C4-2350-GigE Camera

Hardware Reference Manual

Rev 1.6

Automation Technology GmbH

Table Of Contents

Table Of Contents iii

C4 Camera Series Overview 2

Introduction 2
Measuring Principle 2
Geometry 1 3
Geometry 2 3
Geometry 3 4
Geometry 4 4
The C4-2350-GigE Camera General Specifications 5
Mechanical Drawings: 6
The C4-2350-GigE Camera Sensor Specifications 8

C4-2350-GigE Camera Operational Reference 10

C4-2350-GigE Camera GenICam Features 10
DeviceInformation 10
ImageFormatControls 10
AcquisitionControl 11
CameraControls – AOIs (Areas Of Interest) 11
CameraControls – ModeAndAlgorithmControls 11
CameraControls – SensorControls 12
CameraControls – SensorControls – AdvancedSensorsettings .. 12
CameraControls – DataOutput 12
CameraControls – Commands 13
CameraIO 13
TriggerControls 14
TriggerControls – ResolverRS422 14
GigEVisionTransportLayer 14
UserSets 15
ChunkDataControl 16
EventGeneration 16
FileAccessControl 16
The GenICam Features Configuration of C4-2350-GigE 17
Correction of Column Fixed Pattern Noise (FPN) of C4-2350-GigE 19
The C4-2350-GigE Camera Algorithms 20
The Image Mode (IMG) 20
The Maximum Intensity Profile Mode (MAX) 21

The Threshold Mode (TRSH) 22
The Center Of Gravity Mode (COG) 23
The Data Output Format of C4-2350-GigE 24
The Data Channel Assignment DC0-DC2 24
The Output Frame Structure 25
C4-2350-GigE Camera Triggering 29
Description of Profile Trigger Modes 29
Description of Modes for Triggering of Sequencer/Frame and Profile Acquisition 31
The Chunk Data Mode of C4-2350-GigE 33
General Description 33
Payload Layout in Chunk Data Mode 34
XML Descriptors and Id's 35
Chunk Data Structure 36
The GigE-Vision Events of C4-2350-GigE 37
C4-2350-GigE Camera Interface 38
The GigE Interface 38
The I/O & Power Interface 38
The Illumination Control 39
Schematic of C4-2040-GigE digital inputs 40
Schematic of C4-2040-GigE digital outputs 41
Description of LEDs 42
Integrated RS232 serial interface and Camera Boot Log 43
The External C4 I/O Panel 45

Service Information **47**

Document Revision 47
Product Information and Updates 47
Warranty Conditions 48

Disclaimer
While care has been exercised in the preparation of this document to ensure that it is fully correct and comprehensive, the owners assume no responsibility for errors or omissions. Neither is any liability assumed for damages resulting from the use of the information contained herein. No license is granted under any patents or patent right of AT – Automation Technology GmbH.

Trademarks
All nationally and internationally recognized trademarks and tradenames are hereby acknowledged.
This document is subject to change without notification. All rights reserved.

C4 Camera Series Overview

Introduction

The C4 camera series is a revolutionary product family of intelligent high speed sensors. It is optimised for 3D profile measurement by means of laser triangulation technique. The 3D profile extraction is performed in the camera by using high performance Field Programmable Gate Array processors. At the same time the 3D profile data is sent to the PC over a Gigabit Ethernet interface (GigE). This extreme data reduction boosts the measuring speed to unprecedented levels without affecting the performance of the connected image processing unit.

Measuring Principle

The C4 camera acquires height profiles and height images based on the laser triangulation principle. According to this method a laser line is projected on the object from one direction. The C4 camera views the object from another angle defining the triangulation geometry. The resulting sensor image is evaluated by the C4 camera core and converted into a single height profile. By scanning the laser line over the object a complete height image can be acquired.

The figures below demonstrate some typical triangulation geometries. The following notation is used in the approximation of height resolution:

ΔX= resolution along the laser line (lateral),

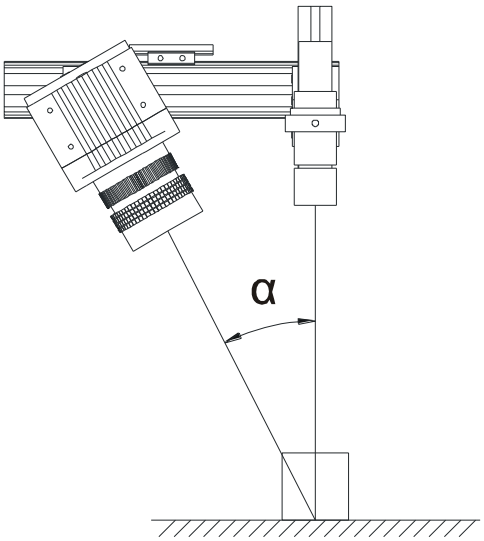
ΔY= resolution perpendicular to the laser line (longitudinal in the direction of motion),

ΔZ= height resolution.

Geometry 1

The laser line is projected perpendicular to the object surface, while the camera views the object under the triangulation angle α.

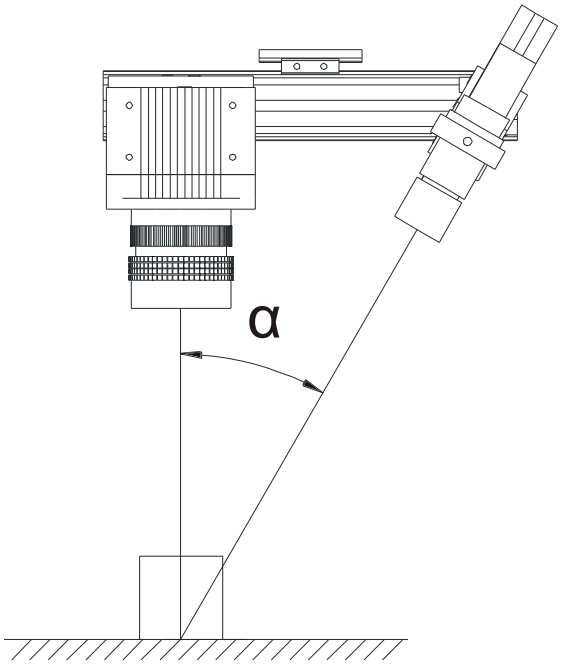
The height resolution can be approximated: $\Delta Z \approx \Delta X / \sin(\alpha)$



Geometry 2

The camera views the object perpendicularly to its surface, while the laser line is projected under the triangulation angle α.

The height resolution can be approximated: $\Delta Z \approx \Delta X / \tan(\alpha)$

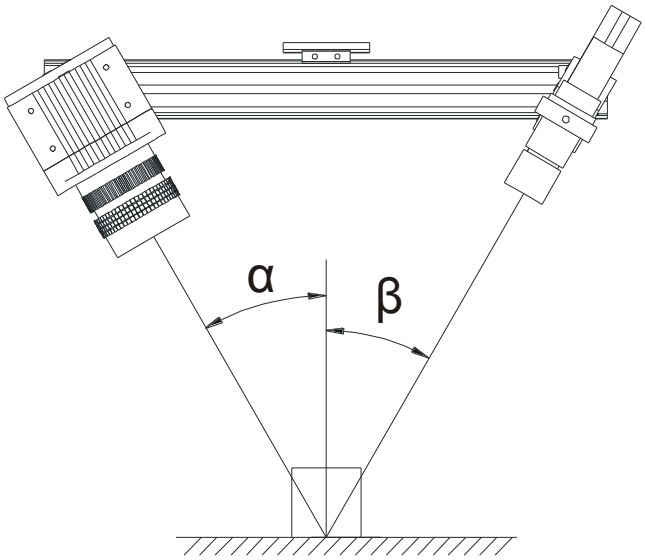


Geometry 3

The camera views the object under an angle α, while the laser line is projected under a different angle β.

The height resolution can be approximated: $\Delta Z \approx \Delta X * \cos(\beta) / \sin(\alpha + \beta)$,

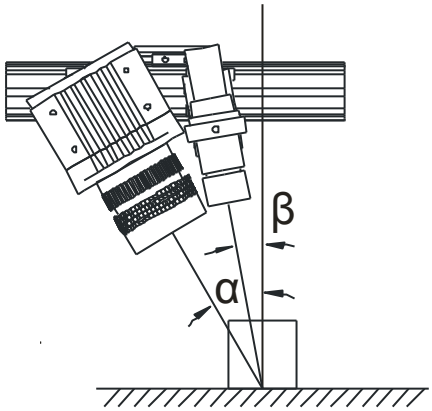
in case $\alpha = \beta$ (direct reflex) : $\Delta Z \approx \Delta X / 2 * \sin(\alpha)$



Geometry 4

The camera views the object under an angle α, while the laser line is projected under a different angle β at the camera side.

The height resolution can be approximated: $\Delta Z \approx \Delta X * \cos(\beta) / \sin(\alpha - \beta)$,



The C4-2350-GigE Camera General Specifications

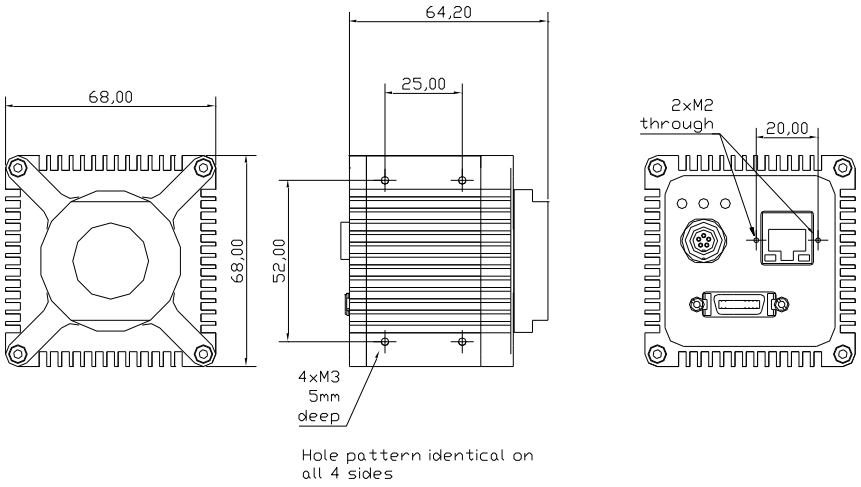
Camera Controls	
Synchonization Modes	Free running, Triggered, Software Triggered
Explosure Modes	Programmable, Pulse controlled
Shutter Modes	Rolling Shutter
Digital Trigger Input	2 optoisolated inputs, 5V or 24V with C4-I/O-Panel
	VIL, logic ‚0' Voltage < 2.5V
	VIH, logic ‚1' Voltage > 3.5V
Encoder Trigger Input	RS422 Standard with 100 Ohm termination
Digital Output	2 optoisolated outputs
	VOL, logic ‚0' Voltage 0.5V
	VOH, logic ‚1' Voltage OC output with 4.7kOhm pull-up to VCC I/O
	IOH, logic ‚1' output current OC output with 4.7kOhm pull-up to VCC I/O
	IOL, logic ‚0' output current 8mA
Illumination Control	Power 5V DC, 200mA, Modulation 20kHz
Features	
3D-Algorithms	MAX, TRSH, COG, user specific
Smart Camera	Dedicated CPU for custom image processing, 1Gb image memory, 256 Mb processor instruction and data memory
High Speed Acquisition	Full frame: 190 fps
Optical Interface	
Lens Mount	M42x1 with Back Focal Distance 6.52mm
Adapter for C-Mount lens (must be ordered separately)	Back Focal Distance 17.52mm
Adapter for F-Mount lens with Bajonett mount (must be ordered separately)	Back Focal Distance 46.50 mm
Mechanical Interface	
Camera Size	68 mm x 68 mm x 64.2 mm (C-Mount)

