C4-2350-GigE Camera

Hardware Reference Manual

Rev 2.5

AT - Automation Technology GmbH

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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),

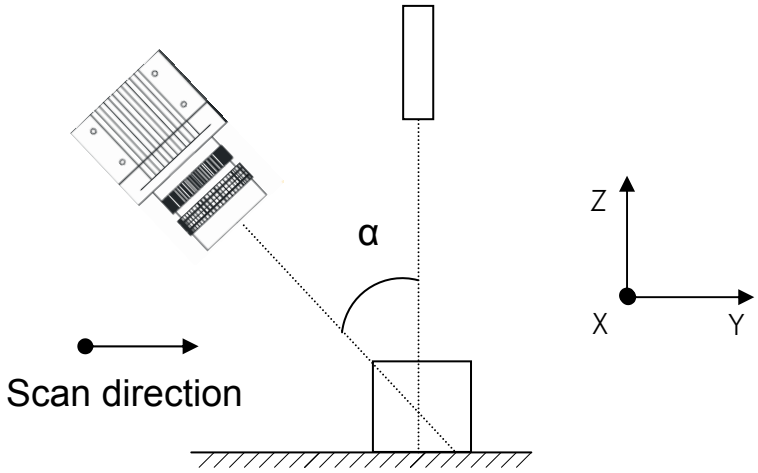
ΔY= resolution perpendicular to the laser line (longitudinal in the direction of motion),

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.

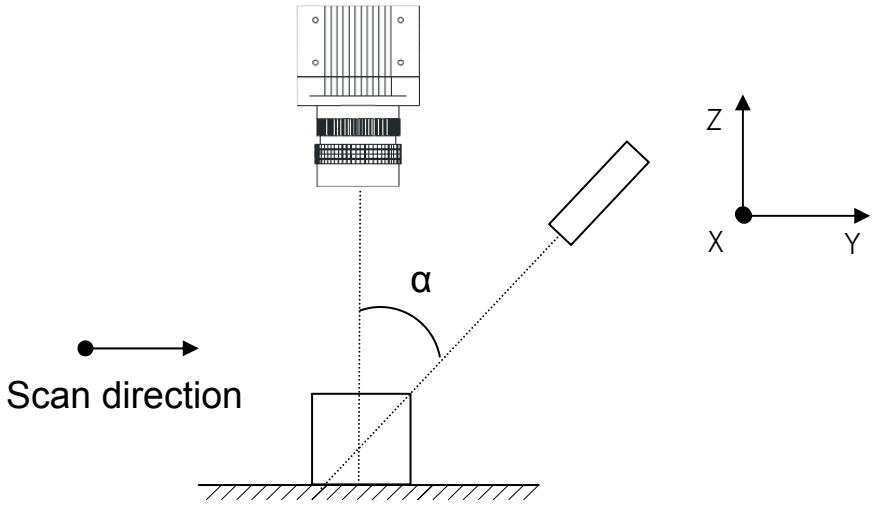
The height resolution can be approximated: $\Delta Z \approx \Delta X / \sin(\alpha)$



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: $\Delta Z \approx \Delta X / \tan(\alpha)$

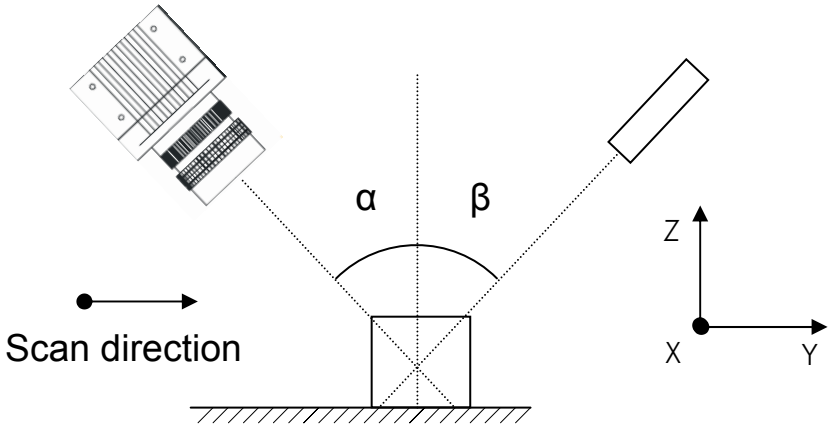


Geometry 3

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: $\Delta Z \approx \Delta X * \cos(\beta) / \sin(\alpha + \beta)$,

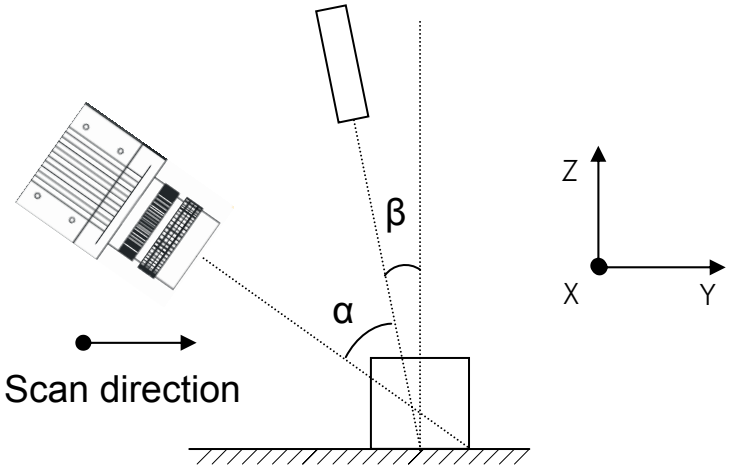
in case $\alpha = \beta$ (direct reflex) : $\Delta Z \approx \Delta X / 2 * \sin(\alpha)$



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: $\Delta Z \approx \Delta X * \cos(\beta) / \sin(\alpha)$,



The C4-2350-GigE Camera General Specifications

Camera Controls	
Synchronization Modes	Free running, Triggered, Software Triggered
Exposure Modes	Programmable, Pulse controlled
Shutter Modes	Rolling Shutter
Digital Trigger Input	2 optoisolated inputs
	5 V Level
	VIL, logic "0" Voltage < 1.5 V
	VIH, logic "1" Voltage > 3.5 V
	24V Level (with C4-I/O-Panel only)
	VIL, logic "0" Voltage < 7.5 V
	VIH, logic "1" Voltage > 17.0 V
Digital Output	2 optoisolated outputs
	VOL, logic "0" Voltage 0.6 V
	VOH, logic "1" Voltage VCC (internal 20 kOhm pull-up)
	IOH, logic "1" output current (internal 20 kOhm pull-up)
	IOL, logic "0" output current 9 mA
Encoder Trigger Input	RS422 Standard with 100 Ohm termination
Illumination Control	Power 5 V DC, 200 mA, Modulation 20 kHz

Features	
3D-Algorithms	MAX, TRSH, COG
High Speed Acquisition	Full frame: 190 fps
Multiple AOIs / Laser lines	Up to 4

Optical Interface	
Lens Mount	M42x1 with Back Focal Distance 6.52 mm
Adapter for C-Mount lens (must be ordered separately)	Back Focal Distance 17.52 mm
Adapter for F-Mount lens with Bajonett mount (must be ordered separately)	Back Focal Distance 46.50 mm

