document

pco.camera

Camera Control Commands

This document describes the command structure of the new pco.camera series.

Table of Content:

document

(Table of Content ... continued)

(Table of Content ... continued)

A. Command Structure

Within this document the commands for controlling the pco.camera at the SDK/API level are described. Where it seems to be necessary also further explanations are made for the commands or settings or modes that can be configured.

1   General

- Conventions in this manual
- Hardware elements and interface connectors

1.1   Conventions

The following typographic conventions are used in this manual:

bold: **get camera type**
Functions, procedures or modes, that can be used

[words in brackets]:   [run]
Possible values or "states" of the described functions

ALL CAPITAL WORDS: TRUE
Logical or boolean values like TRUE, FALSE, ON, OFF, 0, 1, RISING, FALLING, HIGH, LOW

<words in arrows>:   <acq enbl>
Names of hardware input / output signals

1.2 Hardware elements, interface connectors
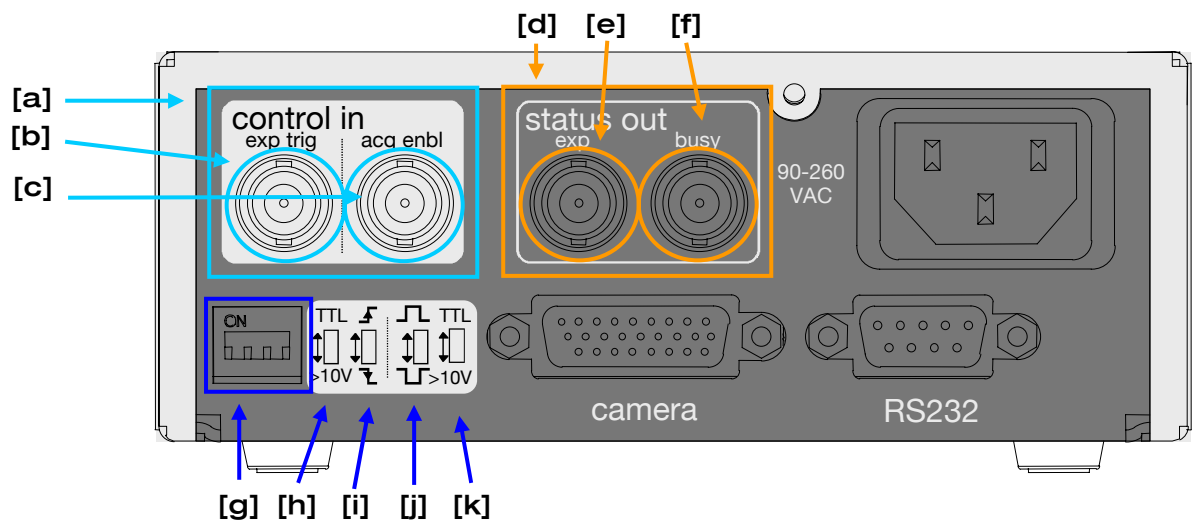
figure 1:   View of back panel of **pco.**power

legend:

  [a] <control in> - general input for external control signals, BNC plugs
  [b] <exp trig> - external exposure trigger input
  [c] <acq enbl> - external acquire enable input
  [d] <status out> - general status output signals, BNC plugs
  [e] <exp> - exposure output signal
  [f] <busy> - busy output signal
  [g] DIP switch, which sets polarity, HIGH and LOW levels and level of voltages
  [h] [TTL] or [>10V] selects voltage level either TTL = 5V or larger than 10V
  [i]   ⌐ or ⌐ trigger edge selection for <exp trig> input, either rising or falling edge
  [j]   ⊓ or ⊔ trigger level selection for <acq enbl> input, HIGH or LOW active
  [k] [TTL] or [>10V] selects voltage level either TTL = 5V or larger than 10V

2 Overview of commands

The total set of control commands is subdivided into six sections:

- Camera
- Image Sensor
- Timing
- Storage
- Recording
- Image Read

2.1 Camera

This section contains general instructions to control the camera and request information about the camera:

- Request camera type, hardware/firmware version, serial number, interface type
- Request camera status (warnings, errors etc.)
- Reset all settings to default values
- Initiate selftest procedure
- Get camera / power supply temperature

2.2 Image Sensor

This group contains all instructions to control the image sensor and to request information about the sensor. These are:

- Get Camera description: sensor type, standard resolution, extended resolution, dynamic resolution (bit), delay- exposure times…
- Set/request sensor format: [standard] / [extended].
- Set/request ROI settings.
- Set/request binning settings.
- Set/request pixel rate (frequency for shifting the pixels out of the sensor shift registers).
- Set/request conversion factor (gain) settings.
- Set/request double image mode (expose two images one after another immediately).
- Set/request ADC mode (use one or two ADCs for digitizing the pixel data of the sensor).
- Set/request IR sensitivity setting (ON/OFF).
- Set/request cooling setpoint temperature.
- Set/request Offset Mode.

2.3 Timing

This group contains all available commands for control of the timing of the imaging process:

- Set / request delay and exposure time (timebase, timetable) for taking images.
- Set / request trigger mode for exposures: [auto trigger], [force trigger], [extern edge triggered], [extern exposure pulse trigger][1]. Controls the usage of the <exp trig> control input. See the below for a detailed description of the trigger modes.
- Force trigger: this software command starts an exposure if the trigger mode is in the state [auto trigger], [force trigger] or [extern edge triggered]. If in [extern exposure pulse trigger] mode nothing happens
- Request busy status: A trigger is ignored, if the camera is still busy (exposure or readout). In case of [force trigger] command the user may request the camera busy status in order to be able to generate a valid [force trigger] command
- Set / request power down time (threshold value, which becomes available in case of exposure times longer than 1s)
- Read control input (<exp trig>): read TRUE or FALSE level of external control input[2] (<control in>).

Notes:

(1) Edge type (FALLING edge / RISING edge) as well as the electrical sensitivity (trigger level) is selected by DIP switches at the power supply unit near the trigger input(<control in>). In double image mode: the first exposure time is affected by the trigger commands. The duration of the second exposure is always given by the readout time of the first image.

(2) If the DIP switch shows RISING edge then HIGH level signal is TRUE and LOW level signal is FALSE. If the DIP switch shows FALLING edge then HIGH level signal is FALSE and LOW level signal is TRUE.

The following table shows how the different trigger modes work:

Trigger mode	Description of operation
auto trigger	An exposure of a new image is started automatically best possible compared to the readout of an image. If using a CCD and if images are taken in a sequence, then exposures and readout of the sensor are started simultaneously.
software trigger	An exposure can only be started by a **force trigger** command.
extern exposure & software trigger	A delay / exposure sequence is started at the RISING or FALLING edge [1] of the trigger input (<control in>)or by a [force trigger] command.
extern exposure control	the exposure time is defined by pulse length at the trigger input (<control in>). The delay and exposure time values defined by the **set / request delay and exposure** command are ineffective.

2.4 Storage

This set contains all commands needed for controlling the memory and the storage process.

The total camera memory is divided into 4 segments (similar to partitions on hard discs).

- Request RAM size (pages) and page size (pixels)
- Request / set RAM segment size in pages
- Clear RAM segment
- Get / set active RAM segment

Note:
Consistency check (e.g. in order to avoid that buffers overlap) must be done by the application software!

Each segment also contains information about the image settings (ROI / binning etc.) for the images stored within this segment (all images must have the same format).

2.5 Recording

- Set / request storage mode: [recorder mode] / [FIFO buffer mode] (see insert box 2.5.1 for further explanations)
- Set / request recorder submode: [sequence] / [ring buffer] (see insert box 2.5.2 for further explanations)
- Set / request recording state: [run] / [stop] (see insert box 2.5.3 for further explanations)
- Arm: prepare camera for recording command
  This function is necessary before a new recording (**set recording** = [run]) command is released. This function takes the settings of delay, exposure, triggering, recorder mode … compiles them and prepares the camera to start immediately when a start of recording (**set recording** = [run]) is performed.
- Set / request acquire mode: [auto] / [external], controls the usage of the <acq enbl> control input
  - [auto]: the external control input <acq enbl> is ignored
  - [external]: the external control input <acq enbl> is a static enable signal of images. If this input is TRUE, then exposure triggers are accepted and images are taken. If this signal is set FALSE, then all exposure triggers are ignored and the sensor readout is stopped.
- Read control input (<acq enbl>): read TRUE or FALSE level of external control input[1] (<control in>)
- Set date / time
- Set / request timestamp mode

Notes:

Active (TRUE) level (LOW/HIGH) as well as the electrical sensitivity is selected by DIP switches at the power supply unit near the acquire enable input(<acq enbl>).

(1) If the DIP switch shows ⌐⌐ then HIGH level signal is TRUE and LOW level signal is FALSE. If DIP switch shows ⌐⌐ then HIGH level signal is FALSE and LOW level signal is TRUE.

Box 2.5.1

recorder mode	FIFO buffer mode
- images are recorded and stored within the internal camera memory (camRam) "live view" transfers the most recent image to the PC for (for viewing / monitoring) - indexed or total readout of images after the recording has been stopped	- all images taken are transferred to the PC in chronological order - camera memory (camRAM) is used as huge FIFO buffer to bypass short bottlenecks in data transmission. If buffer overflows the oldest images are overwritten. In **FIFO buffer mode** images are send directly to the PC interface (Firewire, USB …) like a continuous data stream. Synchronization is done with the interface.

Box 2.5.2

recorder submode: sequence	recorder submode: ring buffer
• recording is stopped when the allocated buffer is full	• camera records continuously into ring bufferif the allocated buffer is full, the older images are overwrittenrecording is stopped by software command

Box 2.5.3

Recording: [run] / [stop]
The recording command controls the status of the camera. If the recording state is [run], images can be released by **exposure trigger** and **acquire enable**. If the recording state is [stop] all image readout or exposure sequences are stopped and the sensors (CCDs or CMOS) are running in a special idle mode to prevent dark charge accumulation.

The recording state has the highest priority compared to functions like **acquire enable** or **exposure trigger**.

The recording state is started by:

• software command: **Set recording** = [run]

The recording state is stopped by:

• powering on the camera
• software command: **Set recording** = [stop]
• software command: Reset all settings to default values.
• in recorder submode = [sequence], if the buffer overflows.

2.6 Image Read

• Request image settings for this segment (ROI, binning, horizontal x vertical resolution)
• Request number of images in segment
• Request / set live view: ON/OFF (**recorder mode** only)
• Read image addressed / indexed (**recorder mode** only)

B. Implementation Details

3 Communication Layers

camera status and command layer
PC application
PC DLL (interface to driver layer)
PC driver layer
hardware transmission layer
camera communication port

camera µP	camera FPGA
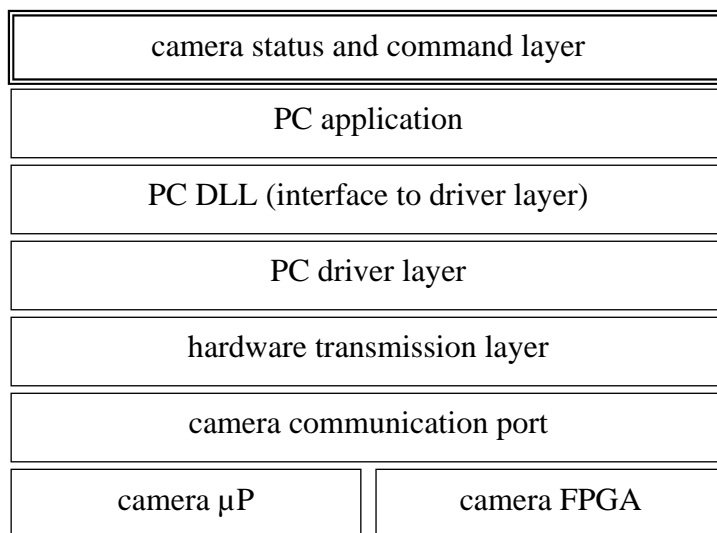
The application software running on the PC is able to send commands to the camera as well as requesting status information from the camera. There is also a channel for transmitting image data.

The DLL links the application software to the camera device driver layer. Commands sent to the driver should be common for all versions of cameras as well as for all types of interfaces (Firewire, USB etc.). Thus the driver converts the commands to the used hardware port.

camera status and command layer (example: Firewire – IEEE1394)
PC application (e.g. camware)
camera API (generic DLL for all media)

Firewire - IEEE 1394 driver constructed upon the
asynchronuous   driver stack   isochronuous

Firewire (400 MB/s, later 800 MB/s)

asynch.   camera Firewire card   isochronuous
UART   16 bit parallel

commands, status   image data

camera µP	camera FPGA
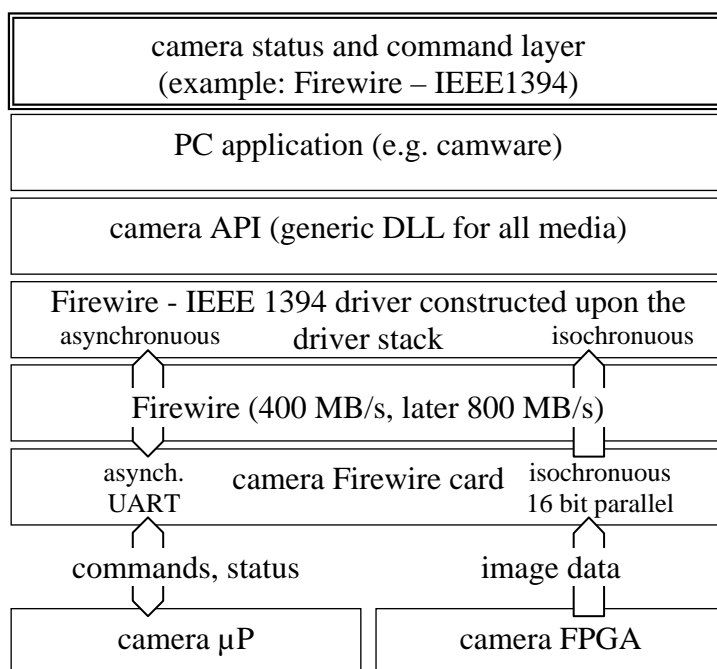
Example of Layer structure applied to the Firewire interface between PC and camera.

Commands and status information are sent between the PC and the camera µP, the image data are transferred by the camera FPGA to the FireWire interface.

Interfaces which will be implemented are Firewire – IEEE1394, Camera Link, USB 2.0 and Ethernet (TCP/IP). The latter one is somewhat different since within the PC the layers up to the application layer are already implemented within the operating system.

The communication port, that is the path from the PC driver layer down separates the data path into channels for commands, status messages and image data.

4 Communication Basics

In normal operation the interfaces are used for establishing a point-to-point-connection. Command messages are sent asynchronous, whereas status messages are sent periodically (e.g. every 500 ms, or after an image was taken etc.).

Each message, which has been sent, contains a checksum calculated over all bytes of the message (except the checksum). So if a message length is 4 byte without the checksum byte, the checksum byte is added and the complete message length is 5 byte. The receiving microcontroller (µC, in the camera or the pco.power) also calculates the checksum over the payload data and compares the result with the sent checksum. If the calculated checksum differs from the sent checksum, the command is ignored and the addressed µC responds a dummy message with [0xFFFF] (hexadecimal) as command.