Mechanical Interface	
	68 mm x 68 mm x 93.2 mm (F-Mount)
Mass (without optics)	350g (C-Mount), 420g (F-Mount)
Power connector	20-pin MDR
Ethernet connector	RJ45
Illunimation control connector	5-pin M9

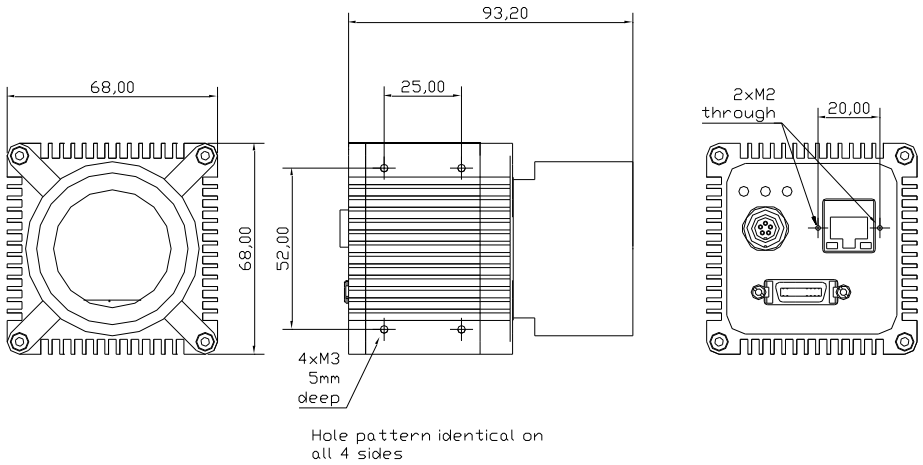
Electrical Interface	
Input Voltage	10 - 24V DC
Power consumption	<10W
Operating Temperature	0°C to +50°C (non condensing)
Output Data Interface	Gigabit Ethernet (IEEE 802.3)
Communication Protocol	GigE Vision with GeniCam

Mechanical Drawings:

C4-2350-GigE with C-Mount adapter:



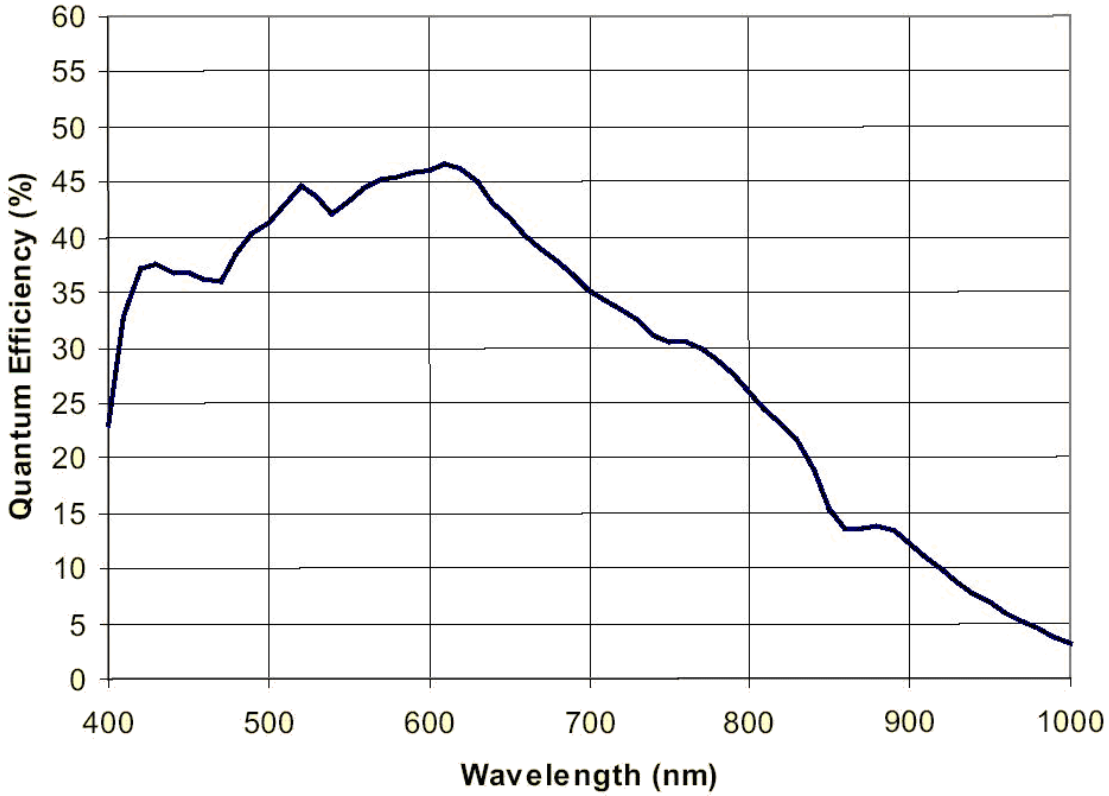
C4-2350-GigE with F-Mount adapter:


93,20
68,00
25,00
2xM2
through
20,00
68,00
52,00
4xM3
5mm
deep
Hole pattern identical on
all 4 sides

The C4-2350-GigE Camera Sensor Specifications

Parameters	Specifications
Sensitivity at peak response	17000 LSB / µJ / cm² @610nm
Resolution	2352 x 1728
Pixel Size	7µm x 7µm
Sensor Size	16.46mm x 12.10mm, diagonal: 20.43mm
Optics	1"
Sensor ADC Resolution	10 bit
Sensor Dynamic Range	59dB
Max. Internal Full-Frame Rate	190fps
Max. External Full-Frame Rate	25fps
Max. Profile Rate at Max. Row Length = Max. Internal Row Frequency / Number of Rows	23450 Hz (14 rows) 12160 Hz (27 rows) 3040 Hz (108 rows) 1520 Hz (216 rows) 760 Hz (432 rows) 380 Hz (864 rows) 190 Hz (1728 rows)

Spectral sensitivity of C4-2350-GigE sensor


Quantum Efficiency (%)
60
55
50
45
40
35
30
25
20
15
10
5
0
400
500
600
700
800
900
1000
Wavelength (nm)

C4-2350-GigE Camera Operational Reference

C4-2350-GigE Camera GenICam Features

DeviceInformation

Name	Rev.	Interface	Access	Description
DeviceVendorName	1.0	IString	R	The name of the device vendor.
DeviceModelName	1.0	IString	R	The name of the device model.
DeviceManufacturerInfo	1.0	IString	R	Additional info from manufacturer about this device.
DeviceVersion	1.0	IString	R	A string identifying the version of the device.
DeviceID	1.0	IString	R	Version of firmware/software.
DeviceFirmwareVersion	1.0	IString	R	A unique identifier of the device, e.g., a serial number or a GUID (User Data in GigE Boot register).
DeviceUserID	1.0	IString	R/W	User-programmable device identifier.
DeviceScanType	1.0	IEnumeration	R	Shows the device type - Areascan
DeviceReset	1.0	ICommand	W	Resets and reboots the device immediately.
DeviceRegistersStreamingStart	1.2	ICommand	W	Announces the start of registers streaming without immediate checking for consistency.
DeviceRegistersStreamingEnd	1.2	ICommand	W	Announces the end of registers streaming and perform validation for registers consistency before activating them. This will also update the DeviceRegistersValid flag.
DeviceRegistersCheck	1.2	ICommand	W	Performs an explicit register set validation for consistency.
DeviceRegistersValid	1.2	IBoolean	R	Indicates whether the current register set is valid and consistent.
DeviceTemperature	AT	IFloat	R	Device temperature in degrees Celsius (°C).
DeviceMaxThroughput	1.2	IInteger	R	Maximum Bandwidth of data in Bytes/sec.

ImageFormatControls

Name	Rev.	Interface	Access	Description
PayloadSize	1.0	IInteger	R	PayloadSize provides the number of bytes transferred for each image on the stream channel
SensorWidth	1.0	IInteger	R	Width of sensor (effective pixels)
SensorHeight	1.0	IInteger	R	Height of sensor (effective pixels)
Width	1.0	IInteger	R/(W)	Width of Image/Area Of Interest. In Image-Mode writing this manipulates AOI[0].width.
Height	1.0	IInteger	R/(W)	Height of Image/Area Of Interest. In Image-Mode writing this manipulates AOI[0].height
PixelFormat	1.0	IEnumeration	R/(W)	Format of the image pixels. For more details, see the Pixel Format description chapter. - Mono8 - Mono16
ReverseY	1.0	IBoolean	R/W	When set to true, this parameter flips the image vertically.

Name	Rev.	Interface	Access	Description
OffsetX	1.0	IInteger	R/W	X Offset of AOI
TestImageSelector	1.0	IEnumeration	R/W	Selection of the test image to be used. - Off - GreySensorColumnPattern
LinePitch	1.0	IInteger	R	Distance between consecutive lines in bytes.
PixelDynamicRangeMin	1.0	IInteger	R	Minimum pixel value sent by the camera.
PixelDynamicRangeMax	1.0	IInteger	R	Maximum pixel value sent by the camera.

AcquisitionControl

Name	Rev.	Interface	Access	Description
AcquisitionStart	1.0	ICommand	W	Issues the START command. This starts the acquisition.
AcquisitionStop	1.0	ICommand	W	Issues the STOP command. This stops the acquisition.
AcquisitionMode	1.0	IEnumeration	R/W	Defines the type of acquisition: - SingleFrame - MultiFrame - Continuous
AcquisitionAbort	1.0	ICommand	W	Issues the ABORT command. This immediately aborts the acquisition without completing the current frame.
AcquisitionFrameCount	1.0	IInteger	R/W	Number of frames to be acquired in MultiFrame acquisition mode. The minimum allowable value is 1.
AcquisitionFrameRateAbs	1.2	IFloat	R	The frame rate of the imager. Absolute units are in Hz.
AcquisitionStatusSelector	1.2	IEnumeration	R/W	Selector for AcquisitionStatus to read: - AcquisitionTriggerWait - AcquisitionActive - AcquisitionTransfer - FrameTriggerWait
AcquisitionStatus[AcquisitionStatusSelector]	1.2	IBoolean	R	Status of the selected acquisition flag

CameraControls – AOIs (Areas Of Interest)

Name	Rev.	Interface	Access	Description
MaxNumAOIs	AT	IInteger	R	Maximum number of AOIs.
NumAOIs	AT	IInteger	R/W	Number of used AOIs.
ImageModeAoiSelector	AT	IInteger	R/W	Selects the AOI to show in image mode
AoiSelector	AT	IInteger	R/W	Selects which AOI to control
AoiHeight	AT	IInteger	R/W	Number of sensor rows in AOI
AoiOffsetY	AT	IInteger	R/W	Offset distance in rows between the first row of AOI and the first row of sensor chip
AoiThreshold	AT	IInteger	R/W	Intensity threshold value for selected AOI.