Mechanical Interface

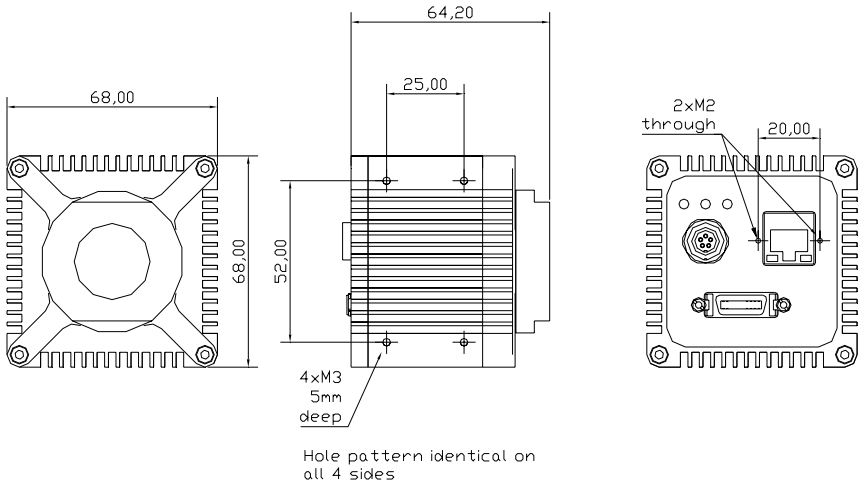
Camera Size	68 mm x 68 mm x 64.2 mm (C-Mount)
	68 mm x 68 mm x 93.2 mm (F-Mount)
Mass (without optics)	350 g (C-Mount), 420 g (F-Mount)
Power connector	20-pin MDR
Ethernet connector	RJ45
Illumination control connector	5-pin M9

Electrical Interface

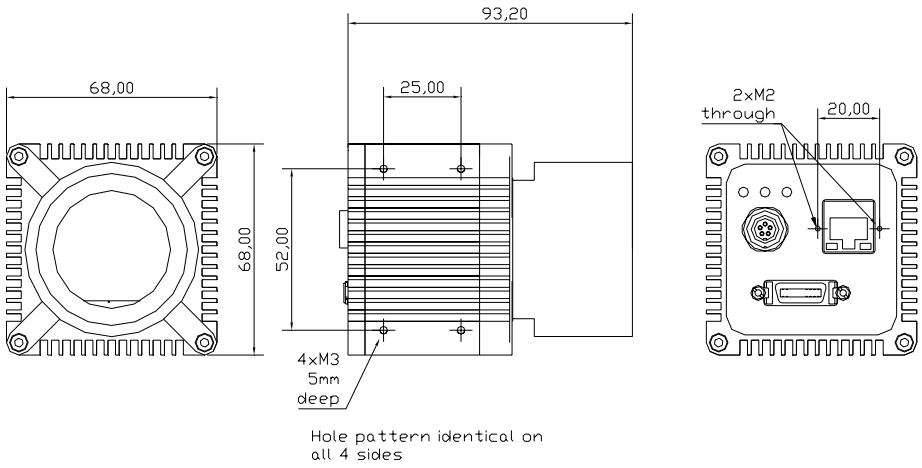
Input Voltage	10 – 24 V DC
Power consumption	< 10 W
Operating Temperature	0 °C to +50 °C (non condensing)
Output Data Interface	Gigabit Ethernet (IEEE 802.3)
Communication Protocol	GigE Vision with GeniCam

Mechanical Drawings:

C4-2350-GigE with C-Mount adapter:



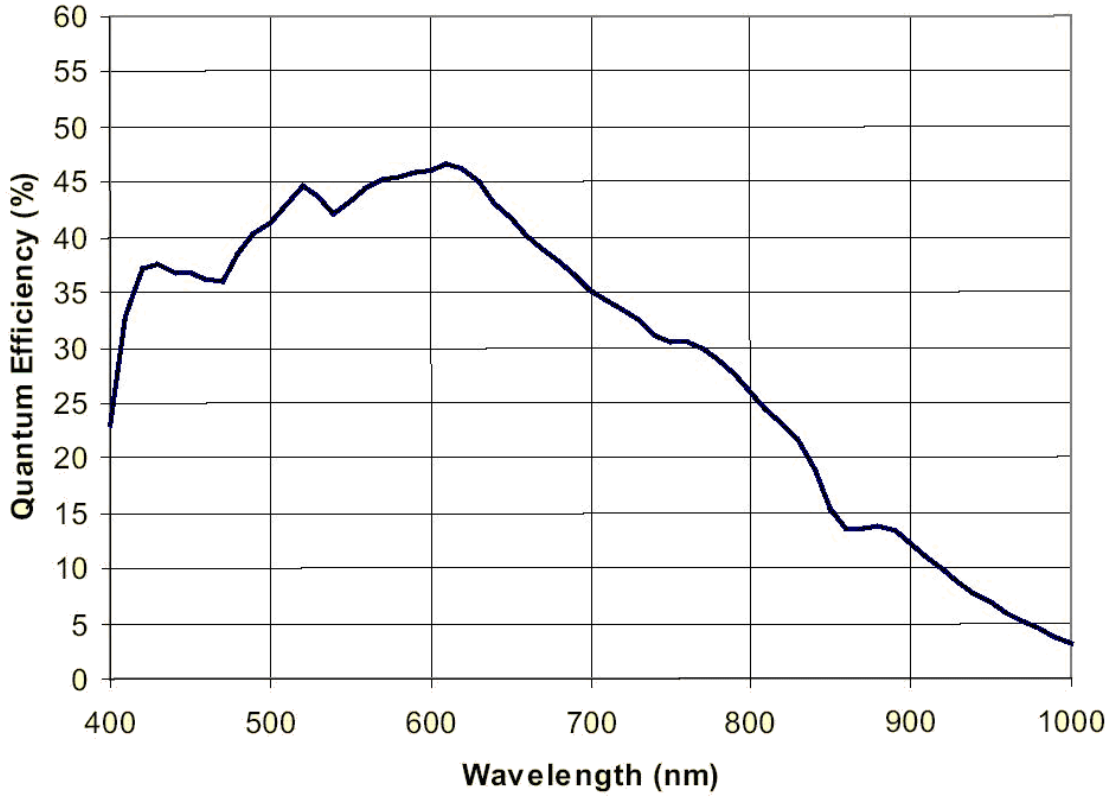
C4-2350-GigE with F-Mount adapter:



The C4-2350-GigE CMOS Imager Specifications

Parameters	Specifications	
Sensitivity at peak response	17000 LSB / μJ / cm^2 @ 610 nm	
Resolution	2352 x 1728 pixels	
Pixel Size	7 μm x 7 μm	
Sensor Size	16.46 mm x 12.10 mm, diagonal: 20.43 mm	
Sensor Format	1″	
Sensor ADC Resolution	10 bit	
Sensor Dynamic Range	59 dB	
Max. Internal Full-Frame Rate	190 fps	
Max. External Full-Frame Rate (limited due to GigE bandwidth)	25 fps	
Effective Frame / Profile Rate at Max. Row Length	Number of Rows	Effective Frame / Profile Rate (Hz)
	14	23450
	27	12160
	108	3040
	216	1520
	432	760
	864	380
	1728	190

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 sensor 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
AcquisitionMaxBufferedFrameCount	AT	IInteger	R	Maximum number of buffered frames

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).