The messages are transferred binary in order to speed up the transfers as well as to minimize the transferred volume thus optimizing the overall system performance. Sending ASCII message would have the benefit of better readability, however the transfer time and volume are as twice as much as for the binary transmission. For maintenance and service purposes a protocol analyzer may be used which visualizes the messages on a PC and which is also able to generate command messages.

Also "handshaking" is performed between communicating devices. Each message, which has been sent, will be responded by the receiving device. Basically three different cases have to be regarded:

- Transmission is ok - executed command was successful
- Transmission of the command failed - command was ignored
- Transmission is ok - but executed command failed

The transmitter has to wait a reasonable time due to the command and the status of the camera for the response message of the receiving device, as the receiving device has to execute the command and then send back the result in the response message. The timeout limit has to be specific for the command, as some commands as programming- or erase-flash-commands may take some time.

In order to allow also an ASCII protocol simultaneously to the messages, the range of message applicable bytes in the message header are limited to ASCII codes commonly not used in plain text communication. Thus the receiver algorithm may look at each byte and either let pass all "standard" ASCII code or open the appropriate message queue for the header. More details are described in this manual.

Every programmable device inside the camera (µP, FPGA, CPLD) is ready for being updated. The hardware as well as the software environment are designed to meet this requirement. The update will be done using the serial interface of a PC which runs an appropriate application controlling the serial interface.

In case users try to use or configure inconsistent parameters (modes not compatible etc.), the camera will reject the command. However, it is ensured, that a user can still change the

configuration of the camera with successive commands. There are several pathways to achieve this purpose, for example, some basic settings can have a higher priority than other settings derived from the former. Changing a higher priority setting is always possible, in this case lower prioritized settings, which are not consistent, are set to appropriate default values. Changing lower prioritized settings to inconsistent values will be rejected. Another possibility is to check the consistency with an **Arm camera** command. In all cases the application software has to ensure and check that all settings are consistent.

4.1 General message format

4.1.1 Message Format

There is defined a general message format which facilitates the message handling for transmitter and receiver:

Command		Message Length		Payload Data					Chksum
0x01	0x01	0x0A	0x00	0x00	0xFF	0xFF	0x00	0x00	0x0A
Group Code	*Message Code*	*Low Byte*	*High Byte*	*Length of Payload data depends on the message. The data may be divided into blocks of different meaning again.*					*Sum of all bytes before*

Detailed description of the message:

- The group code defines the group to which the command belongs.
- The message code defines the command or message itself.
- The message length is the length of the complete message in bytes, including the checksum byte. Please note, that it is delivered in low byte – high byte order. Since the data bytes must not exceed 256 bytes, the maximum length is 261 bytes.
- The payload data is data e.g. needed for executing the command, e.g. parameter for settings, data byte for programming and update commands. However there may be messages with no data at all. The length of the data is simply calculated based on the message length minus 5. The maximum number of data byte is 256.
- The checksum is the sum over all preceding bytes of the message.

A corresponding C language structure representing a general command looks like this:

```
typdef struct          // C structure representing a general command
{
  WORD wCommand;       // Command of telegram
  WORD wLength;        // Length of telegram
  BYTE bData[256];     // Data
};
```

Note: The checksum is not regarded within the structure since its position is not constant for the complete set of messages. Please note also that low byte is sent before the high byte!

Because both transmitter and receiver know all commands, the receiver has to decide on the first two bytes which command is sent and then will fill the appropriate structure of the command.

4.2 Message Acknowledgement

Basically there three possible cases for message handshaking or acknowledgement:

- Transmission is ok, executed command was successful.
- Transmission of the command failed, command was ignored.
- Transmission is ok, but executed command failed.

The response messages for these three cases sent are described below.

4.2.1 Regular Response Message

Each command has to be answered by the receiver. As sign of acknowledgement the responded message's group code is changed by adding 0x80 through a logical OR operation (setting bit 15 of the command word).

Command		Message Length		Data Returned (Status, command success etc.)					Chksum
0x81	0x01	0x0A	0x00	0x00	0xFF	0xFF	0x00	0x00	0x8A
Group Code + 0x80	*Message Code*	*Low Byte*	*High Byte*	*Data returned has not to be the data sent, also the length of the response message may differ from the received message!*					*Sum of all bytes before*

Note:
The response message may not have the same length as the original message!

4.2.2 Failure / Warning Response Message

a.) Transmission Failure

However if the transmission of the message fails or the checksum is wrong then there is no responded message. The sender has to synchronize itself via timeouts!

Please note, that no message is sent only in case of transmission errors, i.e. the receiver gets a message with erroneous checksum or an undefined message code. If the command executed fails, this has to be handled via messages described below.

b.) Command Execution Failed

If the transmission is ok, but the command execution fails, the receiving device will indicate the failure with the following kind of message:

Command		Message Length		Data Returned				Chksum
0xC1	0x01	0x09	0x00	0xFF	0xFF	0xFF	0xFF	0xFF
Group Code + 0xC0	*Message Code*	*Low Byte*	*High Byte*	*E.g. return status etc.*				*Sum of all bytes before*

The group code is changed by a logical OR operation with 0x80 to indicate, that it's a response message.
An additional change by a logical OR operation with 0x40 (thus resulting in an OR with 0xC0 = 0x80 + 0x40) indicates a failure or a warning of the requested command.

Note:
The response message may not have the same length as the original message!

4.2.3 Synchronization messages

In order to initialize, to resynchronize (after failures) and to test the communication between two devices synchronization messages are defined.

Command		Message Length		Chksum
0x##	0x##	0x05	0x00	0x##
Group Code	*Message Code*	*Low Byte*	*High Byte*	*Sum of all bytes before*

There is no payload data and no action is triggered by the command, except sending a response message. Thus one device is able to test, if the other device is connected and listening. If a failure occurred one device is able to send synchronization messages till the connected device is responding and the communication is reestablished again.

4.3 Group codes

In order to also allow an ASCII protocol in parallel to the messages the range of allowed message header byte is limited to ASCII codes commonly not used in plain text communication. Thus the receiver algorithm may look at each byte and either let pass all ASCII code or open the appropriate message queue for the header. As mentioned above, there also has to be a range of group codes for response and failure response messages, these are the regular group codes with bit 7 set (bit 15 of the word) for indicating response messages and bit 6 (bit 14 of the word) set for indicating a failure of the command.

5 Command Sections

Group codes:	
General Control/Status	0x10
Image Sensor Control	0x11
Timing Control	0x12
Storage Control	0x13
Recording Control	0x14
Image Read	0x15

5.1 General Control / Status

The group id code for General Control/Status Commands is 0x10. Thus the least significant byte of all command id codes is 0x10. The command id codes are 0x??10, the code of the response message 0x??90 or in case of a failed command 0x??D0.

Overview:

Command:	Cmd. Code	Resp. Code	Error Code
Get Camera Type	0x0110	0x0190	0x01D0
Get Camera Health Status	0x0210	0x0290	0x02D0
Reset Settings to Default	0x0310	0x0390	0x03D0
Initiate Selftest Procedure	0x0510	0x0590	0x05D0
Get Temperature	0x0610	0x0690	0x06D0
Get Hardware Versions	0x0710	0x0790	0x07D0
Get Firmware Versions	0x0810	0x0890	0x08D0

5.1.1 Get Camera Type

Request camera type, hardware/firmware version, serial number etc.

a.) Command Message:

Code	Length	Cks.
0x0110	0x0005	0x16

Parameter: None

b.) Response Message:

Code	Length	Cam. Type	Cam.Sub. Type	Ser. No.	HW Version	FW Version	Interf. Type	Cks.
0x0190	0x0017	0x####	0x####	0x########	0x########	0x########	0x####	0x##

Return values:
- camera type as word, see table below
- camera sub type as word
- serial no. as long word.
- hardware version as long word, where the most significant word is the version no. and the lower significant word is the revision no. (ver.rev e.g. 2.01 = [0x00020001])
- firmware version as long word, where the most significant word is the version no. and the lower significant word is the revision no. (ver.rev e.g. 2.01)
- interface type as word, see table below

Camera Type codes:			
pco.1200 hs	0x0100	pco.4000	0x0260
pco.1300	0x0200	pco.(future 1)	0x0300
pco.1600	0x0220	pco.(future 2)	0x0400
pco.2000	0x0240	pco.(future 3)	0x0500

Interface Type codes:			
FireWire	0x0001	Ethernet	0x0004
Camera Link	0x0002	Serial Interface	0x0005
USB	0x0003	Reserved	0x0006

Note: The fact that a special interface type is mentioned here is no guaranty for availability!

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x01D0	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.1.2 Get Camera Health Status

Request the current camera health status: warnings, errors.

a.) Command Message:

Code	Length	Cks.
0x0210	0x0005	0x17

Parameter: None

b.) Response Message:

Code	Length	Warnings	Errors	Status	Cks.
0x0290	0x000D	0x########	0x########	0x########	0x##

Return values: • Warnings encoded as bits of a longword. Bit set indicates warning, bit cleared indicates that the corresponding parameter is ok. See table on the next page.
• System errors encoded as bits of a longword. Bit set indicates error, bit cleared indicates that the corresponding status is ok. See table on the next page.
• System Status encoded as bits of a longword. For meaning of the bits see table on the next page.

The tables on the next page show the mask value (not the bit no.) for requesting the corresponding error / warning status:

```
// -- C/C++ example -----------------------------------------------
if (errorcode & 0x00000001)   //  power supply voltage range error
{
  // report error to user etc.
}
// ----------------------------------------------------------------
```

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x02D0	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

d.) Warnings:

Warning mask codes:	
0x00000001	Power Supply Voltage Range
0x00000002	Power Supply Temperature
0x00000004	Camera temperature (board temperature / FPGA temperature)
0x00000008	Image Sensor temperature (for cooled camera versions only)

e.) Errors:

Error mask codes:	
0x00000001	Power Supply Voltage Range
0x00000002	Power Supply Temperature
0x00000004	Camera temperature (board temperature / FPGA temperature)
0x00000008	Image Sensor temperature (for cooled camera versions only)
0x00010000	Camera Interface failure
0x00020000	Camera RAM module failure
0x00040000	Camera Main Board failure
0x00080000	Camera Head Boards failure

f.) Status:

Status mask codes:	
0x00000001	Default State: • Bit set: Settings were changed since powerup or reset. • Bit cleared: No settings changed, camera is in default state.
0x00000002	Settings Valid: • Bit set: Settings are valid (i.e. last "Arm Camera' was successful and no settings were changed since 'Arm camera', except exposure time). • Bit cleared: Settings were changed but not yet not checked and accepted by 'Arm Camera' command.
0x00000004	Recording State: • Bit set: Recording state is on. • Bit cleared: Recording state is off.

5.1.3 Reset Settings to Default

Resets all camera settings to default values. During a power-up sequence this function is executed.

a.) Command Message:

Code	Length	Cks.
0x0310	0x0005	0x18

Parameter: None

b.) Response Message:

Code	Length	Cks.
0x0390	0x0005	0x98

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x03D0	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

d.) These are the defaults settings:

Setting:	Default:
Sensor Format	standard
ROI	full resolution
Binning	no binning
Pixel Rate	(depending on image sensor)
Gain	Normal gain (if setting available due to sensor)
Double Image Mode	Off
IR sensitivity	Off (if setting available due to sensor)
Cooler Setpoint	-12 C°
ADC mode	Using one ADC
Exposure Time	20 ms
Delay Time	0 µs
Trigger Mode	Auto Trigger
Recording state	stopped
Memory Segmentation	Total memory allocated to first segment
Storage Mode	Recorder Ring Buffer + Live View on
Acquire Mode	Auto

Note: If the camera is running during this command is sent, it will be stopped!

5.1.4 Initiate Selftest Procedure

Request the current camera operation status: warnings, errors.

a.) Command Message:

Code	Length	Cks.
0x0510	0x0005	0x1A

Parameter:　　　None

b.) Response Message:

Code	Length	Warnings	Errors	Cks.
0x0590	0x000D	0x########	0x########	0x##

Return values: • same as for command "Get Camera Health Status", see section 5.1.2

c.) Failure / Warning Response Message (could'nt initiate selftest):

Code	Length	Message	Cks.
0x05D0	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.1.5 Get Temperature

Request the current camera operation temperateures

a.) Command Message:

Code	Length	Cks.
0x0610	0x0005	0x1B

Parameter: None

b.) Response Message:

Code	Length	CCD temp.	Cam. temp.	PS temp.	Cks.
0x0690	0x000B	0x####	0x####	0x####	0x##

Return values:
- CCD temperature as signed word in tenth of °C.
- Camera temperature as signed word in °C.
- Power Supply temperature as signed word in °C.

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x06D0	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.1.6 Get Hardware Versions

Request the versions of the avaiable hardware components.

a.) Command Message:

Code	Length	Cks.
0x0710	0x0005	0x1C

Parameter: None

b.) Response Message:

Code	Length	Number of components	10 times structure below	Cks.
0x0790	0x00E3	0x####		0x##

Name of component	BatchNo of component	Revision of component	Variant of component
################ ###############	0x####	0x####	0x####

Return values:
- Number of Components
- String with name of each avaiable component
- BatchNo of each avaiable component
- Revision of each avaiable component
- Variant of each avaiable component

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x07D0	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.1.7 Get Firmware Versions

Request the versions of the Firmware of installed components.

a.) Command Message:

Code	Length	Cks.
0x0810	0x0005	0x1C

Parameter: None

b.) Response Message:

Code	Length	Number of components	10 times structure below	Cks.
0x0890	0x00E3	0x####		0x##

Name of component	Minor Rev. of component	Major Rev. of component	Variant of component
################ ################	0x####	0x####	0x####

Return values:
- Number of Components
- String with name of each avaiable component
- Minor Revision of each avaiable component
- Major Revision of each avaiable component
- Variant of each avaiable component

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x07D0	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.2 Image Sensor

The group id code for image sensor control commands is 0x11. Thus the least significant byte of all command id codes is 0x11. The command id codes are 0x??11, the code of the response message 0x??91 or in case of a failed command 0x??D1.

