CV60 Area Scan Camera

Product Reference Guide

ZEBRA

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About This Guide

The CV60 Area Scan Camera complies with GenICam standards. For additional information, go to emva.org/standards-technology/genicam/.

This document describes supported functions using the Standard Feature Naming Convention (SFNC) standard. For additional information, go to emva.org/wp-content/uploads/GenICam_SFNC_v2_7.pdf.

Configurations

This guide covers the following configurations:

Table 1 CV60 Configurations

SKU	Description
CV60-AS02MG-0000W	Vision Camera, Area Scan, 2.3MP, Monochrome, GigE Interface, Worldwide
CV60-AS05MG-0000W	Vision Camera, Area Scan, 5MP, Monochrome, GigE Interface, Worldwide
CV60-AS09MG-0000W	Vision Camera, Area Scan, 8.9MP, Monochrome, GigE Interface, Worldwide
CV60-AS12MG-0000W	Vision Camera, Area Scan, 12.3MP, Monochrome, GigE Interface, Worldwide
CV60-AS02CG-0000W	Vision Camera, Area Scan, 2.3MP, Color, GigE Interface, Worldwide
CV60-AS05CG-0000W	Vision Camera, Area Scan, 5MP, Color, GigE Interface, Worldwide
CV60-AS09CG-0000W	Vision Camera, Area Scan, 8.9MP, Color, GigE Interface, Worldwide
CV60-AS12CG-0000W	Vision Camera, Area Scan, 12.3MP, Color, GigE Interface, Worldwide

Accessories

This section provides information for using the accessories for the device. The table lists the communication cables, lenses, lens filters, and power accessories available for the device.

Table 2 Communication Cables

Part Number	Description
Communication Cables	
CBL-ENT00200-R4501	Cable, GigE 2M, Locking RJ45 to RJ45, Standard Flex

Table 2 Communication Cables (Continued)

Part Number	Description
CBL-ENT00500-R4501	Cable, GigE 5M, Locking RJ45 to RJ45, Standard Flex
CBL-ENT01000-R4501	Cable, GigE 10M, Locking RJ45 to RJ45, Standard Flex
CBL-ENT02000-R4501	Cable, GigE 20M, Locking RJ45 to RJ45, Standard Flex
Lenses	
LENS-U0800-0100	C-Mount Lens, 8mm Focal Length, Large Format, 55mm Filter Thread
LENS-U1200-0100	C-Mount Lens, 12mm Focal Length, Large Format, 35.5mm Filter Thread
LENS-U1600-0100	C-Mount Lens, 16mm Focal Length, Large Format, 35.5mm Filter Thread
LENS-U2500-0100	C-Mount Lens, 25mm Focal Length, Large Format, 35.5mm Filter Thread
LENS-U3500-0100	C-Mount Lens, 35mm Focal Length, Large Format, 35.5mm Filter Thread
LENS-M0800-0100	C-Mount Lens, 8mm Focal Length Lens, Large Format, 25.5mm Filter Thread
LENS-M1200-0100	C-Mount Lens, 12mm Focal Length Lens, Large Format, 25.5mm Filter Thread
LENS-M1600-0100	C-Mount Lens, 16mm Focal Length Lens, Large Format, 25.5mm Filter Thread
LENS-M2500-0100	C-Mount Lens, 25mm Focal Length Lens, Large Format, 25.5mm Filter Thread
LENS-M3500-0100	C-Mount Lens, 35mm Focal Length Lens, Large Format, 25.5mm Filter Thread
Lens Filters	
FLTR-BP635-25400	Red Bandpass Filter, 635 nm, 25.4, For Use On C-Mount Lens
FLTR-BP470-25400	Blue Bandpass Filter, 470 nm, 25.4 mm, For Use On C-Mount Lens
FLTR-BP850-25400	IR Bandpass Filter, 850 nm, 25.4 mm, For Use On C-Mount Lens
FLTR-BP850-25400	IR/UV Blocking Filter, 550 nm, 25.4 mm, For Use On C-Mount Lens
FLTR-BP635-55000	Red Bandpass Filter, 635 nm, 55 mm, For Use On C-Mount Lens
FLTR-BP470-55000	Blue Bandpass Filter, 470 nm, 55 mm, For Use On C-Mount Lens
FLTR-BP850-55000	IR Bandpass Filter, 850 nm, 55 mm, For Use On C-Mount Lens
FLTR-BP550-55000	IR/UV Block Bandpass Filter, 550 nm, 55 mm, For Use On C-Mount Lens
FLTR-PZ120-55000	Ultra High Contrast Polarizer, 55 mm, For Use On C-Mount Lens
FLTR-BP635-35500	Red Bandpass Filter, 635 nm, 35.5 mm, For Use On C-Mount Lens
FLTR-BP470-35500	Blue Bandpass Filter, 470 nm, 35.5 mm, For Use On C-Mount Lens
FLTR-BP850-35500	IR Bandpass Filter, 850 nm, 35.5 mm, For Use On C-Mount Lens
FLTR-BP550-35500	IR/UV Block Bandpass Filter, 550 nm, 35.5 mm, For Use On C-Mount Lens
FLTR-PZ120-35500	Ultra High Contrast Polarizer, 35.5 mm, For Use On C-Mount Lens
FLTR-BP635-25500	Red Bandpass Filter, 635 nm, 25.4 mm, For Use On C-Mount Lens
FLTR-BP470-25500	Blue Bandpass Filter, 470 nm, 25.4 mm, For Use On C-Mount Lens

Table 2 Communication Cables (Continued)

Part Number	Description
FLTR-BP850-25500	IR Bandpass Filter, 850 nm, 25.4 mm, For Use On C-Mount Lens
FLTR-BP550-25500	IR/UV Blocking Bandpass Filter, 550 nm, 25.4 mm, For Use On C-Mount Lens
FLTR-PZ120-25500	Ultra High Contrast Polarizer, 25.4 mm, For Use On C-Mount Lens
Power Supplies and Power Cords	
PWR-24V03A-0000	Power Supply, 24V DC, 3.3A
PWR-24V05A-0000	Power Supply, 24V DC, 5A
PWR-POE30W-0000	Power Over Ethernet (POE) Injector, 30W, 55V DC Output, 100-240V AC Input
PWR-POE60W-0000	Power Over Ethernet (POE) Injector, 60W, 55V DC Output, 100-240V AC Input
CBL-PWR00200-FLY00	Power Cable, 2 M length, 6-pin female Hirose connector to flying leads
CBL-PWR00500-FLY00	Power Cable, 5 M length, 6-pin female Hirose connector to flying leads
CBL-PWR01000-FLY00	Power Cable, 10 M length, 6-pin female Hirose connector to flying leads
CBL-PWR02000-FLY00	Power Cable, 20 M length, 6-pin female Hirose connector to flying leads

Notational Conventions

The following notational conventions make the content of this document easy to navigate.

- **Bold** text is used to highlight the following:
  - Dialog box, window, and screen names
  - Dropdown list and list box names
  - Checkbox and radio button names
  - Icons on a screen
  - Key names on a keypad
  - Button names on a screen
- Bullets (•) indicate:
  - Action items
  - List of alternatives
  - Lists of required steps that are not necessarily sequential.
- Sequential lists (for example, those that describe step-by-step procedures) appear as numbered lists.

Icon Conventions

The documentation set is designed to give the reader more visual clues. The following visual indicators are used throughout the documentation set.

NOTE: The text here indicates information that is supplemental for the user to know and that is not required to complete a task.

IMPORTANT: The text here indicates information that is important for the user to know.

CAUTION: If the precaution is not heeded, the user could receive a minor or moderate injury.

WARNING: If danger is not avoided, the user CAN be seriously injured or killed.

DANGER: If danger is not avoided, the user WILL be seriously injured or killed.

Service Information

If you have a problem with your equipment, contact Zebra Global Customer Support for your region. Contact information is available at: zebra.com/support.

When contacting support, please have the following information available:

- Serial number of the unit
- Model number or product name
- Software type and version number

Zebra responds to calls by email, telephone, or fax within the time limits set forth in support agreements.

If your problem cannot be solved by Zebra Customer Support, you may need to return your equipment for servicing and will be given specific directions. Zebra is not responsible for any damages incurred during shipment if the approved shipping container is not used. Shipping the units improperly can possibly void the warranty.

If you purchased your Zebra business product from a Zebra business partner, contact that business partner for support.

Using CaptureWorks and Design Assistant

CaptureWorks is a utility that allows users to discover, configure and test GenICam-compliant cameras. Assign IP addresses and DeviceUserID names to them. After the cameras are configured, you can confidently use Design Assistant to build a project which allocates one or more cameras. Additional modifications to the camera's settings can be made within a Design Assistant project.

Design Assistant provides the ability to create a project as a series of steps using a flowchart, capture and process images from your camera using a wide variety of processing and analysis operations, and transfer result information via several Industrial protocols such as EtherNet/IP, PROFINET, MODBUS, OPC-UA or the serial port or a TCP connection or save images locally or across the network.

The Design Assistant User Guide provides comprehensive information to configure the tool to fit your use case.

- For general information on the Design Assistant User Interface, refer to Introducing Matrox Design Assistant in Chapter 1.
- For information on building a flowchart, configuring cameras, and acquiring images, refer to Building the Flowchart in Chapter 2.
- For video training courses on using Design Assistant, refer to the Vision Academy.
- For the latest information on using Design Assistant, refer to the Design Assistant User Guide.
- For the latest CaptureWorks documentation, refer to the CaptureWorks User Guide.

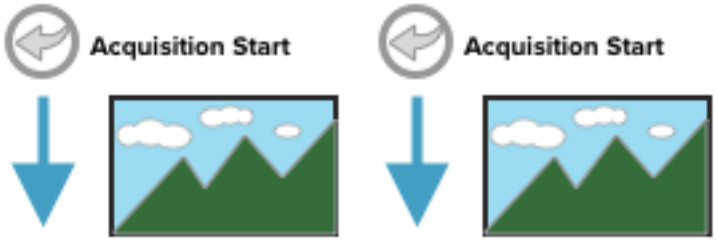
Main Functions

Acquisition Control

The camera has three Acquisition modes **(SingleFrame**, **MultiFrame,** and **Continuous).** Configure the **AcquisitionControl** settings to perform operations for image capture.

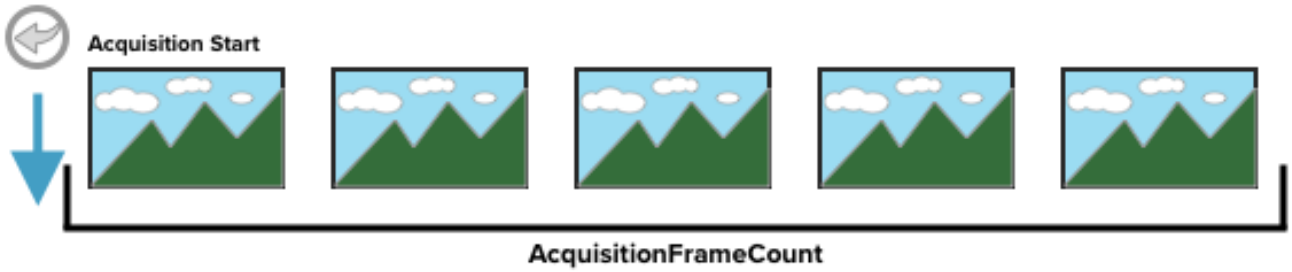
- **SingleFrame** - acquires a single image frame when the **AcquisitionStart** command is executed.

  Figure 1 SingleFrame



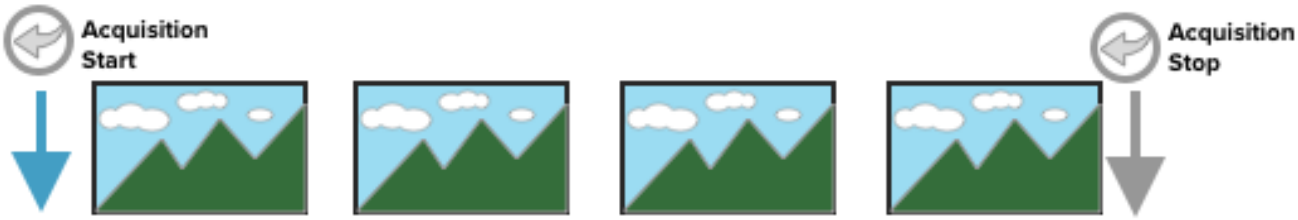
- **MultiFrame** - acquires image frames based on the number of frames set in **AcquisitonFrameCount** when the **AcquisitionStart** command is executed.

  Figure 2 MultiFrame



- **Continuous** - image frame acquisition continues until the **AcquisitionStop** command is executed after the **AcquisitionStart** command is executed.

Figure 3 Continuous



Exposure Mode

This camera has three Exposure modes (**Off**, **Timed**, and **TriggerWidth**). Use the **AcquisitionControl** settings to perform operations and settings for exposure.

- ExposureMode = Off
  - When **ExposureMode** is **Off**, exposure control is not performed (free-running operation). The exposure time is the longest possible time within the operating conditions, such as the frame rate.
- ExposureMode = Timed
  - When **ExposureMode** is **Timed**, exposure control is performed using exposure time. Acquire images using an exposure time configured beforehand on an external trigger. In this mode, the exposure time is adjusted automatically by setting **ExposureAuto**.
- ExposureMode = TriggerWidth
  - When **ExposureMode** is set to **TriggerWidth**, the exposure time control is performed using the pulse width of the trigger input signal. The exposure time is equal to the pulse width of the trigger input signal.

Figure 4 Exposure Mode

NOTE: The settings for exposure control and triggers are related to each other. Configure the settings as described in Trigger Control.

Trigger Control

Perform the following controls using external trigger signals.

