

# PROTON OS

Reference Manual

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## 1 Introduction

This manual describes the usage of PROTON cameras running the PROTON Operating System (short: PROTON OS).

Details on the general operation of a camera running PROTON OS can be found in chapter 2. Instructions for firmware updates in chapter 3.

PROTON OS uses a custom control protocol, but it is also compatible with the ProVideo protocol from ATOM one cameras via alias functions (see chapter 5.3). This means PROTON cameras can be controlled with a special version of the ProVideo GUI, for details and a download link see chapter 4.

If you want to control the device via a terminal application or a custom hardware controller, see chapter 4 for tool recommendations and chapter 5 and following for a detailed description of the command protocol.

This manual covers the following PROTON devices:

- PROTON CAM

## 2 General Operation

The device is connected via two sockets which are either integrated into the housing or detached via cables:

1. Power and control: 6 pin Hirose HR10 connector, see chapter 2.1.
2. SDI video: Mini BNC or Micro BNC connector.

The device will immediately power on when the supply voltage is connected, the boot process takes a few seconds. Once the device is operational the LED on the backside will blink blue. For details on the status LED see chapter 2.2.

The device is controlled via an RS485 half-duplex serial interface. The camera acts as a slave device and will not send data without a request from the host. That makes it possible to connect multiple devices to the same host without data corruption. In this case each device must have a unique device address. For details on how device addressing works, see chapter 5.1.1.1.

To control the device attach it to an RCP (e.g. [CyanView](#)) or connect it to a PC using the bundled RS485 USB dongle.

**TODO: Add example schematics of how the device can be connected.**

### 2.1 Power and Control Connector

For power and control a 6 pin Hirose HR10 connector is used. The pin assignment is as follows:

Table 1: Pinning of power and control connector.

Pin	Wire Color	Function
1	White	RS485 A / +
2	Black	RS485 B / -
3		Unused
4		Unused
5	Blue	Ground
6	Brown	Supply Voltage (4.5V to 25V)

**TODO: Add image of connector with PIN numbers.**

### 2.2 Status LED

On the back of the device is a RGB status LED that indicates the current device state. You can change the brightness of the status LED with the `system status_led` command. The following blink codes are possible:

Table 2: Status LED blink codes.

State	Blink Code	Description
<b>Boot</b>	Blinks cyan, 2.5x per second (200ms on, 200ms off)	Device is booting after power got connected. This state is very short so normally this code is barely visible for a few milliseconds. If a firmware install is interrupted due to power-loss this state will take longer while the bootloader recovers.
<b>Verify / Upgrade Firmware</b>	Blinks green, 2.5x per second (200ms on, 200ms off)	Device is verifying or installing a firmware. This happens both during normal boot (a few seconds) and during a firmware upgrade (about two minutes).
<b>Boot Error</b>	Flashes red, 1x per second (200ms on, 800ms off)	Device failed to start. This is a critical error that cannot be recovered. Contact PROTON customer support.
<b>Startup</b>	Solid purple	Device is initializing after boot (loading stored settings).
<b>Normal</b>	Blinks blue, 2.5x per second (200ms on, 200ms off)	Device is streaming video and waiting for commands.
<b>Busy</b>	Blinks yellow, 2.5x per second (200ms on, 200ms off)	Device is busy processing a command.
<b>Error</b>	Blinks red, 2.5x per second (200ms on, 200ms off)	Device encountered an error, e.g. while loading settings or processing a command. This should not happen during normal operation. To get the error log use the <code>system error</code> command. If the error persists, contact PROTON customer support.
<b>Over Temperature</b>	Blinks red long, 1x per second (800ms on, 200ms off)	Device reached critical temperature and is in cooldown mode. For details see chapter 2.3.

## 2.3 Overtemperature Protection

Since PROTON cameras are optimized for a small form factor, they will reach high temperatures under operation. To protect the device, it will enter a cooldown mode if the critical system temperature of **100°C** is reached.

Cooldown mode is signaled by a red status LED which is turned on long (800ms) and off shortly (200ms). In this mode the camera does not output a video signal to reduce the heat output and reach a save temperature again. The device will still respond to commands, but most camera and video commands will fail or have no effect.

Once the system temperature falls below **80°C** video processing is restarted.

You can check the current temperature using the `system temp` command. The device also logs the maximum temperature which can be read using the `system temp max` command and the amount of over temperature events which can be read using `system temp count`. For details see temperature command section 7.3.12.

