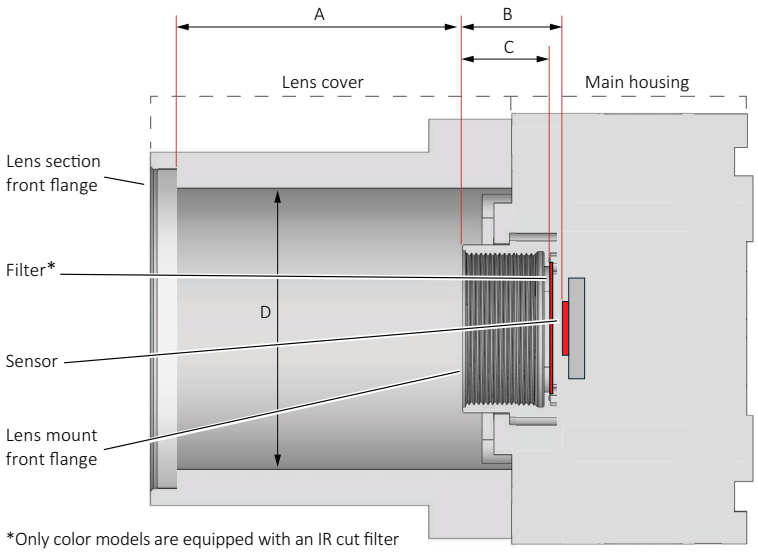


Figure 15: Maximum dimensions for lenses > Drawing

Dimension	Description	Value
A	Lens tube's front glass to lens mount front flange	32 mm, 49 mm, or 70 mm
B	Lens mount front flange to sensor (optical)	17.526 mm (max. protrusion)
C	Lens mount front flange to filter	13.6 mm (max. protrusion)
D	Lens tube inside diameter	46 mm

Table 37: Maximum dimensions for lenses > Values

No need to readjust lens mounts

Lens mounts in Alecs is adjusted with high precision during manufacturing. Construction ensures permanent accuracy without need to readjust.

IR cut filter

Table 38 shows which Alecs models are equipped with an IR cut filter. The filter is permanently installed and cannot be removed.

Chroma	C-Mount
Color	Type IRC 625 colored glass filter screwed in
Monochrome	No filter

Table 38: 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 16 for filter transmission.

Spectral transmission values

The following curve shows typical transmission for type IRC 625 colored glass filter. Values may vary slightly by filter lot.

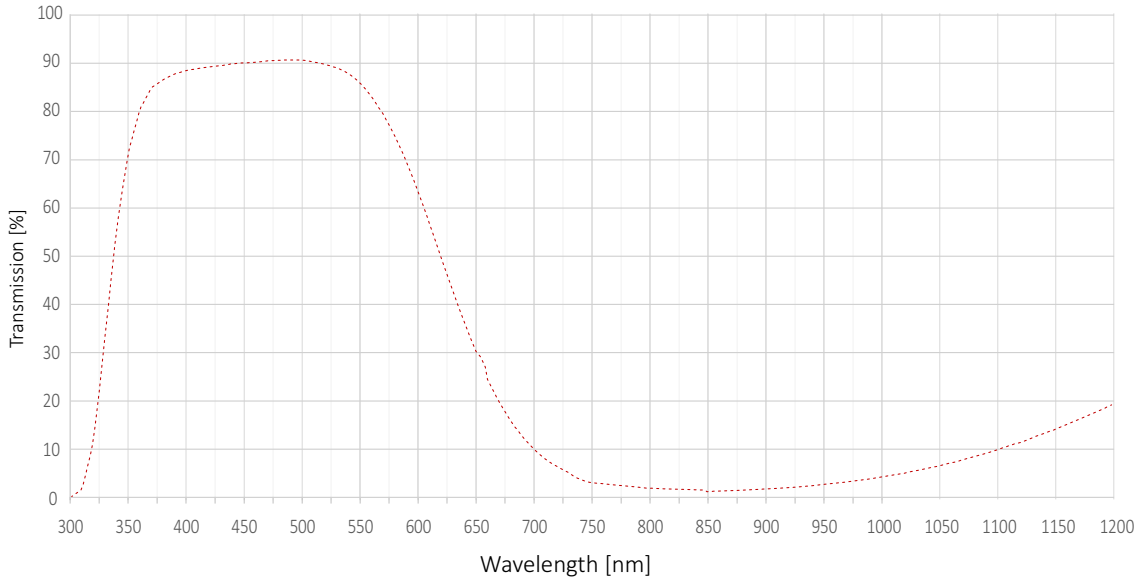
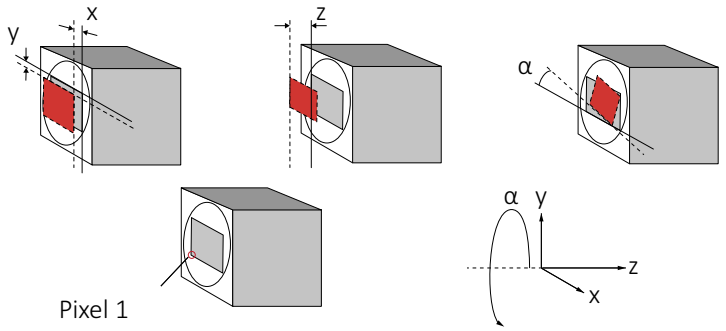


Figure 16: Type IRC 625 colored glass filter spectral transmission (exemplary curve)

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.

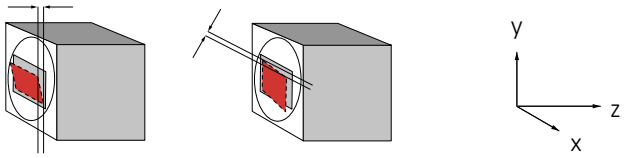
Figure 17: Sensor shift and rotation > Parameters

The following table defines the manufacturing accuracy for sensor positioning with the cameras in Alecs embedded camera systems.

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[1]	±150 µm (sensor shift)
	z	0 to -100 µm (optical back focal length)
	α[1]	±0.5 deg (sensor rotation as the deviation from the parallel to the camera bottom)

Table 39: Sensor shift and rotation > Values

Sensor tilt



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

Figure 18: Sensor tilt > Parameters

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

Alecs model	Pixel size	Maximum tilt
Alecs G1-030 VSWIR	5 µm × 5 µm	50 µm
Alecs G1-130 VSWIR	5 µm × 5 µm	50 µm
Alecs G1-320 VSWIR	3.45 µm × 3.45 µm	24 µm
Alecs G1-530 VSWIR	3.45 µm × 3.45 µm	24 µm
Alecs-G1-510m/c	2.74 µm × 2.74 µm	18 µm
Alecs-G1-1242m/c	2.74 µm × 2.74 µm	18 µm

Table 40: Sensor tilt > Values

mipi GenICam for CSI-2 Access

User sets

Supported features

`UserSet` features enable to store individual settings on Alecs embedded camera systems. These user sets can be loaded by default, without needing to set values by software after every restart of Alecs. Or they can be used to switch between different settings, for example, to adjust from daylight to artificial light.

User sets support all features except for:

- Command features
- Read-only features
- Features in the `LUTControl` category#
- Selectors: Used to choose between various instances of a functionality.

GenICam for CSI-2 Access

Trigger features and UserSetDefault

Trigger features are reset to default values when the default user set is loaded.

Column `UserSetLoad` displays how user values are affected when the command for `UserSetLoad` is executed.

Feature	Default value	UserSetDefault
`TriggerActivation`	*`RisingEdge`*	Default value
`TriggerMode`	*`Off`*	Default value
`TriggerSelector`	*`AcquisitionStart`*	User value
`TriggerSoftware`	[Command]	Not applicable
`TriggerSource`	*`Software`*	Default value

Table 41: Trigger features being reset

Camera feature availability

Alecs supports a number of standard and extended controls and features. The following tables compare the availability of selected controls and features by model.

Feature descriptions and firmware downloads

GenICam for CSI-2 Access: Alecs Features Reference
Video4Linux Access: Alecs V4L2 Controls Reference

www.alliedvision.com/en/support/Alecs G1-documentation

Image control	Monochrome models	Color models	Supported models
Adaptive noise correction	✓	✓	All
Auto exposure	✓	✓	All
Auto gain	✓	✓	All
Auto white balance	-	✓	All
Color transformation (including hue, saturation)	-	✓	All
Contrast	✓	✓	All

Table 42: Image control features by Alecs model (sheet 1 of 2)

Image control	Monochrome models	Color models	Supported models
Custom convolution	✓	✓	All
De-Bayering up to 5×5	-	✓	All
Digital binning	✓	✓	All
DPC (defect pixel correction)	✓	✓	All
FPNC (fixed pattern noise correction)	✓	✓	Alecs G1-510, G1-1242
Gamma	✓	✓	All
Lens shading correction	✓	✓	All
Look up table (LUT)	✓	✓	All
Reverse X/Y	✓	✓	All
Sensor binning	✓	-	Alecs G1-510, G1-1242
Sharpness/Blur	✓	✓	All
SIngle ROI (region of interest)	✓	✓	All

Table 42: Image control features by Alecs model (sheet 2 of 2)

Camera control	Monochrome models	Color models	Supported models
Acquisition frame rate	✓	✓	All
Counters and timers	✓	✓	All
Firmware update in the field	✓	✓	All
Image chunk data	✓	✓	All
I/O and trigger control	✓	✓	All
Sensor ADC readout modes (`SensorBitDepth`)	✓	✓	Alecs G1-030 VSWIR, G1-130 VSWIR, G1-320 VSWIR, G1-530 VSWIR
Temperature monitoring: SoM CPU	✓	✓	All
Temperature monitoring: Housing, mainboard, (image sensor[1])	✓	✓	All
User sets	✓	✓	All

[1] The sensor temperature can be output only when the camera is not streaming.

Table 43: Camera control features by Alecs model

Lenses

This chapter includes:

Lenses and lens tubes

We have done comprehensive tests to define sets of lenses covering typical fields of view and object distances, while ensuring optimum image quality. To support IP67, use Alecs with lens tubes only. Table 44 shows suitable combinations:

<table>
<tr><th rowspan="2">Product code</th><th rowspan="2">Lens</th><th colspan="6">Alecs model</th></tr>
<tr><th>G1-030 VSWIR</th><th>G1-130 VSWIR</th><th>G1-320 VSWIR</th><th>G1-510</th><th>G1-530 VSWIR</th><th>G1-1242</th></tr>
<tr><td>17446</td><td>C-Mount-Lens-Type1/1.8-4.5mm-F2.0-7.5MP</td><td colspan="3" rowspan="10">N.a.</td><td>LT4632</td><td rowspan="14">N.a.</td><td rowspan="5">N.a.</td></tr>
<tr><td>10851</td><td>C-Mount-Lens-Type1/1.8-6mm-F1.4-7.5MP</td><td rowspan="5">LT4649</td></tr>
<tr><td>22196</td><td>C-Mount-Lens-Type2/3-8.5mm-F1.3-7.5MP</td></tr>
<tr><td>9513</td><td>C-Mount-Lens-Type2/3-12mm-F1.8-7.5MP</td></tr>
<tr><td>9516</td><td>C-Mount-Lens-Type2/3-16mm-F1.6-7.5M</td></tr>
<tr><td>8077</td><td>C-Mount-Lens-Type2/3-25mm-F1.4-7.5MP</td><td rowspan="5">LT4670</td><td rowspan="5">LT4670</td></tr>
<tr><td>18531</td><td>C-Mount-Lens-Type2/3-35mm-F1.65-7.5MP</td></tr>
<tr><td>22421</td><td>C-Mount-Lens-Type1.2-16mm-F2.4-25MP</td></tr>
<tr><td>22422</td><td>C-Mount-Lens-Type1.2-25mm-F2.4-25MP</td></tr>
<tr><td>22423</td><td>C-Mount-Lens-Type1.2-35mm-F2.4-25MP</td></tr>
<tr><td>22424</td><td>C-Mount-Lens-Type1.2-50mm-F2.4-25MP</td></tr>
<tr><td>31261</td><td>C-Mount-Lens-Type1/1.8-4.5mm-F2.0-7.5MP-SWIR</td><td colspan="3">LT4632</td><td rowspan="9">N.a.</td><td rowspan="9">N.a.</td></tr>
<tr><td>31273</td><td>C-Mount-Lens-Type1/1.8-6.0mm-F1.4-7.5MP-SWIR</td><td colspan="3" rowspan="6">LT4649</td></tr>
<tr><td>31276</td><td>C-Mount-Lens-Type2/3-8.5mm-F1.3-7.5MP-SWIR</td></tr>
<tr><td>31277</td><td>C-Mount-Lens-Type2/3-12mm-F1.8-7.5MP-SWIR</td><td rowspan="4">LT4649</td></tr>
<tr><td>31278</td><td>C-Mount-Lens-Type2/3-16mm-F1.6-7.5MP-SWIR</td></tr>
<tr><td>31279</td><td>C-Mount-Lens-Type2/3-25mm-F1.4-7.5MP-SWIR</td></tr>
<tr><td>31280</td><td>C-Mount-Lens-Type2/3-35mm-F1.65-7.5MP-SWIR</td></tr>
</table>

Table 44: Alecs models, lenses, and lens tubes

Lens tubes and Alecs models can be swapped if this is required for your application.