Overview:

Command:	Cmd. Code	Resp. Code	Error/ Warning Code
Get Camera Description	0x0111	0x0191	0x01D1
Get Sensor Format	0x1411	0x1491	0x14D1
Set Sensor Format	0x1511	0x1591	0x15D1
Get ROI	0x0211	0x0291	0x02D1
Set ROI	0x0311	0x0391	0x03D1
Get Binning	0x0411	0x0491	0x04D1
Set Binning	0x0511	0x0591	0x05D1
Get Pixelrate	0x0611	0x0691	0x06D1
Set Pixelrate	0x0711	0x0791	0x07D1
Get Conversion Factor	0x0811	0x0891	0x08D1
Set Conversion Factor	0x0911	0x0991	0x09D1
Get Double Image Mode	0x0A11	0x0A91	0x0AD1
Set Double Image Mode	0x0B11	0x0B91	0x0BD1
Get ADC Operation	0x0C11	0x0C91	0x0CD1
Set ADC Operation	0x0D11	0x0D91	0x0DD1
Get IR Sensitivity	0x0E11	0x0E91	0x0ED1
Set IR Sensitivity	0x0F11	0x0F91	0x0FD1
Get Cooling Setpoint Temperature	0x1011	0x1091	0x10D1
Set Cooling Setpoint Temperature	0x1111	0x1191	0x11D1
Get Offset Mode	0x1211	0x1191	0x11D1
	0x1311	0x1191	0x11D1
Get Noise Filter Mode	0x1911	0x1991	0x19D1
Set Noise Filter Mode	0x13A1	0x1A91	0x1AD1

5.2.1 Get Camera Description

Request camera description (sensor type, horizontal / vertical / dynamic resolution/ binning/ delay/ exposure ...). The response message describes the sensor type, the readout hardware and its possible operating range.

a.) Command Message:

Code	Length	Cks.
0x0111	0x0005	0x17

Parameter: None

b.) Response Message:

Code	Length	Sensor Type	Sensor Sub Type	Hor. Res. standard	Vert. Res. standard	Hor. Res. extended	Vert. Res. extended	Dyn. Res.
0x0191	0x007D	0x####	0x####	0x####	0x####	0x####	0x####	0x####
Max Binn hor	**Binn hor steps**	**Max Binn vert**	**Binn vert steps**	**ROI hor steps**	**ROI vert steps**	**ADC's**	**Pixelrate 1**	**Pixelrate 2**
0x####	0x####	0x####	0x####	0x####	0x####	0x####	0x#### ####	0x#### ####
Pixelrate 3	**Pixelrate 4**	**Convers. Factor 1**	**Convers. Factor 2**	**Convers. Factor 3**	**Convers. Factor 4**	**IR – Sens.**	**Min Del Time (nsec)**	**Max Del Time (msec)**
0x#### ####	0x#### ####	0x####	0x####	0x####	0x####	0x####	0x#### ####	0x#### ####
Min Del Step (nsec)	**Min Exp Time (nsec)**	**Max Exp Time (msec)**	**Min Exp Step (nsec)**	**Min Del Time IR (nsec)**	**Max Del Time IR (msec)**	**Min Exp Time IR (nsec)**	**Max Exp Time IR (msec)**	**Time Table**
0x#### ####	0x#### ####	0x#### ####	0x#### ####	0x#### ####	0x#### ####	0x#### ####	0x#### ####	0x####
Double Image Mode	**Min Cooling Setpoint**	**Max Cooling Setpoint**	**Default Cooling Setpoint**	**Power Down Mode**	**Offset Regulation**	**Color Pattern**	**Color Pattern Type**	**Reserved**
0x####	0x####	0x####	0x####	0x####	0x####	0x####	0x####	0x#### ####
Reserved	**Reserved**	**Reserved**	**Reserved**	**Reserved**	**Reserved**	**Reserved**	**Reserved**	**Cks.**
0x#### ####	0x#### ####	0x#### ####	0x#### ####	0x#### ####	0x#### ####	0x#### ####	0x#### ####	0x##

Return values:
- image sensor type as word, see table "Sensor Type codes" below.
- image sensor sub type as word.
- horizontal resolution standard in pixels (all effective pixels).
- vertical resolution standard in pixels (all effective pixels).
- horizontal resolution extended in pixels (all pixels; dummy + dark + eff.).
- vertical resolution extended in pixels (all pixels; dummy + dark + eff.).
- dynamic resolution in bits/pixel. (i.e. 12, 14 …)
- max. binning value horizontal (allowed values from 1 to max. resolution)
- binning steps horizontal
  1 = linear step (binning from 1 to max i.e. 1,2,3…max is possible)
  0 = binary step (binning from 1 to max i.e. 1,2,4,8,16…max is possible)
- max. binning value vertical (allowed values from 1 to max. resolution)
- binning steps vertical
  1 = linear step (binning from 1 to max i.e. 1,2,3…max is possible)
  0 = binary step (binning from 1 to max i.e. 1,2,4,8,16…max is possible)
- ROI steps horizontal (e.g. 10, => ROI right = 1, 11, 21, 31 ...)
- ROI steps vertical
- ADC's (number of ADC's inside camera; i.e. 1..8)
- pixelrate 1 (long word; frequency in Hz)
- pixelrate 2 (long word; frequency in Hz; if not available, then value = 0)
- pixelrate 3 (long word; fequency in Hz; if not available, then value = 0)
- pixelrate 4 (long word; frequency in Hz; if not available, then value = 0)
- conversion factor 1 (in electron / counts)
  (the value 100 corresponds to 1; i.e. 610 = 6.1 electron/counts)
- conversion factor 2 (in electron / counts; if not available, then value = 0)
  (the value 100 corresponds to 1; i.e. 610 = 6.1 electron/counts)
- conversion factor 3 (in electron / counts; if not available, then value = 0)
  (the value 100 corresponds to 1; i.e. 610 = 6.1 electron/counts)
- conversion factor 4 (in electron / counts; if not available, then value = 0)
  (the value 100 corresponds to 1; i.e. 610 = 6.1 electron/counts)
- IR-sensitivity; sensor can switch to improved IR sensitivity
  (0 = function not supplied; 1 = possible)
- min. delay time in nsec (long word; non IR-sensitivity mode)
- max. delay time in msec (long word; non IR-sensitivity mode)
- min. delay time step in nsec (long word)
  Note: Applies both to non IR-sensitivity mode and IR-sensitivity mode
- min. exposure time in nsec (long word; non IR-sensitivity mode)
- max. exposure time in msec (long word; non IR-sensitivity mode)
- min. exposure time step in nsec (long word)
  Note: Applies both to non IR-sensitivity mode and IR-sensitivity mode
- min. delay time in nsec (long word; IR-sensitivity mode)
- max. delay time in msec (long word; IR-sensitivity mode)
- min. exposure time in nsec (long word; IR-sensitivity mode)
- max. exposure time in msec (long word; IR-sensitivity mode)

(Return values of command "Get Camera Description" continued)

- time table ; camera can perform a timetable with several delay/ exposures
  (0 = function not supplied; 1 = possible)
- double image mode; camera can perform a double image with short interleave
  time between exposures (0 = function not supplied; 1 = possible)
- min. cooling setpoint (in °C)
  (if all setpoints are 0, then cooling is not available)
- max. cooling setpoint (in °C)
  (if all setpoints are 0, then cooling is not available)
- default cooling setpoint (in °C)
  (if all setpoints are 0, then cooling is not available)
- power down mode; switch sensor into power down mode for reduced dark
  current (0 = function not supplied; 1 = possible)
- offset regulation; automatic offset regulation with reference Pixels
  (0 = function not supplied; 1 = possible)
- color pattern (word), see detailed description below
- color pattern type (word), where:
  - 1 is bayer pattern
  - 2 is bayer pattern CMY
- reserved (9 long words; for future use)

Sensor Type codes:			
monochrome sensors:		color sensors:	
Sony ICX285AL	0x0010	Sony ICX285AK	0x0011
Sony ICX263AL	0x0020	Sony ICX263AK	0x0021
Sony ICX274AL	0x0030	Sony ICX274AK	0x0031
Sony ICX407AL	0x0040	Sony ICX407AK	0x0041
Sony ICX414AL	0x0050	Sony ICX414AK	0x0051
Kodak KAI-2000M	0x0110	Kodak KAI-2000CM	0x0111
Kodak KAI-2001M	0x0120	Kodak KAI-2001CM	0x0121
Kodak KAI-4010M	0x0130	Kodak KAI-4010CM	0x0131
Kodak KAI-4020M	0x0140	Kodak KAI-4020CM	0x0141
Kodak KAI-11000M	0x0150	Kodak KAI-11000CM	0x0151
Micron MV13 bw	0x1010	Micron MV13 col	0x1011

Note: This list will be updated with new entries and available on the www.pco.de web page.

Description of the color pattern information inside the pco.camera descriptor.

All color pco cameras work with the Bayer pattern demosaicking. The color filter pattern of those color CCD can be reduced to a 2x2 matrix. The CCD can be seen as a matrix of those 2x2 matrixes. It may occur that there is only a half matrix on the lower and right edge of the CCD. The wColorPattern inside the camera descriptor describes the upper left corner of the color CCD and determines the color values of the single entries in this 2x2 matrix. The WORD is divided into 4 nibbles with 4 bits for each nibble. Each nibble describes the color (see color definitions) the filter in the CCD has got at the corresponding position. Upper left is 0, upper right is 1, lower left is 2 and lower right is 3.

Color	hex code
red	1H
green	2H
blue	4H
cyan	5H
magenta	6H
yellow	7H

Color definitions

See the following example:

Color pattern descriptor:			
MS nibble			*LS nibble*
color p(1,1)	color p(0,1)	color p(1,0)	color p(0,0)
green	blue	red	green
2	4	1	2
resulting color pattern word: 2412H			
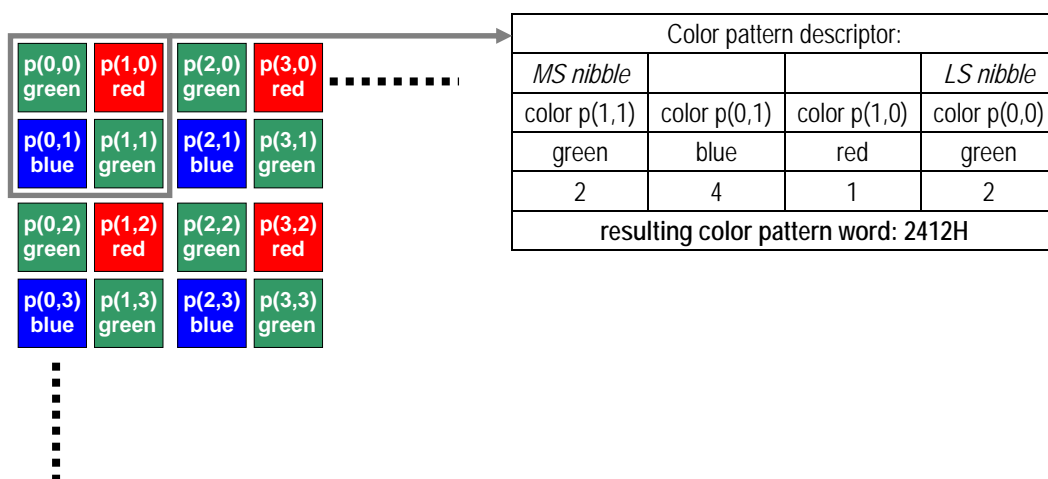
c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x01D1	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.2 Get Sensor Format

Get format of sensor. The [standard] format uses only effective pixels, while the [extended] format shows all pixels inclusive effective, dark, reference and dummy.

a.) Command Message:

Code	Length	Cks.
0x1411	0x0005	0x2A

Parameter:　　　None

b.) Response Message:

Code	Length	Format	Cks.
0x1491	0x0007	0x####	0x##

Return values:　　• x0000 = [standard]
　　　　　　　　• x0001 = [extended]

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x14D1	0x0009	0x########	0x##

Return values:　　• error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.3 Set Sensor Format

Set format of sensor. The [standard] format uses only effective pixels, while the [extended] format shows all pixels inclusive effective, dark, reference and dummy.

a.) Command Message:

Code	Length	Format	Cks.
0x1511	0x0007	0x####	0x##

Parameter:
- x0000 = [standard]
- x0001 = [extended]

Note: This command will be rejected, if Recording State is [run].

b.) Response Message:

Code	Length	Format	Cks.
0x1591	0x0007	0x####	0x##

Return values:
- x0000 = [standard]
- x0001 = [extended]

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x15D1	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.4 Get ROI

Get ROI (region or area of interest) window. The ROI is equal to or smaller than the absolute image area which is defined by the settings of **format** and **binning**.

a.) Command Message:

Code	Length	Cks.
0x0211	0x0005	0x18

Parameter: None

b.) Response Message:

Code	Length	ROI x0	ROI y0	ROI x1	ROI y1	Cks.
0x0291	0x000D	0x####	0x####	0x####	0x####	0x##

Return values: • x0, x1, y0, y1: region of interest (in pixels) within the complete image of the sensor (see also figure below).
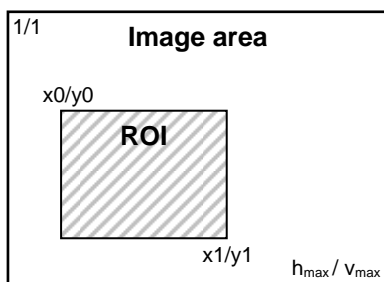
c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x02D1	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.5 Set ROI

Set ROI (region or area of interest) window. The ROI must be equal to or smaller than the absolute image area which is defined by the settings of **format** and **binning**.

a.) Command Message:

Code	Length	ROI x0	ROI y0	ROI x1	ROI y1	Cks.
0x0311	0x000D	0x####	0x####	0x####	0x####	0x##

Parameter:
- x0, x1, y0, y1: set region of interest (in pixels) within the complete image of the sensor.

Notes:
- valid ROI settings range from 1/1 to h_{max}/v_{max}
  (h_{max}/v_{max} are dependent from the settings of **format** and **binning**)
- values out of range result in a failure response message
- the command will be rejected, if Recording State is [run]

b.) Response Message:

Code	Length	ROI x0	ROI y0	ROI x1	ROI y1	Cks.
0x0391	0x000D	0x####	0x####	0x####	0x####	0x##

Return values:
- x0, x1, y0, y1: configured region of interest (in pixels) within the complete image of the sensor (see also figure below).

Notes:
- valid ROI settings range from 1/1 to h_{max}/v_{max}
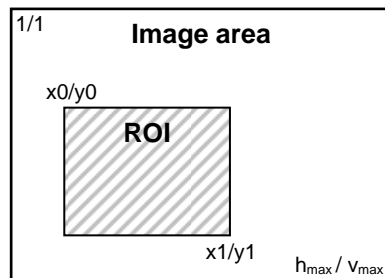
c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x03D1	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.6 Get Binning

Get binning information

a.) Command Message:

Code	Length	Cks.
0x0411	0x0005	0x1A

Parameter: None

b.) Response Message:

Code	Length	Binning x	Binning y	Cks.
0x0491	0x0009	0x####	0x####	0x##

Return values: • current binning x (horizontal direction) and binning y (vertical direction).

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x04D1	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.7 Set Binning

Set binning

a.) Command Message:

Code	Length	Binning x	Binning y	Cks.
0x0511	0x0009	0x####	0x####	0x##

Parameter: • set binning x (horizontal direction) and binning y (vertical direction)

Notes: • valid binning settings generally are 1, 2, 4, 8, 16, 32, other values may be possible depending on the camera type
• values not valid result in a failure response message
• the command will be rejected, if Recording State is [run]

b.) Response Message:

Code	Length	Binning x	Binning y	Cks.
0x0591	0x0009	0x####	0x####	0x##

Return values: • configured binning x (horizontal direction) and binning y (vertical direction)

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x05D1	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.8 Get Pixelrate

Get pixelrate for reading images from the image sensor.

a.) Command Message:

Code	Length	Cks.
0x0611	0x0005	0x1C

Parameter: None

b.) Response Message:

Code	Length	Pixelrate	Cks.
0x0691	0x0009	0x########	0x##

Return values: • current pixelrate as long word in Hz.