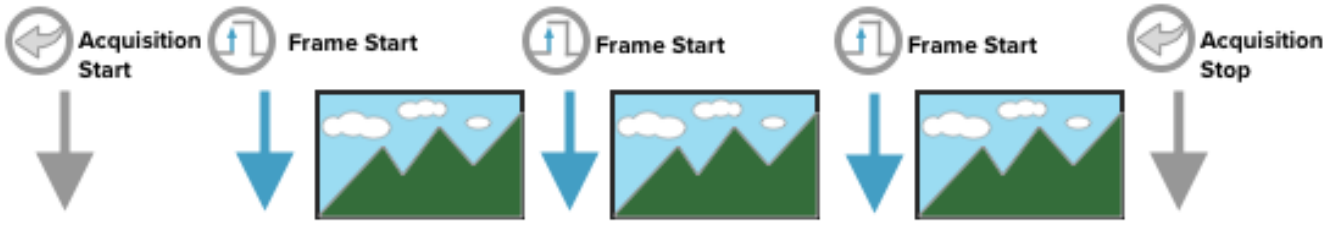
Table 3 TriggerSelector Descriptions

TriggerSelector	Description
AcquisitionStart	Start image acquisition in response to the external trigger signal event.
AcquisitionEnd	Stop image acquisition in response to the external trigger signal event.
FrameStart	Start exposure and frame capture in response to the external trigger signal input. Use **ExposureMode** set to **TriggerWidth** to perform exposure time control using external triggers width
AcquisitionTransferStart	Start the output of acquired image data in response to external trigger signal input (delayed readout).

NOTE: Enable a trigger delay when exposure starts after a trigger is received by a specified duration of time by configuring **TriggerDelay**.

Select the trigger type with **TriggerSelector**, and set the following items for each trigger:

- TriggerMode - Switch to enable or disable.
- TriggerSource - Select the source signal:
  - PulseGenerator0
  - UserOutput0
  - UserOutput1, UserOutput2, UserOutput3, Software, Line5, Nand0Out, Nand1Out
    - Executed by the **TriggerSoftware[TriggerSelector]** command only when the software is configured.
- TriggerActivation - Sets the polarity of the trigger signal.
- TriggerDelay - Specify a delay after receiving the trigger signal until the trigger is enabled.



Pixel Format

The camera supports the following pixel formats:

- Color model: BayerRG8, BayerRG10, BayerRG10Packed, BayerRG12, BayerRG12Packed

- Monochrome model: Mono8, Mono10, Mono10Packed, Mono12, Mono12Packed

NOTE: In the color model, the image flip function changes the Bayer array.

- ReverseX: 0 (False) ReverseY: 0 (False) -> BayerRG
- ReverseX: 0 (False) ReverseY: 1 (True) -> BayerGB
- ReverseX: 1 (True) ReverseY: 0 (False) -> BayerGR
- ReverseX: 1 (True) ReverseY: 1 (True) -> BayerBG

Image Flip Function

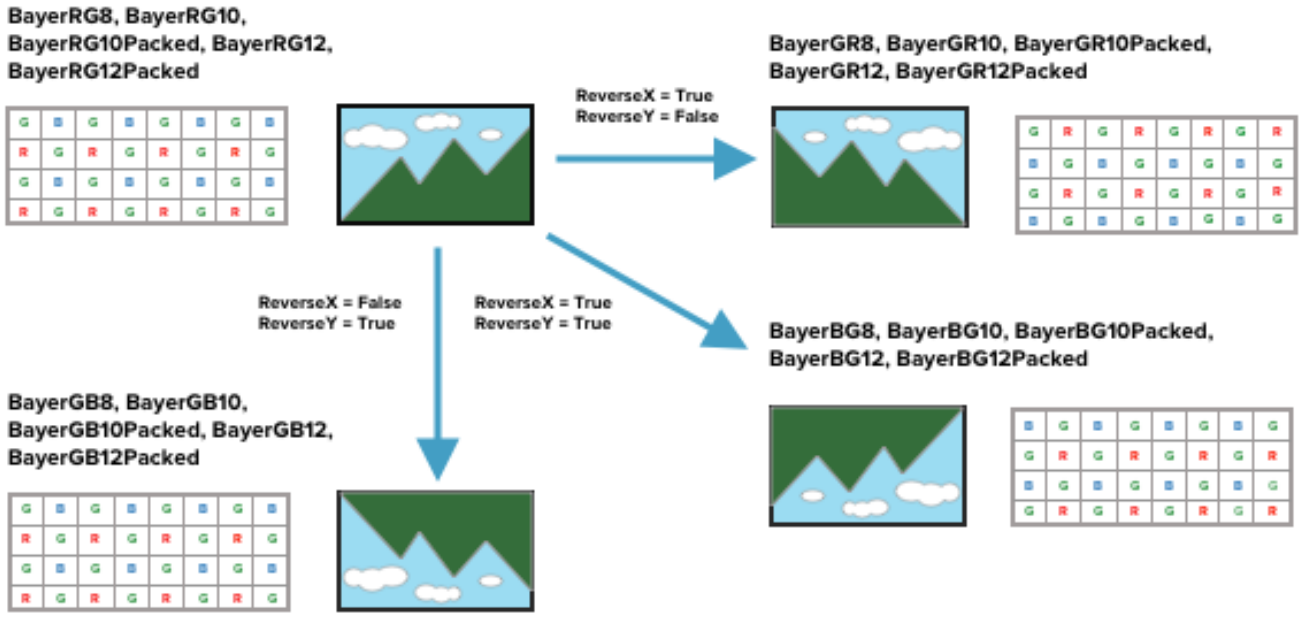
Output the image by inverting it horizontally or vertically using the Image Flip function.

To reverse the image horizontally, set **ReverseX** to **True** in the **ImageFormatControl** settings.

To reverse the image vertically, set **ReverseY** to **True**.

In the color model of the camera, the image flip function changes the Bayer array.

Figure 5 Image Flip



GPIO

Configure the input/output signals for the external input/output connectors.

External Output	Line 2: Opt Out	DC IN/TRIG IN connector (6-pin round)
External Input	Line 5: Opt In	DC IN/TRIG IN connector (6-pin round)

These signals can be used as triggers and other necessary signals within the camera or as signals output from the camera to the system, such as those used for lighting equipment control.

Select an input or output in **LineSelector**. Next, review **LineMode** and **LineFormat** to set [LineInverter].

Monitor the status of each digital I/O as shown in the table with **LineStatusAll**.

LineSelector	LineMode	LineFormat	LineInverter	LineStatusAll	
Line2	Output	OptoCoupled	True/False	bit1	DC IN / TRIG IN connector (6-pin round)
Line5	Input	OptoCoupled	False (fixed)	bit4	DC IN / TRIG IN connector (6-pin round)
Nand0In1	Input	InternalSignal	True/False		
Nand0In2	Input	InternalSignal	True/False		
Nand1In1	Input	InternalSignal	True/False		
Nand1In2	Input	InternalSignal	True/False		
TimestampReset	Internal Connection	InternalSignal	False (fixed)		

Set the output source signal using **LineSource** when configuring digital output. Next, set the source signal for NAND Logic (Nand0In1, Nand0In2, Nand1In1, NandIn2) and **TimestampReset**.

Video Process Bypass Mode

The video process bypass mode is a function that bypasses internal video processing on the camera. The sensor output and camera output data can be set to the same bit depth when video process bypass mode is enabled.

NOTE: Only 12-bit outputs can be performed in video process bypass mode.

NOTE: AnalogGain and **BlemishCompensation** are available in video process bypass mode.

Calculating the Maximum Frame Rate

This section describes how to calculate an approximate maximum frame rate. The maximum frame rate depends on the sensor's scanning range and the GigE bandwidth.

The maximum frame rate (GigE bandwidth): Interface_FR[Hz] = BandwidthPerPixelFormat x 1000000 ÷ (Width x Height)*)

NOTE: When using the Binning function, specify the number of pixels and the number of lines after binning for the width and height values.

The maximum frame rate (sensor scanning rate): Sensor_FR[Hz] = 1000000 ÷ (H_Period x (Height-S + InvalidLine))

H_Period = MAX(HMAX_Period, HMAX_Width) HMAX_Width = (PixelSizeCount / 111375) x Width-S

NOTE: For the values of width-S and height-S, specify the number of pixels read by the sensor and the number of lines (the number of pixels and the number of lines before binning).

NOTE: When using the CV60-AS02MG, 2x2 binning is processed on the image sensor. As a result, the maximum sensor frame rate can be increased. In this case, for the values of width-S and height-S, specify the number of pixels and the number of lines after binning.

Refer to the following table for **PixelSizeCount**, **BandwidthPerPixelFormat**, **HMAX_Period**, and **InvalidLine**.

Pixelformat	PixelSizeCount	BandwidthPerPixelFormat
Mono8	594	115
Bayer8		
Mono10Packed	891	76.6
Bayer10Packed		
Mono12Packed		
Bayer12Packed		
Mono1	1188	57.5
Mono12		
Bayer10		
Bayer12		

Model Name	HMAX_Period	InvalidLine
CV60-AS02MG	10.586[1]	22
CV60-AS02CG		
CV60-AS05MG	13.415	34
CV60-AS05CG		
CV60-AS09MG	21.738	36
CV60-AS09CG		
CV60-AS12MG	21.738	36
CV60-AS12CG		

During Continuous operation (**FrameStart** trigger is **Off**)

- FR_Cont[Hz] = MIN(Interface_FR, Sensor_FR)

When **TriggerMode** is **On** (**FrameStart** trigger is **On**)

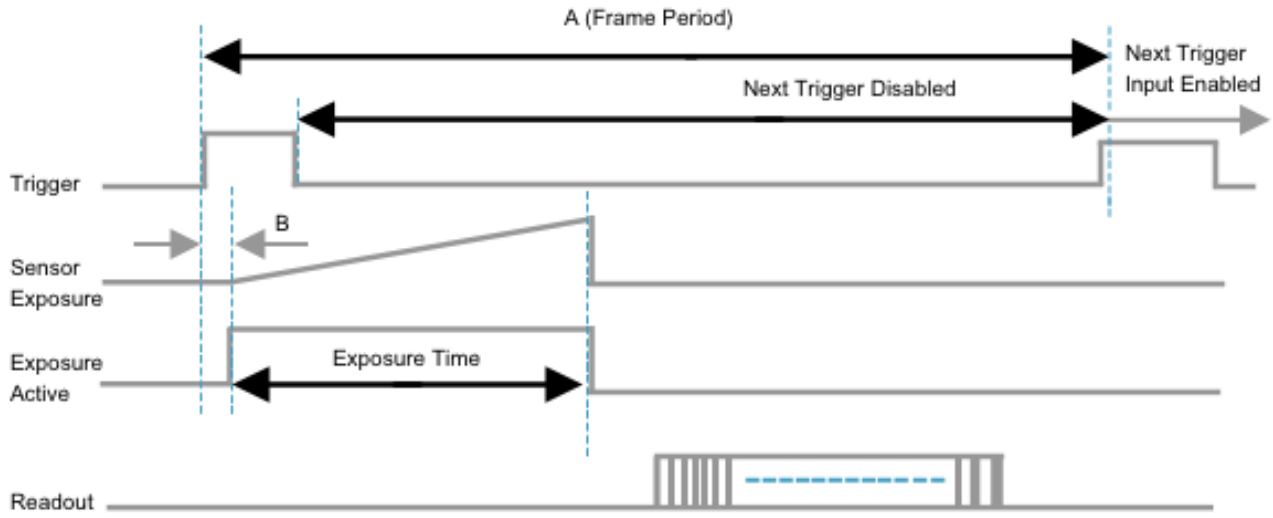
- Calculate the maximum **OverlapTime** value for the shortest trigger cycle: MaxOverlapTime_TrOlrd[us] = (1000000/FR_Cont) - (14 x H_period)
  - When **ExposureTime** is less than or equal to MaxOverlapTime_TrOlrd:
    - FR_TrOlrd[Hz] = FR_Cont (Same as during Continuous operation)
  - When **ExposureTime** is greater than MaxOverlapTime_TrOlrd:
    - Non-OverlapExposureTime_TrOlrd = ExposureTime - MaxOverlapTime_TrOlrd
    - FR_TrOlrd[Hz] = 1000000/{ (1000000/FR_Cont) + Non-OverlapExposureTime_TrOlrd }

Timing Charts

The following diagrams describe the trigger behavior of the camera while specific functions are enabled.

CV60-AS02MC Timing Diagram

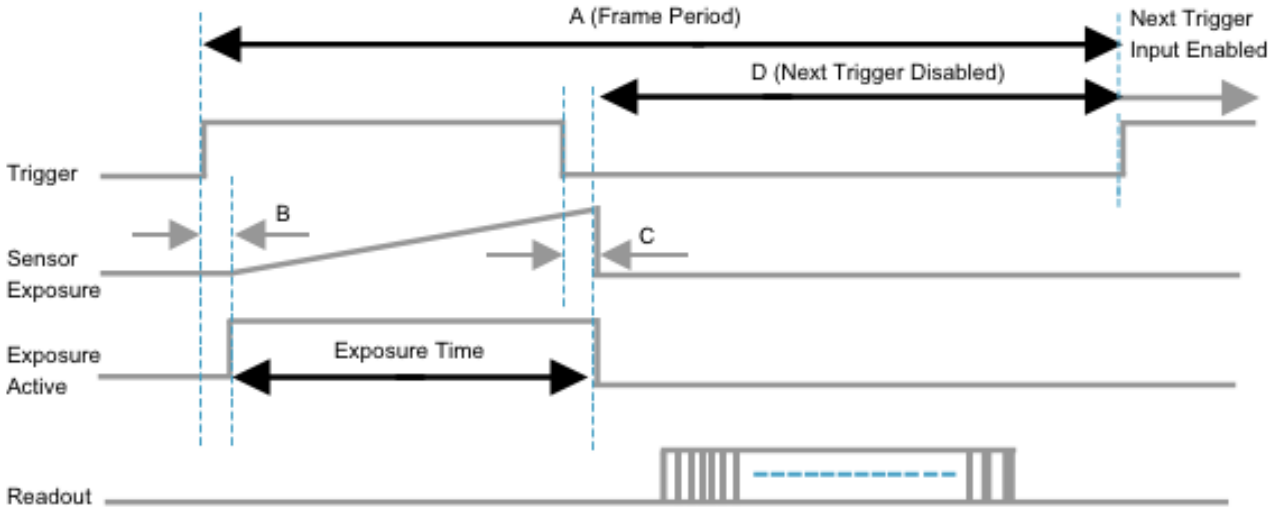
The following diagram outlines triggering behavior when **ExposureMode** is set to **TriggerTimed** and the **FrameStart** trigger is **On**.