Recommended lenses

You can find compatible lenses at www.alliedvision.com/en/products/lenses.

Lens tubes for larger lenses

If you want to use lenses that require lens tubes with a different size, please contact your Allied Vision Sales representative or visit www.alliedvision.com/en/about-us/contact-us/contact-sales.

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.

We help you to find a proper lens

For demanding applications, we suggest testing lenses on Alecs to find a suitable setup. If you have questions, please contact your Allied Vision Sales representativ or visit www.alliedvision.com/en/about-us/contact-us/contact-sales.

Focal length versus field of view

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

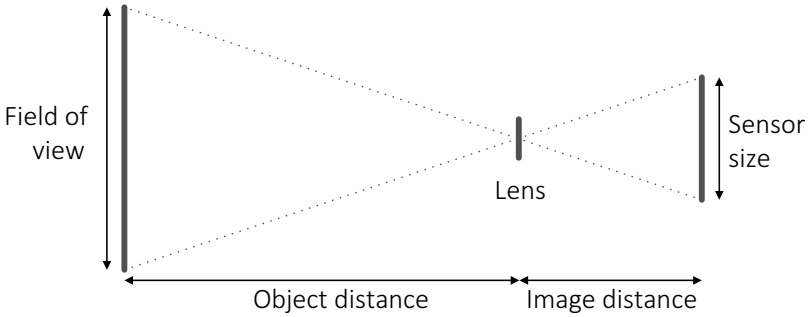


Figure 19: Parameters used in tables for focal length versus FOV

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.

Alecs G1-030 VSWIR

Values for G1-030 VSWIR cameras with Type 1/4 (4.1 mm diagonal) sensors:

Focal length [mm]		Field of view (H × V [mm])	
With lens tube[1]	**Without lens tube**	**Object distance = 500 mm**	**Object distance = 1000 mm**
-	4	407 × 322	817 × 647
5	5	775 × 773	1557 × 1553
6	6	644 × 642	1296 × 1293
8	8	481 × 480	970 × 968
12	12	318 × 317	644 × 642
16	16	237 × 236	481 × 480
25	25	149 × 148	305 × 304
35	35	104 × 104	216 × 215
-	50	70 × 70	149 × 148

[1] See Table 44 on page 98

Table 45: Focal length versus field of view for Alecs G1-030 VSWIR

Alecs G1-130 VSWIR

Values for G1-130 VSWIR cameras with Type 1/2 (8.2 mm diagonal) sensors:

Focal length [mm]		Field of view (H × V [mm])	
With lens tube[1]	**Without lens tube**	**Object distance = 500 mm**	**Object distance = 1000 mm**
5	5	671 × 560	1348 × 1125
6	6	558 × 466	1122 × 937
8	8	417 × 348	840 × 701
12	12	275 × 230	558 × 466
16	16	205 × 171	417 × 348
25	25	129 × 107	264 × 221
35	35	90 × 75	187 × 156
-	50	61 × 51	129 × 107

[1] See Table 44 on page 98

Table 46: Focal length versus field of view for Alecs G1-130 VSWIR

Alecs G1-320 VSWIR

Values for G1-320 VSWIR cameras with Type 1/1.8 (8.9 mm diagonal) sensors:

Focal length [mm]		Field of view (H × V in [mm])	
With lens tube[1]	**Without lens tube**	**Object distance = 500 mm**	**Object distance = 1000 mm**
6	6	591 × 439	1189 × 882
8	8	441 × 328	890 × 661
12	12	292 × 217	591 × 439
16	16	217 × 161	441 × 328
25	25	136 × 101	280 × 208
35	35	95 × 71	198 × 147
-	50	65 × 48	136 × 101
-	75	41 × 30	89 × 66

[1] See Table 44 on page 98

Table 47: Focal length versus field of view for Alecs G1-320 VSWIR

Alecs G1-510m/c

Values for G1-510m/c with Type 1/1.8 (8.8 mm diagonal) sensors:

Focal length [mm]		Field of view (H × V in [mm])	
With lens tube[1]	**Without lens tube**	**Object distance = 500 mm**	**Object distance = 1000 mm**
-	5	671 × 560	1348 × 1125
6	6	558 × 466	1122 × 937
8	8	417 × 348	840 × 701
12	12	275 × 230	558 × 466
16	16	205 × 171	417 × 348
25	25	129 × 107	264 × 221
35	35	90 × 75	187 × 156
-	50	61 × 51	129 × 107

[1] See Table 44 on page 98

Table 48: Focal length versus field of view for Alecs G1-510m/c

Alecs G1-530 VSWIR

Values for G1-530 VSWIR cameras with Type 1/1.4 (11.4 mm diagonal) sensors:

Focal length [mm]		Field of view (H × V in [mm])	
With lens tube[1]	**Without lens tube**	**Object distance = 500 mm**	**Object distance = 1000 mm**
-	6	736 × 584	1481 × 1175
-	8	550 × 436	1109 × 880
12	12	364 × 288	736 × 584
16	16	271 × 215	550 × 436
25	25	170 × 135	349 × 277
35	35	119 × 94	247 × 196
-	50	80 × 64	170 × 135
-	75	51 × 40	110 × 87

[1] See Table 44 on page 98

Table 49: Focal length versus field of view for Alecs G1-530 VSWIR

Alecs G1-1242m/c

Values for G1-1242m/c with Type 1/1.1 (14.0 mm diagonal) sensors:

Focal length [mm]		Field of view (H × V in [mm])	
With lens tube[1]	**Without lens tube**	**Object distance = 500 mm**	**Object distance = 1000 mm**
-	6	931 × 679	1874 × 1365
-	8	696 × 507	1403 × 1022
-	12	460 × 335	931 × 679
16	16	342 × 249	696 × 507
25	25	215 × 157	441 × 321
35	35	150 × 109	312 × 227
50	50	102 × 74	215 × 157
-	75	64 × 47	139 × 102

[1] See Table 44 on page 98

Table 50: Focal length versus field of view for Alecs G1-1242m/c

Access modes

This chapter includes:

Overview

Alecs embedded camera systems support various access modes:

Access mode	Camera control by
GenICam for CSI-2 Access 	GenICam features, using the Allied Vision driver for CSI-2 cameras directly. **Vimba X SDK** with GenICam Access is pre-installed on Alecs embedded camera systems, so you can easily port your previous GeniCam application for new designs. See the Alecs Features Reference document at www.alliedvision.com/en/support/alecs-documentation.
Video4Linux Access 	V4L2 controls, directly using the Allied Vision driver for CSI-2 cameras included in Alecs embedded camera systems. Existing PC-based machine vision applications can be scaled down to V4L2 on lean embedded systems, reducing power consumption and costs. See the Alecs V4L2 Controls Reference document at www.alliedvision.com/en/support/alecs-documentation.

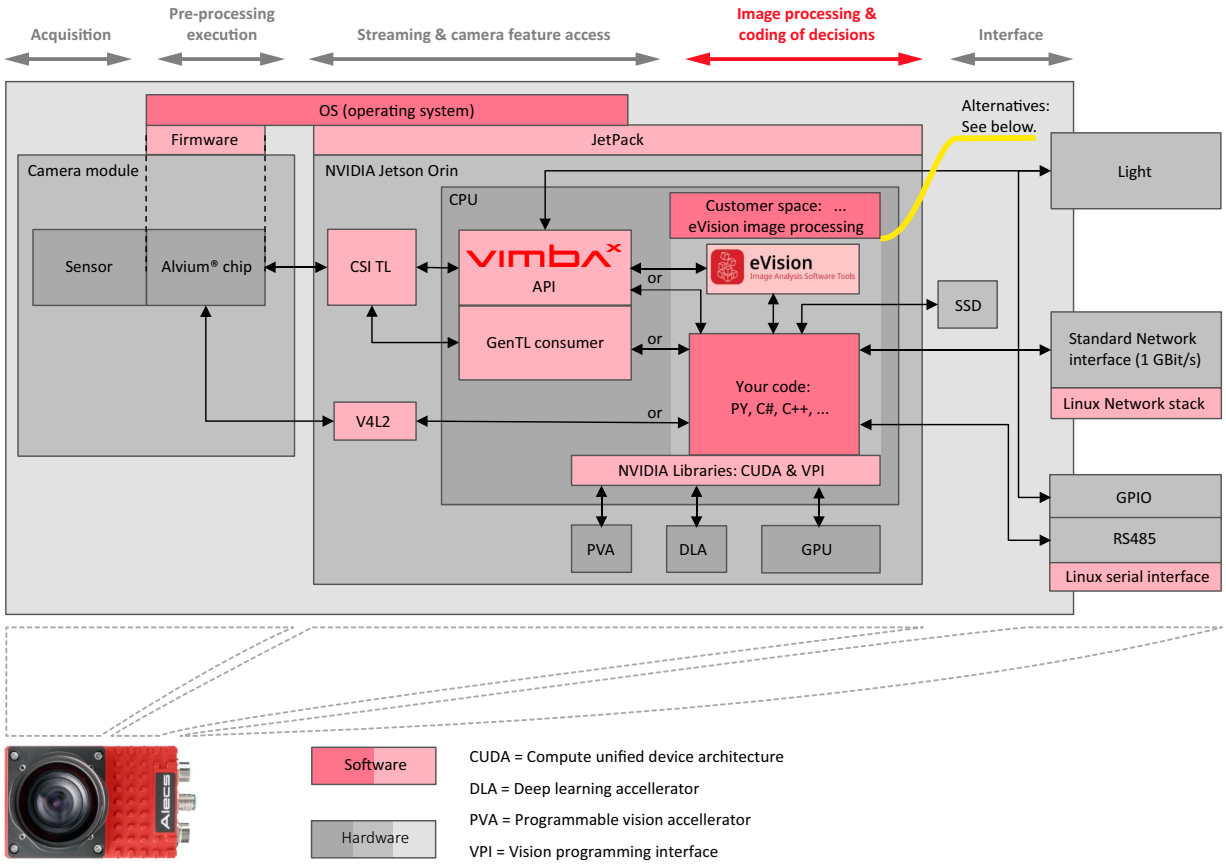
Table 51: Access modes overview

Figure 20 on page 105 shows how Alecs is controlled using the different access modes.

Notes on GenICam for CSI-2 Access

Before using **GenICam for CSI-2 Access**, see GenICam for CSI-2 Access > Limitations on page 107 for smooth operation.

Data flow



Customer space – Alternative setups:

Open eVision

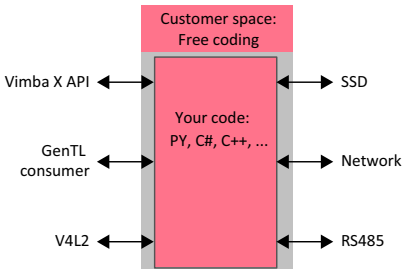
Image processing by eVision libraries
Decision coding by customers

See above.

https://www.alliedvision.com/en/products/software/evision-libraries

Free coding

Image processing by customers
Decision coding by customers



Machine vision software

Image processing by external software
Decision coding by external software

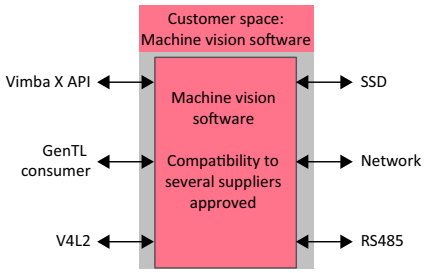


Figure 20: Camera control using the different access modes

eVision Libraries

For more information, see
www.alliedvision.com/en/products/software/evision-libraries.

V4L2 controls and register controls

Embedded applications often use V4L2 controls provided with the Linux kernel to operate and configure the camera.

V4L2 controls > General information

Consider that V4L2 controls change through the Linux kernel development.

For information on such as supported Linux kernels, see https://github.com/alliedvision.

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

GenICam features

Machine vision applications typically use GenICam SFNC features enabled by a transport layer communicating between a software development kit (SDK) and the interface driver.

GenICam features > Descriptions

For GenICam feature descriptions, see the Alecs Features Reference at www.alliedvision.com/en/support/alecs-documentation.

GenICam for CSI-2 Access > Limitations

Need to restart Alecs

Whenever you change between different access modes:

- Perform a soft reboot of the Linux system on Alecs.
- Closing the application while Alecs is streaming is not sufficient.

Debouncer

If `LineDebounceMode` is enabled, an error is shown when changing the `LineDebounceDuration`. Power cycle the camera to enable operation again.

Device reset

The `DeviceReset` command does not work. Reboot the Linux system instead.

User sets

Settings, including user sets are not transferred between the access modes.

Before you switch from **GenICam for CSI-2 Access** to another access mode, disable individual user sets. Set `UserSetDefault` and `UserSetSeletor` to *`Default`* to enable factory settings.

Installing your Alecs

This chapter includes:

Touching hot Alecs

CAUTION

Risk of burns

In operation, Alecs embedded camera systems can reach temperature levels that could cause burns.

- Wear protective gloves when you touch Alecs when it is hot.
- Ensure proper cooling of Alecs.

