IMAGING SOLUTIONS GROUP
The Intelligent Solution

Technical Manual

Allegro

USB3 Vision™ Cameras

Version 2.0.1

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Introduction

Allegro smart cameras are the *Intelligent Solution* for your needs. Allegro cameras feature compact form factors, high resolution and high performance, along with unmatched programmability and flexibility for vision system designers. We put more intelligence in the camera with large FPGAs, huge image buffers and other features to improve performance and simplify integration.

The internal LightWise® Image Pipeline enables us to differentiate our image quality from the competition. Since Allegro cameras are easier to integrate with our Medley SDK, you will get your vision systems to market faster, with better performance and higher margins.

About This Guide

This manual contains information, instructions, and guidelines for the Allegro USB3 Camera system. It provides a detailed introduction, including care, installation, use, interface guides, physical descriptions, and functional specification. This camera system is one that is complex and continually improved. Therefore if any errors or omissions are found, please contact us using the Support information below.

This symbol highlights important information.

This symbol highlights important instructions, ones that you must follow to avoid malfunction

Support

Contact Type	Contact Information
Email	Sales@isgcameras.com; support@isgcameras.com
Knowledge Base and Downloads	www.isgcameras.com
Main Office	Imaging Solutions Group of NY, Inc 1387 Fairport Road, Suite 890 Fairport, NY 14450

FCC Compliance

This device complies with Part 15 of the FCC rules. Its operation is subject to the following two conditions:

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

Hardware Warranty

The Allegro USB3 Camera shall be covered under an industry leading hardware warranty for four (4) years. To obtain detailed information on how to repair or replace your camera please contact support@isgcameras.com. Also see the terms and conditions on our website for more details:

http://isgcameras.com/docs/company/ISG_Standard_Tems_and_Conditions.pdf

WEEE

This product may not be treated as household waste. When the product is ready to be disposed of please ensure you follow the appropriate waste handling method as the improper disposal of this product may cause potential hazards to the environment and human health. For more detailed information about disposing of, or recycling of this product please contact Imaging Solutions Group.

Trademarks

Imaging Solutions Group, LightWise

Allegro USB3 Specifications

Building on the success of the original LightWise 1394 camera series, the Allegro camera offers many new features, including enhanced opto-isolated GPIO, an on-camera frame buffer, non-volatile flash memory for data storage, new trigger modes and improved imaging performance.

General Specifications

Camera Name	Sensor Vendor	Technology	Image Sensor	Frame Size	Resolution	Pixel Size	Color
LW-AL-CMV2000C-USB3 COLOR	CMOSIS	CMOS	CMV2000	2 MP	2048 x 1024	5.5 µm	Color
LW-AL-CMV2000M-USB3 MONO	CMOSIS	CMOS	CMV2000	2 MP	2048 x 1024	5.5 µm	Mono
LW-AL-CMV4000C-USB3 COLOR	CMOSIS	CMOS	CMV4000	4 MP	2048 x 2048	5.5 µm	Color
LW-AL-CMV4000M-USB3 MONO	CMOSIS	CMOS	CMV4000	4 MP	2048 x 2048	5.5 µm	Mono
LW-AL-CMV12000C-USB3 COLOR	CMOSIS	CMOS	CMV12000	12 MP	4096 x 3072	5.5 µm	Color
LW-AL-CMV12000M-USB3 MONO	CMOSIS	CMOS	CMV12000	12 MP	4096 x 3072	5.5 µm	Mono
LW-AL-IMX174C-USB3 COLOR	Sony	CMOS	IMX174	2.3 MP (HD+)	1920 x 1200	5.86 µm	Color
LW-AL-IMX174M-USB3 MONO	Sony	CMOS	IMX174	2.3 MP (HD+)	1920 x 1200	5.86 µm	Mono
LW-AL-IMX249C-USB3 COLOR	Sony	CMOS	IMX249	2.3 MP (HD+)	1920 x 1200	5.86 µm	Color
LW-AL-IMX249M-USB3 MONO	Sony	CMOS	IMX249	2.3 MP (HD+)	1920 x 1200	5.86 µm	Mono
LW-AL-IMX250C-USB3 COLOR	Sony	CMOS	IMX250	5.1 MP	2464 x 2056	3.45 µm	Color
LW-AL-IMX250M-USB3 MONO	Sony	CMOS	IMX250	5.1 MP	2464 x 2056	3.45 µm	Mono

Imaging Performance	Sensor Image Data
A/D Converter	10 and or 12 bit in sensor
Video Data Output	8,10 and 12 bit firmware available
Image Data Formats	Mono:8 or 10 bit packed, 12 bit firmware available Color: Bayer 8 or 10 bit packed, RGB, YCC 422
Image Processing Pipeline (Color Models)	Bayer Interpolation, Gamma, White Balance, Color Space Conversion and Correction
Partial Image Modes	Binning and Region of Interest (ROI) Modes
Shutter	Global Shutter with Programmable Integration
Gain	Programmable Digital Gain
Digital Interface	USB 3.0 interface with screw locks for camera control, data and power
Transfer Rates	5 Gbit/s
GPIO	12-pin Hirose HR10A GPIO, opto isolated trigger, 2 opto isolated strobes
External Trigger Modes	Single Frame, Burst Mode, Bulb Mode
Synchronization	Via external trigger or software trigger
Image Buffer	256 MB Buffer
Flash Memory	8 MB nonvolatile flash memory
Dimensions	
Mass	
Power Consumption	5V via USB3.0 interface, maximum <4.5W
Machine Vision Standard	IIDC v 1.32, USB3 Vision v1
Camera Control	Via ISG SDK, CSRs, or third party software
Camera Updates	In-field firmware updates
Lens Mount	C-mount
Temperature	Operating: 00 to 450 C; Storage -300 to 600 C
Humidity	Operating: 20 to 80% (no condensation); Storage 20 to 90% (no condensation)
Compliance	CE, FCC, RoHS
Operating System	Windows 7, 8, 8.1, 10
Warranty	Two Years

Handling Precautions and Camera Care

Opening the camera housing will cause damage and will void the hardware warranty detailed in the beginning of this document. Since the Allegro Camera is a precisely manufactured device it must be handled with care. Some tips for device care are below:

1. Electrostatic charging should be avoided
2. Avoid touching the lens when handling the camera, as fingerprints will affect the quality of the image produced by the device.
3. When cleaning the lens do not use excessive force and please use a standard camera lens cleaning kit or clean dry cotton cloth.
4. Avoid exposure to bright sunlight, dusty environments, rain etc. as this may cause problems with the electronic and optics of the system.
5. Mishandling of the device such as excessive shaking, dropping and force should be avoided.

Case Temperature and Heat Dissipation

For the camera to function correctly, it is required to provide sufficient heat dissipation for the internal operating environment. Since the camera electronics are neatly packed into a small space it can become very warm to the touch when running in some modes; this is expected behavior and will not damage the electronics.

The use of a cooling fan to set up positive air flow around the camera in order reduce is suggested. Please take into consideration the following precautions:

1. Mount the camera on a heat sink that is composed of a heat conductive material like aluminum, such as a camera mounting bracket.
2. Ensure the flow of heat from the camera case to the bracket is not blocked by a non-conductive material like plastic.
3. Provide enough space around the camera to facilitate the free flow of air.

Allegro USB3 Installation

Before You Install

Will your system configuration support the camera?

Operating System	CPU	RAM	Video	Ports	Software
Windows 7, 8, 8.1, 10 (Linux Supported via USB3 vision Standard)	Intel Core i3 3.1 GHz or equivalent	4GB	128 MB RAM	PCIe 2.0 compatible host controller with USB 3.0 connector	Microsoft Visual Studio 2010 (to compile and run example code)

Recommended USB3 Interface Cards:

The USB3 desktop motherboards supporting the Intel Z77 or Z78 chipset or newer will support high bandwidth USB3. USB3 cards may also be added to provide the ports. The two cards below have been successfully tested with ISG cameras:

1. 2-port card, both ports share a total 5 Gbps bandwidth:
   http://isgcameras.com/product/u12-startech-pexusb3s24-2-port-hba/

2. 4-port card, with each port having its own 5 Gbps bandwidth for total of 20 Gbps.
   http://isgcameras.com/product/u13-startech-pexusb3s44v-4-port-hba/

Do you have all the parts you need?

To install your camera you will need the following components:

1. USB 3.0 cable (see Interface Cables)
2. 12-pin Trigger/Strobe cable
3. C-mount Lens
4. Tripod adapter (optional) (see Mounting with the Case or Optional Tripod Mount)
5. Interface card

ISG sells a number of the additional parts required for installation. To purchase, please visit the ISG Web Site. www.isgcameras.com

Do you have the required software?