Name	Rev.	Interface	Access	Description
PosValidationEn	AT	IBoolean	R/W	Enable validation of position value of a Gauss curve 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: Symbolic Value / Integer Value - Out1_IntegrationActive: 0 - Out1_SequencerActive: 1 - Out1_High: 4 - Out1_Low: 5 - Out1_InternalTrigger: 6 - Out1_SequencerTriggerActive: 7
Output2	AT	IEnumeration	RW	Selects the output signal for OUT2: Symbolic Value / Integer Value - Out2_IntegrationActive: 0 - Out2_High: 3 - Out2_Low: 4 - Out2_TriggerOverrun: 5 - Out2_ResolverCountDir: 6 - Out2_TriggerBusy: 7
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)
Output1MinPulseWidth	AT	IInteger	R/W	Output1 minimum pulse width in microseconds (µs)
Output2MinPulseWidth	AT	IInteger	R/W	Output2 minimum pulse width in microseconds (µs)

Name	Rev.	Interface	Access	Description
Output1Delay	AT	IInteger	R/W	Output1 delay in microseconds (µs)
Output2Delay	AT	IInteger	R/W	Output2 delay in microseconds (µs)
Output1Invert	AT	IBoolean	R/W	True: Output1 inverted False: Output1 not inverted
Output2Invert	AT	IBoolean	R/W	True: Output1 inverted False: Output1 not inverted

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	IEnumeration	R/W	Enables trigger mode using single channel resolver: - Off - Enable A/IN1 - Enable B/IN2
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
UseAlternateResolverInputs	AT	IBoolean	R/W	True: Use IN1/IN2 instead of A/B as encoder input False: Use A/B as encoder input
UseAlternateResolverInputsInverted	AT	IBoolean	R/W	True: Invert encoder input over IN1/IN2 False: Do not invert encoder input over IN1/IN2

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
GevSupportedIPConfigurationDHCP	1.2	IBoolean	R	Indicate if DHCP is supported by the selected 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

Name	Rev.	Interface	Access	Description
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 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 - TransferStart - TransferEnd
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. - Read - Write

Name	Rev.	Interface	Access	Description
				- ReadWrite
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: - Success - Failure
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:

```
CameraMode CenterOfGravity
ProfileTriggerMode FreeRun
EnableDC2 1
EnableDC1 0
TestImageSelector Off
PixelFormat Mono8
Width 2352
ReverseY 0
ExposureTimeAbs 100
FramePeriode 5218
ShortIntegrationMode 1
DarkOffsetEnable 1
UsePersistentFPNdata 1
NumAois 1
AoiSelector 1
AoiHeight 1728
AoiOffsetY 0
AoiThreshold 128
AbsOffsetPos 0
TrshFirstFalling 0
NumCOGSP 6
ValidationWidthMin 0
ValidationWidthMax 1727
ValidationSumMin 0
ValidationSumMax 65535
CameraMode CenterOfGravity
ProfilesPerFrame 100
ClearInvalidPos 0
PosValidationEn 0
EnableDC0 0
EnableDC1 0
EnableDC1TrshWidth 0
EnableDC1Width 0
EnableDC1Flags 0
EnableDC2 1
EnableDC2TrshSP 0
EnableDC0Shift 1
AcquisitionFrameCount 1
AcquisitionMode Continuous
Output1 Out1_SequencerActive
Output2 Out2_IntegrationActive
LaserPower 0
TurnLaserOn 0
TurnLaserOnAuto 0
Output1MinPulseWidth 0
Output2MinPulseWidth 0
Output1Delay 0
Output2Delay 0
Output1Invert 0
```

Output2Invert 0
SequencerMode FreeRun
ProfileTriggerMode FreeRun
GevStreamChannelSelector 0
GevSCPSPacketSize 1500
GevSCPD 5000
ChunkModeActive 0
EventSelector None
EventNotification Off
EventSelector AcquisitionStart
EventNotification Off
EventSelector AcquisitionEnd
EventNotification Off
EventSelector TransferStart
EventNotification Off
EventSelector TransferEnd
EventNotification Off
EventSelector AcquisitionStart

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.

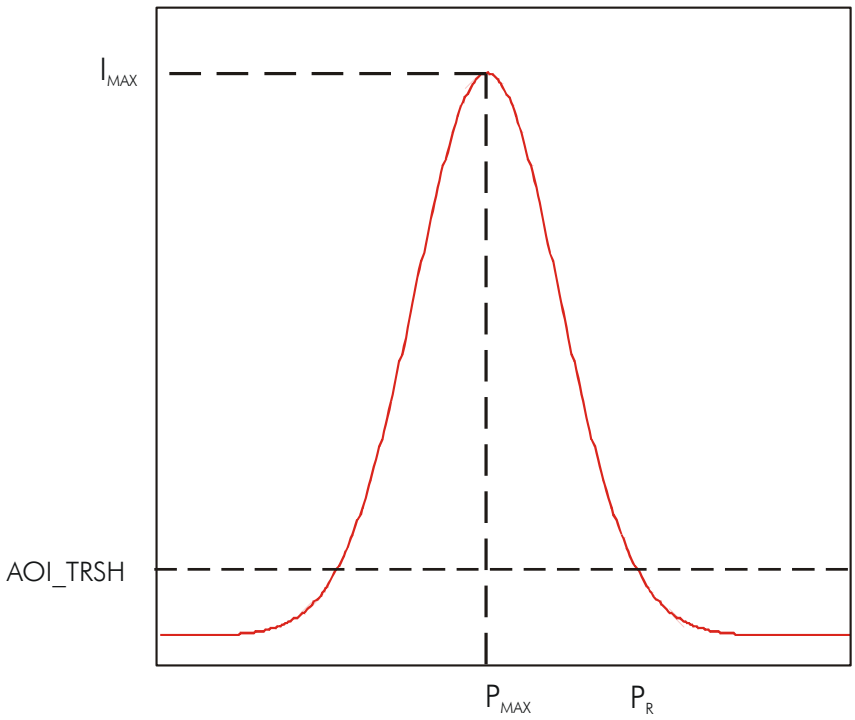
In all profile modes only intensity values higher than the AOI intensity threshold AOI_TRSH are processed in order to suppress weak signal noise. In case that no position value can be found, e.g. no intensity value is higher than threshold, the position value 0 is returned.

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)

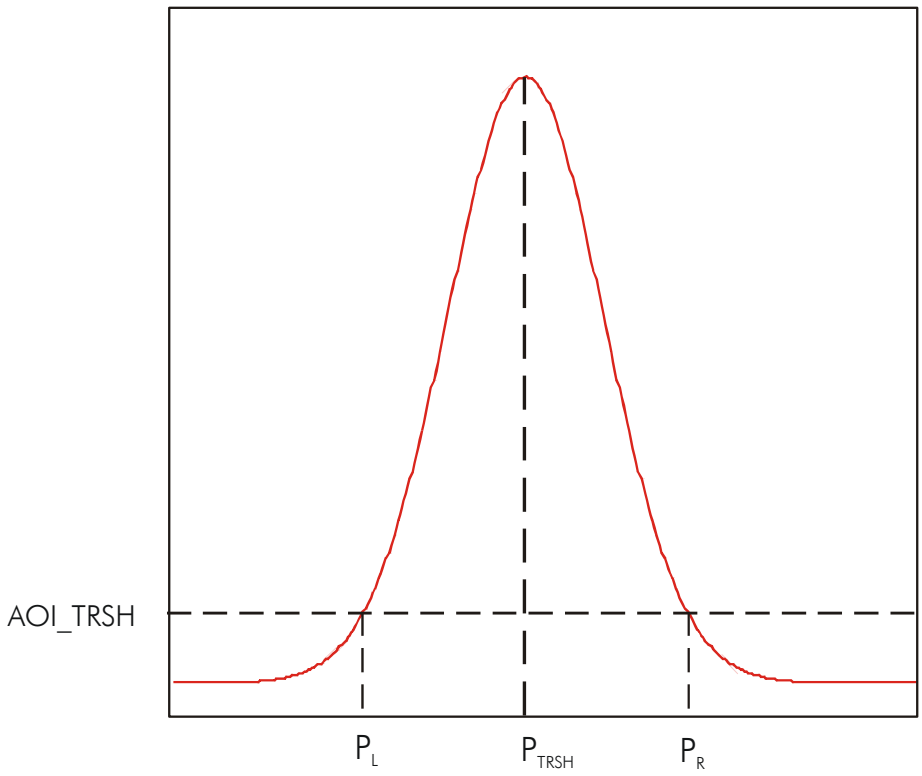
In this mode the position of the maximum intensity of laser beam profile is calculated. The result includes the position value of the maximum (P_{MAX}) as well as the maximum intensity value (I_{MAX}).