## 3 Firmware Update

Firmware updates are performed via the camera's serial interface. The update is a two-step process:

1. Transfer new firmware to the device.
2. Install and verify new firmware.

### 3.1 Data Transfer

Before data transfer is started, the camera must be switched to firmware update mode, see `system update` command for details. The update process is robust regarding interruptions and data corruption.

The update speed mainly depends on the configured RS485 baud rate which can be changed before starting the update with the `system rs485 baudrate` command.

## 3.2 Install and Verify

After the firmware has been transferred successfully the camera is restarted with the `system reboot` command. During boot it will detect the new firmware, install and verify it. This process takes about **two minutes**, during install the status LED will blink cyan and green. In case the image cannot be verified by the bootloader (wrong image uploaded, data got corrupted) the update will be aborted, and the camera starts with the previous firmware.

After the firmware has been installed and verified the camera continues to boot. During initialization of the application a self-check is performed. Should the camera not be able to initialize, the status LED will blink red. In this case the camera will revert to the previous firmware when it is power cycled or rebooted with the `system reboot` command.

## 3.3 PROTON Updater GUI

Firmware updates are performed via the PROTON Updater GUI application which automatically executes the transfer, install and verify steps. The GUI is supplied with every firmware release:

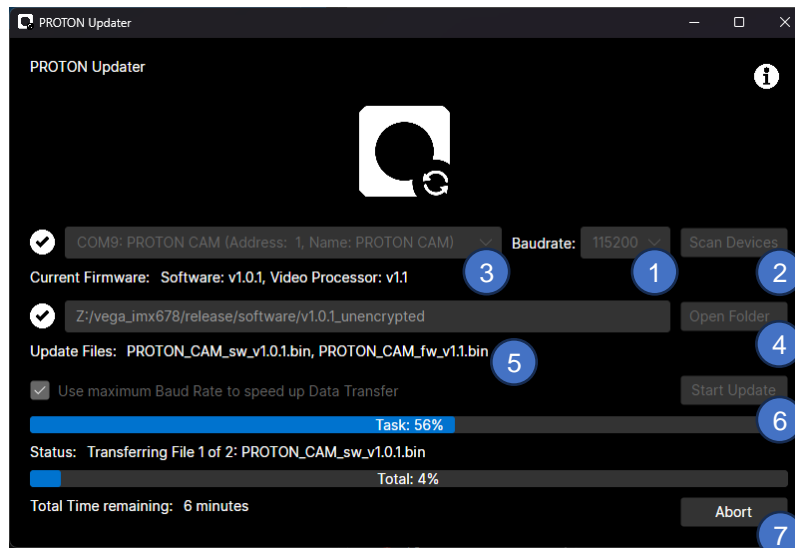


Figure 1: Example for the PROTON Updater GUI

To install a firmware update with the PROTON Updater GUI, follow these steps:

- Connect your camera to your PC using a USB to RS485 adapter. It is possible to have multiple devices on the same RS485 interface.
- Open the "PROTON Updater.exe" from the firmware release folder.
- Select the baud rate which is currently configured in the camera (1) and click *Scan Devices* (2), the GUI will automatically scan all available COM ports for connected PROTON devices and show them in the drop-down menu besides the *Scan Devices* button.
- If only one camera is connected it will automatically be selected. If you have multiple cameras connected (via separate RS485 dongles or on the same bus) select the camera you want to update from the drop-down list (3).
- Click the *Open Folder* button (4) and navigate to the folder which contains the firmware updates you want to install.
- Verify that the GUI has found the correct update files, they are displayed below the update folder path (5).
- Click *Start Update* (6) The whole process takes about 6 minutes. The upper progress bar will fill several times (once for each update file and finally for the install and verify step). The overall progress and the estimated total time remaining are displayed at the bottom of the window.

- The process can be aborted anytime by clicking the *Abort* button (7). Unless you close the GUI or disconnect the camera, the progress is retained, and you can continue by clicking the *Start Update* button (6) again.
- **Note:** Only after all files have been transferred successfully the update is made permanent. If the camera is power cycled before all files are transferred, the progress is lost.

## 4 Control Software

PROTON cameras are compatible with the ProVideo protocol and can be controlled using a special version of the ProVideo GUI which is available for download here:

<https://gitlab.com/proton-camera/provideo-gui/-/releases>

The above repository also includes the full source code, feel free to adapt it to your needs if you respect the used open-source licenses.

In the future a custom GUI application will be provided which is currently under development.

