CAMMC134x Camera Reference Guide V 2.0

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About This Reference Guide

This reference guide is written for the experienced programmer and systems integrator. It provides all information about the features of the high speed CAMMC134x (Cube4) camera in order to integrate the camera into a system. This manual does not cover the installation and the explanation of the driver software on the Host PC. This is covered in the Director 2 Software Manual.

Although this description has been produced with care, it can neither be complete nor be free of errors. MIKROTRON GmbH cannot be held legally responsible for any errors or missing information in this description. In case problems occur, please contact our service team:

Email: info@mikrotron.de

Phone: +49 - 89 - 7263 4243

This description is subject to change without notice.

Remarks, Notes and Warnings

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

Remark		Provides hints and helpful information
	**Note**	Hints concerning frame quality or timeouts and other helpful information
	WARNING	Important information concerning data loss or camera damage

It is quite unlikely that personal damage will occur by using the 12V-cameras described. Therefore a fourth grade warning is not to be found.

Registered Trademarks

In this description the following product names are registered trademarks:

- MotionBLITZ®
- Microsoft®
- Microsoft Windows®

In the following, these product names are not specially marked as registered trademarks. This does in no way imply that these product names may be used freely.

Warranty and Non-Warranty Clause

Warranty is described in §8 of our General Terms and Conditions which can be downloaded on MIKROTRONS' webpage: http://www.mikrotron.de/en/terms.html

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

WARNING

- **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.**
- **The camera may only be used with a supply voltage according to the camera 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.**
- **Our warranty does not protect against accidental damage, loss, or acts of nature.**
- **MIKROTRON cannot be held responsible for the loss of data. We recommend a backup plan.**

Necessary information to fill in the RMA form on the identification plate of the camera

Before sending back the camera, ask for a RMA number and form either by

- phone: +49 - 89 - 7263 4250 or by
- email: info@mikrotron.de

Write down the camera type and serial no. and send the camera back to your distributor. If no distributor is available, send it back to MIKROTRON (☞ page 54).

Conformity and Use of the Product

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.

Remark: You are herewith cautioned that any changes or modifications not expressly approved in this reference guide 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。

注意事項：　　このリファレンスガイドに明示的に承認していない変更や修正を行った場合には、本製品を使用する権利が無効となることがあります。

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.

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.

EU Declaration of Conformity

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

Camera type: MotionBLITZ EoSens
Kameratyp: MotionBLITZ EoSens

Models: CAMMC134x
Modelle: CAMMC134x

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

Title / Titel	EU Directive / EU-Richtlinie
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/EC 2004/108/EG

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

Title / Titel	EU Standard / EU-Norm
Information technology equipment - Immunity characteristics - Limits and methods of measurement Einrichtungen der Informationstechnik – Störfestigkeitseigenschaften - Grenzwerte und Prüfverfahren	EN 55024:1998 + A1:2001 + A2:2003
Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement Einrichtungen der Informationstechnik – Funkstöreigenschaften - Grenzwerte und Messverfahren	EN 55022:2006 + A1:2007

Unterschleissheim, May 6, 2015
Unterschleißheim, den 06.05.2015

Dipl.-Kfm. Christian Pilzer

Hardware

The CAMMC134x (Cube4) is a high speed CMOS camera with a resolution of 1280 x 1024 pixels. It provides up to 4 GByte of internal memory. Benefits of CMOS technology are high speed random access to pixels with free programmability and low power consumption.

An internal NiMh battery allows video recording at 1000 fps and 1280 x 1024 pixels of resolution for more than one hour. If the camera is not connected with an external power supply, data of stored image sequences will be available for a few hours. Video data is accessible by the build-in Gigabit high speed serial interface.

The camera is provided with an industry standard c mount adapter which can easily be exchanged for an f mount lens adapter. The sensor diagonal amounts to 1.25” with square pixels measuring 12 μm^2.

Before exposure starts, the content of all light sensitive elements is deleted. After exposure, the accumulated charge is transferred to an analog memory associated which each pixel where it is stored until it is read out (and discharged) by the A/D conversion cycle. As all light sensitive elements are exposed at the same time, even fast moving objects are captured without geometric distortion.

The internal frame memory consists of up to two DDR2 RAM boards, each with 4 GByte. Total memory capacity amounts to max. 8 GByte.

All CAMMC134x color cameras use a Bayer filter for color separation.

Scope of Delivery

Please check whether the delivery is complete, before you start to install the camera:

- ✓ Camera CAMMC134x (Cube4)
- ✓ C-Mount Lens
- ✓ Mikrotron Support CD
- ✓ 1 power supply 12 VDC; 1.25A min.
- ✓ 1 power cable

Identification Plate

The identification plate of your camera shows the:

- camera name (EoSens Cube4)
  CAMMC134x

- serial number (in this example: S/N 00111)

- MAC No. (00-11-1C-F1-74-32)
  stands for Media Access Control address which is the unique hardware address of the network adapter. This address will be used as identifier in networks.

- Invisible optional features are listed under options with the following abbreviations:

Abbreviation	Meaning
C	color
HG	High-G: ruggedized version shock: 100g; vibration: 10g at 5 to 2500 Hz
IB	ImageBLITZ option
IG	IRIG-B input processing option
M6/M11/M13	extended buffer size
MS	multi sequence mode
PR	power on recording
SB	standby

- Voltage: allowed voltage DC 10.5 – 30 V

Interfaces and Buttons

One side of the CAMMC134x camera provides 3 connectors, 2 buttons and several LEDs (☞ page 12). The pin assignments of the connectors are described on page 49.

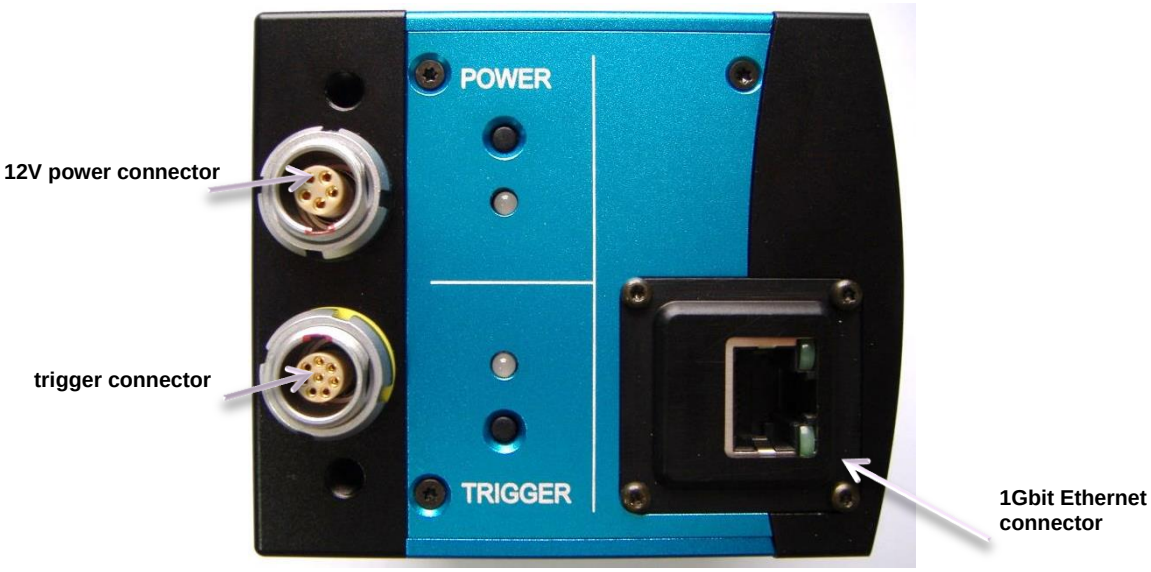


Figure 1: Connectors and GigE-Interface of the Cube camera

If you switch on the camera, it will take a few seconds until it will be ready for high speed recording at full resolution. As this camera is equipped with a rechargeable battery, a connection to the PC will only be needed for downloading recorded sequences or modifying camera parameters.

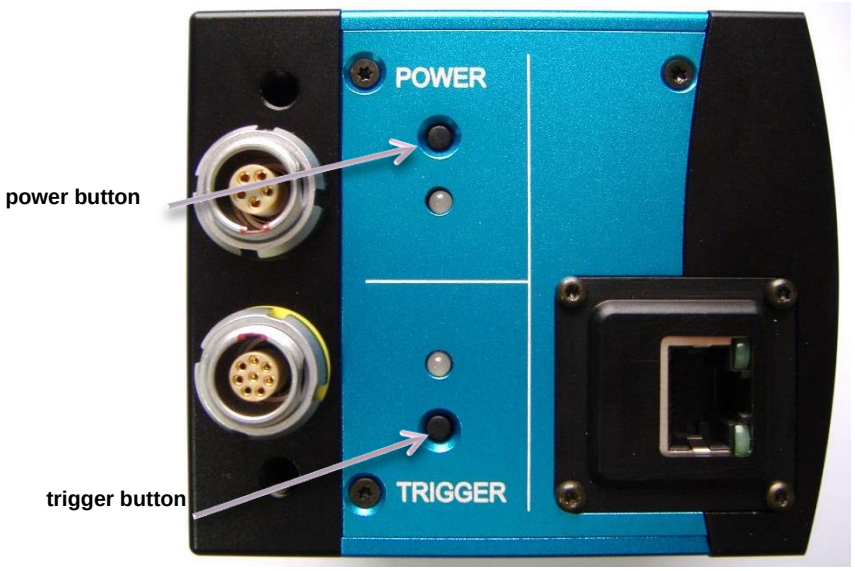


Figure 2: Buttons and LEDs of the camera

Remark: For more information about the pinning of the power and trigger connector ☞ page 49.

Power and Camera Status LEDs

The CAMMC134x can be operated with the internal NiMh battery and/or an external DC supply providing 10.5 … 30 V @ 10 Watt max.

The power LED indicates the power status:

Color	LED status	Power supply
For cameras supporting the standby function:		
RED/ ORANGE	flashing	Standby mode with external power supply
GREEN	flashing	Switched on, with internal power supply (battery)
Color	**LED status**	**Camera/battery status**
OFF	dark	camera is switched-off, battery will not be charged
RED	constant	camera is switched-off, battery charging in progress
GREEN	constant	camera is switched-on, no charging (battery full or no power supply connected)
ORANGE	constant	camera is switched-on, battery charging in progress

Remark: In case the batteries are empty, it will take a few minutes of initial charging before the camera can be switched on.

The internal NiMh battery has a capacity of 2.2 Ah and is charged automatically within three to four hours if an external power supply is available. If the camera is operating and external power is applied, the battery will be charged.

The camera's status LED indicates the actual operating status.

Color	LED state	Operating state
OFF	-	power OFF, no communication
RED	flashing	power ON, new firmware will be loaded
RED	constantly	FPGA configuration failed, consult our service team
ORANGE	after power ON 3 sec	FPGA configuration is in progress
GREEN	constant	ready for the first recording after power-up
ORANGE	flashing	circular recording in progress
ORANGE	constantly	circular recording stopped

Power Supply

CAMMC134x cameras come with an external power supply. Connect it with the power connector of the camera in order to charge the battery and/or to operate the camera in case battery status is low.

