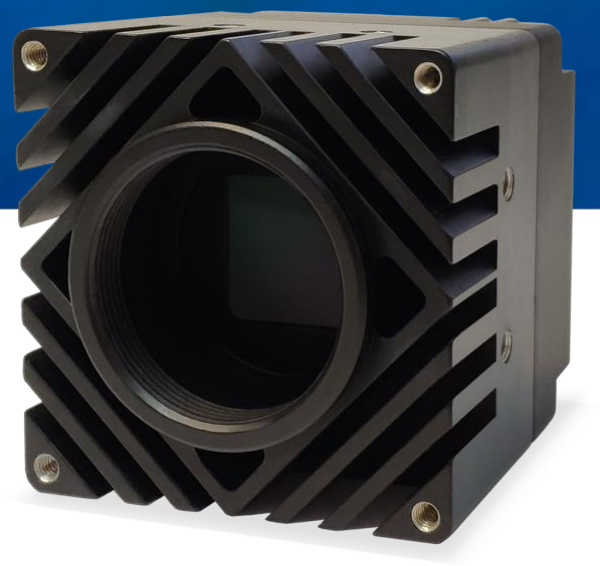
IRON SDI
User Manual



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KAYA INSTRUMENTS

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2 Revision History

Ver	Date	Notes
1.0	01.2020	Initial release
1.1	05.2020	Added the Subsampling mode
1.2	12.2020	Added section no. 6: Quick Startup Guide Added section no. 7: Image Processing Flow. Added appendix no. 1: firmware update. Section no. 8: updated new commands and re-ordered them.
1.3	02.2021	Section no. 8: added subsection 8.13 – “Genlock”
2.0	05.2021	Added Region of Interest support Added RS485 interface support and Multi-Camera Mode Added video output time-code control support Added extended auto-exposure features configurations
2.1	11.2021	Added Genlock crosslock and termination Updated genlock_offset command
2.2	08.2022	Added anti-aliasing image filter Added unsharpen image filter Added multi-matrix color correction
3.0	03.2024	Added section: Q-factor calculation logic Added subsection: video_data Updated cam_info, cam_roi_offset_info, stat_roi_info commands

Table 1 – Revision History

3 Introduction

3.1 Safety Precautions

With your ***Iron*** camera in hand, please take the time to read through the precautions listed below in order to prevent preventable and unnecessary injuries and damage to you, other personnel or property. Read these safety instructions carefully prior to your first use of the product, as these precautions contain safety instructions that must be observed. After reading through this manual, be sure to follow it to prevent misuse of product.

⚠ Caution! Read Carefully and do not disregard these instructions.
In the event of a failure, disconnect the power supply. Disconnect the power supply immediately and contact our sales personnel for repair. Continuing to use the product in this state may result in a fire or electric shock.
If an unpleasant smell or smoking occurs, disconnect the power supply. Disconnect the power supply immediately! Continuing to use the product in this state may result in a fire or electric shock. After verifying that no smoking is observed, contact our sales personnel for repair.
Do not disassemble, repair or modify the product. This may result in a fire or electric shock due to a circuit shortage or heat generation. Contact our sales personnel prior to inspection, modification or repair.
Do not place the product on unstable surfaces. Otherwise, it may drop or fall, resulting in injury to persons or the camera.
Do not use the product if dropped or damaged. Otherwise, a fire or electric shock may occur.
Do not touch the product with metallic objects. Otherwise, a fire or electric shock may occur.
Do not place the product in dusty or humid environments, nor where water may splash. Otherwise, a fire or electric shock may occur.
Do not wet the product or touch it with wet hands. Otherwise, the product may fail or it may cause a fire, smoking or electric shock.
Do not touch the gold-plated sections of the connectors on the product. Otherwise, the surface of the connector may be contaminated by sweat or skin-oil, resulting in contact failure of a connector, malfunction, fire or electric shock due to static electricity discharge.
Do not use or place the product in the following locations. ▪ Unventilated areas such as closets or bookshelves. ▪ Near oils, smoke or steam. ▪ Next to heat sources. ▪ A closed (and not running) car where the temperature becomes high. ▪ Static electricity replete locations ▪ Near water or chemicals. Otherwise, a fire, electric shock, accident or deformation may occur due to a short circuit or heat generation.
Do not place heavy objects on the product. Otherwise, the product may be damaged.
Be sure to discharge static electricity from body before touching any sensitive electronic components. The electronic circuits in your computer and the circuits on the ***Iron*** camera and the ***Predator II*** board are sensitive to static electricity and surges. Improper handling may seriously damage the circuits. In addition, do not let your clothing come in contact with the circuit boards or components. Otherwise, the product may be damaged.

3.2 Disclaimer

This product should only be used for image capturing and processing. KAYA Instruments will assume no responsibility for any damage that may ensue by the use of the camera for any purpose other than intended, as previously stated. Without detracting from what was previously written, please be advised that the company will take no responsibility for any damages caused by:

- Earthquake, thunder strike, natural disasters, fire caused by use beyond our control, wilful and/or accidental misuse and/or use under other abnormal and/or unreasonable conditions.
- Secondary damages caused by the use of this product or its unusable state (business interruption or others).
- Use of this product in any manner that contradicts this manual or malfunctions that may occur due to connection to other devices. Damage to this product that is out of our control or failure due to modification.
- Accidents and/or third parties that may be involved.

Additionally, KAYA Instruments assumes no responsibility or liability for:

- Erasure or corruption of data caused by the use of this product.
- Any consequences or other abnormalities following the use of this product.

Repairs to this product are carried out by replacing it on a chargeable basis and not by repairing the faulty device. Non-chargeable replacement is offered for initial failure, as long as it is reported no later than two weeks post-delivery of the product.

4 Overview

This user manual provides a detailed overview of KAYAS's IRON SDI cameras operation. All cameras are suited for a wide variety of applications such low light surveillance, special effects, sports broadcasting, etc.

With our customers' convenience in mind we had made sure that connecting and streaming can be easily achieved in few easy steps and require little configurations. Control of the camera as well as advanced configurations are made easy using the SDIControlPoint software and terminal, enabling enhanced streaming and image processing of the cameras' outputs. Hardware reference is covered in chapter 9, Hardware Reference.

It is important to note that some parameters might vary slightly compared to this document or may be absent entirely, subject to the active firmware capabilities: a firmware upgrade might be needed to support complete functionality set. Please feel free to contact our support team at support@kayainstruments.com with any questions that may arise.

5 Supported Formats

Iron SDI camera support multiple standard video formats including HD-SDI, 3G-SDI, 6G-SDI and 12G-SDI, depending on the camera's sensor resolution. Changing format can be done dynamically, using serial interface, or format configuration can be saved and loaded on startup.

Table no. 2 describes the supported formats:

Mode	IIRON SDI 265	IRON SDI 305	Video Standard	Resolutions supported	Frame rates supported (fps)
HD-SDI	V	V	ST 292 (ST 274)	1080i 10-bit 4:2:2	50, 59.94, 60
				1080p 10-bit 4:2:2/RAW	23.98, 24, 25, 29.97, 30
			ST 292 (ST 2048-2)	2K 10-bit 4:2:2	23.98, 24, 25, 29.97, 30
3G-SDI			ST 425-1 (ST 274)	1080p 10-bit 4:2:2/RAW	50, 59.94, 60
			ST 425-1 (ST 2048-2)	2K 10-bit 4:2:2	47.95, 48, 50, 59.94, 60
6G-SDI	X		ST 2081-10 M1, (ST 2036-1)	UHD 10-bit 4:2:2	23.98, 24, 25, 29.97, 30
			ST 2081-10 M1, (ST 2048-1)	4K 10-bit 4:2:2	23.98, 24, 25, 29.97, 30
12G-SDI			ST 2082-10 M1, ST 425-5 (ST 2036-1)	UHD 10-bit 4:2:2	50, 59.94, 60
			ST 2082-10 M1, ST 425-5 (ST 2048-1)	4K 10-bit 4:2:2	47.95, 48, 50, 59.94, 60

Table 2 – Supported SDI parameters

6 Quick Start Guide

6.1 Camera Connection

KAYA's Iron SDI cameras are easy to set up and operate. The camera needs to be connected to a power source, using the supplied cable, and to an SDI capture card or monitor. Under normal circumstances the camera will start streaming to an SDI input as soon as it is powered.

Advanced camera settings can be configured using the provided serial command line interface. The camera can also be controlled using KAYA's SDIControlPoint application. For more details, see section 8, Camera Operation.

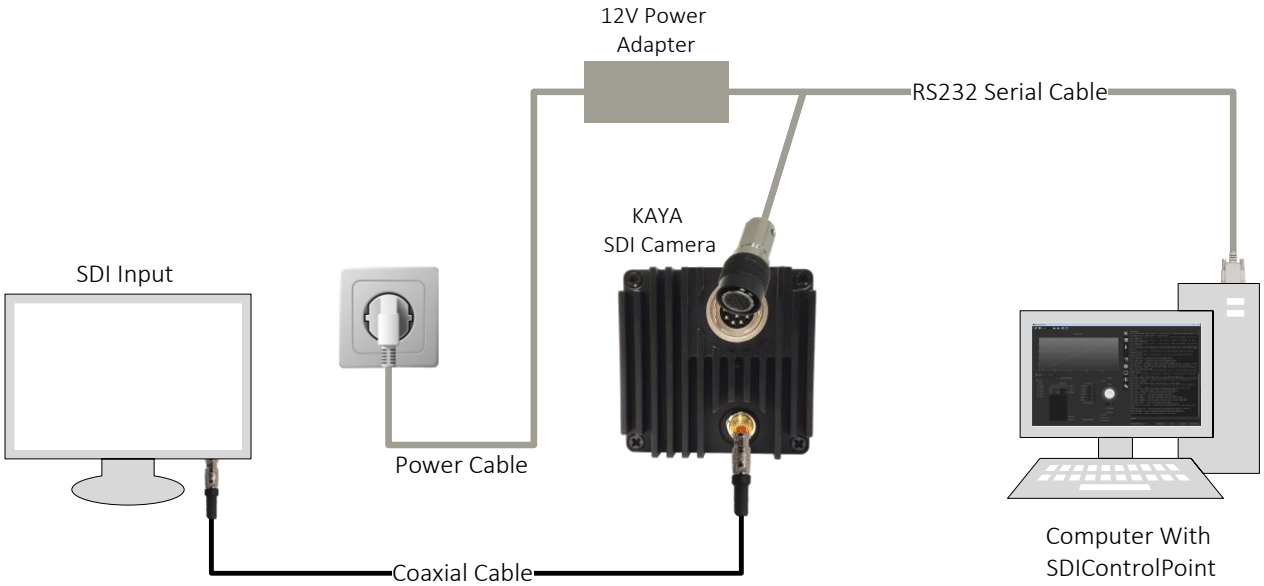


Figure 1 – Camera connections diagram

6.1.1 Power and Image Streaming

1. Connect the camera to an SDI Input using a coaxial cable.
2. Connect the camera to a 11-28V power source.
3. Video should start streaming to the SDI capture card or monitor.