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 3454 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.

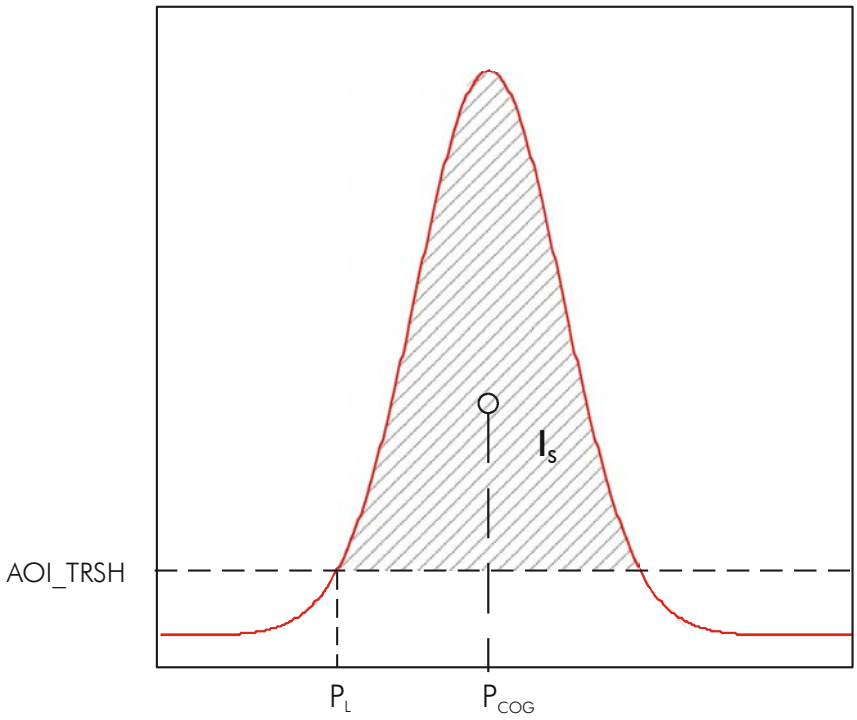
The Center Of Gravity Mode (COG)

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, DC1 and DC2

Camera Mode	DC0	DC1	DC2
Image	Sensor intensity	Not used	Not used
MaximumIntensity	Maximum intensity of Gauss	Position of rising edge of Gauss (PosL)	Position of maximum intensity of Gauss (PosM)
Threshold	Maximum intensity of Gauss	- Position of rising edge of Gauss (PosL) or - Gauss width (PosR-PosL)	- Position of falling edge of Gauss (PosR) or - Position of Gauss with 1/2 pixel resolution (PosL+PosR)
CenterOfGravity	Sum of intensity values of Gauss I_s	- Position of rising edge of Gauss (PosL) or - Gauss width (PosR-PosL)	Position of center of gravity of Gauss with $1/(2^N)$ pixel resolution, where N=number of subpixel bits (0-6)

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,

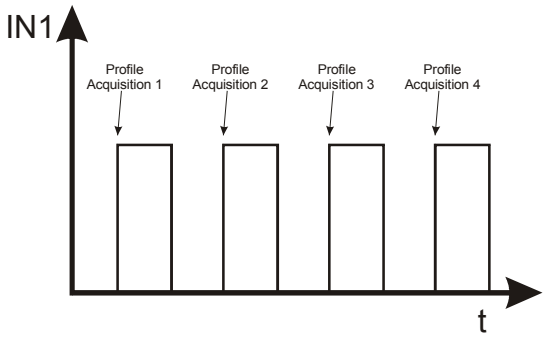
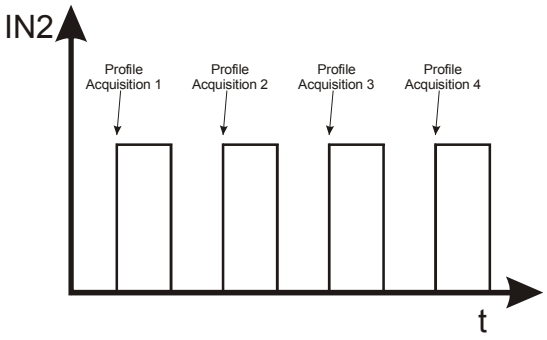
EnableDC1=false

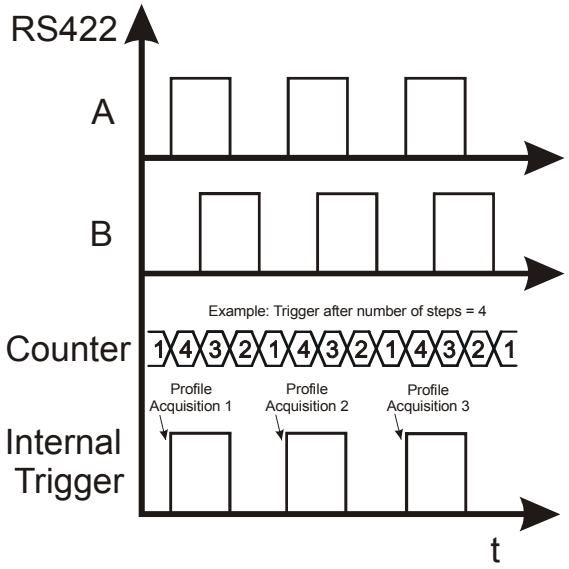
EnableDC2=true

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

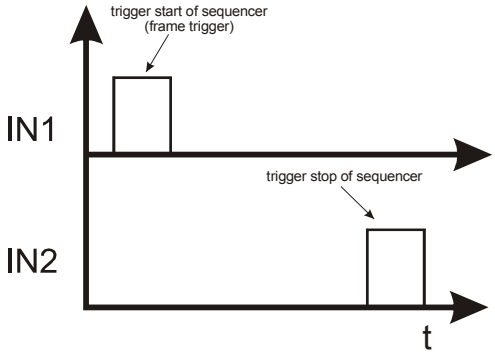
No.	Profile Trigger Mode (PTM)
0	Free-run (PTM0)
1	Camera input 1 (PTM1) 
2	Camera input 2 (PTM2) 