WARNING

Serious Camera Damage

- **Only a maximum voltage of 10.5 to 30 V @ 10 W is permitted. Higher input voltages may seriously damage the camera. Damages caused by supplying the wrong voltage are not covered by warranty.**
- **The battery of CAMMC134x camera is equipped with an additional fuse and a temperature probe. Therefore, never change the battery yourself! Instead, contact our service team and ask for a RMA number info@mikrotron.de and send the camera back to MIKROTRON. Damages caused by battery change are not covered by warranty.**

Although each camera comes with a power supply, the power connector pinning of the 5-pin Lemosa might be helpful e.g. when cables have to be extended. Please, refer to page 49.

Charging the Battery

CAMMC134x cameras are equipped with an integrated, rechargeable battery. It provides the necessary voltage for operation and will automatically be charged as long as the power supply is connected with the camera and the camera is switched off. Charging a completely empty battery will take about three hours.

If the batteries are charged, the camera can be disconnected from the PC and will record autonomously.

Remarks:

- If the battery is completely charged, the green Power LED will signal it by a quintuple blinking. If the battery is empty, the LED will indicate it by a single blinking.

- If the camera is switched-on and a power supply is connected, battery charging will be very slow. Nevertheless, the camera might operate in stand-alone mode for a few minutes after being disconnected from the power supply.
- In order to charge the battery completely, connect it with the power supply and switch the camera OFF.
- A completely charged battery will discharge within a few days if not used. If the battery is completely charged,
  - + CAMMC134x cameras will record in ring mode for up to 60 minutes at full resolution without power connection
  - + recorded images can be kept in the camera for up to 24 hours if *Standby after Record* is set

WARNING

Data Loss

If the battery status is unknown, make sure to connect the external power supply. If the battery is discharged, recording will be stopped. In this case all recorded frames will be lost.

Standby Mode

Without an external power supply, frames will be kept for up to 24 hours if the CAMMC134x camera is in standby mode (optional feature). This is achieved by switching OFF several components of the camera's electronics. In standby mode, only the image memory will be supplied with power. That is why you do not have access to the image memory in standby mode.

Procedure:

1. **In order to change into standby mode, press the power switch for less than 1 second**
2. **In order to change into operating mode, again press the power switch for less than 1 second**

WARNING

Data Loss

If you press the power button longer than 1 second, the camera will be shut down completely and all recorded frames will be deleted.

If a CAMMC134x camera is in standby mode, the Status LED will be OFF and the Power LED will be flashing.

Remark: A camera in standby mode has to be connected with the power supply before waking it up.

Installation of the Camera

Only a few steps are needed to install MotionBLITZ Eo*Sens* cameras.

Remark: In multi-camera mode we recommend to connect all cameras via a switch with the Ethernet card of your PC.

Procedure:

1. **Install all drivers and support software on your image processing system**
2. **Make sure that your network card has been installed properly (☞ manual of your network card)**
3. **Take off the cover of the cameras' sensor and mount the lens**
   In case an f-mount lens has to be mounted ☞ page 46.
4. **Connect the power supply first with the camera, then with the main supply**
   The status LED lights orange and becomes green after a few seconds.

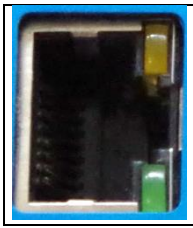
WARNING

Camera Damage

Connect only the power supply NTCAM137XL or a power supply with exactly the same technical data and pinning.

Connecting a wrong power supply might damage the camera!

5. **Connect the shielded Gigabit Ethernet cable first with the camera, then with your PC**
   The data transfer status is indicated by the upper data transfer LED:



LED Color	Data transfer
orange	data transfer in progress
green	data transfer at 1 Gbit

Remark: Normally, an IP address will be assigned automatically. This may take a few minutes. In case you want to accelerate this process or in order to assign a certain IP address (☞page 18).

Connecting External Signals

When applying external signals, e.g. to trigger events or synchronize one or more cameras it is important to know the internal circuits of the CAMMC134x camera.

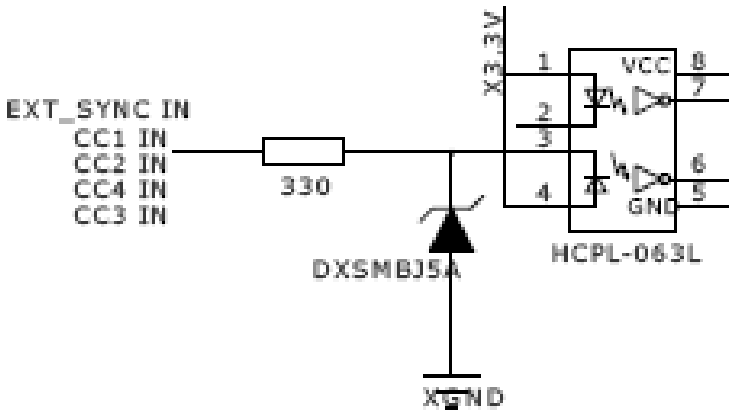
Digital 4/Trigger and SyncIN

The Digital Input 4/ Trigger and the Sync Input are isolated from the rest of the circuitry by an optical coupler. The pull-up resistors R33/R32 are powered by an internal DC/DC converter (X3.3V). The optical coupler will switch if the input is connected to the common GND signal (pin 1 on signal I/O connector).

A positive edge on the SYNC input will output the next image, if the positive “Sync edge” is selected in the camera menu (:rf[3] = 0/1 = pos/neg edge).

A positive edge on the Trigger input will stop a circular recording if the positive “Trigger edge” is selected in the camera menu (:r7[8]).

The trigger input is debounced with 100 ms retrigger suppress time.



Analog Input Signal Definition

The analog input is protected by a 330kΩ series resistor and adjusted to deliver the digital value of 255 for 2.55V input voltage.

Digital Inputs 1-3 Signal Definition

The signals DIG IN1-3 are TTL input signals and are used as process signals, which are superimposed to the image.

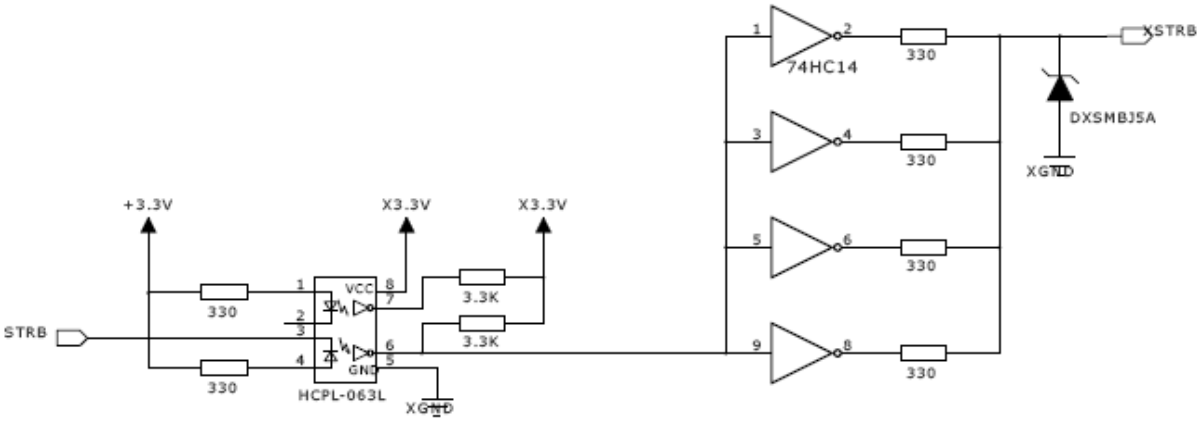
Sync/ARM Output

According to the settings in the Camera IO menu of VisualMARC, this pin will either output a Sync or an ARM signal. If Sync out is selected, this output will carry a strobe that corresponds to the selected exposure time of the camera. If ARM is selected, it will be active when the camera runs in Ring Mode and is recording.

SYNC OUT / ARM Output Signal Definition

This pin can output a SYNC OUT signal or an ARM signal, which can be selected by switching register bit rf[1]. If SYNC OUT is selected, this output will carry a strobe that corresponds to the selected exposure time of the camera. If ARM is selected, it will be active if the camera runs in circular recording mode.

Four CMOS inverters are paralleled to drive transmission lines with 50 OHMs impedance. The inverters are supplied with an isolated power supply. The output polarity is positive when the selected signal is active. The suppressor diode protects the output against reverse voltages. It starts conducting if the voltage at the output pin is greater 6V.



Configuration

The CAMMC134x camera has several registers:

Register	Number	Width
sensor registers r1 .... rf_h	15	10 bit
D/A registers a1....a8	8	8 bit
random clock select registers	2	6 Bytes
memory control registers	3	32 bits

The content of all registers is called a profile and can be stored into a non-volatile memory.

Any change of a specific register via the serial interface will immediately be processed and written into the volatile part of the memory. Its content will get lost when power is OFF. A command has to be used to store the actual setting of the power-up profile in the non-volatile memory. After power-up the PowerUpProfile is loaded from the non-volatile memory into the volatile part of the memory.

Note: All values are given in hexadecimal notation, e.g.: 0xff or 0ffh = 255 dec.

Commands

Commands to change camera settings are ASCII strings. They all start with a colon, followed by one command character and a value in hexadecimal notation with as many ASCII characters as required by the command (2....8 characters).

Note: All alphabetic characters in commands are case-sensitive.

After a command has been recognized it will be processed immediately. This applies to all commands except the save type commands (e.g. :pc). The execution of these commands require EEPROM write time depending on the quantity of data, but at least some 10 ms. An answer is provided with the read type commands (:v, :w, :W, :z). In case the command “command acknowledge flag” is set, the answer will be an ACK or NAK. Wrong commands will not be processed. Processing is stopped immediately after recognizing the error.

Frame Memory Overview

There are two independent pointers with three associated counters. The write pointer with its counter and an independent trailer counter controls writing to memory. The read pointer controls reading. All pointers and counters use OctoWORD (16 Bytes) entities.

Writing and reading can be done simultaneously up to a total bandwidth of approximately 1.5 GBytes/s. Reading bandwidth is limited to 66 MBytes/s.