6.1.2 Advanced Control

1. Connect the camera's GPIO to a serial RS232 port (cable provided).
2. Connect to the camera's command user interface via a standard serial terminal (see section 8.2, Terminal Usage) or KAYA's SDIControlPoint application.
3. To chance the video mode use the video_mode command (see section 8.8.1, video_mode).
4. To save the current settings use the save_settings command (see section 8.5.1, save_settings).

6.2 Troubleshooting

1. Make sure that the camera is connected to a 11-28V power source.
2. Make sure that all components are properly connected (camera, cables and capture card). See Figure 1 and section 9.2 Micro BNC Connector.
3. Make sure that the coaxial cable supports the proper output stream bandwidth:

   - 3G SDI for 2k video streaming.
   - 12G SDI for 4k video streaming.

4. Check to see whether the LED on the back of the camera is blinking green. The issue may be resolved by power cycling the camera (turning power off and back on). More LED indicators are described in section no. 9.1 (Status LED).
5. Make sure the SDI input (SDI capture card or monitor) supports the output video format of the camera – contact the SDI input's manufacturer for support and additional information. To change the camera's output video mode, see section 8.8.1, video_mode <mode>.

7 Image Processing Flow

Figure 2 describes the image processing flow in KAYA's SDI cameras, from a raw image acquired by the sensor and to an SDI-standard compatible output. All commands implemented in the processing pipe are described in chapter no. 8, "Camera Operation".

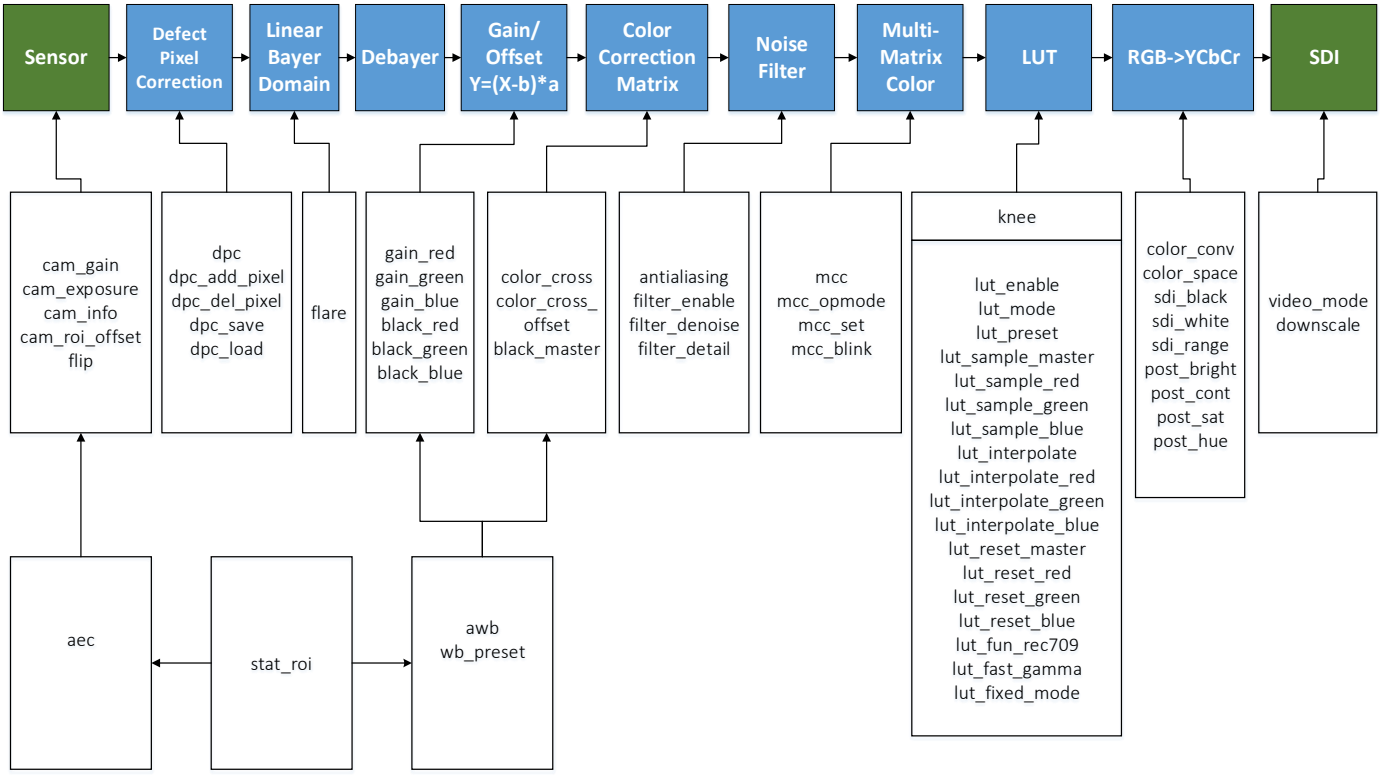


Figure 2 – Image Processing Flow

8 Camera Operation

8.1 SDIControlPoint

KAYA Instruments provides a free, open-source camera control software (named: SDIControlPoint). A downloadable file as well as the software's user manual (KAYA SDIControlPoint Manual.pdf) are available at the following address for your convenience: cloud.kayainstruments.com/s/SDI

8.2 Terminal Usage

8.2.1 Terminal

The Iron SDI can be controlled via a simple terminal connection. All commands consist of ASCI characters.

8.2.2 Terminal Settings

The terminal interfaces are either RS232 or RS485 and are connected via the GPIO connector. The default interface settings are:

- 115200 baud
- 8 bit data
- no parity
- 1 stop bit
- no flow control

The camera accepts commands in text form and responds in text messages. Every command is confirmed by either an "OK" or a "FAIL" to indicate whether it had been successfully implemented or not, respectably; errors have to be handled by the user or a host software which is used to control the device. Depending on the **prompt** setting one may receive a "=>" prompt after start up. Commands can then be sent to control the device or receive information.

8.2.3 General Command Format

If the **prompt** command is enabled the firmware will send its prompt ("=> ") when awaiting commands. Every command line is accepted as a single text line, terminated by either CR or LF. The command consists of a command string, possibly followed by one or more parameters separated by a single space. Depending of the command the parameters can come in one of these formats:

- Signed decimal : -323, 422
- Hexadecimal: 0x35ff34aa
- String : any_string

The command will be executed and may produce some text output in a single line or more, followed by a single status line consisting of either "OK" or "FAIL". In case of failure an error code may be added in the same line, e.g. "FAIL 3". The lines sent by the firmware are terminated with both CR and LF. Most commands do have parameters. The parameters depend on the given command.

8.3 Commands

8.3.1 Help Dialog

Typing **help** will give a full list of supported commands. It is possible to get a detailed help for each command by typing "help <cmd>".

Example:

help video_mode<Enter>
video_mode <video mode> - set video mode

8.3.2 Set Functions

Running a command with its required matching parameters will change the settings.

Example:

Command: **video_mode 5**
Response: **OK** (returned)

8.3.3 Get Functions

Any setting can be checked by running a function ***without parameters.*** The output of the **get** function represents a valid command followed by parameters. This string can be parsed by external applications to extract the current settings out of the system.

Example:

Command: **video_mode**
Response: **video_mode 5** (returned)
OK (returned)

8.3.4 List of Commands

#	Command	Parameters	Description
1	help		Gives a full list of supported commands
2	rs485_baud	<baud_rate>	Sets the baud rate of the serial communication
3	rs485_addr	<address>	Sets the unique device serial address
4	rs485_bc_addr	<address>	Sets the serial broadcast address
5	rs485_bc_master	<address>	Sets master device for command acknowledge of broadcast commands
6	save_settings	<id>	Saves the current settings into camera non-volatile memory
7	load_settings	<id>	load saved settings on demand
8	default_settings	<id>	Select the default settings set applied on startup
9	reset_settings		Resets the system into factory default run
10	dump_settings		dumps current settings configured on the device
11	prompt	<flag>	Set prompt mode of the command output