PixelFormat	Frame Period [A] (usec)	Time Between Trigger Start and Exposure Start [B] usec
Binning Off		
Mono8	20,080	32.8
Mono10/Mono12	40,161	62.5
Mono10Packed/Mono12Packed	30,121	62.5
Bayer8	20,080	32.8
Bayer10/Bayer12	40,161	62.5
Bayer10Packed/Bayer12Packed	30,121	62.5
Horizontal Binning On		
Mono8	13,038	32.8
Mono10	25,189	62.5
Mono10Packed	25,189	62.5
Vertical Binning On		
Mono8	13,038	32.8
Mono10	25,189	62.5
Mono10Packed	25,189	62.5

PixelFormat	Frame Period [A] (usec)	Time Between Trigger Start and Exposure Start [B] usec
Horizontal and Vertical Binning On		
Mono8	5,015	19
Mono10	10,030	31.8
Mono10Packed	7,519	31.8

The following diagram outlines triggering behavior when **ExposureMode** is set to **TriggerWidth** and the **FrameStart** trigger is **Enabled**.

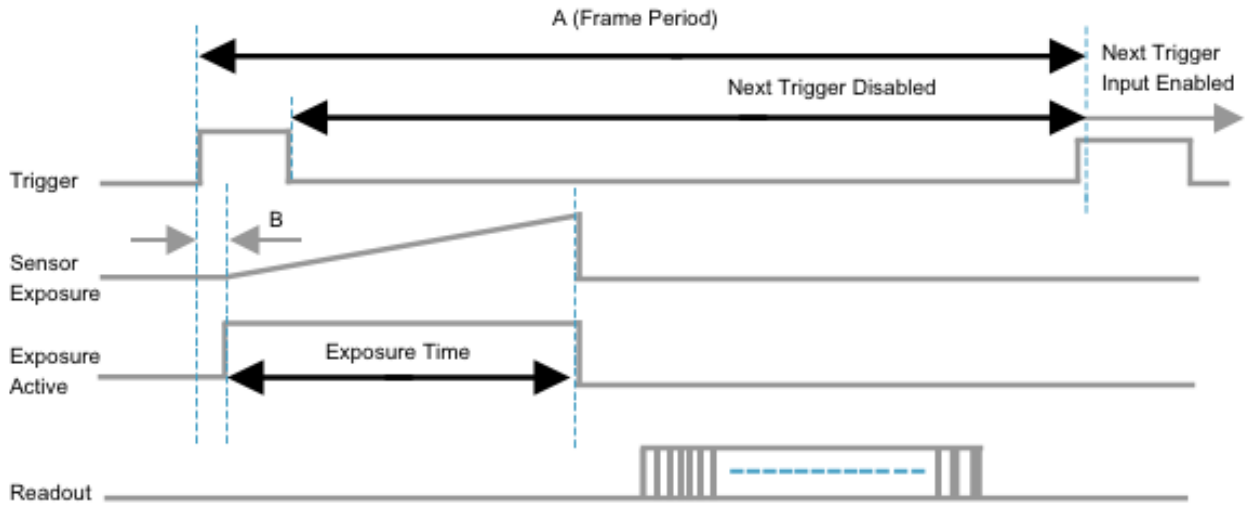


PixelFormat	FramePeriod [A] (usec)	Time Between Trigger Start and Exposure Start [B] usec	Time Between Trigger End and Exposure End [C] usec	Time From Exposure End to Next Trigger [D] usec
Binning Off				
Mono8	17,857	35.2	35.2	35.3
Mono10/Mono12	34,247	66.5	66.5	66.7
Mono10Packed/ Mono12Packed	34,247	66.5	66.5	66.7
Bayer8	17,857	35.2	35.2	35.3
Bayer10/Bayer12	34,247	66.5	66.5	66.7
Bayer10Packed/ Bayer12Packed	34,247	66.5	66.5	66.7
Horizontal Binning On				
Mono8	17,857	35.2	35.2	35.4
Mono10	34,247	66.5	66.5	66.7
Mono10Packed	34,247	66.5	66.5	66.7
Vertical Binning On				

PixelFormat	FramePeriod [A] (usec)	Time Between Trigger Start and Exposure Start [B] usec	Time Between Trigger End and Exposure End [C] usec	Time From Exposure End to Next Trigger [D] usec
Mono8	17,857	35.2	35.2	35.3
Mono10	34,247	66.5	66.5	66.8
Mono10Packed	34,247	66.5	66.5	66.8
Horizontal and Vertical Binning On				
Mono8	17,857	35.2	35.2	35.3
Mono10	34,247	66.5	66.5	66.7
Mono10Packed	34,247	66.5	66.5	66.8

CV60-AS05MC Timing Diagrams

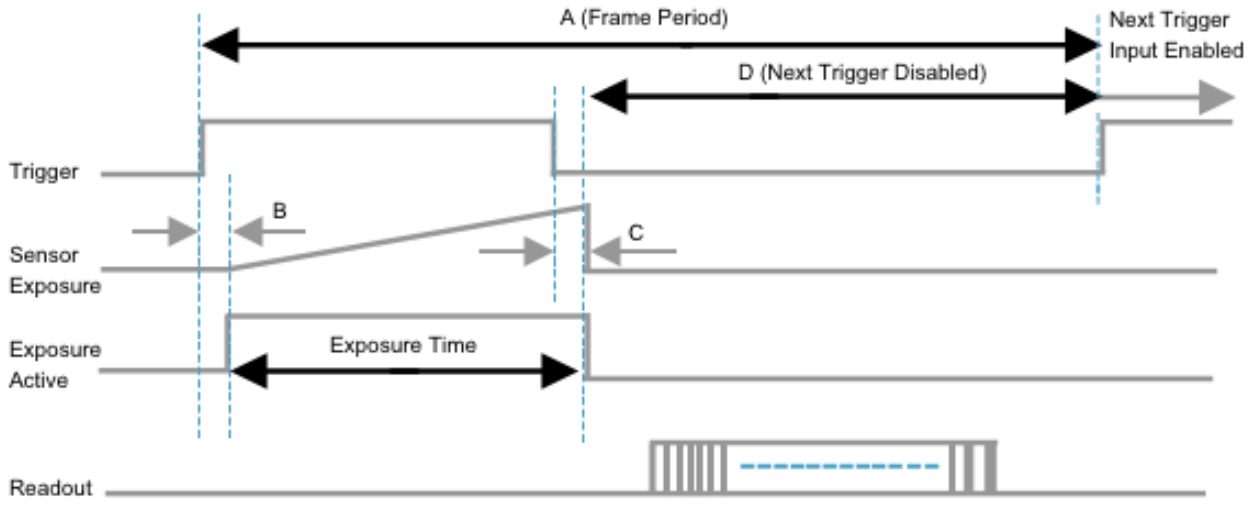
The diagram below outlines triggering behavior when **ExposureMode** is set to **TriggerTimed** while the **FrameStart** trigger is **On**.



PixelFormat	Frame Period [A] (usec)	Time Between Trigger Start and Exposure Start [B] usec
Binning Off		
Mono8	43,669	41.2
Mono10/Mono12	87,720	79.2
Mono10Packed/Mono12Packed	65,790	79.4
Bayer8	43,669	41.2
Bayer10/Bayer12	87,720	79.2
Bayer10Packed/Bayer12Packed	65,790	79.4
Horizontal Binning On		

PixelFormat	Frame Period [A] (usec)	Time Between Trigger Start and Exposure Start [B] usec
Mono8	27,933	41.3
Mono10	54,054	78.9
Mono10Packed	54,054	78.9
Vertical Binning On		
Mono8	27,933	41.3
Mono10	54,348	79.4
Mono10Packed	54,348	79.4
Horizontal and Vertical Binning On		
Mono8	27,933	41.3
Mono10	54,054	78.9
Mono10Packed	54,054	78.9

The diagram below outlines triggering behavior when **ExposureMode** is set to **TriggerWidth** while the **FrameStart** trigger is **On**.

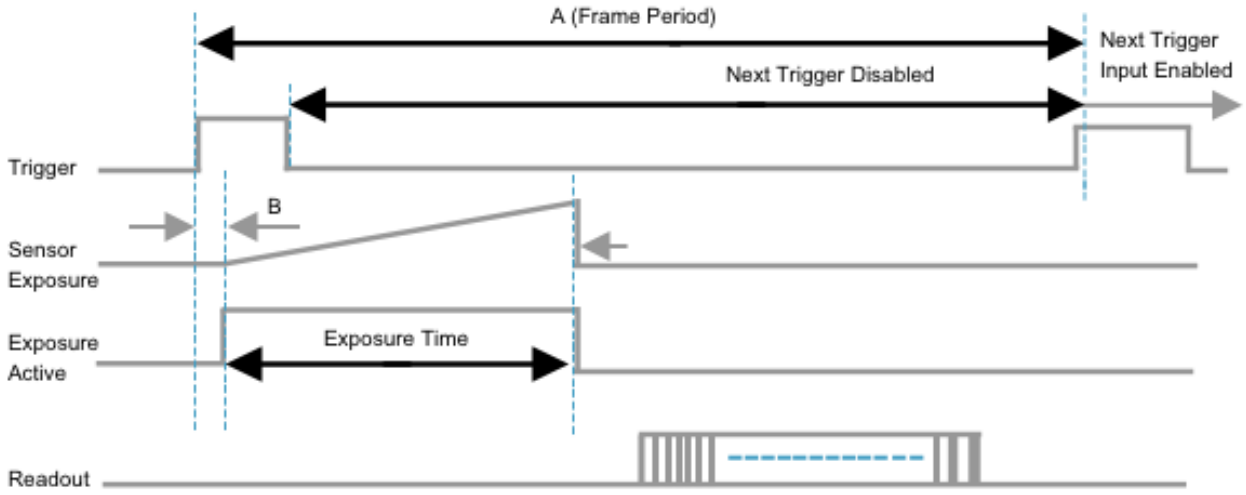


PixelFormat	FramePeriod [A] (usec)	Time Between Trigger Start and Exposure Start [B] usec	Time Between Trigger End and Exposure End [C] usec	Time From Exposure End to Next Trigger [D] usec
Binning Off				
Mono8	27,855	41.2	41.2	150
Mono10/Mono12	54,348	79.3	79.3	290
Mono10Packed/ Mono12Packed	54,348	79.3	79.3	290
Bayer8	27,855	41.2	41.2	150
Bayer10/Bayer12	54,348	79.3	79.3	290

PixelFormat	FramePeriod [A] (usec)	Time Between Trigger Start and Exposure Start [B] usec	Time Between Trigger End and Exposure End [C] usec	Time From Exposure End to Next Trigger [D] usec
Bayer10Packed/ Bayer12Packed	54,348	79.3	79.3	290
Horizontal Binning On				
Mono8	27,855	41.2	41.2	150
Mono10	54,348	79.3	79.3	290
Mono10Packed	54,348	79.4	79.4	290
Vertical Binning On				
Mono8	27,855	41.2	41.2	150
Mono10	54,348	79.3	79.3	290
Mono10Packed	54,348	79.4	79.4	290
Horizontal and Vertical Binning On				
Mono8	27,855	41.2	41.2	150
Mono10	54,054	78.9	78.9	290
Mono10Packed	54,054	78.9	78.9	290

CV60-AS09MC Timing Diagrams

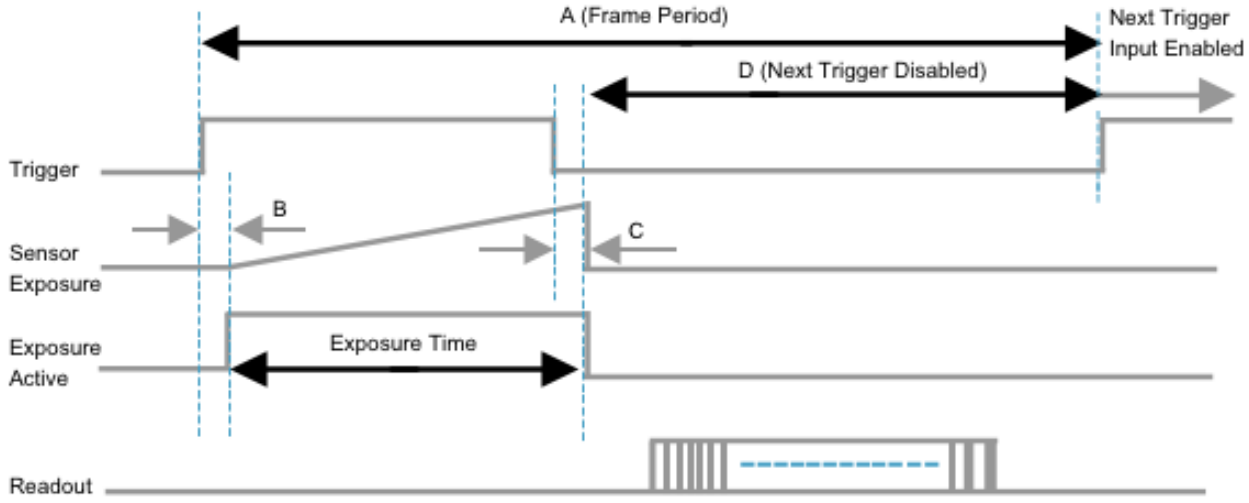
The following diagram outlines triggering behavior when **ExposureMode** is set to **TriggerTimed** and the **FrameStart** trigger is **On**.



PixelFormat	Frame Period [A] (usec)	Time Between Trigger Start and Exposure Start [B] usec
Binning Off		
Mono8	77,520	66.2

PixelFormat	Frame Period [A] (usec)	Time Between Trigger Start and Exposure Start [B] usec
Mono10/Mono12	156,251	132
Mono10Packed/Mono12Packed	116,280	132.1
Bayer8	77,520	66.2
Bayer10/Bayer12	156,251	132
Bayer10Packed/Bayer12Packed	116,280	132.1
Horizontal Binning On		
Mono8	47,847	66.3
Mono10	96,154	132.1
Mono10Packed	96,154	132.1
Vertical Binning On		
Mono8	47,847	66.3
Mono14	96,155	132.1
Mono10Packed	96,155	132.1
Horizontal and Vertical Binning On		
Mono8	47,847	66.3
Mono10	96,155	132.1
Mono10Packed	96,155	132.1

The following diagram outlines triggering behavior when **ExposureMode** is set to **TriggerWidth** and the **FrameStart** trigger is **Enabled**.