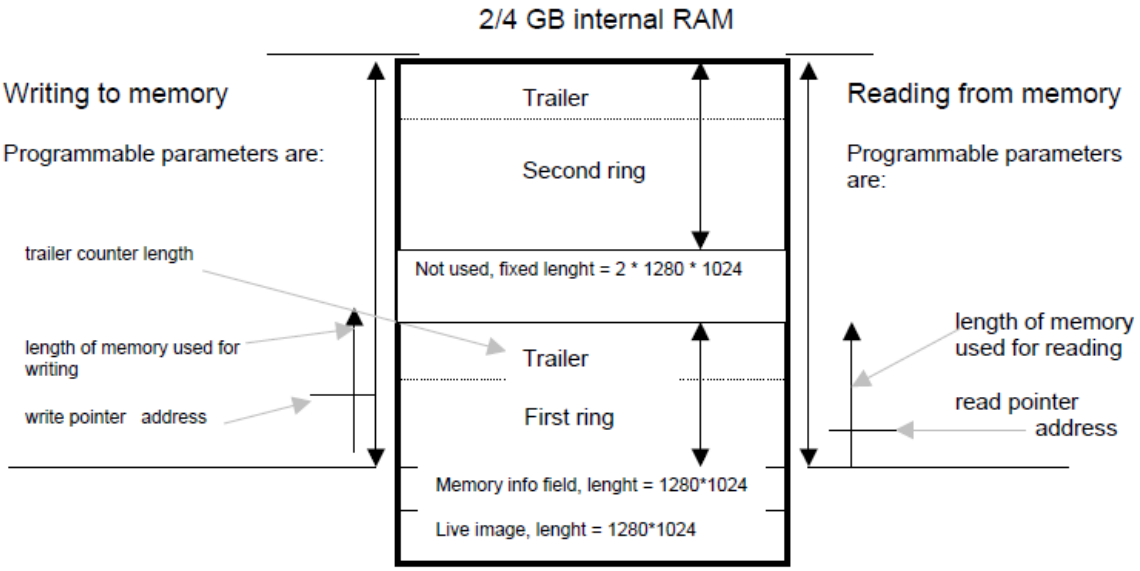
Write Pointer/Counter

The write pointers start address is programmed in register :R2[0,29...0] and its length in :R2[8,29...0]. Writing to memory can be done continuously because the write pointer wraps automatically to its programmed start address when the write counter has expired (ring memory).

Even if continuous writing is selected (:R1[1] = 1), this bit can be cleared at any time by stopping writing on an expired write or trailer counter.

If single writing is selected, writing to an expired write or trailer counter will automatically be stopped.

Multiple ring operation is possible with :R1[31...28]. It has to be set according to the :R1 bit description. The figure below shows a two ring operation.



The camera will continuously write into the first ring (1/2 of memory) until :R1[1] is lowered and the trailer counter expired. Then frames are automatically written into ring2 until :R1[1]=0. At that time memory control logic will lower :R1[0]. The control program will continuously poll :R1[0] to insure that :R1[1] will not be raised again if :R1[0] = 0.

Trailer Counter

The trailer counter can count in parallel with the write counter, if selected. If selected (:R1[27] = 1), it will stop writing as soon as it is expired. This is useful if a continuous writing procedure is interrupted by an external signal but a previously defined number of frames should be recorded after the signal came in (a “trailer” should be written).

Memory Registers

Memory is organized in 8 WORDS (16 Bytes). Its address is a linear physical address that starts with 0 and ends at 0x1FFFFFFF. A memory board provides 2 GByte. CAMMC134x cameras can be equipped with two memory boards providing 4 GBytes altogether (see also :v command for camera identifier and memory size).

Use the capital letter :R in order to program the memory register.

Memory Write Register :R1

Register 1 is the memory control register which defines the size of the memory, the image size (line length, no. of lines per image), and the image mode (live image, circular or non-circular recording) as well as some control bits. It can be read at any time with the command :z1. Its content consists of eight ASCII characters.

Syntax	Bits	Value	Description
:R1<xxxxxxxx> xxxxxxxx = 8 ASCII hex characters	0	0 1	stop write memory write frames to memory (address = R20xxxxxxx, length = :R28xxxxxxx)
	1	0 1	write frames to memory address non continuously write frames to memory continuously
	2	0 1	dual die 2 Gbit RAMs single die 1 or 2 Gbit RAMs
	3	0 1	2 Gbit RAMs 1 Gbit RAMs
	4	0 1	normal operation reset logic, but not registers
	6...5	 00 01 02	RAM size: 2 GByte 4 GByte 8 GByte
	7	0 1	normal operation select internal grey scale camera: linelen = :1+R1[15...8] [8words] numlin = 1+R1[27...16] [lines]
	15....8	0x4F…1	linelen = 1+:R1[15...8] [8words]
	25....16	0x3ff....1	numlin = 1+R1[27...16] [lines]
	26	 0 1	write wrap indicator (read only): cleared when start write issued Set when write memory counter (:R2[8]) has reached its end position
	27	0 1	no standby after end of recording sequence request standby mode after end of recording sequence
	30....28	0....4	select number of rings: value 0,1,2,3 = 2,4,8,16 rings
	31	0 1	single ring multiple rings

bits 1....0 select mode of write operation:

If :R1[1...0] = 1, frames of total length = :R2[8,29...0] are written to memory address :R2[0,29...0]. Bit 0 is cleared automatically on completion of this action.
If :R1[1...0] = 3, frames of total length = :R2[8,29...0] are written to memory address :R2[0,29...0] continuously.
If bit 1 is cleared while writing continuously, the current write action will be continued until :R2[8,29...0] is expired. Writing will stopped and bit 0 cleared automatically.

bits 3…2 are selected according to the extended camera identifier retrieved with the command :V and should be set to the same value as read with :z1 after power up of the camera. Please pay attention: the bits in :R1 are not the same as in :V response!

bit 4 can be cleared/set if a reset of memory control logic is required.

bits 6…5 select the memory size: 0=2GByte, 1=4Gbyte, 2=8Gbyte, must be initialized by control program on power up. Other settings are not allowed and will be ignored.

bit 7 selects an internal grey scale camera simulation. This can be used to fill memory with a known pattern.

bits 15…8 selects an x-counter *linelen* to generate internal LVAL signals that are necessary for the Gbit interface.
Calculate this value according to: :R1[15...8] = r5-r4

bits 25....16 selects a y-counter *numlin* to generate internal FVAL signals that are necessary for the Gbit interface. Calculate this value according to:
:R1[25...16] = r3

Note: *linelen* and *numlin* are used only with the Gbit Ethernet interface. The length of video data stored in the memory is defined by :R2[8,29...0]. Make sure that :R2[8,29...0] is a multiple of *linelen*+1**numlin*+1.

bit 26 is read only and indicates that the write counter has expired once. It is cleared by toggling the write enable bit, e.g.: by restarting write. (:R1[0])

bit 27 Request standby mode after end of recording sequence. Works together with the :k1 command

bit 28....30 select number of rings in multiple ring operation: 0…4 = 2, 4, 8, 16 rings.

bit 31 selects multiple ring operation.

Memory Pointer/Counter Register :R2

The memory register :R2 is an address/length register. The two most significant bits of register 2 serves as an index for:

- WriteBaseAddress
- ReadBaseAddress
- WriteLength
- ReadLength

All other bits serve as pointers/counters for memory read or write actions. Register :R2[0,29...0], R2[4,29...0], :R2[8,29...0], :R2[c,29...0] can be read at any time with the :z command. The length registers contain the current count value and can be read with :R2[8,29...0], :R2[c,29...0].

Syntax	Bits	Value	Description
:R2<ixxxxxxx> i = 0, 4, 8, 0xc xxxxxxx = 7 ASCII hex characters	31...30	0 4 8 c	WriteBaseAddress register [8words] ReadBaseAddress register [8words] WriteLength register [8words] ReadLength register [8words]
	29...0	0x3fffffff....5	Write/Read address/length [8words]

Memory Read Register :R3[31...30] = 0

R3 can be used as read control bit and to set the trailer counter.

Syntax	Bits	Value	Description
:R3<xxxxxxxx> xxxxxxxx = 8 ASCII hex characters	0	0 1	stop Read memory read frames from memory (address = R24xxxxxxx, length = :R2Cxxxxxxx)
	1	0 1	read single frame range from memory address read last previously written frame from memory continuously if :R1[1...0] is 3 and :R3[0] = 1. WriteXorRead frames to/from memory continuous if :R1[1...0] is 1
	2	0	reserved
	29...3	0x3fffffff....5	write trailer counter
	31...30	0	select trailer counter

bits 1…0 select mode of read operation:

If :R3[1...0] = 1, a single frame range of the length :R2[c,29...0] is read from the memory address :R2[4,29...0]. Bit 0 will be cleared automatically after this action is completed. Use this mode to selectively retrieve an image or a sequence of images from memory, one at a time.

If :R3[1...0] = 3, frames of length = :R2[c,29...0] are read from last previously completely written memory address continuously.

If bit 1 is cleared while reading continuously, the current read action is continued until :R2[c,29...0] will be expired. The reading will be stopped and bit 0 cleared automatically.

If :R3[1...0] = 3 and :R1[1...0] = 1, a special WriteXorRead action is done continuously. After one single frame is written, a single frame is read. This will be repeated until some other mode is selected. WriteXorRead can be used for automatic life display action without issuing memory commands. It maintains the integrity of the read images. Reading is much slower than writing (maximum ¼ of write bandwidth). Otherwise a read image would be overwritten by new images while reading is in progress.

If :R3[1...0] = 3 and :R1[1...0] = 3, memory is written and read at the same time. Maximum read bandwidth is 1/32 of write bandwidth. Use this mode only for test purpose.

If :R3[31...30] = 0, bits 29...3 contain the trailer counter. This counter counts frames (and not the number of Bytes!) to be written after bit 1 of :R1(the continuous write bit) has been reset, e.g. by a sending an according :R1-command or by applying an external trigger. Register 3 can be read at any time with the :z6 command. It will return its content in 8 ASCII characters.

Concatenated Memory Register Settings

Register :R1 and :R3 bits 1...0 define several modes of memory operation:

:R1[1...0]	:R3[1...0]	Mode	Remark
0	0	memory stop	no memory activity, memory is refreshed
1	0	write single	write frames with a total length of: :R2[8,29...0] to memory pointed to by :R2[0,29...0]
3	0	write continuously	writes frames with a total length of: :R2[4,29...0] to memory pointed to by :R2[0,29...0] continuously use this mode for circular storage stop continuous writing by clearing :R1[1] when :R3[31...2] = 0 if :R3[31...2] is > 0, as many frames are written as defined by the trailer counter after a stop is issued
0	1	Read single	read a single frame range with length: :R2[c,29...0] from memory pointed to by :R2 [4,29...0]. use this command to read memory. set the read length to one or more frames. Length of multiple frames is more efficient, because viewer commands are issued.
3	1	write continuously, read single	use this mode to read data that is being circularly written.
1	3	WriteXorRead	memory is alternatively written and read. use this mode for live display.
3	3	write and read continuously	frame to be read is the last previously and completely written frame. Use this mode for live display while (continuous) recording is in progress size for read frame = :R2[0xC,29...0]

ExposureTime Register :R3[31...30] = 4

The ExposureTime register loads a 28 bit down counter that is clocked from the internal x-counter counting the sensor clock modulo 86. Its output defines the width of the internal exposure signal that is also output on the strobe output signal.

Range for ExposureTime register: 0x00000002 … 0x0001ffff

Calculation of ExposureTime: t_{exp} = R34 * 86 / sensor clock

t_{exp}	*exposure time in s*
sensor clock	*sensor clock in Hz*
R34	*value of R34*

Example: *sensor clock = 89.100 MHz*
ExposureTime/step = 0.965 µs
min. ExposureTime = 1.93 µs
max. ExposureTime = 126.51 ms

Note: ExposureTime setting is limited by the time for one frame, which is set with FrameRate register. ExposureTimes, which are longer than one frame, will be reduced to the duration of one frame.

FrameRate Register :R3[31...30] = 8

The FrameRate register loads a 28-bit down counter that is clocked from the internally fixed 25MHz quartz oscillator. Its output triggers the internal frame rate logic if not set to external synchronization.

