EoSens 4CXP Camera Reference Guide V2.9

4CXP Camera

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CHAPTER

1

Before You Start

Please, read this chapter carefully. It provides important information on

- how to use this reference guide
- conformity and use of the product
- the warranty and non-warranty clause and how to ask for repair service
- the EU Declaration of conformity

About This Reference Guide

This reference guide contains helpful information to install and operate the here described camera. It has been produced with care. Nevertheless, information might be erroneous or incomplete. MIKROTRON GmbH cannot be held responsible for any problems resulting from incomplete or erroneous information.

In case you detect errors or need further information, please inform us via mail:

info@mikrotron.de

or call +49 89 7263420

In case you need support, visit:

www.mikrotron.de/en/services/support.html

and send your request.

We highly recommend to read this reference guide carefully.

This reference guide is subject to change without notice.

Tips, Remarks, Notes and Warnings

This reference guide contains tips, remarks, notes, and warnings that are helpful and often important in order to avoid data loss or camera damage. They are emphasized as follows:

Tip: Gives hints.

Remark: Important information.

Note: Information concerning frame quality, timeouts, or other...

WARNING! Important information concerning data loss or camera damage.

Registered Trademarks

In this reference guide the following registered trademarks are used:

1. CoaXPress®
2. *EoSens®*
3. GenICam®
4. Microsoft® and Windows®

In the following, these trademarks are not specially marked as registered trademarks. This in no way implies that these trademarks can be used in another context without the trade mark sign!

Conformity and Use

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These requirements are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions given in this reference guide, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will have to correct the interference at its own expense.

Note: **You are herewith cautioned that any changes or modifications not expressly approved in this description could void your authority to operate this equipment.**

制造说明：

此设备的生产与测试依照 FCC 条例第 15 条条例，符合 A 类电子设备标准。产品提供在商用使用环境中的合理保护，以防止使用过程中可能涉及到的损害。

此设备会产生、使用并可发射出无线电波，如果未按照本手册中所述安装和使用，可能会对无线通信设备产生干扰。如本设备在居民区操作出现干扰等情况，用户需要自费处理。

备注：请注意，如未按照此使用说明操作而自行更改设备，那么您将无权使用本设备。

規制適合宣言とご使用について（米国 FCC)
この機器は、FCC 規則のパート 15 に定められたクラス A デジタル装置に関する規制要件に基づいて所定の試験が実施され、その適合が認証されています。　これらの規制要件は、商業環境において機器を使用する際、有害な干渉に対する妥当な保護を提供するために設けられています。この機器は、無線周波数エネルギーを生成かつ利用するとともに、放射することもあります。　このリファレンスガイドの指示に従って設置および使用が行われない場合は、無線通信に有害な干渉を引き起こす恐れがあります。　この機器を住宅地で利用すると有害な干渉を起こすこともあり、その場合、使用者は自己負担において適切な対策を講じる必要があります。
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Supplements

For customers in Canada

This apparatus complies with the Class A limits for radio noise emissions set out in Radio Interference Regulations.

Pour les utilisateurs au Canada

Cet appareil est conforme aux normes Classe A pour bruits radioélectriques, spécifiées dans le Règlement sur le brouillage radioélectrique.

Life Support Applications

The products described in this reference guide are not designed for use in life support appliances or devices and systems where malfunction of these products can reasonably be expected to result in personal injury.

DANGER! **MIKROTRON customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify MIKROTRON for any damages resulting from such improper use or sale.**

Warranty and Non-Warranty Clause

Warranty is described in §8 of our General Terms and Conditions which can be downloaded on MIKROTRONS' web-page:

www.mikrotron.de/en/terms.html

In addition, take the following non-warranty clauses into account.

Note The camera does not contain serviceable parts. Do not open the body of the camera. If the camera has been opened, the warranty will be void.

WARNING! **The camera has to be used with a supply voltage according to the camera's specification. Connecting a lower or higher supply voltage, AC voltage, reversal polarity or using wrong pins of the power connector may damage the camera. Doing so will void warranty.**

Note Our warranty does not protect against accidental damage, loss, or acts of nature.

Note MIKROTRON cannot be held responsible for the loss of data. We recommend a backup plan.

In case of warranty, please, make a note of the camera type and its serial number.

You find all necessary information on the identification plate of the camera.

Before sending back the camera, ask for a RMA (return merchandise authorization) number and RMA form either by:
phone: +49 - 89 - 7263 4250 or
e-mail: service@mikrotron.de

Then send the camera back to your distributor. If no distributor is available, send it back to MIKROTRON.

EU Declaration of Conformity
EU-Konformitätserklärung

MIKROTRON GmbH
Landshuter Str. 20-22
D-85716 Unterschleissheim
www.mikrotron.de

Phone: +49 (0)89 72634200
Fax: +49 (0)89 726342-99
Mail: info@mikrotron.de

We herewith declare under our sole responsibility that the products mentioned below:
Hiermit erklären wir in alleiniger Verantwortung, dass die folgenden Produkte:

Product type: Camera
Produkt: Kamera

Models: MC4082 and 4083, MC4086 and 4087
Modelle: MC4082 and 4083, MC4086 and 4087

are in conformity with the following EU directives:
den folgenden EU-Richtlinien entsprechen:

Title / Titel	EU Directive
RoHS Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment RoHS-Richtlinie zur Beschränkung der Verwendung bestimmter gefährlicher Stoffe in Elektro- und Elektronikgeräten	2011/65/EU
Approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC Angleichung der Rechtsvorschriften der Mitgliedstaaten über die elektromagnetische Verträglichkeit und zur Aufhebung der Richtlinie 89/336/EWG	2004/108/EC2014/30/EU

During conformity-testing the following standards were consulted:
Die Konformitätsvermutung wurde nach folgenden Standards überprüft:

Title / Titel	EU Standard
Information technology equipment - Immunity characteristics - Limits and methods of measurement Einrichtungen der Informationstechnik – Störfestigkeitseigenschaften - Grenzwerte und Prüfverfahren	EN55024:2011-09
Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement Einrichtungen der Informationstechnik – Funkstöreigenschaften - Grenzwerte und Messverfahren	EN55022:2011-12

CHAPTER

2

Introduction

This chapter describes the camera in general, which means, it informs about:

- the most important camera features and its sensor
- where it can be used
- what is part of the delivery
- system requirements

Overview

All cameras of the EoSens 4CXP family are CoaXPress compliant. These high-speed CMOS cameras come with a 4 Mega pixel sensor of 2336(H) x 1728(V).They are widely configurable and scalable to fit to your needs and are available in monochrome and color (Bayer Filter).

The CoaXPress high speed interface technology allows transfer rates of up to 6.25 Gbps. Your CXP camera supports CoaXPress Link Speeds from 1.25 Gbps to 6.25 Gbps.

In addition they offer a very high frame rate of over 560 fps at full resolution. By defining a Region of Interest (ROI) the frame rate can be increased to several 1000ths of frames.

Another important feature of 4CXP cameras is the high photo sensitivity of 1600 ASA (monochrome) or 1200 ASA (RGB).

Configuring the camera to Full HD resolution at 1920 x 1080 pixels using a frame rate of nearly 1000 fps opens a fascinating field of new applications. Full HD recordings are not only precious in industrial or high-speed applications but also when shooting a scene in high resolution documentary films or commercial clips.

The camera electronic is enclosed in a compact and solid full metal housing making it robust enough to comply with the requirements in heavy industrial surroundings. Shielded coaxial cables as recommended by the CoaXPress standard will support this.

4CXP cameras can be equipped with standard C-Mount or F-Mount lenses made for industrial purpose.

The most important features of the 4CXP camera are:

- 4 Mega pixel high speed CMOS sensor
- max. 560 fps
- more than 17,236 frames/s with reduced resolution
- 4/3” optical format (20.35 mm diagonal)
- active sensor area of 16.35 (H) x 12.10 (V) mm
- 7 μm^2 pixels
- max. 3 ROI
- resolution of 2336 x 1728 pixels
- speed raise will be reached by lines
- 11V/lux.s@550nm
- 10/8 bit pixel output (256 gray levels)

- dynamic range of 60dB
- fill factor 0.4
- asynchronous trigger
- trigger IN; strobe OUT
- trigger frequency of 150 (one edge) and 300 kHz in AnyEdge mode
- horizontal and vertical decimation
- FPN correction (5x5 matrix)
- CoaXPress link speeds: CXP1, CXP2, CXP3, CXP5 and CXP6
- wide power supply range of 12 – 24V

This high-speed camera comes with an electronically readable manual, describing all available GenICAM commands. For more information see "*Configuring the Camera*" on page 4-4.

Scope of Delivery

The following components are part of delivery. Please, check whether the delivery is complete, before you start installing the camera:

- Camera MC408x
- F-Mount or C-Mount lens adapter as ordered
- MIKROTRON's Support CD with
  - VCAM2 software
  - GenICam XML file
  - product documentation

Firmware can be updated remotely via a special updating software.

Tip: *In case you need a firmware update, inform MIKROTRON via mail: info@mikrotron.de*

Optional Accessories

Lenses: Only lenses for industrial purpose are suitable. To find lenses or other accessories, visit www.mikrotron.de/en

Cables

- The four bundle cable KKRDDINDINxx/6Gx4 with DIN 1.0/2.3 connector at both ends (4x) is available in lengths of 5, 10, 15, or 20 m. It is used to connect the frame grabber and camera when both are equipped with DIN 1.0/2.3 connectors.

Tip: *The triangle on the connector indicates connection number 1.*

- The cable KKRDDINBNCxx/6Gx4 with DIN 1.0/2.3 at one end and 4 BNC connectors at the other is available lengths of 5, 10, 15, 20 or 25m. It is used to connect a frame grabber with BNC sockets with the camera.

- 5W5: there are several cables (KKRD5W5BNCxx) for 6 GHz with a length of 5, 10, 15, 20 m or longer available. Please, contact your sales representative

- **Power Supply:** If you do not use power over CXP, you need an external power supply unit, e.g.:
  - MC4086/MC4087: NTCAM132x (12 V/2.5 A) with 12 pin Hirose connector (HR10A-10P-12S(73)) and 5 m cable or
  - MC4082/MC4083: NTCAM13xx with 6 pin Hirose (HR10A-7P-6P) connector and 5/10 m cable

  - MC4082/MC4083: NTCAM13xx with 6 pin Hirose connector and a strobe output and 5/10 m cable

- F-mount adapter

System Requirements

In order to use the MC408x camera you need:

- an image processing system, e.g.: PC and operating system according to the requirements of the frame grabber
- a completely installed frame grabber with device driver and software
- CoaXPress cable with DIN 1.0/2.3 or 5W5 connector
- if wanted, an external power supply (NTCAM132x or NTCAM13xx)

Tip: *Read more about frame grabbers that were tested with MIKROTRON cameras in the Application Note AN0036.*

Note All cables, connectors and the frame grabber have to be CoaXPress V1.1 compliant.

CHAPTER

3

The 4CXP Camera

The chapter describes the camera in general which means:

- the camera types and its differences
- its operating temperature and additional cooling
- how to connect frame grabber and an external power supply including pinning and internal circuit
- LED to verify the camera status
- correlation between transfer speed and resolution
- how to clean lens and sensor

Camera Description

4CXP cameras are available with 5W5 or DIN connector. All are equipped with the same sensor providing a resolution of 2336 x 1728 pixels.

The sensor of the color camera is covered with a Bayer filter in order to get the RGB information of each image pixel.

In addition, color cameras are equipped with an UV/IR cut filter. Light with wavelengths between 370 and 670 nm will be transmitted. These filters assure accurate color images.

There are four camera types available:

Type	Data width	Mono: m Color: c	Lens Adapter	Link speed	Max. fps@ 2336x1728	Connector
MC4082	8/10 bit	m	C-/F-mount	CXP-6	563 fps	5W5
MC4083	8/10 bit	c	C-/F-mount	CXP-6	563 fps	5W5
MC4086	8/10 bit	m	C-/F-mount	CXP-6	563 fps	DIN1.0/2.3
MC4087	8/10 bit	c	C-/F-mount	CXP-6	563 fps	DIN1.0/2.3

Operating Temperature

Despite of its high performance, the fanless CXP camera is compact and works noiselessly. Supposed, the camera is mounted on mechanical parts, heat, generated during operation, will be dissipated by the cooling fins at the rear of the camera and the mechanical parts.

Note The camera's body temperature must not exceed 55°C.

In case of overheating, the camera will automatically be switched off and the communication between camera and PC will be interrupted. Wait until the camera has cooled down, then switch it on again.

After a restart of the software the camera can be re-initialized. Please, take appropriate cooling measures as described below before operating the camera again.

Note The camera is not intended for use on an isolated mounting plate or in a closed housing because the temperature of the camera will rise.