Sensor damage by ESD

NOTICE

Possible damage to the sensor

In Alecs embedded camera systems, sensors can be damaged by ESD. In the output image, this may become visible as bubbles or blobs, for example. For details, see Possible damage to image sensors due to electrostatic discharge on page 43.

- Provide ESD protection measures in accordance with technical standards.
- Follow the instructions in ESD on page 40.

Cables and levels

NOTICE

Damage to Alecs by wrong connections

If connected using wrong pinning or voltage levels, Alecs can be damaged.

- Use cables by Allied Vision.
- Observe the specifications in Electrical interfaces and LEDs on page 126.

NOTICE

Damage by serial communication voltage levels

If you are using RS485 communication, keep voltage levels in the range defined in I/O connection on page 128.

I/O cables maximum length

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

Default signal levels at Alecs startup

Signals for opto-isolated GPO0, GPO1, and Strobe-Out are low.

Scope of instructions

Hardware installation

Software downloads and documentation

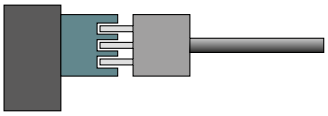
This chapter describes hardware installation only. For information on the pre-installed BSP (board support package), for drivers, libraries, and programming examples, see What else do you need? on page 18.

This chapter instructs on using Alecs safely and effectively. Because the software to control the device is designed by the users, the instructions mostly focus on installing the hardware.

Connector naming

To separate between connectors, the following terms are used:

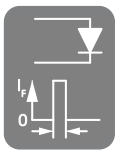
Alecs: Socket Cable: Plug



User actions and specifications

These icons guide you through the installation:

Specifications User actions



Hardware overview

This is the Alecs embedded camera system without cabling:

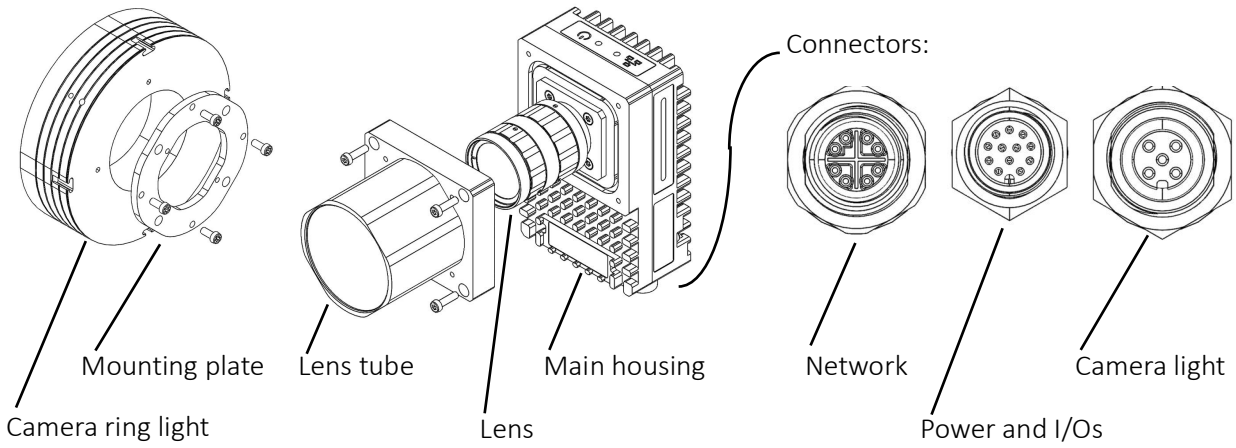


Figure 21: Alecs hardware components

Instructions overview

Step-by-step instructions on page 112 describe setting up your Alecs embedded camera system.

Figure 22 shows the instruction steps for a typical setup. You can jump between the steps by clicking the corresponding icons.

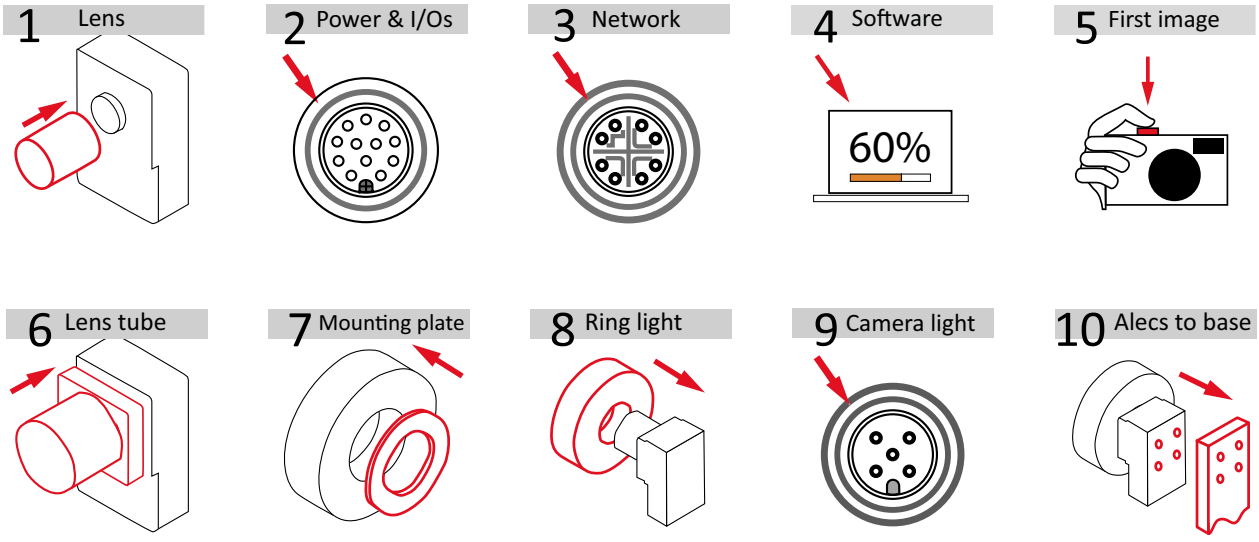
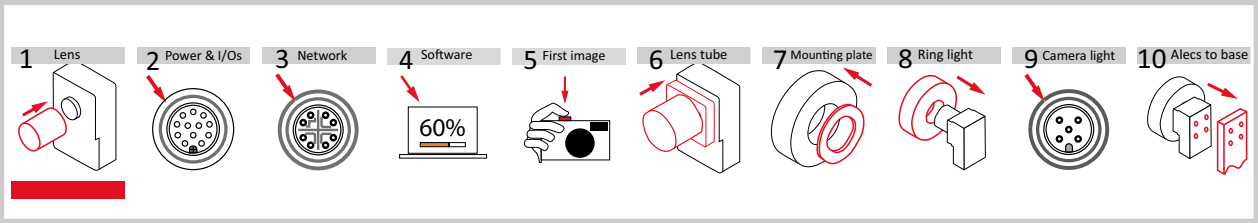


Figure 22: Instruction steps

Step-by-step instructions



1. Mounting the lens

CAUTION

Injury by a falling lenses

Especially if you are going to operate Alecs without a lens tube: Screw lenses into the lens mount until you feel resistance.

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 cameras by unsuitable lenses

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

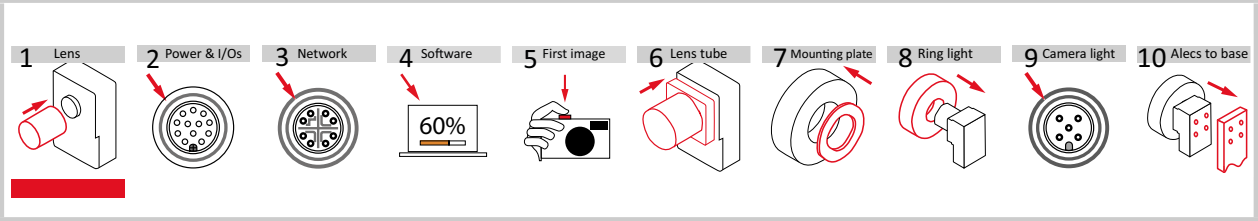
Use lenses with less than 13.6 mm maximum protrusion.

NOTICE

Damage to lenses or lens tubes

Lenses or the lens tube's front glass can be damaged if lenses are used that exceed the dimensions of the lens tube.

- Use only lenses within the dimensions of the lens tube.
- Observe that some lenses change in length when focus or zoom are used.



...Mounting the lens > Instructions

Note
We recommend you to have a protection cap for the C-Mount ready to keep dirt out of the camera if you want to remove the lens.

1. Remove the lens' back cover and lay it back on the lens thread to avoid dirt. Set the lens down on the front side.
2. Hold Alecs with the camera's lens mount facing the ground to keep dirt out of the lens mount.
3. With your finger tips, starting from the edge, slowly pull the circular protection foil (b) off the lens mount until removed completely.
4. If you have no cap to protect the C-Mount from dirt, store the protection foil in a safe place: You can reuse it to keep dirt out.
5. Lift the lens' back cover.
6. Fit the thread (a) of the lens to the C-Mount thread (d) of the camera.
7. Screw the lens clockwise against the main housing (c) until you feel resistance.

◊ The lens is ready for use. Continue with Connecting power and I/Os on page 114.

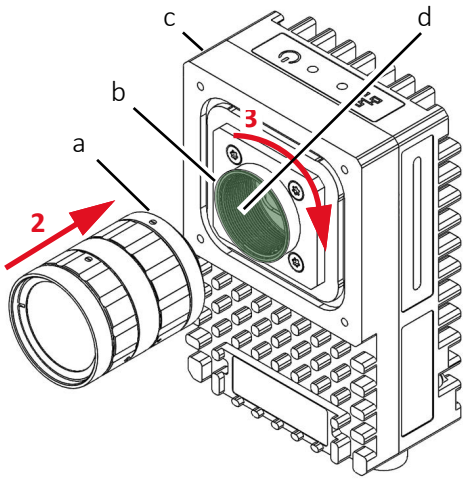
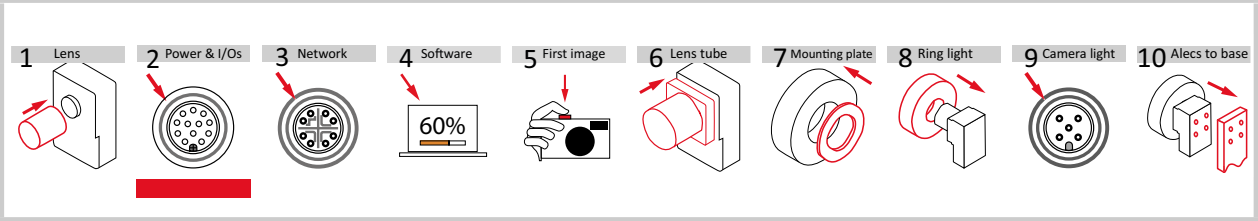
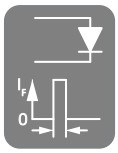


Figure 23: Mounting the lens



2. Connecting power and I/Os



For descriptions of connectors, pin assignment, signals, levels, and timings, see I/O connection on page 128.

NOTICE

Damage by high voltage levels

If Alecs is powered above the maximum voltage allowed, Alecs can be damaged.

Power Alecs below 24 VDC ±10%.

NOTICE

Damage by reverse polarity

If powered with reverse polarity, Alecs can be damaged.

Power Alecs according to the specifications in I/O connection on page 128.

NOTICE

Damage by unsuitable signal levels

If unsuitable signal levels are used, Alecs can be damaged.

- Ensure the maximum currents and voltages specified by the RS485 standard for serial communication are not exceeded.
- For all other signals, observe the specifications in I/O connection on page 128.

NOTICE

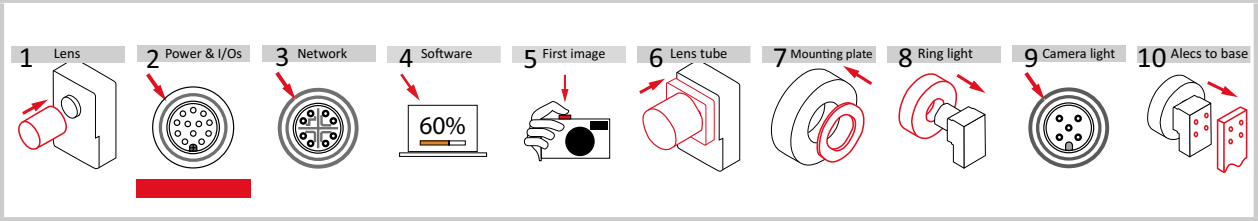
Damage by unsuitable cables

If cable plugs do not fit tightly, Alecs can be damaged.

- For IP67 compliance, use only cables by Allied Vision.
- Before using other cables, apply tests for IP67 compliance.

I/O cables maximum length

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



...Connection power and I/Os
> Instructions

Notes

Because there is very little space between the other 2 sockets, the instructions to connect Alecs start with the power and I/O socket.

However, the open ends of the I/O cable can be connected to peripherals only after Connecting to the Network on page 116.

1. Ensure that all lines of the I/O cable are disconnected.
2. Remove the protection cap from the I/O socket.
3. Store the protection cap in a safe place: You need it to maintain IP67 protection for Alecs if you disconnect the cable.
4. With the **coding shapes** (a) matching, push the locking sleeve (b) of the cable plug towards the Alecs housing until you feel resistance.
5. Rotate the locking sleeve (b) clockwise and fasten at a maximum torque of 1.2 to 1.5 Nm.