There are many helpful resources available to you on the ISG downloads page including:

1. Software; including drivers that are needed for installation
2. Firmware; updates and release notes.
3. Dimensional drawings and CAD Models
4. Documentation

Installing your Software

Overview

In order to operate the ISG USB3 camera, please visit the ISG website (http://www.isgcameras.com) for the software downloads and installation instructions. For more information see *Allegro USB Software and Control* in this document.

Installing Your Camera

1. Install the Tripod Mounting Bracket (optional)
2. Attach a Lens
    a. Unscrew the dust cap from the C-mount lens holder to install a lens
3. Connect the interface card and cable to the camera
    a. Plug the interface cable into the host controller and the camera. The cable jack screws should be used for a secure connection
4. Plug in the GPIO Connector (optional)
    a. GPIO can be used for trigger and strobe
5. Confirm successful installation
    a. Check the device manager to confirm the installation was successful
    b. Go to the **start menu** and select **run** and enter **devmgmt.msc**
    c. Verify the camera is listed as Allegro U3V (this will normally be found under the "ibusb (WinUSB) devices" header)

Camera Firmware

Firmware is programming that is inserted into the programmable memory (programmable ROM) of ISG cameras. Firmware is created and tested like software. When ready, it can be distributed like other software and installed in the programmable memory by the user.

The latest firmware versions often include significant bug fixes and feature enhancements. To determine the changes made in a specific firmware version, consult the Release Notes.

Firmware is identified by a version number, a build date, and a description.

Determining Firmware Version

To determine the firmware version number of your camera:

1. In the ISG, open the "About" Dialog.
2. Query the GenICam feature DeviceFirmwareVersion.

Upgrading Camera Firmware

Camera firmware can be upgraded or downgraded with either an earlier or later version contact support@isgcameras.com.

Allegro USB3 Attributes

Pixel Formats

The pixel formats describe the encoding scheme of the pixels in the camera output images. Pixel formats describe each pixel in terms of color encoding, bit depth and formatting within the data stream.

	*Pixel formats conform to the GenICam Pixel Format Naming Convention (PFNC) v2.0. The full PFNC can be found on the EMVA.org website and contains more details than provided below. Not all features are available on all cameras.*

The camera sensor Analog to Digital Converter (ADC) produces pixels at a particular bit depth, typically 10 bits. If the selected pixel format has fewer bits than the ADC output, the least significant bits are dropped. If the selected pixel format has more bits per pixel than the ADC, the least significant bits are padded with zeros.

Mono

Mono formats include Mono8 (8 bit per pixel) and Mono10p (10 bits per pixel). Mono cameras only output these formats. Selecting a Mono format bypasses image processing features and thus offers the highest frame rates available.

RGB

Color sensors using a Bayer color filter array support Bayer pixel formats. The camera supports BayerLM8 and BayerLM10p. Where L and M are one of R, G, or B and describe the ordering of pixels within the Bayer pattern (see the PFNC document). These formats require the host software to reconstruct a full color image. The color processing in the camera is bypassed when a Bayer format is selected offering the highest available frame rate.

YCrCb/YUV

This format consists of a brightness (luma) component, Y, and color (chroma) components Cb and Cr (also referred to as U and V). So called YCC444 format is 24 bits per pixel. Subsampling the chroma channels allows YCbCr data to use 16 bits per pixel for a faster transfer rate without significant visual difference. This is referred to as YCC422.

Image Format Control

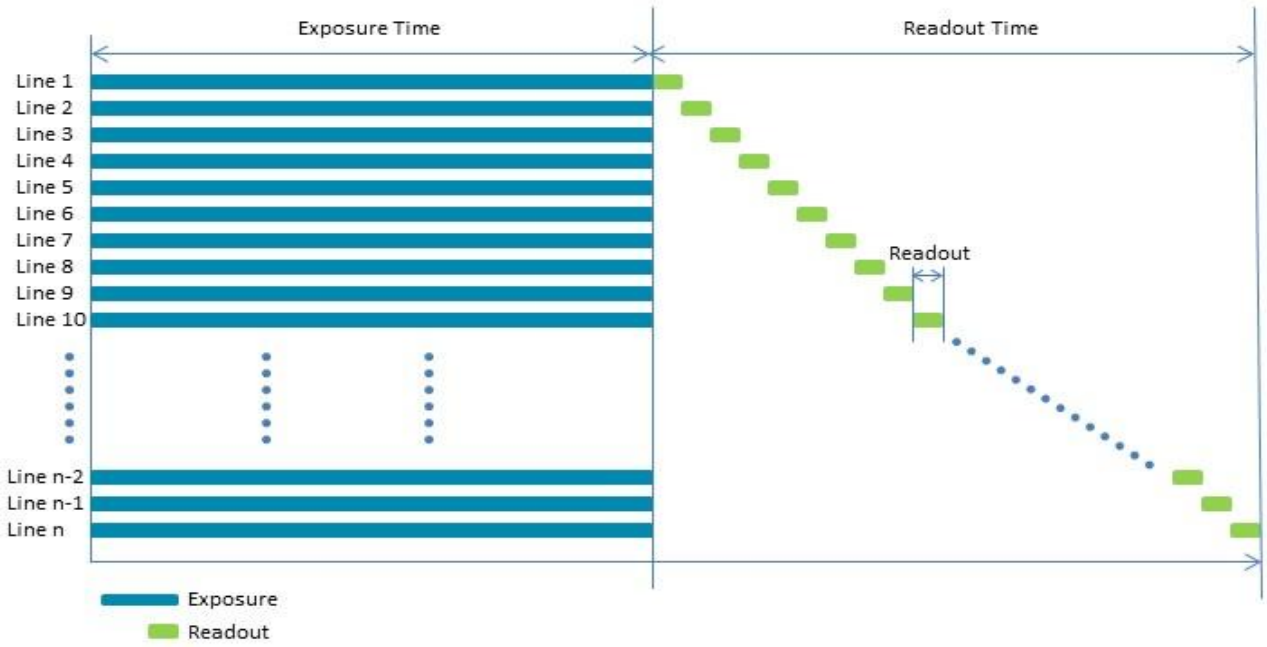
Name	Display Name	Description	Value
Width	Width	Width of the image provided by the device (in pixels)	Sensor Dependent
Height	Height	Height of the image provided by the device (in pixels	Sensor Dependent
Offset X	X Offset	Horizontal offset from the origin to the region of interest (in pixels)	
Offset Y	Y Offset	Vertical offset from the origin to the region of interest (in pixels)	
PixelFormat	Pixel Format	Format of the pixels provided by the device. It represents all the information provided by PixelCoding, PixelSize, PixelColorFilter combined in a single feature	Sensor Dependent Mono8, Mono10p Bayer8, Bayer10p, RGB8, YCC444, YCC422
RegionSelector	Region Selector	Selects region of interest (ROI) to control. Regiono represents a read-only composite image constructed from all of the enabled ROI regions.	
RegionMode	Region Mode	Controls whether the selected region of interest (ROI) is active and streaming	Off On

Shutter Types

Global Shutter

For each frame in cameras with a global shutter sensor the start and stop time for exposure is the same. The length of time for exposure is also the same.

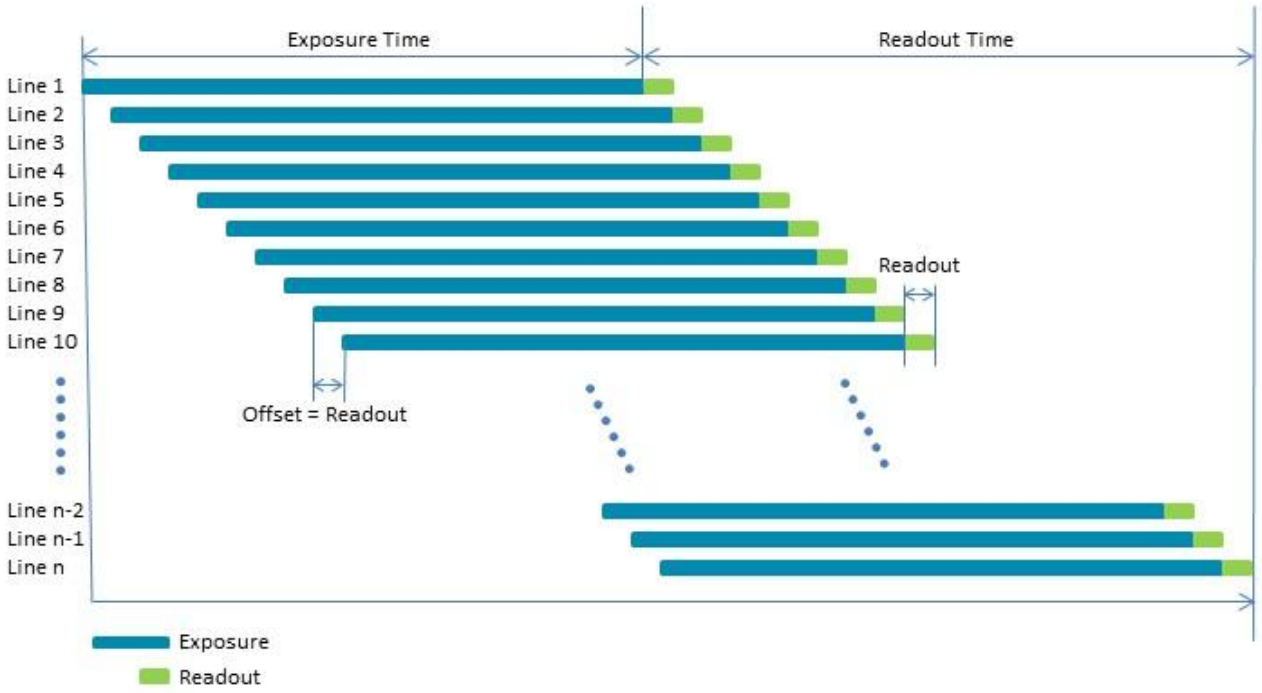
For cameras with a global shutter sensor, for each frame all of the lines start and stop exposure at the same time. The exposure time for each line is the same. Following exposure, data readout begins. The readout time for each line is the same but the start and end times are staggered.