Additional Cooling

Tip: *If the camera is e.g. mounted on a sturdy aluminum structure, not only cooling is ensured but also a stable optical path. In addition, vibrations will be minimized within the entire system.*

If the ambient temperature is constantly exceeding 40°C, additional cooling will be required. This can be achieved by an

- air- or water-cooling system or by
- air-conditioned housings

Interfaces of the Camera

At the rear of the camera with DIN connector you find one:

1) **status LED**
   in order to verify the operating status of the camera
2) **CoaXPress DIN1.0/2.3 connector with four channels**
   which is used to connect the camera with a CoaXPress compliant frame grabber. It can supply the camera with power via power over coax (PoC)
3) **12 pin Hirose power connector**
   which is used when an external power supply (12 - 24V) has to be connected, an external trigger is connected and/or an output signal is used.

Tip: *Before connecting an external trigger, check the pinning of the Hirose connector, described on page 3-8. In addition, take the trigger settings into account. For more information see "Acquistion Control" on page 5-2.*

Image 3-1: CXP camera with DIN connector

At the rear of the camera with 5W5 connector you find:

1) **status LED**
   in order to verify the operating status of the camera
2) **5W5 connector**
   is used to connect the camera via 4 lines with a CoaXPress frame grabber. It can supply the camera with power via power over coax (PoC)
3) **6 pin Hirose power connector**
   which is used when an external power supply (12 - 24V) and/or an output signal (OUT0) is connected

Image 3-2: CXP camera with 5W5 connector

Connecting a Frame Grabber

At the time being, the CoaXPress standard describes four connections for data transmission between camera and frame grabber. The transmission speed of a 4CXP camera can either be set to 1.25, 2.5, 3.125, 5 or 6.25 Gbit/s. The possible cable length depends on the cable type used, its quality, and the selected transmission speed. The following table gives examples. These values will only be reached if the signal quality meets the requirements of the CXP-1.1 specification.

Tip: The maximal cable length depends also on the quality of the cables. We recommend to buy best quality e.g. CXP cables from MIKROTRON.

Please, take into account that all lines have to be of the same length.

CXP-Type	Transmission speed [Gbit/s]	Max. cable length RG59 style [m]
CXP-1	1.25	up to 130
CXP-2	2.5	up to 110
CXP-3	3.125	up to 100
CXP-5	5	up to 60
CXP-6	6.25	up to 40
4x CXP-6	4*6.25 = 25	up to 40

DIN Connector

In order to connect a 4CXP camera with a frame grabber you can use any CoaXPress 1.1 compatible cable with DIN connector. MIKROTRON offers cables with the following connectors. For more information see "*Optional Accessories*" on page 2-4.

- DIN ←→DIN
  (cable KKRDDINDINxx/6Gx4)
- DIN ←→BNC
  (cable KKRDDINBNCxx/6Gx4)

Note Please, carefully connect and release the socket with the DIN1.1/2.3 connector. Connect them precisely to avoid deformation of the connectors or other damages!

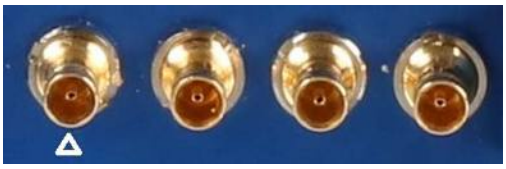
If connecting a frame grabber via DIN ←→ BNC, keep the order from left to right when connecting one, two, or four BNC connectors.

Tip: Pin 1 always has to be connected.

If you look at the back of the camera, the left DIN connector is the master connector number 1 (marked by a triangle). Connect it with

channel one of the frame grabber (please, read the frame grabber documentation).

The possible connector combinations are shown in the table below.



No. of Connections	Connector combination
1	1
2	1+2 (link)
4	1+2+3+4 (link)

Tip: *All connections are hot-pluggable.*

On DIN ←→ DIN cables from MIKROTRON (KKRDDINDINxx/6Gx4), pin1 is marked with a triangle on the connector housing.

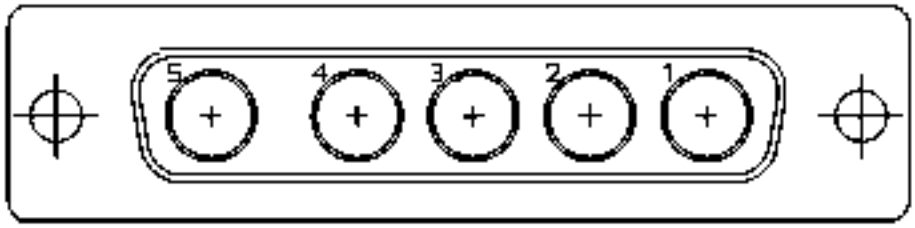
The assignment of the DIN-cables KKRDDINDINxx/6Gx4 and KKRD-DINBNCxx/6Gx4 connector pins is as follows:

DIN connector pin	Frame grabber
1 (triangle)	TX channel 0
2	TX channel 1
3	TX channel 2
4	TX channel 3

5W5 Connector

In order to connect a MC4082/4083 camera with a frame grabber, use MIKROTRON's cable KKRD5W5BNC0x for 3 or 6 GHz and different lengths.

If connecting a frame grabber via BNC, keep the order from right to left.



Tip: *The outer right connector (1) is the master connector and always has to be connected.*

The assignment of the 5W5 connector pins is as follow:

5W5 connector pin	Cable color	Function
1	red	TX channel 0
2	green	TX channel 1
3	blue	TX channel 2
4	white	TX channel 3
5	yellow	TX channel 0 (not yet assigned) **Must not be used**!

Tip: *All connections are hot-pluggable.*

Connecting an External Power Supply or I/O Signals

In case you prefer an external 12 - 24V DC power supply (min. 18 W), connect it with the Hirose connector at the rear of the camera.

WARNING! **The power connector of the camera has to be connected with a DC power supply providing 12 to 24 V DC. Connecting a lower or higher supply voltage, an AC voltage, reversal polarity or using wrong pins of the power connector may damage the camera and will void warranty!**

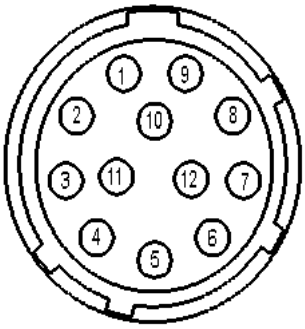
MIKROTRON offers the power supply unit NTCAM132xx with cables of 5 or 10 meters. In case you assemble your own cable, pay attention to the pinning described below.

Cameras with a DIN connector are equipped with a 12 pin and cameras with 5W5 connector with a 6 pin Hirose power connector.

12 Pin Hirose Connector and I/O Signals

In case you prefer an external power supply for MC4086/4087, connect it with the 12 pin Hirose connector (HR10A-10R-12PB (71)) at the back of the camera. The DC power supply has to deliver 12 - 24 V DC (7 W) and has to be equipped with a HR-10A-10P-12S plug.

The 12 pin connector provides two inputs for an external trigger and one output signal. The output signal can be controlled. For more information see "*LineSource*" on page 12-3.



Remark: The I/O pins 7 and 8 are not in use.

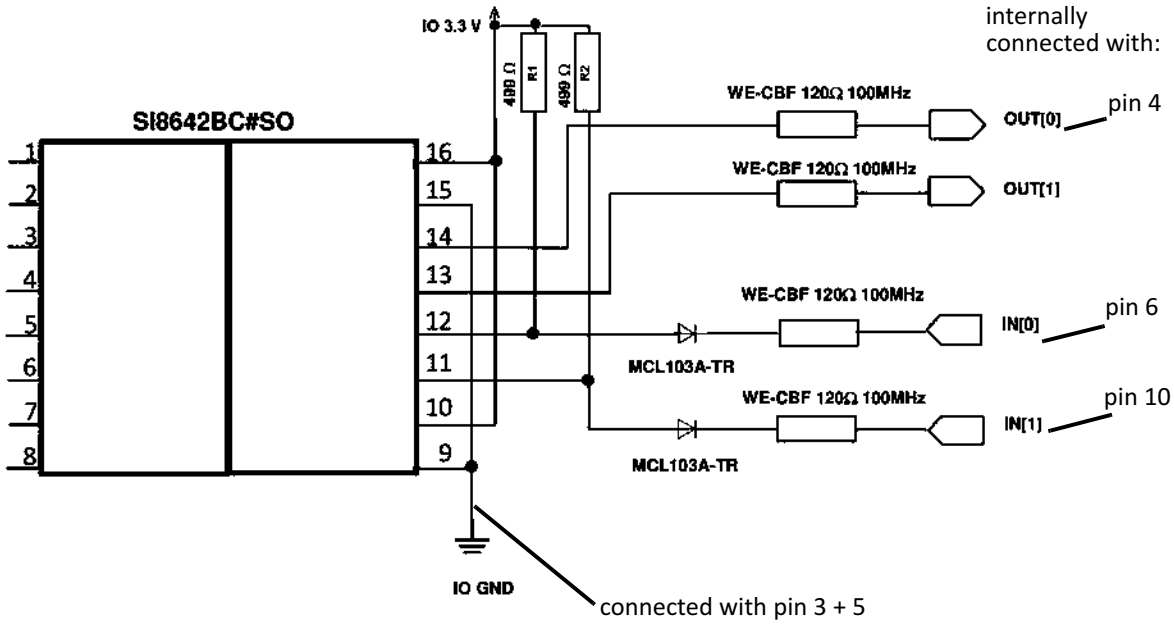
Table 3-1: Pinning of the 12 pin power connector

Pin	Signal	Pin	Signal
1 + 12	GND	5	IO_{GND}
2 + 11	VCC (8 - 24 V)	6	IN0
3	IO_{GND}	9	IO_{GND}
4	OUT0	10	IN1

Note The I/O standard 3.3V LVTTL applies to all signal I/Os.

When connecting an external trigger, it might be helpful to know how the OUT and IN pins are internally connected.

Image 3-3: Connection of in- and output signals with the internal circuit

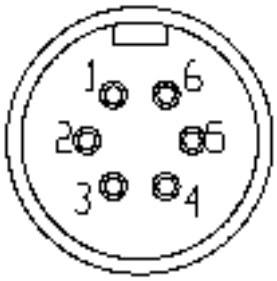


Note that the voltage of the low level has to be < 0.3 V.

6 Pin Hirose and I/O Signals

The power connector of the cameras MC4082/MC4083 has to be connected via the 6-pin Hirose connector (HR10A-7P-6S) with a DC supply voltage between 12 and 24 V at a power consumption of 7W max. the power supply has to be equipped with a HR10A-7P-6P plug.

Please, take attention to the pinning of the connector as described below.

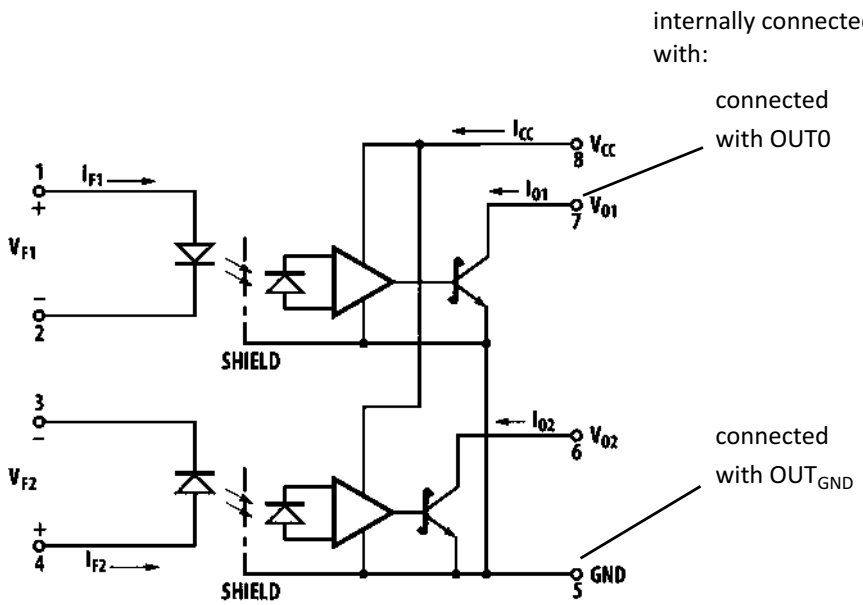


Pin	Signal	Pin	Signal
1	VCC	6	GND
2	VCC	5	GND
3	OUT0	4	OUT_{GND}

The 6 pin connector provides one output. Several outputs can be connected. For more information see "*LineSource*" on page 12-3.

The signal of pin 3 (OUT0) has to be connected internally with pin 7 and the ground pin 4 (OUT_{GND}) with pin 5 of the internal circuit.

Image 3-4: Connection of the output signal with the internal circuit



Status LED

A multi-color LED (1) indicates camera and CXP connection states according to the CXP 1.1 standard.