12	reboot		Preforms a system reboot
13	fw_update		Set the system into firmware update mode
14	version		Dumps a detailed version information about the system
15	name	<name string>	Sets the device name
16	flip	<mode>	Sets the image flip or rotation mode
17	temp	<sensor id>	Sets the image flip or rotation mode
18	cam_gain	<gain>	Set the analog gain for the sensor
19	cam_exposure	<time>	Sets the exposure time/shutter width
20	cam_info		Reports the min / max gain and exposure
21	identify		display device connection details
22	video_mode	<mode>	Sets the output video mode
23	downscale	<channel=1> <downscale> <reserved=0>	The **downscale** command is used to output Full HD or 2K resolution from UHD or 4K downscaled source image
24	video_data	<type>	Select the SDI output mode
25	sdi_black	<offset>	Sets the black level for SDI in legal range mode
26	sdi_white	<offset>	Sets the white level for SDI in legal range mode
27	sdi_range	<flag>	Sets the SDI output range type
28	post_bright	<offset>	Sets post processing brightness
29	post_cont	<factor>	Sets post processing contrast
30	post_sat	<factor>	Sets post processing color saturation
31	post_hue	<offset>	Sets post processing color hue offset angle
32	wb		Triggers single shot white-balance
33	wb_threshold	<threshold>	Sets wb maximum calculation threshold
34	awb	<flag>	Enable continuous white balance adjustment
35	wb_preset	<id>	Sets calibrated white balance presets
36	gain_red	<gain>	Sets gain factor for red component for selected output channel
37	gain_blue	<gain>	Sets gain factor for blue component for selected output channel
38	gain_green	<gain>	Sets gain factor for green component for selected output channel
39	black_master	<offset-red> <offset-green> <offset-blue>	Sets the black-level offset for red, green and blue-components for selected output channel
40	black_red	<offset>	Sets offset for red component for selected output channel as black level setting
41	black_blue	<offset>	Sets offset for blue component for selected output channel as black level setting
42	black_green	<offset>	Sets offset for green component for selected output channel as black level setting
43	flare	<red level> <green level> <blue level>	Sets flare compensation level (= Defogging)
44	color_cross	<c0> .. <c8>	Sets the color cross talk matrix
45	color_cross_offset	<red_offset> <green_offset> <blue_offset>	Sets the color cross talk offset
46	color_conv	<c0> .. <c8>	Sets the color conversion matrix
47	color_space	<color space>	Change the color space matrix
48	stat_roi	<width> <height> <offsetX> <offsetY>	Set the ROI where auto compensation calculations are made
49	stat_roi_info	<maxWidth> <maxHeight> <widthStep> <heightStep>	Gets the auto compensation max ROI coordinates
50	cam_roi_offset	<offsetX> <offsetY>	Moves the absolute image ROI position across the sensor. Default position in center

51	cam_roi_offset_info	<offsetXMax> <offsetYMax> <offsetXStep> <offsetYStep>	Gets the maximum camera roi offset
52	dpc	<flag>	Enable deflect pixel correction
53	dpc_add_pixel	<x> <y>	Adds a pixel coordinate to defect pixel table or dumps the whole table
54	dpc_del_pixel		Deletes all pixel coordinates from the defect pixel table
55	dpc_save		Saves defect pixel table to persistent memory
56	dpc_load		Loads defect pixel table from persistent memory
57	knee	<flag> <knee_point> <knee_slope> <white_clip>	Knee function for highlight control
58	lut_enable	<reserved=0> <flag>	Enables the function for look up table
59	lut_mode	<mode>	Selects the LUT operational mode
60	lut_preset	<index>	Selects the preset storage for the current LUT interpolator
61	lut_sample_master	<xi_0><yi_0> ... <xi_7> <yi_7>	Defines the sample points in a lookup table for all colors
62	lut_sample_red	<xi_0><yi_0> ... <xi_7> <yi_7>	Same as lut_sample, but only for the red component
63	lut_sample_green	<xi_0><yi_0> ... <xi_7> <yi_7>	Same as lut_sample, but only for the green component
64	lut_sample_blue	<xi_0><yi_0> ... <xi_7> <yi_7>	Same as lut_sample, but only for the blue component
65	lut_interpolate		Interpolates all look up tables based on the given sample point
66	lut_interpolate_red		Interpolates the red look up table based on the given sample points
67	lut_interpolate_green		Interpolates the green look up table based on the given sample points
68	lut_interpolate_blue		Interpolates the blue look up table based on the given sample points
69	lut_reset_master		Clears all color channels look up sample points
70	lut_reset_red		Clears all red look up sample points
71	lut_reset_green		Clears all green look up sample points
72	lut_reset_blue		Clears all blue look up sample points
73	lut_fun_rec709	<threshold> <linear-contrast> <linear-brightness> <contrast> <gamma> <brightness>	Sets new LUT sample points according to REC.709 for selected LUT preset
74	lut_fast_gamma	<gamma>	The fast gamma function uses the same formula as the lut_fun_rec709 command, but the user only has to specify the desired gamma value
75	lut_fixed_mode	<mode>	The fixed gamma mode contains three presets which are shown in the table below
76	stat_rgb		Dumps the average image value for each color channel (RGB)
77	aec	<enable> <setPoint> <speed> <clmTolerance> <activeGain> <activeExposure> <activeApt> <maxExposure> <maxGain>	Auto Exposure and Gain are used to control the picture brightness by adjusting Exposure and Gain values automatically in order to reach desired luminance level
78	genlock	<mode>	The genlock mechanism is used to synchronize multiple cameras video signals
79	genlock_status		Used to check the current genlock status
80	genlock_lol_filter	<time_ms>	Can be configured to prevent glitches in the unstable genlock signals
81	genlock_offset	<v_offset>	The vertical position offset that is added to the reference sync signal

		<h_offset>	
82	genlock_offset_info	<v_offset_phase> <h_offset_pahse	The vertical position offset that is added to the reference sync signal
83	genlock_term	<enable>	Modifies the genlock input/output 75R termination
84	genlock_crosslock	<vmode>	Set the genlock input Tri-level signal other than current video mode
85	timecode	<hour> <minute> <second>	Sets SDI time code which is embedded into the SDI signal
86	timecode_hold	<flag>	This command can be used to hold the timecode on the SDI output
87	antialiasing	<enable>	Enable anti-aliasing image filter
88	filter_enable	<enable>	Enable unsharpen (de-noising) filter
89	filter_denoise	<level>	Set the unsharpen denoise level
90	filter_detail	<level>	Set the unsharpen detail enhance level
91	mcc	<enable>	Enable multi matrix correction control
92	mcc_opmode	<mode>	Sets the number of color angles/segments for the multi matrix
93	mcc_set	 <saturation> <hue>	Set the multi matrix color parameters
94	mcc_blink	<mask> <period_ms>	Select multi matrix color range blink with a given period time
95	qfactor_mode	<mode>	Select Q-factor calculation mode
96	qfactor	<samples average> <Q factor value> < Q factor value normalized to samples average>	Read Q-Factor calculated value
97	qfactor_roi_info	<maxWidth> <maxHeight> <widthStep> <heightStep>	Read the maximum resolution for the Q-Factor ROI
98	qfactor_roi	<width> <height> <offsetX> <offsetY>	Set the ROI where Q-Factor calculations are made

Table 3 – List of commands

8.4 RS485 Interface

An RS485 Bus allows for multiple Iron SDI systems to be used simultaneously with a single RS485 Master controller; please note that an RS485 to RS232 adapter must be used.

Commands can also be sent to a group of cameras at once as long as they are connected to the same RS485 bus. To accommodate for this, each camera has a personal address and a broadcast address which can be set via the rs485_addr and rs485_bc_addr commands, respectively. The former is used for individual control while the latter is used to communicate commands to a group.

Master and slave communication is commenced in the following command format for both individual and group communication: <address> <command> <parameter>.

8.4.1 rs485_baud <baud_rate>

Sets the baud rate for the RS485 terminal interface. Possible baud rates are:

#	Baud Rate
1	9600
2	14400
3	19200
4	57600
5	115200 (defualt)

Remarks:

1. It is advised to leave the baud rate at 115200 (default) for faster device response.
2. Setting RS485 baud rate will also change the RS232 interface baud rate.

8.4.2 rs485_addr <address>

Sets the address for the RS485 interface. It is impossible to set the device's address to be the same as the broadcast address, an attempt to do so will return "FAIL".

Value	Default	Minimal	Maximal
Device Address	1	0	99

Remarks:

1. Make sure, that each address is unique on your RS485 bus system. Address conflicts can be checked and resolved at any time via RS232 console, or by removing devices from the bus until the contention is solved.
2. Address 100 is reserved as a fail-safe address: all devices will always replay to commands sent over this address, as if it was their current device address. This can be used to identify or change the device address if it has been lost.

8.4.3 rs485_bc_addr <address>

Sets the broadcast address for the RS485 interface. It is impossible to set the broadcasting address to be the same as the device's address, an attempt to do so will return "FAIL".

Value	Default	Minimal	Maximal
Broadcast Address	0	0	99

To change the broadcast address of an already existing broadcast group, simply send an **rs_485_bc_addr** command over the broadcast channel.

Example 1:

```
// change the broadcast address of all connected cameras to 8
rs485_bc_addr 8
```

Example 2:

```
// change the broadcast address of all connected cameras associated
// with existing broadcast group 8 to new broadcast address 9
8 rs485_bc_addr 9
```

8.4.4 rs485_bc_master <address>

This command enables the broadcast master mode on a camera with a given device address. If the command is transmitted as a get command (without an argument) it will reply with a flag (0 or 1) rather than the broadcast master address. The flag indicates whether this camera currently is the broadcast master or not (0 for no and 1 for yes).

Value	Default	Minimal	Maximal
Device Address of the Broadcast Master	Broadcast Master Disabled	0	99

Remarks:

1. Sending an address value of "-1" will disable the broadcast master mode.

Example 1:

```
// Disable broadcast master mode on all cameras in the group with the "0" broadcast address.
0 rs485_bc_master -1
```

Example 2:

```
// Sends a command to all cameras in the group (with the "0" broadcast address) and sets the camera with a "1"
// device address as the broadcast master, whilst disabling "broadcast master" on all other cameras.
0 rs485_bc_master 1
```

8.5 Settings Handling

8.5.1 save_settings <id>

Saves the current settings into the selected configuration in the camera non-volatile memory. There are 8 optional sets of settings which can be saved, with an id range of 0-7.

Remarks:
1. A **save_setteings** command with no parameters will save the first configuration and set it as the default.

Example:

save_settings 2

8.5.2 load_settings <id>

The **load_settings** command can be used to load saved settings on demand, which will overwrite the current camera settings. There are 8 optional sets of settings available, with an id range of 0-7. Only previously stored settings configuration will be applied and return an OK, while other commands will return a FAIL.

Remarks:
1. **load_settings** command with no parameters will load the first configuration.

Example:

load_settings 2

8.5.3 default_settings <id>

The **load_settings** command selects the default settings configuration which will be automatically loaded on camera startup. There are 8 optional sets of settings available, with an id range of 0-7. Reading value of "-1" will indicate that the factory settings are currently applied. **reset_settings** should be used to set factory as default settings.

Example:

defualt_settings 2

8.5.4 reset_settings

Resets the system into factory default run.