CameraControls – ModeAndAlgorithmControls

Name	Rev.	Interface	Access	Description
CameraMode	AT	IEnumeration	R/W	Selects the camera mode or algorithm: - Image - CenterOfGravity - Threshold - MaximumIntensity
ProfilesPerFrame	AT	IInteger	R/W	This feature represents the number of Profiles per Frame in 3D-Mode expelled by the camera.
AbsOffsetPos	AT	IBoolean	R/W	True: Position values are referenced to the first row of sensor chip (absolute position). False: Position values are referenced to the first row of AOI.
TrshFirstFalling	AT	IBoolean	R/W	Stops the position calculation along an AOI column, as soon as the falling edge of a Gauss curve is detected.
NumCOGSP	AT	IInteger	R/W	Number of subpixel bits of COG output (0-6).
PosValidationEn	AT	IBoolean	R/W	Enable validation of position value of a Gauss curve

Name	Rev.	Interface	Access	Description
				using tolerances for width and sum of intensity. Perform validation during scan of image column and immediately after detecting a Gauss falling edge. Clear the result, if the position value is invalid.
ClearInvalidPos	AT	IBoolean	R/W	Enable validation of position value using tolerances for width and sum of intensity. Perform validation at the end of scan of image column. Invalid position values are set to zero in all DCs.
ValidationWidthMin	AT	IInteger	R/W	Minimum width of valid intensity distribution in 3D-mode.
ValidationWidthMax	AT	IInteger	R/W	Maximum width of valid intensity distribution in 3D-mode.
ValidationSumMin	AT	IInteger	R/W	Minimum sum of intensity of valid intensity distribution in 3D-mode.
ValidationSumMax	AT	IInteger	R/W	Maximum sum of intensity of valid intensity distribution in 3D-mode.

CameraControls – SensorControls

Name	Rev.	Interface	Access	Description
SensorFrameCounter	AT	IInteger	R	Sensor frame counter.
SensorReadoutTime	AT	IInteger	R	Sensor Readout Time in µs.
ExposureTimeAbs	AT	IInteger	R/W	Sensor integration time in µs.
FramePeriode	AT	IInteger	R/W	Time between two frames in µs.
FrameRate	AT	IFloat	R	Frame rate in Hz
ExposureMode	AT	IEnumeration	R/W	Sensor exposure mode: - Rolling
ShortIntegrationMode	AT	IBoolean	R/W	Enables the short integration mode, for exposure times shorter than the Sensor Readout Time
ShortIntegrationRows	AT	IInteger	R	Number of Sensor Rows used to adjust the exposure time in Short Integration Mode

CameraControls – SensorControls – AdvancedSensorsettings

Name	Rev.	Interface	Access	Description
RawEndPause	AT	IInteger	R	Row end pause in number of CLKs.
VREF1_Channel	AT	IFloat	R/W	AADC reference voltage (DAC 0).
VREF2_Channel	AT	IFloat	R/W	Reference voltage for ADC calibration (DAC 1).
VREF3_Channel	AT	IFloat	R/W	Determines the dark offset together with VCLAMP3 (DAC 2).
VCLAMP3_Channel	AT	IFloat	R/W	Determines the dark offset together with VREF3 (DAC 3).
VRSTPIX_Channel	AT	IFloat	R/W	VRSTPIX (DAC4).
VLN1_Channel	AT	IFloat	R/W	Bias for pixel source follower (DAC5).
VLP_Channel	AT	IFloat	R/W	Bias for column buffer (DAC7).
VREF4_Channel	AT	IFloat	R/W	ADC reference voltage should be equal to VREF1 (DAC7).
DarkOffsetEnable	AT	IBoolean	R/W	Dark offset enable.
UsePersistentFPNData	AT	IBoolean	R/W	Enable the use of perstistent data for FPN correction.

CameraControls – DataOutput

Name	Rev.	Interface	Access	Description
EnableDC0	AT	IBoolean	R/W	Activates the output data channel DC0.
EnableDC1	AT	IBoolean	R/W	Activates the output data channel DC1.
EnableDC2	AT	IBoolean	R/W	Activates the output data channel DC2.
EnableDC0Shift	AT	IBoolean	R/W	Right shift twice the intensity value in DC0, when PixelFormat is Mono8.
EnableDC2TrshSP	AT	IBoolean	R/W	Controls the output in channel DC2, when TRSH algorithm is selected: True: DC2 outputs the position value with 1 subpixel. False: DC2 outputs the right edge position.
EnableDC1TrshWidth	AT	IBoolean	R/W	Controls the output in channel DC1, when TRSH algorithm is selected: True: DC1 outputs the laser line width.

Name	Rev.	Interface	Access	Description
				False: DC1 outputs the left edge position.
EnableDC1Width	AT	IBoolean	R/W	Controls the output in channel DC1, when COG algorithm is selected: True: DC1 outputs the laser line width. False: DC1 outputs the left edge position.
EnableDC1Flags	AT	IBoolean	R/W	When in 16 bit mode, the bits 12-15 of output channel DC1 contain additional algorithm flags

CameraControls – Commands

Name	Rev.	Interface	Access	Description
StartPulse	AT	ICommand	W	Send Start pulse.
StopPulse	AT	ICommand	W	Send Stop pulse.
TriggerPulse	AT	ICommand	W	Send Trigger pulse.
CalibSensor	AT	ICommand	W	Start internal sensor FPN calibration.
LoadFPNData	AT	ICommand	W	Load current FPN data into the sensor memory persistenly.
StoreFPNData	AT	ICommand	W	Transfer FPN data from sensor memory to camera memory persistenly.
RstFrameCnt	AT	ICommand	W	Reset frame counter to zero.

CameraIO

Name	Rev.	Interface	Access	Description
Input1	AT	IEnumeration	R	Lists the input signals available for IN1: - Input1_Unused. - Input1_FrameStart - Input1_EnableFrame - Input1_Trigger
Input2	AT	IEnumeration	R	Lists the input signals available for IN2: - Input2_Unused. - Input2_StopFrame - Input2_Trigger
Output1	AT	IEnumeration	RW	Selects the output signal for OUT1: - Out1_IntegrationActive - Out1_SequencerActive - Out1_High - Out1_Low - Out1_InternalTrigger - Out1_SequencerTriggerActive
Output2	AT	IEnumeration	RW	Selects the output signal for OUT2: - Out2_IntegrationActive, - Out2_High - Out2_Low - Out2_TriggerOverrun - Out2_ResolverCountDir - Out2_TriggerBusy
TriggerOverrun	AT	IBoolean	R	Trigger Overrun Flag.
Input1Level	AT	IEnumeration	R	The voltage level of IN1: - Input1Level_High - Input1Level_Low
Input2Level	AT	IEnumeration	R	The voltage level of IN2: - Input2Level_High - Input2Level_Low
RS422ChannelALevel	AT	IEnumeration	R	Voltage level of RS422 Channel A: - RS422ChannelALevel_High - RS422ChannelALevel_Low
RS422ChannelBLevel	AT	IEnumeration	R	Volatge level of RS422 Channel B - RS422ChannelBLevel_High - RS422ChannelBLevel_Low
LaserPower	AT	IFloat	R/W	Sets the output analog voltage of illumination control in the range 0.0-5.0 V DC (corresponds to 0...100%)
TurnLaserOn	AT	IBoolean	R/W	Laser turn on/off.
TurnLaserOnAuto	AT	IBoolean	R/W	Laser turn on automatically during sensor integration.
VoltageIn	AT	IFloat	R	Reads the input analog voltage of illumination control (range 0.0-5.0 V DC)

TriggerControls

Name	Rev.	Interface	Access	Description
SequencerMode	AT	IEnumeration	R/W	Selects the start trigger mode: - FreeRun - StartStopCameraInput12 - StartCameraInput1 - GateCameraInput1 - StartStopCameraInput12Event
ProfileTriggerMode	AT	IEnumeration	R/W	Selects the profile trigger mode: - FreeRun - CameraInput1 - CameraInput2 - EncoderResolverInterfaceRS422.
ClearTriggerOverrun	AT	ICommand	W	Command to clear the trigger overrun flag.

TriggerControls – ResolverRS422

Name	Rev.	Interface	Access	Description
TriggerDivider	AT	IInteger	R/W	Trigger divider.
TriggerCoord	AT	IInteger	R	Resolver trigger coordinates
TriggerDirectionMode	AT	IBoolean	R/W	A sensor image is triggered when the internal pulse counter is countdown to 0. Upon start of acquisition, the initial value of pulse counter is equal to trigger divider. This parameter controls the behaviour of the pulse counter: True: The pulse counter is decreased and countdown to 0, when resolver pulses are generated from both moving directions (forwards and backwards). False: The pulse counter is decreased and countdown to 0, when resolver pulses are generated from one moving direction only (e.g. forwards). In that case, pulses corresponding to the opposite moving direction (e.g. backwards) will increase the pulse counter.
TriggerReverseDirection	AT	IBoolean	R/W	Reverse the pulse count direction.
TriggerDividerLoadAtStart	AT	IBoolean	R/W	Loads the value of trigger divider into the pulse counter, when start trigger occurs.
TriggerSingleChannelMode	AT	IBoolean	R/W	Enables trigger mode using single channel resolver.
LoadTriggerDivider	AT	ICommand	W	Command to load the value of trigger divider into the pulse counter.
ClearTriggerCoord	AT	ICommand	W	Reset trigger coordinate counter
TriggerCoordinateCountAlways	AT	IBoolean	R/W	Controls when trigger coordinates shall be counted: True: Trigger coordinates are counted always False: Trigger coordinates are counted only during image acquisition

GigEVisionTransportLayer

Name	Rev.	Interface	Access	Description
GevVersionMajor	1.2	IInteger	R	This field represents the major version of the GigE Vision specification supported by this device
GevVersionMinor	1.2	IInteger	R	This field represents the minor version of the GigE Vision specification supported by this device
GevDeviceModeIsBigEndian	1.2	IBoolean	R	This represents the endianess of bootstrap registers (FALSE: Little-endian device TRUE: Big-endian device)
GevDeviceModeCharacterSet	1.2	IEnumeration	R	This feature represents the character set of all boot strap strings: - CharacterSet_UTF8
GevInterfaceSelector	1.2	IEnumeration	R	Indicates the index of the network interface to configure: - EnumEntry_GevInterfaceSelector_Interface_0
GevMACAddress	1.2	IInteger	R	48-bit MAC address of the selected interface
GevSupportedIPConfigurationLLA	1.2	IBoolean	R	Indicate if LLA (Auto-IP) is supported by the selected interface
GevSupportedIPConfigurationDHC	1.2	IBoolean	R	Indicate if DHCP is supported by the selected