Table 3-2: LED indications

LED State	Indication
OFF	no power
solid orange	system is booting
slow pulse red	powered, but nothing connected (not applicable if PoC is used)
fast flash alternate green/orange	connection detection in progress, PoC active
fast flash orange	connection detection in progress, PoC not in use
slow flash alternate red/green	device incompatible, PoC active
slow flash alternate red/orange	device incompatible, PoC not in use
solid green	device connected but no data being transferred
slow pulse orange	device connected, waiting for event (e.g. trigger)
fast flash green	device connected, data being transferred
slow flash alternate green/orange	connection test packets being sent
red - 500 ms pulse	error during data transfer
slow flash alternate red/green/orange	compliance test mode enabled
fast flash red	system error

Resolution and Speed

The table below shows the correlation between camera resolution and the transmission speed for an 8-bit image and the connections from 1.25 to 6.25 Gbit/s.

Resolution [Pixel]		Frame rate [Gbit/s]				
H	**V**	**1.25**	**2.5**	**3.125**	**5**	**6.25**
2336	1728	114	229	281	457	563
1920	1080	222	444	450	750	900
1024	1024	440	474	474	791	949
1280	720	479	674	674	1124	1349
640	480	1010	1010	1010	1684	2020
256	256	1887	1887	1887	3146	3775

Tip: *Use our camera compare tool to calculate the frame rate for a certain ROI size.*

www.mikrotron.de/cameracompare

Cleaning Sensor and Lens

If necessary, clean the window of the sensor and the lens with a dry and soft lens-cleaning tissue.

WARNING! **Unplug the camera before you clean any parts!**
In no case open the housing when cleaning the window of the sensor.

Note If the camera has been opened, warranty will be void.

WARNING! **If there are coarse particles on the lens or the window of the sensor, use a vacuum cleaner to remove them before cleaning. Otherwise, the lens or sensor might be scratched.**

WARNING! **Don't use tools that may harm the sensor/lens.**

CHAPTER

4

First Steps

In this chapter you learn

- how to connect the camera with the image processing system
- about initial settings the camera provides when being powered-up
- basics on the configuration of the camera via GenICam

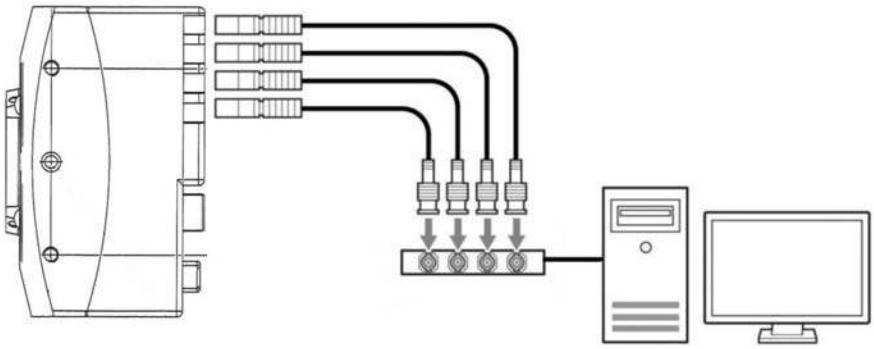
Connect Camera and Image Processing System

Before you start, make sure that all components of the camera/host chain like camera, connectors, cable and frame grabber as well as the software are fully CoaXPress V1.1 compliant.

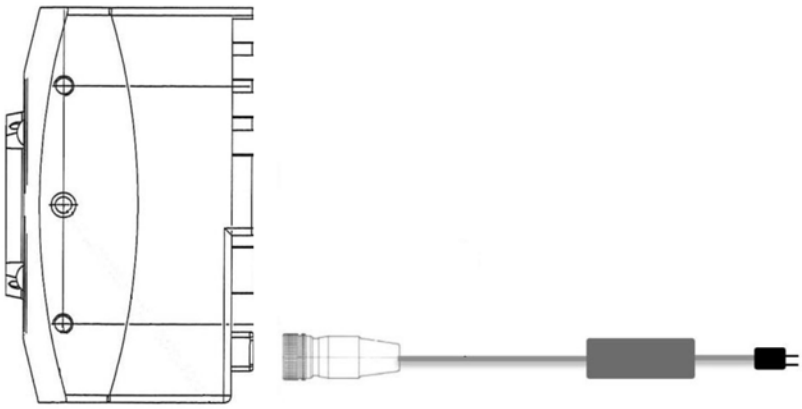
Step 1. Switch off the image processing system

Step 2. Connect the 5W5/DIN V1.1/2.3 cable with the camera

Step 3. Connect the other end of the cable with your CoaX-Press V1.1 compatible frame grabber



Step 4. If an external power supply is needed, connect the power supply NTCAM132x (12 - 24 V) via the 12 pin Hirose connector with the camera



Step 5. In case you want to connect an external trigger, take the pinning into account. For more information see "*Connecting an External Power Supply or I/O Signals* on page 3-8".

Step 6. Unscrew the dust protection cover of the camera

Step 7. Mount the lens

Step 8. If an external power supply is used, connect it with the main supply

Step 9. Switch-on the image processing system

Step 10. Check the LED of the camera to verify that the camera is ready for use. (For more information see "*Status LED* on page 3-11.)

Power-up Profile

If the camera is powered-up, the power-up profile which is permanently stored in the non-volatile memory of the camera, will be loaded. This profile consists of a number of camera settings like sensor resolution and frame rate. It is used to bring the camera into a defined operation mode.

Tip: *The camera has NOT to be configured by the host to start operation. The power-up profile will deliver all necessary values.*

Serial number and firmware version are provided in the non-volatile memory of the camera too. Use the GenICam feature DeviceSerialNumber to read the serial number and the firmware revision. Read the chapter Bootstrap Registers for more information.

If you need the serial number only, you find it on the identification plate of the camera.

Configuring the Camera

All MIKROTRON's CXP cameras are compliant to the CoaXPress specification. CoaXPress standardizes down- and uplink protocols, interfaces, cables, and connectors used by CoaXPress compliant cameras and frame grabbers.

All our CXP cameras use GenICam, which is a standardized generic programming interface. It is used to configure and control the CXP camera and supports five main features:

1. camera configuration
2. frame acquisition
3. graphical user interface (GUI)
4. transfer of camera data but also time stamps, region of interest (ROI) and histogram data
5. transfer of events like a trigger

GenICam for CXP cameras consists of four parts:

1. GenAPI
   GenAPI is the application programming interface. It is used to configure and control a camera. All features are written in an XML file. The API is available for several operating systems.
2. Standard Features Naming Convention (SFNC)
   SFNC provides standardized names and types for common device features.
3. Pixel Format Naming Convention
   PFNC is a pixel format naming convention.
4. GenTL
   The GenTL transport layer is supported by CoaXPress compliant frame grabbers and cameras. It allows to read and write into registers and to grab frames.

According to GenICam the camera uses registers for configuration. In order to change a value, e.g. the exposure time, the hexadecimal value has to be written into the camera register representing the exposure time (e.g. 0x1100).

Reading the XML File

All features of a CXP camera are described in the GenICam XML file. Extensible Markup Language (XML) is used to describe each feature as a XML feature knot. Feature knots are displayed in a tree structure.

A knot consists of a feature knot and a register knot. The feature knot contains the description of the command whereas the register knot shows how it is implemented in the camera. For example the type of the feature (command, string, integer,...), its access mode (R/W), a descriptive name (friendly name), the corresponding register address, and a short description of the feature in plain ASCII text. Some features have min. and max. values or a default value. Each feature corresponds to a camera setting.

Example:

Feature knot

```
<Command Name="AcquisitionStart">
        <ToolTip>Starts the Acquisition of the device.</ToolTip>
        <Description>Starts the Acquisition of the device.</Description>
        <DisplayName>Acquisition Start</DisplayName>
        <Visibility>Beginner</Visibility>
        <pValue>AcquisitionStartReg</pValue>
        <CommandValue>0</CommandValue>
</Command>
```

Register knot

```
<IntReg Name="AcquisitionStartReg">
        <Address>0x8204</Address>
        <Length>4</Length>
        <AccessMode>WO</AccessMode>
        <pPort>Device</pPort>
        <Endianess>BigEndian</Endianess>
</IntReg>
```

Port knot

```
</Group>
<Port Name="Device">
<ToolTip>Port giving access to the device.</ToolTip>
</Port>
```

The port knot allows the connection to the device.

Tip: *All integer values are interpreted as 32 bit unsigned integers, if not other mentioned. All strings are NULL terminated and consist of 8 bit characters.*

The features in the XML file or your CXP camera are grouped according to their meaning. Available registers are:

- "Bootstrap Registers" on page 6-2
- "Acquistion Control" on page 5-2
- "Device Control" on page 7-1
- "Image Format Control" on page 8-1
- "User Set Control" on page 10-1
- "Custom Features" on page 11-1
- "Analog Control" on page 9-1
- "Digital I/O Control" on page 12-1

The XML file is an ASCII file which is to be found on the DVD delivered with your product. It can either be saved (compressed or uncompressed) in the camera or saved as an external file on a local computer or a remote host. The path (URL) of the file can be read from the camera using the feature XmlUrlAddress.

Use the Software delivered by the frame grabber’s manufacturer to configure camera and frame grabber. In case you use a frame grabber from Active Silicon, MIKROTRON’s VCAM Software which is part of the delivery, can be used alternatively.

Please, refer to www.emva.org/standards-technology/genicam for further details on the GenICam standard.

CHAPTER

5

Acquisition Control

This chapter provides information on available settings to control image acquisition and:

- configure the trigger settings
- control exposure
- set and read the (maximal) acquisition frame rate
- select a test image

Acquistion Control

The following commands allow to make settings required for image acquisition and to control an external trigger. Settings can only be changed if image acquisition is stopped.

Name	Access	Length [Bytes]	Register Interface	Page
AcquisitionMode	R/W	4	Enumeration	5-2
AcquisitionStart	W	4	Command	5-3
AcquisitionStop	W	4	Command	5-3
TriggerSelector	R/W	4	Enumeration	5-4
TriggerMode	R/W	4	Enumeration	5-4
TriggerSource	R/W	4	Enumeration	5-5
TriggerActivation	R/W	4	Enumeration	5-6
TriggerCount	R/W	4	Integer	5-6
TriggerDebouncer	R/W	4	Integer	5-7
AcquisitionBurstFrameCount	R/W	4	Integer	5-3
TriggerSoftware	WO	4	Integer	5-5
ExposureMode	R/W	4	Enumeration	5-7
ExposureTime	R/W	4	Integer	5-8
ExposureTimeMax	R	4	Integer	5-8
AcquisitionFrameRate	R/W	4	Integer	5-8
AcquisitionFrameRateMax	R	4	Integer	5-9
TestImageSelector	R/W	4	Enumeration	5-9

AcquisitionMode

This feature is used to set the device into a certain acquisition mode.

Access	read / write	
Type	enumeration	
In	**Continuous**	the camera records continuously a sequence of frames
Out	selected mode	
Remark	frame acquisition can be stopped with the feature AcquisitionStop	

AcquisitionStart

This feature enables the device to send sampled images to the host.

Access	write
Type	command
In	0x00000001
Out	—
Remark	AcquisitionMode defines how frames will be acquired

AcquisitionStop

This feature stops acquiring frames after the acquisition of the current frame has been completed.

Access	write
Type	command
In	x00000001
Out	—

AcquisitionBurstFrameCount

This feature defines the number of frames to be acquired after each FrameBurstStart trigger. For more information see "*TriggerSelector*" on page 4.

Access	read/write
Type	integer
In	x00000001
Out	number of frames to be acquired

Tip: *If FrameBurstStart is selected in TriggerSelector, ExposureMode has to be set to Timed to make recording possible.*

TriggerSelector

This feature is used to select the type of trigger to be configured.

Access	read / write	
Type	enumeration	
In	**FrameStart**	the camera will take one picture per trigger signal
	FrameBurstStart	the camera will take as many frames as defined in AcquisitionBurstFrameCount
Out	trigger selector type	
Remark	Set AcquisitionBurstFrameCount in order to define the number of frames to be acquired when FrameBurstStart is active.	

Tip: *If FrameBurstStart is selected, ExposureMode will have to be set to Timed. Otherwise, recording will not be possible.*

TriggerMode

This feature activates or deactivates the trigger type selected by the feature TriggerSelector.

Access	read / write	
Type	enumeration	
In	**ON**	enables the selected trigger type; the camera waits for a trigger signal before acquiring a frame. The trigger signal can be a signal from the frame grabber, the 12-pin Hirose connector input, or a software trigger initiated by a software command. The trigger source has to be set in the feature TriggerSource. In trigger mode, the frame rate of the camera depends on the frequency of the trigger signals
	OFF	disables the selected trigger type; all trigger signals will be ignored. The camera is set into the current acquisition mode
Out	active mode	
Remark	If a trigger is active, ExposureMode defines whether the exposure of an image is defined by the feature ExposureTime (fixed exposure time) or by the duration of the trigger signal itself (variable exposure time). The settings in ExposureMode will only become effective if triggered mode is ON.	

TriggerSource

This feature defines the source of the trigger signal.