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

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

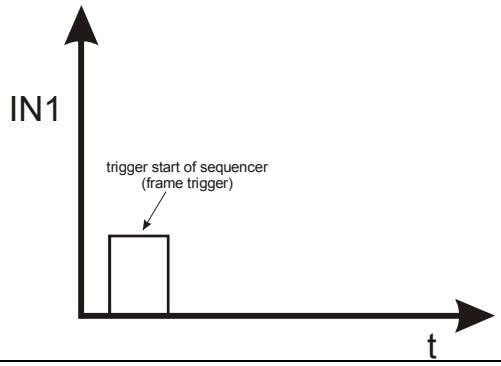
<table>
<tr><th>No.</th><th>Sequencer/Frame Trigger Mode</th><th>Profile Trigger Mode (PTM)</th></tr>
<tr><td rowspan="4">0</td><td rowspan="4">Free-run</td><td>PTM0 (free-run)</td></tr>
<tr><td>PTM1(IN1)</td></tr>
<tr><td>PTM2 (IN2)</td></tr>
<tr><td>PTM3 (RS422)</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Start/stop over camera input 1 / 2

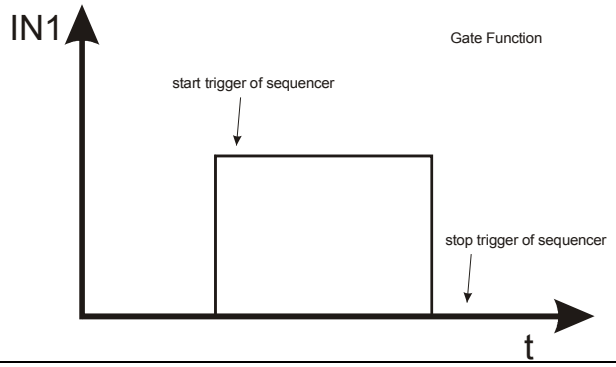
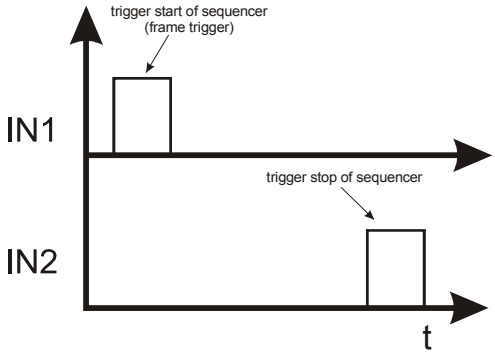
Continuous frame acquisition is started with the rising edge of camera input 1 (IN1) and stopped with rising edge of camera input 2 (IN2)

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 Continuous 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 identifying 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.

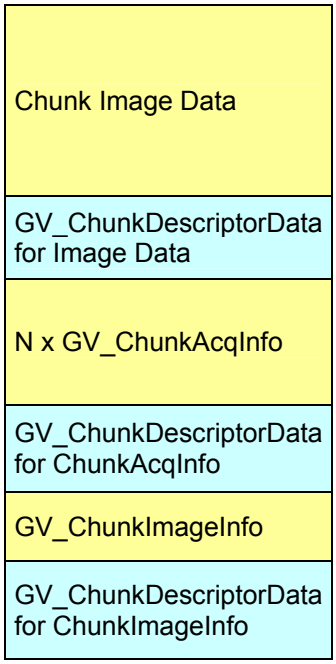
When ChunkMode is disabled, the camera uses the “regular“ GEV image protocol, in which the optional transfer of frames with variable height and payload is supported.

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)

#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_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             DAC;             // 17..18
          unsigned short             ADC;             // 19..20
          unsigned char              INT_idx;         // 21
          unsigned char              AOI_idx;         // 22
          unsigned short             AOI_ys;          // 23..24
          unsigned short             AOI_dy;          // 25..26
          unsigned short             AOI_xs;          // 27..28
          unsigned short             AOI_trsh;        // 29..30
          unsigned char              AOI_alg;         // 31
} GV_ChunkAcqInfo;


#define CHUNKIMAGEINFO_FLAG_BIT_START_FRAME                 0x01
#define CHUNKIMAGEINFO_FLAG_BIT_STOP_FRAME                  0x02
#define CHUNKIMAGEINFO_FLAG_BIT_BUFFER_OVERRUN              0x04