Name	Rev.	Interface	Access	Description
P				interface
GevSupportedIPConfigurationPersistentIP	1.2	IBoolean	R	Indicate if Persistent IP is supported by the selected interface
GevCurrentIPConfigurationLLA	1.2	IBoolean	R/W	This feature indicates if Link Local Address IP configuration scheme is activated on the given network interface
GevCurrentIPConfigurationDHCP	1.2	IBoolean	R/W	This feature indicates if DHCP Address IP configuration scheme is activated on the given network interface
GevCurrentIPConfigurationPersistentIP	1.2	IBoolean	R/W	This feature indicates if PersistentIP IP configuration scheme is activated on the given network interface
GevCurrentIPAddress	1.2	IInteger	R	IP address of the selected interface
GevCurrentSubnetMask	1.2	IInteger	R	Subnet mask of the selected interface
GevCurrentDefaultGateway	1.2	IInteger	R	Default gateway of the selected interface
GevPersistentIPAddress	1.2	IInteger	R/W	Persistent IP address for the selected interface
GevPersistentSubnetMask	1.2	IInteger	R/W	Persistent subnet mask for the selected interface
GevPersistentDefaultGateway	1.2	IInteger	R/W	Persistent default gateway for the selected interface
GevLinkSpeed	1.2	IInteger	R	Link speed in Mbps.
GevFirstURL	1.2	IString	R	NULL-terminated string providing the first URL to the XML device description file
GevSecondURL	1.2	IString	R	NULL-terminated string providing the second URL to the XML device description file
GevNumberOfInterfaces	1.2	IInteger	R	Indicates the number of physical network interfaces on this device
GevMessageChannelCount	1.2	IInteger	R	Indicates the number of message channels supported by this device
GevStreamChannelCount	1.2	IInteger	R	Indicates the number of stream channels supported by this device
GevSupportedOptionalCommandsUserDefinedName	1.2	IBoolean	R	Indicates if the User-defined Name register is supported
GevSupportedOptionalCommandsSerialNumber	1.2	IBoolean	R	Indicates if the Serial Number register is supported
GevSupportedOptionalCommandsEVENTDATA	1.2	IBoolean	R	Indicates if EVENTDATA_CMD and EVENTDATA_ACK are supported
GevSupportedOptionalCommandsEVENT	1.2	IBoolean	R	Indicates if EVENT_CMD and EVENT_ACK are supported
GevSupportedOptionalCommandsPACKETRESEND	1.2	IBoolean	R	Indicates if PACKETRESEND_CMD is supported
GevSupportedOptionalCommandsWRITEMEM	1.2	IBoolean	R	Indicates if WRITEMEM_CMD and WRITEMEM_ACK are supported
GevSupportedOptionalCommandsConcatenation	1.2	IBoolean	R	Indicates if multiple operations in a single message are supported
GevHeartbeatTimeout	1.2	IInteger	R/W	Current heartbeat timeout in milliseconds
GevTimestampTickFrequency	1.2	IInteger	R	64-bit value indicating the number of timestamp clock tick in 1 second
GevTimestampControlLatch	1.2	ICommand	W	Latches the current timestamp value of the device
GevTimestampControlReset	1.2	ICommand	W	Resets the timestamp count of the device
GevTimestampValue	1.2	IInteger	R	Latched 64-bit value of the timestamp. Value must first be latched using GevTimestampControlLatch.
GevStreamChannelSelector	1.2	IInteger	R/W	Indicate which stream channel to configure
GevSCPInterfaceIndex	1.2	IInteger	R	Index of network interface
GevSCPSPacketSize	1.2	IInteger	R/W	The size of the stream packet to send on this channel
GevSCPD	1.2	IInteger	R/W	Delay (in timestamp counter unit) to insert between each packet for this stream channel

UserSets

Name	Rev.	Interface	Access	Description
UserSetSelector	1.2	IEnumeration	R/W	Selects the feature User Set to load, save or configure: - Factory - UserSet1 - UserSet2 - UserSet3
UserSetLoad[UserSetSelector]	1.2	ICommand	W	Loads the User Set specified by UserSetSelector to the device and makes it active.
UserSetSave[UserSetSelector]	1.2	ICommand	W	Saves the selected User Set specified by

Name	Rev.	Interface	Access	Description
				UserSetSelector to persistent memory.
UserSetDefaultSelector	1.2	IEnumeration	R/W	Selects the feature User set to load at power up: - Factory - UserSet1 - UserSet2 - UserSet3

ChunkDataControl

Name	Rev.	Interface	Access	Description
ChunkModeActive	1.2	IBoolean	R/W	Enables the chunk data mode.
ChunkModeSelector	1.2	IEnumeration	R/W	Selects the chunk data mode: - OneChunkPerFrame - OneChunkPerProfile

EventGeneration

Name	Rev.	Interface	Access	Description
EventSelector	1.2	IEnumeration	R/W	Selector for the Event to control: - None, - AcquisitionStart, - AcquisitionEnd.
EventNotification	1.2	IEnumeration	R/W	Notification type to issue when selected event occurs: - Off, - GigEVisionEvent.

FileAccessControl

Name	Rev.	Interface	Access	Description
FileSelector	1.2	IEnumeration	R/W	Selects the target file in the device.: - UserSetDefault - UserSet1 - UserSet2 - UserSet3 - UserData
FileOperationSelector	1.2	IEnumeration	R/W	Selects the target operation for the selected file in the device. This Operation is executed when the FileOperationExecute feature is called: - Open - Close - Read - Write
FileOperationExecute	1.2	ICommand	W	Executes the operation selected by FileOperationSelector on the selected file.
FileOpenMode	1.2	IEnumeration	R/W	Selects the access mode in which a file is opened in the device.
FileAccessOffset	1.2	IInteger	R/W	Controls the Offset of the mapping between the device file storage and the FileAccessBuffer.
FileAccessLength	1.2	IInteger		Controls the Length of the mapping between the device file storage and the FileAccessBuffer.
FileOperationStatus	1.2	IEnumeration	R	Represents the file operation execution status.
FileOperationResult	1.2	IInteger	R	Represents the file operation result. For Read or Write operations, the number of successfully read/written bytes is returned.
FileSize	1.2	IInteger	R	Represents the size of the selected file in bytes.

The GenICam Features Configuration of C4-2350-GigE

Due to dependencies of the XML nodes of C4-2350-GigE registers, it is recommended to follow a specific order, when configuring the GenICam features of the camera. The list shown below, generated as a CXC file by the CX-Explorer, demonstrates an example of the correct write order:

EnableDC2 1
EnableDC1 0
CameraMode CenterOfGravity
ProfileTriggerMode FreeRun
AoiSelector 1
AoiHeight 1728
AoiOffsetY 0
AoiThreshold 128
NumAois 1
ShortIntegrationMode 1
ExposureTimeAbs 250
FramePeriode 5218
UsePersistentFPNdata 1
DarkOffsetEnable 1
EnableDC1 0
EnableDC0Shift 0
EnableDC1Flags 0
EnableDC2 1
EnableDC1TrshWidth 0
EnableDC1Width 0
EnableDC0 0
EnableDC2TrshSP 0
ProfilesPerFrame 100
TrshFirstFalling0
ValidationWidthMin 0
ValidationSumMax 65535
AbsOffsetPos 0
PosValidationEn 0
CameraMode CenterOfGravity

ValidationWidthMax 1727
NumCOGSP 4
ValidationSumMin 0
ClearInvalidPos 0
GevStreamChannelSelector 0
GevSCPSPacketSize 1500
GevSCPD 5000
TurnLaserOn 0
LaserPower 0
Output2 Out2_IntegrationActive
Output1 Out1_SequencerActive
TurnLaserOnAuto 0
ChunkModeActive 0
ProfileTriggerMode FreeRun
SequencerMode FreeRun
Width 2352
TestImageSelector Off
PixelFormat Mono16
ReverseY 0

Correction of Column Fixed Pattern Noise (FPN) of C4-2350-GigE

Although, in theory, the image acquisition of a target surface with homogeneous intensity should deliver a homogeneous intensity image, in practice, the resulted image contains intensity variations from column to column. This effect, which is known as Column Fixed Pattern Noise, is caused due to variations in the pixel column amplification of the sensor chip. The C4-2350-GigE provides a function to correct the FPN sensor artefact and homogenize the acquired image intensity. The correction takes place for every column of the sensor.

The following text describes the procedure to perform the column FPN correction.

Before the column FPN correction can begin, it is necessary that the camera is already warmed up and has reached a stable temperature. The internal camera temperature can be monitored over DeviceInformation→DeviceTemperature. (Note: XML grid visibility should be set to "Guru")

Furthermore, it is necessary that the camera has been booted with factory settings (Userset "Factory"). If this is not the case, the factory settings can be loaded manually using UserSets→UserSetSelector = "Factory" and executing the command UserSets→UserSetLoad.

Set pixel format to "Mono16" (ImageFormatControls→PixelFormat="Mono16").

Cover the objective lens of the camera and set integration time to 0, CameraControls→SensorControls→ExposureTimeAbs=0 ("Sensor integration time in µs").

Grab a single image. Start FPN calibration by executing the command CameraControls→Commands→CalibSensor ("Start FPN Calibration").

Start continuous image grab. Adjust the intensity level by modifying the sensor voltage VCLAMP3 (CameraControls→SensorControls→Advanced Sensorsettings→VCLAMP3). The mean intensity value of the intensity data should be ca. 63 gray scale units.

Stop continuous image grab. Store current FPN data persistently by executing the command CameraControls→Commands→StoreFPNData ("Store current FPN data persistently".

Power cycle the camera. The column FPN of the sensor is corrected and the camera is now ready to be used.

The C4-2350-GigE Camera Algorithms

The C4-2350-GigE camera can be operated both in a variety of 3D profile modes and in image mode. The current operation mode can be chosen by setting the parameter Camera Controls→ ModeAndAlgorithmControls→CameraMode.

The frame rate can be increased in all camera modes by reducing the AOI size. In the image mode the frame rate is limited by the output rate of the camera interface (GigE). However, due to reduced data size in profile mode the frame rate is limited only by the sensor output rate. As a matter of principle the processing speed is independent of the chosen profile mode and is determined by the AOI size.