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x06D1	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.9 Set Pixelrate

Set pixelrate

a.) Command Message:

Code	Length	Pixelrate	Cks.
0x0711	0x0009	0x########	0x##

Parameter: • pixelrate to be configured as long word in Hz.

Notes: • valid values depend on camera type, the adjustable values are defined in the camera description
• non valid values result in a failure response message
• the command will be rejected, if Recording State is [run]

b.) Response Message:

Code	Length	Pixelrate	Cks.
0x0791	0x0009	0x########	0x##

Return values: • configured pixelrate as long word in Hz.

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x07D1	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.10   Get Conversion Factor

Get image sensor gain setting

a.) Command Message:

Code	Length	Cks.
0x0811	0x0005	0x1E

Parameter: None

b.) Response Message:

Code	Length	Conv.	Cks.
0x0891	0x0007	0x####	0x##

Return values: • current conversion factor in electrons/count (the variable must be divided by
100 to get the real value)
i.e. 0x01B3 (hex) = 435 (decimal) = 4.35 electrons/count
conversion factor must be valid as defined in the camera description

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x08D1	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.11   Set Conversion Factor

Set image sensor gain

a.) Command Message:

Code	Length	Conv.	Cks.
0x0911	0x0007	0x####	0x##

Parameter:
- conversion factor to be set in electrons/count (the variable must be divided by 100 to get the real value)
  i.e. 0x01B3 (hex) = 435 (decimal) = 4.35 electrons/count
  conversion factor must be valid as defined in the camera description

Notes:
- non valid values result in a failure response message
- the command will be rejected, if Recording State is [run]

b.) Response Message:

Code	Length	Gain	Cks.
0x0991	0x0007	0x####	0x##

Return values:
- Conversion Factor in electrons/count

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x09D1	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.12   Get Double Image Mode

Get double image mode setting

a.) Command Message:

Code	Length	Cks.
0x0A11	0x0005	0x20

Parameter: None

b.) Response Message:

Code	Length	Mode	Cks.
0x0A91	0x0007	0x####	0x##

Return values: • current mode:
                 0x0001 = double image mode ON, 0x0000 = double image mode OFF

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x0AD1	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.13 Set Double Image Mode

Set double image mode - some cameras (defined in the camera description) allow to make a double image with two exposures separated by a short interleaving time.

a.) Command Message:

Code	Length	Mode	Cks.
0x0B11	0x0007	0x####	0x##

Parameter: • mode:
 0x0001 = double image mode ON, 0x0000 = double image mode OFF

Notes: • non valid values result in a failure response message
 • the command will be rejected, if Recording State is [run]

b.) Response Message:

Code	Length	Gain	Cks.
0x0B91	0x0007	0x####	0x##

Return values: • configured mode:
 0x0001 = double image mode ON, 0x0000 = double image mode OFF

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x0BD1	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.14 Get ADC Operation

Get analog-digital-converter (ADC) operation for reading the image sensor data. Pixel data can be read out using one ADC (better linearity) or in parallel using two ADCs (faster). Only available for some camera models (defined in the camera description).

a.) Command Message:

Code	Length	Cks.
0x0C11	0x0005	0x22

Parameter:　　　None

b.) Response Message:

Code	Length	Mode	Cks.
0x0C91	0x0007	0x####	0x##

Return values:　　• current usage:
　　　　　　　　　　0x0001 = 1 ADC or 0x0002 = 2 ADCs are used…

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x0CD1	0x0009	0x########	0x##

Return values:　　• error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.15   Set ADC Operation

Set analog-digital-converter (ADC) operation for reading the image sensor data. Pixel data can be read out using one ADC (better linearity) or in parallel using two ADCs (faster). Only available for some camera models.

a.) Command Message:

Code	Length	Mode	Cks.
0x0D11	0x0007	0x####	0x##

Parameter: • operation to be set:
               0x0001 = 1 ADC or 0x0002 = 2 ADCs should be used…

Notes: • non valid values result in a failure response message.
               • the command will be rejected, if Recording State is [run]

b.) Response Message:

Code	Length	Mode	Cks.
0x0D91	0x0007	0x####	0x##

Return values: • configured operation:
                 0x0001 = 1 ADC or 0x0002 = 2 ADCs are used…

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x0DD1	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.16 Get IR Sensitivity

Get IR sensitivity setting for the image sensor. Only available for special camera models with image sensors which have improved IR sensitivity.

a.) Command Message:

Code	Length	Cks.
0x0E11	0x0005	0x24

Parameter: None

b.) Response Message:

Code	Length	Mode	Cks.
0x0E91	0x0007	0x####	0x##

Return values: • current mode:
                    0x0001 = IR sensitivity ON or 0x0000 = IR sensitivity OFF

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x0ED1	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.17   Set IR Sensitivity

Set IR sensitivity for the image sensor. Only available for special camera models with image sensors which have improved IR sensitivity.

a.) Command Message:

Code	Length	Mode	Cks.
0x0F11	0x0007	0x####	0x##

Parameter: • mode to be set:
               0x0001 = IR sensitivity ON or 0x0000 = IR sensitivity OFF

Notes: • non valid values result in a failure response message
               • the command will be rejected, if Recording State is [run]

b.) Response Message:

Code	Length	Mode	Cks.
0x0F91	0x0007	0x####	0x##

Return values: • configured mode:
                0x0001 = IR sensitivity ON or 0x0000 = IR sensitivity OFF

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x0FD1	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.18   Get Cooling Setpoint Temperature

Get the temperature setpoint for cooling the image sensor (only available for cooled cameras).

a.) Command Message:

Code	Length	Cks.
0x1011	0x0005	0x26

Parameter: None

Notes:
- the actual temperature of the sensor can be read with **get temperature** command (see 5.1.5)

b.) Response Message:

Code	Length	Temp.	Cks.
0x1091	0x0007	0x####	0x##

Return values:
- current cooling temperature setpoint as signed word in °C units

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x10D1	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.19   Set Cooling Setpoint Temperature

Set the temperature setpoint for cooling the image sensor (only available for cooled cameras, the default setpoints are [0] in the camera description).

a.) Command Message:

Code	Length	Temp.	Cks.
0x1111	0x0007	0x####	0x##

Parameter: • cooling temperature setpoint to be adjusted as signed word in °C units

Notes: • valid range depends on camera type, non valid values result in a failure response message
   • the actual temperature of the sensor can be read with **get temperature command** (see 5.1.5)

b.) Response Message:

Code	Length	Mode	Cks.
0x1191	0x0007	0x####	0x##

Return values: • configured cooling temperature setpoint as signed word in °C units

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x11D1	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.20   Get Offset Mode

Get the mode for the offset regulation with reference pixels (see camera manual for further explanations).

a.) Command Message:

Code	Length	Cks.
0x1211	0x0005	0x28

Parameter: • none

b.) Response Message:

Code	Length	Mode	Cks.
0x1291	0x0007	0x####	0x##

Return values: • mode:
                        0x0000 = [auto] or 0x0001 = [OFF]

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x12D1	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.21   Set Offset Mode

Set the mode for the offset regulation with reference pixels (see camera manual for further explanations).

a.) Command Message:

Code	Length	Mode	Cks.
0x1311	0x0007	0x####	0x##

Parameter: • mode:
0x0000 = [auto] or 0x0001 = [OFF]

Notes: • the command will be rejected, if Recording State is [run]

b.) Response Message:

Code	Length	Mode	Cks.
0x1391	0x0007	0x####	0x##

Return values: • mode:
0x0000 = [auto] or 0x0001 = [OFF]

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x13D1	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.22 Get Noise Filter Mode

Get the actual noise filter mode

a.) Command Message:

Code	Length	Mode	Cks.
0x1911	0x0007	0x####	0x##

Parameter: • mode:
0x0000 = [auto] or 0x0001 = [OFF]

Notes: • the command will be rejected, if Recording State is [run]

b.) Response Message:

Code	Length	Mode	Cks.
0x1991	0x0007	0x####	0x##

Return values: • mode:
0x0000 = Noise filter off
0x0001 = Noise filter on
0x0101 = Noise filter on and Hotpixel Correction

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x19D1	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.2.23   Set Noise Filter Mode

Set the noise filter mode

a.) Command Message:

Code	Length	Mode	Cks.
0x1A11	0x0007	0x####	0x##

Parameter: • mode:
                     0x0000 = set Noise filter off
                     0x0001 = set Noise filter on
                     0x0101 = set Noise filter on and enable Hotpixel Correction

Notes: • the command will be rejected, if Recording State is [run]

b.) Response Message:

Code	Length	Mode	Cks.
0x1A91	0x0007	0x####	0x##

Return values: • mode:
                     0x0000 = Noise filter off
                     0x0001 = Noise filter on
                     0x0101 = Noise filter on and Hotpixel Correction

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x1AD1	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.3 Timing

The group id code for the Timing Control Commands is 0x12. Thus the least significant byte of all command id codes is 0x12. The command id codes are 0x??12, the code of the response message 0x??92 or in case of a failed command 0x??D2.

Overview:

Command:	Cmd. Code	Resp. Code	Error/ Warning Code
Get Timebase	0x0C12	0x0C92	0x0CD2
Set Timebase	0x0D12	0x0D92	0x0DD2
Get Delay / Exposure Time	0x0112	0x0192	0x01D2
Set Delay / Exposure Time	0x0212	0x0292	0x02D2
Get delay / exposure time table	0x0A12	0x0A92	0x0AD2
Set delay / exposure time table.	0x0B12	0x0B92	0x0BD2
Get FPS Exposure Mode	0x1312	0x1392	0x13D2
Set FPS Exposure Mode	0x1412	0x1492	0x14D2
Get Trigger Mode	0x0312	0x0392	0x03D2
Set Trigger Mode	0x0412	0x0492	0x04D2
Force Trigger	0x0512	0x0592	0x05D2
Get Camera Busy status	0x0612	0x0692	0x06D2
Get Power Down Mode	0x0E12	0x0E92	0x0ED2
Set Power Down Mode	0x0F12	0x0F92	0x0FD2
Get User Power Down Time	0x0712	0x0792	0x07D2
Set User Power Down Time	0x0812	0x0892	0x08D2
Get <exp trig> Signal Status	0x0912	0x0992	0x09D2
Get COC Runtime	0x1012	0x1092	0x10D2

5.3.1 Get Timebase

Get timebase for delay and exposure times.

a.) Command Message:

Code	Length	Cks.
0x0112	0x0005	0x23

Parameter: None

b.) Response Message:

Code	Length	Timebase Delay	Timebase Exposure	Cks.
0x0192	0x0009	0x####	0x####	0x##

Return values:
- timebase for delay and exposure times
    - 0x0000 => timebase = [ns] $(10^{-9}s)$
    - 0x0001 => timebase = [µs] $(10^{-6}s)$
    - 0x0002 => timebase = [ms] $(10^{-3}s)$

Note:

- delay and exposure values are multiplied with the configured **timebase** unit values

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x0CD2	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.3.2 Set Timebase

Set timebase for delay and exposure times.

a.) Command Message:

Code	Length	Timebase Delay	Timebase Exposure	Cks.
0x0D12	0x0009	0x####	0x####	0x##

Parameter:
- timebase to be selected for delay and exposure times
  - 0x0000 => timebase = [ns] $(10^{-9}s)$
  - 0x0001 => timebase = [µs] $(10^{-6}s)$
  - 0x0002 => timebase = [ms] $(10^{-3}s)$

b.) Response Message:

Code	Length	Timebase Delay	Timebase Exposure	Cks.
0x0D92	0x0009	0x####	0x####	0x##

Return values:
- configured timebase for delay and exposure times
  - 0x0000 => timebase = [ns] $(10^{-9}s)$
  - 0x0001 => timebase = [µs] $(10^{-6}s)$
  - 0x0002 => timebase = [ms] $(10^{-3}s)$

Note:

- delay and exposure values are multiplied with the configured **timebase** unit values

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x0DD2	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.3.3 Get Delay / Exposure Time

Get delay / exposure time

a.) Command Message:

Code	Length	Cks.
0x0112	0x0005	0x18

Parameter: None

b.) Response Message:

Code	Length	Delay	Exposure	Cks.
0x0192	0x000D	0x########	0x########	0x##

Return values: • delay and exposure time as multiples of timebase units

Note:

- delay and exposure values are multiplied with the configured **timebase** unit values
- for image sequences see 5.3.5 and 5.3.6.

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x01D2	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.3.4 Set Delay / Exposure Time

Set delay / exposure time

a.) Command Message:

Code	Length	Delay	Exposure	Cks.
0x0212	0x000D	0x########	0x########	0x##

Parameter: • delay and exposure time to be adjusted as multiples of timebase units

b.) Response Message:

Code	Length	Delay	Exposure	Cks.
0x0292	0x000D	0x########	0x########	0x##

Return values: • configured delay and exposure time as multiples of timebase units

Note:

- delay and exposure values are multiplied with the configured **timebase** unit values
- If **exposure** is set to zero an error is generated
- for image sequences see 5.3.5 and 5.3.6.

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x02D2	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.3.5 Get Delay / Exposure Time Table

Get delay / exposure time table

General note:

For some camera types it is possible to define a table with delay / exposure times (defined in the camera description). After start of exposure the camera will take a series of consecutive images with delay and exposure times as defined in the table. Therefore a flexible message format has been defined. The table consists of maximum 16 delay / exposure time pairs. If an exposure time entry is set to the value zero, then at execution time this delay/ exposure pair is disregarded and the sequence is started automatically with the first entry in the table. This results in a sequence of 1 to 16 images with different delay and exposure time settings. External or automatic triggering of images is fully functional for every image in the sequence. If the user wants maximum speed (at CCDs overlapping exposure and read out is taken), [auto trigger] should be selected and the sequence should be controlled with the <acq enbl> input.

a.) Command Message:

Code	Length	Cks.
0x0A12	0x0005	0x21

Parameter: None

b.) Response Message:

Code	Length	Delay 1	Exp. 1	Delay/ Exp. 2 - 15	Delay 16	Exp. 16	Cks.
0x0A92	0x0085	0x########	0x########	… / …	0x########	0x########	0x##

Return values: • exposure and delay table (16 pairs) as multiples of timebase units

Note:

- delay and exposure values are multiplied with the configured **timebase** unit values
- If an exposure value is set to zero, the sequence is repeated from the beginning (first entry)
- If exposure 1 is set to zero, an error is generated
- If all exposure entries are non zero, the sequence consists of 16 images

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x0AD2	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.3.6 Set Delay / Exposure Time Table

Set delay / exposure time table.