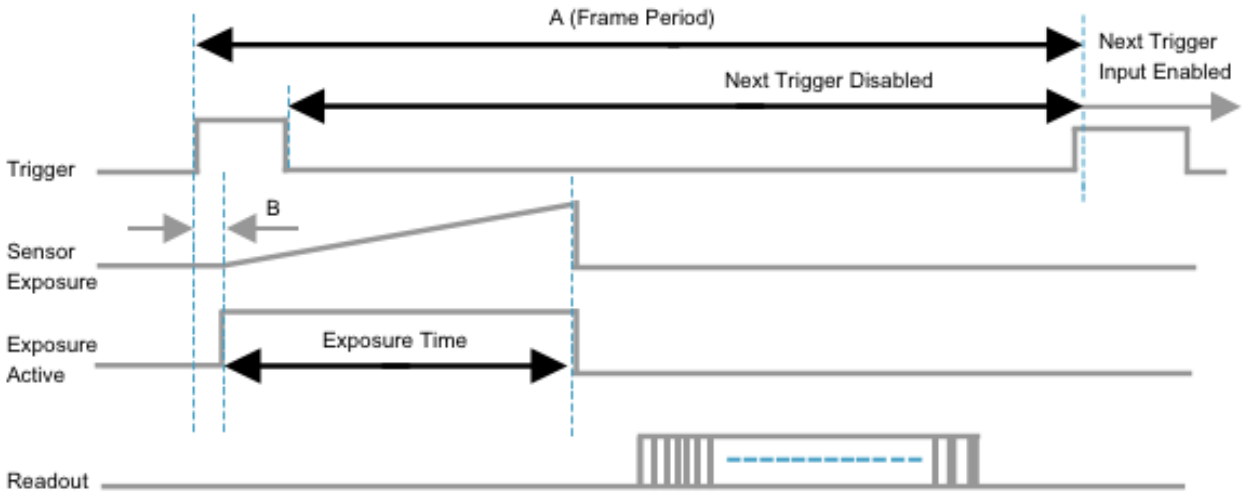


PixelFormat	FramePeriod [A] (usec)	Time Between Trigger Start and Exposure Start [B] usec	Time Between Trigger End and Exposure End [C] usec	Time From Exposure End to Next Trigger [D] usec
Binning Off				

PixelFormat	FramePeriod [A] (usec)	Time Between Trigger Start and Exposure Start [B] usec	Time Between Trigger End and Exposure End [C] usec	Time From Exposure End to Next Trigger [D] usec
Mono8	47,619	66	66	240
Mono10/Mono12	96,154	132.1	132.1	484
Mono10Packed/ Mono12Packed	96,154	132.1	132.1	484
Bayer8	47,619	66	66	240
Bayer10/Bayer12	96,154	132.1	132.1	484
Bayer10Packed/ Bayer12Packed	96,154	132.1	132.1	484
Horizontal Binning On				
Mono8	47,619	66	66	240
Mono10	96,154	132.1	132.1	484
Mono10Packed	96,154	132.1	132.1	484
Vertical Binning On				
Mono8	47,619	66	66	240
Mono10	96,155	132.1	132.1	484
Mono10Packed	96,155	132.1	132.1	484
Horizontal and Vertical Binning On				
Mono8	47,619	66.2	66.2	240
Mono10	96,154	132.1	132.1	484
Mono10Packed	96,154	132.1	132.1	484

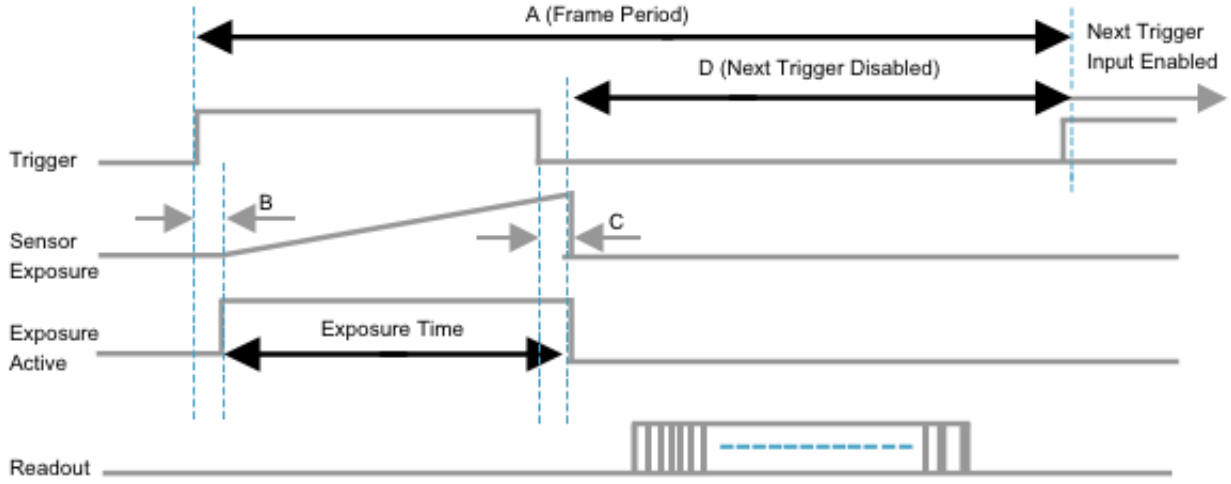
CV60-AS12MC Timing Diagrams

The following diagram outlines triggering behavior when **ExposureMode** is set to **TriggerTimed** and **FrameStart** trigger is **On**.



PixelFormat	Frame Period [A] (usec)	Time Between Trigger Start and Exposure Start [B] usec
Binning Off		
Mono8	107,528	66.1
Mono10/Mono12	217,393	132
Mono10Packed/Mono12Packed	161,291	132
Bayer8	107,528	66.1
Bayer10/Bayer12	217,393	132
Bayer10Packed/Bayer12Packed	161,291	132
Horizontal Binning On		
Mono8	66,226	66.3
Mono10	133,334	132.1
Mono10Packed	133,334	132.1
Vertical Binning On		
Mono8	66,226	66.3
Mono10	133,334	132.1
Mono10Packed	133,334	132.1
Horizontal and Vertical Binning On		
Mono8	66,226	66.3
Mono10	133,334	132.1
Mono10Packed	133,334	132.1

The following diagram outlines triggering behavior when **ExposureMode** is set to **TriggerWidth** and the **FrameStart** trigger is **On**.



PixelFormat	FramePeriod [A] (usec)	Time Between Trigger Start and Exposure Start [B] usec	Time Between Trigger End and Exposure End [C] usec	Time From Exposure End to Next Trigger [D] usec
Binning Off				
Mono8	66,226	66.2	66.2	240.6
Mono10/Mono12	133,334	132.1	132.1	482.8
Mono10Packed/ Mono12Packed	133,334	132.1	132.1	482.8
Bayer8	66,226	66.2	66.2	240.6
Bayer10/Bayer12	133,334	132.1	132.1	482.8
Bayer10Packed/ Bayer12Packed	133,334	132.1	132.1	482.8
Horizontal Binning On				
Mono8	66,226	66.3	66.3	240.6
Mono10	133,334	132.1	132.1	482.8
Mono10Packed	133,334	132.1	132.1	482.8
Vertical Binning On				
Mono8	66,226	66.2	66.2	240.6
Mono10	133,334	132.1	132.1	482.8
Mono10Packed	133,334	132.1	132.1	482.8
Horizontal and Vertical Binning On				
Mono8	66,226	66.2	66.2	240.6
Mono10	133,334	132.1	132.1	482.8
Mono10Packed	133,334	132.1	132.1	482.8

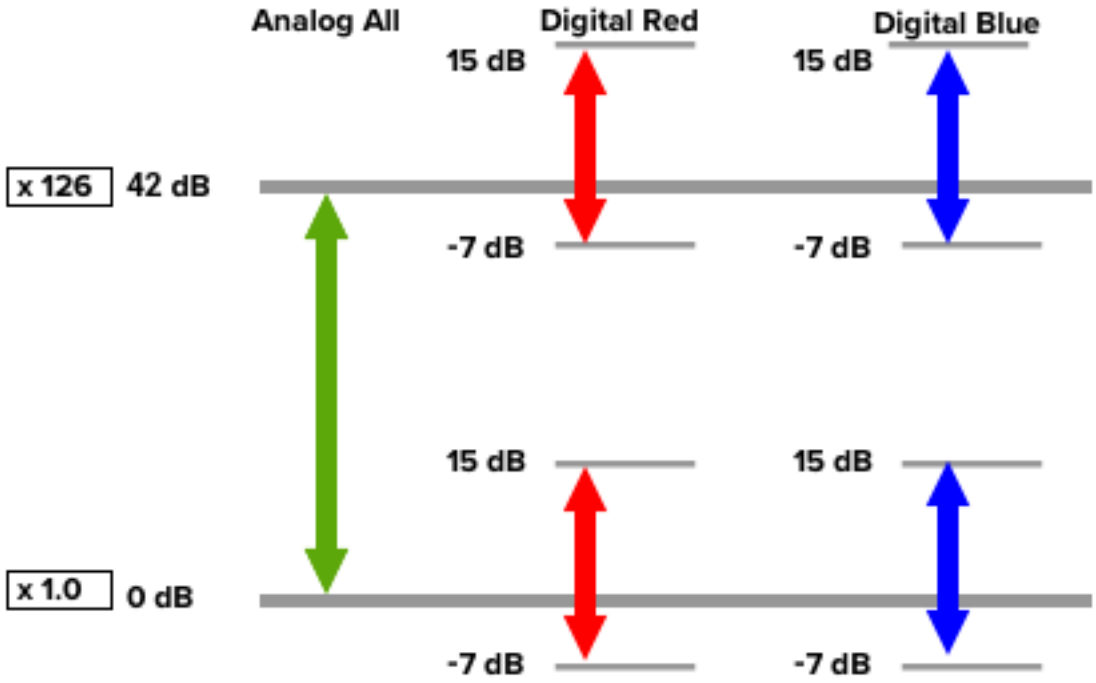
Gain Control

Adjust the **AnalogAll** (master gain) setting, then adjust the **AnalogRed** and **DigitalRed** settings.

Color Camera Gain Control

The following diagram outlines gain control for color cameras.

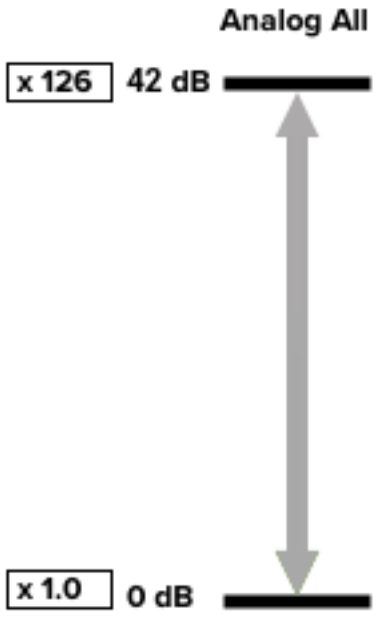
Figure 6 Gain Control for Color Cameras



Monochrome Camera Gain Control

The following figure displays gain control for monochrome cameras.

Figure 7 Gain Control for Monochrome Models



White Balance

To adjust the white balance automatically, set **BalanceWhiteAuto** to **Once** (automatic adjustment) or **Continuous**. The metering area is configurable for automatic adjustment. To restrict the metering area, specify each of the 16 areas with **AWBAreaSelector** and set **AWBAreaEnable** to **True** or **False**.

HighLeft	HighMidLeft	HighMidRight	HighRight
MidHighLeft	MidHighMidLeft	MidHighMidRight	MidHighRight
MidLowLeft	MidLowMidLeft	MidLowMidRight	MidLowRight
LowLeft	LowMidLeft	LowMidRight	LowRight

NOTE: The white balance is adjusted for specific color temperature lighting.

Select one of the following presets:

- 3200K
- 5000K
- 6500K
- 7500K

Automatic Level Control

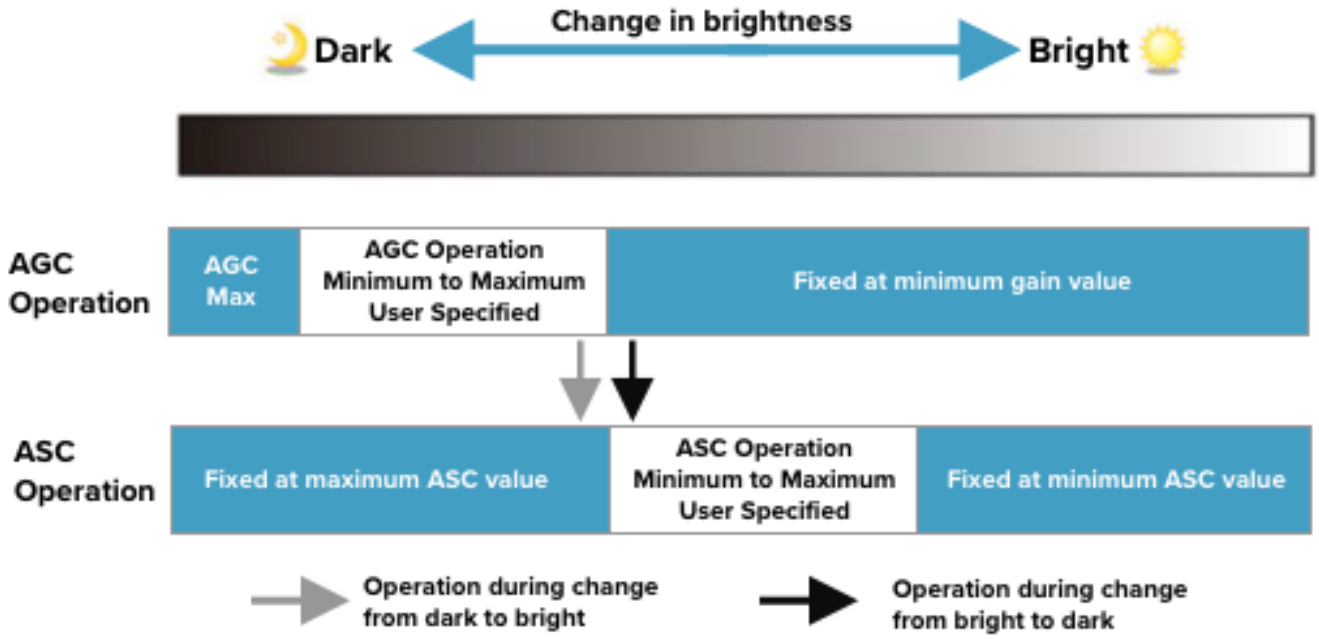
The Automatic Level Control (ALC) function combines the Automatic Gain Control (AGC) and Automatic Shutter Control (ASC) functions to handle deviations in brightness.