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


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

#pragma pack(pop)
```

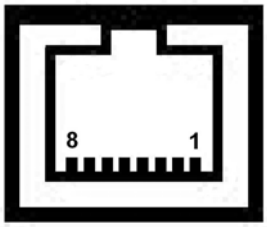
The GigE-Vision Events of C4-2350-GigE

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	36882	Frame Acquisition is started
AcquisitionEnd	36883	Frame Acquisition is terminated
TransferStart	36884	Frame transfer is started from the camera
TransferEnd	36885	Frame transfer is terminated

C4-2350-GigE Camera Interface

The GigE Interface



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

The I/O & Power Interface

Pin Nr.	Signal Name	Description
1	GND_EXT	main camera ground
2	VCC_EXT	camera supply voltage (10 – 24 V 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 (5 V)
10	IN2	optoisolated Input2 (5 V)
11	GND_EXT	main camera ground
12	VCC_EXT	camera supply voltage (10 – 24 V 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+)
17	VCC_OUT	Power supply voltage of camera optoisolated outputs (5 V / 24 V DC)

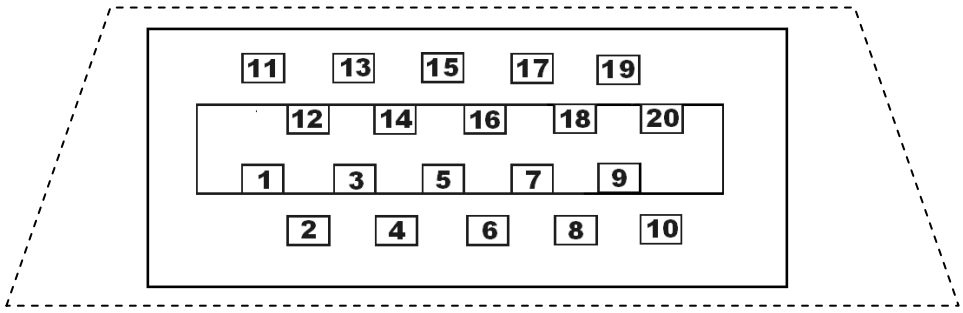
Pin Nr.	Signal Name	Description
18	GND_OUT	Ground of camera optoisolated outputs
19	GND_IN1	GND for optoisolated Input1
20	GND_IN2	GND for optoisolated Input2
Shield	SHIELD	is connected to camera case

Part Numbers for I/O Connector MDR 20

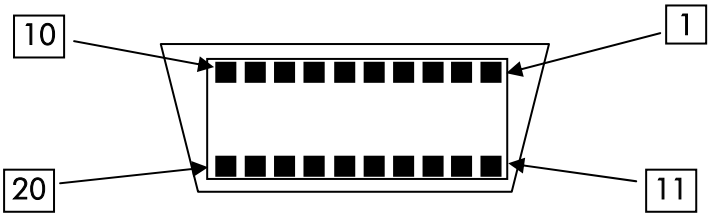
Description	Part Number 3M
20-pin Connector	10120
lockable connector case	10320

MDR20 I/O Connector Pin Assignment

Cable Plug: View from solder side:

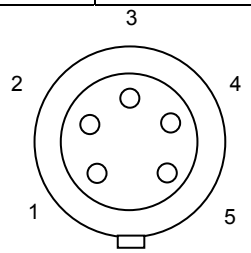


Camera Receptable: View from rear side of camera:



The Illumination Control

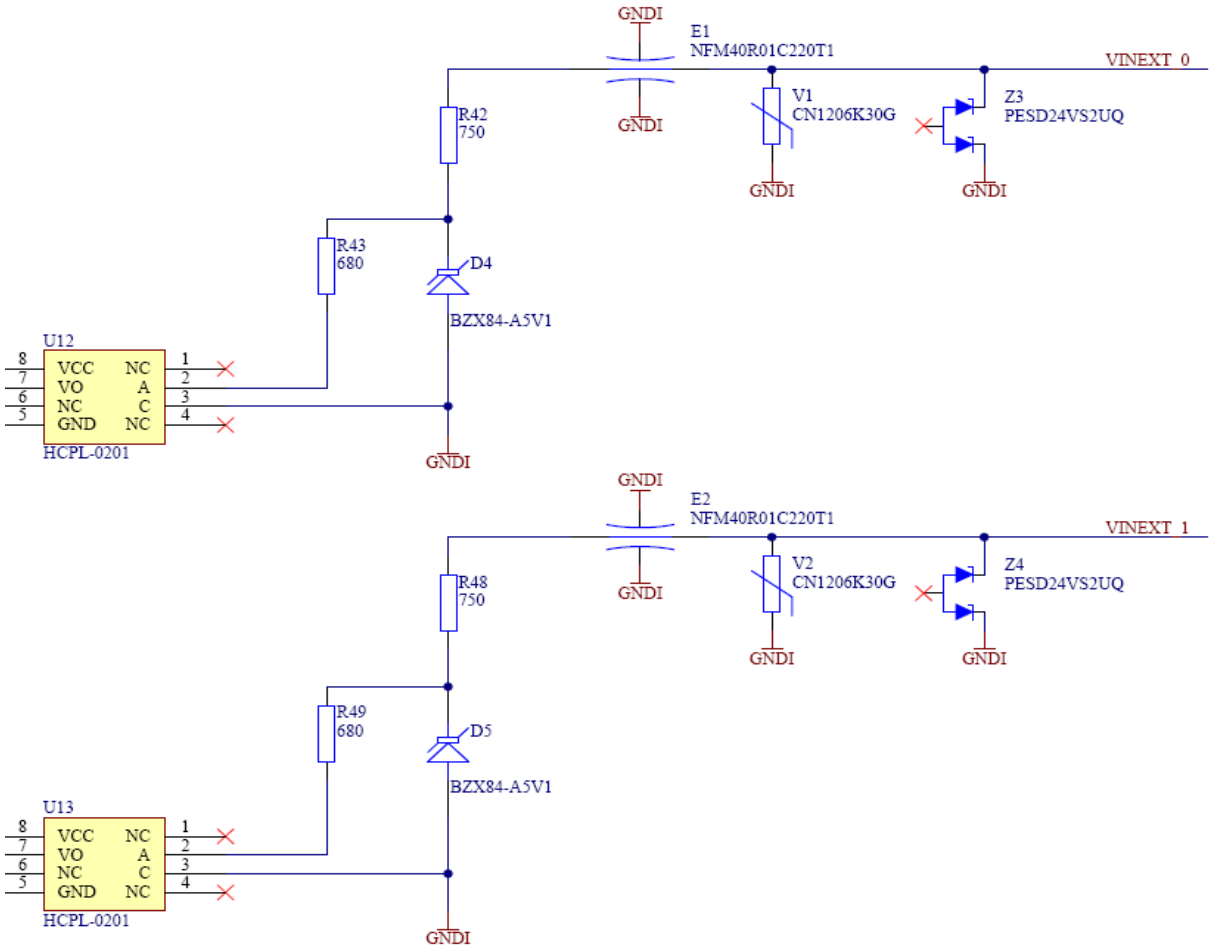
Pin Nr.	Signal Name	Description
1	VCC_LASER	Output to power the illumination device (5 V, max. 200 mA, fused)
2	GND_LASER	Ground for illumination device
3	LASER_DOUT	Output for digital modulation of illumination device (TTL signal)
4	LASER_AOUT	Output for analog modulation of illumination device (0 –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



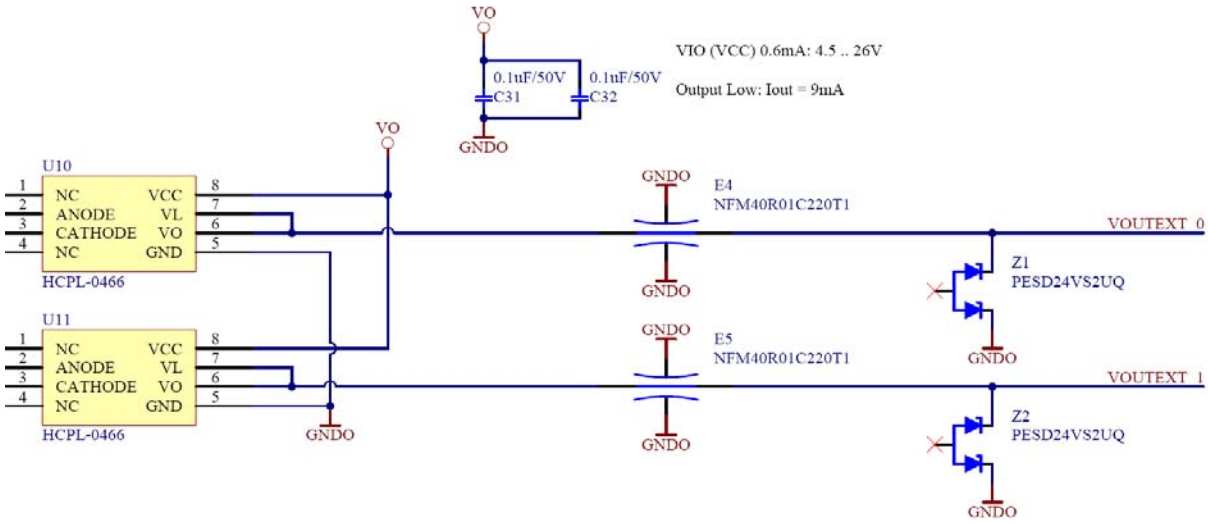
Part Number for Illumination Control Connector

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

```
**************************************
MCB InitDone. (WaitClks 92637(104465))
Bootloader(build Jan  6 2012, 12:36:24)