◊ Alecs is ready for Connecting to the Network on page 116.

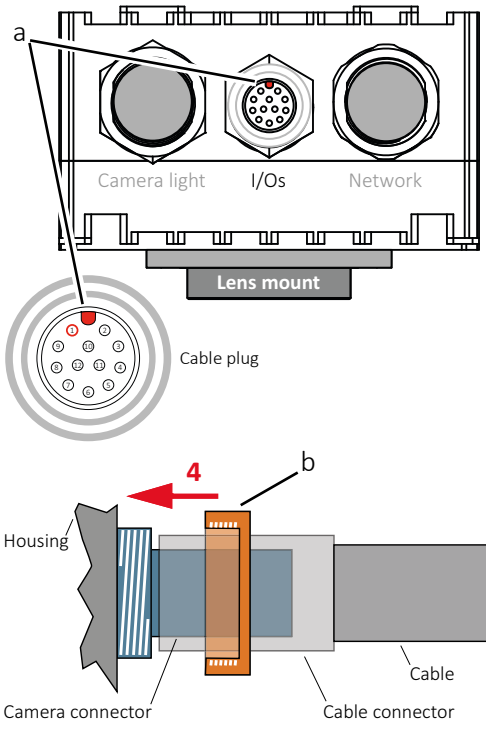
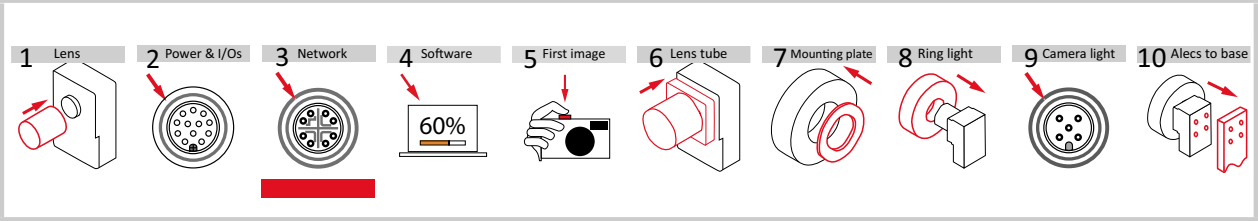


Figure 24: Connecting power and I/Os



3. Connecting to the Network

Alecs Ethernet connector: Standard 8-pin M12 X-coded Kinsun 4003Q80000

NOTICE

Attacks to your network

Alecs is delivered with an image to be used only for development purposes.

In open networks, use Alecs with further protection. See Cyber security on page 39.

Note

Before the network cable can be connected, the I/O cable must be connected. See Connecting power and I/Os on page 114.

1. Ensure that the other plug of the network cable disconnected.
2. Remove the protection cap from the network socket.
3. Store the protection cap in a safe place: You need it for IP67 protection if you disconnect the cable.
4. With the **coding shapes** (a) matching, push the locking sleeve (b) of the cable plug towards the Alecs housing until you feel resistance.
5. Rotate the locking sleeve (b) clockwise and fasten at a maximum torque of 1.2 to 1.5 Nm.
6. **After assuring that the power and I/O sources comply with Alecs specifications**, connect the open ends of the I/O cable to peripherals. See I/O connection on page 128.
7. Connect the RJ45 plug to the NIC of the host computer.

◊ Alecs is ready for basic operation. Continue with Installing the imaging software on page 117.

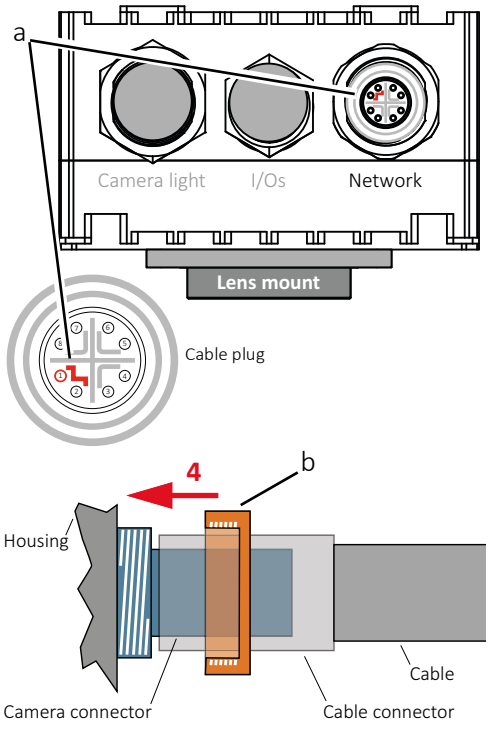
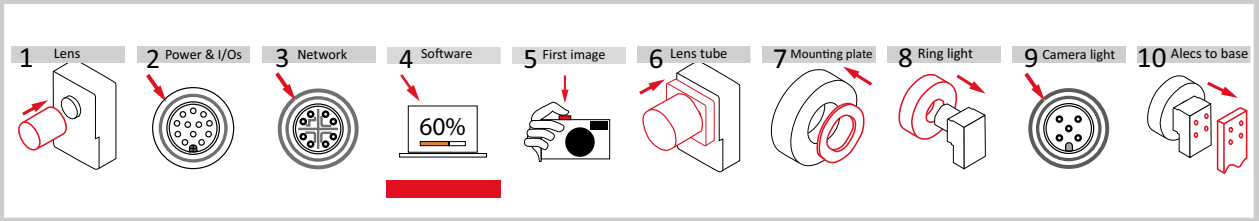


Figure 25: Connecting to the network



4. Installing the imaging software

System recovery

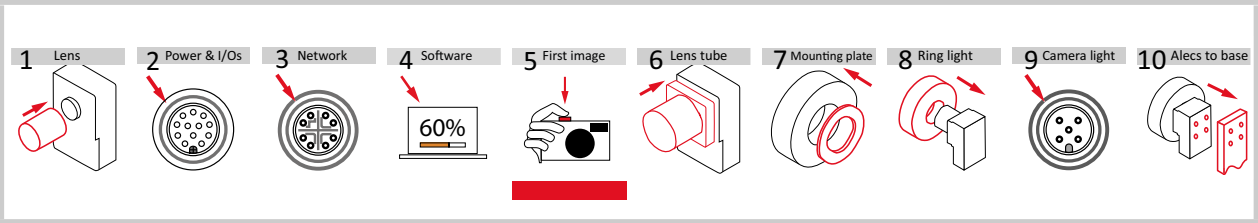
For system recovery, see System recovery on page 146. From the BSP, you can install any packets you need for your application.

Third party software

We intend to provide information for cross compiling software in the future.

Alecs is a versatile hardware platform. It comes with a preinstalled BSP (board support package) containing everything you need for operation and to develop vision applications. The BSP is an **NVIDIA® JetPack** environment with additional drivers and standard **Vimba X SDK** for camera control.

On top of that, a preinstalled version of **Open eVision Studio** with a 30 days test license is included. See eVision tools and naming on page 140.



5. Acquiring a first image

Note
To avoid having to readjust the lens later, you may move Mounting Alecs on page 125 before this action step. This can make other steps difficult.

1. Set up an SSH (Secure Shell Protocol) connection:
   IP address: 192.168.1.10 | User name: alecs | Password: alecs

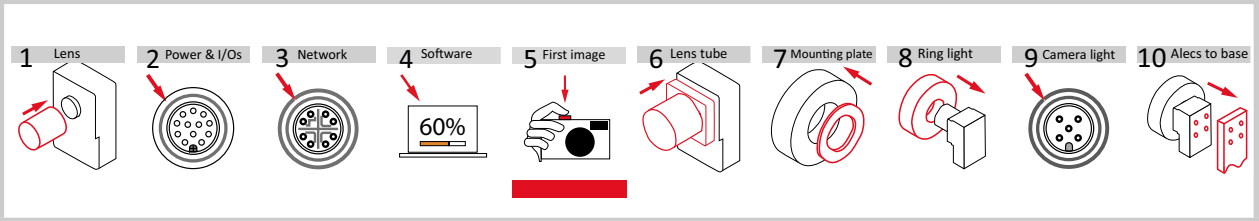
2. Select from these 3 options to quickly get an image from Alecs:

   2.1. Easiest:
      2.1.1. Start **eVision Demonstrator** in the browser of any PC in the same network: http://192.168.1.10:8080 (Step 1 SSH is not needed).
      2.1.2. See eVision tools and naming on page 140.

   2.2. Full feature exploration with **Vimba X Viewer**
   (with small restrictions in performance due to X11 forwarding):
      2.2.1. On Windows systems, install an SSH client with X support (such as **MobaXterm X11** server).
      2.2.2. Connect to Alecs with `ssh -X alecs@192.168.1.10`
      2.2.3. Open **VimbaXViewer**.

   2.3. Most versatile (LXB-G1-...-**NX**... **models only**):
      2.3.1. Go to `$ cd /opt/alecs_examples/ folder`.
      2.3.2. Type in the Terminal `source .venv/bin/activate` to access the virtual environment.
      2.3.3. Copy **stream.sdp** from /alecs_examples/ folder to your receiving system.
      2.3.4. Run `$ python send_stream.py <destination IP>` using Python on your Alecs.
      2.3.5. Start **stream.sdp** with **VLC Player** (for example) on your receiving system.

3. Continue with Step 4. on page 119.



...Acquiring a first image > Continued

4. Put Alecs into its final mounting position.
5. Point the lens at a test object.
6. Open the lens aperture to the smallest f/# value (F-number).
7. For fair image brightness, adjust values for frame rate, exposure time, and possibly gain in the viewer application.
8. Set lens focus for a sharp image.
9. The image may show wrong colors due to inadequate white balance setting or you may see a flicker by interference between the light frequency and the selected frame rate. You can care for that later.

◊ If you get a rough image, Alecs is ready for image acquisition. Continue with Mounting the lens tube on page 120.

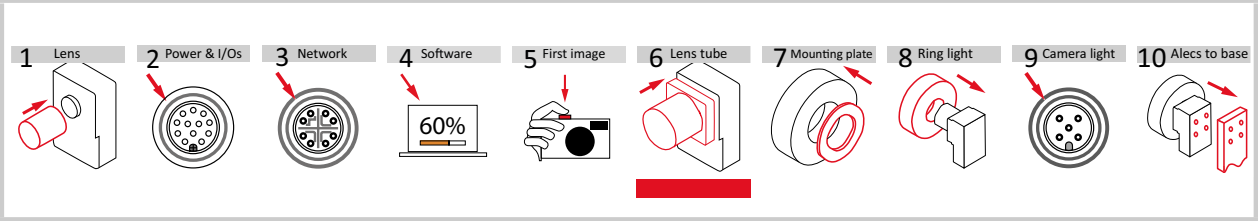
Example code

You can find examples for simple imaging applications:

- In the root directory of Alecs system disc: /opt/alecs_examples
- On https://github.com/alliedvision/Alecs.

Using third party software

See the application notes on www.alliedvision.com/en/support/camera-documentation/smart-camera-documentation/alecs-documentation such as getting started guides for operating Alecs with **eVision** or **HALCON**.



6. Mounting the lens tube

CAUTION

Injury by falling lens tubes

- Tighten screws at 1.0 Nm maximum torque.
- Follow the instructions below.

NOTICE

Damage to lenses or lens tubes

Lenses or the lens tube's front glass can be damaged if lenses are used that exceed the dimensions of the lens tube.

- Use only lenses within the dimensions of the lens tube.
- Observe that some lenses change in length when focus or zoom are used.

The delivery contents of Alecs embedded camera systems include 4 screws M3-12↓ to mount the lens tube to the main housing.

1. Fit the 4 mounting holes (b) of the lens tube (a) to the 4 threads (c) of the main housing (d).
2. Feed the screws M3-12↓ screws (e) trough the mounting holes (b) and tighten at 1.0 Nm maximum torque.
3. **For final assembly**, to ensure that the screws do not become loose over time:
   We recommend you to use means for securing screws, such as screw locking varnish.

◊ Lens settings are protected against changes. Continue with Mounting the mounting plate to the camera ring light on page 121.

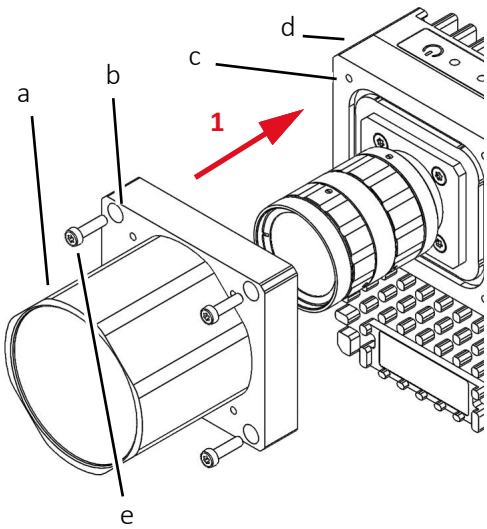
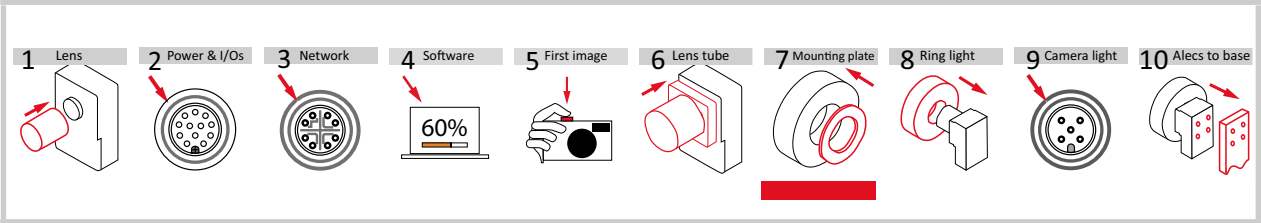


Figure 26: Mounting the lens tube



7. Mounting the mounting plate to the camera ring light

CAUTION

Injury by a falling camera ring lights

- Tighten screws at 1.0 Nm maximum torque.
- Follow the instructions below.