Calculation: R38 = (f_{osz}/FrameRate) - 1 (hex value)

f_{osz}	frequency of quartz oscillator = 25,000 MHz
FrameRate	frame rate in fps (frames per second)
R38	value of R38

Example: *1000 fps wanted*

R38value = (25,000 MHz / 1000 Hz) - 1 = 24.999$_{dec}$ = 0x61A7$_{hex}$
Resulting command for R38: *:R3800061A7* (in ASCII characters)

Read Single Memory Registers

Use :z1 ... :z8 commands to read memory registers :R1...:R38. Eight ASCII characters with their hex contents are returned.

Syntax	Description
:z1	read :R1, bit 0 might be clear thru previous stop write action
:z2	read :R2[0,29...0]
:z3	read :R2[4,29...0]
:z4	read actual write pointer
:z5	read actual read pointer
:z6	read :R30, bit 0 might be clear thru previous stop read action
:z7	read :R34 (not yet supported)
:z8	read :R38

Note: Result of command :z4 and :z5 will change with repeated readings if memory read/write is in progress.

Read All Analog Registers

Use command :Za to read all memory registers :a1-:a8 with one instruction.

Syntax	Description
:Za	read all memory registers

Response 8*2 characters, e.g.:

```
5c64e4ead7207b6e
|  |  |  |  |  |  |  |a8
|  |  |  |  |  |  |a7
|  |  |  |  |  |a6
|  |  |  |  |a5
|  |  |  |a4
|  |  |a3
|  |a2
|a1
```

Sensor Commands

The sensor logic of the CAMMC134x is the same as the logic of the industrial proven CAMMC131x camera series. Therefore all CAMMC1310 commands apply to the CAMMC134x.

Syntax	Range	Response	Description
:a<n><xx>	<n> = 1....8 <xx> = 0....ff_h	ACK*	set one of eight analog voltages for the sensor
:b<n>	<n> = 0....4	ACK*	select baud rate: 0=9600 Bd (default setting), 1=19.2 kBd, 2=38.4 kBd, 3=56.8 kBd, 4=115.2 kBd
:c	--	--	RESET and initialization of the camera, new load of PowerUpProfile; duration: some seconds
:e....	--	--	receive and save new sensor FPGA configuration
:fc	--	ACK*	load factory profile to camera profile
:gc	--	ACK*	load power-up profile to camera profile
:i<n><c….c>	<n>= 0…f_h , <c....c> = 16 char	ACK*	write one line of text buffer (16lines x 16 char)
:n…	48 char	ACK*	write camera name into camera
:pc	--	ACK*	save PowerUpProfile to non-volatile memory
:r<n><xxx>	<n> = 1....f_h , <xxx> =0…3ff_h	ACK*	write a FPGA - register
:v	--	#005433A 11-B2.03- V0.82- F1.71	read serial number (#), part of identifier, microcontroller-version (V....) and FPGA - version (F....).
:w	--	camera profile:	read actual PowerUpProfile, data output in hex

		80 bytes in hex	
:z<n>	<n> = 1...8	e.g. 03ff4f2c	read memory register values directly from FPGA
:A<n>	<n> = „y“,“Y“,“n“,“N“		enable or disable a command acknowledge or not acknowledge (ACK or NAK)
:Dc<c><ii>…	<c>=”i”,”l”,”r”,”s” <ii>=0…ff_h …= data (hex)	ACK* for <c>=”r”: data in ASCII or hex	column correction commands for loading or reading a correction table, enabling or disabling function and reading status byte
:ERASE<ccc>	<ccc> = “APP”, “EPCS1”	--	erase of camera internal firmware, camera stops working, please, read command description before executing it
:F<nnnnnn>	<n…n>=different functions and values	ACK*	program sensor clock directly in units of 1 kHz additionally load, read, save the clock setting table to or from non-volatile memory
:I<n>	<n>= 0…f_h	ACK*	read text line no. <n>, 16 bytes answer
:N	--	ACK*	read camera name, 48 bytes length
:P<nnnnnn>	<n...n>= 0 – 150000 (ASCII)	ACK*	program pixel clock directly in units of 1000Hz, insert leading zeros
:R<n><xxxxxxxx>	<n>=1-3h, <x...x> = hex value	ACK*	write memory register
:T	--	+45.0°C	read camera internal temperature
:V	--	e.g. 1340000000003831	read complete identifier of the camera
:W	--	Camera profile: 265 bytes in ASCII	read actual PowerUpProfile, data output in ASCII
:?par	-	<xx>	read 8 bits data of port A
:?paw<xx>	<xx> = 0....ff_h	ACK*	write 8 bits to port A bit 7 = switch to standby mode
:k<n>	<n> 0...1	ACK*	switch to standby mode after end of recording: 0 = no switching 1 = switching if bit 27 of Memory write register :R1 is set

Sensor Registers

All sensor registers are 10 bits wide and represented by three ASCII hex characters 000...3ff.

Syntax	Bits	Value	Description	
:r1<xxx>	9....0	0...0x3ff	address of first line to be output	
:r2<xxx>	9....0	0....0x3ff	burst trigger in non-circular mode	
			0	no trigger
			1 … 0x3fe	number of frames per trigger
			0x3ff	recording while trigger is active
:r3<xxx>	9....0	0....0x3ff	number of lines + 1	
:r4<xxx>	9....0	0....0x4f	address of first pixel of a line	
:r5<xxx>	9....0	0....0x4f	address of last pixel of a line	

:r6<xxx>	9....0		modes of operation
	0	0	invert „arm“ signal
	1	0	reserved
	2	0 1	normal operation vertical binning
	3	0	reserved
	7....4	0	camera stop
		1	synchronous operation, no shutter
		3	synchronous operation, with shutter
		0xB	asynchronous exposure, shutter control by pulse width
		0xF	asynchronous exposure, shutter control by timer
	8	0	reserved
	9	0	reserved
:r7<xxx>	9....0		modes of operation
	0	0	reserved
	1	1->0->1	clear image timer/counter
	3....2	0 1 2 3	digital gain 0, multiply grey values by 1 digital gain 0, multiply grey values by 2 digital gain 0, multiply grey values by 4 digital gain 0, multiply grey values by 8
	4	0 1	normal operation enable horizontal pixel binning
	5	0	reserved
	6	1	test pattern
	7	1	reserved
	8	1	invert trigger input
	9	1	enable exchange columns
:r8<xxx>	6....0	0....0x4f	ImageBLITZ window x-start (mod16)
	8.....7 9	0 1	reserved indicates an element of the exchange columns table
:r9<xxx>	9....0	0....0x4f	ImageBLITZ window x-end (mod16)
:ra<xxx>	7....0 8 9	0....0xff	threshold release condition, msb enable ImageBLITZ top/bottom line zebra striped indicator in the frames
:rb<xxx>	9....0	0...0x3ff	release condition 10 is :ra[8]
:rc<xxx>	9...0	0...0x3ff	ImageBLITZ top line address
:rd<xxx>	9...0	0...0x3ff	ImageBLITZ bottom line address
:re<xxx>	9...0	0...0x3ff	write ImageInformationField

:rf<xxx>	0	1	enable external sync signal
	1	1	select „arm“ signal on strobe output
	2	0/1	set “arm” signal accordingly
	3	1	invert external Sync Signal
	4	0	reserved
	5	0	reserved
	6	1	enable IRIG-B processing
	7	1	disable trigger input
	8	0	reserved
	9	1	enable bad pixel correction

Image Quality

There are eight D/A converters which can be used to influence image quality. Black level (VCLAMP3) might be adjusted if sensor clock changes. All eight parameters are stored in a non-volatile memory as part of the selected profile.

Most analog parameters will directly influence the image quality and may differ between each camera. Thus changes should be made very carefully. It is recommended to use the factory preset adjustments.

VLN1

VLN1 is a sensor internal bias voltage that goes to column analog buffers. The value can be optimized for better column gain uniformity. VLN1 has also an influence to brightness and fixed pattern noise. In order to adjust it set the lens out of focus and to a medium grey level.

Command: **:a1<x_1x_0>** <x_1x_0> : range typ. 32h C8h

Response: none or ACK (if enabled)

VREF1, Gain

VREF1 sets the maximum unclipped signal conversion voltage. This is the threshold for the A/D converters. The standard value is 66h for approximately 1V. One step is app. 10mV. To increase the gain the value of a2 has to be lowered.

Command: **:a2<x_1x_0>** <x_1x_0> : range, typ. 14h 96h

Response: none or ACK (if enabled)

VREF2

VREF2 is the ADC calibration voltage and is typically adjusted to 46h. VREF2 influences the column correction stage inside the sensor and should not be set to values below 30h.

Command: **:a3<x_1x_0>** <x_1x_0> : range, typ. 14h 96h
Response: none or ACK (if enabled)

PIXVDD

PIXVDD is the supply voltage of the analog stage of each pixel inside the sensor. This parameter is important for the image quality. The factory adjustment is recommended to use.

Command: **:a4<x_1x_0>** <x_1x_0> : range, typ. 32h 40h
Response: none or ACK (if enabled)

VCLAMP3, Black Level

VCLAMP3 or Black Level changes the basic brightness of the image. A higher value will lower the brightness. If VCLAMP3 = 0 and camera lens is closed most of the pixel values are higher than 0. This parameter may change in dependence of the sensor clock. Increase this parameter until the grey value of each pixel in no light condition (closed lens) is close to zero.

Command: **:a5<x_1x_0>** <x_1x_0>: range, typ. 00h ....ffh
Response: none

Note: For color cameras: Changes of VCLAMP3 may also change the white balance of the image.

VREF3

VREF3 works inverted to VCLAMP3, means a higher value of VCLAMP3 increases the brightness of the image. The factory setting of VREF3 is recommended.

Command: **:a6<x_1x_0>** <x_1x_0> : range, typ. 00h .... ffh
Response: none or ACK (if enabled)

VLN2

VLN2 is a sensor internal bias for ADC comparators. The factory presetting is recommended to use. The adjustment of this parameter does not depend on the camera settings.

Command: **:a7<x_1x_0>** <x_1x_0> : range, typ. 32h 78h
Response: none or ACK (if enabled)

VLP

VLP is a sensor internal reference voltage for the buffers. The factory presetting is recommended to use. It does not depend on the camera settings.

Command: **:a8<x_1x_0>** <x_1x_0> : range, typ. 32h .... ffh
Response: none or ACK (if enabled)

Image Size and Position

Image size and position within the sensor is defined by four parameters:

Bit(s)	Description
r1[9...0]	number of first line, 0...3FD$_h$
r3[9...0]	number of lines, 0...3FF$_h$
r4[6...0]	address/16 of the first pixel
r5[6...0]	address/16 of the last pixel

Address of the First Line

Register r1 defines the first line to be displayed.

Command: **:r1<$x_2x_1x_0$>** <$x_2x_1x_0$> .... Range 000h 3fdh

Response: none

Example: :r1100
100h = image starts at line 257

Number of Lines

Register r3 defines the number of lines to output.

Command: **:r3<$x_2x_1x_0$>** <$x_2x_1x_0$> .... Range 000 h 3ffh

Response: none

Example: :r3200 200h = display 513 lines

Note: The sum of r1 and r3 must be ≤ 0x3ff/1023.