The following graphic displays how Automatic Level Control operates in response to brightness deviations:

To change from bright to dark: ASC ➔ AGC

To change from dark to bright: AGC ➔ ASC

Figure 8 Automatic Level Control



To use the ALC function:

1. Set **GainAuto** or **ExposureAuto** to **Continuous**.
2. Configure the minimum and maximum values for AGC and ASC under **ZebraCustomControlALC**.
3. Configure the target video levels for AGC and ASC in **ALCReference**. For example, when **ALCReference** is set to 95%, video levels are maintained at 95% using AGC and ASC.

In color models, set a channel to serve as a reference for the ALC using **ALCControlReference**. Next, select whether to specify the **SelectedChannel** to channel (R, G, B) or **PeakChannel** to the channel with the highest average image level.

NOTE: If **ALCControlReference** is equal to **SelectedChannel**, set **ALCControlChannel** to **Red**, **Green**, or **Blue**.

Set the speed of ALC control from 1 to 100 (fastest) in **ALCControlRatio**.

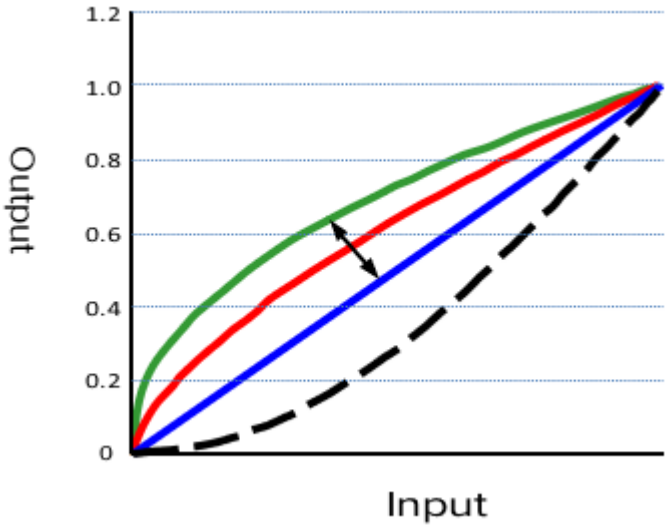
- If the **ALCControlRatio** setting is large, the ALC operation may cause hunting depending on the **AcquisitionFrameRate** setting. In this case, lower the **AcquisitionFrameRate** or **ALCControlRatio**.

Gamma Function

The Gamma function corrects the output signals from the camera beforehand (reverse correction), considering the monitor display's light-emitting properties. As the light-emitting properties of the monitor are not linear, the entire image may be darker, or the gradation in the dark areas may be less noticeable when the camera outputs are displayed without processing.

The Gamma function can correct the camera signals with an opposite-direction curve and produce a display close to linear.

The following graph displays the light-emitting properties of the monitor display.



To use the gamma function, configure the settings in the following table:

Item	Setting Value/Selected Range	Description
Gamma	0.45, 0.5, 0.55, 0.6, 0.65, 0.75, 0.8, 0.9, 1.0	Select the gamma correction value.
LUTMode	Gamma	Use Gamma

NOTE: Use the LookUp Table function to configure a curve with more detailed points.

Lookup Table

The Lookup Table (LUT) function generates a non-linear mapping between signal values captured on the sensor and those output from the camera.

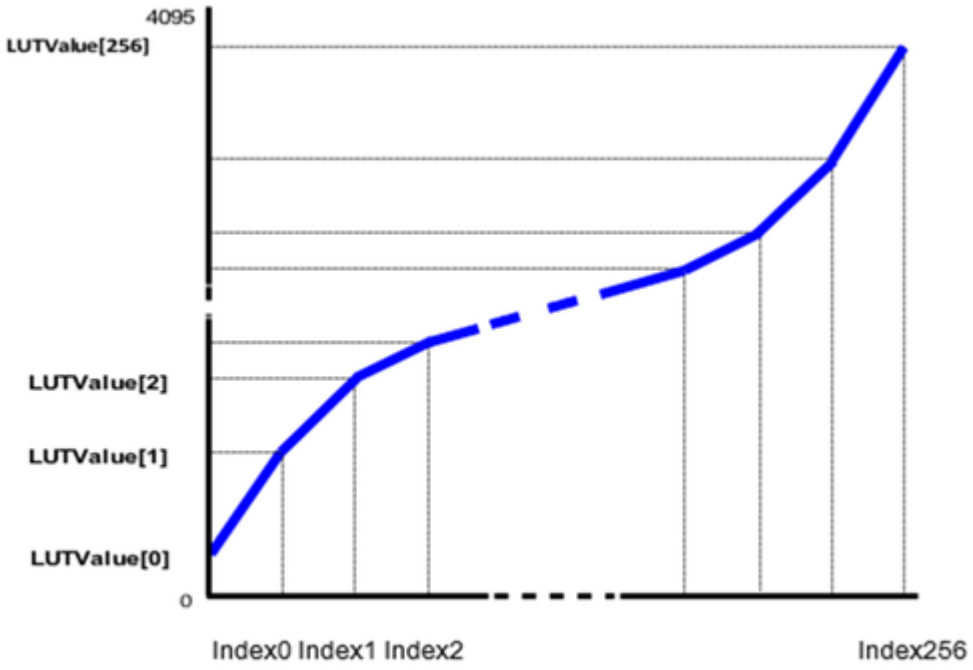
Specify the output curve using 257 setting points (indexes).

Configure the settings in the following table to use the Lookup Table function.

Item	Setting Value/ Selectable Range	Description
LUTMode	LUT	Use LUT.

Item	Setting Value/ Selectable Range	Description
LUTSelector	Red, Green, Blue	Select the LUT channel to control.
LUTIndex	0-256	Select the LUT index to configure. Indexes represent the possible pixel values captured on the sensor, from the lowest value (Index 0) to the highest (Index 256). For example, Index 0 represents a full black pixel, and Index 256 represents a full white pixel.
LUTValue	0-4095	Set the LUT output value for the selected index.

LUT values range from 0 to 4095. Linear interpolation is used to calculate LUT values between the index points.



NOTE: Values between points are determined using the linear interpolation values of data to the left and right.

Blemish Compensation

Multiple defective pixels that are not adjacent to each other can occur on conventional CMOS sensor cameras.

This camera interpolates defective pixels using the surrounding pixels. Up to 256 pixels can be corrected. Pixel interpolation is performed using automatic detection or point-by-point manual settings.

Automatic Detection

Automatic Detection identifies lit defective pixels (for example, white blemishes).

To use Automatic Detection to identify defective pixels:

1. Shield the camera sensor. If a lens is attached, use the lens cap as a shield.
2. Configure the threshold level for defective pixel detection. Up to 256 pixels can be corrected. The threshold value is specified as a percentage. The default setting is 10, with 10% of the full scale (100%) defined as the threshold value.
3. Execute **BlemishDetect** to start automatic detection. After detection, the interpolation data is saved to the camera's internal memory.

NOTE: Review the number of pixels interpolated using Automatic Detection by loading the **BlemishNum** data.

Manual Configuration

1. Select the index in **BlemishCompensationIndex** from 1 to 256.

NOTE: Arrange the indexes in order starting with the smallest index. If you skip indexes while configuring settings, interpolation may not be performed.

2. Specify the pixel points for interpolation using the **BlemishCompensationPositionX** and **BlemishCompensationPositionY** settings.

NOTE: Using **BlemishCompensationDataClear** [BlemishCompensationIndex], return a specific pixel correction setting to the default value (storage is not required).

3. Configure the values within the total effective pixel area and specify the pixels that do not require interpolation when -1 is specified. If 0 is set, the first line or first pixel is not interpolated.
4. Execute **BlemishStore**.

NOTE: Blemish compensation data is not stored.

5. Set **BlemishEnable** to **True** and execute interpolation.

NOTE: Blemish compensation is not effective when set to false.

Shading Correction

The **ShadingCorrection** function corrects non-uniformity (for example, shading) in the light generated by the lens and lighting equipment. This function makes corrections when the top, bottom, and left areas do not have proper shading and are not symmetrical in relation to the center of the screen (horizontal and vertical).

This function is helpful when the effective image area (with width and height set to more than 128) is limited by the ROI function. In such cases, the ROI configures the correction area in the image. The block size is 256 x 256 pixels.

NOTE: The number of blocks and pixels that form each block differ from an entire image when using the ROI function.

The following shading correction modes are available on the camera:

- **FlatShading** (monochrome and color models): Correction is performed using the area of the screen with the highest brightness level as the reference and adjusting the brightness levels of the other areas to match this level.
- **ColorShading** (color models only): R-channel and B-channel properties are adjusted using the G-channel shading properties as a reference.

NOTE: For **FlatShading** and **ColorShading**, the maximum correction gain for all pixels equals eight times the gain before correction. If the area in the screen with the highest brightness level is 175 LSB or less (during 10-bit video output), proper correction is not possible.

When using the **ShadingCorrection** function, configure the settings as outlined in the following table:

Item	Setting Value	Description
ShadingCorrectionMode	FlatShading, ColorShading	Select the shading correction mode.
ShadingMode	User1, User2, User 3, Off	Select the user area to save the shading correction value to.

To display a white chart under a uniform light, execute the **PerformShadingCalibration** function.

NOTE: After executing the **ShadingCorrection** function, the shading correction value is automatically saved to the user area selected in **ShadingMode**.

Binning Function

Use the Binning function to combine the signal values of clusters of adjacent pixels to create improved virtual pixels. Using the function results in images with a lower pixel resolution and higher sensitivity.

NOTE: The Binning function is available for monochrome models only.

NOTE: When using the CV60-AS02MG, 2x2 binning is processed in the image sensor.

Model	Horizontal Binning	Vertical Binning
CV60-AS02MG	Digital addition or averaging processing.	Digital addition or averaging processing.
CV60-AS05MG	Digital addition or averaging processing.	Digital addition or averaging processing.
CV60-AS09MG	Digital addition or averaging processing.	Digital addition or averaging processing.
CV60-AS12MG	Digital addition or averaging processing.	Digital addition or averaging processing.

NOTE: BlemishDetect is not available when the Binning function is active.

Decimation Mode

Decimation mode performs downsampling of the image horizontally, vertically, or both. This reduces the file size for processing or storage while maintaining the entire image field of view. Set **DecimationHorizontal**, **DecimationVertical** in **PixelFormatControl**.

NOTE: Decimation mode cannot be used with binning or ROI.

NOTE: BlemishDetect is not available when Decimation mode is active.

Single ROI

Use the ROI (region of interest) function to output images by specifying the areas to scan. Define the area to scan by specifying width, height, and horizontal or vertical offset values under **ImageFormatControl**. Increase the frame rate by specifying a lower height as the number of lines scanned decreases.

NOTE: BlemishDetect is not available when the ROI function is active.

The setting ranges for the ROI function's readable area based on the Binning setting **(BinningHorizontal** or **BinningVertical)** are outlined in the following table.

Table 4 Monochrome Model Width and Height

Model	Width (Pixels)	Height (Lines)
CV60-AS02MG	H Binning Off: 96 to 1920 step 16 H Binning On: 48 to 960 step 8	V Binning Off: 8 to 1200 step 16 V Binning On: 4 to 600 step 16
CV60-AS05MG	H Binning Off: 96 to 2048 step 16 H Binning On: 48 to 1024 step 8	V Binning Off: 8 to 1536 step 16 V Binning On: 4 to 768 step 16
CV60-AS09MG	H Binning Off: 96 to 4096 step 16 H Binning On: 48 to 2048 step 8	V Binning Off: 8 to 2160 step 16 V Binning On: 4 to 1080 step 16
CV60-AS12MG	H Binning Off: 96 to 4096 step 16 H Binning On: 48 to 2048 step 8	V Binning Off: 8 to 3000 step 16 V Binning On: 4 to 1500 step 16

Table 5 Monochrome Model Offset X and Offset Y

Model	Offset X (Pixels)	Offset Y (Lines)
CV60-AS02MG	H Binning Off: 0 to 1824 step 16 H Binning On: 0 to 912 step 8	V Binning Off: 0 to 1192 step 2 V Binning On: 0 to 596 step 1
CV60-AS05MG	H Binning Off: 0 to 1952 step 16 H Binning On: 0 to 976 step 8	V Binning Off: 0 to 1524 step 2 V Binning On: 0 to 762 step 16
CV60-AS09MG	H Binning Off: 0 to 4000 step 16 H Binning On: 0 to 2000 step 8	V Binning Off: 0 to 2152 step 2 V Binning On: 0 to 1076 step 16

Table 5 Monochrome Model Offset X and Offset Y (Continued)

Model	Offset X (Pixels)	Offset Y (Lines)
CV60-AS12MG	H Binning Off: 0 to 4000 step 16 H Binning On: 0 to 2000 step 8	V Binning Off: 0 to 2992 step 2 V Binning On: 0 to 1496 step 16

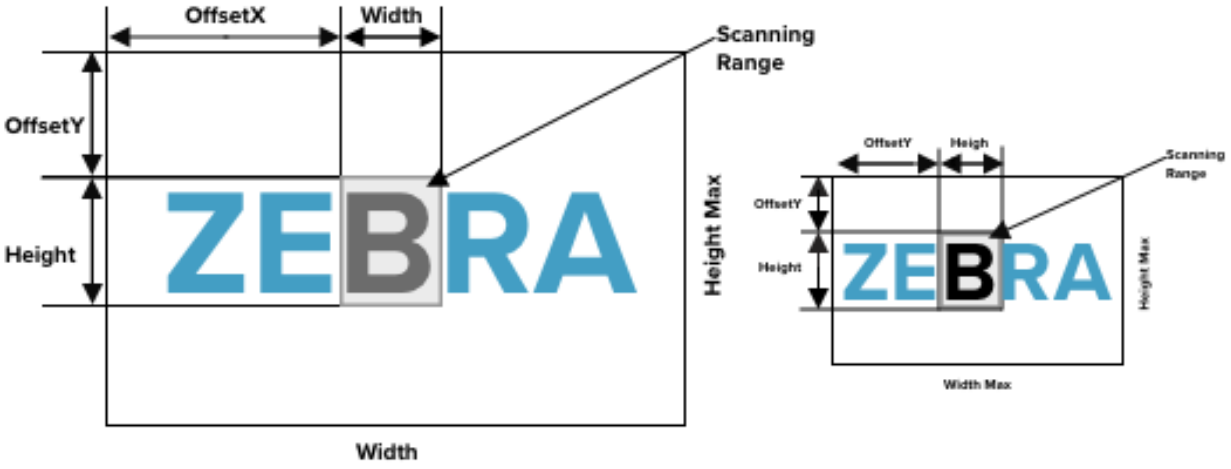
Table 6 Color Model Width and Height

Model	Width (Pixels)	Height (Lines)
CV60-AS02CG	96 to 1920 step 16	8 to 1200 step 2
CV60-AS05CG	96 to 2048 step 16	8 to 1536 step 2
CV60-AS09CG	96 to 4096 step 16	8 to 2160 step 2
CV60-AS12CG	96 to 4096 step 16	8 to 3000 step 2