8.5.5 dump_settings

The **dump_settings** command dumps current settings configured on the device.

Remarks:

1. Some commands have no settings that can be dumped and thus do not show up when **dump_settings** is used.

8.6 System Commands

8.6.1 prompt <flag>

Set prompt mode of the command output.

Flag	Function
0	No prompt
1 (reset)	'=>' prompt

8.6.2 reboot

Preforms a system reboot (warm start). A full reboot may take several seconds.

8.6.3 fw_update

Set the system into firmware update mode. The firmware update file should be uploaded using XMODEM protocol via standard serial port interface. Please see Appendix 1: Firmware Update for a detailed explanation.

Remarks:
1. Only official firmware update file, provided by KAYA Instruments should be used to update camera. Other binary files may, or may not harm the camera and make it un-usable.

8.6.4 version

Dumps a detailed version information about the system with system ID and firmware version.

Examples:

Command: **version**
Response: **platform: IronSDI**
device name: Empty
system-id: 003F001E-30324703-37313437-FFFFFFFF
hw revision: 00000101
system validity: LICENSED
feature mask HW: 0000003F
feature mask SW: 00000000
resolution mask: 00000000-001FFFFF-000FFCFF
loader version: 1 (0)
sw-release-id: V3.0
sw-release-date: 2021-01-01
sw-build-date: 2021-01-01
OK

8.6.5 name <name string>

The device name, which is shown in the output of the **version** command can be changed using **name** command. The chosen name must consist of maximum 32 characters with no spaces. The **save_settings** command must be used after a name change for it to take permanent effect.

Example:

name New_device_name_1

8.6.6 flip <mode>

Sets the image flip or rotation mode.

Mode	Function
0 (reset)	Normal (no flip)
1	Vertical flip
2	Horizontal flip
3	Rotated by 180°

8.6.7 temp <sensor id>

Dumps camera temperature values in degree centigrade. The output has the format **temp <id> <value> <name>**

Temperature Sensor ID	Function
0	Processor temperature (with 0.1°C accuracy)
1	Sensor temperature (with 0.1°C accuracy)

Example 1:

Command: **temp 0**
Response: **temp 0 43.3 Processor**
OK

Example 2:

Command: **temp 1**
Response: **temp 1 45.2 Sensor**
OK

8.7 Camera Commands

8.7.1 cam_gain <gain>

Set the analog gain for the sensor. Gain can be read at any time, including when the auto exposure control is enabled.

Value	Reset	Minimal	Maximal
gain	1000	1000 (1x 0dB)	252000 (252x 48dB)

Example:

```
// Example to set gain of 3x => input value should be 3000 = round (3 * 1000)
cam_gain 3000
```

8.7.2 cam_exposure <time>

Sets the exposure time/shutter width, in microseconds [µsec], in which sensor is exposed to light.

Remarks:

1. The exposure time might be adjusted, if video mode is changed using **video_mode** command and the value exceeds the maximum allowed value for the new video mode.
2. Exposure can be read at any time, also when the auto exposure control is enabled.

Example:

```
//Example to set exposure of 10000usec
cam_exposure 10000
```

8.7.3 cam_info

Reports the min / max gain and exposure in the following order: minimum gain, maximum gain, minimum exposure, maximum exposure, gain normalized multiplication factor (1000 = 1x)

Return:

```
cam_info <analog_gain_min> <analog_gain_max> <exposure min> <exposure_max> <iso_min>
```

Example:

```
Command: cam_info
Response:  cam_info 1000 252000 75 33333 1000
           OK
```

8.7.4 identify

Provides essential system information including the platform, RS485 configuration and the device name. This command can be used to identify all devices which are connected to one RS485 bus by sending it to device address 100 (the fail-safe device address).

Each device will wait in turn before sending its ID string. The higher value the RS485 address of the device, the longer the device will wait before sending its stats: this ensures that the bus does not get corrupted.

Each device will report the following parameters:

- RS485 ID, RS485 Broadcast Address and RS485 Broadcast Master.
- Device Name: name which can be set by the user.

Example:

Command: **name New_device_name_1** // Set camera name (optional)
100 identify // Identify
Response: **id: IronSDI 1 0 0 New_device_name_1**
OK

8.8 Video Commands

8.8.1 video_mode <mode>

Sets the output video mode.

Mode ID	Resolution	Frame Rate
4	1920x1080p (FHD)	30
5	1920x1080p (FHD)	25
6	1920x1080p (FHD)	24
7	1920x1080p (FHD)	23.98
8	1920x1080p (FHD)	29.97
9	1920x1080p (FHD)	50
10	1920x1080p (FHD)	60
11	1920x1080i (FHD)	60
12	1920x1080i (FHD)	50
13	1920x1080i (FHD)	59.94
14	1920x1080p (FHD)	59.94
15	2048x1080p (2K)	30
16	2048x1080p (2K)	25
17	2048x1080p (2K)	24
18	2048x1080p (2K)	23.98
19	2048x1080p (2K)	29.97
20	2048x1080p (2K)	50
21	2048x1080p (2K)	60
22	2048x1080p (2K)	59.94
23	2048x1080p (2K)	48
24	2048x1080p (2K)	47.96
25	3840x2160p (UHD)	30
26	3840x2160p (UHD)	25
27	3840x2160p (UHD)	24
28	3840x2160p (UHD)	23.98
29	3840x2160p (UHD)	29.97
30	3840x2160p (UHD)	50
31	3840x2160p (UHD)	60
32	3840x2160p (UHD)	59.94
33	3840x2160p (UHD)	48
34	3840x2160p (UHD)	47.96
35	4096x2160p (4K)	30
36	4096x2160p (4K)	25
37	4096x2160p (4K)	24
38	4096x2160p (4K)	23.98
39	4096x2160p (4K)	29.97
40	4096x2160p (4K)	50
41	4096x2160p (4K)	60
42	4096x2160p (4K)	59.94
43	4096x2160p (4K)	48
44	4096x2160p (4K)	47.96

8.8.2 downscale <channel=1> <downscale> <reserved=0>

The **downscale** command is used to output Full HD or 2K resolution from UHD or 4K downscaled source image. The downscale is only applied if the current video mode allows it and the camera support 4K resolutions.

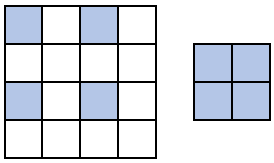


Figure 3 – Downscale example

The following table lists video modes which support the downscale.

Mode ID	Mode
4	1920x1080p 30
5	1920x1080p 25
6	1920x1080p 24
7	1920x1080p 23.98
8	1920x1080p 29.97
9	1920x1080p 50
10	1920x1080p 60
11	1920x1080i 60
12	1920x1080i 50
13	1920x1080i 59.94
14	1920x1080p 59.94
15	2048x1080p 30
16	2048x1080p 25
17	2048x1080p 24
18	2048x1080p 23.98
19	2048x1080p 29.97
20	2048x1080p 50
21	2048x1080p 60
22	2048x1080p 59.94
23	2048x1080p 48
24	2048x1080p 47.96

Remarks:

1. <channel> input parameter should always be 1
2. <reserved> input parameter should always be 0
3. The downscale is only applied if the current video mode allows it and the camera support 4K resolutions.

Example:

```
downscale 1 1 0
```

8.8.3 video_data <type>

Select the SDI output mode.
Changing this value to 1 disables image processing and compensation algorithms to output RAW data as captured from the sensor. RAW data are transferred via the Y (luma) channel, Cb and Cr channels are constant.

Enable	Function
0	Standard video
1	RAW 10bit sensor data

8.8.4 sdi_black <offset>

Sets the black level for SDI in legal range mode (see sdi_range).
An offset value of 0 will result in SDI black value of 64 (SMTP conform). When changing this value, the black level on the SDI interface can be set different than 64 (not SMTP conform). This value changes the SDI range limiter and will stretch output values to adapt to the new range.

Value	Reset	Minimal	Maximal
Offset	0	-60	+60

8.8.5 sdi_white <offset>

Sets the white level for SDI in legal range mode (see sdi_range). An offset value of 0 will result in an SDI white value of 940 (SMTP conform). When changing this value, the white level on the SDI interface can be set different than 40 (not SMTP conform). This value changes the SDI range limiter and will stretch output values to adapt to the new range.

Value	Reset	Minimal	Maximal
offset	0	-80	+79

8.8.6 sdi_range <flag>

Sets the SDI output range type.

Flag	Mode	Digital Code Range	Note
0	Legal	Y ranges from 64 + sdi_black offset Y ranges from 940 + sdi_white offset U/V range from 64 to 960	Used for broadcast and monitors with defined black and white levels.
1	Extended	Y/U/V range from 4 to 1019	Used for recoding with maximum dynamic.

Example:

```
// Enable the extended pixel range which depends on sdi_black and sdi_white values.
sdi_range 0
```

8.8.7 post_bright <offset>

Sets post processing brightness.

Y_out = Y + offset

Neutral value is 0.

Value	Reset	Minimal	Maximal
offset	0	-128	+127

8.8.8 post_cont <factor>

Sets post processing contrast.

Y_out = Y * factor / 128

Neutral value is 128.

Value	Reset	Minimal	Maximal
factor	128	0	255

Example:

```
// Set a contrast value of 1.23 => input value should be 157 = round (1.23 * 128.0)
post_cont 157
```

8.8.9 post_sat <factor>

Sets post processing color saturation.

Cb,r_out = Cb,r * factor / 128

Neutral value is 128.

Value	Reset	Minimal	Maximal
factor	128	0	255

Example:

```
// Set a saturation value of 1.23 => input value should be 157 = round (1.23 * 128.0)
post_sat 157
```

8.8.10 post_hue <offset>

Sets post processing color hue offset angle.

Cb' = Cb * cos (offset * 90 / 128) + Cr * sin (offset * 90 / 128)
Cr' = -Cb * sin (offset * 90 / 128) + Cr * cos (offset * 90 / 128)

Neutral value is 0.

Value	Reset	Minimal	Maximal
value	0	-128 (-90 degree)	127 (+89 degree)

Example:

```
// Set a hue value of 12.3 => input value should be 17 = round (12.3 * 128.0 / 90.0)
post_hue 17
```

8.8.11 wb

Triggers single shot white-balance.