Address of the First Pixel of a Line

Register r4 defines the leftmost pixel. The value is the pixel address divided by 16.

Command: **:r4<$x_2x_1x_0$>** <$x_2x_1x_0$> .... Range 000h 4fh
Response: none

Calculation of the value of r4:
Value of r4 = Pixel no./16

Address of the Last Pixel of a Line

Register r4 defines the rightmost pixel. The value is the pixel address divided by ten.

Command: **:r5<$x_2x_1x_0$>** <$x_2x_1x_0$> .... Range 000h 04fh
Response: none

Calculation of the value of r5:
Value of r5 = Pixel no./16

Note: The difference r5 - r4 has to be in the range of 0 ≤ r5-r4 ≤ 4fh.

Clock Selection

The MC134x works with two clocks (pixel and sensor clock) inside. Pixel clock is factory preset to 100 MHz, sensor clock to 88 MHz. Both parameters are fixed and should be not adjusted.

Calculation of sensor clock: $F_{SENS} = 85 \bullet FR \bullet (NUMLIN + 1)$

FSENS	sensor clock in Hz
FR	frame rate in 1/s (=Hz)
NUMLIN	actual number of lines

The calculated sensor clock is selected with the :F command in 1000 Hz units.

Example: *87,040 MHz is programmed as :F087040*
The calculated sensor clock is selected with the :F command in 1000 Hz units.

To set the sensor clock in the following code must be sent to the camera:

Command **:F <x_0>**

<x_0> ... always 6 characters, requested frequency in 1 kHz units with leading zeros if necessary.

Note: For speed and/or the image format changes please us the recommended command sequence in chapter Image Format/Speed change.

Image Format Change

There are several steps necessary for a change of image format:

1. If the memory controller is not idle (e.g. life image or recording is in progress), program :R3/R1[1...0]==0 and wait for 1/fps (100 ms max for 10 fps) until the last pending image has been output completely.
2. Set memory controller to new linelen/numlin (:R1) and number of 16words (:R2[8Cxxxxxxx]) .
3. Set GigE interface to new linelen/numlin parameters
4. Disable sensor controller with :r6[4] = 0
5. Set sensor controller to new image size (:r1,:r2, :r3, :r4, :r5)
6. Enable sensor controller (:r6[4]=1) and wait for 1/fps to insure that there are output correct images
7. Enable (if necessary) the memory controller to desired action.

Image Speed

A slower Image speed can be requested regardless of the cameras operating mode. (e.g.:idle, life, recording) Do not change the pixel clock, e.g.: do not send the pixel clock code (:Pxxxxxx), even if it is the same as it was before.

bits 27...0 of register R38xxxxxxx define image speed:

$$F_{frame} = 25 \bullet 10^6 \ / \ (R38xxxxxxx + 1) \quad [Hz]$$

xxxxxxx ....frame speed divider

Note: Image speed < (:r3+1) • SensorClock / 85

Exposure Time

bits 27...0 of register R34xxxxxxx define exposure time:

$$ExpTime = (1/Fsens \bullet 85 \ / \ R34xxxxxxx \ [sec]$$

xxxxxxx ....ExpTime multiplier

Note: ExpTime < 1/ ImageSpeed

Synchronization

CAMMC134x cameras are synchronized by an internal or external signal. The internal signal is divided from the 25MHz master crystal clock. Use :R3[31...0] = 8 to program the required divider.

Multiple CAMMC134x cameras can be synchronized to an external signal with a frequency that is below the free-running frame rate of the cameras. A master camera's strobe output can be used to synchronize the slave cameras. Make sure that the master camera's free-running frame rate is selected to be a little below the one of the slave cameras.

Use Pin 8 of the I/O connector as input. Synchronization is enabled with register **:rf[0] = 1**. Use only with synchronous exposure (:r6[7...4]=3).

ImageBLITZ Trigger

This signal is generated in the sensor FPGA and fed through the micro controller to the memory control FPGA to stop a cyclic recording action just as the external trigger switch/signal.

When activated, the grey values of an ROI:

:r8[9...0] = x-start(mod16),

:r9[9...0] = x-end(mod16),

:rc[9...0] = top line address,

:rd[9...0] = bottom line address

within the visible image area are stored as reference, every time the ImageBLITZ trigger is activated:

:r7[0] = 0->1

Note: The total number of pixels within the trigger window should not exceed 20480 pixels.

After activation of ImageBLITZ, all subsequent images within the given ROI are compared to the stored image, and if at least once within a group of 10 pixels the absolute value of the difference between actual grey value and stored grey value exceeds the limit given in:

:ra[7...0] = threshold

the release condition counter is incremented. If the counter value equals the value given in:

:rb[9...0] = release condition [9...0]

:ra[8] = release condition 10

the ImageBLITZ output signal is activated and stored until the next activation of ImageBLITZ:

:r7[0] = 0->1 happens.

The trigger ROI is marked by a top & bottom dashed line when activated.

Digital Gain

Out of the 10-bits sensor data either the most significant 8 bits (gain 1), or bits 8...1 (gain 2), or the least significant 8 bits (gain 4) are selected.

Command: **:r700x**

x = 0: gain 1

x = 4: gain 2

x = 8: gain 4

Test Image

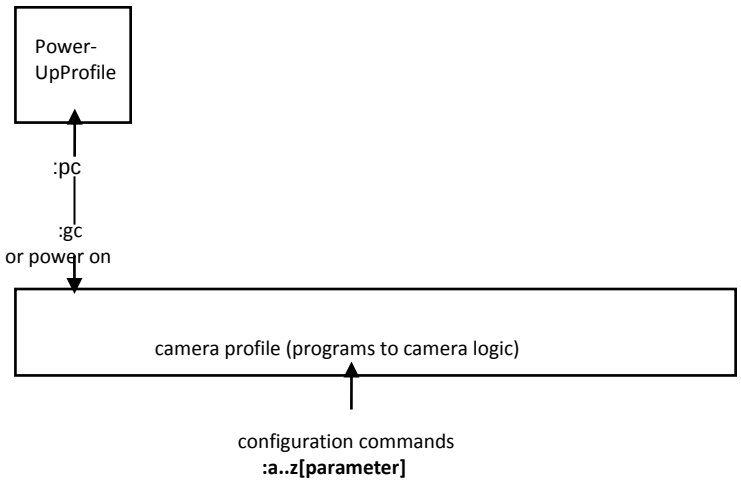
For testing of camera logic and video data transmission, sensor data can be replaced by an internal gray scale pattern with pixel values of 0...127. Use digital gain command to see pixel values of 0...255.

Command example: **:r7040** r7[6]

Response: none

Profile Processing

All camera settings are loaded or stored as complete data blocks (= Profiles). There are 3 profiles, the Camera profile, the PowerUpProfile and the factory profile



Read Camera Profile

The response to the read Camera profile command **:w** is a hex string of the contents of all actual camera registers. See chapter 0 Read Camera Settings

Write PowerUpProfile

The volatile camera profile can be stored to the non-volatile PowerUpProfile, which is used as camera setting and adjustment during start-up of the camera.

Command: ***:pc***

Note: Issue this command only, if the PowerUpProfile was successfully tested.

Load Camera PowerUpProfile

Loads the PowerUpProfile to the camera profile and adjusts all camera settings according to the settings in the PowerUpProfile.

Command: ***:gc***

Load Factory Profile

The camera has an internally stored factory profile, which can only be read, but not changed. With command :fc the profile can be loaded into the camera profile and may be used. It's preset to 1.280 x 1.024, 1.000 fps.

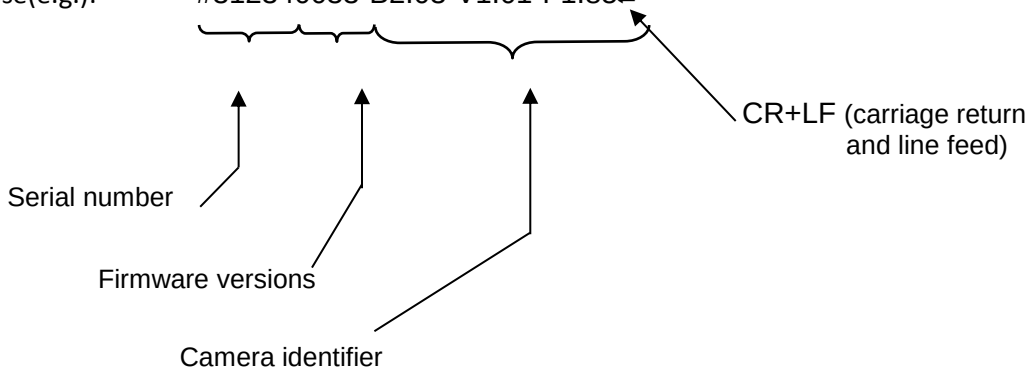
Command: **:fc**

Read Serial Number, Firmware Revision and Model

The serial number, firmware revision, and camera identification can be read with the **:v** command.

Command: **:v**

Response(e.g.): #312340033-B2.03-V1.01-F1.85↵



Firmware versions e.g.:

B2.03	....	bootloader program version of microcontroller
V1.01	....	application program version of microcontroller
F1.85	....	sensor FPGA program version

Identifier bit no.	Bit mask in hex	Description	Values
0	0001	camera type (mono, color)	0 = monochrome 1 = color
2,1	0006	no. of memory modules - 1	0 = 1 memory module 1 = 2 memory modules
3	0008	reserved	0
4	0010	output interface	0 = not defined 1 = gigabit Ethernet
5	0020	size per memory module	0 = 2 GByte 1 = not defined
6	0040	frame size limitation and/or speed limitation	0 = none 1 = limited
7	0080	reserved	0
8	0100	achievement	0 = HG (high G) 1 = standard
9	0200	company version	0 = Weinberger 1 = Mikrotron
11,10	0C00	camera type	00 = MC133x 01 = MC253x 10 = MC134x 11 = not defined
12	1000	multi-sequence feature (MS)	0 = disabled 1 = enabled
13	2000	ImageBlitz feature (IB)	0 = disabled 1 = enabled
14	4000	IRIG-B	0 = IRIG-B not supported 1 = IRIG-B is supported
15	8000	reserved	0

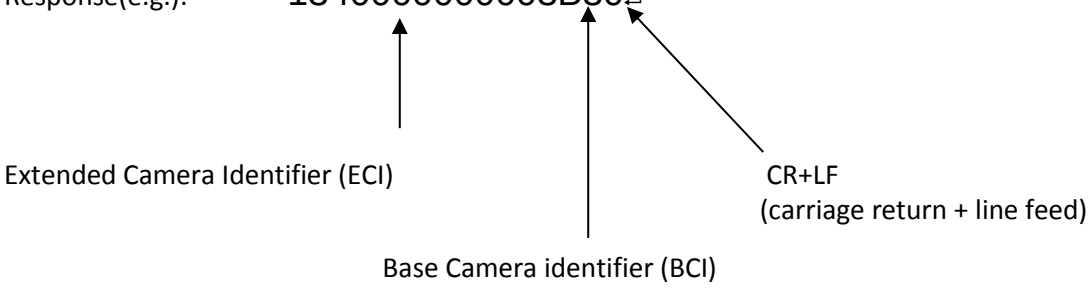
Example: version string: #012343813-B2.03 …
identifier = 3813 means:

- color camera
- Gigabit Ethernet interface
- 2 memory modules with 2 GByte = 4 GByte memory
- no limitations
- standard version
- for Mikrotron
- camera type = MC134x
- Multi-sequence and ImageBlitz enabled

Read Extended Camera Identifier

Command: **:V**

Response(e.g.): 1340000000003B30↵



Example: *Extended + Base Camera Identifier 103B30 means*

- *monochrome camera*
- *2 GByte memory*
- *standard (not HI-G) Mikrotron MotionBLITZ Cube4 (CAMMC134x)*
- *Multi sequence and ImageBlitz installed*
- *Memory made of 1Gbyte Rams*

Extended + Base Camera Identifier description, all digits in hexadecimal notation: 8+2+1 = B

Char number in ECI	16	15	14	13	7	6	5	4	3	2	1
MotionBLITZ CAMMC134x, 1,6s memory, monochrome	1	3	4	0		0	0	0	b	3	0
Color											+1
HI-G									-1		
3s/6s memory, 4/8 GByte total											+2/+4
Standby						+1					
Multi-sequence								+1			
ImageBLITZ								+2			
RAM Chip: 1Gb							+0				
RAM Chip: 2Gb							+2				
RAM Chip: 2Gb Dual Die							+3				

Read Camera Settings

The actual camera settings can be read out. The result will be the values of all camera registers.