Table 7 Color Model Offset X and Offset Y

Model	Offset X (Pixels)	Offset Y (Lines)
CV60-AS02CG	0 to 1824 step 16	0 to 1192 step 2
CV60-AS05CG	0 to 1952 step 16	0 to 1524 step 2
CV60-AS09CG	0 to 4000 step 16	0 to 2152 step 2
CV60-AS12CG	0 to 4000 step 16	0 to 2992 step 2

Figure 9 Binning

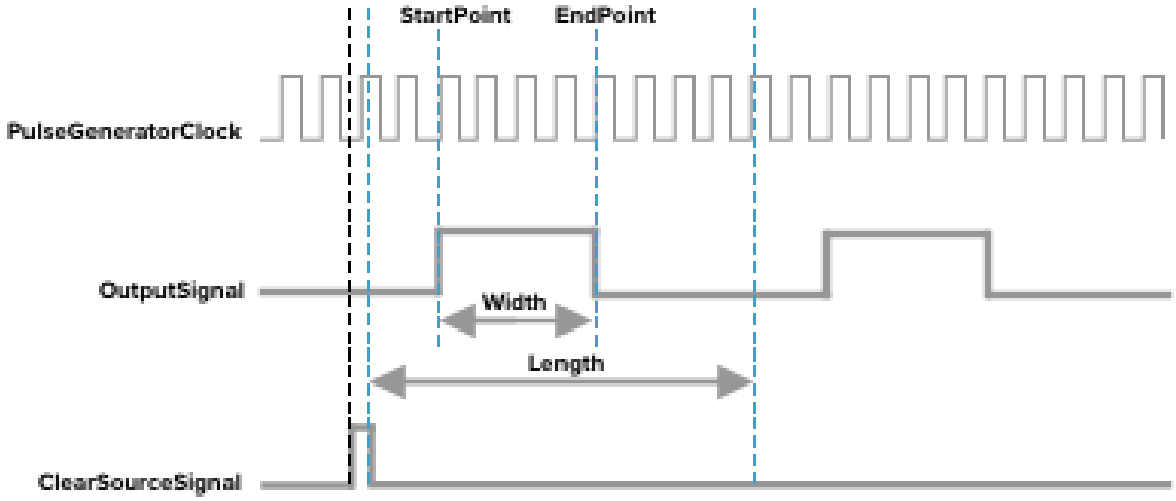


Pulse Generator

Use the Pulse Generator to generate a signal inside the camera.

- PulseGeneratorStartPoint = 2
- PulseGeneratorEndPoint = 6
- PulseGeneratorLength = 10
- PulseGeneratorPulseWidth = 4
- PulseGeneratorClearSyncMode = AsyncMode

Figure 10 Pulse Generator



Sequencer

Use the Sequencer function to define up to 32 index combinations of exposure time, gain, ROI, and other settings enabled each time a trigger is received. This is helpful for use cases that require capturing multiple exposures of objects under inspection to adjust for areas or components with significantly different reflectance levels. Specify the following index in the sequence and the order in which indexes execute. Multiple indexes can be implemented repeatedly.

Two operation modes (**TriggerSequencer** mode and **CommandSequencer** mode) are available for the Sequencer function.

CAUTION: If the values of **ImageFormatControl** width and height are smaller than **SequencerControl, SequencerWidth,** and **SequencerHeight,** the image may not be output as expected. When using **SequencerWidth** or **SequencerHeight,** set the width and height to the default values in advance.

Using Indexes

NOTE: SequencerFrameNumber and **SequencerSetNext** are only available for configuration in **TriggerSequencer** mode.

Trigger Sequence Mode

Trigger Sequence Mode enables a user-defined Sequencer Trigger pattern.

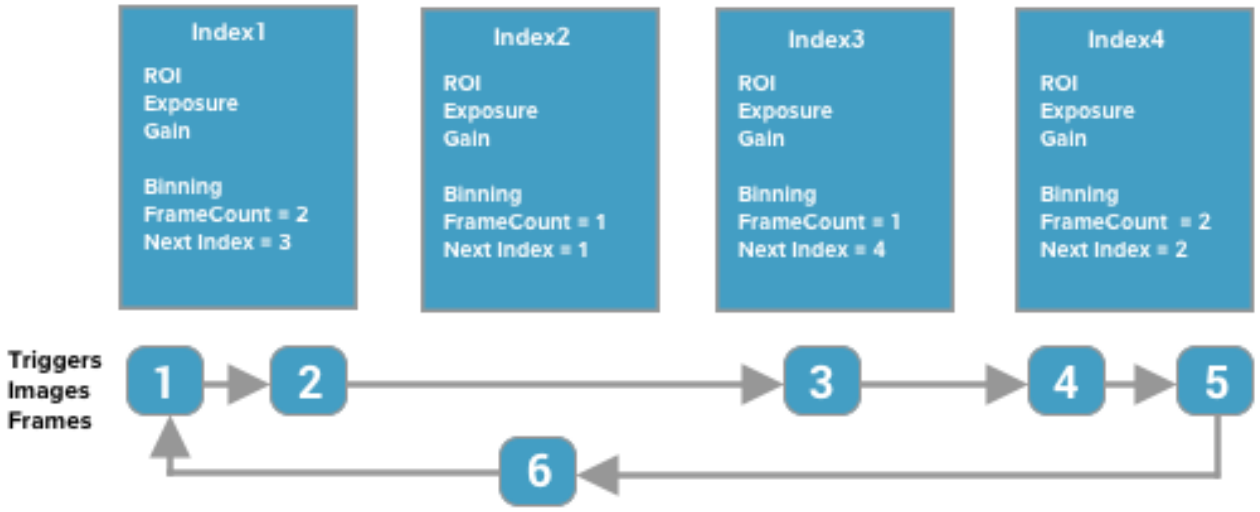
The operation of this mode is controlled using the following commands:

- **SequencerSetActive** - confirm the index number displayed on the next trigger reception.
- **SequencerSetStart** - configure the index number to execute at the start of the **TriggerSequencer** mode.
- **SequencerReset** - enable this to switch the index number executed to the one specified in **SequencerSetStart** during **TriggerSequencer** mode operation.
- **SequencerRepetition** - this parameter applies to **TriggerSequencer** patterns with the **SequencerROINextIndex** set to **0 (Off)**. When execution completes, the index **SequencerROINextIndex** is set to **0 (Off)**, and the **SequencerRepetition** (range = 1-255) is decremented internally. If the result of the decrement is not zero, the **TriggerSequencer** pattern restarts from the index specified in **SequencerSetStart**. If the result of the decrement is zero, the status updates to **Acquisition Stop** and external triggers are not accepted.

Sample TriggerSequencer Mode Operation

1. Specify 1 in **SequencerSetStart**, and start **TriggerSequencer** mode with index 1.
2. Capture a 2-frame image with the first and second triggers.
3. For the following index, configure index three specified in **SequencerSetNext,** and capture an image with the number of frames (the number of triggers) specified in **SequencerFrameNumber.**

Figure 11 TriggerSequencer Mode Operation



Proceed to sequence from index 4 to index 2 to index 1.

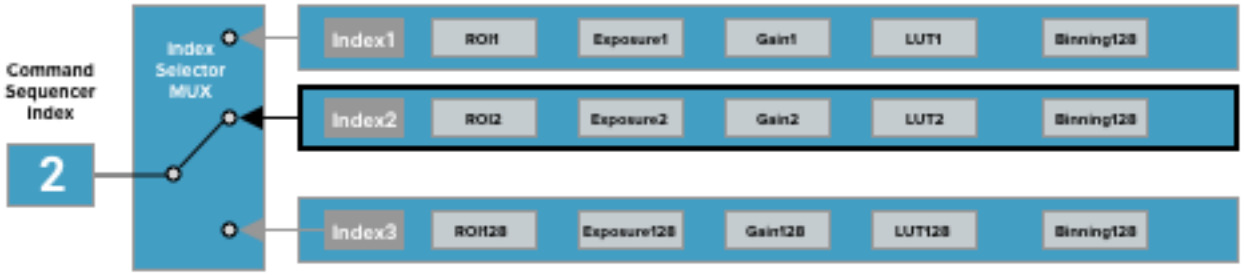
NOTE: You can also specify 0 to indicate the end of **TriggerSequencer** mode in **SequencerSetNext** in an index of 2 and specify the number of repetitions in **SequencerRepetition.**.

Command Sequencer Mode

Define up to 32 indexes and set **SequencerCommandIndex** to point to a preconfigured index. This index is executed on each trigger until it is changed to point to a different index defined by the vision application. Use Command Sequencer mode to programmatically adjust your sequence in response to image analysis or input from other sensors.

NOTE: The same index table is executed for subsequent triggers unless the **CommandSequencerIndex** value is changed. **SequencerFrameNumber** and **SequencerSetNext** cannot be used in Command Sequencer mode.

Figure 12 Command Sequencer



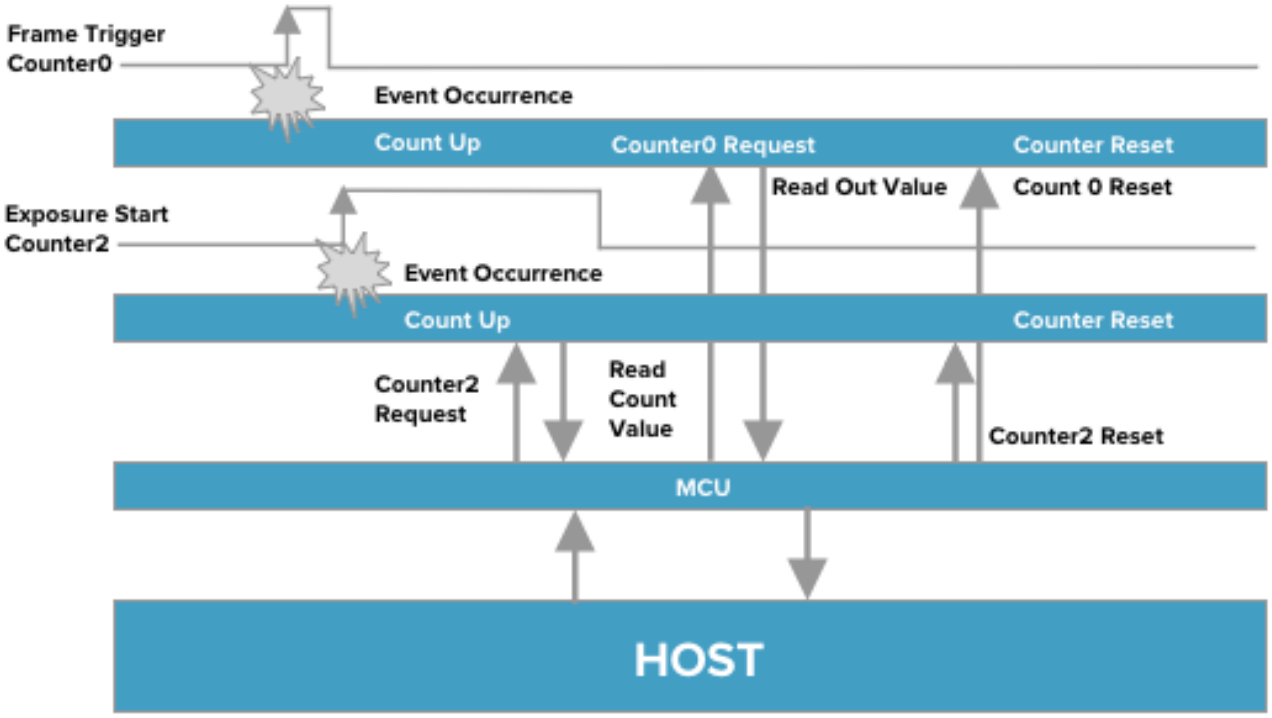
Counter and Timer Control

The Counter function counts up change points in the camera's internal signals using the camera's internal counter and reads that information from the host side. This function verifies error conditions using the count value and internal camera operations. Four counters are available on the camera; Counter0, Counter1, Counter2, and Counter3. The functions that can be counted are fixed for each counter.

- Counter0: Counts the number of **FrameTrigger**.
- Counter1: Counts the number of **ExposureStart**.
- Counter2: Counts the number of **SensorReadOut**.
- Counter3: Counts the number of **FrameTransferEnd**.

When an issue occurs in a system that includes this camera, comparing the values from multiple counters allows you to verify the extent of normal operability and can help investigate the cause.