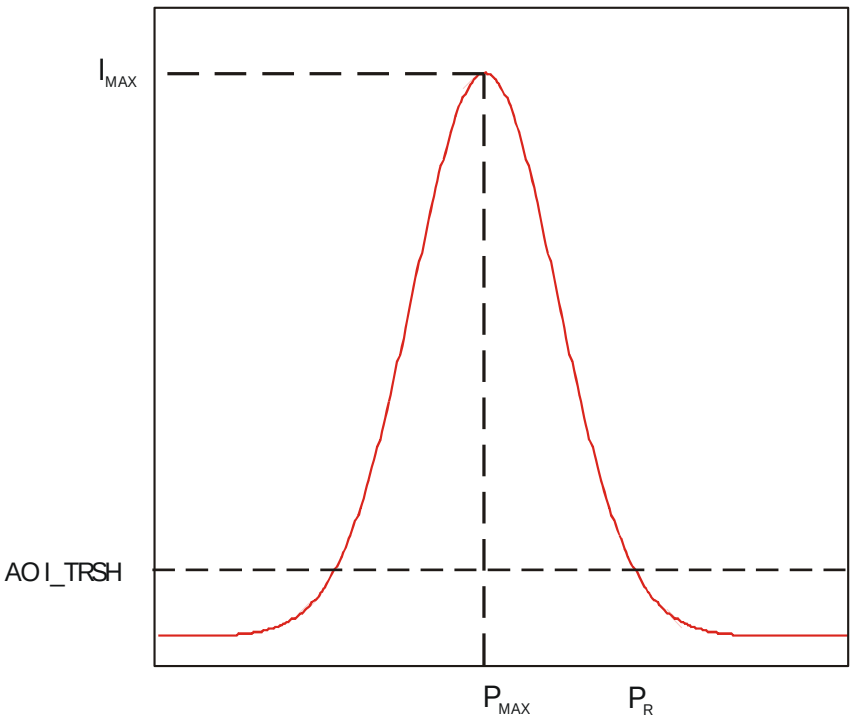
In all profile modes only intensity values higher than the AOI intensity threshold AOI_TRSH are processed in order to suppress weak signal noise. In case that no position value can be found, e.g. no intensity value is higher than threshold, the position value 0 is returned.

The Image Mode (IMG)

In the image mode the C4-2350-GigE camera is operated similar to a standard CMOS camera. In this mode grey scale data of 8 or 10 bit resolution are acquired over the camera interface. Furthermore, the sensor can be divided into multiple regions, whose data can be summarised in one output frame.

The Maximum Intensity Profile Mode (MAX)

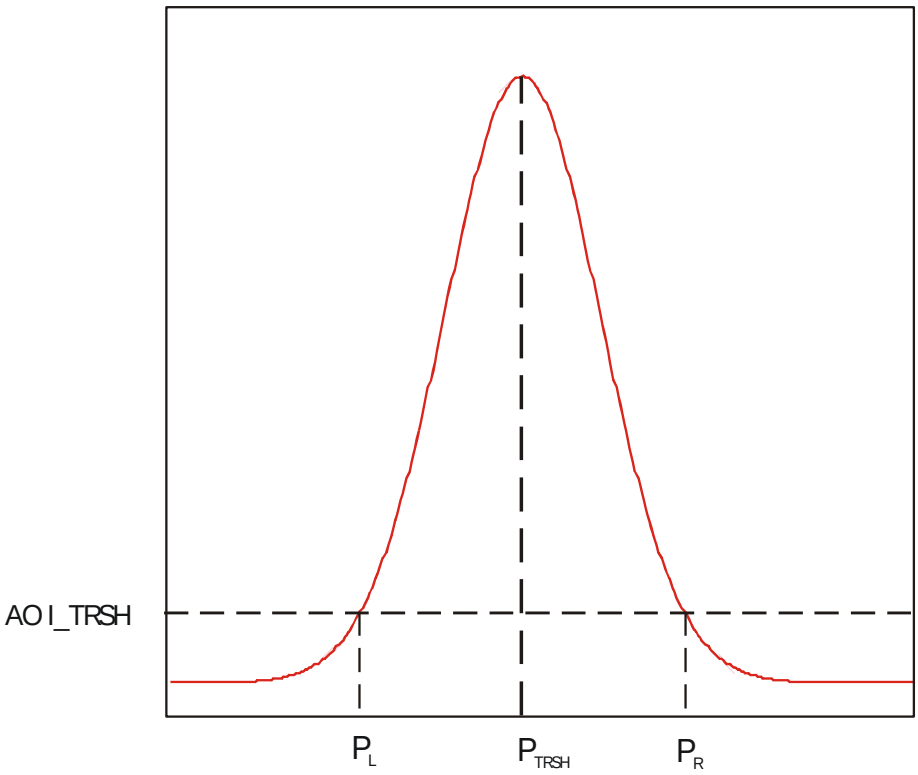
In this mode the position of the maximum intensity of laser beam profile is calculated. The result includes the position value of the maximum (P_{MAX}) as well as the maximum intensity value (I_{MAX}).



The calculation of position value is performed with simple pixel accuracy, i.e. the evaluation of 1728 rows delivers a position range from 0 to 1727 pixels (11 bit). If there is more than one local maximum, the position of the first maximum (starting from row zero) is used.

The Threshold Mode (TRSH)

In this mode the left (P_L) and (P_R) right edge position of the laser beam profile are calculated for a given threshold value of intensity AOI_TRSH.



The position value of the laser line is approximated: $P_{TRSH} = (P_L+P_R) / 2$. In order to simplify the digital representation the division over 2 is not performed and thus an integer representation with one subpixel is realised. The evaluation of 1728 rows delivers a position range from 0 to 2047 pixels (12 bit).

In threshold mode the camera can output either the left and right threshold position separately or the subpixel position (P_L+P_R) and the line width (P_R-P_L). Moreover, the maximum intensity value can be optionally delivered.

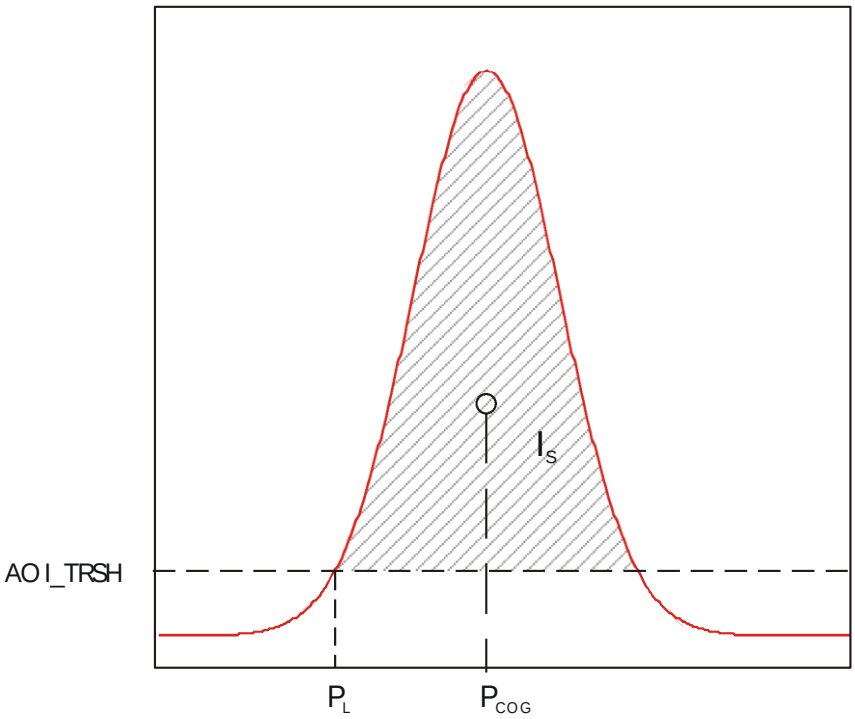
The Center Of Gravity Mode (COG)

In this mode the center of gravity of laser beam profile is calculated. For this purpose the following parameters are computed:

Position value of the left edge of laser beam profile for a given intensity threshold value P_L ,

Sum of intensity value $I_s = \sum I_p$,

Sum of first order moment $M_s = \sum I_p * P$.



The position value of laser line (center of gravity of beam profile) is then obtained from:

$P_{COG} = P_L + M_s / I_s$.

In addition the laser line width can be delivered over the Data Channel DC1. The average intensity of the illumination profile can be calculated by normalising the sum of intensity value I_s with the line width.

The Data Output Format of C4-2350-GigE

The image and 3D data output is performed by selecting the data channel DC0-DC2 (node Camera Controls→DataOutput). Depending on the algorithm the data can be acquired by enabling the corresponding output Data Channel (DC). Every DC is saved in a new image row. The bit depth of output data depends on the selected algorithm. In 3D mode the camera outputs data with 16 bit. In Image mode the camera can output 8 or 16 bit data. When in 8 bit Image mode, the DC0 delivers the 8 most significant bits of the 10 bit intensity data.

The Data Channel Assignment DC0-DC2

Alg.	DC0	DC1	DC2
IMG	Grey scale values	Not used	Not used
TRSH	Maximum intensity	Left edge of laser line (PosL) or line width (PosR-PosL)	Right edge of laser line (PosR) or line position with 1/2 pixel accuracy (PosL+PosR)
MAX	Maximum intensity	Left edge of laser line (PosL)	Position of maximum intensity (PosM)
COG	Sum of intensity values I_s	Left edge of laser line (PosL) or laser line width (PosR-PosL)	Line position with 1/X pixel resolution, where X=1,2,4,8,16,32,64

Alg. Flags – Output over DC1 (16 bit mode):

Bit14 = LEFT_TRSH_FOUND_FLAG: indicates that the left edge of laser line was found
Bit15 = RIGHT_TRSH_FOUND_FLAG: indicates that the right edge of laser line was found

The Output Frame Structure

Depending on configuration, the C4-2350-GigE writes data to the output frame according to following scheme:

```
for (profile_idx=1; profile_idx <=ProfilesPerFrame; profile_idx ++)
{
      for(AOI_idx=1; AOI_idx<=NumAOIs; AOI_idx++)
      {
            if(EnableDC0==true)
                  write_data_of_DC0 (AOI_idx);
            if(EnableDC1==true)
                  write_data_of_DC1 (AOI_idx);
            if(EnableDC2==true)
                  write_data_of_DC2 (AOI_idx);
      }
}
```

Index Definition

Index #	Range	Description
Profile_idx	1-16384	Index of Profile
AOI_idx	1-4	Index of sensor AOI

Examples of Output Frame Structure

1) Configuration with single AOI, single DC and output of 6 profiles resulting to a frame height of 6 rows:

ProfilesPerFrame=10

NumAOIs=1

EmableDC0= false,

EnableDC1=false

EnableDC2=true

Row #	Description	Profile #
1	Data of DC2 readout from AOI1	1
2	Data of DC2 readout from AOI1	2
3	Data of DC2 readout from AOI1	3

4	Data of DC2 readout from AOI1	4
5	Data of DC2 readout from AOI1	5
6	Data of DC2 readout from AOI1	6

2) Configuration with two AOIs, two DCs and output of 5 profiles resulting to frame height of 20 rows:

ProfilesPerFrame=5

NumAOIs=2

EmableDC0= true,

EnableDC1=false

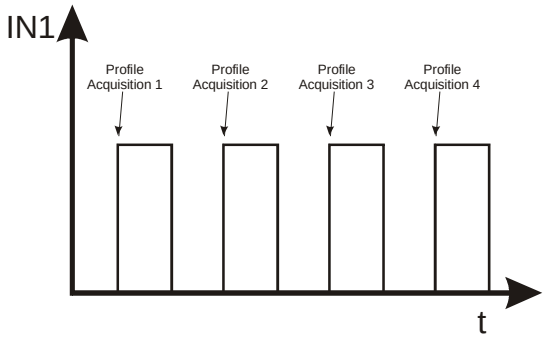
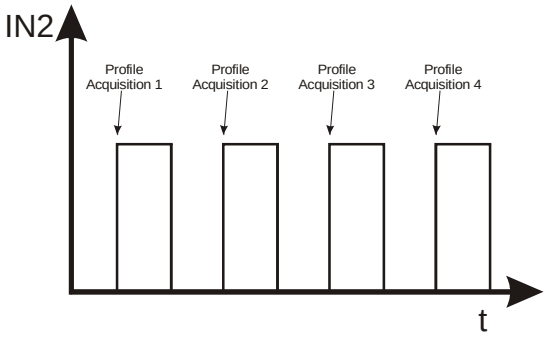
EnableDC2=true

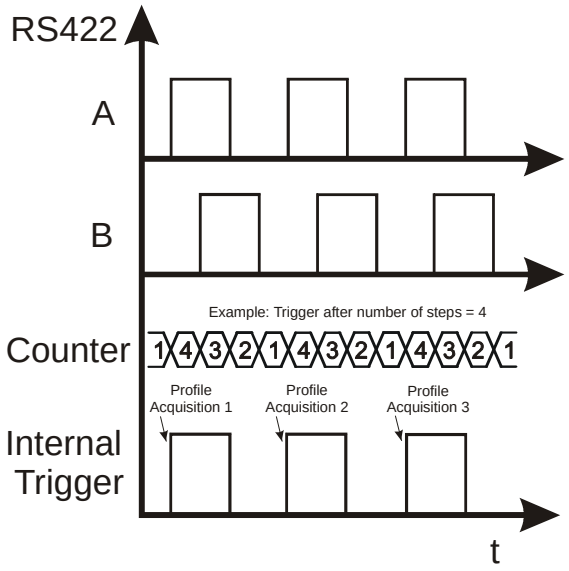
Row #	Description	Profile #
1	Data of DC0 readout from AOI1	1
2	Data of DC2 readout from AOI1	
3	Data of DC0 readout from AOI2	
4	Data of DC2 readout from AOI2	
5	Data of DC0 readout from AOI1	2
6	Data of DC2 readout from AOI1	
7	Data of DC0 readout from AOI2	
8	Data of DC2 readout from AOI2	
9	Data of DC0 readout from AOI1	3
10	Data of DC2 readout from AOI1	
11	Data of DC0 readout from AOI2	
12	Data of DC2 readout from AOI2	
13	Data of DC0 readout from AOI1	4
14	Data of DC2 readout from AOI1	
15	Data of DC0 readout from AOI2	

16	Data of DC2 readout from AOI2	
17	Data of DC0 readout from AOI1	5
18	Data of DC2 readout from AOI1	
19	Data of DC0 readout from AOI2	
20	Data of DC2 readout from AOI2	

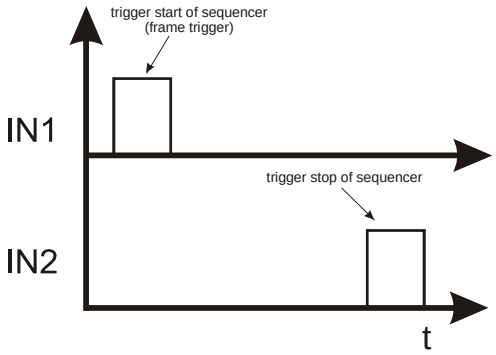
C4-2350-GigE Camera Triggering

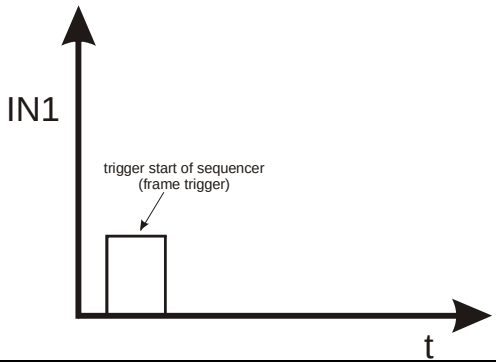
Description of Profile Trigger Modes

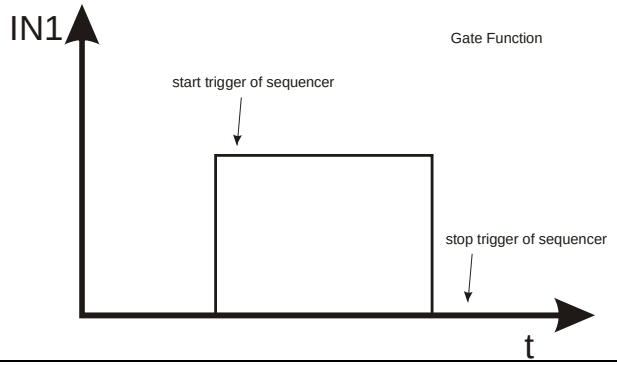
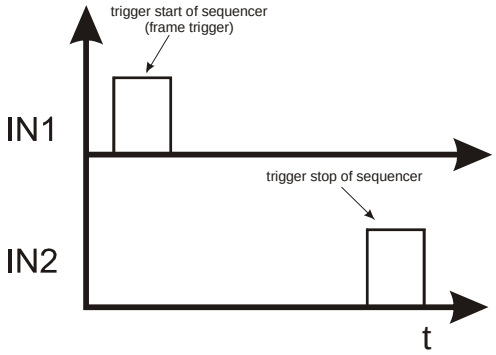
No.	Profile Trigger Mode (PTM)
0	Free-run (PTM0)
1	Camera input 1 (PTM1) 
2	Camera input 2 (PTM2) 

No.	Profile Trigger Mode (PTM)
3	Encoder/Resolver Interface (PTM3) 

Description of Modes for Triggering of Sequencer/Frame and Profile Acquisition

<table>
<tr><th>No.</th><th>Sequencer/Frame Trigger Mode</th><th>Profile Trigger Mode (PTM)</th></tr>
<tr><td rowspan="4">0</td><td rowspan="4">Free-run</td><td>PTM0 (free-run)</td></tr>
<tr><td>PTM1(IN1)</td></tr>
<tr><td>PTM2 (IN2)</td></tr>
<tr><td>PTM3 (RS422)</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Start/stop over camera input 1 / 2
Continuous frame acquisition is started with the rising edge of camera input 1 (IN1) and stopped with rising edge of camera input 2 (IN2)
 

When “stop” occurs, the frame is not transmitted immediately over the GigE interface but the camera continues to acquire profile data, until the predefined frame height is reached.</td><td>PTM0 (free-run)</td></tr>
<tr><td>PTM3 (RS422)</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">Start over camera input 1
Single frame acquisition is triggered over the rising edge of camera input 1 (IN1)
 
</td><td>PTM0 (free-run)</td></tr>
<tr><td>PTM2 (IN2)</td></tr>
<tr><td>PTM3 (RS422)</td></tr>
</table>

No.	Sequencer/Frame Trigger Mode	Profile Trigger Mode (PTM)
3	**Gate over camera input 1** Continuous frame acquisition is performed as long as the camera input 1 is on high state  	PTM0 (free-run) PTM2 (IN2) PTM3 (RS422)
4	**Start/stop with instant transmission over camera input 1 / 2** <u>Continuous</u> frame acquisition is started with rising edge of camera input 1 (IN1) and stopped with rising edge of camera input 2 (IN2)  When "stop" occurs, the frame is transmitted immediately over the GigE interface. Using the Chunk Data mode of C4 camera, it is possible to determine how many rows of the frame contain valid data (see ChunkImageInfo for details).	PTM0 (free-run) PTM3 (RS422)

Remarks:

The above table applies also to acquisition in image mode. In this case the camera delivers a gray scale sensor image for every profile trigger.

The Chunk Data Mode of C4-2350-GigE

General Description

The C4-2350-GigE features a Chunk Data mode for providing additional information to the acquired image data. The implementation of XML nodes is performed according to SFNC 1.4:

- Category ChunkDataControl
- ChunkModeActive
- ChunkModeSelector (OneChunkPerFrame, OneChunkPerProfile)

The ChunkData generated by the camera have the following format:

- ChunkImage
- 1…N x ChunkAcqInfo
- ChunkImageInfo

Depending on camera mode (image or 3D) the ChunkData block („ChunkAcqInfo“) can be sent as follows:

- in image mode, the camera can send only one ChunkAcqInfo block per image frame.
- in 3D mode, the camera can send one ChunkAcqInfo block either per 3D frame (“OneChunkPerFrame”) or per 3D profile (“OneChunkPerProfile”).

The „ChunkImageInfo“ is the last ChunkData sent by the camera and contains following data:

- number of valid rows in ChunkImage
- number of valid ChunkAcqInfo blocks
- flags identifing the current frame as „Start“ or „Stop“

The ChunkAcqInfo block consists of totally 32 bytes containing following data

- 64 bit timestamp
- 32 bit frame counter
- 32 bit trigger coordinate
- Trigger status
- I/O Status
- reserved

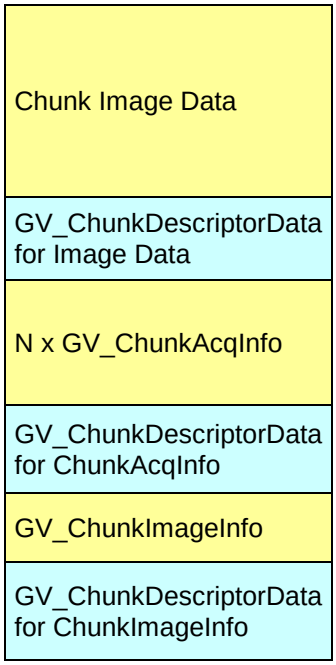
The data of timestamp, frame counter, trigger coordinate, trigger status and I/O status are assigned at the start of every image integration.

When ChunkMode is disabled, the camera uses the "regular" GEV image protocol, in which the optional transfer of frames with variable height and payload is supported.

Furthermore, when ChunkMode is enabled, the camera sends the full payload, even if the ChunkImage or ChunkAqInfo blocks contain partially valid data. The number of valid ChunkImage rows and ChunkAqInfo blocks can be read from ChunkImageInfo.

For example, when in Start/Stop mode with instant frame transmission, the camera stops the frame acquisition as soon as the stop trigger occurs and transfers the complete contents of internal image buffer. Using the ChunkImageInfo data block, it is possible to detect how many image rows and ChunkAqInfo blocks are valid in the payload buffer. The tag of ChunkData has big endian byte order. The data of ChunkData has little endian byte order. An endian converter for ChunkData is not supported.