Executing program starting at address: 0x50000000
**************************************
00004677 ms: Camera start.
------------------------------------------
Start HardwareInit.
Reset sensor.
PLL sensor.
Wait PLL locked. Locked.
Start sensor streaming.
StreamAlignMV40 done.
Stream pattern stable (0x032A).
Start serdes error monitor.
Reset sensor to defaults.
------------------------------------------
Ready to start GEV.
00004721 ms: Start system monitoring.
Stack info: Current Stack position changed to 0x00001F94.
00004729 ms: Load Bootstrap registers.
00004733 ms: **************************************
00004737 ms: Camera type: 2350
00004740 ms: Model: C4_2350_GigE
```

00004743 ms: MAC: 0-50-C2-8E-D4-77

00004746 ms: Serial Number: 20607220

00004749 ms: Device Version: 2.0.0

00004752 ms: Firmware Version: 1.3.5

00004756 ms: Application build: Development 1.4.0.1477 - Wed Apr 25 14:13:21 2012

00004763 ms: LwIP build: Patched Lwlp 1.30 Mar 16 2012, 08:59:34

00004769 ms: Installed Modules:

00004772 ms: File: C4_2350_GigE_1.3.3.zip, Rev.: 1030300, Device: 1, Length: 19202

00004779 ms: File: Bitstream.bin, Rev.: 1030300, Device: 1, Length: 2453092

00004786 ms: File: Bitstreamfb.bin, Rev.: 1030300, Device: 1, Length: 2453092

00004792 ms: File: 2350S6.srec, Rev.: 1030300, Device: 1, Length: 710970

00004799 ms: File: 2350S6.srec, Rev.: 1030300, Device: 1, Length: 710970

00004805 ms: GEV Version 1.1

00004808 ms: XML-URL1: Local:C4_2350_GigE_1.3.3.zip;0x8C400904;0x4B02

00004814 ms: XML-URL2: http://www.automationtechnology.de/genicam/C4_2350_GigE_1.3.3.zip

00004822 ms: IP config mode:

00004824 ms: Persistent IP

00004827 ms: IP: 169.254.64.2

00004829 ms: Netmask: 255.255.0.0

00004832 ms: Gateway: 0.0.0.0

00004835 ms: LLA always ON.

00004838 ms: ************************************

00004943 ms: Persistent FPN data not found. Sensor auto calibration.auto-negotiated link speed: 1000

00004972 ms: Wait for end of IP configuration...

00004975 ms: Start IP configuration with persistent IP

00004980 ms: Enable hw InterPacketDelay.

00004983 ms: Network interface is up, speed: 1000 Mbps

00004988 ms: IP: 169.254. 64. 2

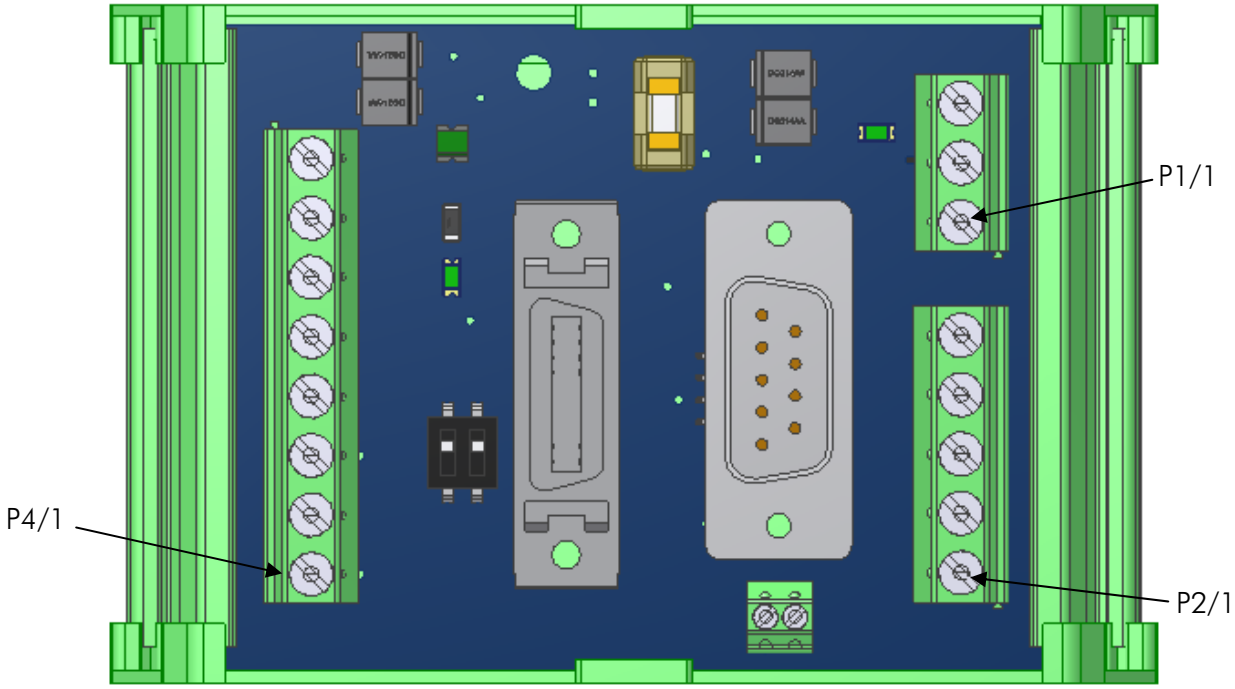
00004992 ms: Netmask: 255.255. 0. 0

00004995 ms: Gateway: 0. 0. 0. 0

00004998 ms: Assigned from static address

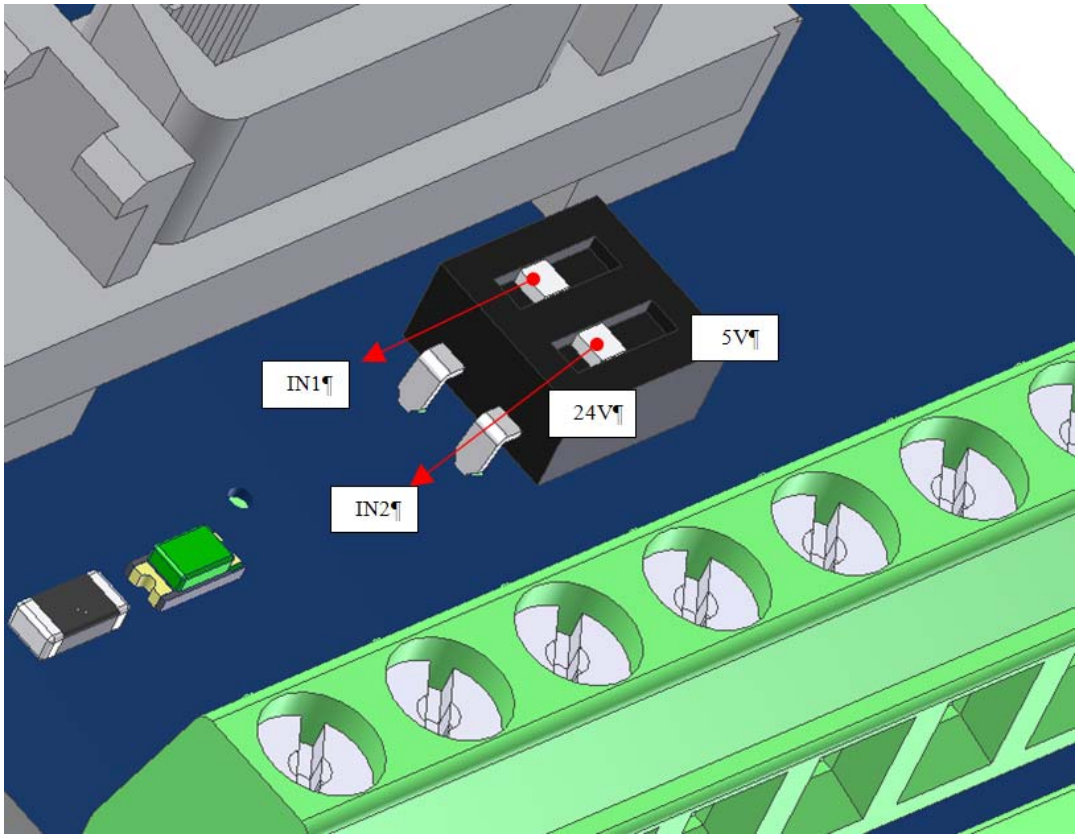
The External C4-I/O-Panel (#202 182 006)

Revision 1.3



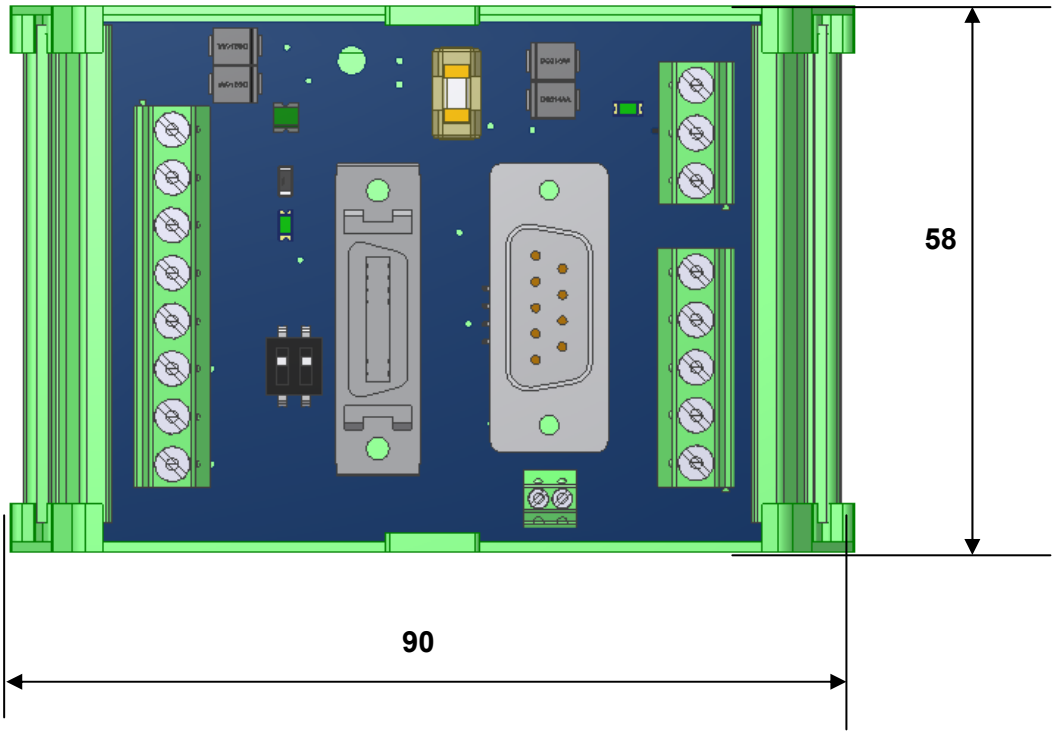
Clamp Pin Nr.	Signal Name	Description
P1 / 1	SCHIELD	camera shield
P1 / 2	GND_EXT	camera ground
P1 / 3	VCC_EXT	camera supply voltage (10 – 24 V DC)
P2 / 1	ENC_B-	encoder Track2 RS422 reversible input (B-)