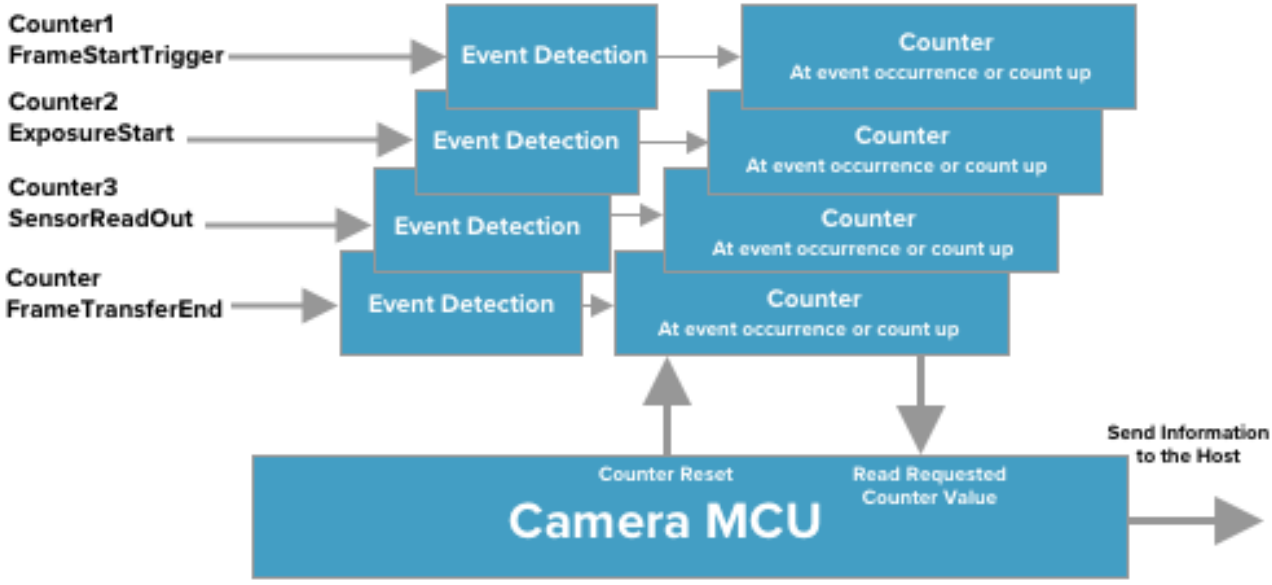
Figure 13 Counter



NOTE: Reset a specific counter's count value by executing **CounterReset** [Counter0, Counter1, Counter2, Counter3].

The following diagram outlines the internal camera blocks:

Figure 14 Camera Blocks



Use the Counter function by specifying a counter and configuring the following settings:

Table 8 Counter Function Settings

Item		Setting Value/ Selectable Range	Description
Counter 0-3		Counter 0-3	Select the counter.
	CounterEventSource	Counter 0: Off, FrameStartTrigger Counter1 Off, ExposureStart Counter2 Off, SensorReadOut Counter3 Off, FrameTransferEnd	Select the counter-event signal for which to read the count value. When set to Off, the counter operation stops but does not reset.
	CounterEventActivation	Rising Edge, Falling Edge	Specify the timing cadence: • Counter0 - Rising Edge • Counter1 - Rising Edge • Counter2 - Rising Edge • Counter3 - Rising Edge

Chunk Data

The Chunk Data function adds camera configuration information to the image data output from the camera. Embedding camera configuration information in the image data allows you to use the camera's serial number as a search key and find specific image data from large volumes of image data. In addition, when images are captured with a single camera in sequence under multiple setting conditions, the images are searchable by their setting conditions.

Set **ChunkModeActive** to **True** to configure Chunk Data.

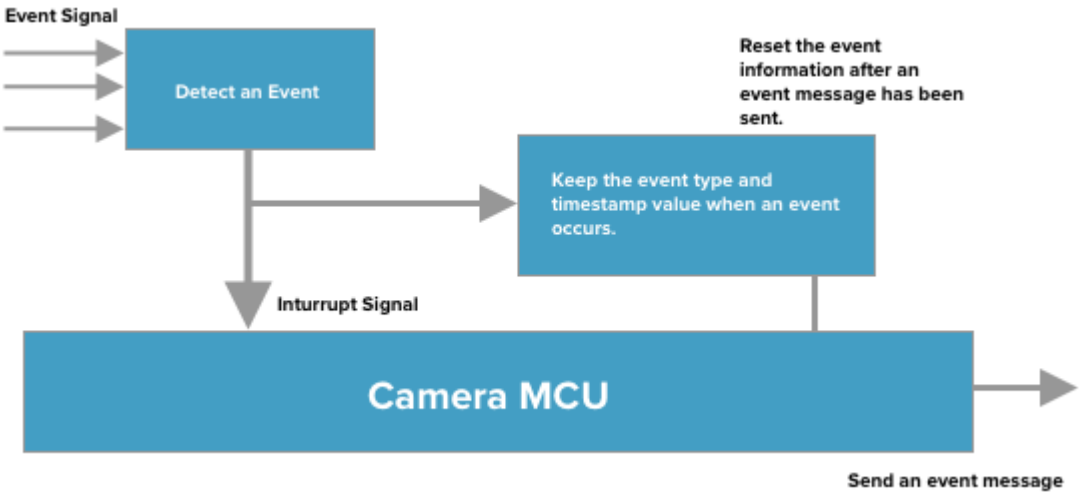
CAUTION: The Chunk Data function settings cannot be changed during image output. To change the settings, stop image acquisition.

Event Control

The Event Control function outputs a signal change point inside the camera as information indicative of an event occurrence (event message) by using GigE Vision Control Protocol (GVCP).

The following diagram shows the flow from detecting an event to sending an event message.

Figure 15 Event Detection



Specify whether or not to send an event message when an event occurs.

The Event Control function uses the following events:

- AcquisitionTrigger
- FrameStart
- FrameEnd
- ExposureStart
- ExposureEnd

Action Control

The Action Control function executes a pre-configured action when the camera receives action commands. Action commands send unicast and broadcast messages that provide instructions for actions to multiple cameras simultaneously by broadcasting them. A camera with this function can also provide instructions for actions to different types of cameras. Although this function includes jitter and delays, it is also helpful for controlling multiple cameras simultaneously.

Actions are performed when the following conditions are met:

1. **ActionDeviceKey** is set to the camera and **ActionDeviceKey** in the action command match.
2. **ActionGroupKey** is set to the camera and **ActionGroupKey** in the action command match.
3. **ActionGroupMask** is set to the camera, and **GroupMask** in the action command performs an operation that produces a non-zero result.

Configuring Camera Settings

To configure camera settings:

1. Specify the **ActionDeviceKey**

2. Specify two actions that can be configured on the camera:
   a. Action 1:
      a. Select 1 in **ActionSelector**
      b. Specify **ActionGroupMask** [ActionSelector]
      c. Specify **ActionGroupKey** [ActionSelector]
   b. Action 2:
      a. Select 2 in **ActionSelector**
      b. Specify **ActionGroupMask** [ActionSelector]
      c. Specify **ActionGroupKey** [ActionSelector]
3. Set triggers (**AcquisitionStart**, **AcquisitionEnd**, **FrameStart**, **AcquisitionTransferStart**) to **Action1** and **Action2**.

Precision Time Protocol

The camera operates as instructed by the Precision Time Protocol defined in IEEE 1588. When the IEEE 1588 primary clock exists in the network where the camera is connected, this function synchronizes the camera to the time of the primary clock.

- Transport:
  - Multicast UDP datagram (224.0.1.129)

NOTE: Delay Resp is a unicast UDP datagram.

- Destination port number:
  - 319: Sync, Delay Req, Pdelay Req, Pdelay Resp
  - 320: Announce, Follow Up, Delay Resp, Pdelay Resp, Management, Signaling
- Items for synchronization:
  - Time synchronization is performed. Frequency tuning is not performed.
- PTP time data:
  - 80-bit (elapsed time in 1 ns, with 00:00:00, January 1 1970 set as the origin)
- Timestamp:
  - 64-bit (PTP synchronization: LSB64bit of PTP time data)
- Supported PTP messages:
  - Announce message (receive only)
  - Sync message (receive only)
  - Follow Up message (receive only)
  - Delay Req message (send only)
  - Delay Resp message (receive only)

CAUTION: The Timestamp Tick Frequency register value is fixed at 1,000,000,000 (1 GHz).

CAUTION: When PTP synchronization is performed, the Timestamp Reset function is disabled.

CAUTION: GenICam handles the timestamp (64-bit) as a 64-bit signed integer. Therefore, 63-bit is the timestamp data without the sign bit.

Non-Volatile Flash Memory

The camera has non-volatile memory to store data.

NOTE: The non-volatile flash memory may not have enough memory capacity to store large data. As a result, Zebra recommends saving images to the PC or another storage location.

Troubleshooting

This section describes potential issues that could arise while using the camera.

Table 9 Troubleshooting

Source	Problem	Cause/Solution
Power Supply and Connections	The Power/Trigger LED remains lit amber and does not turn green after power is supplied to the camera.	Camera initialization may not be complete due to a lack of power. Check the 6-pin power cable connection. The connection might not be established. Check the Ethernet cable connection.
Image Display	Gradation in dark areas is not noticeable.	Use the gamma function to correct the display. As the light-emitting properties of the monitor are not linear, the entire image may be darker, or the gradation in the dark areas may be less noticeable when the camera outputs are displayed without processing. Using the gamma function performs correction to produce a display close to linear.
Settings and Operations	Settings cannot be saved to user memory.	You cannot save to user memory while the camera is acquiring images. Stop image acquisition before performing the save operation.
	Cannot restore the factory default settings.	Load the **Default** under **User Set Selector** in the **Feature Properties** tab to restore the factory default settings.

Specifications

Specifications

For additional device specifications, go to zebra.com/support.

Table 10 Portfolio Specifications

Specification	Description
System Clock	74.25 MHz (for pulse generator)
EMVA 1288 Parameters Absolute Sensitivity Maximum SNR	10-bit output format Monochrome: 3.71 p, Color: 4.86 p (l = 527 nm) Monochrome: 39.7 dB, Color: 39.7 dB
Traditional SNR	Monochrome: greater than 60 dB Color: greater than 60 dB (0 dB gain, 10-bit)
Video Signal Output	Monochrome: 8/10/12-bits Color: 8/10/12-bit Bayer
Gain Output	Manual/auto 0 dB to +42 dB
White Balance	Off, presets, or one-push/continuous AWB
Gamma/LUT	0.45 to 1.0 (9 steps) or 257-point programmable LUT
Synchronization	Internal
Video Modes	Normal/Single ROI, Sequencer (Trigger and Command)
Trigger Input	Opto In, Pulse Generators (4), Software, NAND Out (2), User Output (4)
Exposure Modes	Timed/EPS, RCT, Trigger Width, Auto
Shading Correction	Flat shading, color shading (color model only)
Pre-Processing Functions	H and V flip (mirroring), blemish compensation, H and V decimation
Operating Temperature	23°F/-5°C to 113°F/45°C (20 to 80% non-condensing)

Table 10 Portfolio Specifications (Continued)

Specification	Description
Storage Temperature	-13°F/-25°C to 140°F/60°C (20 to 80% non-condensing
Vibration	10 G (20 Hz to 200 Hz, XYZ directions)
Shock	80 G
Regulations	CE(EN 55032:2015(CISPR32:2015), EN 55035:2017(CISPR35:2016)), FCC Part 15 Class A, RoHS/ WEEE, KC
Power	6-pin: +10 V to +25V DC, 2.7 W typical @ +12V PoE: +36 V to +57 V DC, 3.7 W typical @ +48 V
Lens	C-mount
Dimensions (H x W x L)	29 mm x 29 mm x 51.1 mm
Weight	65 g

Table 11 Model Specifications

Model	Specification	Description
2.3 MP GigE (Color and Monochrome)	Sensors	2.3 MP
	Pixels	1920 x 1200 px
	Light Spectrum	Color: Visible Monochrome: Visible and NIR
	Frame Rate	50 fps
	Sensor Name	IMX392
	Optical Format	1/2.3 in.
	Sensor Diagonal	7.8 mm
	Active Sensor Area	6.6 x 4.4 mm
	Read Out Modes	Full: 1920 (h) x 1200 (v) up to 49.9 fps ROI (Single): H: 90 to 1904 pixels in 16-pixel steps, V: 8 to 1198 lines in 2-line steps Binning: 1x2, 2x1, 2x2 (monochrome only)
	Electronic Shutter	Timed: 14.73 µs to 8 s in 1 step Auto: 100 µs to 20 ms at full resolution
	Automatic Level Control (ALC)	Shutter Range: from 100 µs to 20 ms Gain Range: from 0 dB to +42 dB

Table 11 Model Specifications (Continued)

Model	Specification	Description
5 MP GigE (Color and Monochrome)	Sensors	5 MP
	Pixels	2448 x 2048 px
	Light Spectrum	Color: Visible Monochrome: Visible and NIR
	Frame Rate	22 fps
	Sensor Name	IMX264
	Optical Format	2.3 in.
	Sensor Diagonal	11 mm
	Active Sensor Area	8.5 x 7.1 mm
	Read Out Modes	Full: 2448 (h) x 2048 (v) up to 22.9 fps ROI (Single): H: 96 to 2432 pixels in 16-pixel steps, V: 8 to 2046 lines in 2-line steps Binning: 1x2, 2x1, 2x2 (monochrome only)
	Electronic Shutter:	Timed: 14.73 µs to 8 s in 1 µs step Auto: 100 µs to 43.6 ms at full resolution
	Automatic Level Control (ALC)	Shutter Range: from 100 µs to 43.6 ms Gain Range: from 0 dB to +42 dB
8.9 MP GigE (Color and Monochrome)	Sensors	8.9 MP
	Pixels	4096 x 2160 px
	Light Spectrum	Color: Visible Monochrome: Visible and NIR
	Frame Rate	12 fps
	Sensor Name	IMX267
	Optical Format	1 in.
	Sensor Diagonal	16 mm
	Active Sensor Area	14.1 x 7.4 mm
	Read Out Modes	Full: 2448 (h) x 2048 (v) up to 22.9 fps ROI (Single): H: 96 to 4080 pixels in 16-pixel steps, V: 8 to 2158 lines in 2-line steps Binning: 1x2, 2x2 (monochrome only)