Notes

These instructions apply only if you are using Ring Light RMX140.

Before the camera ring light can be mounted to the main housing, the mounting plate must be mounted.

The delivery contents of Allied Vision's camera ring light include 4 screws M4-10↓ to mount the mounting plate to the camera ring light.

1. Fit the 4 mounting holes (c) of the mounting plate (d) to the 4 threads (b) of the camera ring light (a).
2. Feed the 4 × M4-10↓ screws (e) trough the mounting holes (c) and tighten at 1.0 Nm maximum torque.
3. **For final assembly**, to ensure that the screws do not become loose over time:
   We recommend you to use means for securing screws, such as screw locking varnish.

◊ The camera ring light is ready to be mounted to the main housing.
Continue with Mounting the camera ring light on page 122.

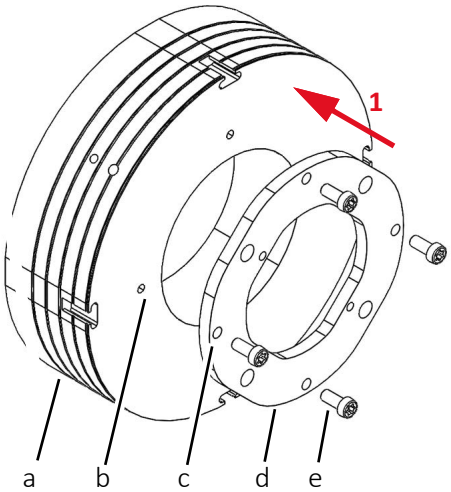
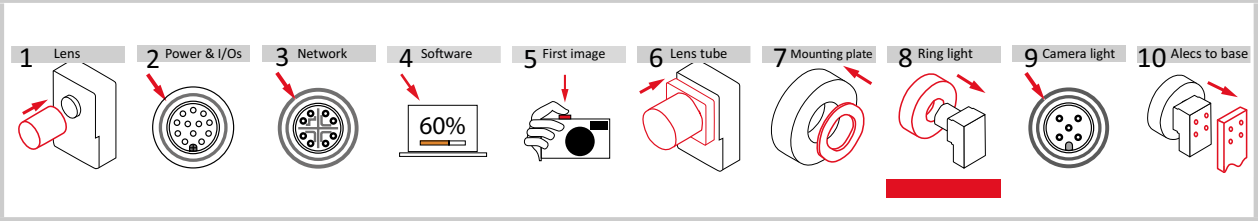


Figure 27: Mounting the mounting plate



8. Mounting the camera ring light

CAUTION

Injury by a falling camera ring lights

- Tighten screws at 1.0 Nm maximum torque.
- Follow the instructions below.

Notes

These instructions apply only if you are using Ring Light RMX140.

Before the camera ring light can be mounted to the main housing, the mounting plate must be mounted. See Mounting the mounting plate to the camera ring light on page 121.

The delivery contents of Allied Vision's camera ring light include 4 screws M3-12↓ to mount the camera ring light to the main housing.

1. Fit the 4 mounting holes (c) of the mounting plate (b) to the 4 threads (e) of the lens tube (d).
2. Feed the M3-12↓ screws (a) trough the mounting holes (c) and tighten at 1.0 Nm maximum torque.
3. **For final assembly**, to ensure that the screws do not become loose over time:
   We recommend you to use means for securing screws, such as screw locking varnish.

◊ The camera ring light is mounted to the main housing. Continue with Connecting the camera ring light on page 123.

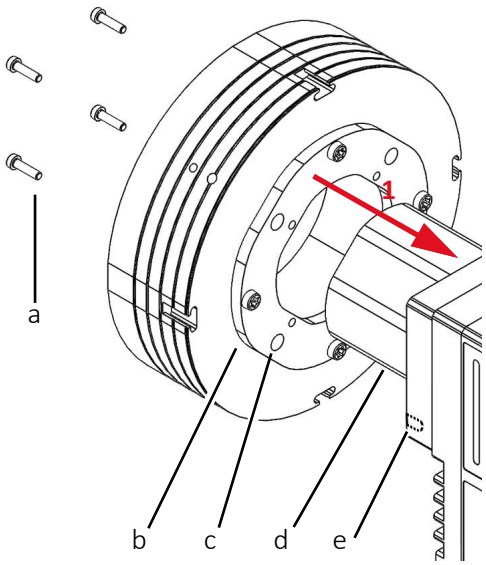
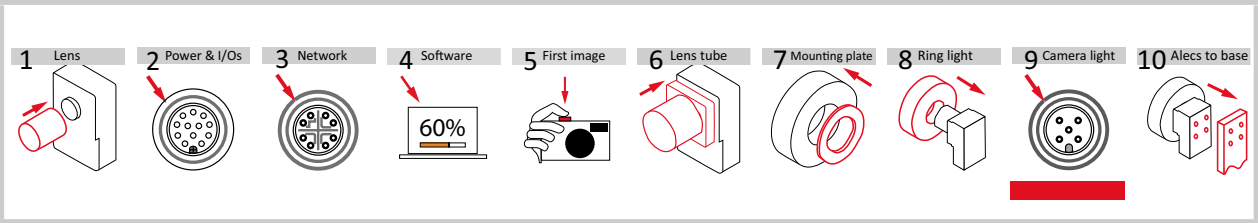
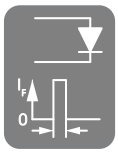


Figure 28: Mounting the ring light



9. Connecting the camera ring light



For descriptions of connectors, pin assignment, signals, and levels, see Camera light connection on page 132.

NOTICE

Damage to Alecs electronics and connected peripherals

If the power output is used beyond the specified limits, Alecs can be damaged.

- Keep the maximum output for **VCC-Light** below 5.9 A.
- Observe that above 700 mA, **Strobe-PNP** is limited to 50 ms and 10% duty cycle.
- Observe the specifications in Camera light connection on page 132.
- Use **leds-rmx140** driver to ensure proper and safe operation of the strobe output.
- If the SoM is operated in another power mode than default 15 W, power lighting externally, **not** by Alecs.

Connections for external lighting

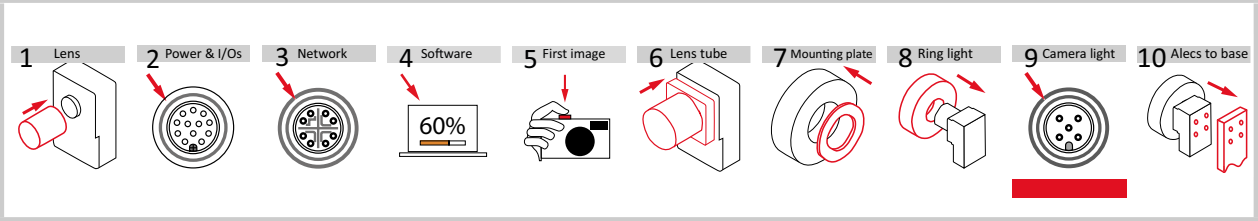
Allied Vision offers compatible Y-cables at different lengths to separate electrical lines for lighting control by Alecs from lighting power by external power supplies, see www.alliedvision.com/en/support/accessory-documentation.

NOTICE

Damage by unsuitable cables

If cable plugs do not fit tightly, the Alecs can be damaged.

- For IP67 compliance, use only cables by Allied Vision.
- Before using other cables, apply tests for IP67 compliance.



...Connecting the camera ring light > Instructions

Note
Before the cable for the camera ring light can be connected, the I/O cable must be connected. See Connecting power and I/Os on page 114.

1. Ensure that all lines of the cable for the camera ring light are disconnected.
2. Remove the protection cap from the lighting socket.
3. Store the protection cap in a safe place: You need it to maintain IP67 protection for Alecs if you disconnect the cable.
4. With the **coding shapes** (a) matching, push the locking sleeve (b) of the cable plug towards the Alecs housing until you feel resistance.
5. Rotate the locking sleeve (b) clockwise and fasten at a maximum torque of 1.2 to 1.5 Nm.
6. **If the camera light (and additional power source) comply with Alecs specifications**, connect the other cable sides as defined in Camera light connection on page 132.

◊ Alecs is connected to the camera light. Continue with Mounting Alecs on page 125.

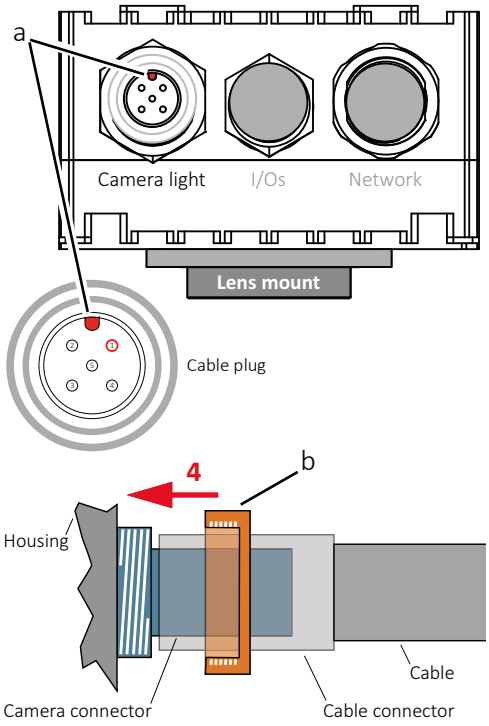
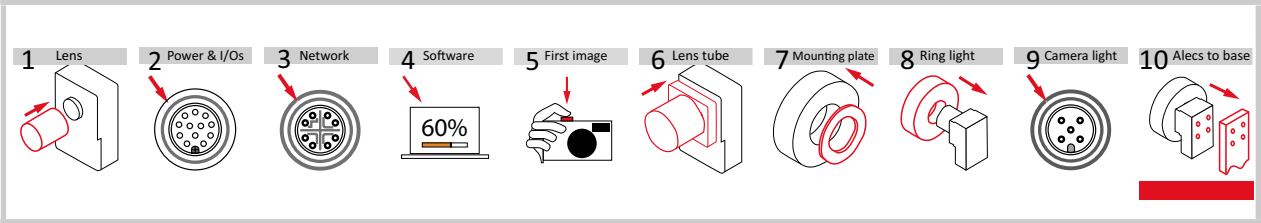


Figure 29: Connecting power and I/Os



10. Mounting Alecs

CAUTION

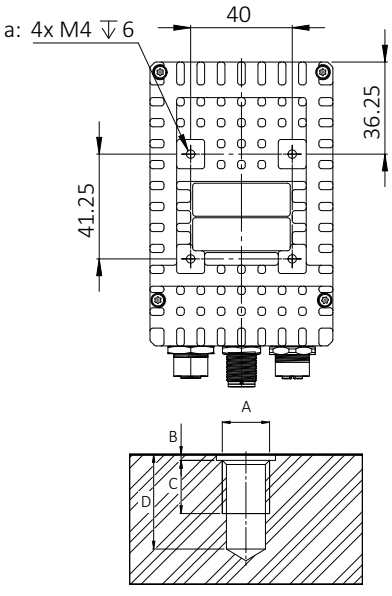
Injury by a falling Alecs embedded camera systems

- Ensure proper mounting of Alecs, especially for dynamic applications.
- Mount Alecs as described in the instructions.
- Always make sure the mounting threads are intact.
- Fasten screws with maximum torque, using the specified thread engagement. For less thread engagement, calculate torque values correspondingly.

Note:
The maximum torque value applies only if the entire thread engagement is used. For other values, calculate values correspondingly. See Technical drawings on page 86 for details of Alecs housings.

1. As shown in Figure 30, mount the camera to the base using suitable M4 screws for mounting thread a: At 1.2 Nm maximum torque for a thread engagement (C) of minimum 3.0 mm between screws and mounting threads.
2. **For final assembly**, to ensure that the screws do not become loose over time:
   We recommend you to use means for securing screws, such as screw locking varnish.

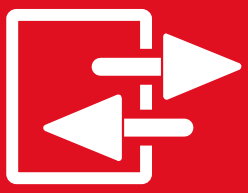
◊ The Alecs embedded camera system is ready for operation.