Example:

```
wb
```

8.8.12 wb_threshold <threshold>

Limits the maximum threshold value when the white balance compensation algorithm counts. Assists with ignoring over saturated pixels in calculations.

Value	Reset	Minimal	Maximal
value	4000	0	4095

8.8.13 awb <flag>

Enable continuous white balance adjustment. Compensate sensor output colors to true colors. The algorithm works on the assumption that average color of image in selected ROI is gray.

Enable	Function
0	disable
1	enable

8.8.14 wb_preset <id>

Sets calibrated white balance presets (gains and color-cross matrices). List of calibrated presets are described in the following table:

ID	Illumination	Color temperature
0	disable preset	
1	horizon	2200K
2	candle light (A)	2700K
3	fluorescent (CWF)	4000K
4	daylight sunny (D50)	5000K
5	daylight (D65)	6500K
6	daylight cloudy (D75)	7500K

8.8.15 gain_red <gain>

Sets gain factor for red component for selected output channel. This function is for basic color correction or white balance.

red_out = red * gain / 256

Value	Reset	Minimal	Maximal
gain	256	0	2047

Example:

```
// Set a red gain value of 1.23 => input value should be 315 = round (1.23 * 256.0)
gain_red 315
```

8.8.16 gain_blue <gain>

Same as gain_red but for blue color channel.

8.8.17 gain_green <gain>

Same as gain_red but for green color channel.

8.8.18 black_master <offset-red> <offset-green> <offset-blue>

Sets the black-level offset for red, green and blue-components for selected output channel. The processing is done in linear RGB domain (pre gamma).

red_out = (red_in – offset-red) *4095 / (4095 – offset-red)

Value	Reset	Minimal	Maximal
offset	0	-2047	2048

Example 1:

```
// Set black-level for all components to 100
black_master 100
```

Example 2:

```
// Set black-level for red to 10, for green to 20 and blue to 30
black_master 10 20 30
```

8.8.19 black_red <offset>

Sets offset for red component for selected output channel as black level setting. The processing is done after de-bayering. The offset is defined as singed value. A value of zero is treated as neutral.

red_out = red + offset

Value	Reset	Minimal	Maximal
offset	0	-4096	4095

8.8.20 black_blue <offset>

Same as black_red but for blue color channel.

8.8.21 black_green <offset>

Same as black_red but for green color channel.

8.8.22 flare <red level> <green level> <blue level>

Sets flare compensation level (= Defogging). The processing is done in the linear BAYER domain (pre de-bayering). The level is defined as unsigned value. A value of zero is treated as neutral (disable flare).

$$\mathrm{red}_{\mathrm{out}} = \frac{4095 * (\mathrm{red}_{\mathrm{in}} - \mathrm{level} * -\mathrm{red})}{4095 - \mathrm{level} * -\mathrm{red}}$$

Value	Reset	Minimal	Maximal
offset	0	0	65535

Example 1:

// Set flare value of 0.1 (10%) => input value should be 6554 = round (0.1 * 65536.0)
flare 6554 6554 6554

Example 2:

Set same flare level for all components:
flare 6554

8.8.23 color_cross <c0> .. <c8>

Sets the color cross talk matrix, which can be used for correction of cross talk effects and color space shifts. The cross talk compensation unit performs a regular RGB to R'G'B' color space conversion, to compensate the cross talk between color components of the image. The matrix coefficients provide the ability to correct each pixel value with the following matrix operation:

R' = (R*c0 + G*c1 + B*c2) / 4096
G' = (R*c3 + G*c4 + B*c5) / 4096
B' = (R*c6 + G*c7 + B*c8) / 4096

Value	Reset	Minimal	Maximal
color_cross_c0	4096	-32768	32767
color_cross_c1	0	-32768	32767
color_cross_c2	0	-32768	32767
color_cross_c3	0	-32768	32767
color_cross_c4	4096	-32768	32767
color_cross_c5	0	-32768	32767
color_cross_c6	0	-32768	32767
color_cross_c7	0	-32768	32767
color_cross_c8	4096	-32768	32767

Example:

// Set a color_cross_c2 value of 1.23 => input value should be 5038 = round (1.23 * 4096)
color_cross 4096 0 5038 0 4096 0 0 0 4096

8.8.24 color_cross_offset <red_offset> <green_offset> <blue_offset>

Sets the color cross talk offset. In addition to the matrix multiplication (see **color_cross**) an offset can be added to the pixel values for R, G and B separately. This offset is applied after the matrix multiplication. A value of zero is treated as no offset.

Value	Reset	Minimal	Maximal
red_offset	0	-2048	2047
green_offset	0	-2048	2047
blue_offset	0	-2048	2047

8.8.25 color_conv <c0> .. <c8>

Sets the color conversion matrix. The following formula is used for the conversion:

Y = (c0*R + c1*G + c2*B) / 4096 + 64
Cb = (c3*R + c4*G + c5*B) / 4096 + 512
Cr = (c6*R + c7*G + c8*B) / 4096 + 512

Value	Reset	Minimal	Maximal
color_conv_c0	871	-8192	8191
color_conv_c1	2929	-8192	8191
color_conv_c2	296	-8192	8191
color_conv_c3	-469	-8192	8191
color_conv_c4	-1579	-8192	8191
color_conv_c5	2048	-8192	8191
color_conv_c6	2048	-8192	8191
color_conv_c7	-1860	-8192	8191
color_conv_c8	-188	-8192	8191

Example:

```
// Set a color_cross_c2 value of 1.23 => input value should be 5038 = round (1.23 * 4096)
color_conv 871 2929 5038 -469 -1579 2048 2048 -1860 -188
```

8.8.26 color_space <color space>

Change the color space matrix by updating the **color_conv** matrix coefficients according to standard RGB to YCbCr conversion method.

Value	Color Space	Usually used for
0 (reset)	Rec.709	HD / SDR
1	Rec.2020	UHD / HDR

8.8.27 stat_roi <width><height><offsetX><offsetY>

Defines the ROI for auto compensation algorithms such as auto exposure, auto gain and white balance. "ROI definition" refers to Region of Interest which will be used for brightness calculations. The ROI OffsetX and OffsetY refer to the distance of the ROI from top left corner of the output image area:

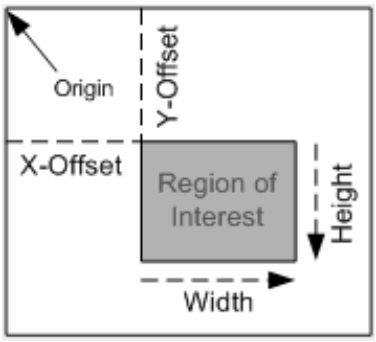


Figure 4 – ROI position in relation to the origin

By default, ROI defined to be the maximum possible area: i.e. the horizontal and vertical offsets are 0 and the ROI width and height as the output image size.

8.8.28 stat_roi_info

Reports the maximum allowed values for stat_roi command parameters. The values depend on the selected video mode.

Return:
stat_roi_info <maxWidth><maxHeight><widthStep><heightStep>

Example:

Command: stat_roi_info
Response: stat_roi_info 2048 1080 4 4
OK

8.8.29 cam_roi_offset <offsetX><offsetY>

While the image resolution is defined by the selected video mode (see the video_mode command), the cam_roi_offset provides an option to move absolute image ROI position across the sensor. The ROI offset is in the center of the sensor by default but can be modified in case a digital ROI compensation is required as an alternative to physical camera shift.

The maximal allowed compensation varies according to the maximal sensor size and selected video mode: these values can be acquired using cam_roi_offset_info command.

8.8.30 cam_roi_offset_info

Reports the maximum allowed values for cam_roi_offset parameters.

Return:
cam_roi_offset_info <offsetXMax><offsetYMax><offsetXStep><offsetYStep>

Example:

Command: cam_roi_offset_info
Response: cam_roi_offset_info 2048 1080 4 4
OK

8.9 Defect Pixel Correction

The defected pixel correction will correct up to 32 pixels in the sensor and up to 2 adjacent pixels in a row. The pixel correction coordinates represent pixels of sensor's visible ROI, therefore identifying the correct X and Y coordinate should be done using default, full resolution image. The algorithm will correct the defect pixel based on the value of existing adjacent pixels. The correction for Mono and Color sensor is slightly different and described as follows:

The defect pixel $P(x, y)$ value will be the average value of two pixels from both sides of pixel $P(x, y)$ in the same row, corresponding to the same Bayer color element.

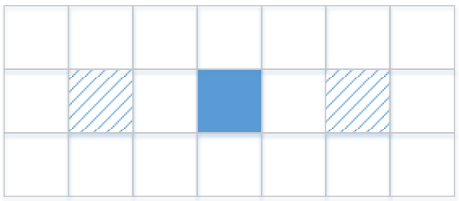


Figure 5 – Defect pixel correction position

8.9.1 dpc <flag>

Enable deflect pixel correction.

Flag	Function
0	No correction
1 (reset)	Correction enabled

8.9.2 dpc_add_pixel <x> <y>

Adds a pixel coordinate to defect pixel table or dumps the whole table. Valid values for the x and y coordinates.

Value	Minimal	Maximal
X coordinate	0	<max_width> - 1
Y coordinate	0	<max_height> - 1

Example 1:

```
// Add pixel coordinate (123, 456) into defect pixel table
dpc_add_pixel 123 456
```

Example 2:

```
// Dump dead pixel table
Command: dpc_add_pixel
Response:  dpc_add_pixel 100 100
           dpc_add_pixel 200 200
           OK
```

8.9.3 dpc_del_pixel

Deletes all pixel coordinates from the defect pixel table.

8.9.4 dpc_save

Saves defect pixel table to persistent memory.

8.9.5 dpc_load

Loads defect pixel table from persistent memory.