For direct control via commands, you can also use any terminal application which supports opening serial ports including:

- Putty: <https://www.putty.org/>
- TeraTerm: <https://teratermproject.github.io/index-en.html>

## 5 Command Interface

PROTON cameras are controlled via a text-based command interface on the RS485 serial port. All commands consist of human readable ASCII characters.

The interface uses the following settings:

- Default baud rate: 115200 baud (adjustable, see `system rs485 baudrate` command)
- 8-bit data, no parity, 1 stop bit (aka 8BitN1)
- No HW flow control

### 5.1 Operational Modes

The camera has two operational modes:

1. Controller Mode: Default mode, RS485 addressing is enabled, echo is disabled.
2. Interactive Mode: For testing and debugging, RS485 addressing is disabled, echo is enabled.

These are described in detail below.

To switch between the modes, use the `system rs485 mode` command or the `controller` and `interactive` alias commands.

#### 5.1.1 Controller Mode

This is the default mode. In controller mode the camera uses RS485 addressing (see below) so that multiple cameras can be connected to one host on the same RS485 bus.

In this mode the camera has reduced output to keep the RS485 bus as free as possible:

- No prompt printed at new line.
- No echo output.
- No or reduced help and error messages.

This mode is used when controlling the camera via a HW controller or the GUI.

#### 5.1.1.1 RS485 Addressing

In controller mode each command send to the camera must be prefixed with the cameras RS485 address. The address is an integer value from 0 to 99 which can be changed using the `system rs485 device_address` command.

When multiple devices are connected to the same RS485 bus each camera must have a unique address, otherwise multiple devices will reply to the same command causing garbage on the bus. You will have to setup each device separately before connecting them to the same bus.

The address 100 is reserved as the fail-safe address. Every device will always reply to commands send on address 100. This can be used if the current device address is unknown but should only be used if only one device is currently connected to the RS485 bus. Exception: To scan the bus for connected devices you can send the `system identify` command to the fail-safe address and all devices will report back in order of their device addresses. For details see the `identify` command description.

#### 5.1.1.2 RS485 Broadcasting

In addition to a unique device address each camera also has a broadcast address. Multiple cameras that have the same broadcast address form a broadcast group. Within each group one camera acts as the broadcast master. Commands which are send to the broadcast group are processed by all camera which are part of that group, but only the broadcast master will reply keeping the bus clean.

The Broadcast address can be changed using the `system rs485 broadcast_address` command, valid addresses are values from 0 to 99 but it is not allowed to set it to the same value as the device address.

After the broadcast address has been configured select the broadcast master using the `system rs485 broadcast_master` command. The following example shows how to setup the broadcast group 10 which consists of three cameras with the device addresses 1, 2 and 3 where camera 3 becomes the broadcast master:

```
→ 1 system rs485 broadcast_address 10
← OK
→ 2 system rs485 broadcast_address 10
← OK
→ 3 system rs485 broadcast_address 10
← OK
→ 10 system rs485 broadcast_master 3
← OK
```

Note that the last `OK` was sent from camera 3 while camera 1 and 2 processed the command but stayed silent.

#### 5.1.2 Interactive Mode

Interactive mode is intended for **single device operation** (only one camera on the RS485 bus) using a terminal program.

In this mode the camera provides an interactive console (like a UNIX shell) so local echo must be turned off and the terminal program should support VT100 emulation for the best user experience (see chapter 4 for recommended terminal applications). This mode is mainly used for debugging, but it is also a good way to play around with the command interface and get to know the camera.

Interactive mode disables RS485 addressing, so commands must not be prefixed with the device address. Also, the camera produces extended output:

- At the start of each line the prompt `proton-os:~$` is printed.
- Echo is enabled so all characters send to the device are sent back to the host.
- Extended help and error messages.

Additionally, there are several comfort features enabled which implement a fully featured command shell:



- Command editing: You can navigate in the typed text by using the *Arrow Left* and *Arrow Right* keys, delete text with *Backspace* or *Delete*, insert text with *Insert* and jump to the start or end of the command with the *Home* and *End* keys.
- Tab auto completion: Type only part of a command and hit *Tab* to automatically complete the command. When multiple matches are found all of them are printed.
- Command history: Use the *Arrow Up* and *Arrow Down* keys to quickly scroll through the last typed commands. To print the whole history, use the `history` command.
- Clear: Send the `clear` command to clear the whole screen.
- Resize: Adjust the width of the terminal to your current terminal application's window size with the `resize` command.
- Colored output and cursor control: Messages are colored for better readability (e.g. errors are red, warnings yellow and info messages green) and the cursor is controlled using VT100 commands.
- Extended command output: Some commands (e.g. `video mode list`) will print additional information.