Detail c: M4 ↓7.0 ↓8.0
A=M4 | B=0.4 | C=3.0 to 7.0 | D=8.0

Figure 30: Mounting Alecs

Electrical interfaces and LEDs



This chapter includes:

Connector overview

Alecs has three IEC 61076 sockets on the bottom side. Table 52 shows the type and orientation of the mating connectors:

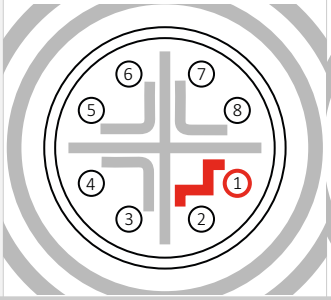
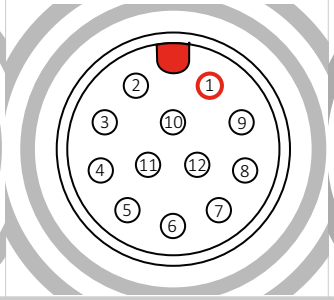
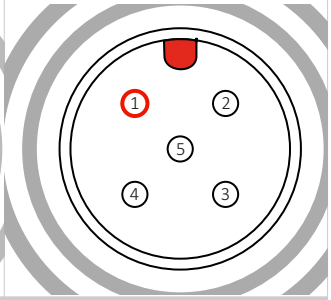
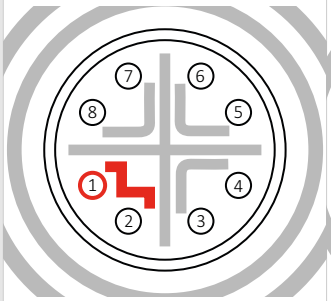
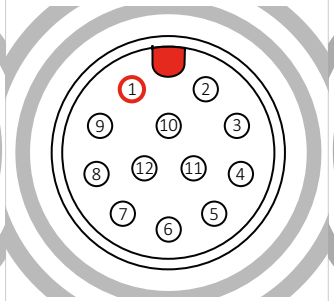
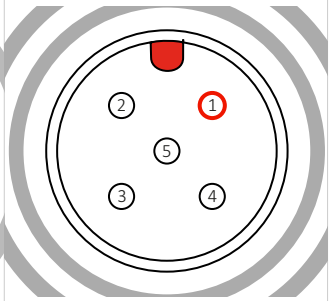
	Network	I/Os	Lighting
Alecs sockets	M12 X-coded	M12 A-coded 12-pin	M12 A-coded 5-pin
	Kinsun 4003Q80000	Kinsun 4002T2412-02	Kinsun 4002N50002
			
Cable plugs			

Table 52: Alecs sockets and mating cable plugs

Suitable cables

For proper connections, we recommend using cables by Allied Vision.
See www.alliedvision.com/en/support/accessory-documentation.

Network connection

For the network connection, observe the standard for 8-pin M12 X-coded cables.

NOTICE

Attacks to your network

Alecs is delivered with an image to be used only for development purposes.

In open networks, use Alecs with further protection. See Cyber security on page 39.

I/O connection

NOTICE

Damage to Alecs by wrong power voltages

Exceeding the specified maximum power supply voltage damages Alecs.

- Power Alecs below 24 VDC ±10%.

Schematics

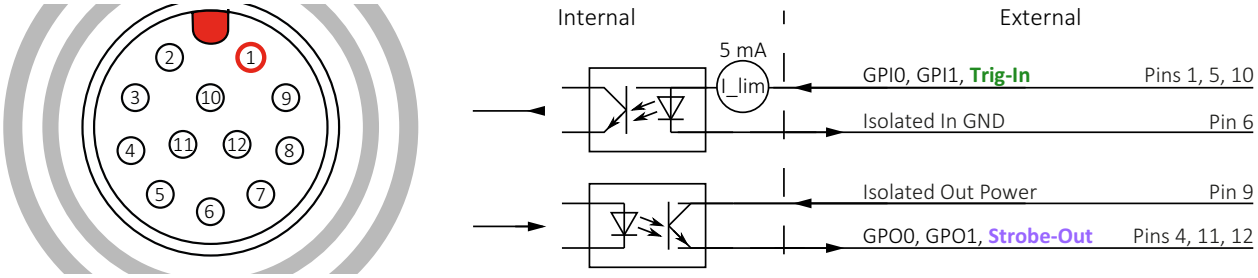


Figure 31: I/Os > Connector and schematics

Pin assignment

Pin	Color [1]	Signal	Direction	Level	Description
1	Brown	GPI0	In	$V_{in(high)}$ = 3.0 to 24.0 VDC [2] $V_{in(low)}$ = 0 to 1.0 VDC	Opto-isolated input
2	Orange	RS485+	In/Out	Max. common mode range ±25 VDC	RS485 interface, positive
3	Yellow	RS485-	In/Out	See Pin 2 (RS485+)	RS485 interface, negative
4	Green	GPO0	Out	Open emitter, max. 10 mA	Opto-isolated output
5	Blue	GPI1	In	See Pin 1 (GPI0)	Opto-isolated input
6	Purple	OPTO-IN-GND	—	0 VDC	Opto-isolated input ground
7	Red	PWR-IN	In	24 VDC (±10%)	Power supply voltage
8	Black	PWR-GND	—	0 VDC	Supply ground
9	Gray	OPTO-OUT-PWR	In	Max. 30 VDC	Power for Opto-isolated output
10	White	**Trig-In** [3]	In	See Pin 1 (GPI0)	Opto-isolated trigger input
11	Pink	GPO1	Out	See Pin 4 (GPO0)	Opto-isolated output
12	Light green	**Strobe-Out** [3]	Out	See Pin 4 (GPO0)	Opto-isolated strobe trigger output

[1] Open ends of power and I/O cables by Allied Vision | [2] For >24.0 to 36 VDC, connect a 3.3 kΩ external resistor in series.
[3] Logical signals are: **Line0**, **Line1**, see Logical and electrical I/O lines on page 131 for details.

Table 53: I/O connector > Pin assignment

Opto-isolated input description

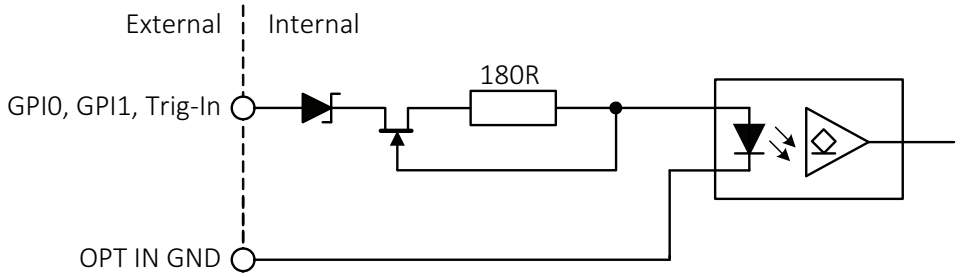


Figure 32: Input block diagram

The input can be connected directly to the system for voltages up to 24 VDC.
An external resistor is not necessary.

Levels

Parameter	Value
V_{in} (low)	0 to 1.0 VDC
V_{in} (high)	3 to 24 VDC
Current (constant-current source)	3 to 4 mA

Table 54: Input parameters

Minimum pulse width

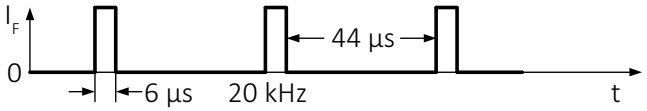


Figure 33: Minimum pulse width

Test conditions

The input signal was driven with 3.3 VDC and no external additional series resistor.

Opto-isolated output description

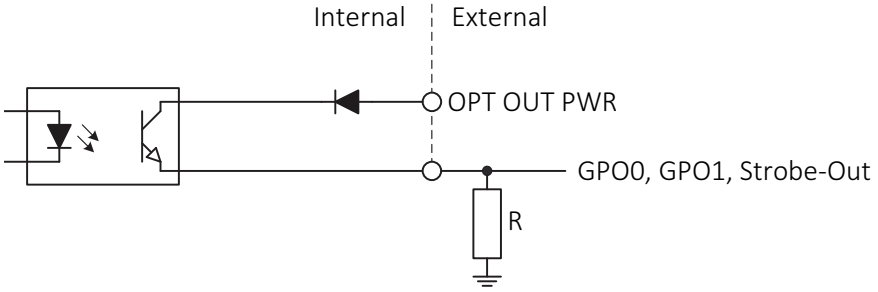


Figure 34: Output block diagram

Levels

NOTICE

Damage to Alecs by high output current or voltage

Exceeding the maximum output voltage or current can damage Alecs.

Keep maximum output voltage below 24 VDC and output current below 10 mA.

Possible low output voltage

Output voltage may drop **by approximately 2.5 VDC** under full load.

Opto-isolated out power	Resistor value[1]	
5 VDC	1.0 kΩ	at ~ 5 mA minimum required current draw
12 VDC	2.4 kΩ	
24 VDC	4.7 kΩ	

[1] A resistor is required when GPO0, GPO1, or Strobe-Out are connected to devices with a high impedance < 5 mA draw.

Table 55: Opto-isolated out power and external resistor

Switching times

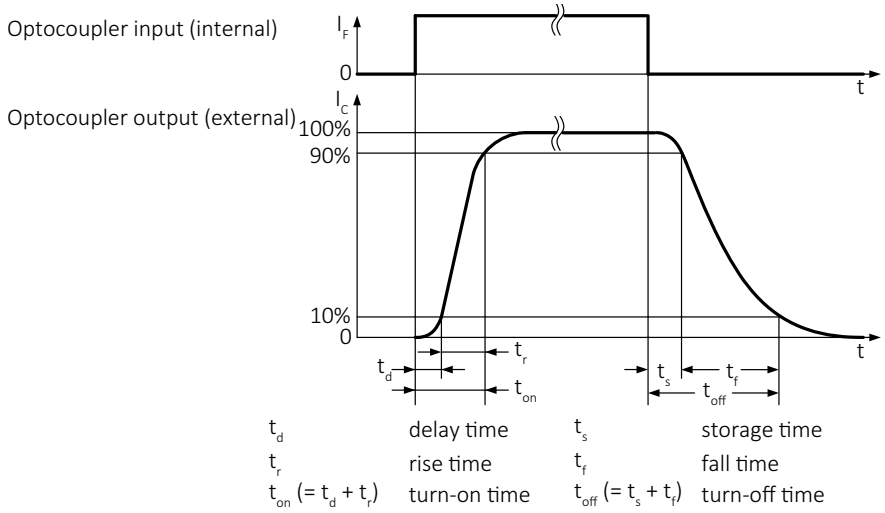


Figure 35: Output switching times

Parameter and value	
$t_d \approx 1$ µs	$t_s \approx 26$ µs
$t_r \approx 1$ µs	$t_f \approx 21$ µs
$t_{on} = t_d + t_r \approx 2$ µs	$t_{off} = t_s + t_f \approx 47$ µs (t_{off} can deviate by ± 5 µs)

Table 56: Output parameters

Test conditions

Output: external 2.4 kΩ resistor to GND, opto-isolated out power set to 12 VDC.
Note that Higher external values increase the times in the previous table.

Logical and electrical I/O lines

Logical lines used by camera module's firmware features refer to electrical lines:

Logical line	Direction	Connector	Electrical line	Active when	Usage (example)
Line0	Input	12-pin I/O connector	Trig-In	Level = High	*FrameStart*
Line1	Output	12-pin I/O connector	Strobe-Out	Level = High	*ExposureActive*
		5-pin lighting connector	Strobe PNP-Out	Level = High	
Note: GPI0, GPI1, GPO0, and GPO1 are SoM I/Os that can be controlled by the transport layer module.					

Table 57: Electrical and logical lines

Feature descriptions

The Alecs Features Reference describes the corresponding firmware features.
See www.alliedvision.com/en/support/alecs-documentation.

Camera light connection

Connector view and pin assignment

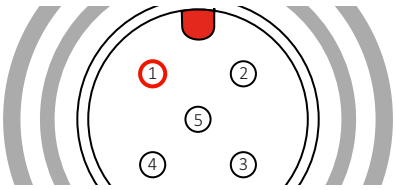


Figure 36: Lighting connector > View

Pin	Color [1]	Signal	Direction	Level	Description
1	Red	VCC-Light	Out	Max. PWR-IN	Power for connected camera light
2	N.a.	Not used			
3	Black	GND-Light	—	0 VDC	Supply ground for connected camera light
4	N.a.	Strobe-PNP	Out	Max. PWR-IN	Trigger signal for connected camera light
5	N.a.	Intensity	Out	0 to 10 VDC, max. 50 mA	Intensity signal for connected camera light

[1] Open ends of Y-cables by Allied Vision to control and power lighting

Table 58: Lighting connector > Pin assignment

Output signal polarity

The **Strobe-PNP Out** signal is inverted. Use `LineInverter` feature to trigger strobe lights.

The opto-coupled **Strobe-Out** signal on Pin 12 of the 12-Pin I/O connector is not inverted. It can be used for triggering without the `LineInverter` feature.

NOTICE

Damage to Alecs electronics and connected peripherals

If the power output is used beyond the specified limits, Alecs can be damaged.

- Keep the maximum output for **VCC-Light** below 5.9 A.
- Observe: Above 700 mA, **Strobe-PNP** is limited to 50 ms and 10% duty cycle.
- Use the preinstalled **leds-rmx140** driver. The dedicated V4L2 controls and Vimba X features use it automatically.