Increased uniform brightness and minimal motion blur are some advantages of global shutter.

Rolling Shutter

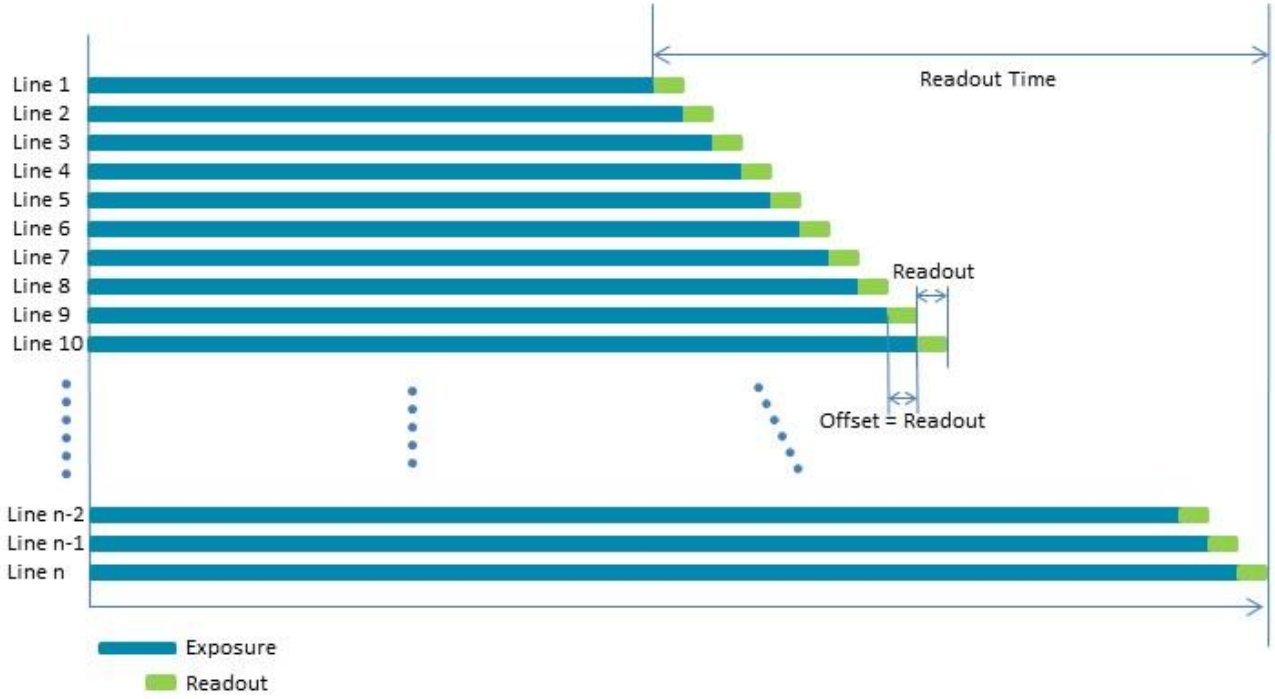
For each frame in cameras with a rolling shutter sensor the exposure for each line begins at an offset equal the readout time for each line. While the exposure time for each line is the same, the start and stop times are staggered. Each line's data readout begins immediately following the exposure. Readout time for each line has the same length but staggered start and stop times.



Increase sensitivity is one of the advantages of rolling shutter, however due to the varying start times throughout the frame, there are known artifacts such as skew, wobble and partial exposure. Please see rolling for additional information.

Rolling Shutter with Global Reset

For each frame in cameras with a rolling shutter with global reset, the lines have the exposure start time while the stop time for exposure is delayed by the offset of the previous line's readout. For each line the exposure time gradually lengthens and data readout begins immediately following the line's exposure. While the readout time for each line is the same, the start and stop times are staggered.



The reduction in image artifacts such as skew and wobble that can be typical of rolling shutters is an advantage of the global reset feature. However, due to increased exposure length throughout each frame there may be an increase in brightness moving from top to bottom on an image.

Allegro USB3 Software and Control

The Allegro USB3's features can be accessed using various controls, including:

1. ISG Medley SDK - extensive support for a comprehensive variety of industry standard programming interfaces and methodologies. Designed for plug-and-play operation.
2. ISG Legacy SDK - API examples and the ISG GUI program. Designed for custom C/C++ applications.
3. GenICam based 3rd party and customer specific applications using ISG libraries

Examples of the controls are provided throughout this document. This camera family follows the Standard Features Naming Convention version v2.3. The SFNC will give more detailed usage models and descriptions of operations.

Using the Medley SDK

Medley is a powerful SDK is included with all Allegro cameras. It is designed for plug-and-play operation using popular environments like Visual Studio C/C++/C#, MATLAB, LabVIEW, DirectShow, TWAIN, ImageJ and more. The user can monitor or control features of the camera through Medley API examples or through the Medley GUI.

The Medley GUI is a streaming image viewer that can be used to test many of the capabilities of your Allegro camera. It allows you to view a live video stream from the camera, save individual images, adjust the various video formats, frame rates, properties and settings of the camera, and access camera registers directly.

For more information on the Medley SDK, visit http://isgcameras.com/medley-sdk

Custom Applications Built Using the ISG Legacy API

The ISG API that allows customers to create custom applications to control ISG Imaging Products. Included in downloads that are available on the ISG web site are a number of source code examples to help programmers get started.

Available downloads include:

1. Compiled and installable GUI.
2. Source code examples from the ISG GUI indicating how to access camera parameters. (IsgU3VGuiSample.zip)
3. The ISG DLL Header file which describes the API, and an API description document (ISG_USB3_Interface_Guide_ISG_U3V_API.pdf).
4. Instructions on how to locate the Header file can be found in: ISG_USB3_Interface_Guide_ISG_U3V_API.pdf

For more information on the Legacy SDK, http://isgcameras.com/allegro-usb-3-documentation-drivers-update

Allegro USB3 Operation using GenICam

Using GenICam Applications

USB3 Vision is a communication interface for vision applications based on the USB 3.0 technology. All cameras supporting USB3 Vision interact the same way with software also supporting USB3 Vision.

The standard defines required elements for camera identification, control, and output. It uses GenICam, a programming interface for camera attribute control. GenICam allows camera vendors to define features and attributes in an XML file stored inside the camera. The file is parsed by the host application when the camera is initially discovered. One of the key benefits of GenICam is the ability for camera vendors to introduce new camera-specific features without needing to update the host application.

Each camera attribute, such as exposure time, is controlled by a specific GenICam feature. The camera includes an XML device description file for interfacing with third-party GenICam-compliant APIs. A full listing of features that are included in the XML file is provided in GenICam Features. Throughout this document, GenICam features are referenced with their applicable operation.

For more information on the USB3 Vision standard, visit visiononline.org.