Access	read / write	
Type	enumeration	
In	**Line0**	CXP cameras with DIN connector offer one trigger input with two physical lines via the 12 pin Hirose connector (see page 3-6); the trigger signal can either be sent via line 0 or line 1
	Line1	CXP cameras with DIN connector offer one trigger input with two lines via the 12 pin Hirose connector; the trigger signal can either be sent via line 0 or line 1
	Software	if TriggerSoftware is set, the trigger will be generated by the software using the feature TriggerSoftware; no external (hardware) trigger signal is needed
	CXPTrigger	if CXPTrigger is set, the camera will wait for an external trigger signal from the frame grabber before acquiring another frame; exposure time for the next image is the time defined in the feature ExposureTime
Out	active source	
Remark	Only one trigger source can be active.	

TriggerSoftware

This feature generates an internal trigger.

Access	write
Type	command
In	0x00000001
Out	—
Remark	In order to generate a software trigger signal, “Software” has to be set in TriggerSource.

Tip: *When using TriggerSoftware, the exposure time of the next frame cannot be defined by TriggerWidth of the feature ExposureMode. Instead, it has to be defined by the feature ExposureTime.*

TriggerActivation

Tip: If AnyEdge is selected, a fixed exposure time (ExposureMode = Timed) has to be set.

This feature defines the activation mode for a trigger signal defined in TriggerSelector.

Access	read / write	
Type	enumeration	
In	**RisingEdge**	camera will start to acquire frames on the arrival of a CXP 'trigger rising edge' trigger packet; this activator expects a subsequent 'trigger falling edge' trigger packet to finish the trigger sequence
	Falling Edge	camera will start to acquire frames on the arrival of a CXP 'trigger falling edge' trigger packet; this activator expects a subsequent 'trigger rising edge' trigger packet to finish the trigger sequence
	Any Edge	camera will start to acquire frames on the arrival of a CXP 'trigger falling edge' as well as a 'trigger rising edge' trigger packet
Out	selected activator	
Remark	Using the activator AnyEdge doubles the maximal trigger frequency.	

TriggerCount

This feature counts the incoming trigger signals after a trigger debounce. It allows e.g. to compare the number of frames transferred to the frame grabber with the number of triggers.

Access	read / write	
Type	integer	
In	**min.**	0
	max.	0 zero is the only value accepted and is used to reset the trigger counter
Out	number of counted trigger signals	
Remark		

TriggerDebouncer

In TriggerDebouncer the debounce period is defined. This period starts with the occurrence of a trigger edge. Within the debounce period, a new trigger signal will be ignored. Debouncing might e.g. be necessary if the trigger signal jitters.

Access	read / write	
Type	integer	
In	**min.**	0 µs
	max.	430 µs
Out	the set debounce period	
Remark	The default value amounts to 1 µs.	

Tip: *The best way to find the appropriate value for the debounce period is to measured it with an oscilloscope.*

ExposureMode

This feature sets the operation mode of the shutter. It defines how long a picture will be exposed if TriggerMode is activated.

Access	read / write	
Type	enumeration	
In	**Timed**	exposure time is defined in the feature ExposureTime;
	Trigger Width	width of the current trigger signal pulse is used to control the exposure time; if TriggerActivation is set to RisingEdge, it will be the time the trigger stays high; if TriggerActivation is set to Falling Edge it will last as long as the trigger stays low.
Out	set exposure mode	
Remark	ExposureMode is enabled in trigger mode only. If you choose AnyEdge in TriggerActivator, Timed has to be set. Timed also has to be set if the TriggerSelector is set to FrameBurstStart.	

ExposureTime

If the exposure mode is set to Timed or no hardware trigger is defined, this feature allows to define the duration of exposure [µs].

Access	read / write
Type	unsigned integer
In	1 … highest possible exposure time
Out	current exposure time
Remark	incremented by 1

ExposureTimeMax

Remark: This feature will soon expire. Use ExposureTime to get the highest possible exposure time.

This feature returns the highest possible exposure time for the current camera settings in [µs].

Access	read
Type	unsigned integer
In	—
Out	max. exposure time
Remark	The exposure time depends on the current frame rate settings.

AcquisitionFrameRate

Tip: *If TriggerMode = ON, AcquisitionFrameRate will be disabled.*

This feature defines the acquisition rate in [Hz] when TriggerMode is OFF.

Access	read / write
Type	unsigned integer
In	>10... highest possible frame rate
Out	AcquisitionFrameRate
Remark	incremented by 1; min. 10

AcquisitionFrameRateMax

This feature returns the highest possible frame rate in [Hz].

Access	read
Type	unsigned integer
In	—
Out	max. frame rate
Remark	The max. frame rate depends on the defined frame size, the used link speed, and the number of CoaXPress lines used for image streaming.

Remark: This feature will soon expire. Use AcquisitionFrameRate to get the highest possible frame rate.

TestImageSelector

This feature selects the type of test image sent by the camera.

Access	read/write	
Type	enumeration	
In	**OFF**	TestImageSelector is disabled
	GreyHorizontal Ramp	camera will send a test image that shows vertically oriented gray scale bars moving into horizontal direction on the screen
	GreyDiagonal HorizontalRamp	camera will send a test image that shows diagonally oriented gray scale bars moving on the screen into horizontal direction
Out	current test image selection	
Remark	A connection reset sets the camera into normal operation mode.	

CHAPTER

6

Bootstrap CoaXPress

The chapter provides information on:

- bootstrap registers which are mainly used to deliver information about the camera in order to allow a communication between frame grabber and camera

Bootstrap Registers

CoaXPress compliant devices have to support a number of bootstrap registers. In contrast to other CXP camera features each bootstrap register is assigned to a fixed camera address as it is defined in the CoaXPress specification.

Bootstrap registers are defined for device information and allow frame grabbers to establish and maintain the connection between host and camera in a standardized way. Usually, the connection between camera and frame grabber is running in the background.

Name	Address	Access	Length [Bytes]	Register interface	Page
Standard	0x00000000	R	4	Integer	6-3
Revision	0x00000004	R	4	Integer	6-3
XmlManifestSize	0x00000008	R	4	Integer	6-4
XmlManifestSelector	0x0000000C	R/W	4	Integer	6-4
XmlVersion	0x00000010	R	4	Integer	6-4
XmlSchemeVersion	0x00000014	R	4	Integer	6-5
XmlUrlAddress	0x00000018	R	4	Integer	6-6
Iidc2Address	0x0000001C	R	4	Integer	6-5
DeviceVendorName	0x00002000	R	32	String	6-6
DeviceModelName	0x00002020	R	32	String	6-7
DeviceManufacturerInfo	0x00002040	R	48	String	6-7
DeviceVersion	0x00002070	R	32	String	6-8
DeviceSerialNumber	0x000020B0	R	16	String	6-8
DeviceUserID	0x000020C0	R/W	16	String	6-9
WidthAddress	0x00003000	R/W	4	Integer	6-9
HeigthAddress	0x00003004	R/W	4	Integer	6-9
AcquisitionModeAddress	0x00003008	R/W	4	Integer	6-9
AcquistionStartAddress	0x0000300C	R/W	4	Integer	6-9
AcquistionStopAddress	0x00003010	R/W	4	Integer	6-9
PixelFormatAddress	0x00003014	R/W	4	Integer	6-9
DeviceTapGeometrieAddress	0x00003018	R/W	4	Integer	6-9
Image1StreamIDAddress	0x0000301C	R/W	4	Integer	6-9
ConnectionReset	0x00004000	W/(R)	4	Integer	6-10
DeviceConnectionID	0x00004004	R	4	Integer	6-10
MasterHostConnectionID	0x00004008	R/W	4	Integer	6-10
ControlPacketSizeMax	0x0000400C	R	4	Integer	6-11
StreamPacketSizeMax	0x00004010	R/W	4	Integer	6-11

Name	Address	Access	Length [Bytes]	Register Interface	Page
ConnectionConfig	0x00004014	R/W	4	Enumerate	6-12
ConnectionConfigDefault	0x00004018	R	4	Integer	6-12
TestMode	0x0000401C	R/W	4	Integer	6-13
TestErrorCountSelector	0x00004020	R/W	4	Integer	6-13
TestErrorCount	0x00004024	R/W	4	Integer	6-14
TestPacketCountTx	0x00004028	R/W	8	Integer	6-14
TestPacketCountRx	0x00004030	R/W	8	Integer	6-15
HsUpConnection	0x0000403C	R	4	Integer	6-15
Start of manufacturer specific register space	0x00006000	—	—	—	6-9

Standard

This register provides a magic number indicating that the device implements the CoaXPress standard.

Access	read
Type	unsigned integer
In	—
Out	0xC0A79AE5
Remark	The magic number is an approximation of CoaXPress.

Revision

This register provides the revision of the CoaXPress specification implemented by this device.

Access	read	
Type	unsigned integer	
In	—	
Out	bits **31 - 16** **15 - 00**	 major revision minor revision
Remark	E.g. devices compliant to revision 1.1 of the specification shall return the value 0x00010001.	

XmlManifestSize

This register returns the number of available XML manifests. At least one manifest must be available.

Access	read
Type	unsigned integer
In	—
Out	1

XmlManifestSelector

This register selects the required XML manifest registers. It holds a number between zero and XmlManifestSize – 1.

Access	read / write
Type	unsigned integer
In	0 … XmlManifestSize-1
Out	0 … XmlManifestSize-1
Remark	A connection reset sets the value to 0x00000000.

XmlVersion

This register provides the version number for the XML file given in the manifest referenced by the register XmlManifestSelector.

Access	read	
Type	unsigned integer	
In	—	
Out	bits	
	31 - 24	reserved; shall be 0
	23 - 16	SchemaMajorVersion; major version number of the XML file
	15 - 8	SchemaMinorVersion; minor version number of the XML file
	7 - 0	SchemaSubMinorVersion; sub-minor version number of the XML file

XmlSchemeVersion

This register provides the GenICam schema version for the XML file given in the manifest referenced by the register XmlManifestSelector.

Access	read	
Type	unsigned integer	
In	—	
Out	bits	
	31 - 24	reserved; shall be 0
	23 - 16	SchemaMajorVersion; major version number of the schema used by the XML file
	15 - 8	SchemaMinorVersion minor version number of the schema used by the XML file
	7 - 0	SchemaSubMinorVersion sub-minor version number of the schema used by the XML file

Iidc2Address

Tip: This feature is currently not supported.

This feature is meant for devices supporting the IIDC2 protocol (section 2.2 ref. 6) and will provide the starting address of the IIDC2 register space.

Access	read
Type	unsigned integer
In	—
Out	0x00000000

XmlUrlAddress

This register indicates the start of the URL string referenced by the register XmlManifestSelector.

Access	read	
Type	unsigned integer	
In	—	
Out	register address	
Remarks	Reading the returned register returns the name, register address, and the length of the GenICam XML file stored in the flash memory of the camera. The format of the address string of the following fields is:	
	Local	indicates the XML file is stored in the non-volatile memory in the device
	<Filename>	name of the XML file
	<Extension>	xml: uncompressed XML file zip: compressed ZIP file
	<Address>	address of the file in the device memory map, given in hexadecimal notation without the first to characters “0x”
	<Length>	length of the file in Bytes, given in hexadecimal without the first to characters “0x”
	Example: *“Local:Mikrotron_GmbH_MC258xS11 _Rev1_15_0.xml; 8001000;16C34?SchemaVersion=1.1.0”* indicates a GenICam XML file in the flash memory of the camera. The file can be read starting at address 8001000 and has a length of 16C34 Bytes. MIKROTRON does not support strings that reference a XML file located on the vendors homepage.	

DeviceVendorName

This register provides the name of the manufacturer of the device as a string.

Access	read
Type	string [0...32]
In	—
Out	vendor name
Remark	Example: MIKROTRON GmbH

DeviceModelName

This register provides the model name of the device as a string.

Access	read
Type	string[0...32]
In	—
Out	model name
Remark	Example: MC2586

DeviceManufacturerInfo

This register provides extended manufacturer-specific information about the device as a string.

Access	read
Type	string[0...48]
In	—
Out	manufacturer information
Remark	Example: MIKROTRON GmbH

DeviceVersion

This register provides the version of the camera hardware as a string.

Access	read		
Type	string[0...32]		
In	—		
Out	device version string including the hardware, microcontroller software and FPGA version		
Remark	The firmware version consists of the microcontroller version plus the FPGA version (V00.25.002F00.33.787). The format of the version string (byte numbers from left to right) in detail:		
	byte no.:		e.g.:
	0	hardware tag	H
	1 - 2	hardware version major number	03
	3		**.**
	4 - 5	hardware version minor number	04
	6		.
	7 - 9	hardware version sub minor number	000
	10	microcontroller tag	V
	11 - 12	mc major number	00
	13		**.**
	14 - 15	mc minor number	25
	16		.
	17 - 19	mc sub minor number	002
	20	FPGA tag	F
	21 - 22	FPGA version major number	00
	23		.
	24 - 25	FPGA version minor number	33
	26		.
	27 - 29	FPGA version sub minor number	787

DeviceSerialNumber

This register provides the serial number for the device as a NULL-terminated string.