The shell also supports the following meta-keys:

Table 3: Shell Meta-Keys.

Meta-Key	Action
<b>Ctrl + A</b>	Moves the cursor to the beginning of the line.
<b>Ctrl + B</b>	Moves the cursor backward one character.
<b>Ctrl + C</b>	Preserves the last command on the screen and starts a new command in a new line.
<b>Ctrl + D</b>	Deletes the character under the cursor.
<b>Ctrl + E</b>	Moves the cursor to the end of the line.
<b>Ctrl + F</b>	Moves the cursor forward one character.
<b>Ctrl + K</b>	Deletes from the cursor to the end of the line.
<b>Ctrl + L</b>	Clears the screen and leaves the currently typed command at the top of the screen.
<b>Ctrl + N</b>	Moves in history to next entry.
<b>Ctrl + P</b>	Moves in history to previous entry.
<b>Ctrl + U</b>	Clears the currently typed command.
<b>Ctrl + W</b>	Removes the word or part of the word to the left of the cursor. Words separated by period instead of space are treated as one word.
<b>Alt + B</b>	Moves the cursor backward one word.
<b>Alt + F</b>	Moves the cursor forward one word.

## 5.2 Command Format

A command consists of one or multiple command words followed by no, one, or multiple parameters.

In **controller mode** the general format of a command is:

```
<RS485 address> <command name> <parameters>
```

In **interactive mode** the RS485 address is omitted:

```
<command name> <parameters>
```

The camera stores each received character in an input buffer until a new-line character (Carriage Return (CR) or Line Feed (LF)) is received. Then the command is evaluated and, if valid, executed. During command execution no new commands should be send to the camera. Once execution is done the camera replies with the commands result (nothing or a string) followed by either `OK` or in case of an error with `FAIL` followed by an error code.

**Note:** In the following examples the camera has the default RS485 address of 1.

### 5.2.1 Parameter Data Types

The following parameter data types are supported:

- **Signed Decimals**, e.g.: -2947, 40687

- **Signed Hexadecimals**, e.g.: -0x100, 0x123AF7
- **Strings**, e.g.: plain\_text\_string
- **Booleans**: For commands that accept a Boolean parameter, like an enable flag, the following values can be used:
  - o 0 or 1
  - o true or false
  - o on or off
  - o enable or disable

For an example the following commands have the same effect:

```
settings auto_save 1
settings auto_save true
settings auto_save on
settings auto_save enable
```

## 5.2.2 Hierarchical Command Structure

Commands are structured hierarchical, that means a command can have subcommands. A command string is built by concatenating command words starting from the top level. For an example the command to get or set the RS485 baud rate is:

```
system rs485 baudrate
```

It is part of the `system` top-level command group which has the `rs485` subcommand group which provides the `baudrate` command.

## 5.2.3 Command Types

The following chapter list the different command types.

### 5.2.3.1 Setter and Getter Commands

Most of the commands provide two modes, a “Setter” mode to change a setting and a “Getter” mode to retrieve the current value of the setting.

A setter commands takes one or multiple parameters and applies the given values. The reply only consists of either OK or FAIL <error\_code> and no further output.

Example:

```
→ 1 video mode 9
← OK
```

A getter command takes no arguments and replies with the command name followed by one or multiple values and is terminated by either OK or FAIL <error\_code>.

The above `video mode` command can be called without arguments to act like a getter command:

```
→ 1 video mode
← video mode 9
← OK
```

### 5.2.3.2 Pure Getter Commands

There are also commands which are pure getters, that means they do not have a setter function, e.g.:

```
→ 1 system runtime
← system runtime 237700
← OK
```

### 5.2.3.3 Getter Commands with Arguments

These are special getter commands which require one or multiple arguments. Example:

```
→ 1 system temp 0
← system temp 0 43.6 CPU
← OK
```

#### 5.2.3.4 Special Commands

Some commands combine multiple of the above modes or are completely unique, for an example the `system info` command will only print information but does not have the leading command name and the `video mcc phase` command can be called as a setter, a getter (which lists all MCC phases) or as a getter with arguments (to only list one MCC phase).

These intricacies are described in detail in the following chapters.

#### 5.2.4 Error Codes

The following table lists the most common error codes which can be returned after the `FAIL` keyword:

Table 4: Common command error codes.