General note:

For some camera types it is possible to define a table with delay / exposure times (defined in the camera description). After start of exposure the camera will take a series of consecutive images with delay and exposure times as defined in the table. Therefore a flexible message format has been defined. The table consists of maximum 16 delay / exposure time pairs. If an exposure time entry is set to the value zero, then at execution time this delay/ exposure pair is disregarded and the sequence is started automatically with the first entry in the table. This results in a sequence of 1 to 16 images with different delay and exposure time settings. External or automatic triggering of images is fully functional for every image in the sequence. If the user wants maximum speed (at CCDs overlapping exposure and read out is taken), [auto ext. trigger] should be selected and the sequence should be controlled with the <acq enbl> input.

Note:

- The commands **set delay / exposure time** and **set delay / exposure time table** can only be used alternatively. Using **set delay / exposure time** has the same effect as using the **table** command and setting exposure 2 entry to zero.

a.) Command Message:

First message:

Code	Length	Delay 1	Exp. 1	Delay/ Exp. 2 - 15	Delay 16	Exp. 16	Cks.
0x0B12	0x0085	0x########	0x########	… / …	0x########	0x########	0x##

Return values: • exposure and delay table (16 pairs) to be adjusted as multiples of timebase units

Notes:

- delay and exposure values are multiplied with the configured **timebase** unit values
- If an exposure value is set to zero, the sequence is repeated from the beginning (first entry)
- If exposure 1 is set to zero, an error is generated
- If all exposure entries are non zero, the sequence consists of 16 images
- The command will be rejected, if Recording State is [run]

b.) Response Message:

Code	Length	Delay 1	Exp. 1	Delay/ Exp. 2 - 15	Delay 16	Exp. 16	Cks.
0x0B92	0x0085	0x########	0x########	… / …	0x########	0x########	0x##

Return values: • configured exposure and delay table (16 pairs) as multiples of timebase units

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x0BD2	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.3.7 Get FPS Exposure Mode

The FPS exposure mode is useful if you want to get the maximum exposure time for maximum frame rate.

The maximum image framerate (FPS = Frames Per Second) depends on pixelrate, vertical ROI and exposure time.

$$FPS = FPS_{max} \approx \frac{Pixelrate}{Pixels/line \times n_{lines}} \qquad FPS = \frac{1}{t_{expos}}$$

valid for: $t_{expos} <= 1/FPS_{max}$ *valid for:* $t_{expos} > 1/FPS_{max}$

where:

Pixels / line: Pixel in one full line, horizontal ROI will not affect this number because always a full line (including dummy pixel) has to be read

n_{lines}:   Number of lines (vertical ROI)

Note: The formula for FPS_{max} is a rough estimate. Actually the FPS_{max} will be less due to some overhead time, which depends on camera and sensor type as well as operating modes.

As can be seen from the formula the exposure time affects the frame rate, if it gets longer than the frame rate period time. If the camera is in "FPS Exposure Mode" the maximum possible exposure time is automatically set such that FPS = FPS_{max}.

Please note, that, if the "FPS Exposure Mode" is on, the "Set Delay/Exposure Time" or Set Delay/Exposure Time Table" commands ar ignored!

The FPS Exposure Mode is available for the pco.1200hs camera model only!

a.) Command Message:

Code	Length	Cks.
0x1312	0x0005	0x29

Parameter: None

---

b.) Response Message:

Code	Length	Mode	Exp. time	Cks.
0x1392	0x000B	0x####	0x########	0x##

Return values:
- Mode: current mode
  - 0 = FPS Exposure Mode off, exposure time set by "Set Delay/Exposure Time" or "Set Delay/Exposure Time Table" command.
  - 1 = FPS Exposure Mode on, exposure time set automatically to $1 / FPS_{max}$ "Set Delay/Exposure Time" or "Set Delay/Exposure Time Table" commands are ignored.

- Exposure time: The exposure time that will be set if "FPS Exposure Mode" is on. The exposure time depends on the current settings of vertical ROI and Pixelrate. **The returned time is always in ns!**

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x13D2	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.3.8 Set FPS Exposure Mode

See "Get FPS Exposure Mode" for further explanations!

a.) Command Message:

Code	Length	Mode	Cks.
0x1412	0x0007	0x####	0x##

Parameter:
- Mode to be set:
  - 0 = FPS Exposure Mode off, exposure time set by "Set Delay/Exposure Time" or "Set Delay/Exposure Time Table" command.
  - 1 = FPS Exposure Mode on, exposure time set automatically to $1 / FPS_{max}$ "Set Delay/Exposure Time" or "Set Delay/Exposure Time Table" commands are ignored.

Note: The FPS Exposure Mode is available for the pco.1200hs camera model only!

b.) Response Message:

Code	Length	Mode	Exp. time	Cks.
0x1392	0x000B	0x####	0x########	0x##

Return values:
- Mode: current mode
  - 0 = FPS Exposure Mode off, exposure time set by "Set Delay/Exposure Time" or "Set Delay/Exposure Time Table" command.
  - 1 = FPS Exposure Mode on, exposure time set automatically to $1 / FPS_{max}$ "Set Delay/Exposure Time" or "Set Delay/Exposure Time Table" commands are ignored.

- Exposure time: The exposure time that will be set if "FPS Exposure Mode" is on. The exposure time depends on the current settings of vertical ROI and Pixelrate. **The returned time is always in ns!**

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x14D2	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.3.9 Get Trigger Mode

Get image trigger mode (for further explanations see camera manual)

a.) Command Message:

Code	Length	Cks.
0x0312	0x0005	0x1A

Parameter: None

b.) Response Message:

Code	Length	Mode	Cks.
0x0392	0x0007	0x####	0x##

Return values: • Current trigger mode:
- 0x0000 = [auto trigger]
  An exposure of a new image is started automatically best possible compared to the readout of an image. If using a CCD and images are taken in a sequence, then exposures and readout of the sensor are started simultaneously. Signals at the trigger input (<exp trig>) are irrelevant.
- 0x0001 = [software trigger]:
  An exposure can only be started by a **force trigger** command.
- 0x0002 = [extern exposure & software trigger]:
  A delay / exposure sequence is started at the RISING or FALLING edge (depending on the DIP switch setting) of the trigger input (<exp trig>).
- 0x0003 = [extern exposure control]:
  The exposure time is defined by the pulse length at the trigger input(<exp trig>). The delay and exposure time values defined by the **set/request delay and exposure** command are ineffective. (Exposure time length control is also possible for double image mode; exposure time of the second image is given by the readout time of the first image.)

Note: In modes [extern exposure & software trigger] and [extern exposure control], it depends also on the selected acqire mode, if a trigger edge at the trigger input (<exp trig>) will be effective or not (*see also 5.5.9 Set Acquire mode (Auto / External)*). A software trigger however will always be effective independent of the state of the <acq enbl> input (concerned trigger modes are: [software trigger] and [extern exposure & software trigger].

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x03D2	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.3.10　Set Trigger Mode

Set image trigger mode

a.) Command Message:

Code	Length	Mode	Cks.
0x0412	0x0007	0x####	0x##

Parameters:
- trigger mode to be selected:
  - 0x0000 = [auto trigger]
    An exposure of a new image is started automatically best possible compared to the readout of an image. If using a CCD and images are taken in a sequence, then exposures and readout of the sensor are started simultaneously. Signals at the trigger input (<exp trig>) are irrelevant.
  - 0x0001 = [software trigger]:
    An exposure can only be started by a **force trigger** command.
  - 0x0002 = [extern exposure & software trigger]:
    A delay / exposure sequence is started at the RISING or FALLING edge (depending on the DIP switch setting) of the trigger input (<exp trig>).
  - 0x0003 = [extern exposure control]:
    The exposure time is defined by the pulse length at the trigger input(<exp trig>). The delay and exposure time values defined by the **set/request delay and exposure** command are ineffective. (Exposure time length control is also possible for double image mode; exposure time of the second image is given by the readout time of the first image.)

Notes:
- the command will be rejected, if Recording State is [run]

- In modes [extern exposure & software trigger] and [extern exposure control], it depends also on the selected acqire mode, if a trigger edge at the trigger input (<exp trig>) will be effective or not (*see also 5.5.9 Set Acquire mode (Auto / External)*). A software trigger however will always be effective independent of the state of the <acq enbl> input (concerned trigger modes are: [software trigger] and [extern exposure & software trigger].

b.) Response Message:

Code	Length	Mode	Cks.
0x0492	0x0007	0x####	0x##

Return values:
- Configured trigger modes:
  - 0x0000 = [auto trigger]
  - 0x0001 = [software trigger]
  - 0x0002 = [extern exposure & software trigger]
  - 0x0003 = [extern exposure control]

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x04D2	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.3.11 Force Trigger

This software command starts an exposure if the **trigger mode** is in the state [software trigger] (0x0001) or in the state [extern exposure & software trigger] (0x0002). If in state [extern exposure control] (0x0003), nothing happens. The camera has to be ready: (**recording** = [start]) and [not busy].

a.) Command Message:

Code	Length	Cks.
0x0512	0x0005	0x1C

Parameter: None

b.) Response Message:

Code	Length	Return	Cks.
0x0592	0x0007	0x####	0x##

Return values:
- result:
  - 0x0000 = trigger command was not successful because of camera being busy
  - 0x0001 = a new image exposure has been triggered by the command

Note:

- Due to response and processing times e.g. caused by the interface and/or the operating system on the PC, the delay between command and actual trigger may be several 10ms up to 100ms.
- A force trigger command will be effective independent of the selected acquire mode and independent of the state of the <acq enbl> input.

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x05D2	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.3.12 Get Camera Busy status

Get camera busy status: a trigger is ignored, if the camera is still busy ([exposure] or [readout]). In case of **force trigger** command the user may request the camera busy status in order to be able to start a valid **force trigger** command.

a.) Command Message:

Code	Length	Cks.
0x0612	0x0005	0x1D

Parameter: none

b.) Response Message:

Code	Length	Status	Cks.
0x0692	0x0007	0x####	0x##

Return values:
- camera busy status:
  - 0x0000 = camera is [not busy], ready for a new trigger command
  - 0x0001 = camera is [busy], not ready for a new trigger command

Note:

- The status is according to the hardware signal <busy> at the <status output> at the power supply unit. Due to response and processing times e.g. caused by the interface and/or the operating system, the delay between the delivered status and the actual status may be several 10ms up to 100ms. If timing is critical it is strongly recommended to use the hardware signal (<busy>).

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x06D2	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.3.13   Get Power Down Mode

Get mode for CCD or CMOS power down threshold time (see camera manual)

a.) Command Message:

Code	Length	Cks.
0x0E12	0x0005	0x25

Parameter: None

b.) Response Message:

Code	Length	Pdn. Mode	Cks.
0x0E92	0x0007	0x####	0x##

Return values: • current mode:
                    0x0000 = [auto] or 0x0001 = [user]

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x0ED2	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.3.14   Set Power Down Mode

Set mode for CCD or CMOS power down threshold time control. Power down functions are controllable when **power down mode** = [user] is selected (see camera manual).

a.) Command Message:

Code	Length	Pdn. Mode	Cks.
0x0F12	0x0007	0x####	0x##

Parameter:	• mode to be selected: 0x0000 = [auto] or 0x0001 = [user]
Notes:	• the command will be rejected, if Recording State is [run]

b.) Response Message:

Code	Length	Pdn. Mode	Cks.
0x0F92	0x0007	0x####	0x##

Return values: • configured power down mode

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x0FD2	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.3.15   Get User Power Down Time

Get user values for CCD or CMOS power down threshold time (see camera manual).

a.) Command Message:

Code	Length	Cks.
0x0712	0x0005	0x1E

Parameter: None

b.) Response Message:

Code	Length	Pdn. Time	Cks.
0x0792	0x0009	0x########	0x##

Return values: • current CCD power down threshold time as multiples of ms (0ms .. 47.9days)

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x07D2	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.3.16   Set User Power Down Time

Set user values for CCD or CMOS power down threshold time (see camera manual). If the exposure time is greater than the selected Power Down Time, than the CCD or CMOS sensor is switched (electrically) into a special power down mode to reduce dark current effects. If **power down mode** = [user] is selected, the power down threshold time set by this function will become effective.

The value set by this function will become effective if **power down mode** = [user] is selected.

a.) Command Message:

Code	Length	Pdn. Time	Cks.
0x0812	0x0009	0x########	0x##

Parameter: • CCD power down threshold time to be selected as multiples of ms (0ms .. 47.9days)

Notes: • the command will be rejected, if Recording State is [run]

b.) Response Message:

Code	Length	Pdn. Time	Cks.
0x0892	0x0009	0x########	0x##

Return values: • configured CCD power down threshold time as multiples of ms (0ms .. 47.9days)

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x08D2	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.3.17 Get <exp trig> Signal Status

Get the current status of the <exp trig> user input (one of the <control in> inputs at the rear of pco.power; see 1.2). If the signal level at the <exp trig> input is HIGH and the DIP switch shows ⌐ then the Status is TRUE. If the signal level at the <exp trig> input is HIGH and the DIP switch shows ∟ then the Status is FALSE.

a.) Command Message:

Code	Length	Cks.
0x0912	0x0005	0x20

Parameter: none

b.) Response Message:

Code	Length	Status	Cks.
0x0992	0x0007	0x####	0x##

Return values:
- <exp trig> signal status:
  - 0x0000 = [FALSE]
  - 0x0001 = [TRUE]
- the following combinations are possible:
  - input signal: HIGH   DIP switch: ⌐   Status: TRUE
  - input signal: HIGH   DIP switch: ∟   Status: FALSE
  - input signal: LOW   DIP switch: ⌐   Status: FALSE
  - input signal: LOW   DIP switch: ∟   Status: TRUE

Note:

- due to response and processing times e.g. caused by the interface and/or the operating system, the delay between the software delivered status and the actual status may be several 10ms up to 100ms. If timing is critical it is strongly recommended to use other trigger modes.

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x09D2	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.3.18 Get COC Runtime

Requests the run time for one image. The run time is the time which is required before a new image can be started. Thus the runtime determines the frame rate.

a.) Command Message:

Code	Length	Cks.
0x1012	0x0005	0x27

Parameter: none

b.) Response Message:

Code	Length	Runtime [s]	Runtime [ns]	Cks.
0x1092	0x000F	0x########	0x########	0x##

Return values: • Time for one image is: Runtime [s] + Runtime [ns]

Note:

• A few preliminary firmware versions deliver the second parameter as µs!

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x10D2	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.4 Storage

The group id code for the Storage Control Commands is 0x13. Thus the least significant byte of all command id codes is 0x13. The command id codes are 0x??13, the code of the response message 0x??93 or in case of a failed command 0x??D3.