Access	read
Type	string[0...16]
In	—
Out	serial number of the camera
Remark	Example: 000000000000157

DeviceUserID

This register provides a user-programmable identifier for the camera as a string.

Access	read/write
Type	string[0...16]
In	user ID
Out	user ID
Remark	The User ID can be freely defined by the user. It will be saved in the flash memory of the camera. As a result, it will be preserved if the camera is switched off.

Manufacturer-specific Addresses

The following registers provide the address in the manufacturer-specific register space of the use-case feature with the corresponding name. These registers have a length of 4 bit and are read-only registers.

WidthAddress	manufacturer-specific address of Width
HeightAddress	manufacturer-specific address of Height
AcquisitionModeAddress	manufacturer-specific address of AcquisitionMode
AcquisitionStartAddress	manufacturer-specific address of AcquistionStart
AcquisitionStopAddress	manufacturer-specific address of AcquistionStop
PixelFormatAddress	manufacturer-specific address of PixelFormat
DeviceTapGeometryAddress	manufacturer-specific address of DeviceTapGeometry
Image1StreamIAddress	manufacturer-specific address of Image1StreamID

Manufacturer-specific addresses allow non-GenICam applications or black-box format converters, to support the standard use-case and allow continuous acquisition and display of images.

DeviceConnectionID

This register provides the ID of the device connection via which this register is read.

Access	read
Type	unsigned integer
In	—
Out	connection ID
Remark	A connection ID of zero means that the connection is a master connection. This is a static register, but with a different value depending from which connection it is read.

ConnectionReset

Writing 0x00000001 into this register will reset the connection of the device.

Access	read / write
Type	unsigned integer
In	0x00000001
Out	0x00000000
Remark	A link reset will stop a running image acquisition. A connection reset command via the master connection (connection 0) will reset a connection and activate its discovery connection configuration within 200 ms. The camera resets the register to 0x00000000 when it has activated its discovery connection configuration. Writing by the host should be regarded as “fire and forget” without waiting for acknowledgment. In general it is not possible to read this register while it has the value 0x00000001.

MasterHostConnectionID

This register holds the host connection ID of the host connected to the device master connection.

Access	read/write
Type	unsigned integer
In	host link ID
Out	host link ID
Remark	The value 0x00000000 is reserved to indicate an unknown Host ID. All writings to device extension connection will be ignored.

ControlPacketSizeMax

This register provides the maximum control packet size the host can read from the device or write to the device. The size is defined in Bytes and will be a multiple of 4 Bytes. The defined size is that of the entire packet, not only the payload.

Access	read
Type	unsigned integer
In	—
Out	control packet size in multiples of 4 Bytes
Remark	the control packet size is at least 128 Bytes

StreamPacketSizeMax

This register holds the maximum stream packet size the host can accept. The size is defined in Bytes and will be a multiple of 4 Bytes. The defined size is that of the entire packet, not only the payload.

Access	read / write
Type	unsigned integer
In	stream packet data size in multiples of 4 Bytes
Out	stream packet data size in multiples of 4 Bytes
Remark	The device can use any packet size it wants to up to this size. A connection reset sets the value to 0x00000000.

ConnectionConfig

This register holds a valid combination of the device link speed and the number of active down connections. Writing into this register sets the connection speeds on the specified connections.

Access	read / write	
Type	enumeration	
In	connection configuration example (read the electronically readable manual for further information):	
	CONNECTION1SPEED3125	one connection of 3.125 Gbps per connection
	CONNECTION2SPEED3125	two connections of 3.125 Gbps per connection
	CONNECTION4SPEED3125	four connections of 3.125 Gbps per connection (default)
	CONNECTION1SPEED5000	one connection of 5.000 Gbps per connection
	CONNECTION2SPEED5000	two connections of 5.000 Gbps per connection
	CONNECTION4SPEED5000	four connections of 5.000 Gbps per connection
	CONNECTION1SPEED6250	one connection of 6.250 Gbps per connection
	CONNECTION2SPEED6250	two connections of 6.250 Gbps per connection
	CONNECTION4SPEED6250	four connections of 6.250 Gbps per connection
Out	connection configuration	

ConnectionConfigDefault

This register provides the value of the ConnectionConfig register that allows the Device to operate in default mode. This feature is used to start the camera with the default configuration that is stored in the custom profiles.

Access	read
Type	unsigned integer
In	—
Out	0x00000000
Remark	

TestMode

Writing the value 0x00000001 into this register enables a test packet transmission from the camera to the host.

Access	read / write	
Type	integer	
In	**0x00000000**	normal operation
	0x00000001	sending test packets to host
Out	same as above	
Remark	A connection reset sets the value to 0x00000000. If the value is changed from 0x00000001 to 0x00000000, the device will complete the packet of 1024 test words currently being transmitted.	

TestErrorCountSelector

This register selects the required test count [TestErrorCount] register. It holds a valid device connection ID 0 … n-1, or n for the optional high-speed up-connection.

Access	read / write
Type	unsigned integer
In	0x00000000...0x00000003
Out	0x00000000...0x00000003
Remark	A connection reset sets the value to 0x00000000.

TestErrorCount

This register provides the current connection error count for the connection referred to by the register TestErrorCountSelector.

Access	read / write
Type	unsigned integer
In	0x00000000
Out	error count
Remark	Writing 0x00000000 to this register resets the error count for the connector referred to by the register TestErrorCountSelector to zero. A connection reset sets all connection test counters to zero. The error count is the number of incorrect words that have been received in test packets.

TestPacketCountTx

This register provides the current transmitted connection test packet count for the connection referred to by the register *TestErrorCountSelector*.

Access	read / write
Type	integer
In	0x0000000000000000
Out	packet count
Remark	Writing 0x0000000000000000 into this register will reset to zero the transmitted connection packet count for the connection referred to by the register TestErrorCountSelector. A connection reset sets all connection test counters to zero.

TestPacketCountRx

This register provides the currently received connection test packet count for the connection referred to by the register TestErrorCountSelector.

Access	read / write
Type	integer
In	0x0000000000000000
Out	packet count
Remark	Writing 0x0000000000000000 to this register shall reset to zero the received connection packet count for the connection referred to by register TestErrorCountSelector. A connection reset sets all connection test counters to zero.

HsUpConnection

Tip: This feature is currently not supported.

This register indicates whether the optional high speed up-connection is supported or not.

Access	read
Type	integer
In	bits 1 - 30: reserved; shall be 0 ON = 1 OFF = 0
Out	0 if high speed up-connection is OFF 1 if high speed up-connection is ON

CHAPTER

7

Device Control

The chapter provides the only command on device control which is used to reset the camera.

Introduction

There is only one command to reset the camera.

DeviceReset

This feature resets the device into power-up state.

Access	write
Type	unsigned integer
In	0x00000001
Out	—
Remark	length of 4 Bytes

CHAPTER

8

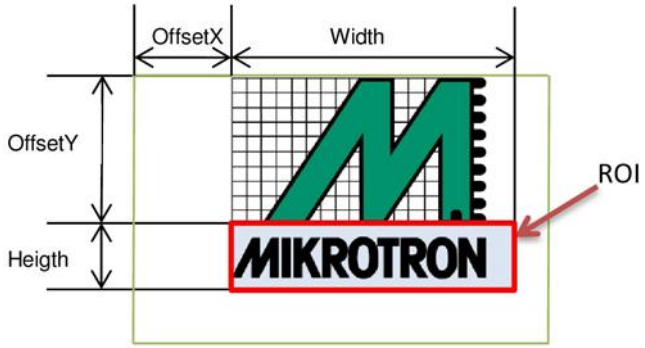
Image Format Control

The chapter provides information on the image format control. You learn how to

- define the size and offset of a ROI
- read the size of the sensor
- read the max. height and width of an image
- read/write the pixel format
- read the TapGeometry
- read the streamID
- read the camera type (line or area scan)

Introduction

These commands allow to set the size of the image, the so called region of interest (ROI). A ROI - like the red field in the figure below - defines the part of an image to be scanned. It is defined by its Width, Heigth, OffsetX and OffsetY.



Name	Access	Length [Bytes]	Register Interface	Page
RegionSelector	R/W	4	Enumeration	8-3
RegionMode	R/W	4	Enumeration	8-3
RegionDestination	R/W	4	Enumeration	8-3
Width	R/W	4	Integer	8-4
Height	R/W	4	Integer	8-4
OffsetX	R/W	4	Integer	8-4
OffsetY	R/W	4	Integer	8-5
DecimationHorizontal	R/W	4	Integer	8-5
DecimationVertical	R/W	4	Integer	8-6
SensorWidth	R	4	Integer	8-6
SensorHeight	R	4	Integer	8-6
WidthMax	R	4	Integer	8-7
HeightMax	R	4	Integer	8-7
PixelFormat	R/W	4	Enumeration	8-7
TapGeometry	R	4	Enumeration	8-8
Image1StreamID	R	4	Integer	8-8
DeviceScanType	R	4	Enumeration	8-8

RegionSelector

This feature selects the region of interest (ROI) to be controlled.

Access	read / write
Type	enumeration
In	region0 = value0
Out	region selector

RegionMode

This feature allows to activate or deactivate the selected region.

Access	read / write
Type	enumeration
In	**ON:** ROI activated **OFF:** ROI deactivated
Out	region mode
Remark	region 0 cannot be disabled

RegionDestination

This feature allows to select the destination of the image stream.

Access	read / write
Type	enumeration
In	stream0
Out	region destination

Width

This feature provides the image width in pixels.

Access	read / write
Type	unsigned integer
In	128 … WidthMax
Out	image width
Remark	the maximum value of this feature equals to SensorWidth; the image width has to be incremented by 64 pixels

Height

This feature provides the image height in lines.

Access	read / write
Type	unsigned integer
In	1 … HeightMax
Out	image height
Remark	the maximum value of this feature equals to SensorHeight; the image height has to be incremented by 1 line

OffsetX

Horizontal offset from the origin to the region of interest (in pixels).

Access	read / write
Type	unsigned integer
In	0 … OffsetXMax
Out	horizontal offset
Remark	the maximal offset equals to SensorWidth. The offset has to be incremented by 64 pixels.

OffsetY

Vertical offset from the origin to the region of interest (in lines).

Access	read / write
Type	unsigned integer
In	0 … OffsetYMax
Out	vertical offset
Remark	The maximal offset equals to SensorHeight. The offset has to be incremented by 1 line.

DecimationHorizontal

Horizontal sub-sampling of the image

Access	read / write
Type	unsigned integer
In	1 … 2
Out	current horizontal decimation factor
Remark	incremented by 1; This value defines that each Nth image pixels in horizontal direction must be sampled to build the image. So the size of the image gets reduced in horizontal direction by the factor of **DecimationHorizontal**. A decimation factor of 1 means no horizontal decimation. The **Width** value must be set to the requested number of horizontal pixels. **Width** * **DecimationHorizontal** may not exceeds the horizontal sensor size or an error gets returned. **Example**: To get a sub sampled image which covers the whole horizontal sensor width but uses just the half number of horizontal pixels you have to set the **Width** parameter to **SensorWidth** / 2 and the **DecimationHorizontal** factor to 2. This will result in an image which is clinched in the horizontal direction by factor 2 but covering the whole horizontal senor width.

DecimationVertical

Vertical sub-sampling of the image

Access	read / write
Type	unsigned integer
In	1 … 255
Out	current vertical decimation factor
Remark	incremented by 1; This value defines that each Nth image pixels in vertical direction must be sampled to build the image. So the size of the image gets reduced in vertical direction by the factor of **DecimationVertical**. A decimation factor of 1 means no vertical decimation. The **Heigth** value must be set to the requested number of lines. **Height** * **DecimationVertical** must not exceeds the maximal vertical sensor size. Otherwise an error will be returned. **Example**: To get a sub sampled image which covers the whole vertical sensor height but uses just the half number of lines you have to set the **Height** parameter to **SensorHeight** / 2 and the **DecimationVertical** factor to 2. This will result in an image which is clinched in the vertical direction by factor 2 but covering the whole senor in vertical direction.

SensorWidth

Effective width of the sensor in pixels.

Access	read only
Type	unsigned integer
In	—
Out	sensor width

SensorHeight

Effective height of the sensor in pixels.

Access	read only
Type	unsigned integer
In	—
Out	sensor height

WidthMax

Maximum width of the image in pixels.

Access	read only
Type	unsigned integer
In	–
Out	maximally usable sensor width

HeightMax

Maximum height of the image in pixels.

Access	read
Type	unsigned integer
In	—
Out	maximally usable sensor height

PixelFormat

This feature returns the bit format the camera uses for acquisition. The default format is 8 bit. It can be changed to 10 bit. For color cameras, the order of the Bayer pattern can be selected.