If the SoM is operated in another power mode than default 15 W while Alecs powers lighting, Alecs and connected peripherals can be damaged. Do one of the following:

- Use default 15 W power mode for the SoM.
- Power lighting externally.

Connections for external lighting

Allied Vision offers compatible Y-cables at different lengths allowing to separate electrical lines for lighting control by Alecs from lighting power by external power supplies, see www.alliedvision.com/en/support/accessory-documentation.

Status LEDs

Alecs is equipped with 2 circular LEDs on the top of the housing and LED panels on the right and left side.

Normal operation

The LEDs on the top of the housing show the power and network status:

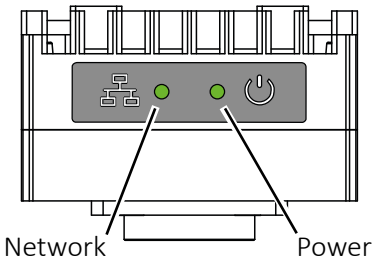
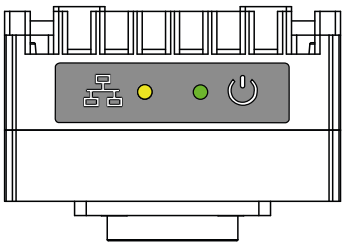
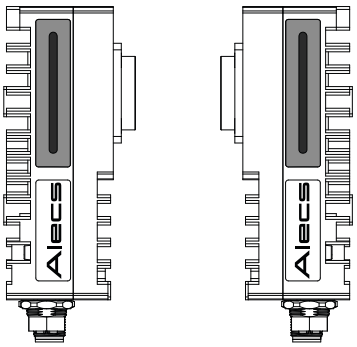
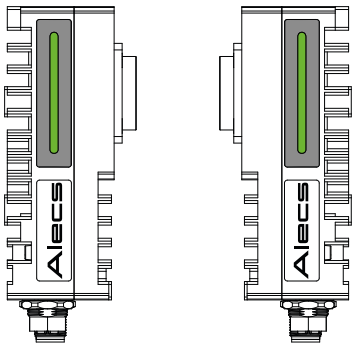
		
Power status	Power is good LED: Green continuous	Power is good LED: Green continuous
Network speed	1 GBit | LED: Green continuous	100 MBit | LED: Yellow continuous

Table 59: Top LEDs > Good power and network status

Default: The LED panels on the side signal the OS status.

User configurable: 5 LEDs can be configured individually for RGB from 0 to 255:

		
Linux OS status	OS start has not been completed LED: Inactive	OS start has been completed LED: Green continuous
Other	User configurable	User configurable

Error conditions

If Alecs comes into an error state:

1. Power cycle Alecs.
2. If this does not help, see System recovery on page 146.

Triggering and timings

This chapter includes:

Trigger signal flow

Figure 37 shows an ideal diagram for the trigger signal flow for Alecs embedded camera systems. The external signal can be a physical source, such as a 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.

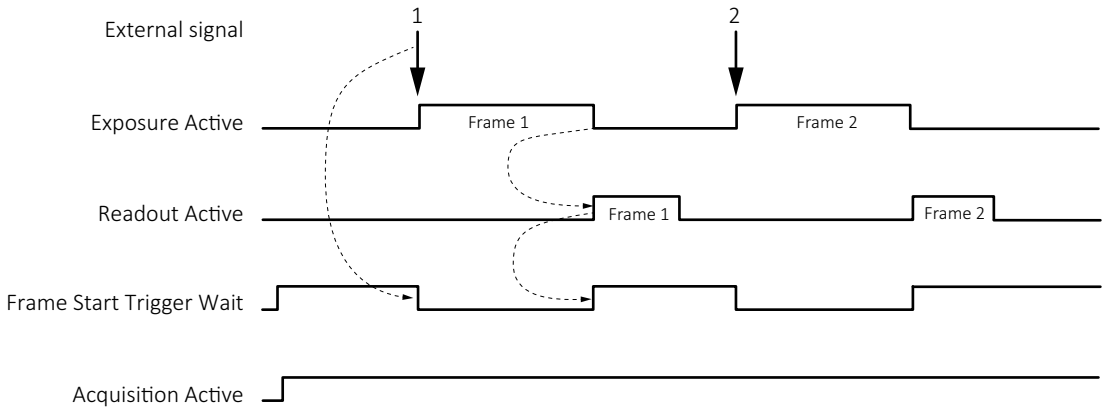


Figure 37: Triggering > Signal flow

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 60: Triggering > Signals

Trigger controls description

For more information on triggering controls, see the Alecs Register Controls Reference at www.alliedvision.com/en/support/alecs-documentation.

Trigger features and UserSetDefault

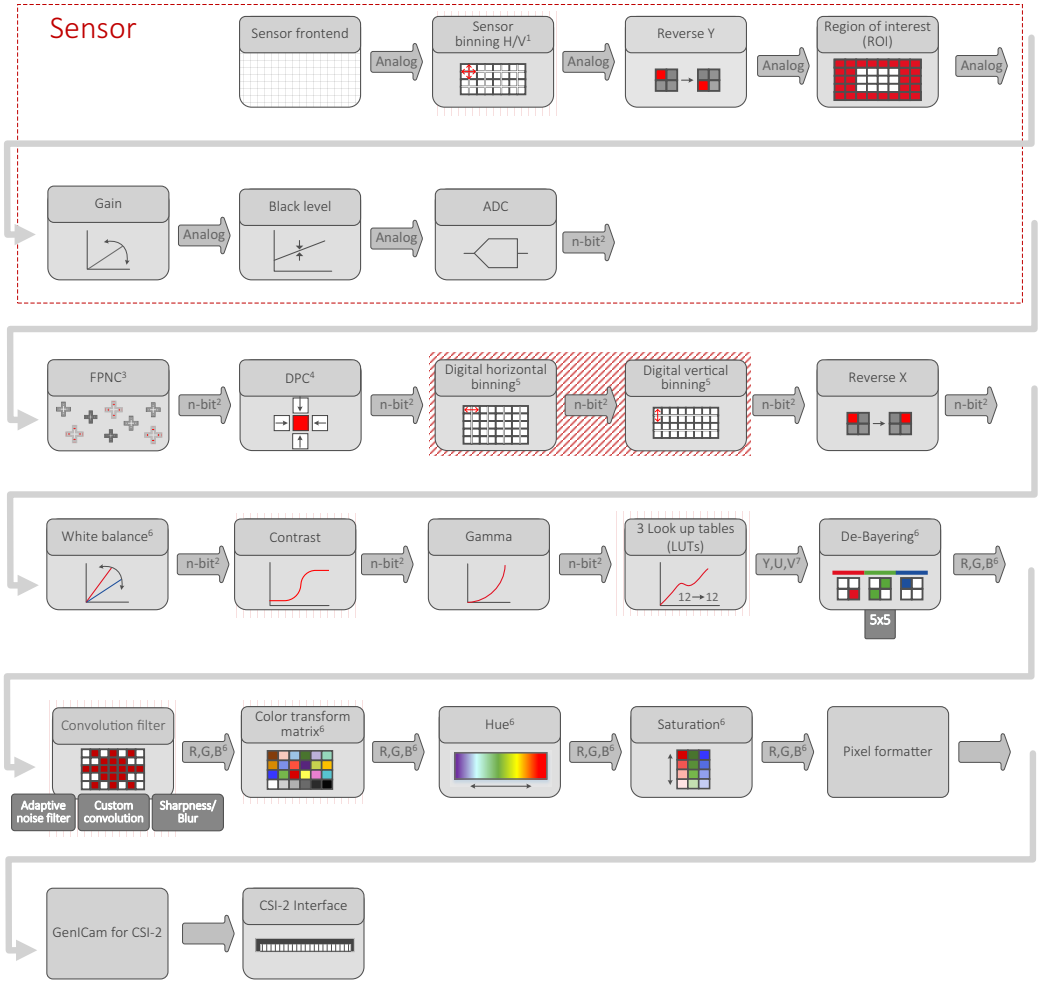
See Trigger features and UserSetDefault on page 95.

Image data flow

This chapter includes:

Image data flow diagram

Figure 38 shows the order in which the controls are **processed** on Alecs embedded camera systems. See Value changes by control interdependencies on page 147 for the recommended order to **configure** Alecs.



GenICam for CSI-2 Access only

GenICam for CSI-2 Access / **Direct Register Access**: Different behavior

[1] Selected models only: See tables in Alecs model specifications on page 61

[2] Model dependent: See ADC bit depths in Alecs model specifications on page 61.

[3] Factory preset for FPNC = Fixed Pattern Noise Correction.
See FPNC support on page 138 for supported models.

[4] Factory preset for DPC = Defect pixel correction

[5] For **Direct Register Access**: Values for H and V are commonly adjusted.

[6] Color models only

[7] For monochrome models: Y only

Figure 38: Image data flow on Alecs embedded camera systems

Descriptions for controls and features

The shown functionalities represent controls or groups of controls:

- For GenICam features, see the Alecs Features Reference at www.alliedvision.com/en/support/alecs-documentation.
- For V4L2 controls, see the Alecs V4L2 Controls Reference at www.alliedvision.com/en/support/alecs-documentation and definitions at www.linuxtv.org.

FPNC support

Table 61 shows which Alecs models support FPNC (Fixed pattern noise correction):

Model	Sensor	FPNC support
Alecs-030 VSWIR	IMX991	-
Alecs-130 VSWIR	IMX990	-
Alecs-320 VSWIR	IMX993	-
Alecs-510	IMX548	✓
Alecs-530 VSWIR	IMX992	-
Alecs-1242	IMX545	✓

Table 61: FPNC availability by Alecs model

eVision Web Demonstrator

This chapter includes:

eVision tools and naming

eVision Library provides advanced image processing algorithms out of the box.

You can access these algorithms using **eVision Web Demonstrator** for evaluation purposes or ***Open*** **eVision Studio** in the productive environment.

eVision Web Demonstrator

Open http://192.168.1.10:8080 in the Browser of any PC in the same Network.

For first use, when Alecs has connected to the host, the preinstalled **eVision Web Demonstrator** is launched:

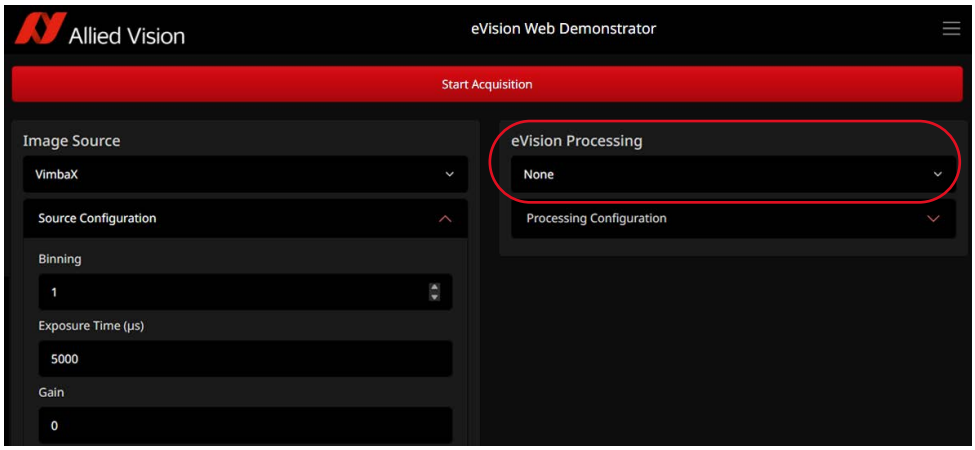


Figure 39: App view at start (more options follow below Gain)

None selects no image processing. No license is required. Here you can adjust the settings for pixel format (**Pixel Type**), binning, exposure time, gain, color balance, as well as horizontal and vertical flipping.

GenICam features > Descriptions

For GenICam feature descriptions, see the Alecs Features Reference at www.alliedvision.com/en/support/alecs-documentation.

Others modes for image processing support ready-to-use functions including various modes for code recognition. See Advanced image processing on page 141.

Advanced image processing

eVision software enables various kinds of image processing. For test purposes, you can use examples from the **EasyImage Library** as shown in this section.

License conditions

Before setting **eVision Processing** to anything else but ***None***, please read Licenses on page 143.