8.10 Knee Function

8.10.1 knee <flag> <knee_point> <knee_slope> <white_clip>

Knee function for highlight control. 3 parameters can be set for the knee function:

Value	Reset	Minimal	Maximal
flag (enable)	0 (off)	0	1
knee_point [%]	85	1	100
knee_slope	140	100	1600
white_clip [%]	109	100	109

Example:

```
// Enable knee at 85% with a slope of 1.4 and white clip at 109%
knee 1 85 140 109
```

8.11 Loop-up Table Management

The LUT Control can be used to re-map the image linear output in different manner. Mostly to compensate for the non-linear scene emission. Each index at the LUT corresponds to the original pixel value, and the LUT value at this index corresponds to the new value that the pixels should be replaced with.

Pixel value is replaced according to the following equation:

$$\overline{P_{red}(x,y)} = LUT_{red}[P_{red}(x,y)]$$
$$\overline{P_{green}(x,y)} = LUT_{green}[P_{green}(x,y)]$$
$$\overline{P_{blue}(x,y)} = LUT_{blue}[P_{blue}(x,y)]$$

Where P(x,y) is the pixel at offset X in horizontal and Y in vertical, of specific color.

Lookup table can be set in one of the following methods:

1. LUTs can be programmed using up to 48 sample points. All intermediate values are calculated with a spline interpolator (see **lut_sample_<channel>** commands).
2. LUTs can be programmed by specifying a set of parameters which will be used to calculate and apply a gamma curve according to REC.709 standard (see **lut_fun_rec709** command).
3. LUTs can be fast configured by specifying only the desired gamma value of the REC.709 gamma function (see **lut_fast_gamma** command).
4. LUTs can be configured with a fixed configuration of three presets which include the default REC.709 gamma curve and two HDR gamma curves: PQ and HLG (see **lut_fixed_mode** command).

8.11.1 lut_enable <reserved=0> <flag>

Enables the function for look up table.

Flag	Function
0	Disable (linear) 1 (
1 (reset)	Enable

Remarks:

1. <reserved> input parameter should always be 0

Example:

```
// Apply LUT table configuration.
lut_enable 0 1
```

8.11.2 lut_mode <mode>

Selects the LUT operational mode which are described in the following table:

Mode	Description
0	Table based using interpolation. The user has to specify a table with a maximum of 48 values. Intended for offline calibration.
1	Fast gamma mode where the user only specifies the desired gamma value. Can be used for gamma changes during runtime.
2	Fixed gamma mode where the user selects one of three fixed gamma tables.

8.11.3 lut_preset <index>

Selects the preset storage for the current LUT interpolator. There are up to 5 presets which can be modified.

Index	Factory preset
0	Linear
1	Linear
2	Linear
3	Linear
4	Linear

Example:

```
// Select lut preset 1
lut_preset 1
```

8.11.4 lut_sample_master <xi_0> <yi_0> ... <xi_7> <yi_7>

Defines the sample points in a lookup table for all colors. The x-value is the input value, the y-value is output.

Value	Minimal	Maximal
xi_n	0	4095
Yi_n	0	4095

Sets up to 8 sample points at a time, up to a total of 48 for the look up definition for all colors. For setting more than 8 points, the function can be called multiple times. In case a x-position is set twice, the previous value is overwritten.

Remarks:

1. When more than 48 points are defined, an error message is dumped.
2. lut_sample_<color> command should be used to read back the current sample point. lut_sample_master will not return sample data.

Example:

```
// Add LUT sample points to preset 1 and start curve interpolation.
// Set following points: (0, 200), (4095, 800), (300, 500), (700, 600). This will result in new image range
// from 200 (index 0 and up) to 800 (index 4095 and down)

lut_enable 0 0                          // disable lut
lut_mode 0                              // select lut mode 0 (Table based using interpolation)
lut_preset 1                            // select preset 1 to modify
lut_reset                               // reset preset 1
lut_sample_master 0  200 4095 800       // up to 8 pairs of point
lut_sample_master 300 500 700 600       // up to 8 pairs of point
lut_interpolate                         // interpolate lut table, fill in values between the specified samples
lut_enable 0 1                          // enable lut
```

8.11.5 lut_sample_red <xi_0> <yi_0> ... <xi_7> <yi_7>

Same as lut_sample_master, but only for red component.

8.11.6 lut_sample_green <xi_0> <yi_0> ... <xi_7> <yi_7>

Same as lut_sample_master, but only for green component.

8.11.7 lut_sample_blue <xi_0> <yi_0> ... <xi_7> <yi_7>

Same as lut_sample_master, but only for red component.

8.11.8 lut_interpolate

Interpolates all look up tables based on the given sample points - fill in lut values in between the specified samples according to a spline interpolator.

8.11.9 lut_interpolate_red

Interpolates the red look up table based on the given sample points.

8.11.10 lut_interpolate_green

Interpolates the red look up table based on the given sample points.

8.11.11 lut_interpolate_blue

Interpolates the red look up table based on the given sample points.

8.11.12 lut_reset_master

Clears all color channels look up sample points.

8.11.13 lut_reset_red

Clears all red look up sample points.

8.11.14 lut_reset_green

Clears all green look up sample points.

8.11.15 lut_reset_blue

Clears all blue look up sample points.

8.11.16 lut_fun_rec709 <threshold> <linear-contrast> <linear-brightness> <contrast> <gamma> <brightness>

Sets new LUT sample points according to REC.709 for selected LUT preset. Sets the gamma curve for all color channels.

Value	Minimal	Maximal	REC.709
Threshold	0	1000	18
Contrast (linear)	0	20000	4500
Brightness (linear)	-1000	1000	0
Contrast (non-linear)	0	10000	1099
Gamma (non-linear)	1100	3000	2222
Brightness (nonlinear)	-1000	1000	-99

The following image shows the normalized REC.709 gamma curve and it's transition from linear to non-linear (power function) part. The linear part ranges from 0 to <0.018 and is computed by the following formula:

$$V_{out} = 4.5 * V_{in}$$

The maximum value in this range is:

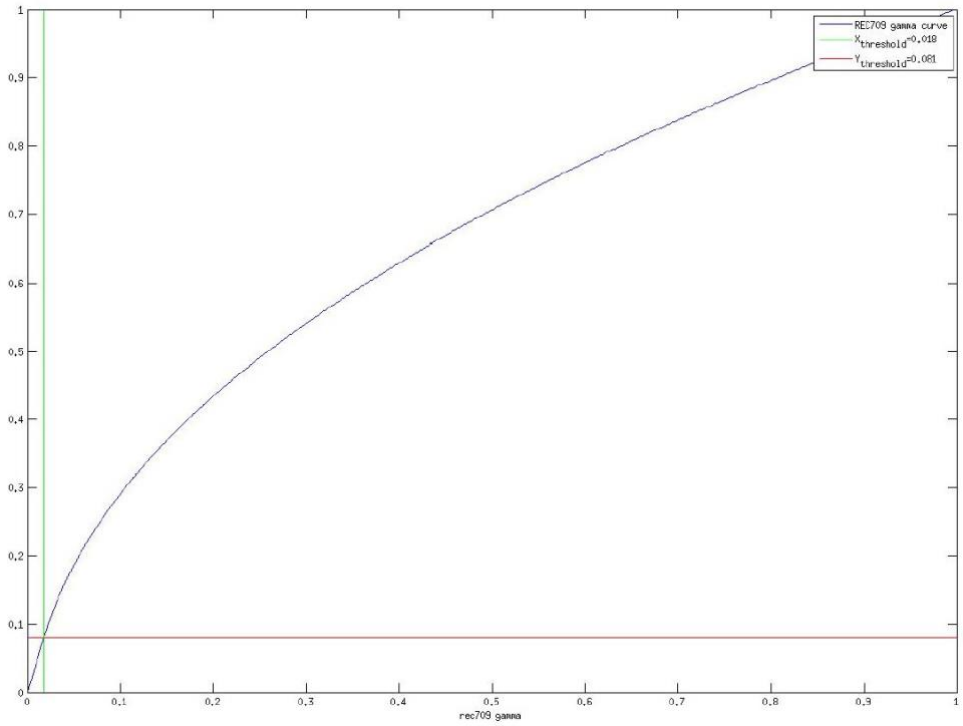
$$V_{out,min} = \lim_{V_{in} \to 0.018} (4.5 * V_{in}) = 4.5 * 0.018 = 0.081$$

The non-linear part ranges from 0.018 to 1 and is computed by the following formula:

$$V_{out} = 1.099 * V_{in}^{(1/2.222)} - 0.099$$

The minimum value in this range is:

$$V_{out,min} = 1.099 * 0.018^{(1/2.222)} - 0.099 = 0.081$$



To avoid a discontinuity in the gamma-function select the brightness (offset) for the non-linear part by the following formula:

$$V_{\text{out,linear max}} \approx V_{\text{out,linear min}}$$

$$\text{brightness}_{\text{non-linear}} \approx (\text{Contrast}_{\text{linear}} * \text{threshold} + \text{Brightness}_{\text{linear}}) - \text{Contrast}_{\text{non-linear}} * \text{threshold}^{\text{Gamma}}$$

Remarks:

1. The values are normalized to a range from 0.0 to 1.0 and multiplied by a scaling coefficient of 1000.

Example:

```
// Compute LUT sample points according to REC.709 and store in preset 1, then start curve interpolation

// <threshold>          18 => 0.018 * 1000
// <linear-contrast>    4500 => 4.5 * 1000
// <linear-brightness>  0 => 0 * 1000
// <contrast>           1099 => 1.099 * 1000
// <gamma>              2222 => 2.222 * 1000
// <brightness>         -99 => -0.099 * 1000

lut_enable 0 0                  // disable lut
lut_mode 0                      // select lut mode 0 (Table based using interpolation)
lut_preset 1                    // select preset 1 to modify
lut_fun_rec709 18 4500 0 1099 2222 -99
lut_interpolate                 // interpolate lut table – fill in values between specified samples
lut_enable 0 1                  // enable lut
```

8.11.17 lut_fast_gamma <gamma>

The fast gamma function uses the same formula as the lut_fun_rec709 command, but the user only has to specify the desired gamma value. All other values are fixed or computed as needed.

Value	Minimal	Maximal	REC.709
Gamma	1100	3000	2222

Remarks:

1. The value is normalized to a range from 0.0 to 1.0 and multiplied by a scaling coefficient of 1000.
2. Setting a value of 2222 will result in the default REC.709 gamma curve.