Overview:

Command:	Cmd. Code	Resp. Code	Error/ Warning Code
Get Camera RAM size	0x0113	0x0193	0x01D3
Get Camera RAM Segment Size	0x0213	0x0293	0x02D3
Set Camera RAM Segment Size	0x0313	0x0393	0x03D3
Clear RAM Segment	0x0413	0x0493	0x04D3
Get Active RAM Segment	0x0513	0x0593	0x05D3
Set Active RAM Segment	0x0613	0x0693	0x06D3

5.4.1 Get Camera RAM size

Get the camera RAM (camRAM) size

a.) Command Message:

Code	Length	Cks.
0x0113	0x0005	0x19

Parameter: None

b.) Response Message:

Code	Length	RAM size	Page Size	Cks.
0x0193	0x000B	0x########	0x####	0x##

Return values:
- RAM size: size of the total camera RAM as multiples of pages
- page size: size of one page as multiples of pixels

Note:

- One page is the smallest unit for RAM segmentation as well as for storing images. Segment sizes can only configured as multiples of pages. The size reserved for one image is also calculated as multiples of whole pages, therefore there may be some unused RAM memory if the page size is not exactly a multiple of the image size.

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x01D3	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.4.2 Get Camera RAM Segment Size

Get camera RAM (camRAM) segment size

a.) Command Message:

Code	Length	Cks.
0x0213	0x0005	0x1A

Parameter: None

b.) Response Message:

Code	Length	Segm. 1 size	Segm. 2 size	Segm. 3 size	Segm. 4 size	Cks.
0x0293	0x0015	0x########	0x########	0x########	0x########	0x##

Return values: • size of segment 1 .. segment 4 as multiples of RAM pages

Note:

- the sum of all segment sizes must not be larger than the total size of the RAM (as multiples of pages)
- **size** = [0] indicates that the segment will not be used
- using only one segment is possible by assigning the total RAM size to segment 1 and 0x0000 to all other segments.

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x02D3	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.4.3 Set Camera RAM Segment Size

Set Camera RAM Segment Size.

a.) Command Message:

Code	Length	Segm. 1 size	Segm. 2 size	Segm. 3 size	Segm. 4 size	Cks.
0x0313	0x0015	0x########	0x########	0x########	0x########	0x##

Return values: • size of segment 1 .. segment 4 as multiples of RAM pages

Note:

- the sum of all segment sizes must not be larger than the total size of the RAM (as multiples of pages)
- a single segment size can have the value 0x0000, but the sum of all 4 segments must be greater than 0x0000
- the command will be rejected, if Recording State is [run]
- the segment size must be large enough to store at least 3 images
- **The function will result in all segments to be cleared. All images recorded before are lost!**

b.) Response Message:

Code	Length	Segm. 1 size	Segm. 2 size	Segm. 3 size	Segm. 4 size	Cks.
0x0393	0x0015	0x########	0x########	0x########	0x########	0x##

Return values: • configured sizes of segment 1 .. segement4 as multiples of RAM pages

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x03D3	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.4.4 Clear RAM Segment

Clear active camera RAM segment, delete all image info and prepare segment for new images

a.) Command Message:

Code	Length	Cks.
0x0413	0x0005	0x1C

Parameter: None

b.) Response Message:

Code	Length	Cks.
0x0493	0x0005	0x9C

Return values: none

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x04D3	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.4.5 Get Active RAM Segment

Get the active camera RAM segment - the active segment is the segment where images are stored

a.) Command Message:

Code	Length	Cks.
0x0513	0x0005	0x1D

Parameter: None

b.) Response Message:

Code	Length	Segm.	Cks.
0x0593	0x0007	0x####	0x##

Return values:
- segment number of the currently active segment

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x05D3	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.4.6 Set Active RAM Segment

Set the active camera RAM segment - the active segment is the segment where images are stored

a.) Command Message:

Code	Length	Segm.	Cks.
0x0613	0x0007	0x####	0x##

Parameter: • segment number of the segment to be set active

b.) Response Message:

Code	Length	Segm.	Cks.
0x0693	0x0007	0x####	0x##

Return values: • segment number of the configured active segment

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x06D3	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.5 Recording

The group id code for the Recording Control Commands is 0x14. Thus the least significant byte of all command id codes is 0x14. The command id codes are 0x??14, the code of the response message 0x??94 or in case of a failed command 0x??D4.

Overview:

Command:	Cmd. Code	Resp. Code	Error/ Warning Code
Get Storage Mode (Recorder / FIFO buffer)	0x0114	0x0194	0x01D4
Set Storage Mode (Recorder / FIFO buffer)	0x0214	0x0294	0x02D4
Get Recorder Submode (Sequence / Ring buffer)	0x0314	0x0394	0x03D4
Set Recorder Submode (Sequence / Ring buffer)	0x0414	0x0494	0x04D4
Get Recording Status	0x0514	0x0594	0x05D4
Set Recording State	0x0614	0x0694	0x06D4
Arm Camera	0x0A14	0x0A94	0x0AD4
Get Acquire mode (Auto / External)	0x0714	0x0794	0x07D4
Set Acquire mode (Auto / External)	0x0814	0x0894	0x08D4
Get <acq enbl> Signal Status	0x0914	0x0994	0x09D4
Set Date / Time	0x0B14	0x0B94	0x0BD4
Get Timestamp Mode	0x0C14	0x0C94	0x0CD4
Set Timestamp Mode	0x0D14	0x0D94	0x0DD4
Get Record Stop Event	0x0E14	0x0E94	0x0ED4
Set Record Stop Event	0x0F14	0x0F94	0x0FD4
Stop Record	0x1014	0x1094	0x10D4

5.5.1 Get Storage Mode (Recorder / FIFO buffer)

Get storage mode [recorder] or [FIFO buffer]

a.) Command Message:

Code	Length	Cks.
0x0114	0x0005	0x1A

Parameter:　　　None

b.) Response Message:

Code	Length	Mode	Cks.
0x0194	0x0007	0x####	0x##

Return values:
- current storage mode (see boxes below):
    - 0x0000 = [recorder] mode
    - 0x0001 = [FIFO buffer] mode

Recorder Mode	FIFO Buffer mode
• images are recorded and stored within the internal camera memory (camRAM) • Live View transfers the most recent image to the PC (for viewing / monitoring) • indexed or total readout of images after the recording has been stopped	• all images taken are transferred to the PC in chronological order • camera memory (camRAM) is used as huge FIFO buffer to bypass short bottlenecks in data transmission • if buffer overflows the oldest images are overwritten

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x01D4	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.5.2 Set Storage Mode (Recorder / FIFO buffer)

Set storage mode [recorder] or [FIFO buffer]

a.) Command Message:

Code	Length	Mode	Cks.
0x0214	0x0007	0x####	0x##

Parameter:
- storage mode to be selected (see boxes below):
  - 0x0000 = [recorder] mode
  - 0x0001 = [FIFO buffer] mode

Notes:
- the command will be rejected, if Recording State is [run]

b.) Response Message:

Code	Length	Mode	Cks.
0x0294	0x0007	0x####	0x##

Return values:
- configured storage mode (see boxes below):
  - 0x0000 = [recorder] mode
  - 0x0001 = [FIFO buffer] mode

Recorder Mode	FIFO Buffer mode
• images are recorded and stored within the internal camera memory (camRAM) • Live View transfers the most recent image to the PC (for viewing / monitoring) • indexed or total readout of images after the recording has been stopped	• all images taken are transferred to the PC in chronological order • camera memory (camRAM) is used as huge FIFO buffer to bypass short bottlenecks in data transmission • if buffer overflows the oldest images are overwritten • if Set Recorder = [stop] is sent, recording is stopped and the transfer of the current image to the PC is finished. Images not read are stored within the segment and can be read with the Read Image From Segment command.

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x02D4	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.5.3 Get Recorder Submode (Sequence / Ring buffer)

Get recorder submode: [sequence] or [ring buffer] (see explanation boxes below). Recorder submode is only available if the storage mode is set to [recorder].

a.) Command Message:

Code	Length	Cks.
0x0314	0x0005	0x1C

Parameter: None

b.) Response Message:

Code	Length	Mode	Cks.
0x0394	0x0007	0x####	0x##

Return values: • current recorder submode:
- 0x0000 = [sequence]
- 0x0001 = [ring buffer].

recorder submode = [sequence]	recorder submode =[ring buffer]
• recording is stopped when the allocated buffer is full	• camera records continuously into ring bufferif the allocated buffer overflows, the oldest images are overwrittenrecording is stopped by software or disabling acquire signal (<acq enbl>)

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x03D4	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.5.4 Set Recorder Submode (Sequence / Ring buffer)

Set recorder submode: [sequence] or [ring buffer] (see explanation boxes below). Recorder submode is only available if the storage mode is set to [recorder].

a.) Command Message:

Code	Length	Mode	Cks.
0x0414	0x0007	0x####	0x##

Parameter:
- recorder submode to be selected:
  - 0x0000 = [sequence]
  - 0x0001 = [ring buffer]

Notes:
- the command will be rejected, if Recording State is [run]

b.) Response Message:

Code	Length	Mode	Cks.
0x0494	0x0007	0x####	0x##

Return values:
- configured recorder submode:
  - 0x0000 = [sequence]
  - 0x0001 = [ring buffer]

recorder submode = [sequence]	recorder submode = [ring buffer]
• recording is stopped when the allocated buffer is full	• camera records continuously into ring bufferif the allocated buffer overflows, the oldest images are overwrittenrecording is stopped by software or disabling acquire signal (<acq enbl>)

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x04D4	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.5.5 Get Recording Status

Requests the current **recording status**.

The **recording status** controls the status of the camera. If the **recording status** is [run], images can be started by **exposure trigger** and <acq enbl>. If the **recording status** is [clear]'ed or [stop]'ped, all image readout or exposure sequences are stopped and the sensors (CCD or CMOS) are running in a special idle mode to prevent dark charge accumulation.

The **recording status** has the highest priority compared to functions like <acq enbl> or **exposure trigger**.

The **recording status** is controlled by:

- software command: **set recording status** = [run]

The **recording status** is cleared by:

- powering ON the camera
- software command: **set recording status** = [stop]
- software command: **reset** all settings to default values

a.) Command Message:

Code	Length	Cks.
0x0514	0x0005	0x1E

Parameter: None

b.) Response Message:

Code	Length	Status	Cks.
0x0594	0x0007	0x####	0x##

Return values: • current recording status:
-   0x0001 = camera is running, in **recording status** = [run]
-   0x0000 = camera is idle or [stop]'ped, not ready to take images

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x05D4	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.5.6 Set Recording State

Sets the current **recording status**.

The **recording status** controls the status of the camera. If the **recording status** is [run], images can be started by **exposure trigger** and <acq enbl>. If the **recording status** is [clear]'ed or [stop]'ped, all image readout or exposure sequences are stopped and the sensors (CCD or CMOS) are running in a special idle mode to prevent dark charge accumulation.

The **recording status** has the highest priority compared to functions like <acq enbl> or **exposure trigger**.

The **recording status** is controlled by:

- software command: **set recording status** = [run]

The **recording status** is cleared by:

- powering ON the camera
- software command: **set recording status** = [stop]
- software command: **reset** all settings to default values

Notes:

- It is necessary to issue an **arm camera** command before every **set recording status** command in order to ensure that all settings are accepted correctly. Do not change settings between **arm camera** command and **set recording status** command.

- If a **set recording status** = [stop] command is sent and the current status is already [stop]'ped, nothing will happen (no warning, error message)

- If a **set recording status** = [run] command is sent and the current status is already [run], a warning message will be generated

- If a successful **set recording status** = [run] command is sent and recording is started, the images from a previous record to the active segment are lost!

a.) Command Message:

Code	Length	Status	Cks.
0x0614	0x0007	0x####	0x##

Parameter:
- recording status to be selected:
  - 0x0001 = [run]
  - 0x0000 = [stop], switch camera to idle mode

b.) Response Message:

Code	Length	PostLen	Cks.
0x0694	0x0007	0x####	0x##

Return values:
- Configured recording status:
  - 0x0001 = [run], camera is in recording mode.
  - 0x0000 = [stop] camera is idle, not ready to take images.

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x06D4	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.5.7 Arm Camera

Arms, i.e. prepares the camera for a consecutive **set recording status** = [run] command. All configurations and settings made up to this moment are accepted and the internal settings of the camera are prepared. Thus the camera is able to start immediately when the **set recording status** = [run] command is performed.

Note: It is required to issue an **arm camera** command before every **set recording state** = [run] command in order to ensure that all settings are accepted correctly. Do not change settings between **arm camera** command and **set recording status** command.

a.) Command Message:

Code	Length	Cks.
0x0A14	0x0005	0x23

Parameter: None

b.) Response Message:

Code	Length	Cks.
0x0A94	0x0005	0xA3

Return values: None

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x0AD4	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.5.8 Get Acquire mode (Auto / External)

Get acquire mode: [auto] or [external] (see camera manual for explanation)

a.) Command Message:

Code	Length	Cks.
0x0714	0x0005	0x20

Parameter: None

b.) Response Message:

Code	Length	Mode	Cks.
0x0794	0x0007	0x####	0x##

Return values:
- current acquire mode:
  - 0x0000 = [auto] - the external <acq enbl> input is ignored
  - 0x0001 = [external] - external signal at the <acq enbl> input controls whether images are stored or not

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x07D4	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.5.9 Set Acquire mode (Auto / External)

Set acquire mode: [auto] or [external] (see camera manual for explanation)

a.) Command Message:

Code	Length	Mode	Cks.
0x0814	0x0007	0x####	0x##

Parameter:
- acquire mode to be selected:
  - 0x0000 = [auto] - all images taken are stored
  - 0x0001 = [external] - the external control input <acq enbl> is a static enable signal of images. If this input is TRUE (level depending on the DIP switch), exposure triggers are accepted and images are taken. If this signal is set FALSE, all exposure triggers are ignored and the sensor readout is stopped.

Notes:
- the command will be rejected, if Recording State is [run]

b.) Response Message:

Code	Length	Mode	Cks.
0x0894	0x0007	0x####	0x##

Return values:
- configured acquire mode:
  - 0x0000 = [auto] - all images taken are stored
  - 0x0001 = [external] - the external control input <acq enbl> is a static enable signal of images. If this input is TRUE (level depending on the DIP switch), exposure triggers are accepted and images are taken. If this signal is set FALSE, all exposure triggers are ignored and the sensor readout is stopped.

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x08D4	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.5.10 Get <acq enbl> Signal Status

Get the current status of the <acq enbl> user input (one of the <control in> inputs at the rear of pco.power; see 1.2). If the signal level at the <acq enbl> input is HIGH and the DIP switch shows ⌐⌐ then the Status is TRUE. If the signal level at the <acq enbl> input is HIGH and the DIP switch shows ⌐⌐ then the Status is FALSE. ⌐⌐ or ⌐⌐

a.) Command Message:

Code	Length	Cks.
0x0914	0x0005	0x22

Parameter: none

b.) Response Message:

Code	Length	Status	Cks.
0x0994	0x0007	0x####	0x##

Return values:
- <acq enbl> signal status:
  - 0x0000 = [FALSE]
  - 0x0001 = [TRUE]
- the following combinations are possible:
  - input signal: HIGH   DIP switch: ⌐⌐   Status: TRUE
  - input signal: HIGH   DIP switch: ⌐⌐   Status: FALSE
  - input signal: LOW   DIP switch: ⌐⌐   Status: FALSE
  - input signal: LOW   DIP switch: ⌐⌐   Status: TRUE

Note:

- Due to response and processing times e.g. caused by the interface and/or the operating system, the delay between the delivered status and the actual status may be several 10 ms up to 100 ms. If timing is critical it is strongly recommended to use other trigger modes.