Command: **:w** Output as hexadecimal digits
(Format: 80 bytes total binary string)

Response (e.g.):

5C 64 E4 EA D7 20 7B 6E 10 00 00 08 77 20 00 00 00 00 01 FF 00 00 00 1F 00 31 00 87 00 10 00 10 00 01 00 00 00 00 00 03 00 00 02 A 01 FF 1F 2C 00 00 00 00 40 00 00 00 80 00 40 00 C0 00 40 00 00 00 00 04 40 00 00 81 80 00 13 87 C0 00 00 00

all values hex, e.g.: $5C_{HEX} = 92_{DEC}$

Sequence of transmitted data bytes:

A1 A2 A3 A4 A5 A6 A7 A8 Sa Sb r1 .... r15 R1 R20 R24 R28 R2C R30 R34 R38 R3C

A1....A8	8 * 1 byte image level control (FPN, contrast…)
Sa	3 Bytes pixel clock in kHz, e.g. 10 00 00, i.e. 100 MHz
Sb	3 Bytes sensor clock in kHz, e.g. 08 77 20, i.e. 87,7 2MHz
r1…r15	15 * 2 bytes(high byte first) image control, (image position, size, sync….)
R1…R38	7 * 4 bytes (high byte first) memory registers, exposure time & image speed
R3C	1 * 4 bytes (high byte first) reserved register

:W Output the camera settings as ASCII string
Format: 8 * (1 * CR + 32 ASCII-chars) plus 1 * CR at the end,
i.e. 265 Bytes in total

Image Information Field

Every image is marked with 32 Bytes that replace the first 32 Pixels of every image.

Bytes	Value	Description
3...0	0xFF00FF00	start of image marker
5...4	0...0xFFFF	image counter
7...6	0...0x3FF	image row start address
7, bits 7...4	0...0xF0	digital input 4...1
14...8	0...0xFFFFFFF	absolute timer, counts every 51,52 usec, clear when ImageInformation field is deactivated
15	0...0xFF	analog Input
27...16	ASCII string	first line of free text
31...28		IRIG-B

Bytes 27...16 are automatically updated when the first line of Free Text (next chapter) is written.

The image counter and the absolute timer is cleared when this function is deactivated/activated. (toggle r7[1])

Command example: **:r7002** r7[1]
Response: none

Memory Information Field

The special “end of recording frame” contains the memory information field. This quasi special image (memory space 0x14000 … 0x27fff) is marked with 76 Bytes that replace Pixel 32 to 109 of that image. Every four Pixel contain a DWORD with the following description:

DWORDS	Bits	Description
15...0	28...0 31	value of write pointer after completion of one of up to 16 sequences. wrap flag within one of 16 rings
16	31...0	register :R1 when recording was started
17	31...0	register :R2[8] when recording was started
18	31...0	register :R3 when recording was started

This information is needed for getting the chronological order of a recorded sequence. The “end of recording frame” is for internal use only. The area for the recorded sequences begins immediately after this frame.

Cameras with firmware versions before MC134xM638F259.ibf hold the memory information field in the live-frame area (memory space 0 … 0x13fff), the area for the recorded sequences begins at address 0x14000.

Free Text

Up to 16 lines, 16 characters of free text are stored as long as the MC134x is powered. Use this command to store descriptive text and absolute time together with recorded sequences.

Command: **:i<n><16char.text>** ; write free text
n = text line number

Command: **:I<n>** ; read free text
n = text line number

IRIG-B

MC134x equipped with an IRIG-B input can decode the modulated 1 kHz time code that is typically derived from a GPS receiver. The MC134x internal frame rate time base is then synchronized once per second to the IRIG-B 1sec marker, and therefore phase aligned to the 1 kHz IRIG-B signal. The decoded time code is inserted in Image Information Field into each image according to the following format:

Byte	28	29	30	31	32
Bits	7654 321	7654 321	7654 321	7654 321	7654 321
Time BCD	100d ----	10d 1d	10h 1h	10m 1m	10s 1s

1s.: 1’s seconds of the minute in BCD Code

100d.: 100’s days of the year in BCD Code

10d.: 10’s days of the year in BCD Code

1d.: 1’s days of the year in BCD Code

10h.: 10’s hours of the day in BCD Code

1h.: 1’s hours of the day in BCD Code

10m.: 10’s minutes of the hour in BCD Code

1m.: 1’s minutes of the hour in BCD Code

10s.: 10’s seconds of the minute in BCD Code

The decoded Time is GMT.

Standby Mode

The intended purpose of the standby mode is to store the camera’s recorded images for a longer time (up to ca. 20 hours) without any external power supply.

To manage this, in standby mode several components of the camera’s electronic will be shut down and mainly only the image memory will be provided with power.

In standby mode, there is no access to the camera’s image memory.

There are two different techniques to set the camera into standby mode:

Switch to Standby Immediately

To get the camera into the standby mode immediately you have to

1. Press the camera’s power switch for a short moment (less than 1 second), when the camera is ready-to-operate or
2. Set bit 7 of the camera’s port A
   This is achieved by reading the actual content of the port A with the command “:?par”, setting the bit 7 in the read string and resending this to the camera with the “:?paw” command.

Switch to Standby After the End of a Recording Sequence

In order to switch to standby mode automatically after the end of a recording sequence, two conditions must be met:

1. bit 27 of Register :R1 must be set to 1
2. the enable standby after end of recording command ":k1" must be sent to the camera before the sequence is finished

Switch from Standby Mode to Normal Operation

To get the camera out of the standby mode you have to press the camera's power switch for a short moment (less than 1 second).

Note: Please pay attention: If you press the switch longer than 1 second, you will shut down the camera completely and the camera's recording will be lost!

Standby Mode Indication by LEDs

The standby mode will be indicated by the LEDs in the following manner:

- the lower LED (TRIGGER) is switched off
- die upper LED (POWER) is flashing:

Power LED color	Power supply	Remark
red / orange constant flashing	external	
green flashing 1 ... 5 times every 2 seconds	internal (battery)	If the battery is fully charged, there is a quintuple blinking. If the battery gets empty, there is a single blinking.

Firmware

Update Firmware

CAMMC134x's logic is integrated into two FPGAs (**F**ield **P**rogrammable **G**ate **A**rray), which's configuration is stored in an EEPROM. Upon power up or a command the FPGA is loaded with this configuration. Configuration data can be downloaded via the Gigabit Ethernet interface. Mikrotron may provide configuration files (*.ibf) on request.

After downloading configuration data, this data will be permanently stored in the EEPROM, and the FPGA will be configured with the new data. Besides a power cycle, the **:c** command can be used to reconfigure the FPGA with the internally stored configuration data.

Note: Download of *.ibf file via serial link with 19,200 Bd takes app. 1.5 min. There should be no loss of power or communication during this time!

Reset and Configuration of the Internal FPGA

The command **:c** executes a reset in the camera. The FPGA will be reconfigured and all internal registers reloaded with the last saved PowerUpProfile. The FPGA is also configured after each power up.

Command: **:c**

Response: none

Assigning an IP Address

Your PC communicates with the camera via Ethernet. Therefore an appropriate IP address has to be assigned to the network card.

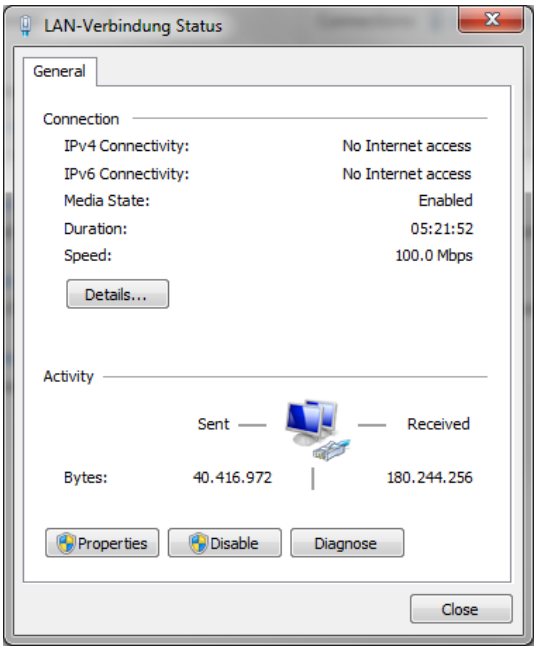
Normally, the IP address will be assigned automatically after connecting a camera. This may take a few minutes. In case you want to accelerate this process or you want to assign a certain IP address, proceed as described below.

Remark: You need administrator rights to do this!

Procedure:

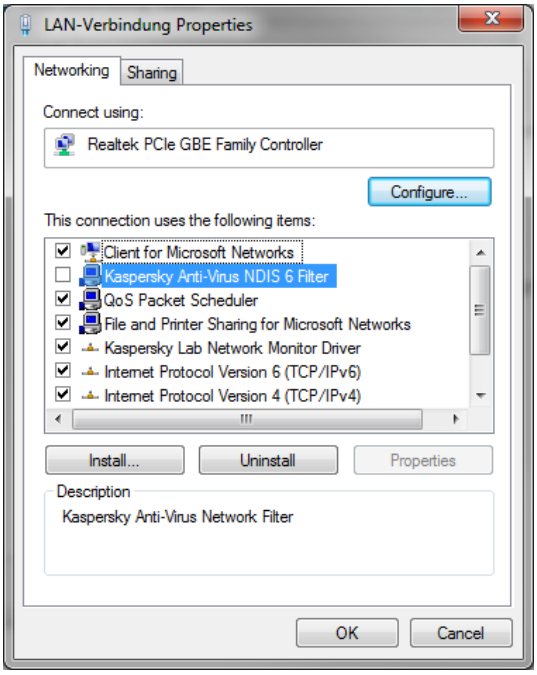
1. **Connect your camera via Gbit Ethernet with your PC (☞ page 11)**
   Use the shielded Gbit Ethernet cable.