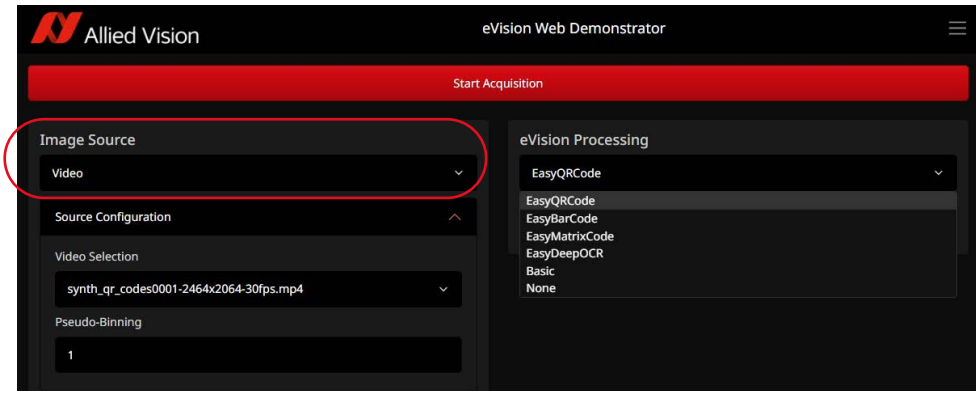


Figure 40: Web Demonstrator > Video Source

EasyImage Library supports ready-to-use functions to process such as:

- QR codes (ISO/IEC 18004)
- Bar codes
- Data matrix codes (SO/IEC 16022)
- OCR (optical character recognition), including Deep Learning techniques that enable text location and reading:

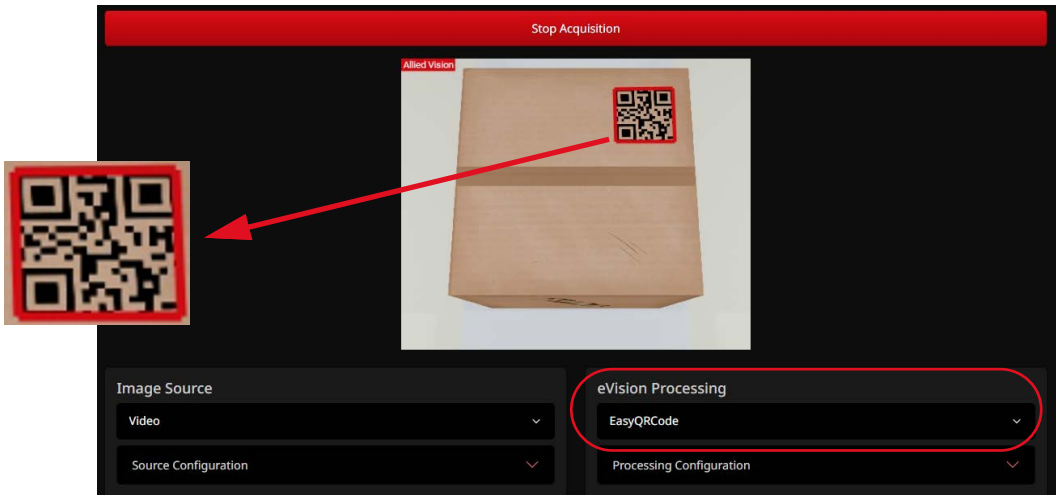


Figure 41: Web Demonstrator > EasyQRCode > The QR Code has been recognized

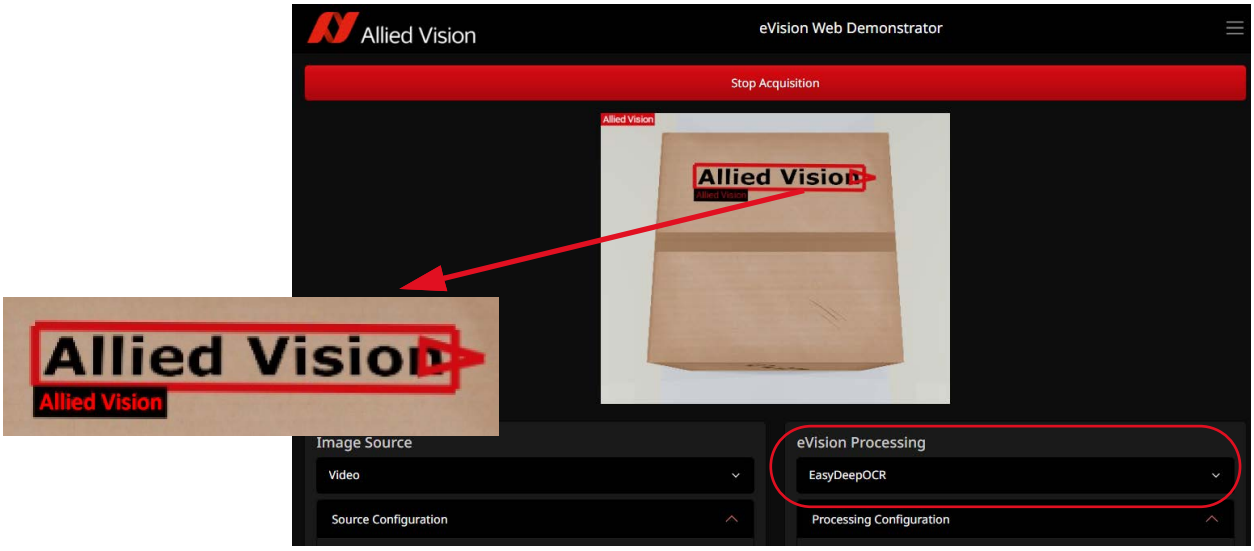


Figure 42: Web Demonstrator > EasyDeepOCR > The text has been recognized

Settings for image processing

You can use these parameters to adjust the processing to your needs:

- **Processing Threads** defines the number of threads used by the current processing. But observe, while more threads yield better and smoother performance, the system's workload is increased.
- **Timeout** defines the period of time [µs] for image processing with code readers. If detecting a code exceeds the Timeout value, the search is aborted for the current image. This prevents slowdowns when processing difficult images.
- **Max Number of Codes** defines the maximum number of codes to be found in images. The process is finished when all codes have been detected, up to the selected number.
- **TensorRT** (**EasyDeepOCR** only) enables or disables **TensorRT**. This Deep Learning engine uses the system's hardware abilities to accelerate the processing. Observe that initializing **TensorRT** can be time-expensive.

Licenses

Alecs comes out from the factory with a 30-day, full trial license for all options of the **eVision Library**. The trial period starts when **eVision Processing** is used the first time:

- **eVision Web Demonstrator** uses another processing type than *None*:

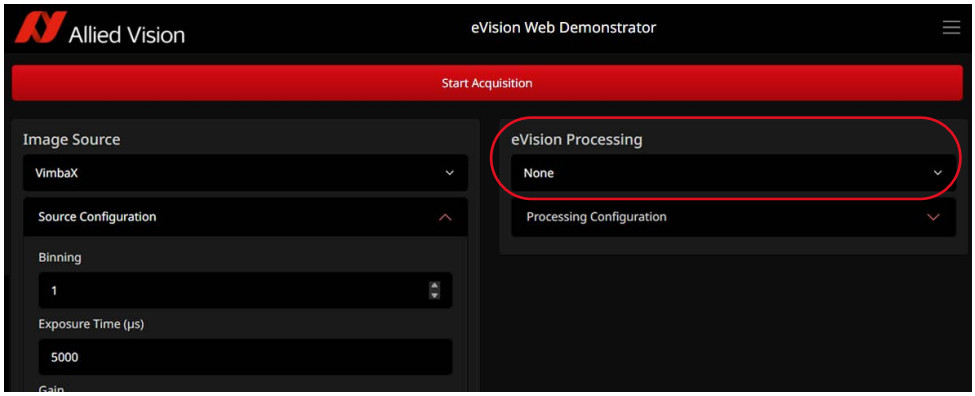


Figure 43: Web Demonstrator > Image processing type > None

Open eVision API is used directly, for instance by running one of the Python or C++ Open eVision samples provided with Alecs.

License validity

This license is installed at factory time. If the system is re-flashed, the license is not present anymore, regardless of the BSP version.

To extend the license, please contact the Allied Vision Sales team at www.alliedvision.com/en/company/contact-us/contact-sales-form.

Documentation and contact

- **Information on Open eVision** and its libraries: www.alliedvision.com/en/products/software/evision-libraries
- **Online documentation**: https://documentation.euresys.com/products/open_evision/open_evision/en-us/content/00_home/home.htm#

Using Open eVision with Alecs

- See the **application note** Getting Started with eVision on Alecs on www.alliedvision.com/en/support/camera-documentation/smart-camera-documentation/alecs-documentation
- Find **code examples** on https://github.com/alliedvision/Alecs.

Performance and troubleshooting

This chapter includes:

Ensuring cyber security for Alecs

Alecs is delivered with a demo image preinstalled on the internal SSD. This image is dedicated for getting started most easily and for flexibility, but only for evaluation and development purposes.

Before operating Alecs in final applications and production environments, especially in open networks, take suitable measures for cyber security:

CYBER SECURITY

Hazard by cyber attacks

To protect your computing system from unauthorized access by criminals or other hostile parties:

- Only use your own images based on the current NVIDIA® Jetson Linux Developer Guide.
- **Update your images frequently** when new security updates are available.
- Activate integrated protection technologies, such as:
  Secure Boot, OP-TEE, Disk Encryption, and Firmware TPM.

Information on protection technologies

For integrated protection technologies, such as: Secure Boot, OP-TEE, Disk Encryption, and Firmware TPM, see the Security- NVIDIA® Jetson Linux Developer Guide at
https://docs.nvidia.com/jetson/archives/r36.4.3/DeveloperGuide/SD/Security.

System recovery

Should data on Alecs' embedded board be corrupted or if an installation fails, the **Recovery Mode** helps you get Alecs working again.

Requirements

- Only Linux operating systems are supported.
- IPv6 must be enabled on the network Alecs is connected to.

1. Disconnect power for Alecs but keep the Ethernet connection.
2. Download the BSP to the host PC.

BSP download

To update or recover your Alecs embedded camera system, or for the latest BSP, see www.alliedvision.com/en/support/firmware-downloads.

3. On the host PC, run the prepare script **once**:
   ```
   sh
   sudo ./prepare.sh
   ```
4. Ensure the Ethernet cable is connected on both sides.
5. Start the flash process:
   ```
   sh
   sudo python3 recovery_flash.py <iface> <mac>
   ```
   where
   `iface` = network interface ALECS is connected to (for example: eth0)
   `mac` = MAC address for Alecs.
6. Repower Alecs.

◊ The lateral LED panels flash **red** for Recovery Mode activity.

The **Recovery Flasher** writes the image to the SoM's SSD, setting Linux to the corresponding BSP version.

After recovery has been completed, the Linux OS is started.

The LED lights up **green** continuously.

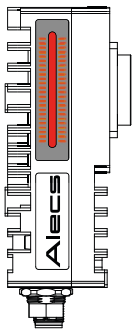


Figure 44: Recovery Mode started

Store your individual BSP configuration regularly

Sometimes things happen at the wrong moment in time. Avoid time consuming efforts to reconfigure your Alecs embedded camera system. Therefore, we recommend you to store your individual BSP image, including the corresponding Linux kernel, software and driver installation, and settings.

Value changes by control interdependencies

The conversion between time and clock cycles affects control values. Controls for pixel format, bandwidth, 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 45 shows the interdependencies.

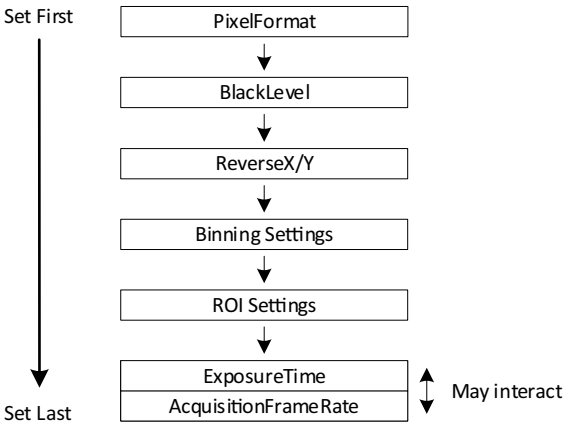


Figure 45: Interdependencies between controls

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 `ExposureTime`.

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 `ExposureTime`, also apply to `ExposureAuto`.
- To avoid readjustments, apply settings in the order shown in Figure 45.

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 62: Impact by other controls

Dark current compensation

All sensors accumulate dark current in the pixels. Dark current increases the signal level and black level. Alecs embedded camera systems compensate for this.

If Alecs is 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.

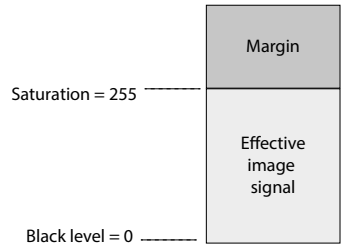
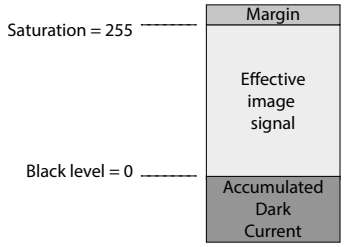
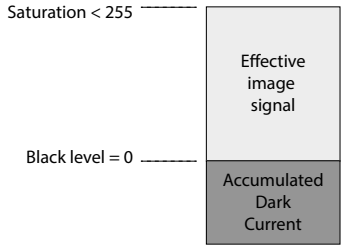
Effective signal versus noise	Description
	The pixel has accumulated no dark current, the margin has maximum size.
	The pixel has accumulated some dark current, reducing the size of the margin.
The following images show a pixel that has accumulated a higher dark current than the margin.	
	The pixel has accumulated dark current, the margin reduces to 0. The compensation is typically applied sensor-internally, often in the analog domain: • Dark current compensation stays active. • Maximum saturation signal decreases. • Fixed pattern noise increases.

Table 63: 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?

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.

Index