Access	read/write		
Type	enumeration		
In	**Mono8**	monochrome, 8 bit/ pixel (default)	monochrome, color camera
	Mono10	monochrome, 10 bit/ pixel packed	monochrome, color camera
	BayerGR8Bayer-RG10msbGR10	order of the Bayer pattern in a color image (☞ chapter Bayer Color Filter)	color camera
Out	see above		
Remark	the available pixel formats depend on the camera connected (monochrome or color)		

TapGeometry

This feature describes the format of the image data that is transferred from the camera to the host.

Access	read	
Type	enumeration	
In	**Geometry_1X_1Y**	single pixel scanning from left to right and single line scanning from top to button
Out	see above	

Image1StreamID

This feature returns the stream ID of the primary image stream of the device.

Access	read only
Type	unsigned integer
In	—
Out	0x00000000

DeviceScanType

This feature returns the value of the camera type (area scan).

Access	read only
Type	enumeration
In	—
Out	Areascan (0x00000000)

CHAPTER

9

Analog Control

The section provides information on how to control the image quality by setting

- black level
- gain and
- gamma

Introduction

Black level defines the brightness in the darkest part of the image. Possible black level settings are values between 0 and 255. If the setting is correct, the sensor will deliver the pixel value 0 for a completely black image. If it is too high, the sensor will deliver a pixel value greater than 0 for black which means a shade of gray. If the value is too small, the sensor will deliver a pixel value of 0 for gray shades.

Gain is used to increase the brightness of the image. The available range depends on the camera connected. If you increase the gain, all pixel values of the image will be increased which means, the whole image becomes brighter. Unfortunately, noise will increase too.

Name	Access	Length [Bytes]	Interface	Page
BlackLevel	R/W	4	Integer	9-2
Gain	R/W	4	Integer	9-3
Gamma	R/W	4	Integer	9-3

BlackLevel

The black level value defines the brightness in the darkest part of an image. An optimal setting means, the pixel value 0 is delivered for a completely black image. If it is too high, it will deliver a pixel value greater than 0 (which is reserved for a shade of gray). It it is too small, it will deliver a pixel value of 0 for a shade of gray.

Access	read/write
Type	enumeration
In	0 to 500
Out	current black level value
Remark	can be incremented by 1

Gain

Gain correction is used to increase the brightness of all pixels in a frame linearly. The higher the gain value, the lower the image quality because noise will increase too.

Access	read/write
Type	integer
In	min: 50 max: 1000
Out	current gain value
Remark	can be incremented by 1

Gamma

Gamma correction adjusts the brightness of an image non-linearly. In contrast to the gain correction, this method does not increase the brightness of all pixels but comes close to the manner the human eye perceives light and color

Access	read/write
Type	integer
In	min: 0.1 max: 3.0
Out	current gain value
Remark	gain can be incremented by steps of 0.1

CHAPTER

10

User Set Control

The chapter provides information on how to

- save the current camera configuration into the internal Flash memory of the camera
- load a saved configuration
- set the default configuration

Introduction

User sets can be saved into the camera's internal Flash memory. A user set can be loaded at runtime. If a user set is defined as default, it will be loaded during the start-up of the camera.

Name	Access	Length [Bytes]	Interface	Page
UserSetSelector	R/W	4	Enumeration	10-2
UserSetLoad	W	4	Command	10-2
UserSetSave	W	4	Command	10-3
UserSetDefaultSelector	R/W	4	Enumeration	10-3

UserSetSelector

This feature selects which user set (up to 3) will be loaded, saved or configured.

Access	read/write	
Type	enumeration	
In	**Default**	selects the factory settings
	UserSet1	selects the first user set
	UserSet2	selects the second user set
	UserSet3	selects the third user set
Out	active user set	
Remark	Set the UserSetSelector first to select a user set for further operations (see below).	

UserSetLoad

Loads the user set specified in UserSetSelector from the camera flash memory to the camera registers and activates it.

Access	write
Type	command
In	
Out	
Remark	If the selected User Set has not been defined previously an error message occurs. The default user set is a set of factory settings predefined by the MIKROTRON.

UserSetSave

This feature saves the user set specified in UserSetSelector into the non-volatile memory of the device.

Access	write
Type	command
In	
Out	
Remark	A previously saved user set will be overwritten. The user set “Default” is a set of factory settings and cannot be overwritten.

UserSetDefaultSelector

This feature selects the user set which will be loaded and activated after a device reset.

Access	read/write	
Type	enumeration	
In	**Default**	selects the factory setting user set
	UserSet1	selects the first user set
	UserSet2	selects the second user set
	UserSet3	selects the third user set
Out	active default user set	
Remark	The user set selector Default is preselected.	

CHAPTER

11

Custom Features

The chapter informs about

- the connected device
- "FixedPatternNoiseReduction" on page 11-10
- "FilterMode" on page 11-10

Introduction

Custom features are manufacturer specific camera functions and therefore are not defined in the standard naming convention.

TxLogicalConnectionReset

This feature resets the next packet transmission to connection 0.

Access	write
Type	command
In	-
Out	-
Remark	guru feature

PrstEnable

This feature enables/disables the Pixel Pulse Reset feature.

Access	read/write
Type	boolean
In	ON/OFF
Out	active setting
Remark	values ON (1) or OFF (0); guru feature

Tip: *If the frame rate amounts to 100 Hz or higher, we recommend to disable PixelResetMode (for more information, read the Application Note 0033).*

PulseDrainEnable

This feature enables/disables the Pulse Drain feature.

Access	read/write
Type	boolean
In	ON/OFF
Out	active setting
Remark	values ON (1) or OFF (0); guru feature

DeviceInformationSelector

This feature selects one of the elements from the device information list

Access	read / write
Type	enumeration

In	**InfoSnr**	serial number of the camera (same as feature DeviceID)
	InfoType	camera type / model
	InfoSubType	camera sub type
	InfoHwRevision	camera hardware revision
	InfoFpgaVersion	camera FPGA program version
	InfoSwVersion	microcontroller software version
	InfoPwrSource	returns the source of the camera power supply (external power supply or PoC)
	InfoPwrConsumption	actual power consumption of the camera in [µA]
	InfoPwrVoltage	actual voltage of the camera power supply in [mV]
	InfoTemperature	sensor temperature in steps of 0.5 degrees Celsius
Out	see row IN	
Remark	First set the selector to define the data you want to read, then read the data by reading the register DeviceInformation (see below).	

DeviceInformation

This feature returns a value of the device information list selected by feature DeviceInfoSelector.

Access	read / write	
Type	unsigned integer	
In	—	
Out	Device information values	
	InfoSnr	serial number of the camera (same as feature DeviceID); e.g.: 0x00000132
	InfoType	camera type/model; e.g.: 0x00002582 for Camera model MC2582
	InfoSubType	sub type number of the camera model; this number describes models with special features or a customized version; e.g. 0x00000001
	InfoHwRevision	describes the revision of the camera hardware bits 31-24: major revision number bits 23-16: minor revision number bits 15-00: build number e.g. 0x0103000B for revision 1.3 Build 11
	InfoFpgaVersion	version of the FPGA program of the camera: bits 31-24: major version number bits 23-16: minor version number bits 15-00: build number e.g.: 0x02050001 for Version 2.5 Build 1
	InfoSwVersion	version of the microcontroller software: bits 31-24: major version number bits 23-16: minor version number bits 15-00: 15-00 e.g.: 0x020F0011 for Version 2.15 Build 17
	InfoPwrSource	returns the source of the camera power supply value 0: external power supply value 1: power over CXP line (PoC)
	InfoPwrConsumption	returns the actual power consumption of the camera in [µA]; e.g: 0x00066580for 419200 µA = 0.4192 A
	InfoPwrVoltage	returns the actual voltage of the camera power supply in [mV]; e.g.: 0x2E4A for 11850 mV = 11.85 Volt
	InfoTemperature	returns the current camera temperature in 0.5 degrees Celsius; the value returned is a signed integer; e.g.: 0x00000040 for 32 degree Celsius 0xFFFFFF2C for -2 degree Celsius
Remark	Model number, hardware revision, FPGA version, and firmware version are also included in the string of the 'DeviceVersion' Bootstrap feature.	

CustomSensorClkEnable

This feature enables/disables the custom defined sensor clock.

Access	read / write	
Type	boolean	
In	**ON**	The camera uses the sensor clock defined by '**CustomSensorClk**'.
	OFF	The camera uses the default sensor clock defined for the current CoaXPress link settings.
Out	active status	
Remark	The 4CXP camera defines a default sensor clock for each CoaXPress link speed to optimize the frame rate/image quality ratio. With the custom sensor clock feature this default value can be overwritten by a customer selected value (see feature '**CustomSensorClk**' below). Overwriting the default sensor clock by a higher sensor clock may result in substantial higher frame rates (depending on the frame size) but may also reduce the image quality.	

Tip: *This feature is especially of use for frame grabbers with a link speed lower than CXP6.*

CustomSensorClk

This feature defines the sensor clock rate to be used if CustomSensorClkEnable = ON.

Access	read / write
Type	enumeration
In	Clk_50MHz Clk_75MHz Clk_100MHz Clk_125MHz Clk_150MHz
Out	active clock rate

AnalogRegisterSetSelector

This feature selects one of the analog registers sets for read/write access.

Access	read / write
Type	enumeration
In	analog Register Set 0 analog Register Set 1
Out	active clock rate
Remark	

AnalogRegisterSelector

This feature selects one of the analog registers for read/write access.

Access	read / write
Type	integer
In	0...15
Out	active register
Remark	incremented by 1

AnalogValue

This feature holds the analog value to read/write.

Access	read / write
Type	integer
In	0...1023
Out	active value
Remark	incremented by 1

InfoFieldFrameCounterEnable

This feature enables/disables the Frame Counter that can be added into the info field in the image. If this option is set a frame counter will be superimposed upon each captured frame or ROI.

The frame counter occupies 4 pixels in the upper left corner of each frame starting with pixel number 0. After each activation, the counter starts with 0. When reaching the maximal value or after each acquisition start command it will restart with 0.

Access	read / write	
Type	boolean	
In	**ON**	info field is enabled (1)
	OFF	info field is disabled (0)
Out	**pixel 0**	frame counter LSB part (counter bits 7...0). The values of pixel 0 and 1 are used to build a consecutive running bit frame counter in little-endian notation. If the 24 bit counter overruns, it restarts with 0.
	pixel 1	frame counter, bits 15 … 8
	pixel 2	frame counter, bits 16 … 23
	pixel 3	ROI number – For cameras with the Multi-ROI feature the frame counter is inserted into each ROI. This starts with 1 for ROI 1. Because a set of ROIs always belongs to one frame the frame counter in each ROI is the same. For cameras without the Multi-ROI feature or if only one ROI is defined, this value is always 1.
Remark	In 10 bit mode the bits 1 … 0 in each pixel will be set to 0;guru feature	

InfoFieldTimeStampEnable

This feature enables/disables the Time Stamp filed in the image. If this feature is enabled, a 32 bit time stamp will be superimposed upon each captured frame or ROI. The frequency of the time stamp counter amounts to 25 MHz (period = 40 nanoseconds). The frame counter occupies 4 pixels in the upper left corner of each frame, starting with pixel number 4.

Access	read / write	
Type	boolean	
In	**ON**	time stamp is enabled (1)
	OFF	time stamp is disabled (0)
Out	**pixel 4**	counter bits 0...7 (LSB)
	pixel 5	counter bits 8...15
	pixel 6	counter bits 16...23
	pixel 7	counter bits 24...31 (MSB)
Remark	guru feature	

InfoFieldROIEnable

This feature enables/disables the ROI info field in the image. If this option is set, ROI info data will be superimposed upon each captured frame or ROI. The ROI info occupies 8 pixels in the upper left corner of each frame, starting with pixel number 8.

Access	read / write	
Type	boolean	
In	**ON**	ROI info field is enabled (1)
	OFF	ROI info field is disabled (0)
Out	**pixel 8**	horizontal offset, LSB, bits 0…7
	pixel 9	horizontal offset, MSB, bits 8…15
	pixel 10	width, LSB, bits 0…7
	pixel 11	width, MSB, bits 8…15
	pixel 12	vertical offset, LSB, bits 0…7
	pixel 13	vertical offset, MSB, bits 8…15
	pixel 14	height, LSB, bits 0…7
	pixel 15	height, MSB, bits 8…15
Remark	To get the value for one of the ROI parameters, multiply its MSB with 256 and add the LSB to the multiplied HSB. **Example:** ROI width = pixel 10 and 11; value of pixel 10 = 224, value of pixel 11 = 1 ROI width = 1 X 256 + 224 = 640 guru feature	

FixedPatternNoiseReduction

This feature can be used to switch the fixed pattern noise (FPN) reduction ON or OFF. Digital sensors have a noise signature, the so called Fixed Pattern Noise. This feature reduces FPN by subtracting the dark current of pixels.

Access	read/write
Type	enumeration
In	**ON:** MIKROTRON's pixel FPN reduction is activated in order to improve the quality of the image **OFF:** MIKROTRON's FPN is deactivated
Out	status (ON/OFF)

FilterMode

The image filter compensates non-linear noises within the image.