Payload Layout in Chunk Data Mode



XML Descriptors and Id's

ChunkImageInfo

<Port Name="FrameInfoPort">
<ChunkID>*11119999*</ChunkID>
</Port>

ChunkAcqInfo

<Port Name="CameraChunkPort">
<ChunkID>66669999</ChunkID>
</Port>

ChunkImage

<Port Name="ImageInfoPort">
<ChunkID>*A5A5A5A5*</ChunkID>
</Port>

Chunk Data Structure

```
#pragma pack(push)
#pragma pack(1)

typedef struct _GV_ChunkAcqInfo
{
      unsigned int      timeStamp64L;           // 0..3
      unsigned int      timeStamp64H;           // 4..7
      unsigned int      frameCnt;               // 8..11
      signed int        triggerCoord;           // 12..15
      unsigned char     triggerStatus;          // 16
      unsigned short    reserved17_18;          // 17..18
      unsigned short    reserved19_20;          // 19..20
      unsigned char     reserved21;             // 21
      unsigned char     reserved22;             // 22
      unsigned short    reserved23_24;          // 23..24
      unsigned short    reserved25_26;          // 25..26
      unsigned short    reserved27_28;          // 27..28
      unsigned short    reserved29_30;          // 29..30
      unsigned char     reserved31;             // 31
}     GV_ChunkAcqInfo;

#define CHUNKACQINFO_TRIGGERSTATUS_BIT_TRIGGER_OVERRUN 0x01
#define CHUNKACQINFO_TRIGGERSTATUS_BIT_RESOLVER_CNT_UP 0x02

#define CHUNKACQINFO_TRIGGERSTATUS_BIT_IN0  0x10
#define CHUNKACQINFO_TRIGGERSTATUS_BIT_IN1  0x20
#define CHUNKACQINFO_TRIGGERSTATUS_BIT_OUT0 0x40
#define CHUNKACQINFO_TRIGGERSTATUS_BIT_OUT1 0x80


typedef struct _GV_ChunkImageInfo
{
      unsigned int mSizeYReal;
      unsigned int numChunkAcqInfo;
      unsigned int flag;
}     GV_ChunkImageInfo;

#define CHUNKIMAGEINFO_FLAG_BIT_START_FRAME 0x00000001
#define CHUNKIMAGEINFO_FLAG_BIT_STOP_FRAME  0x00000002

typedef struct _GV_ChunkDescriptor
{
      unsigned int descriptor;
      unsigned int length;
} GV_ChunkDescriptorData;

#pragma pack(pop)
```

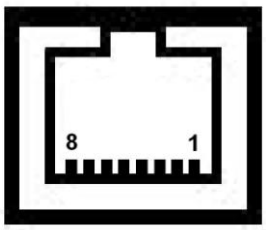
The GigE-Vision Events of C4-2350-GigE

The C4-2350-GigE supports a number of events that can be monitored by a software application by means of a callback function. Events provide real time notification on various stages of the acquisition sequence and data transfer.

Event Name	Event ID	Description
AcquisitionStart	18	Frame Acquisition is started
AcquisitionEnd	19	Frame Acquisition is terminated
TrasnferStart	20	Frame transfer is started from the camera
TransferEnd	21	Frame transfer is terminated

C4-2350-GigE Camera Interface

The GigE Interface



Pin Nr.	GigE Signal Name
1	MX0+
2	MX0-
3	MX1+
4	MX1-
5	MX2+
6	MX2-
7	MX3+
8 Shield	MX3- Shield

The I/O & Power Interface

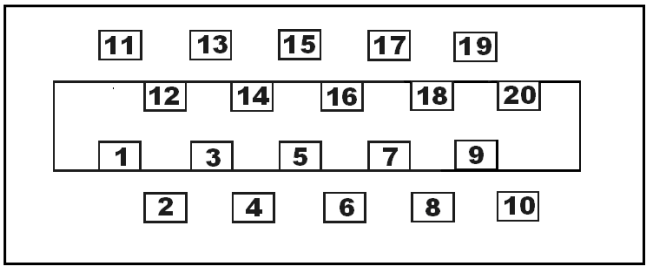
Pin Nr.	Signal Name	Description
1	GND_EXT	main camera ground
2	VCC_EXT	camera supply voltage (10-24V DC)
3	RS232_RX	reserved
4	RS232_GND	reserved
5	ENC_A-	encoder Track1 RS422 reversible input (A-)
6	ENC_B-	encoder Track2 RS422 reversible input (B-)
7	OUT1	optoisolated Output1
8	OUT2	optoisolated Output2
9	IN1	optoisolated Input1
10	IN2	optoisolated Input2
11	GND_EXT	main camera ground
12	VCC_EXT	camera supply voltage (10-24V DC)
13	RS232_TX	reserved
14	ENC_GND	Encoder ground
15	ENC_A+	encoder Track1 RS422 none reversible input (A+)
16	ENC_B+	encoder Track2 RS422 none reversible input (B+)

Pin Nr.	Signal Name	Description
17	VCC_OUT	Power supply voltage of camera optoisolated outputs (5V/24V DC)
18	GND_OUT	Ground of camera optoisolated outputs
19	GND_IN1	GND for optoisolated Input1
20	GND_IN2	GND for optoisolated Input2
Shield	SHIELD	is connected to camera case

Part Numbers for I/O Connector MDR 20

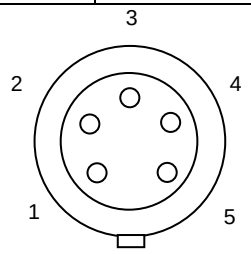
Description	Part Number 3M
20-pin Connector	10120
lockable connector case	10320

MDR20 I/O Connector Pin Assignment (View from solder side of connector)



The Illumination Control

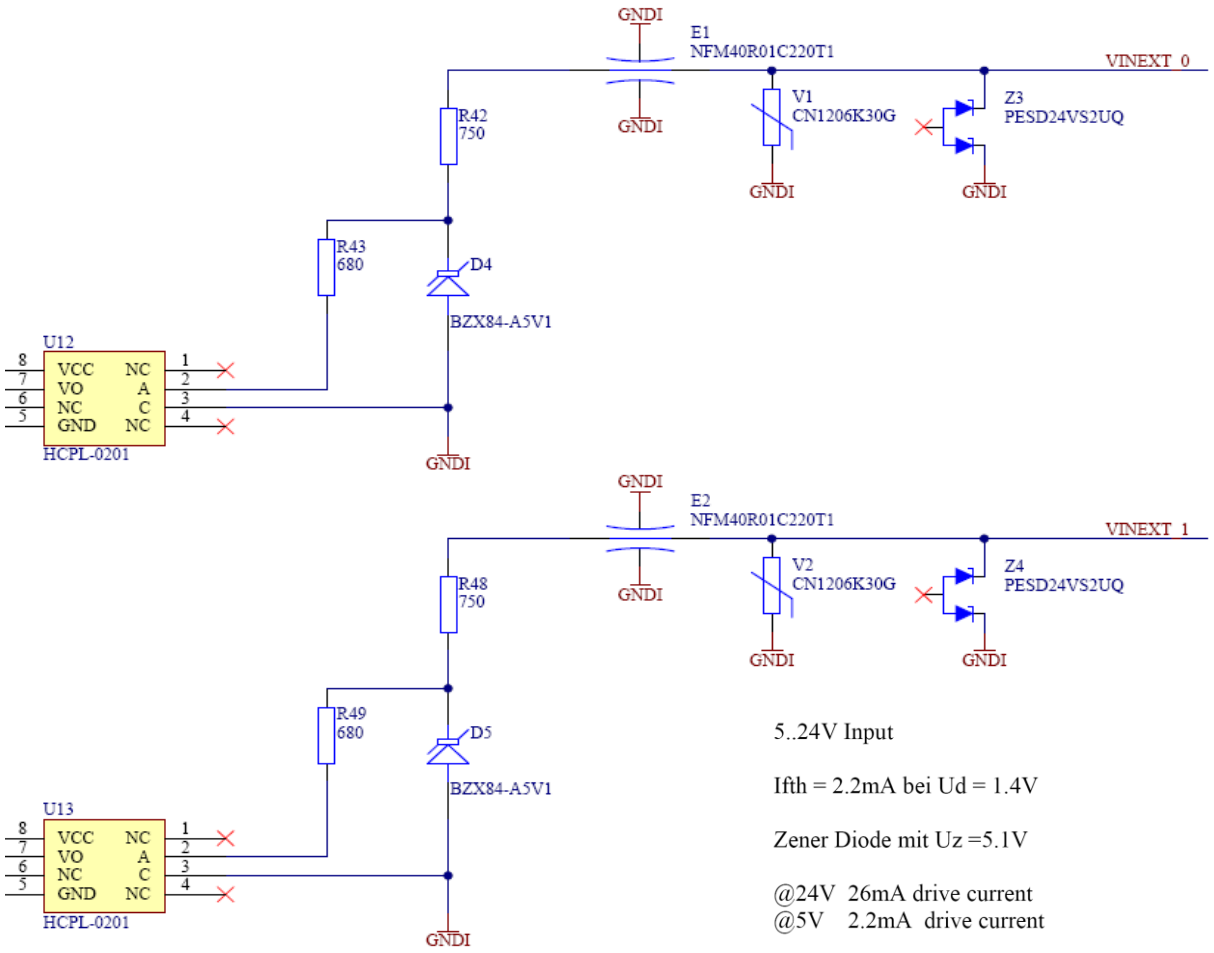
Pin Nr.	Signal Name	Description
1	VCC_LASER	Output to power the illumination device (5V, max. 200mA, fused)
2	GND_LASER	Ground for illumination device
3	LASER_DOUT	Output for digital modulation of illumination device (TTL signal)
4	LASER_AOUT	Output for analog modulation of illumination device (0-5V DC)
5	LASER_AIN	Input for monitoring specific functions of illumination device (0-5V DC)



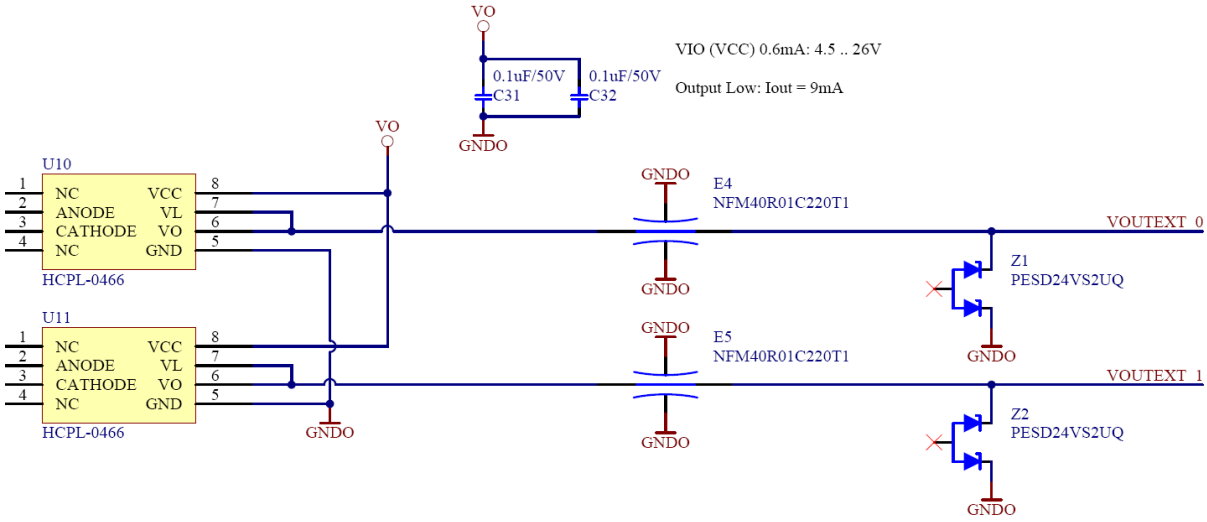
Part Number for Illumination Control Connector