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x09D4	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.5.11   Set Date / Time

Set date and time for the **timestamp** function. The date and time is updated automatically, as long as the camera is supplied with power. When powering up the camera, then this command should be done once.

a.) Command Message:

Code	Length	Date	Time	Cks.
0x0B14	0x000D	0x## 0x## 0x####	0x00## 0x## 0x##	0x##

Parameter: • date: day:month:year binary coded
                  example: 21:march:2003 => 0x150307D3
              • time: hours:min:sec binary coded
                  example: 17h:05min:32sec => 0x00110520

b.) Response Message:

Code	Length	Date	Time	Cks.
0x0B94	0x000D	0x## 0x## 0x####	0x00## 0x## 0x##	0x##

Parameter: • date: day:month:year binary coded
                  example: 21:march:2003 => 0x150307D3
              • time: hours:min:sec binary coded
                  example: 17h:05min:32sec => 0x00110520

Note:

• [ms] and [µs] values are set to zero, when this command is executed
• this command should be performed, when powering up the camera

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x0BD4	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.5.12 Get Timestamp Mode

Get mode of the timestamp function.

a.) Command Message:

Code	Length	Cks.
0x0C14	0x0005	0x25

Parameter: • none

b.) Response Message:

Code	Length	Mode	Cks.
0x0C94	0x0007	0x####	0x##

Parameter:
- 0x0000 = no stamp in image
- 0x0001 = BCD coded stamp in the first 14 pixel
- 0x0002 = BCD coded stamp in the first 14 pixel + ASCII text
- 0x0003 = only ASCII text

Note:

- details about modes are explained in the following command **set timestamp mode**.

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x0CD4	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.5.13   Set Timestamp Mode

Set mode of the timestamp function.
To obtain information about the recording time of images this command can be useful. It writes a continuous image number and date / time information with a resolution of 10 µs direct into the raw image data. The first 14 pixels (top left corner) are used to hold this information. The numbers are coded in BCD with one byte per pixel, which means that every pixel can hold 2 digits. If the pixels have more resolution as 8 bits, then the BCD digits are right bound adjusted and the upper bits are zero. Additionally to this 14 pixels, the information can be written in ASCII text for direct inspection. A 8 by 8 pixel array is used per ASCII digit. The digits are displayed below the BCD coded line.

a.) Command Message:

Code	Length	Mode	Cks.
0x0D14	0x0007	0x####	0x##

Parameter:
- 0x0000 = no stamp in image
- 0x0001 = BCD coded stamp in the first 14 pixel
- 0x0002 = BCD coded stamp in the first 14 pixel + ASCII text
- 0x0003 = ASCII text only

Note:

- the image number is set to value = [1], when an **arm** command is performed
- using this command without setting the [date] / [time] results in an error message

Format of BCD coded pixels:

pixel 1	pixel 2	pixel 3	pixel 4	pixel 5	pixel 6	pixel 7
image counter (MSB) (00 … 99)	image counter (00 … 99)	image counter (00 … 99)	image counter (LSB) (00 … 99)	year (MSB) (20)	year (LSB) (03 … 99)	month (01 … 12)
pixel 8	**pixel 9**	**pixel 10**	**pixel 11**	**pixel 12**	**pixel 13**	**pixel 14**
day (01 ... 31)	h (00 … 23)	min (00 … 59)	s (00 … 59)	µs * 10000 (00 … 99)	µs * 100 (00 … 99)	µs (00 … 90)

Format of ASCII text:

- image number: 8 digits [1 … 99999999]
- date: 9 digits [01JAN2003 … 31DEZ9999]
- time: 15 digits [00:00:00.000000 … 23:59:59.999990]
- number, date and time are separated by blanks

Example:
00103822 03JAN2003 17:35:12.376810
image number: 00103822
date: 03 January 2003
time: 17 h, 35 min, 12 s, 376 ms, 810 µs

b.) Response Message:

Code	Length	Mode	Cks.
0x0D94	0x0007	0x####	0x##

Parameter:
- 0x0000 = no stamp in image
- 0x0001 = BCD coded stamp in the first 14 pixel
- 0x0002 = BCD coded stamp in the first 14 pixel + ASCII text
- 0x0003 = ASCII text

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x0DD4	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.5.14 Get Record Stop Event

For explanation see Set Record Stop Event.

a.) Command Message:

Code	Length	Cks.
0x0E14	0x0005	0x27

Parameter: None

b.) Response Message:

Code	Length	Mode	Delay (Images)	Cks.
0x0E94	0x000F	0x####	0x########	0x##

Return values:
- Mode: record stop event configuration:
  - 0x0000 = no record stop event is accepted (default after power-on).
  - 0x0001 = record stop by software command
  - 0x0002 = record stop by edge at the <acq. enbl.> input or by software
- Delay in images: number of images which are taken after the record stop event. If the number of images are taken, record will be stopped automatically.

Notes:
- Use the record stop event function only when Storage Mode = [Recorder] and Recorder Submode = [Ring buffer]!
- The command is not available for all cameras. Currently it is only implemented within the pco.1200hs

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x0ED4	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.5.15   Set Record Stop Event

This command can be used for setting up the record stop event. After a stop event the camera records the configured number of images and stops after that. The command is useful to record a series of images to see what happens before and after the stop event.

A record stop event can be either a software command or an edge at the <acq enbl> input (at the power unit). The edge detection depends on the DIP switch setting at the power unit. If the DIP switch shows ⎍ then a rising edge is the stop event. If the DIP switch shows ⎇ then a falling edge is the stop event.

The software command is the command "Stop Record" described below.

Use the record stop even function only when Storage Mode = [Recorder] and Recorder Submode = [Ring buffer]!

a.) Command Message:

Code	Length	Mode	Delay (Images)	Cks.
0x0F14	0x000F	0x####	0x########	0x##

Parameter:
- Mode: record stop event configuration:
  - 0x0000 = no record stop event is accepted
  - 0x0001 = record stop by software command
  - 0x0002 = record stop by edge at the <acq. enbl.> input or by software
- Delay in images: number of images which are taken after the record stop event. If the number of images is taken, record will be stopped automatically.

Notes:
- Use the record stop event function only when Storage Mode = [Recorder] and Recorder Submode = [Ring buffer]!
- Due to internal timing issues the actual number of images taken after the event may differ by +/- 1 from the configured number.
- The command is not available for all cameras. Currently it is only implemented for the pco.1200hs

b.) Response Message:

Code	Length	Mode	Delay (Images)	Cks.
0x0F94	0x000F	0x####	0x########	0x##

Return values:
- Mode: record stop event configuration:
  - 0x0000 = no record stop event is accepted
  - 0x0001 = record stop by software command
  - 0x0002 = record stop by edge at the <acq. enbl.> input or by software
- Delay in images: number of images which are taken after the record stop event. If the number of images is taken, record will be stopped automatically.

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x08D4	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

5.5.16   Stop Record

This command is useful to generate a stop event by software for the record stop event mode. See also Set Record Stop Event.

a.) Command Message:

Code	Length	Resrvd	Reserved	Cks.
0x1014	0x000F	0x0000	0x00000000	0x##

Parameter: • Reserved for future use, set to 0!

Notes: • The camera has to configured by the command Set Record Stop Event in order to accept the command (modes 0x0001 and 0x0002).

• The command is not available for all cameras. Currently it is only implemented for the pco.1200hs

b.) Response Message:

Code	Length	Resrvd	Reserved	Cks.
0x1094	0x000F	0x####	0x########	0x##

Return values: • Not used now.

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x08D4	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)
• PCO_ERROR_FIRMWARE_NOTPOSSIBLE when:
  - Recording state = [off]
  - the configured stop event is mode 0x0000 (no event is accepted)

5.6 Image Read

The group id code for the Image Read Commands is 0x15. Thus the least significant byte of all command id codes is 0x15. The command id codes are 0x??15, the code of the response message 0x??95 or in case of a failed command 0x??D5.

Overview:

Command:	Cmd. Code	Resp. Code	Error/ Warning Code
Get Segment Image Settings	0x0115	0x0195	0x01D5
Get Number Of Images in Segment	0x0215	0x0295	0x02D5
Read Images from Segment (Recorder Mode only)	0x0515	0x0595	0x05D5
Request Image	0x0615	0x0695	0x06D5
Cancel Image Transfer	0x0715	0x0795	0x07D5
Repeat Image	0x0815	0x0895	0x08D5
Get Bit Alignment	0x0915	0x0995	0x09D5
Set Bit Alignment	0x0A15	0x0A95	0x0AD5

5.6.1 Get Segment Image Settings

Get the image settings for images stored into a segment.

a.) Command Message:

Code	Length	Segm.	Cks.
0x0115	0x0007	0x####	0x##

Parameter: • number of segment

b.) Response Message:

Code	Length	Segm.	Res. h.	Res. v.	Bin. x	Bin y.	ROI x0	ROI y0	ROI x1	ROI y1	Cks.
0x0195	0x0017	0x####	0x####	0x####	0x####	0x####	0x####	0x####	0x####	0x####	0x##

Return values: • Segm. = number of segment
  • Res. h. = resulting horizontal resolution (sensor resolution, ROI, binning)
  • Res. v. = resulting vertical resolution (sensor resolution, ROI, binning)
  • Bin. x, y = binning setting for horizontal (x) and vertical (y) direction
  • ROI x0, y0, x1, y1 = configured region of interest (ROI, in pixels) within the complete image of the sensor

See also: 5.2.1 Get Camera Description
    5.2.6 Get Binning

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x01D5	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.6.2 Get Number Of Images in Segment

Get the number of valid images within the segment. The operation is slightly different due to the selected storage mode:

In [recorder mode], if recording is not stopped and in [FIFO buffer mode] the number of images is dynamic due to read and write accesses to the camera RAM. If the **camera storage mode** is in [recorder mode] and recording is stopped, the number is fixed.

a.) Command Message:

Code	Length	Segm.	Cks.
0x0215	0x0007	0x####	0x##

Return values: • segment of the camera RAM which is to be requested

b.) Response Message:

Code	Length	Segm.	Valid Num.	Max. Num.	Cks.
0x0295	0x000F	0x####	0x########	0x########	0x##

Return values:
- Segm. = segment of the camera RAM which is to be requested
- Valid Num. = number of valid images in the segment.
- Max. Num. = maximum number of images which may be saved to this segment

In [FIFO buffer mode] the ratio of valid number of images to the maximum number of images is a kind of filling level indicator.

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x02D5	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.6.3 Read Images from Segment (Recorder Mode only)

Read the images recorded to the camera RAM .

Note: Command is only valid, if **storage mode** is set to [recorder] and recording to the camera RAM segment is stopped!

a.) Command Message:

Code	Length	Segment	Start Image	Last Image	Cks.
0x0515	0x000F	0x####	0x########	0x########	0x##

Parameter:
- Segment = number of segment of the RAM segment to read from
- Start Image = index of image in the segment to begin readout with
- Last Image = index of image in the segment which is to be read at last

where: index is running from 1 to the number of valid images in segment

Note: If reading only one image, then set [Start Image] and [Last Image] to the same value!

b.) Response Message:

Code	Length	Segment	Start Image	Last Image	Cks.
0x0515	0x000F	0x####	0x########	0x########	0x##

Parameter:
- Segment = number of segment of the RAM segment to read from
- Start Image = index of image in the segment to begin readout with
- Last Image = index of image in the segment which is to be read at last

where: index is running from 1 to the number of valid images in segment

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x05D5	0x0009	0x########	0x##

Return values:
- Error code, less than 0 (see also section 6. Error / Warning Codes)

5.6.4 Request Image

Start an image transfer, while recording state is set to [on].
If **storage mode** is set to [recorder], the last aquired image is read.
If **storage mode** is set to [FIFO buffer mode] the images are read in the order, in which they have been written into the fifo buffer

a.) Command Message:

Code	Length	Cks.
0x0615	0x0005	0x20

Parameter: None

b.) Response Message:

Code	Length	Cks.
0x0695	0x0005	0xA0

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x06D5	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.6.5 Repeat Image

Repeats an image transfer, with the settings of the last RequestImage or ReadImagesFromSegment call. This is useful, if an error occures during the transmission of the image. The current image transfer must be cancelled before this command can be called.

a.) Command Message:

Code	Length	Reserved	Reserved	Reserved	Reserved	Cks.
0x0815	0x000D	0x####	0x####	0x####	0x####	0x##

Parameter: • set all reserved to 0

b.) Response Message:

Code	Length	Reserved	Reserved	Reserved	Reserved	Cks.
0x0895	0x000D	0x####	0x####	0x####	0x####	0x##

Return values: •

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x08D5	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.6.6 Cancel Image Transfer

Cancel the current image transfer. If an error occures during the image transfer, the current transfer must be cancelled before the repeat image command could be called.

a.) Command Message:

Code	Length	Reserved	Cks.
0x0715	0x0007	0x####	0x##

Parameter: • set the reserved parameter to 0

b.) Response Message:

Code	Length	Reserved	Cks.
0x0795	0x0007	0x####	0x##

Return values: •

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x07D5	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

5.6.7   Get Bit Alignment

Get output data bit alignment mode.

The most interfaces, e.g. FireWire deliver data words which are 16 bits wide. On the other hand the bit resolution of the pixel data delivered by the pco.camera differs from 16 bit, it's 10 bit for the pco.1200hs or 14 bit for the pco.1600 etc.

The bit alignment mode defines how the pixel data are aligned to the 16 bit data.

The figure below shows, how a 10 bit pixel value 1016 = 03F9H is aligned to a 16 bit word depending on the alignment mode:

Mode:	MSB															LSB	Value:
MSB alignment	1	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0	FE40H
LSB alignment	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	1	03F9H

a.) Command Message:

Code	Length	Cks.
0x0915	0x0005	0x29

Parameter: • none

b.) Response Message:

Code	Length	Mode	Cks.
0x0995	0x0007	0x####	0x##

Return values: • bit alignment mode, where:
- 1 = MSB alignment (default)
- 0 = LSB alignment

5.6.8 Set Bit Alignment

Set output data bit alignment mode (see also 5.6.7 Get Bit Alignment).

a.) Command Message:

Code	Length	Mode	Cks.
0x0A15	0x0007	0x####	0x##

Parameter: • bit alignment mode, where:
  - 1 = MSB alignment (default)
  - 0 = LSB alignment

b.) Response Message:

Code	Length	Mode	Cks.
0x0995	0x0007	0x####	0x##

Return values: • the configured bit alignment mode, where:
  - 1 = MSB alignment (default)
  - 0 = LSB alignment

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x02D5	0x0009	0x########	0x##

6 Error / Warning Codes

The error codes are standardized as far as possible. The error codes contain the information of the error source (micocontrollers, CPLDs, FPGAs) and an error code (error cause). Both values are compared by a logical OR operation. Error codes and warnings are always negative values, if read as signed integers, or if read as unsigned word, the MSB is set. Errors have the general format 0x80######, warnings have the format 0xC0######.