For more information on GenICam, visit http://www.emva.org/standards-technology/genicam/

GenICam Acquisition Control

Name	Display Name	Description	Value
AcquisitionMode	Acquisition Mode	Sets the acquisition mode of the device. It defines mainly the number of frames to capture during an acquisition and the way	Continuous
AcquisitionStart	Acquisition Start	Starts the Acquisition of the device. The number of frames captured is specified by	
AcquisitionStop	Acquisition Stop	Stops the Acquisition of the device at the end of the current frame. It is mainly used when AcquisitionMode is Continuous but can be used in any acquisition mode	
TriggerSelector	Trigger Selector	Selects the type of trigger to configure. See chart below.	Acquisition Start FrameStart FrameStartBurst FrameBurstActive

TriggerSource	Trigger Source	Specifies the internal signal or physical input Line to use as the trigger	Software Lineo
TriggerMode	Trigger Mode	Trigger source states	Off On
TriggerActivation	Trigger Activation Mode	Specifies the activation mode of the trigger	Rising Edge Falling Edge
TriggerDelay	Trigger Delay	Specifies the delay in microseconds (us) to apply after the trigger reception before	
TiggerInterval	Tigger Interval	ISG custom register that specifies the time between the start of Burst frames in	
TriggerSoftware	Generate Software Trigger	Generates an internal trigger. TriggerSource must be set to Software.	
ExposureMode	Exposure Mode	Sets how exposure is controlled	Timed TriggerWidth
ExposureTime	Exposure Time	Controls the Absolute exposure time in microseconds (µs). ExposureMode must be set to Timed.	
AcquisitionBurstFrameCount	Acquisition Frame Count	Number of frames to acquire in Burst Frames Acquisition mode	Max = AcquisitionMaxBurstFrameCount
AcquisitionMaxBurstFrameCount	Max Acquisition Frame Count	Max number of frames that can be acquired in Burst Frames acquisition mode. This value is a function of image size and pixel format	Returned from camera based on sensor size and frame buffer

Transfer Mode Summary

For the various transfer modes in the table below, the following are always set:

AcquisitionMode - *Continuous*

TriggerActivation - *RisingEdge*, *FallingEdge*

TriggerSource - *Software* (use **TriggerSoftware** to activate), *Lineo*

TriggerDelay - Delay value (usec)

TriggerInterval - Interval value for Burst Frames mode only (usec)

Transfer Mode	TriggerMode	TriggerSelector	AcquisitionBurst FrameCount	ExposureMode	Comments
Continuous Acquisition	Off	N/A	N/A	Timed	On receiving **AcquistionStart,** frames are sent continuously until **AcquistionStop**.
Continuous Acquisition with AcquisitionStart trigger	On	*AcquisitionStart*	N/A	Timed	On receiving **AcquistionStart** and after trigger, frames are sent continuously until **AcquistionStop**.
Single Frame	On	*FrameStart*	N/A	Timed	On receiving **AcquistionStart,** one frame is sent after each trigger.
Burst Frames	On	*FrameBurstStart*	frames per trigger	Timed	On receiving **AcquistionStart, AcquisitionBurstFrameCount** frames are sent after each trigger. **TriggerInterval** determines the time between the start of frames.
Variable Burst Frames	On	*FrameBurstActive*	N/A	Timed	On receiving **AcquistionStart,** frames are sent continuously while trigger is in its active level.
Bulb trigger	On	*FrameStart*	N/A	*TriggerWidth*	On receiving **AcquistionStart,** one frame is sent after each trigger with Exposure determined by the trigger pulse width.

Trigger and Strobe Control

Asynchronous Triggering

Camera triggering can be sourced from an external signal (Hardware trigger input) or by software trigger. See also section *Transfer Mode Summary* above for GenICam feature register programming.

Auto/One Push shutter and auto/one push gain control is not supported in asynchronous trigger modes

The purpose of this section is to summarize the supported trigger modes for the Allegro cameras. Trigger control is based on the GeniCam SFNC 2.3 specification which goes into more detail if needed.

When the sensors are capable, Triggers will start integration during data readout. Otherwise readout will need to complete before starting integration.

Relevant GeniCam Feature Registers

AcquisitionMode

Continuous – This is the only SFNC supported mode at this time.
SingleFrame, MultiFrame – These are deprecated **ISG specific** modes and are *not* SFNC compatible at this time. These will be updated to SFNC compatibility in the near future or at a customer request.

AcquisitionStart - Starts the Acquisition of the device. The Acquisition might be conditioned by various triggers. An **AcquisitionStart** command must be sent to the device before the acquisition related triggers become effective.

AcquisitionStop - Stops the Acquisition of the device at the end of the current Frame**.**

TriggerMode - Controls if the selected trigger is active. Values are *On* and *Off*.

TriggerSelector - Selects the type of trigger to configure.
AcquisitionStart - Selects a trigger that starts the continuous Acquisition of frames.
FrameStart - Selects a trigger starting the capture of one frame.
FrameBurstStar **-**: Selects a trigger starting the capture of the bursts of frames in an acquisition.
AcquisitionBurstFrameCount controls the length of each burst.
FrameBurstActive - Selects a trigger controlling the duration (active time of trigger based on pulse width) of the capture of the bursts of frames in an acquisition.

TriggerActivation - Specifies the activation mode of the trigger. Values are *RisingEdge* and *FallingEdge*.

TriggerSource - Specifies the internal signal or physical input Line to use as the trigger source.

TriggerSoftware - Generates an internal trigger. **TriggerSource** must be set to *Software***.**

TriggerDelay – Specifies the delay in microseconds to apply after the trigger reception before activating it.

TriggerInterval – An ISG Custom register that specifies the time between the start of frames in useconds. The user should set this to be greater than the higher of either integration time or readout time.

ExposureMode – Values are *Timed*, *TriggerWidth*

Standard External Trigger

In this mode, camera frames are generated using an external signal. When the input signals selected edge is detected, the image sensor begins integration followed by image readout.

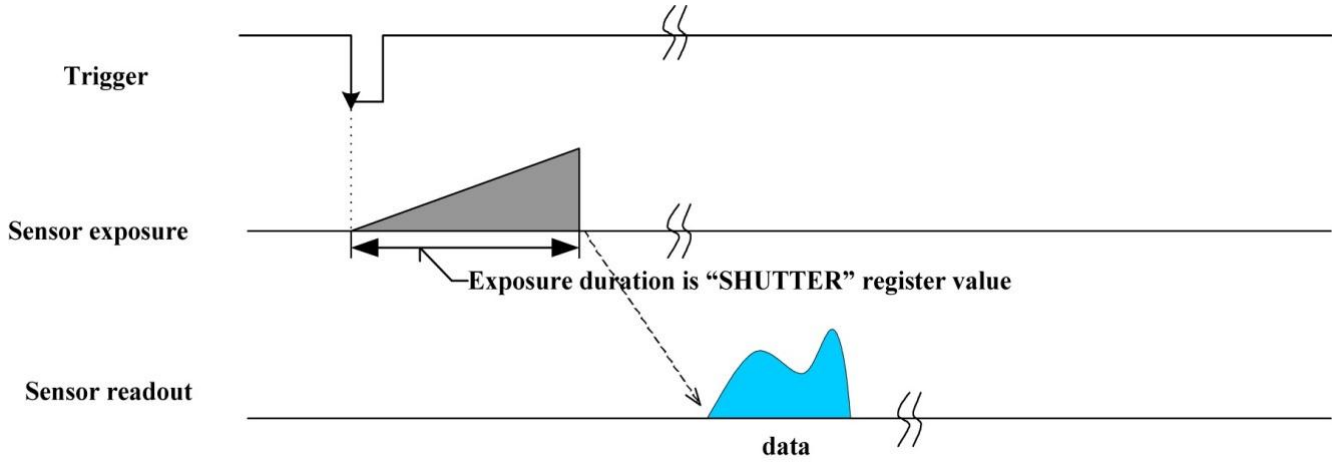


Figure 7.1: Standard External Trigger Mode

GenICam—Acquisition Control	
Acquisition Mode	Continuous
Trigger Selector	Frame Start
Trigger Mode	On
Trigger Source	Line o
Trigger Activation	Rising or Falling edge
Trigger Delay	Adjustable
Exposure Time	Integration Time
Exposure Auto	Off

Bulb Shutter Trigger

Also known as Bulb Shutter mode, the camera starts integration with the leading edge of the input trigger. Integration time terminates on the trailing edge of the input trigger.