Description	Part Number Binder Series 712
M9 5-pin male connector, EMV protected	99-0413-10-05
M9 5-pin male connector 90° angled, EMV protected	99-0413-75-05

Schematic of C4-2350-GigE digital inputs



Schematic of C4-2350-GigE digital outputs



Description of LEDs

LED	Description
1 (PWR)	During boot: Green On = FPGA configuration done Red On = Loader Stop. Boot failed. No valid Image could be loaded. After boot: Green On= Boot completed
2 (USR)	During boot: Green fast blink = boot procedure takes places Green blink = Configuration Error, FPGA configuration failure. Boot procedure is repeated up to 3 times, after which the Factory-Image is loaded. Green On = camera start up completed, FPGA configuration success Off = FPGA configuration successful after error recovery Red On = a boot error has occurred After boot: Red On= no network found Off = network found Green On=CCP status connected
3 (LSR)	On = Laser is ON Off = Laser is OFF
4 (GigE_left)	Green blink = Indication of network activity
5 (GigE_right)	Green On = Linkspeed 1 Gbit Yellow On = Linkspeed 100 Mbit Off = Linkspeed 10 Mbit or wait for end of autonegotiation

Integrated RS232 serial interface and Camera Boot Log

During boot procedure, the camera outputs a log via the integrated RS232 serial interface. The external C4-I/O-Panel provides a D-sub 9-pin male socket for monitoring the boot log. A null-modem cable (crosslinked) must be used to connect the C4-I/O-Panel to a host PC. The parameters of the serial communication are listed as follows:

Baudrate	115200
Data bits	8
Parity	None
Stopbits	1
Handshake	None

Sample camera boot log

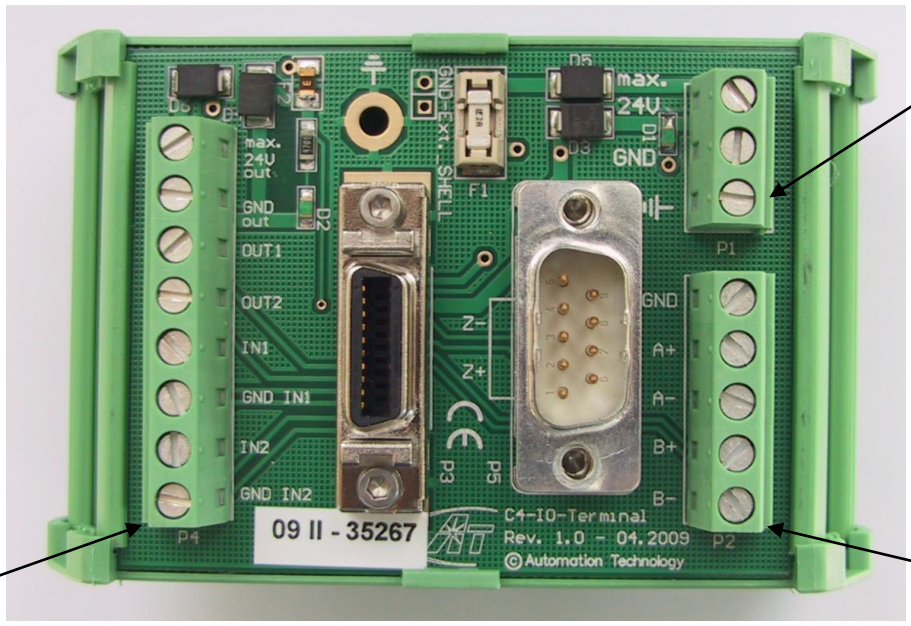
```
**************************************
Bootloader(build Sep 15 2010, 09:08:34)
Executing program starting at address: 000020c4
**************************************
00000000: Virtex core temperature: 34.74 °C
00000000: DCMs locked (0x20C00000).
00000000: DCMs locked (0x30C00000).
00001000: SERDES preset mode.
calib ch 0 0x0083F400 s0 m16 e63 w0, ok1 nok0
calib ch 1 0x0183F400 s0 m16 e63 w0, ok1 nok0
calib ch 2 0x0283F400 s0 m16 e63 w0, ok1 nok0
calib ch 3 0x0383F400 s0 m16 e63 w0, ok1 nok0
calib ch 4 0x0483F400 s0 m16 e63 w0, ok1 nok0
calib ch 5 0x0583F400 s0 m16 e63 w0, ok1 nok0
calib ch 6 0x0683F400 s0 m16 e63 w0, ok1 nok0
calib ch 7 0x0783F400 s0 m16 e63 w0, ok1 nok0
calib ch 8 0x0883F400 s0 m16 e63 w0, ok1 nok0
calib ch 9 0x0983F400 s0 m16 e63 w0, ok1 nok0
calib ch 10 0x0A83F400 s0 m16 e63 w0, ok1 nok0
calib ch 11 0x0B83F400 s0 m16 e63 w0, ok1 nok0
calib ch 12 0x0C83F400 s0 m16 e63 w0, ok1 nok0
calib ch 13 0x0D83F400 s0 m16 e63 w0, ok1 nok0
calib ch 14 0x0E83F400 s0 m16 e63 w0, ok1 nok0
calib ch 15 0x0F83F400 s0 m16 e63 w0, ok1 nok0
```

calib ch 16 0x1083F400 s0 m16 e63 w0, ok1 nok0
00001071: HardwareInit done.
00001075: Load Bootstrap registers.
00001077: **********
00001081: Camera type: 2350
00001083: Model: C4_2350_GigE
00001086: Sensor Version 3.52
00001089: MAC: 0-50-C2-8E-D4-E
00001092: Serial Number: 20607115
00001095: Device Version: 1.2.0
00001097: Firmware Version: 1.3.0RC7.6
00001101: Application build: 1.1.7.1860 - Wed Sep 29 08:53:20 GMT 2010
00001107: LwIP build: Patched Lwlp 1.30 Mar 8 2010, 11:25:36
00001113: Installed Modules:
00001115: File: C4_2350_GigE_1.3.0.zip, Rev.: 1030000, Device: 1, Length: 19450
00001122: File: C4_2350_GigE.srec, Rev.: 1030000, Device: 1, Length: 754534
00001129: File: C4_2350_FPGA.bin, Rev.: 1030000, Device: 1, Length: 1867024
00001135: File: cpld2350.xsvf, Rev.: 1000500, Device: 4, Length: 90213
00001142: File: sensor.xsvf, Rev.: 3060000, Device: 3, Length: 9549725
00001148: GEV Version 1.1
00001150: XML-URL1: Local:C4_2350_GigE_1.3.0.zip;8C400904;4BFA
00001156: XML-URL2: http://www.automationtechnology.de/genicam/C4_2350_GigE_1.3.0.zip
00001163: IP config mode:
00001166: Persistent IP
00001168: IP: 169.254.64.2
00001170: Netmask: 255.255.0.0
00001173: Gateway: 0.0.0.0
00001175: LLA always ON.
00001178: **********
LwIP Msg: PHY address is: 0.
LwIP Msg: Auto-negotiated link speed: 1000.
00001367: Wait for end of IP configuration...
00001370: Start IP configuration with persistent IP
00001374: Enable hw InterPacketDelay.
00001378: Network interface is up, speed: 1000 Mbps
00001382: IP: 169.254.64.2
00001385: Netmask: 255.255.0.0
00001387: Gateway: 0.0.0.0
00001390: Assigned from static address

The External C4 I/O Panel

Clamp Pin Nr.	Signal Name	Description
P1 / 1	SCHIELD	camera shield
P1 / 2	GND_EXT	camera ground
P1 / 3	VCC_EXT	camera supply voltage (7-24V DC)
P2 / 1	ENC_B-	encoder Track2 RS422 reversible input (B-)
P2 / 2	ENC_B+	encoder Track2 RS422 none reversible input (B+)
P2 / 3	ENC_A-	encoder Track1 RS422 reversible input (A-)
P2 / 4	ENC_A+	encoder Track1 RS422 none reversible input (A+)
P2 / 5	ENC_GND	encoder ground is connected to camera ground
P4 / 1	GND_IN2	GND for optoisolated Input2
P4 / 2	IN2	optoisolated Input2
P4 / 3	GND_IN1	GND for optoisolated Input1
P4 / 4	IN1	optoisolated Input1
P4 / 5	OUT1	optoisolated Output1
P4 / 6	OUT2	optoisolated Output2
P4 / 7	GND_OUT	Ground of camera optoisolated outputs
P4 / 8	VCC_OUT	Power supply voltage of camera optoisolated outputs (5V/24V DC)

- the optoisolated inputs of the C4 I/O panel can be operated with 5V or 24 V DC
- the panel features a 2A fuse for camera protection
- in order to avoid signal noise, do not connect the main ground GND_EXT to other GND signals
- a D-sub 9-pin male connector is provided for monitoring the camera during boot over the integrated RS232 serial interface



Service Information

Document Revision

Rev. Nr.	Date	Modification
1.0	28.05.2009	First version
1.1	11.09.2009	Update (GenICam XML file, Trigger Modes, LED, RS232 and boot log)
1.2	03.12.2009	Update GenICam Features
1.3	12.02.2010	Update GenICam Features, Trigger Modes, Specification
1.4	05.10.2010	Update GenICam Features, Trigger Modes, Chunk Data Mode
1.5	05.04.2011	Minor corrections, added I/O schematics
1.6	05.01.2012	Update CXC file, GEV Events, Dataout structure

Product Information and Updates

Updates

www.AutomationTechnology.de

Service and Support

service@AutomationTechnology.de

In order to process your support inquiries immediately, we always need the serial number of the camera, a dump of configuration EEPROMs, a snapshot and a precise problem description.

Product Inquiries and Price Quotations

info@AutomationTechnology.de

Warranty Conditions

Only the manufacturer can recognize the conditions of warranty. Should other parties than the manufacturer be responsible for the malfunctioning, we consider the right of warranty as void. This is the case if the unit is modified electrically or mechanically, particularly in its wiring/soldering, or if the unit is used for purposes not intended by the manufacturer, or if the unit's external wiring is faulty, or if the unit is used under conditions outside those stated in its manual.