2. **Open »Network and Sharing Center« in the Windows Control Panel and open your LAN connection**

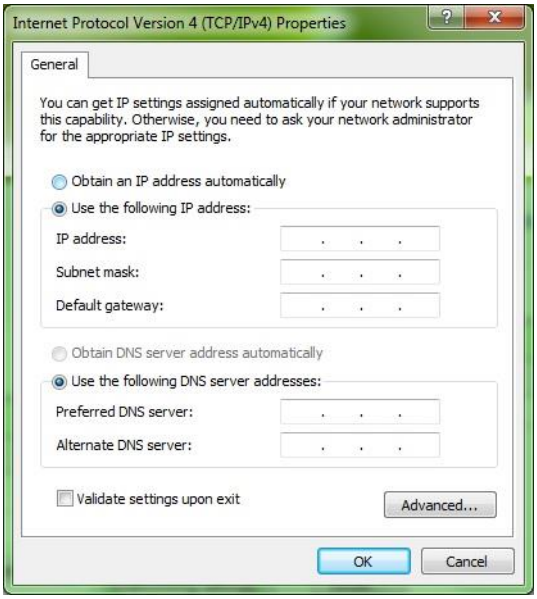


3. **Click [Properties]**
   The properties dialog for the connection will be displayed.

4. **Highlight Internet Protocol Version 4 (TCP/IPv4)**



5. **Click [Configure]**



6. **Assign a valid IP address that is currently not in use, e.g. IP:192.168.110.1, Subnet-mask: 255.255.255.0**

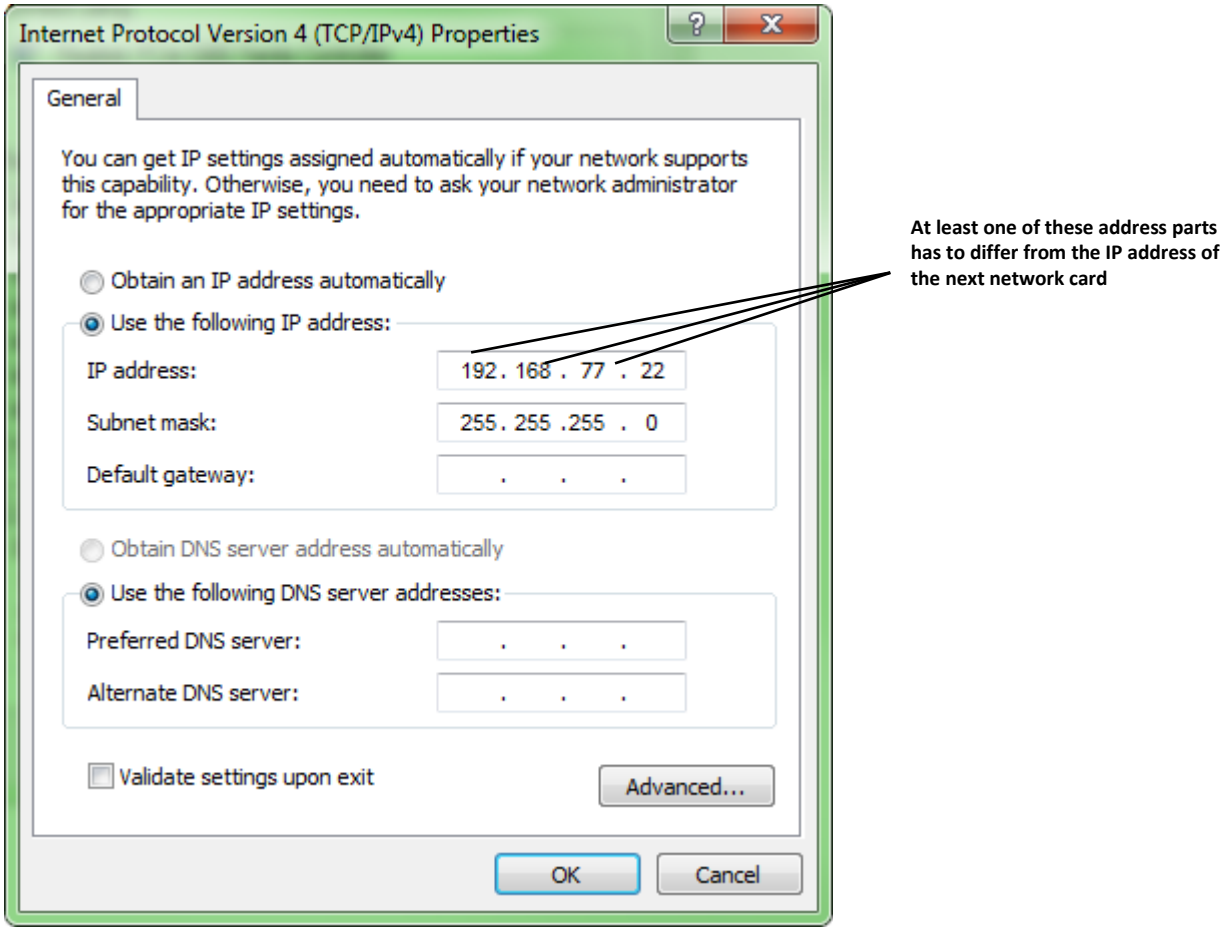
7. **Click [OK]**

Working with Several Network Cards

When working with several network cards, it will be necessary to assign an IP address to each.

If for example the IP address 192.168.77.22 is assigned to the first network card the IP address of the second card will have to differ in at least one address part above the field 255 in the subnet mask.

In the example below the subnet mask contains the number 255 three times. The IP address of the second card has either to differ in the first or the second three digits, for example: 192.169.77.22



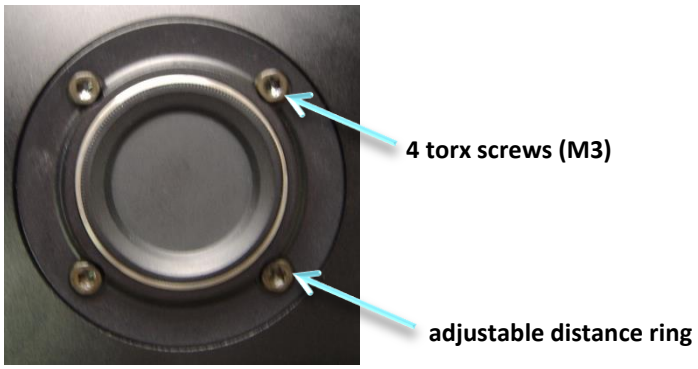
Proceed for each card as described on page 17 and make sure that the subnet mask for each card is the same.

Mount an F-Mount Adapter

For fine adjustment of the focal length the c-mount lens adapter with an adjustment range of ± 1 mm is provided. Use the three screws nearby the sensor window to fasten the lens adapter after a proper adjustment together with the chosen lens.

In case the c-mount adapter has to be replaced by an f-mount lens adapter, proceed as follows:

1. **Loose the 4 torx screws at the camera front housing**



Remark: Please, take care that neither the IR-filter of a color camera nor the plating of the inner f-mount cylinder will be damaged.

Maintenance

Cleaning the Lens

The optical path of the camera needs cleaning occasionally. Information about cleaning the lens is provided by the respective manufacturer.

Cleaning the IR-filter

MotionBLITZ color cameras contain a filter to suppress infrared (IR) light. Infrared light is part of the visible light spectrum and warps the color of the camera's images. Therefore it is necessary to eliminate infrared light.

Dust and dirt, which may deposit on this filter is best removed by means of an oil free air pressure spray or with a lens cleaning tissue. Sticky mud and fingerprints may be cleared with medical alcohol.

WARNING

IR Filter Damage

Improper cleaning agents may damage the filter. Such damage may alter the quality of the images.

Changing the Battery

Cube cameras are equipped with four NiMh accumulator cells which will have to be changed, if the camera does not power-up properly.

WARNING

Serious Camera Damage

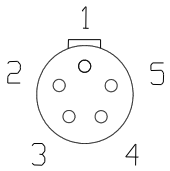
The battery of CAMMC134x cameras is equipped with an additional fuse and a temperature probe. Therefore, never change the battery yourself! Instead, contact our service team and ask for a RMA number (info@mikrotron.de) and send the CAMMC134x camera back to MIKROTRON

Technical Data

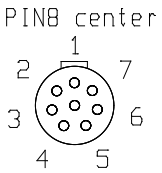
Feature	Value
Camera types	monochrome or color with Bayer Filter
Resolution (number of pixels)	1280 x 1024
Pixel size	12 x 12 µm^2
Active area	15,36 (H) x 12,29 (V) mm
Fill factor	40%
Sensitivity at 550nm@Vref = 1V (a2 = 66h)	1.6V/lux-sec@55nm
Spectral response	400 .... 800nm
Shutter	Electronic „Freeze Frame“ Shutter
Trigger	Trigger and Sync input
Internal Dynamic	59 dB
Power supply	10.5 .... 30 V
Power consumption max., continuous recording @ 1.3 GBytes/sec Thermal resistance typ.	 15 W 6.25°/W
Serial data link	Gbit Ethernet, baud rate 19,200 Bd
Digital video CAMMC134x	Gbit Ethernet
Shock & vibration	100g, 10grms
Dimensions (WxHxD)	93 x 69 x 92 mm (c-mount) 93 x 69 x 128 mm (f-mount)
Case temperature	+5 .... +45° C
Weight	ca. 900 g
Lens mount	C-mount or F-mount

Pin Assignments

Power Connector

Pinning of matching power plug (male, solder side) 	Select the plug according to your needs (right-angled plug / water resistant etc.) under http://www.lemosa.com/ e.g. straight plug: FGG.1B.305.CLAD42ZN (socket of the camera: EEG.1B.305.CLL)	
Pin Nr.	**Signal Level**	**Description**
1	Power	+10.5 to 24V
2	Power	+10.5 to 24V
3	n.c.	
4	Power	GND
5	Power	GND