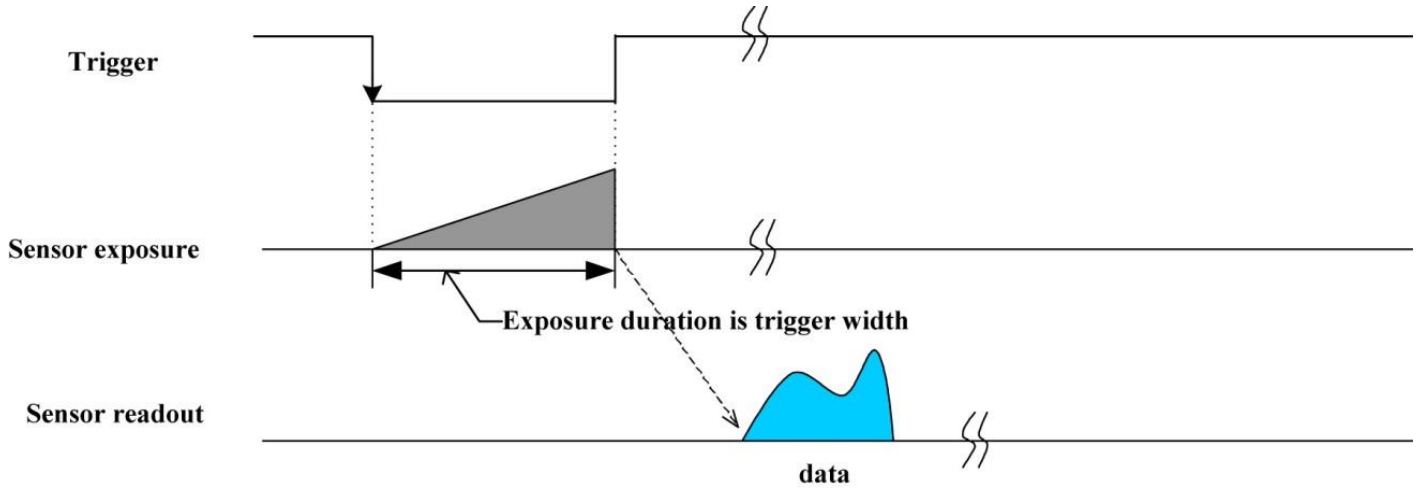


Figure 7.2: Bulb Shutter Trigger

GenICam—Acquisition Control	
Acquisition Mode	Continuous
Trigger Selector	Frame Start
Trigger Mode	On
Trigger Source	Line o
Trigger Activation	Rising or Falling edge
Trigger Delay	o
Exposure Mode	Trigger Width
Exposure Time	Integration Time
Exposure Auto	Off

Burst Mode Trigger (Edge Detect)

This trigger mode allows x number of frames to be generated with one trigger input (hardware or software). The frames are generated when the selected trigger edge is detected. The trigger interval value will determine frame rate. If the imager frame time is greater than the programmed interval, frames will be generated at the maxim sensor frame rate. NOTE: Depending on the sensor, the maximum frame rate in triggered mode may not be the same as in continuous mode.

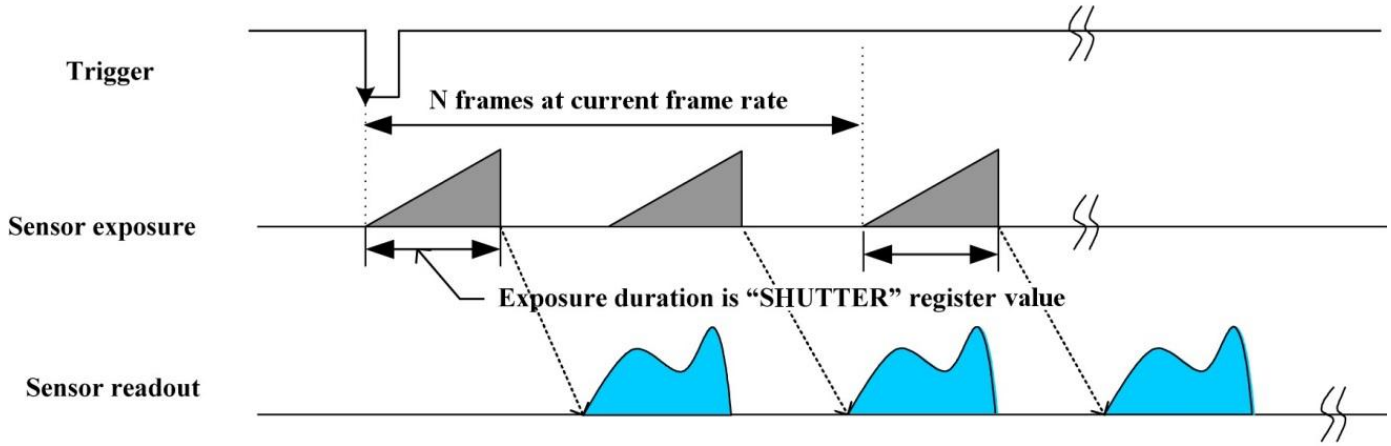


Figure 7.3: Trigger Mode 15 ("Multi-Shot Trigger Mode")

GenICam—Acquisition Control	
Acquisition Mode	Continuous
Acquisition Burst Frame Count	Number of images to be acquired
Trigger Selector	Frame Burst Start
Trigger Mode	On
Trigger Source	Line o
Trigger Activation	Rising or Falling edge
Trigger Delay	Adjustable
Exposure Mode	Timed
Exposure Time	Integration Time
Exposure Auto	Off

Burst Mode Trigger (Level Detect)

In this trigger mode sensor triggers will be generated as long as the input trigger is active. NOTE: Depending on the sensor, the maximum frame rate in triggered mode may not be the same as in continuous mode.

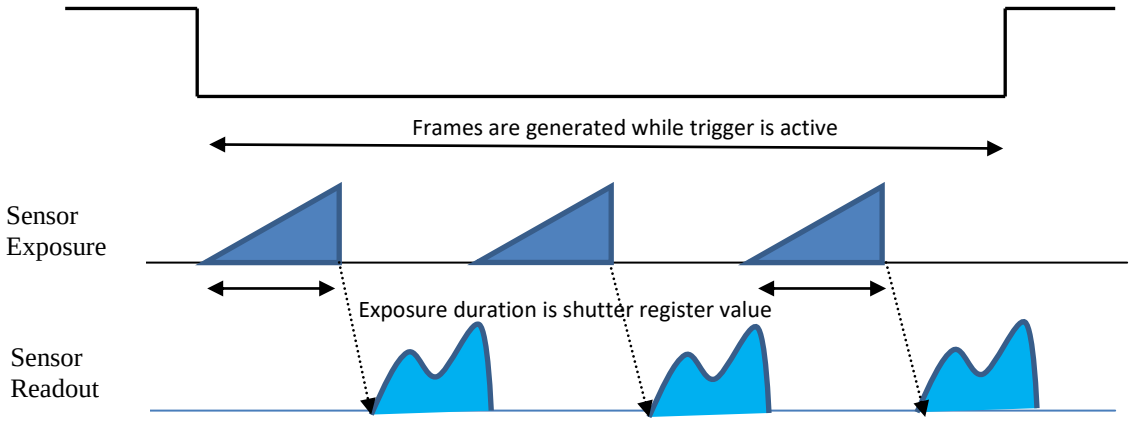
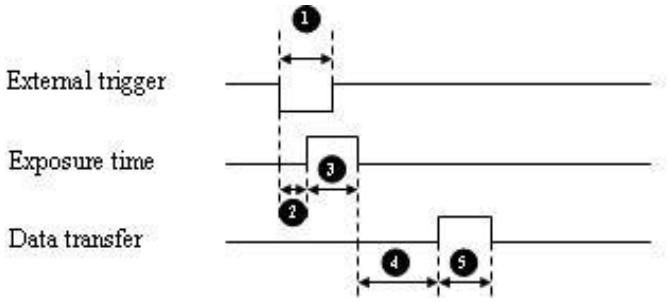


Figure 7.3: Trigger Mode 15 ("Multi-Shot Trigger Mode")

GenICam—Acquisition Control	
Acquisition Mode	Continuous
Acquisition Burst Frame Count	N/A
Trigger Selector	Frame Burst Active
Trigger Mode	On
Trigger Source	Line o
Trigger Activation	Rising or Falling edge
Trigger Delay	Adjustable
Exposure Mode	Timed
Exposure Time	Integration Time
Exposure Auto	Off

External Trigger Timing

The time from the external trigger firing to the start of shutter is shown below:



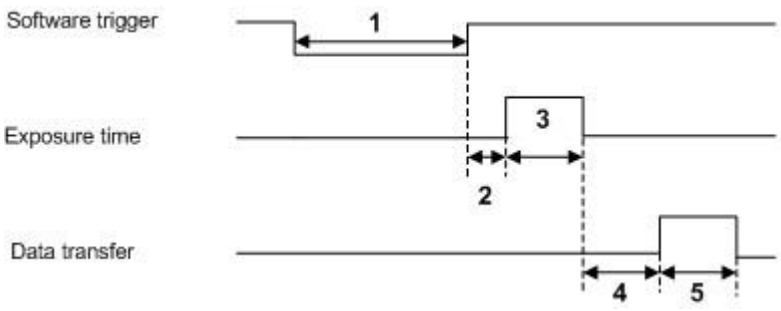
1. Trigger Pulse
2. Propagation Delay
3. Exposure Time
4. Sensor Readout
5. Data Transfer

Figure 7.4: External trigger timing characteristics

Asynchronous Software Triggering

Shutter integration can be initiated by a software trigger by setting the Trigger Source to Software in the GenICam features.