Example:

```
lut_mode 1              // select lut mode 1 (Fast gamma mode)
lut_enable 0 1          // make sure lut is enabled
lut_fast_gamma 2222
```

8.11.18 lut_fixed_mode <mode>

The fixed gamma mode contains three presets which are shown in the table below:

Mode	Description
0 (default)	REC.709 gamma curve
1	PQ gamma curve specified in ITU-R BT.2100 which can be used for HDR content
2	HLG gamma curve specified in ITU-R BT.2100 which can be used for HDR content

Examples:

```
lut_mode 2              // select lut mode 2 (Fixed gamma mode)
lut_enable 0 1          // make sure lut is enabled
lut_fixed_mode 0        // select fixed lut mode 0 (REC.709 gamma curve)
```

8.12 Image statistic commands

8.12.1 stat_rgb

Dumps the average image value for each color channel (RGB). Ranges from 0 to 4095.

Examples:

Command: **stat_rgb**
Response: **stat_rgb 1040 896 1200**

8.13 Auto Exposure

8.13.1 aec <enable> <setPoint> <speed> <clmTolerance> <activeGain> <activeExposure> <activeApt> <maxExposure> <maxGain> <reserved>

Auto Exposure and Gain are used to control the picture brightness by adjusting Exposure and Gain values automatically in order to reach desired luminance level. The algorithm calculates the average picture intensiveness inside the defined ROI and tries to adjust it to desired luminance level, by changing the exposure time and/or analog gain level.

The target luminance is set by the setPoint, this will determine how bright the image looks. A higher setPoint results in a brighter exposed image.

The speed determines how fast the exposure control reacts to luminescence changes. A higher value means a fast reaction to changes.

The clmTolerance sets the effective ratio of average luminescence level as complement to peak luminescence level, whilst the activeGain enables the auto gain algorithm and the activeExposure enables the auto exposure algorithm.

The maxGain parameter can be used to change the maximum sensor gain used by the algorithm. Notice the high maxGain may result in grainy saturate image.

Parameter	Description	Minimal	Maximal	Default	Remarks
enable	Auto brightness compensation	0	1	0	0: Disable 1: Enable
setPoint	Target luminance	0	4095	2048	
speed	Control speed	0	1000	250	0: No filter is applied on luminance update 1000: Maximum low pass fillter is applied on luminance update
clmTolerance	Impact of avarege and peak value on setPoint calculation	0	1000	600	0: Compare SetPoint only with peak value 1000: Compare SetPoint only with average value Other: Compare SetPoint with combination of peak and average values
activeGain	Active auto analog gain	0	1	1	
activeExposure	Active auto exposure	0	1	1	
activeApt	Active auto aperture				For future use
maxExposure	Maximum sensor exposure which is used by the auto exposure control [µs]				*See **can_info** command for valid value range
maxGain	Maximum sensor gain which is used by the auto exposure control	1000	252000	252000	Default: x100 *See **can_info** command for valid value range
reserved					For future use

Example 1:

// Disable aec completely
aec 0

Example 2:

// Enable aec with luminance 1234. Remain other parameters with same value
aec 1 1234

Example 3:

// Enable aec with luminance 1234. Set speed at 25% => input value be 250 = round (0.25 * 1000). Set calculation tolerance at 90% => input value should be 900 = round (0.9 * 1000). All other parameters remain with the same value
aec 1 1234 8

Example 4:

// Activate auto exposure AND auto gain. Limit gain to 12.3x => input value should be 12300 = round (12.3 * 1000). Limit exposure to 20000 µs (microseconst)
aec 1 1234 250 600 1 1 0 20000 12300 0

8.14 Genlock

8.14.1 genlock <mode>

The genlock mechanism is used to synchronize multiple cameras video signals.

Mode	Description
0 (default)	Disabled – the genlock is off and the camera will work in free-run mode
1	Input Slave Auto – automatic genlock signal synchronization. When the genlock input cable is connected the camera, it will try to lock on the external tri-level sync signal, otherwise the camera will run in free-run mode. On lol (loss-of-lock) event the camera will return to free-run mode after specified timeout (see genlock_lol_filter command). Image may flicker or even disappear while camera tries to lock on external tri-level sync signal. The configured video mode (see video_mode command) must match the input sync signal for successful genlock operation.
2	Input Slave Force – genlock is always active and try to sync on external tri-level sync signal. Camera will not output any image unless genlock is synchronized. The configured video mode (see video_mode command) must match the input sync signal for successful genlock operation.

8.14.2 genlock_status

This command is used to check the current genlock status.

Status	Description
0	Genlock is disabled or genlock is enabled and successfully synchronized on external tri-level sync signal.
1	Genlock is enabled and failed to synchronize on external tri-level sync signal. This status indicates that either there is no input signal, the reference input signal doesn't match the configured video mode or the signal is unstable.

Example:

Command: **genlock_status**
Response: **genlock_status 0**

8.14.3 genlock_lol_filter <time_ms>

The loss-of-link (lol) timeout can be configured to prevent glitches in the unstable genlock signal. A loss-of-link is only registered when an unstable link is detected for more than a specified lol timeout, in which case the connection will be reset and an attempt will be made to synchronize the signal again. If a camera re-synchronizes often, it is advised to increase the lol timeout.

Value	Reset	Minimal	Maximal
time_ms	1000	0	10000

8.14.4 genlock_offset <v_offset> <h_offset>

The vertical and horizontal position offset that is added to the reference sync signal and can be adjusted.

Value	Minimal	Maximal
v_offset	- v_offset_phase [1]	v_offset_phase [1]
h_offset	- h_offset_phase [1]	h_offset_phase [1]

Remarks:

1. Minimal and maximal values are symmetric and can be extracted using the genlock_offset_info command.

8.14.5 genlock_offset_info <v_offset_phase><h_offset_phase>

The phase of vertical and horizontal position offset that can be added to the reference sync signal.
Maximum value is +offset_phase an minimum value is - offset_phase for each of the settings.

8.14.6 genlock_term <enable>

Modifies the genlock input/output 75R termination.

Mode	Description
0	Termination off
1	Termination on

8.14.7 genlock_crosslock <vmode>

When camera genlock crosslock is disabled, the tri-level sync signal should match the current video mode.
The genlock could lock on other input signal which can be set using the crosslock configuration.
In general genlock can work with an input signal that is half, same or double of the video format rate, and also interlaced and progressive signals are interchangeable.

VMode	Genlock Tri-level sync input signal
0	Disabled (same as video mode)
4	1080p30
5	1080p25
6	1080p24
7	1080p23.98
8	1080p29.97
9	1080p50
10	1080p60
11	1080i60
12	1080i50
13	1080i59.94
14	1080p59.94

8.15 SDI Time Code

8.15.1 timecode <hour> <minute> <second>

Sets SDI time code which is embedded into the SDI output. The time code can be set manually.

Example 1:

Command: **timecode** // get current system time
Response: **timecode 0 57 24**
OK

Example 2:

Command: **timecode 1 1 1** // set sdi time code to 1h 1m 1s
Response: **OK** // system acknowledgement

8.15.2 timecode_hold <flag>

This command can be used to hold the timecode on the SDI output and can be used to trigger recording in an external recorder.

Flag	Timecode Hold
0	Normal operation, SDI timecode is running
1	On hold, SDI timecode is unchanged until hold is released

Remarks:

1. The timecode will continue to run in the background: as soon as hold is released the SDI timecode will jump to the current time value.

8.16 Image Filter

8.16.1 antialiasing <enable>

Enable anti-aliasing image filter. This helps to blur the image and smooth noise of any adjacent pixels.

Enable	Function
0	disable
1	enable

Example:

Command: **antialiasing 1** // enables anti-aliasing filter
Response: **OK** // system acknowledgement

8.16.2 filter_enable <enable>

Enable unsharpen (de-noising) filter. This filter helps to emphasize object edges and reduce noise caused by object surrounding.

Enable	Function
0	disable
1	enable

Example:

Command: **filter_enable 1** // enable unsharpen filter
Response: **OK** // system acknowledgement

8.16.3 filter_denoise <level>

Set the unsharpen denoise level.

Value	Reset	Minimal	Maximal
level	0	0	65

Example:

Command: **filter_denoise 14** // set unsharpen denoise filter to 14
Response: **OK** // system acknowledgement

8.16.4 filter_detail <level>

Set the unsharpen detail enhance level.

Value	Reset	Minimal	Maximal
level	0	0	65

Example:

Command: **filter_detail 33** // set unsharpen detail filter to 33
Response: **OK** // system acknowledgement

8.17 Multi-Matrix Color Correction

8.17.1 mcc <enable>

Enable multi matrix correction control.

Enable	Function
0	disable
1	enable

Example:

Command: **mcc 1** // enables multi matrix
Response: **OK** // system acknowledgement

8.17.2 mcc_opmode <mode>

Sets the number of color angles/segments for the multi matrix.

Value	Mode	Color Gradations
mode	0	12
	1	16
	2 (default)	24
	3	32

Example:

Command: **mcc_opmode 3** // set number of color angles to 32
Response: **OK** // system acknowledgement

8.17.3 mcc_set <saturation> <hue>

Set the multi matrix color parameters.

Value	Reset	Minimal	Maximal
segment	0	0	31*
saturation	0	0 (0.0)	65535 (3.999938965)
hue	0	-32768 (-180 degrees)	32767 (179.9945 degrees)

* Depending on the chosen “mcc_opmode”

Example:

Command: **mcc_set 18 16384 10922** // for segment number 18 set saturation to 16384 (1.0) and hue to
// 10922 (60 degrees)
Response: **OK** // system acknowledgement

8.17.4 mcc_blink <mask> <period_ms>

Enable color blink with a given period time. This helps to identify the image regions, by color, which will be effected by the multi-matrix color correction.

Value	Minimal	Maximal
mask	0	0xFFFFFFFF
period_ms	0	0xFFFFFFFF

Example:

Command: **mcc_blink 16 2000** // set blink of 2 sec. for color segment number 5
Response: **OK** // system acknowledgement

8.18 Q-factor calculation logic

The Q-Factor algorithm calculates relative quality measurements of a given image; hence it is not represented by a unit of measurement. It is most suitable as an input for an autofocus controller.
The Q-Factor reaches its maximum value, calculated by various search methods, when the focus is optimal for the given captured scene.