P2 / 2	ENC_B+	encoder Track2 RS422 none reversible input (B+)
P2 / 3	ENC_A-	encoder Track1 RS422 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 (5 V / 24 V)
P4 / 3	GND_IN1	GND for optoisolated Input1
P4 / 4	IN1	optoisolated Input1 (5 V / 24 V)
P4 / 5	OUT2	optoisolated Output2
P4 / 6	OUT1	optoisolated Output1
P4 / 7	GND_OUT	Ground of camera optoisolated outputs
P4 / 8	VCC_OUT	Power supply voltage of camera optoisolated outputs (5 V / 24 V DC)

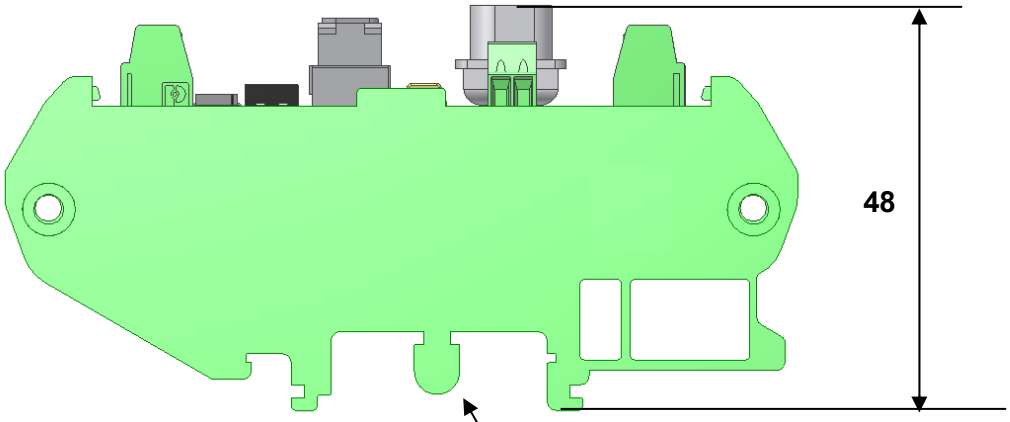
- the optoisolated inputs of the-C4-I/O panel can be operated either with 5V or 24V. The voltage level can be set over the DIP switch:



- 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

Mechanical Dimensions (mm)





Weight of C4-I/O-Panel: 50 g

Mount for DIN rail assembly

The C4 cables

Standard Power & I/O Cables

Part #	Description
202 182 012	C4 cable length 2 m, quick release latches, moulded shell
202 182 013	C4 cable length 5 m, quick release latches, moulded shell
202 182 014	C4 cable length 7 m, quick release latches, moulded shell
202 182 015	C4 cable length 10 m, quick release latches, moulded shell

High Flex Power & I/O Cables for Robot Applications

Part #	Description
202 182 007	C4 cable length 2 m, with locking screws on camera plug, high flex
202 182 016	C4 cable length 5 m, with locking screws on camera plug, high flex
202 182 008	C4 cable length 7 m, with locking screws on camera plug, high flex
202 182 009	C4 cable length 10 m, with locking screws on camera plug, high flex

High Flex GigE Cables for Robot Applications

Part #	Description
202 182 107	GigE cable length 2 m, with locking screws on camera plug, high flex
202 182 116	GigE cable length 5 m, with locking screws on camera plug, high flex
202 182 108	GigE cable length 7 m, with locking screws on camera plug, high flex
202 182 109	GigE cable length 10 m, with locking screws on camera plug, high flex

Miscellaneous

Part #	Description
202 182 401	Y-cable for simultaneously connecting fan and laser to the C4 camera. Please specify the cable length between camera and laser.
202 182 405	Cable for laser control, 5 pin, length 2 m, pigtail

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
1.7	13.08.2012	New XML registers, dimensions C4-I/O-Panel, minor additions and corrections
1.8	18.06.2013	Minor corrections, added C4 cables
1.9	28.11.2013	Minor corrections, 5V digital input limitation
2.0	28.02.2014	Minor corrections
2.1	01.04.2014	Minor corrections
2.2	05.06.2014	Minor corrections
2.3	11.08.2014	Added C4-I/O-Panel Rev. 1.3, minor corrections
2.4	20.02.2015	Minor corrections
2.5	20.06.2016	Minor corrections

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.