The time from a software trigger initiation to the start of shutter is shown below:



1. Software Trigger
2. Trigger Latency
3. Exposure Time
4. Sensor Readout
5. Data Transfer

Figure 7.6: Software trigger timing

The time from when the software trigger is written on the camera to when the start of integration occurs can only be approximated. We then add the trigger latency (time from the trigger pulse to the start of integration) to this.

This timing is solely from the camera perspective. It is virtually impossible to predict timing from the user perspective due to latencies in the processing of commands on the host PC

Programmable Strobe Output

The camera has two independent programmable strobe outputs. The strobe control input can be driven by the sensor (sensor integration active) or the hardware trigger input. This allows for very flexible strobe control. By default, the strobe_1 output is a positive going pulse during sensor integration and the strobe_2 output is an inverted version of strobe_1. By using strobe input select, strobe duration and delay along with programmable input and output polarity, most any strobe application can be implemented.

Name	Display Name	Description	Value
StrobeSelector	Strobe Selector	Selects strobe signal to be modified	STROBE 1 STROBE 2
StrobeSource	Strobe Source	Selects strobe block input signal	INTEGRATION PERIOD TRIGGER INPUT
StrobeDelay	Strobe Delay	Delay from active edge of input to strobe block to assertion of strobe output	microseconds
StrobeDuration	Strobe Duration	Strobe active time	microseconds
InvertStrobeOutput	InvertStrobeOutput	Invert signal into strobe block (invert = active low)	True/False
InvertStrobeInput	InvertStrobeInput	Invert signal out of strobe block (invert = active low)	True/False

GenICam Additional Features

Features that control, monitor and query camera operation are included in the XML device description file on the camera. Since not all operations can be controlled using the XML file those not included are controlled via CSRs.

Except where noted, these features conform to the GenICam Standard Features Naming Convention (SFNC) v2.3. The full SFNC can be found on the EMVA.org website and contains more details than provided below. Not all features are available on all cameras.

Device Control

Device control features provides general information and control for the device (camera) and its sensor

Name	Display Name	Description	Value(s)
DeviceVendorName	Vendor Name	Name of the manufacturer of the device	Imaging Solutions Group
DeviceFamilyName	Family Name	Identifier of the product family of the device	LightWise Allegro
DeviceModelName	Model Name	Model of the Device	
DeviceSerialNumber	Serial Number	Serial number of the device	
DeviceVersion	Hardware Version	Version of the Hardware's device	
DeviceFirmwareVersion	Firmware Version	Device's firmware version	
DeviceUserID	User ID	User-programmable device identifier. Acquisition must be disabled in order to write this value	
DeviceManufacturerInfo	Firmware Build Information	Manufacturer information about the device. This consists of firmware build information	
DeviceSFNCVersionMajor	SFNC Major Version	Major version of the Standard Features Naming Convention that was used to create the device`s GenICam XML	2
DeviceSFNCVersionMinor	SFNC Minor Version	Minor version of the Standard Features Naming Convention that was used to create the device`s GenICam XML	3
DeviceSFNCVersionSubMinor	SFNC Subminor Version	Sub minor version of the Standard Features Naming Convention that was used to create the device`s GenICam	0

		XML	
DeviceManifsetXMLMajorVersion	XML Major Version	Indicates the major version number of the GenICam XML file of the selected manifest entry	
DeviceManifsetXMLMinorVersion	XML Minor Version	Indicates the minor version number of the GenICam XML file of the selected manifest entry	
DeviceManifsetXMLSubMinorVersion	XML Subminor Version	Indicates the subminor version number of the GenICam XML file of the selected manifest entry	
DeviceGenCPVersionMajor	GenCP Major Version	Major version of the GenCP protocol supported by the device	
DeviceGenCPVersionMinor	GenCP Minor Version	Minor version of the GenCP protocol supported by the device	
DeviceU3VVersionMajor	U3V Major Version	Major version of the USB3 Vision protocol supported by the device	
DeviceU3VVersionMinor	U3V Minor Version	Minor version of the USB3 Vision protocol supported by the device	
DeviceTemperatureSelector	Temperature Reading Source	Selections the location within the device where temperature will be measured	
DeviceTemperature	Temperature (°C)	Device temperature in degrees Celsius (°C). It is measured at the location selected by DeviceTemperatureSelector	C
DeviceTemperatureFahrenheit	Temperature (°F)	Device temperature in degrees Fahrenheit (°F). It is measured at the location selected by DeviceTemperatureSelector	F
DeviceLogLevel	Log Level	Selects verbosity of device log entries	o
DeviceReset	Reset Device	Resets the device to its power-up state	
ColumnCorrectionEnable	Column FPN Correction	Enable column FPN correction	On Off
RowCorrectionEnable	Row FPN Correction	Enable row FPN correction	On Off
PixelDefectCorrectionEnable	Pixel Defect Correction	Enable pixel defect correction	On Off
ControllerBoardVersionBootstrap	OTP Controller Board Version #	One-time programmable field to store controller board hardware revision string	

Digital IO Control

Name	Display Name	Description	Value
LineSelector	Strobe Selector	Selects the physical line (or pin) of the external device connector to configure	Strobe1 Strobe2
LineMode	Line Mode	Controls if the physical Line is used to Input or Output a signal	Output
LineInverter	Invert Strobe Output	Controls the inversion of the signal of the selected input or output Line	
InvertStrobeInput	Invert Strobe Input	Custom feature: On this device, this controls the inversion of the signal entering the strobe control block. This should be adjusted such that an active-high signal enters the strobe controller	
LineSource	Strobe Source	Selects which internal acquisition or I/O source signal to output on the selected Line. LineMode must be Output	INTEGRATION PERIOD TRIGGER INPUT
LineFormat	Line Format	Controls the current electrical format of the selected physical input or output Line	Opto-Coupled
StrobeDelay	Strobe Delay (µs)	Controls the delay (in microseconds) of the signal of the selected output Line	
StrobeDuration	Strobe Duration (µs)	Controls the delay (in microseconds) of the signal of the selected output Line	

Analog Control

Name	Display Name	Description	Value
GainSelector	Gain Selector	Selects which Gain is controlled by the various Gain features	DigitalAll
Gain	Gain	Controls the selected gain as an absolute physical value. This is an amplification factor applied to the video signal	
BlackLevelSelector	Black Level Selector	Selects which Black Level is controlled by the various Black Level features	ALL
BlackLevel	Black Level	Controls the selected black level as an integer value. This is an offset factor subtracted from the video signal	
BalanceRatioSelector	Balance Ratio Selector	Controls the mode for automatic white balancing between the color channels. The white balancing ratios are automatically adjusted	Red Green Blue
BalanceRatio	White Balance Ratio	Controls ratio of the selected color component to a reference color component. It is used for white balancing	
BalanceWhiteAuto	Auto White Balance	Controls the mode for automatic white balancing between the color channels. The white balancing ratios are automatically adjusted.	Off Once
Saturation	Saturation	Controls the Saturation Control Coefficient	
SaturationEnable	Saturation Enable	Enables the Saturation	Off On
Gamma	Gamma	Controls the gamma correction of pixel intensity	
GammaEnable	Gamma Enable	Enables the gamma correction of pixel intensity	Off On

Transport Layer Control

Name	Display Name	Description	Value
PayLoadSize	Pay Load Size	Provides the number of bytes transferred for each image or chunk on the stream channel. This includes any end-of-line, end-of-frame statistics or other stamp data. This is the total size of data payload for a data block	
CurrentSpeed	Current Speed	Current speed of USB bus	Low Speed Full Speed High Speed Super Speed

User Sets

The camera can save and restore settings and imaging parameters via on-board user configuration sets, also known as User Sets. This is useful for saving default power-up settings, such as gain, shutter, video format and frame rate, and others that are different from the factory defaults.

UserSeto stores the factory default settings that can always be restored. Two additional user sets are provided for custom default settings. The camera initializes itself at power-up, or when explicitly reinitialized, using the contents of the last saved user set. Attempting to save user settings to the (read-only) factory default user set causes the camera to switch back to using the factory defaults during initialization.

The following camera settings are saved in user sets.

1. Acquisition Frame Rate and Current Frame Rate
2. Image Data Format, Position, and Size
3. Current Video Mode and Current Video Format
4. Frame information
5. Trigger Mode and Trigger Delay
6. Imaging Parameters
7. GenICam User Set Control

GenICam User Set Control

Name	Display Name	Description	Value
UserSetSelector	User Set Selector	Select the feature user set to load, save, or configure	Default = 0 User Set 1 = 1 User Set 2 = 2
UserSetLoad	Load Selected User Set	Loads the User Set specified by UserSetSelector and makes it active	Write Only
UserSetSave	Save Selected User Set	Saves the user set specified by the User Set Selector to the non-volatile memory of the device	Write Only
UserSetDefault	Default User Set	Select the feature user set to load and make active by default when the device is reset	Default User Set 1 User Set 2

Hardware Specifications

Powering the Camera

The power consumption specification is: 5 V via USB 3.0 interface, maximum 900mA.