For optimal focus search follow the next steps:
1. Set the lens focus to the nearest distance.
2. Move the lens in steps to the far most focus distance.
3. For each step get the Q-Factor.
4. Find the position with the highest Q-Factor (which indicates the optimal focus position).
5. Move the lens to the position found in step 4.

8.18.1 qfactor_mode <mode>

Select Q-factor calculation mode. Setting this value to 1 will calculate the Q-Factor continuously. Changing this value to 2 will calculate the Q-Factor only once on the following captured frame, and then it will turn off the calculations. Nevertheless, the last calculated value can be read using “qfactor” command.

Enable	Function
0	disable
1	continues
2	sample once

8.18.2 qfactor

Read Q-Factor calculated value.

Return:

qfactor <samples average> <Q factor value> < Q factor value normalized to samples average>

Example:

Command: **qfactor**
Response: **qfactor 400 320000 800**
OK

8.18.3 qfactor_roi_info

Read the maximum resolution for the Q-Factor ROI.

Return:

qfactor_roi_info <maxWidth> <maxHeight> <widthStep> <heightStep>

Example:

Command: qfactor_roi_info
Response: qfactor_roi_info 2048 1080 4 4
OK

8.18.4 qfactor_roi <width> <height> <offsetX> <offsetY>

Set the ROI where Q-Factor calculations are performed.

9 Hardware Reference

9.1 Status LED

All SDI cameras are equipped with a bi-color LED. Color coded indications are shown in the following table:

	LED state	Indication
	Fast flash green	Camera is connected, data is being transferred
	Solid green	Camera is connected, no data being transferred or settings are being updated
	Solid red	Internal error occurred / BIT failed

Table 4 – Connector indicator lamp states

9.2 Micro BNC Connector

To connect the Micro-BNC cable, first need to align the pin on the male end with the “L” shaped track on the female-connector of the Coaxial cable. Once aligned, the connector should be pushed in place (see figure no. 1). Only mild pressure should be applied to achieve this operation, otherwise it may cause unnecessary damage to the cable or the card.

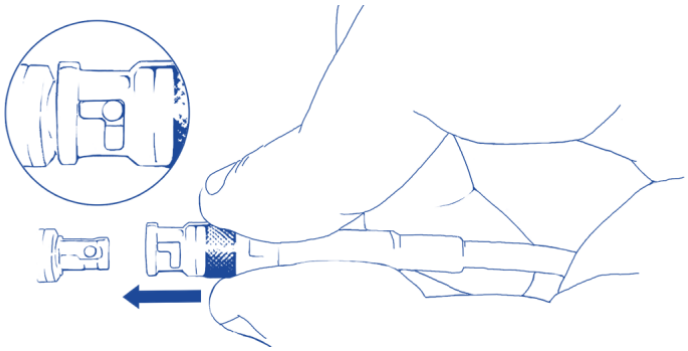


Figure 6 – Pushing the Micro-BNC connector into place

Once pushed all the way through, twist the connector clock-wise. The pin will move in the track locking the connector in position:

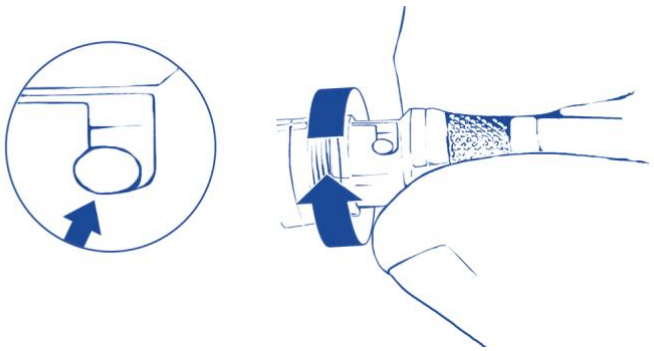


Figure 7 – Twisting the connector and securing it in position

The cable can be removed by reversing the steps: twisting the connector counter-clock-wise and pulling it out. Do not force the cable out! In case of resistance check for the pin location in relation to the track. Adjust as needed and only then pull the cable out.

10 Appendix 1: Firmware Update

Please note that the firmware can also be updated via the SDIControlPoint software that offers a user friendly GUI. For more information, please refer to section 8.1 SDIControlPoint.

The Iron SDI Camera supports firmware update via serial terminal over RS232 protocol. To initiate a firmware update, follow the next steps:

5. Download the latest firmware from KAYA's website.
6. Please make sure to download the correct FW for the camera that you have, as installing an incorrect FW may cause the camera to malfunction.
7. Open serial emulated terminal (usage of Tera Term terminal is recommended) and set serial communication protocol to baud rate 115200, 8bit data, 1bit start, 1bit stop and no flow control. For example, in the Tera Term terminal, this should look as following (the port number might be different):

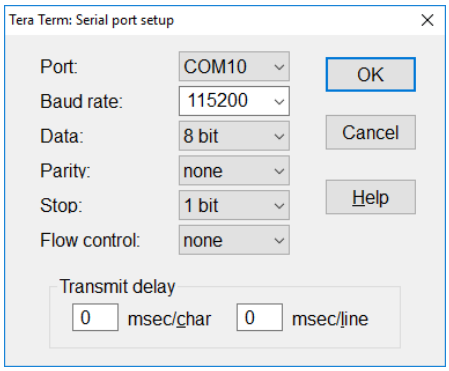


Figure 8 – Serial communication example

8. Choose the firmware update option by entering "fw_update".
9. Under the "File" tab use the terminal "transfer" capability using the XMODEM protocol to initiate the firmware update. Choose "Send" and the firmware update file.

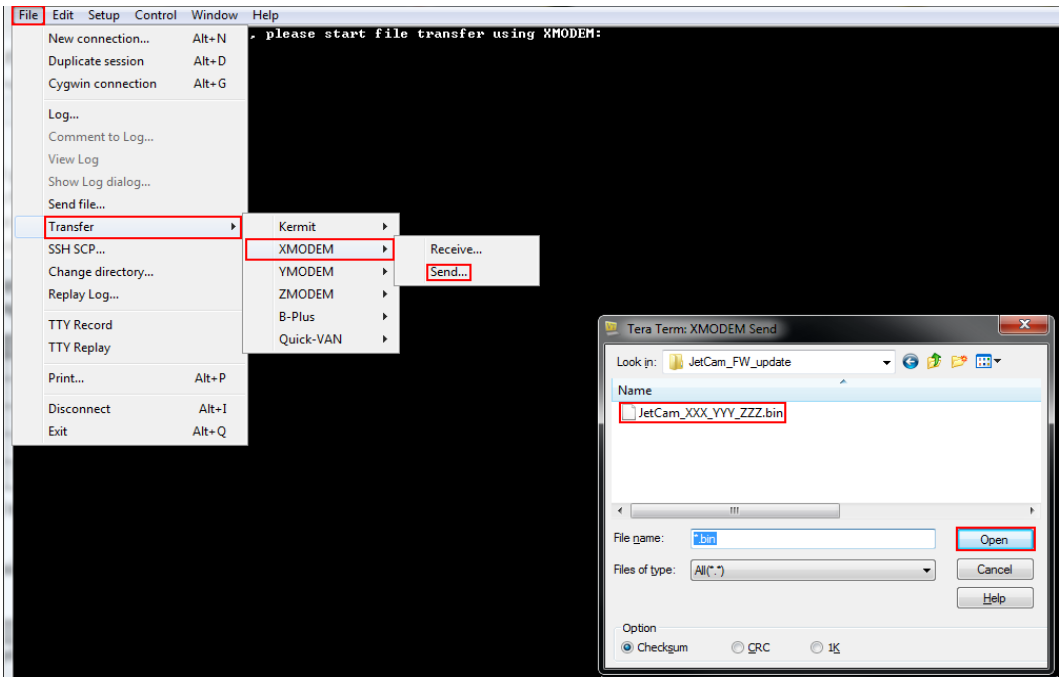


Figure 9 – Firmware terminal initiation

10. If no firmware will be sent during 1 minute, or in case of an error, the firmware update will fail and return to the previous operation mode.

```
IRON:> firmware
Now starting firmware update, please start file transfer using XMODEM:
The Firmware Update was UNSUCCESSFUL. Error: -1
IRON:>
```

Figure 10 – Firmware update fail

11. The firmware update process will take about 10 minutes.

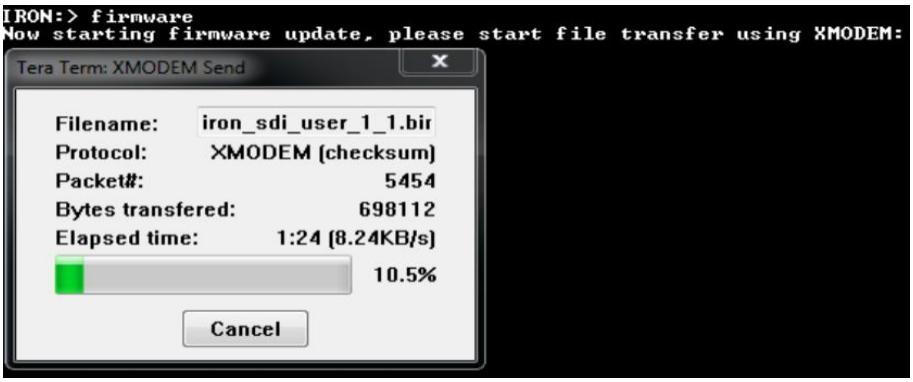


Figure 11 – Firmware update process

12. A successful update will result in an appropriate message:

```
IRON:> firmware
Now starting firmware update, please start file transfer using XMODEM:
The Firmware Update was SUCCESSFUL file size: 6653440
IRON:>
```

Figure 12 – Firmware update succession

To apply the new firmware, the camera should be power cycled by disconnecting the power supply from the camera and connecting it back after a few seconds. After camera has been powered, it should be kept at least ~30 seconds with power before new firmware will be applied.