Access	read/write
Type	enumeration
In	RAW: image filter is deactivated Mono: 3x3 low pass image filter Color: low pass color image filter
Out	status (0 = RAW; 1 = Mono; 2 = Color)
Remark	guru feature

CHAPTER

12

Digital I/O Control

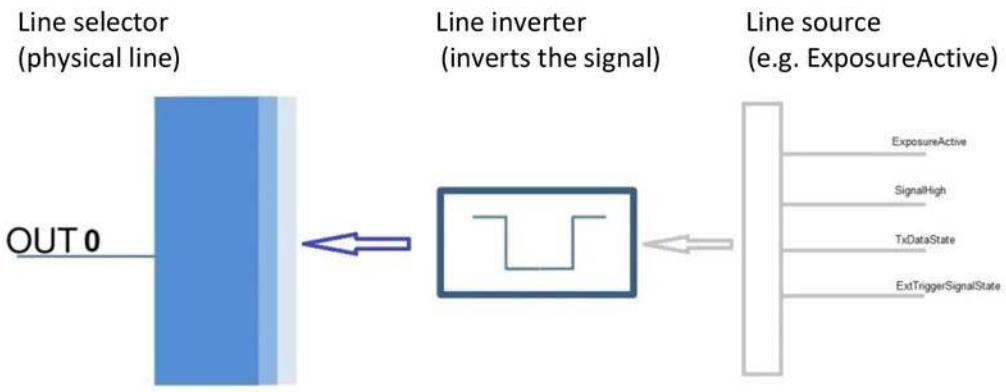
The chapter describes the features of Digital I/O Control used to

- change the signal level of a signal

Introduction

There are three features needed to control the line out signals.

Name	Access	Length [Bytes]	Interface
LineSelector	R/W	4	Enumeration
LineSource	R/W	4	Enumeration
LineInverter	R/W	4	Enumeration



LineSelector

This feature selects the physical line that can be configured with the commands LineSource and LineInverter. Up to now, only OUT0 is available.

Access	read/write
Type	enumeration
In	OUT0
Out	selected output of the Hirose connector
Remark	expert feature

LineSource

This feature defines which signal will apply at the output selected with LineSelector.

Access	read/write
Type	enumeration
In	ExposureActive(STRB): selected signal applies at OUT0
Out	selected signal
Remark	expert feature

LineInverter

This feature controls whether the level of the signal will be inverted or not.

Access	read/write
Type	enumeration
In	inverted = 1 not inverted = 0
Out	setting: inverted or not inverted
Remark	default is 0 (not inverted); expert feature

APPENDIX

A

Technical Data

Sensor

Resolution	2336 x 1728 pixels
Sensor type	4 Mega pixel CMOS; monochrome or color (Bayer color filter)
Operating temperature range	-50 to 60 °C
Pixel depth	8 / 10 bit
Pixel size	7 µm pitch 5T shutter pixel
Pixel type	2nd generation shutter pixel architecture
Active area	4/3" (20.34 mm)
Light sensitivity	11V/ lux.s @ 550 nm
Shutter speed	from 1 µs to 1 s in steps of 2 µs
Internal dynamics	60 dB
Fill factor x quantum efficiency	>40% @ 550 nm
Full well charge	22000e^-

Camera

Video output	CoaXPress CXP-1, CXP-2, CXP-3, CXP-5 and CXP-6
Communication	CoaXPress with Gen<I>Cam based technology
Trigger	asynchronous shutter via CoaXPress interface
Power supply	12 … 24 V external power supply; power over CoaXPress of up to 13 W
Power consumption	10 W @ 12 V
Shock & vibration	70 g, 7 g_{rms} (root-mean-square acceleration)
Dimensions (H x W x D)	80 x 80 x 53 mm (C mount) 80 x 80 x 81 mm (F mount)
Case temperature	between +5 and +50 °C
Weight	450 g (C mount) 490 g (F mount)
Lens mount	C or F mount

APPENDIX

B

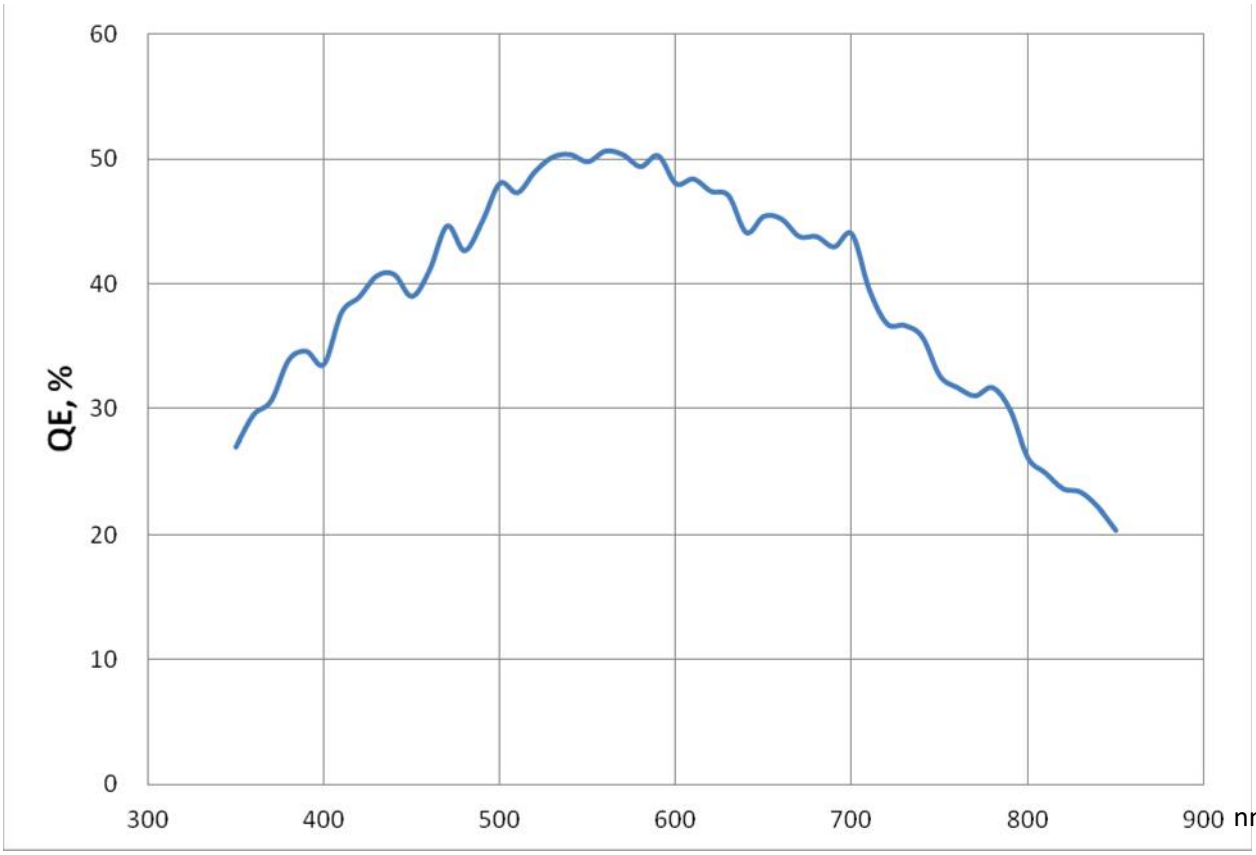
Spectral Response

Monochrome and Color Version

The charts below show the sensitivity of the monochrome and the color sensor with Bayer pattern filter on the sensor glass lid.

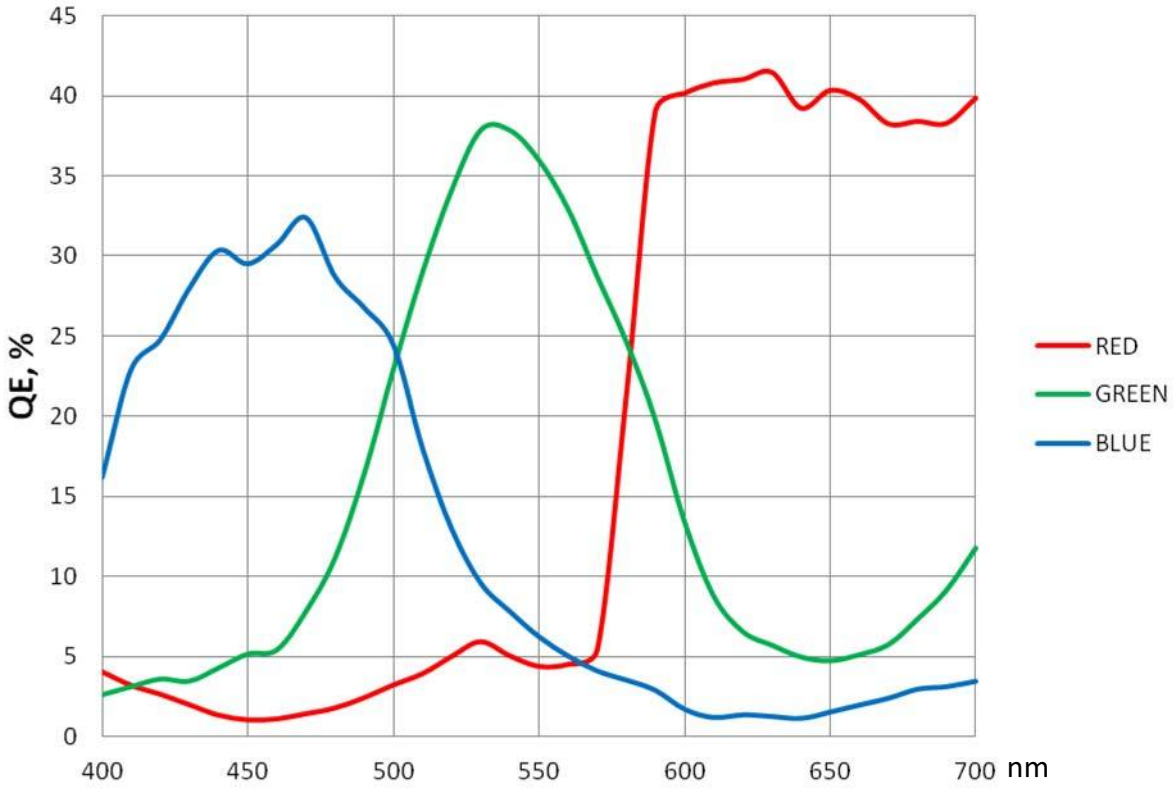
Color cameras are by default equipped with an UV/IR cut filter with a transmittance of 370 to 670 nm resulting in a sensitivity shown in the second chart. On request all types of cameras can be delivered with or without UV/IR cut filter.

Image B-1: Quantum Efficiency Curve for the MC4086 monochrome camera



The next diagram shows the QE for the MC4087 with color sensor

Image B-2: Quantum Efficiency Curve for the MC4087 color camera



APPENDIX

C

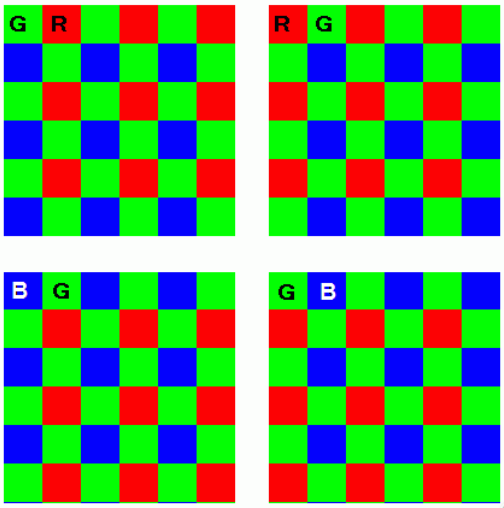
Bayer Pattern

Color Filter Array

The sensor glass lid of MIKROTRON's Eo*Sens* color cameras is covered with a Bayer color filter. In order to get the color information, the imaging software has to decode the information of each pixel into RGB by using the values of its neighbor pixels.

Depending on the sensor type, the color pattern can differ. The entry in the feature PixelFormat in the XML file shows what pattern applies to the sensor you use.

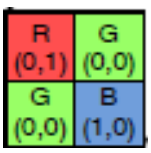
BayerRG10 for example stands for a 10 bit pattern that starts with a red pixel followed by a green one. BayerGB8 stands for an 8 bit pattern that starts with a green pixel followed by a blue one. The figure below shows the four possible Bayer patterns:



Example for BayerRG

In a BayerRGB color pattern pixel (0;0) has a red filter situated in the upper left corner in the first line. Green1 pixels are located in the red-green row, green2 pixels are located in a green-blue row.

Each red, green and blue filter element covers exactly one pixel on the sensor. A matrix of 2 x 2 filter elements builds a filter element matrix.



Conclusions

Because of the size and the order of a filter matrix element three facts can be concluded:

1. Any (sub) region of a Bayer pattern coded image has always to start with the same color on the top left (0;0) pixel position of the region.
2. A Bayer pattern image has to have an even number of pixels and an even number of lines.
3. Changing the image size can only be done by steps of 2 in the horizontal **and** vertically direction.