The USB 3.0 Micro-B connector provides a power connection between the camera and the host computer; a USB3 compliant host port should be used. Caution must be used with USB2 ports or hubs which do not provide the specified 900mA current (USB2 only provides 500 mA per port).

In some cases the host pc, especially laptops, may not provide enough power even through the USB3 port.

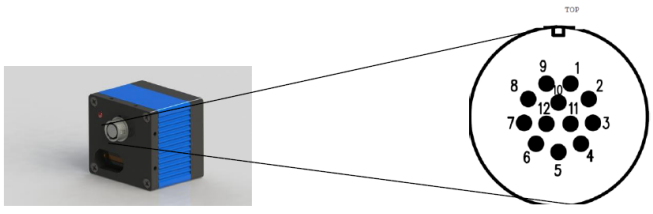
Symptoms of insufficient power generally include either the camera not showing up in the device manager of the host pc or any intermittent camera behavior. **In most instances the CMV12000 will need additional power**. If you experience the insufficient power issue, there are a few options to choose from to sufficiently power the camera.

For further details and information on the solutions listed below, please visit the accessories section of ISG's website (http://www.isgcameras.com/).

1. **Powered USB3 Hub** (hubs listed on our website have been tested by ISG).
2. **External 6V power** via external IO connector (see diagram below).
3. **USB3 Y-Cable,** which sums power from multiple USB ports

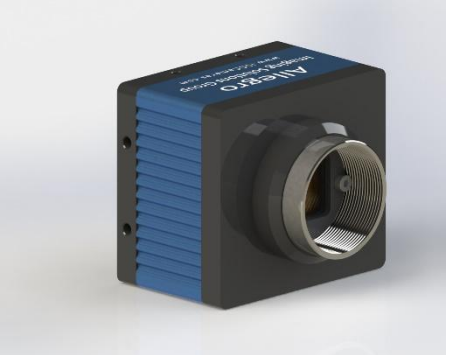
Pin Assignment:

J1.1 , Orange wire	DC-IN
J1.2, Orange wire	DC, IN
J1.3, Black wire	DC-Return
J1.4, Black wire	DC-Return
J1.5, Green wire	STROBE 2
J1.6, Red wire	USUSER GROUND-for-Trigger
J1.7, White wire	TRITRGGER
J1.8, Blue wire	USUSERER VCC 5-24V- FOR STROBES
J1.9, Black wire	DC-Return
J1.10, Brown wire	STSTROBE 1 (OPTO ISOLATED)
J1.11 N/C	Open
J1.12, Yellow wire	Optional Shield / Chassis



J1, EXT IO Connector

Allegro USB3 Physical Description



1. Lens holder
   C Mount Lens ready. (CS Mount available by special order.

2. Glass/IR filter system
   Dust protective glass on monochrome cameras, IR Cut filter on color models. Removable and mounted behind Lens Holder

3. M3x.5 THD x 5 DP mounting holes
   Eight locations on camera case for multiple mounting options.

4. General purpose I/O connector
   The 12 – pin Trigger/Strobe connector. See Trigger and Strobe Control

5. Status LED
   This light indicates the current state of the camera operation. See Status Indicator LED

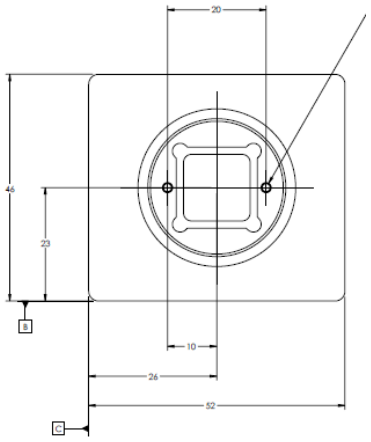
6. USB3 connector
   See USB 3.0 Connector

Allegro USB3 Dimensions

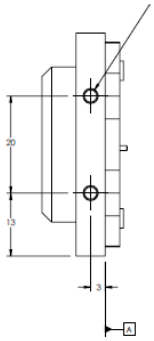
LW-AL-CMV-4000/2000 shown below

Drawings and 3D models for all model numbers available on the ISG Web Site

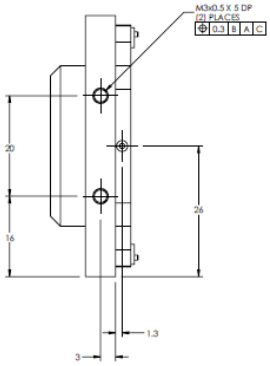
FRONT PANEL



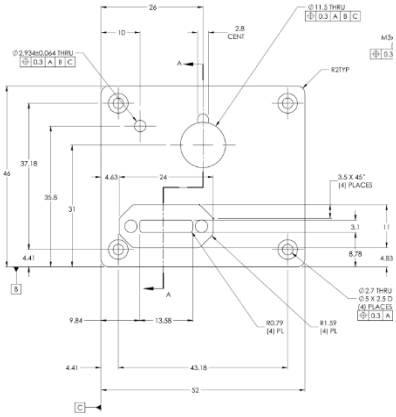
SIDES

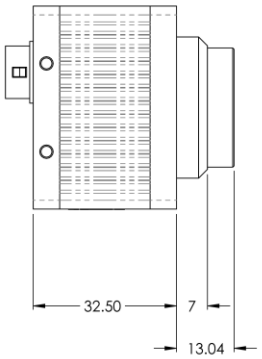


BOTTOM



REAR PANEL





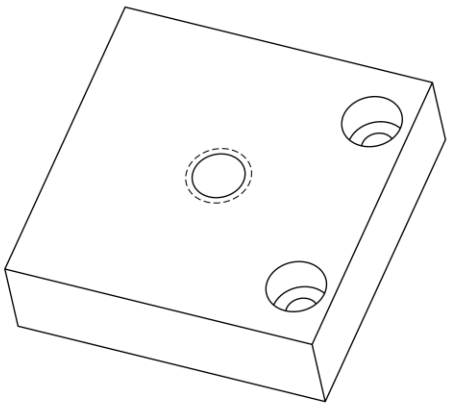
Mounting with the Case or Optional Tripod Mount

The case provides the following mounting holes:

1. Eight (8) M3 x .5 mounting holes on the top bottom and sides of the case.
2. The two M3 x .5 mounting holes on the front bottom of the case can be used to attach the optional tripod mount.

The tripod mount is designed to accept standard tripods with a standard 1/4" - 20 threading.

Tripod Mount:



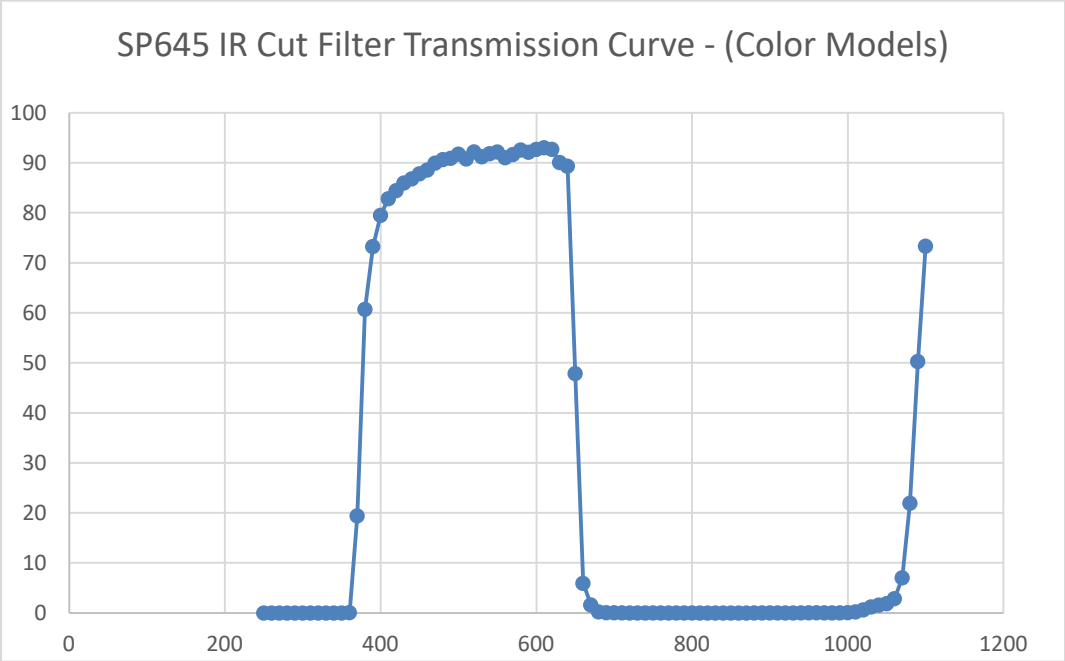
Dust Protection

Designed to prevent dust from falling directly onto the sensor's protective glass surface the Allegro comes with protective camera housing. The shielding is accomplished by placing a piece of clear glass (monochrome camera models) or an IR cut off filter (color models) which sits above the surface of the sensors glass with a removable plastic retainer that keeps the glass/filter in place. The possibility of damage to the sensor when cleaning or of interference from dusty is greatly reduced by the increased distance between the imaging surface and the location of potential dust particles. Additional measures of protection:

1. Cameras are sealed when they are shipped. To avoid contamination, seals should not be broken until cameras are ready for assembly at customer's site.
2. Use caution when removing the protective glass or filter. Damage to any component of the optical path voids the Hardware Warranty.
3. Removing the protective glass or filter alters the optical path of the camera, and may result in problems obtaining proper focus with your lens.