Error / Warning source:

```
0x00010000 ...... error at microcontroller 1
0x00020000 ...... error at microcontroller 2
0x00030000 ...... error at microcontroller 3
0x00040000 ...... error at microcontroller 4
0x00050000 ...... error at FPGA 1
0x00060000 ...... error at FPGA 2
0x00070000 ...... error at I²C
0x000A0000 ...... error at DLL
```

Error codes:

```
0x80000001 ...... timeout in telegram
0x80000002 ...... wrong checksum
0x80000003 ...... no acknowledge
0x80000004 ...... wrong size in array
0x80000005 ...... data is inconsistent
0x80000016 ...... data is out of range
0x80000017 ...... command is not possible
```

Warnings:

```
0xC0000080 ...... function already ON
0xC0000081 ...... function already OFF
```

In case of successful operation the standard Response Message is returned.

C. Appendices: Interface dependent Details

7 Command Implementation per IEEE 1394 Interface

7.1 General

The following description requires some basic knowledge about IEEE 1394 communication. The referred standard is IEEE 1394a-2000.

The camera has implemented the basic functions defined by the IEEE 1394 standard, such that a bus manager can detect what type of device, manufacturer ID, device capabilities etc. The camera cannot act as a bus manager or isochronous resource manager, therefore the master controlling the camera should be able to be bus manager as well as isochronous resource manager. Thus the master is able to reserve isochronous resources for more than one camera connected. (Isochronous resources are used to transfer image data.)

7.2 Communication between Camera and Master

Basically there are the following types of data to be exchanged between the camera and its master controller (a PC in most cases):

- Commands sent by the master controller.
- Command responses sent by the camera.
- Image data sent by the camera.

Commands and command responses are sent as asynchronous write transactions to a defined address within the devices IEEE 1394 address range.

Please note that read transactions (except for the IEEE 1394 requirements, reading device descriptors etc.) are **not** supported. This is mainly because the camera may not be able to answer a read access, which requires any kind of action (for example request the current status of the camera), within the time limits defined by IEEE 1394. Therefore the command is sent as a write access to the camera, which is acknowledged immediately at interface level. The response of the camera is also sent as a write request to the master controller.

In order to avoid writing to any device there are two rules:

- The camera responds only when a valid command was sent to the camera.
- The master controller has to log on with an init command (see "7.3.1 Set IEEE 1394 Interface Params").

Image data are transferred as isochronous packets. The master should be either isochronous resource manager or request resources from another device being the isochronous resource manager. The master tells the camera the isochronous channel and the packet length.

7.2.1 Commands sent by the master controller

As can be seen from the chapters above the master which controls the camera send telegrams to the camera. The telegrams are sent as asynchronous writes to a specific address within the IEEE 1394 address range of the camera. The camera interprets all data written to the IEEE 1394 device address **FFFFFA000000H** as commands. Then it looks at the second word, which is the message length descriptor (see also "4.1 General message format") calculates the checksum over the telegram and compares it to the checksum byte of the telegram. Then it decodes the command by reading the first word being the command ID. If the checksum is correct and the command is known, the camera will execute the command and send a response telegram.

Note: As asynchronous packets are transferred as quadlets the telegram length is padded to a quadlet multiple, if necessary. The padded bytes are not included to checksum calculation. However please set padded bytes to zero.

7.2.2 Command responses sent by the camera

The camera does an asynchronous write containing a command specific response telegram to the IEEE 1394 device address **FFFFF8000000H** of the master. The master is the device which logged on to the camera using the "Set IEEE1394 Interface Params Command" described below.

7.2.3 Image data sent by the camera

Image data are transferred as isochronous packets. As isochronous packet do neither contain a source identifier nor a destination identifier, the packets are identified by their channel no. The IEEE 1394 specifies a process to get a channel no. from the isochronous resource manager, thus a channel no. is used only by one device within the bus topology at a given time.

The master should be either isochronous resource manager or request resources from another device being the isochronous resource manager. Then the master tells the camera the isochronous channel and the packet length. As the images will in most cases be longer than a isochronous packet the image is transferred packet by packet. Image synchronization is done using the sy field.

The following lines describe how the isochronous packets are used to transfer images:

data length	tag	channel	tcode	sy
header crc				
Pixel 1		Pixel 0		
...				
Pixel n - 1		Pixel n		
data crc				

Box 7.2.3: Isochronous data format due to IEEE 1394

The box above shows the isochronous data format due to IEEE 1394. The data are filled as described:

- Data length is the length of the payload data of the packet in bytes.
- The tag is always set to zero.
- The channel no is used to detect, if the data are image data from the camera.
- The tcode field is AH indicating as isochronous stream packet.
- The sy field is set to 1 if the packet is the first packet of an image (image start), 0 for all following packets.

7.2.4 Synchronisation commands sent by the camera

In Firmware Revisions above 2.x an image transfer handshake is implemented, to avoid image read timeouts. If an image is transferred completely the camera now sends an asynchronous message called "Image Transfer Done" message (ID 0x0717) to the master (usually PC) at address 0xFFFFFA000000,.
The master may then request a further image with the "Request image" command or send a "Repeat Image" command to request the last image again.
Image transfer may be cancelled with "Cancel Image" command
Notes:
Do not care about on PC, image handshake is done by driver. Just use the current version of the pco.camera driver. This will avoid image read timeouts.
You do not need to care about for existing control applications, the new implementation works the same way as the old one, just ignore the message sent to the PC/master.

7.3 IEEE1394 specific commands

7.3.1 Set IEEE 1394 Interface Params

Set the parameters required for the IEEE1394 communication.

a.) Command Message:

Code	Length	Master Node ID	Isochronous Channel No.	Isochronous Packet Length	Isochronous Packet Count	Cks.
0x0216	0x000D	0x####	0x####	0x####	0x####	0x##

Parameter:
- Master Node ID: The node ID of the controller. The camera sends responses always to this node ID.
- Isochronous channel no. used for transmitting image data.
- Packet length of a single packet.
- No of packets for one image. If the number of packets is less than required for transmitting a whole image, the transmission is finished after the number of packets is transferred (the rest of the image is cut off).

b.) Response Message:

Code	Length	Master Node ID	Isochronous Channel No.	Isochronous Packet Length	Isochronous Packet Count	Cks.
0x0296	0x000D	0x####	0x####	0x####	0x####	0x##

Return values: • same as for the command message

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x02D6	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

7.3.2 Get IEEE 1394 Interface Params

Get the parameters required for the IEEE1394 communication.

a.) Command Message:

Code	Length	Cks.
0x0116	0x0005	0x1C

Parameter: • none

b.) Response Message:

Code	Length	Master Node ID	Isochronous Channel No.	Isochronous Packet Length	Isochronous Packet Count	Cks.
0x0196	0x000D	0x####	0x####	0x####	0x####	0x##

Return Values:
- Master Node ID: The node ID of the controller. The camera sends responses always to this node ID.
- Isochronous channel no. used for transmitting image data.
- Packet length of a single packet.
- No of packets for one image. If the number of packets is less than required for transmitting a whole image, the transmission is finished after the number of packets is transferred (the rest of the image is cut off).

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x01D6	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

8 Command Implementation per CameraLink Interface

8.1 General

The following description requires some basic knowledge about the CameraLink interface. The referred standard is CameraLink Specification 1.0.

The camera uses the base configuration for data transfer. Data transfer must be started either by command or is continuous, if the camera is set to this mode. The clock frequency of the CameraLink channel and baudrate of the serial interface can be set with commands. The commands and responses are received resp. sent through the serial lines of the CameraLink interface.

8.2 Communication between Camera and Master

Basically there are the following types of data to be exchanged between the camera and the CameraLink controller board:

- Commands sent by the controller board.
- Command responses sent by the camera.
- Image data sent by the camera.
- Control lines set by the controller board

Commands and command responses are sent through the serial lines of the CameraLink interface and should be done in one not interruptable sequence:

- Write command to the camera
- Read command response from the camera
- Check error conditions

Image data is sent as requested, according to the CameraLink specification.

8.2.1 Commands sent by the controller

As can be seen from the chapters above the master which controls the camera send telegrams to the camera. The telegrams are sent as a write to the serial interface of the CameraLink channel. The camera interprets all received data from the serial line (SerTC) as commands. Then it looks at the second word, which is the message length descriptor (see also "4.1 General message format") calculates the checksum over the telegram and compares it to the checksum byte of the telegram. Then it decodes the command by reading the first word being the command ID. If the checksum is correct and the command is known, the camera will execute the command and send a response telegram.

8.2.2 Command responses sent by the camera

The camera does a write to the serial interface of the CameraLink channel containing a command specific response telegram. The controller receives the telegram at the serial line (SerTFG). The controller should read at first two WORD's from the serial interface, extract the size information of the telegram and then read the additional data of the telegram. Then error conditions should be checked. Timeout conditions should also be checked. For most of the commands a timeout of 200ms is sufficient. For the commands "Arm Camera" and "Get COC Runtime" the timeout should be set to 1000ms.

8.2.3 Image data sent by the camera

FVAL, LVAL, DVAL signals are sent as specified in the CameraLink manual. Only the pure image data is sent. There are no additional black lines or pixel. Therefore DVAL is the same as LVAL. Two sets of interval times can be programmed using the "Set CL Configuration" command. Default mode is ShortGapMode other setting is LongGap (values in brackets).

- the interval between two following lines (LVAL - LVAL) is 4 Clks (16 Clks)
- the interval between framestart and the first line (FVAL - LVAL) is 8 Clks (16 Clks)
- the shortest interval between two frames (FVAL - FVAL) is 16 Clks (2560 Clks)

Image data can be transmitted as 1x16bit values or 2x12bit values. This can be programmed using the "Set CL Configuration" command. The 2x12Bit is valid only for pco.1200hs cameras, which have this feature enabled in the camera descriptor.

8.2.4 Control lines set by the controller

The four CameraLink control lines CC1, CC2, CC3, CC4 are assigned to specific functions of the camera. The functionality of the lines can be enabled or disabled using the "Set CL Configuration" command

- CC1:   is used for trigger **instead** of the <exp trig> input at the pco.power unit
- CC2:   is used for acquire **instead** of the <acq enbl> input at the pco.power unit
- CC3:   not used
- CC4:   is used to control the transfer of images **instead** of the internal signals set by the camera firmware. CC4 is used as a gate which is sampled every time, when the camera is able to start an image transfer. If CC4 is '1' the transfer is started, otherwise the camera waits until CC4 changes to '1'. CC4 does not cancel started image transfers.

8.3 CameraLink specific commands

8.3.1 Set CL Configuration

Set the parameters required for the CameraLink Configuration.

a.) Command Message:

Code	Length	Pixelclock	CClines	Dataformat	Transmit continuous	Cks.
0x3516	0x000C	0x########	0x##	0x##	0x##	0x##

Parameter:
- Pixelclock:
  Clockfrequency of the CameraLink Datatransfer in Hz. Possible values are 32 000 000 , 53 333 333 , 64 000 000, 80 000 000 for pco.4000 or 20 000 000, 40 000 000, 66 666 667, 80 000 000 for all other pco.cameras

- CClines:
  Bit0 set: enable CC1 line to be used as trigger instead of <exp trig>
  Bit1 set: enable CC2 line to be used as aquire enable instead of <acq enbl>
  Bit3 set: enable CC4 line to gate image tranfer

- Dataformat:
  CL_FORMAT_1x16 = 0x01: one pixel per clock
  CL_FORMAT_2x12 = 0x02: two pixels per clock
  (only for pco. 1200hs cameras, which have this feature enabled in the camera descriptor)

- Transmit :
  Bit0 set: enables continuous transmit of image data from the camera to the CameraLink interface when the camera is started (recording state: [run]) . Every time a new image is grabbed from the camera, it is sent to the CameraLink interface.
  Bit1 set: enable LongGap mode. Use longer intervals between CameraLink signals FVAL and LVAL

b.) Response Message:

Code	Length	Pixelclock	Cclines	Dataformat	Transmit continuous	Cks.
0x3596	0x000C	0x########	0x##	0x##	0x##	0x##

Return values:
- same as for the command message

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x35D6	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

8.3.2 Get CL Configuration

Get the parameters required for the CameraLink Configuration.

a.) Command Message:

Code	Length	Cks.
0x3416	0x0005	0x1C

Parameter: • None

b.) Response Message:

Code	Length	Pixelclock	Cclines	Dataformat	Transmit continuous	Cks.
0x3496	0x000C	0x########	0x##	0x##	0x##	0x##

Parameter: • Pixelclock:
Clockfrequency of the CameraLink Datatransfer in Hz.

• CClines:
Bit0 set: CC1 line enabled, to be used as trigger instead of <exp trig>
Bit1 set: CC2 line enabled, to be used as aquire enable instead of <acq enbl>
Bit3 set: CC4 line enabled, to gate image transfer

• Dataformat:
CL_FORMAT_1x16 = 0x01: one pixel per clock
CL_FORMAT_2x12 = 0x02: two pixels per clock

• Transmit continuous:
Bit0 set: continuous transmit is enabled.
image date from the camera to the CameraLink interface is
transmitted continuously, when the camera is started (recording
state: [run]) . Every time a new image is grabbed from the
camera, it is sent to the CameraLink interface.
Bit1 set: LongGap mode enabled. Longer intervals between
CameraLink signals FVAL and LVAL are used

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x34D6	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

8.3.3 **Set CL Baudrate**

Set the baudrate of the serial interface of the camera.

a.) Command Message:

Code	Length	Baudrate	Cks.
0x3316	0x0009	0x########	0x##

Parameter:
- Baudrate:
  Possible values are 9 600, 19 200, 38 400, 57 600,115 200
  Default setting is 9 600

b.) Response Message:

Code	Length	Baudrate	Cks.
0x3396	0x000C	0x########	0x##

Parameter:
- Baudrate to be set:

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x33D6	0x0009	0x########	0x##

Return values:
- error code, less than 0 (see also section 6. Error / Warning Codes)

Important note:

Because the configuration of new baudrates must be done on the controller and the Camera, the setting **must** be done in the following manner:

1. Send the "Set CL Baudrate", parameter = new baudrate, using the old baudrate
2. Get the response of camera also with the old baudrate
3. Wait 100 - 200 ms
4. Then set the new baudrate on the controller (using the controller specific commands)
5. Send the command "Get CL Baudrate" (now using the new baudrate)
6. Get the response of camera (using the new baudrate)
7. If no response or error response, switch back to standard baudrate 9600 and try again

8.3.4 Get CL Baudrate

Get the baudrate of the serial interface of the camera

a.) Command Message:

Code	Length	Cks.
0x3216	0x0005	0x1C

Parameter: • None

b.) Response Message:

Code	Length	Baudrate	Cks.
0x3296	0x0009	0x########	0x##

Parameter: • Currently configured baudrate of the camera

c.) Failure / Warning Response Message:

Code	Length	Message	Cks.
0x32D6	0x0009	0x########	0x##

Return values: • error code, less than 0 (see also section 6. Error / Warning Codes)

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