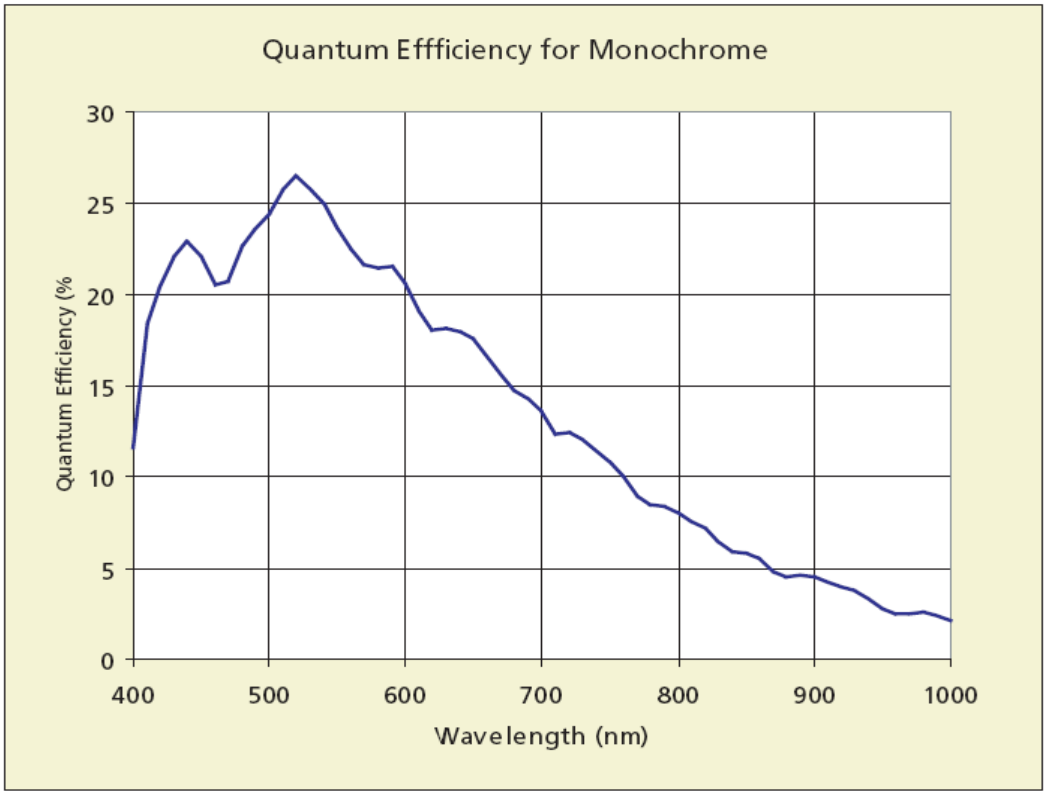
Trigger Connector

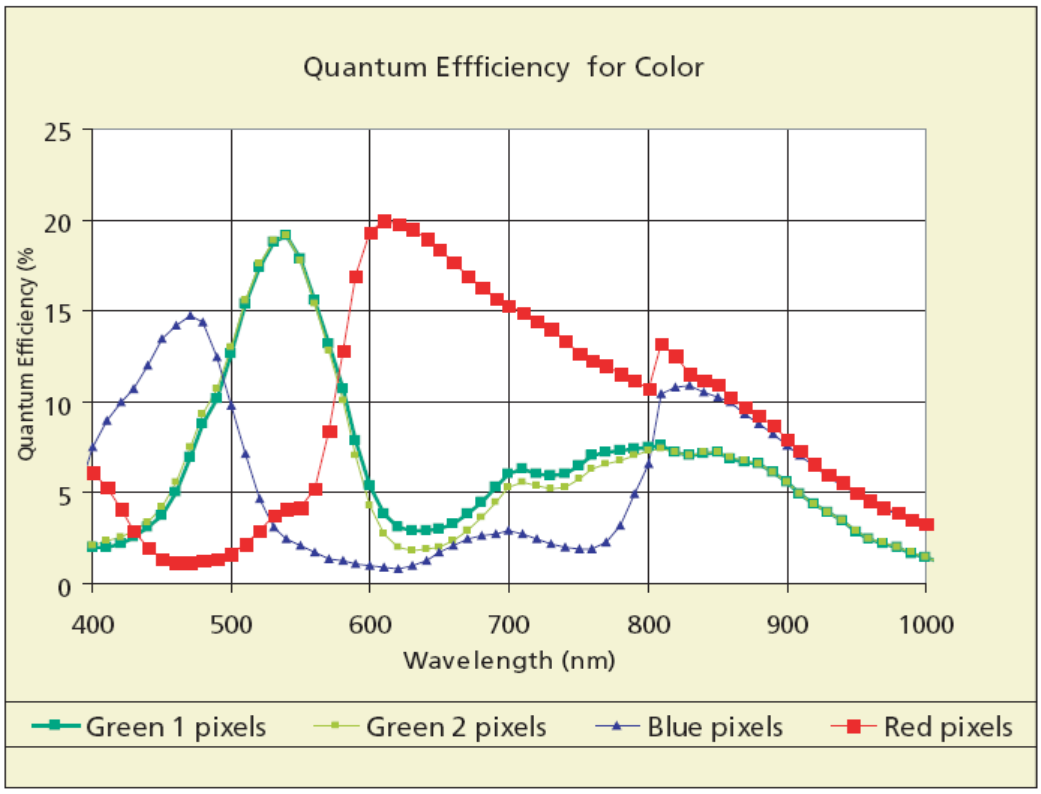
Pinning of matching signal plug (male, solder side) 	Select the plug according to your requirements (right angle plug / water resistant etc.) under http://www.lemosa.com/ e.g. straight plug FGG.1B.308.CLAD52ZJ (socket of the camera: EEG.1B.308.CLL)	
Pin Nr.	**Signal Level**	**Description**
1	GND	Opto GND
2	0...2.5V@ 1MΩ	Analog input voltage, 8-bit resolution
3	LVTTL	Sync Output / ARM
4	LVTTL	Digital Input 1
5	LVTTL	Digital Input 2
6	LVTTL	Digital Input 3/ IRIG-B Input *)
7	LVTTL	Digital Input 4/ Trigger Input
8	LVTTL	SYNC Input

***) IRIG-B input:** The level of the IRIG-B signal connected at pin no. 6 should be typically 3V for ‚mark', 1V for ‚space'. Important is the ratio of the signal level of mark and space of 3 to 1.

Spectral Response of CAMMC134x

Sensor type	CMOS, monochrome or RGB (Bayer Filter)
Resolution	1280 x 1024 pixel
Pixel depth	8 bit
Pixel size	12 x 12 µm^2
Active area	15.36 (H) x 12.29 (V) mm^2
Fill factor	40 %
Light sensitivity	1.6 V/lux-sec @ 550 nm
Dynamic range	up to 59 dB with multiple slope
Full well charge	63000e$^-$



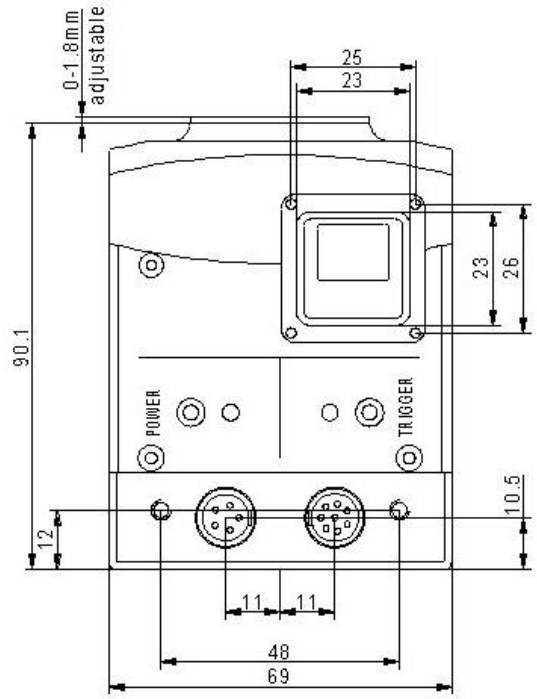

Quantum Effficiency for Color
Quantum Efficiency (%
25
20
15
10
5
0
400
500
600
700
800
900
1000
Wavelength (nm)
Green 1 pixels
Green 2 pixels
Blue pixels
Red pixels

Dimensions

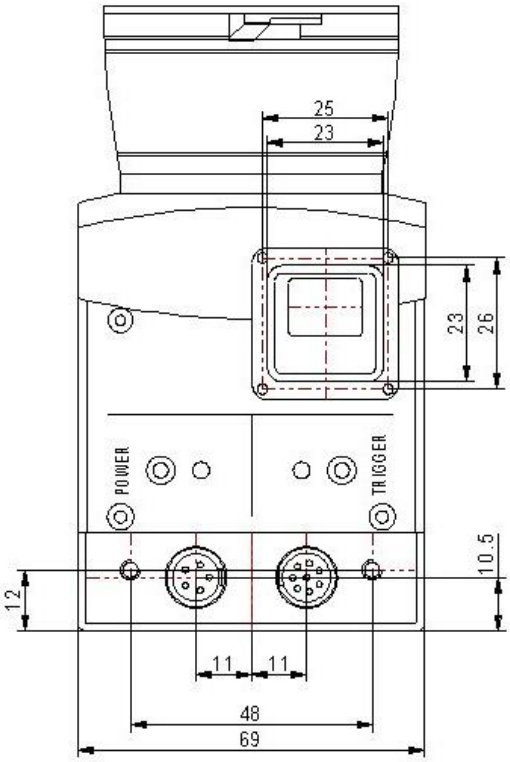
The camera measures 93 x 69 x 92 mm^3 including the C-Mount but without lens. To fasten the camera there are two mounting holes M 4x7 mm and one tripod connection on each side available.

Remark: Maximum torque for M4 fastening screws: 2.5 Nm

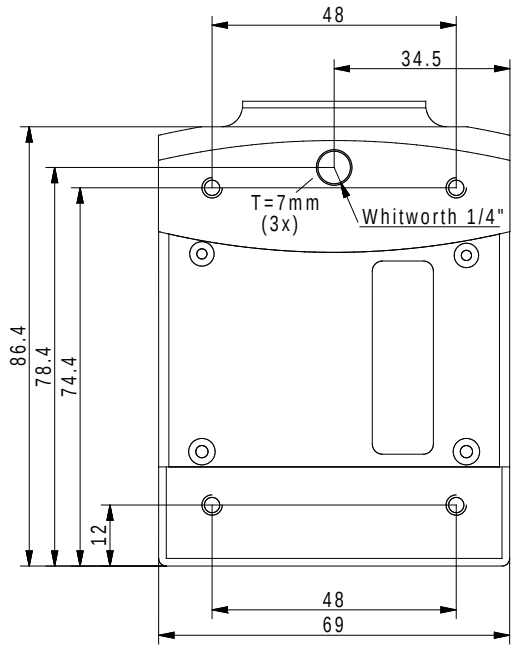
C-Mount



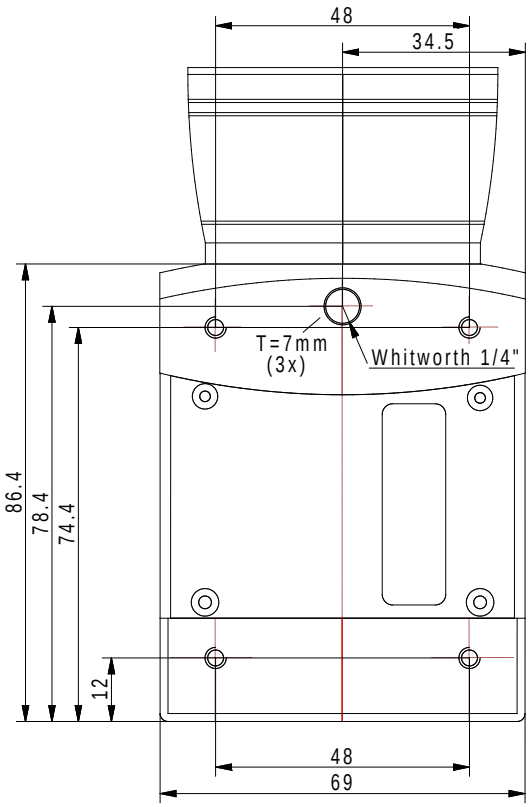
F-Mount



C-Mount



F-Mount



CAMMC134x – Reference Guide

This version has been produced on 26th of October 2018 by

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