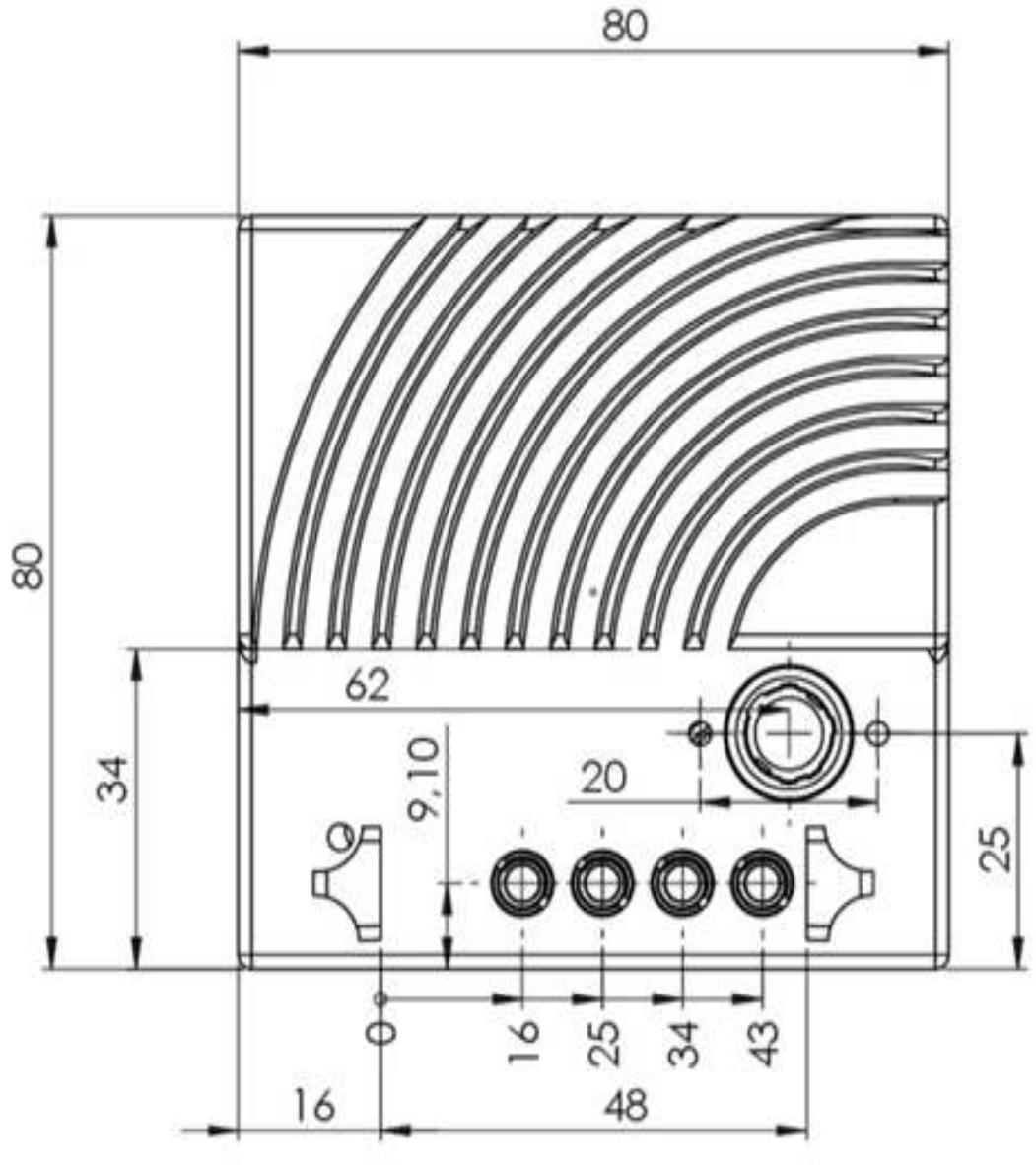
APPENDIX

D

Camera Dimensions

MC4086 and 4087 With DIN Connector

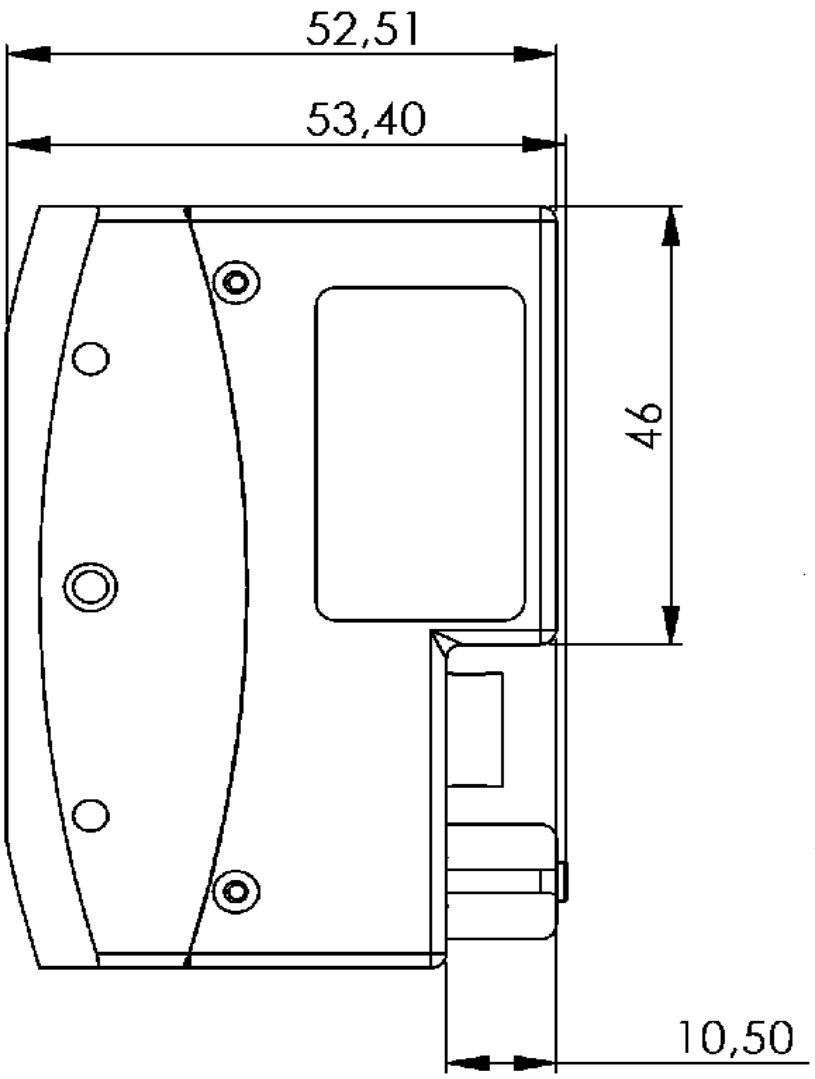
Rear View



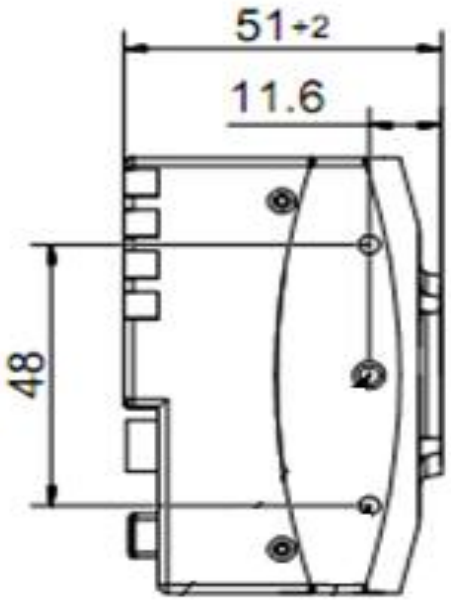
Side Views

There are three side views available.

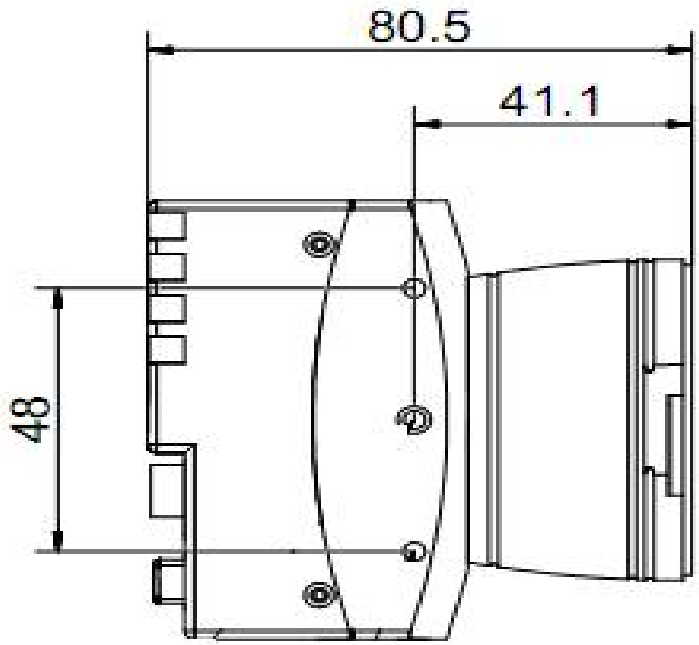
Side View without adapter



Side View with C mount adapter



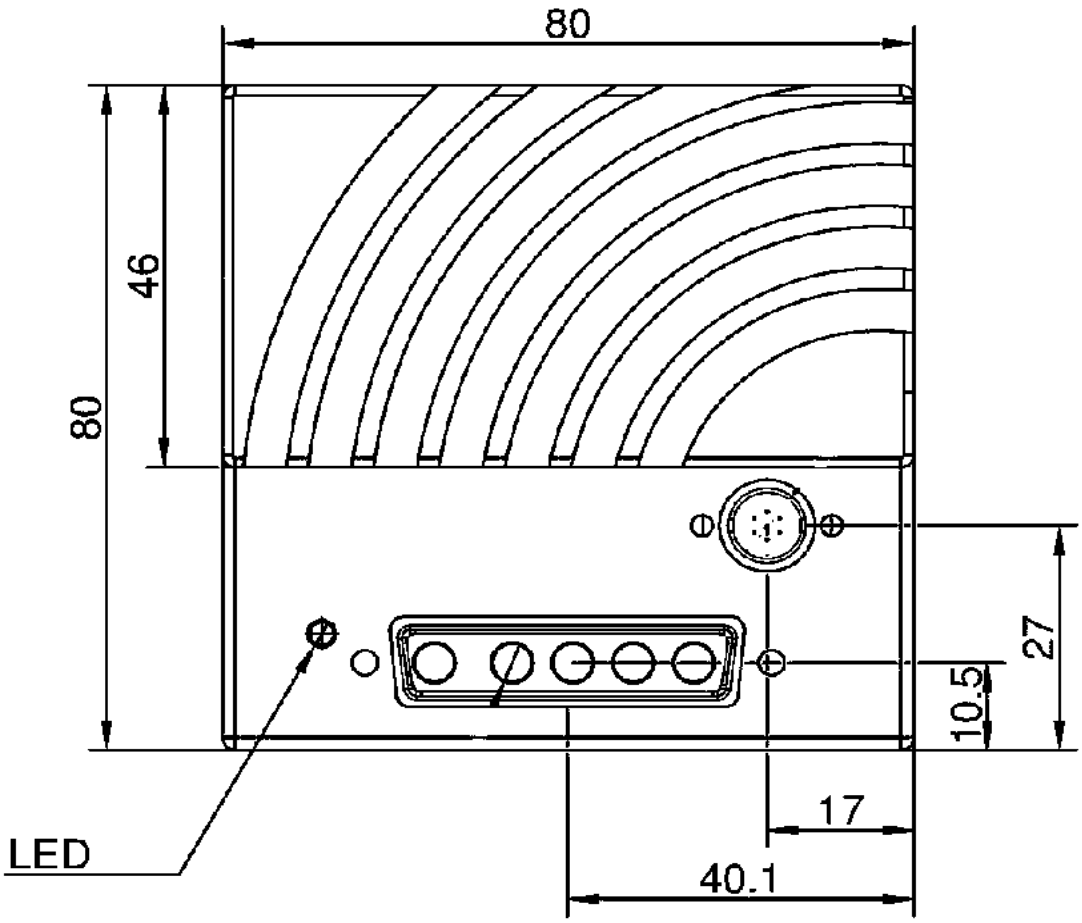
Side View with F mount adapter



MC4082 and 4083 With 5W5 Connector

Rear View

The side views are similar to the ones with DIN connector.



Side Views

The side view dimensions of the MC4082 and MC4083 are the same as for the MC4086 and MC4087 ("Side View without adapter" on page D-3).

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MIKROTRON GmbH
Landshuter Str. 20-22
D-85716 Unterschleissheim / Germany
Phone: 0049 (0)89 7263420
www.mikrotron.de
info@mikrotron.de