Infrared Cutoff Filters

ISG color camera models are shipped with an infrared (IR) cut- off filter. This filter can reduce sensitivity in the near infrared spectrum and help prevent smearing. The properties of this filter are illustrated in the transmission curve below. In monochrome models, the IR filter is replaced with a transparent piece of glass.



USB 3.0 Connector

The camera is equipped with a USB 3.0 Micro-B connector that is used for data transmission, camera control and power. For more detailed information, consult the USB 3.0 specification available from http://www.usb.org/developers/docs/.

Figure 4.5: USB 3.0 Micro B Connector

Pin	Signal Name	Description
1	VBUS	Power
2	D-	USB 2.0 differential pair
3	D+	
4	ID	OTG identification
5	GND	Ground for power return
6	MicB_SSTX-	SuperSpeed transmitter differential
7	MicB_SSTX+	
8	GND_DRAIN	Ground for SuperSpeed signal return
9	MicB_SSRX-	SuperSpeed receiver differential pair
10	MicB_SSRX+	

TABLE 4.1: USB 3.0 MICRO-B CONNECTOR PIN ASSIGNMENTS

The USB 3.0 Micro-B receptacle accepts a USB 2.0 Micro-B plug and, therefore, the camera is backward compatible with the USB 2.0 interface.

When the camera is connected to a USB 2.0 interface, it runs at USB 2.0 speed, and maximum frame rates are adjusted accordingly based on current imaging parameters.

Interface Cables

Because there is not a standard maximum cable length specified in the USB 3.0 standard you may need to purchase a recommended cable. To do so please visit the ISG web site. www.isgcameras.com.

Interface Card

In order to achieve optimum benefits of the USB 3.0 the camera must connect to a USB PCIe 2.0 card.

The camera must connect to an interface card which is often referred to as a host adapter, a bus controller or a network interface card (NIC)

Trigger/Strobe IO Connector Details

Connector Information:

On Camera: Hirose R10A-10R-12SB(71) - J1

Mating Plug (For Cables): Hirose HR10A-10P-12P(73)

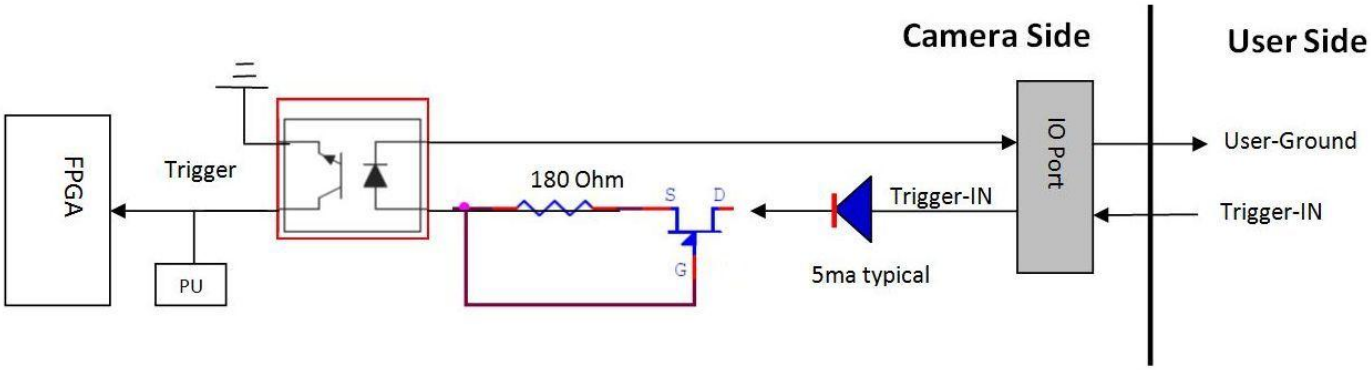
Pin	Assignment
J1.1	Reserved do not attach
J1.2	Reserved do not attach
J1.3	Reserved do not attach
J1.4	Reserved do not attach
J1.5	STROBE 2 (OPTO ISOLATED)
J1.6	USER GROUND – FOR TRIGGER (OPTO ISOLATED)
J1.7	TRIGGER (OPTO ISOLATED)
J1.8	USER VCC 5-24V-FOR STROBES (OPTO ISOLATED)
J1.9	Reserved do not attach
J1.10	STROBE 1 (OPTO ISOLATED)
J1.11	Reserved do not attach
J1.12	Optional Shield / Chassis

Camera Trigger Details

The external interface consists of one isolated programmable Trigger Input and two isolated programmable Strobe outputs.

1. **Trigger input**: The camera receives one optically isolated trigger input. The interface consists of 2 wires
    a. **Trigger In** (signal)
    b. **User-Ground** (signal return). The trigger amplitude should be between 5V to24V. The interface supports the Trigger frequency of up to 1MHZ at 50% duty cycle. The camera interface circuit limits the input current to around 5ma. The design provides reverse polarity protection.
2. **Trigger modes:** are programmable for
    a. Active-high
    b. Active-low
    c. Falling-edge
    d. Rising-edge.

The drawing below shows the camera's Trigger Interface circuit.



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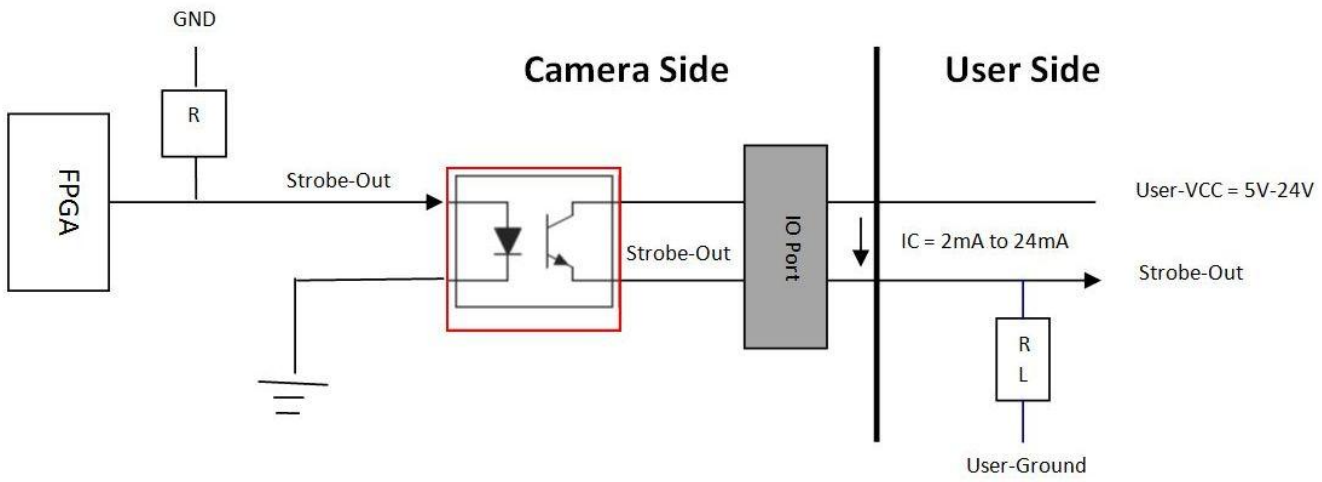
Camera Strobe Details

Strobe1-2 outputs: The camera provides two optically isolated Strobe outputs (NPN transistor). The output modes (level high or level low and pulse duration) are programmable.

The following diagram shows the interface circuit for each of the Strobe outputs.



Note: the amount of current flow, IC, is the function of User-resistor- Load and User-VCC. It is recommended the IC be kept at 2ma to 24ma range when Saturation voltage, VCE, is at 0.5V max.

The table below shows some suggested resistor-load value based on various User-VCC at IC value of 10mA

Load Resistor	IC mA	VC	Comment
2.4K	10	24V	VCE = 0.3
1.2K	10	12V	VCE = 0.3
500-ohm	10	5V	VCE = 0.3