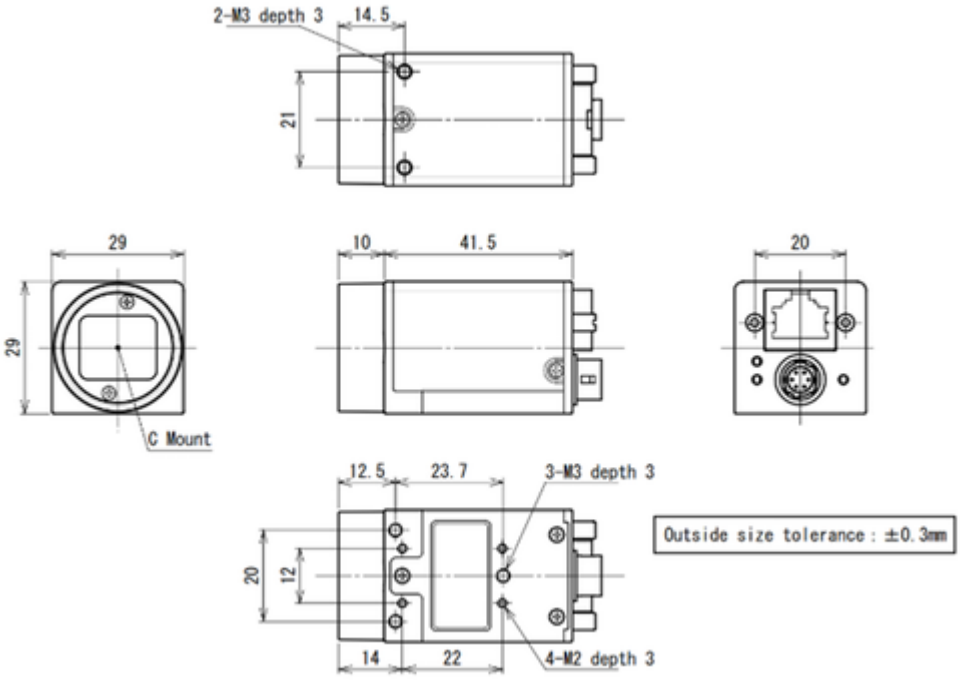
Table 11 Model Specifications (Continued)

Model	Specification	Description
	Electronic Shutter	Timed: 15.26 µs to 8 s in 1 µs step Auto: 100 µs to 76.9 ms at full resolution
	Automatic Level Control (ALC)	Shutter Range: from 100 µs to 76.9 ms Gain Range: from 0 dB to +42 dB
12.3 MP GigE (Color and Monochrome)	Sensors	12.3 MP
	Pixels	4096 x 3000 px
	Light Spectrum	Color: Visible Monochrome: Visible and NIR
	Frame Rate	9 fps
	Sensor Name	IMX304
	Optical Format	1.1 in.
	Sensor Diagonal	17.5 mm
	Active Sensor Area	14.1 x 10.3 mm
	Read Out Modes	Full: 4096 (h) x 3000 (v) up to 9.3 fps ROI (Single): H: 96 to 4080 pixels in 16-pixel steps, V: 8 to 2998 lines in 2-line steps Binning: 1x2, 2x1, 2x2 (monochrome only)
	Electronic Shutter	Timed: 15.26 µs to 8 s in 1 µs step Auto: 100 µs to 107.5 ms at full resolution
	Automatic Level Control (ALC)	Shutter Range: from 100 µs to 107.5 ms Gain Range: from 0 dB to +42 dB

Dimensions

The following illustration displays the dimensions of the camera for mounting.

Figure 16 CV60 Dimensions



Connector Diagrams

The following diagram outlines the pinout for the Power and I/O connector.

Power and I/O Connector

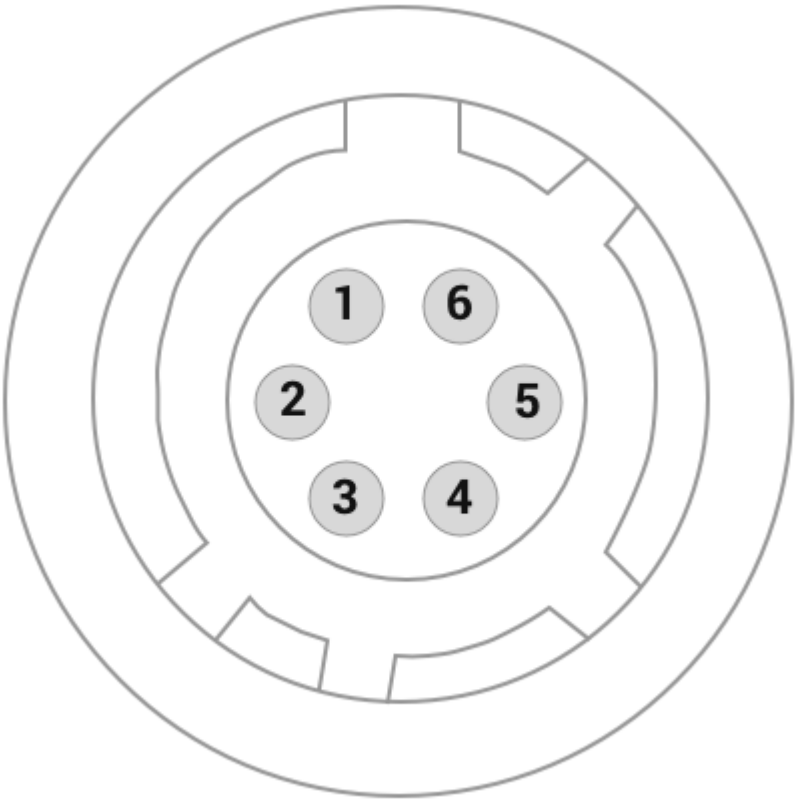


Table 12 Power and I/O Connector Pin Listing

Pin	Color	Description
1	White	DC in +10 V to +25 V
2	Brown	Opto In+
3	Green	Opto In-
4	Yellow	Opto Out+
5	Gray	Opto Out-
6	Pink	Ground

Circuit Diagrams

This section describes circuit diagrams for external input and output for the CV60.

Figure 17 External Input Circuit Reference Diagram

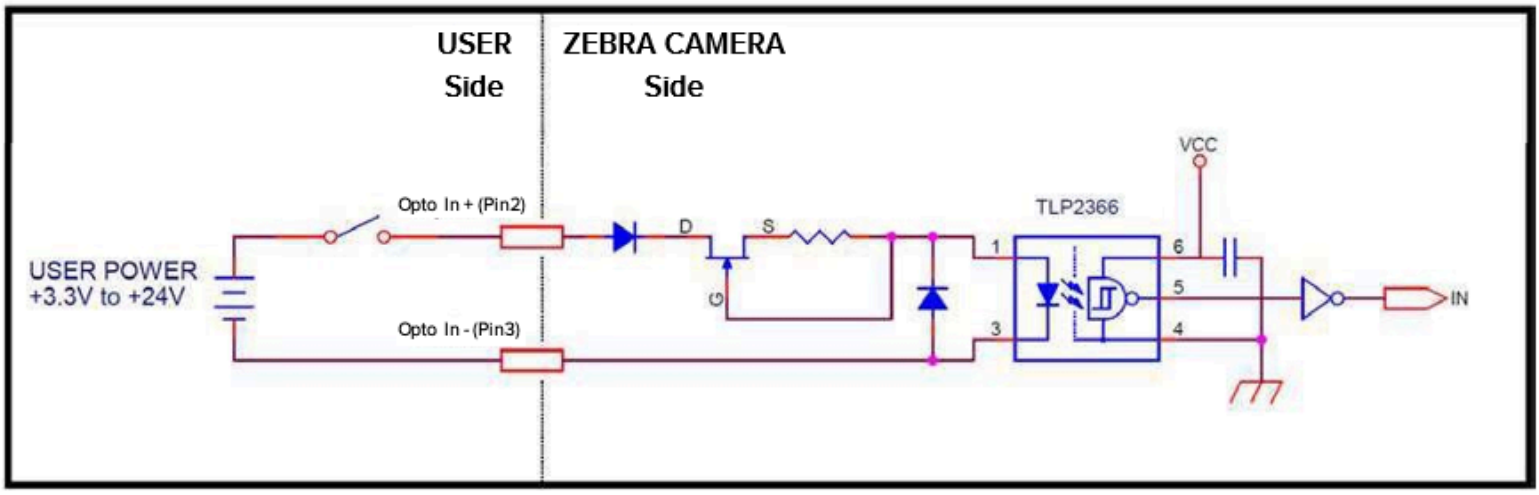
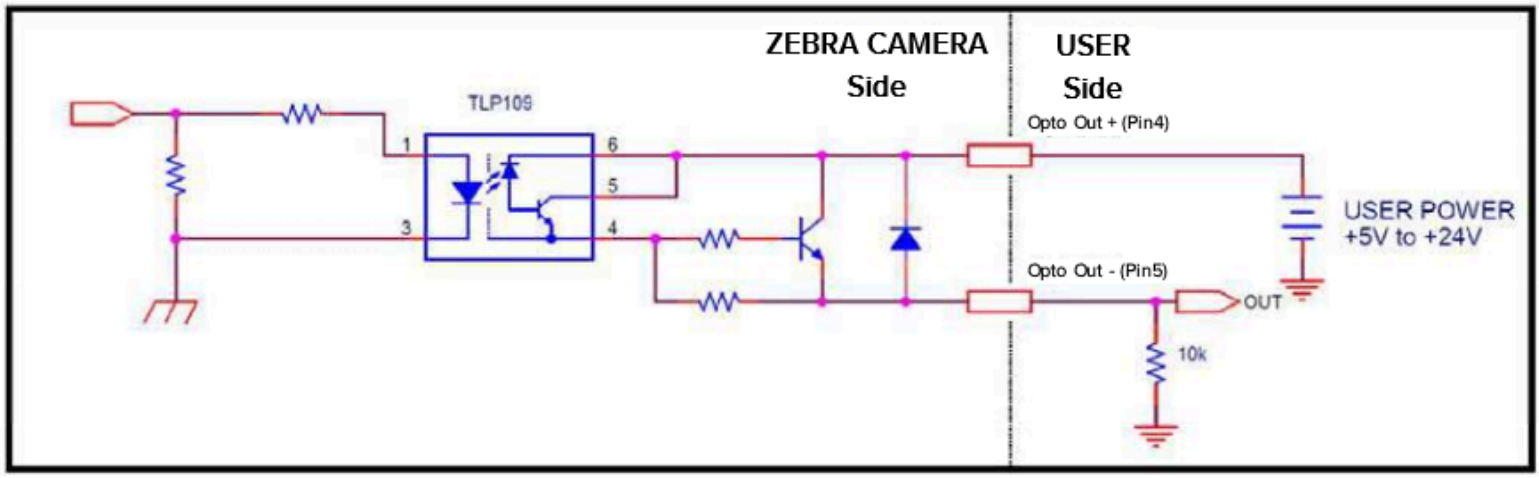


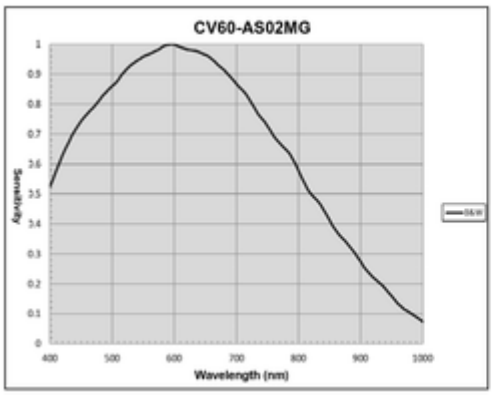
Figure 18 External Output Circuit Reference Diagram

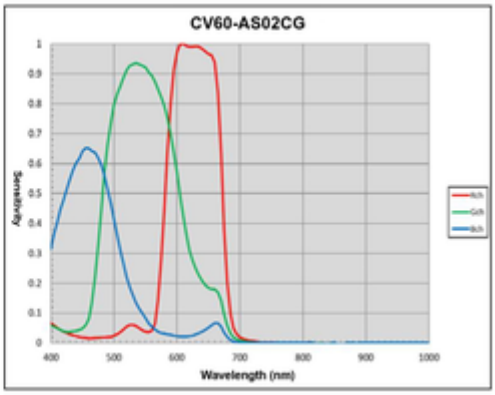


Spectral Response

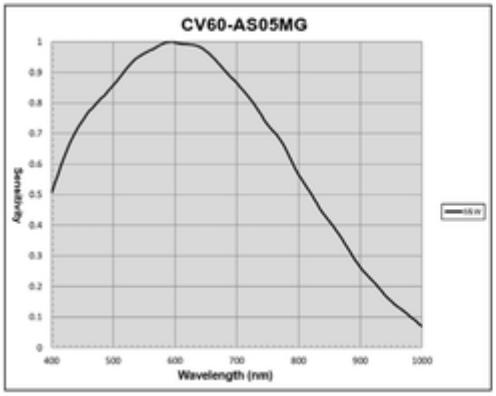
The tables in this section describe the spectral response for monochrome and color models.

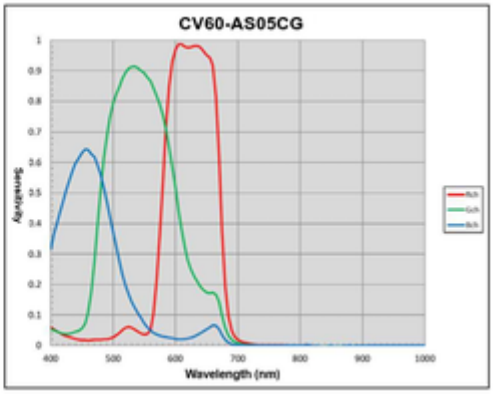
CV60-AS02 Spectral Response Tables



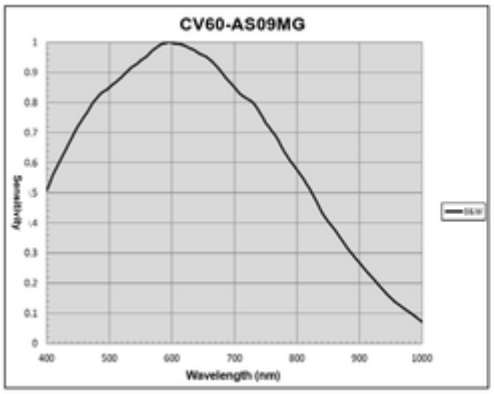


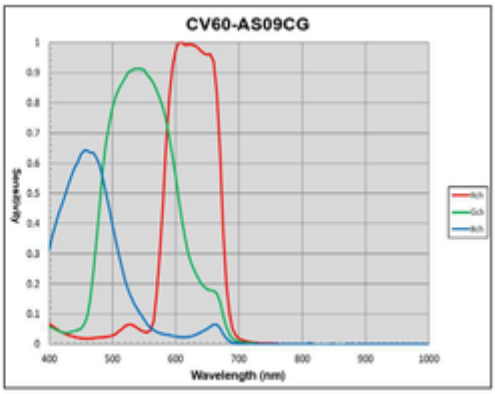
CV60-AS05 Spectral Response Tables





CV60-AS09 Spectral Response Tables





CV60-AS12 Spectral Response Tables