Error Code	Description
1	Help message was printed because the command was malformed.
-8	Command not found: The command is unknown and cannot be executed.
-71	Invalid number of parameters: The number of parameters does not match the given command or the
-22 or -34	Invalid parameter value(s): The given parameters are outside the valid value range.
-134	Operation not supported: The requested operation is not supported.
-140	Operation is currently not allowed because device is in firmware update or over temperature protection mode.

For an example the video mode command expects exactly 1 parameter. If it is called with 2 parameters, the camera replies with error -71:

```
→ 1 video mode 1 2
← FAIL -71
```

### 5.3 Command Alias and ProVideo Protocol Compatibility

To be compatible with the ProVideo protocol and to support shortened command names a command can have an alias. Instead of using the full command syntax, the alias can be used. For an example the command `system temp max` can also be called by its alias `temp_max`.

For compatibility with the ProVideo protocol, some commands behave slightly different when called via the alias instead of the full command syntax. This is noted in the respective command description, one example is the `system info` command.

To get a list of all available aliases use the `alias` command. Example:

```
→ 1 alias
← Available command alias:
← cam_gain -> camera gain
← cam_exposure -> camera exposure
← ...
← OK
```

Aliases can also be combined with the normal command syntax. For an example to change the MCC phase setting you can use any of:

```
video mcc phase (full syntax)
mcc phase (mcc alias for video mcc)
mcc_set (alias for video mcc phase)
```

### 5.4 Built-in Help

PROTON OS includes extensive help messages for all commands. To list general help instructions and a list of all top-level commands, use the `help` command.

To get specific help messages for a command send the command name followed by `-h`. Example:

```
→ 1 video lut -h
← lut - [alias: lut_enable] [getter] [getter with args]
← Enable gamma LUT (0 = bypass, 1 = enabled)
← If called via the alias 'lut_enable' this function expects two
← arguments:
← Index and enable flag. Since only one LUT is supported, the index is
← always 0. This is done for compatibility reasons.
← Usage: lut <enable: [0, 1]>
← lut_enable <idx: 0> <enable: [0, 1]>
← Subcommands:
← mode : [alias: log_mode] [getter]
← Set LUT mode. To get supported modes use the 'lut mode
← list'
← subcommand.
← ...
← OK
```

The first line of the reply contains some general information about the command (e.g., does it have an alias). It is followed by a detailed description of the command and its usage. Finally, all of the command's subcommands are listed (if it has any).

## 5.5 Auto Completion

It is possible to call commands without using their full name if the name is unique. For an example the `system rs485 device_address` command could also be called as:

```
→ system rs485 dev
← system rs485 dev 1
← OK
```

But it is not possible to call the `rs485 broadcast_address` command like this:

```
→ system rs485 br
← FAIL -71
```

Because that would be ambiguous with the `broadcast_master` command.

**Note:** For getter commands the camera always replies with the same command name that was used to query the value, e.g. `system rs485 dev` instead of `system rs485 device_address` for the above example.

Auto completion also works for aliases, for an example you can use `save`, `load` and `reset` instead of the `save_settings`, `load_settings` and `reset_settings` aliases.

**Warning:** When new commands are added to camera in the future old commands may become ambiguous. Therefore, it is not recommended to use shortened commands in your controller software!

## 6 Settings Handling

The device has two types of settings storage:

1. Runtime Storage: Gets reset as soon as the device is rebooted, or power cycled.
2. Persistent Storage: Permanent storage that survives reboot and power-cycle.

By default, all changes made to settings are only stored in the runtime storage. To transfer settings between the two storage types, use the following commands:

- `settings save`: Save all settings to the persistent settings storage.
- `settings load`: Load and apply all settings from persistent storage (restore stored state).

## 6.1 Reset

The camera can be reset to its default state using the `settings reset` command. When called without parameters it will only reset non-critical settings.

To perform a full reset, use the `settings reset all` command, it will also reset the following critical settings:

- Device name
- RS485 configuration:
  - Baud rate
  - Mode (controller / interactive)
  - Device and broadcast addresses
- Auto-save (reset to disable)

**Note:** The bad pixel table calibration data is never reset. Should you find the data to be incorrect (defect pixels are visible), recalibrate the camera as described in chapter 7.5.6.1.

## 6.2 Auto-Save

It is also possible to save settings automatically after a change has been made, to do so enable the auto-save feature using the `settings auto_save` command:

```
→ 1 settings auto_save 1
← OK
```

Saving settings is a slow operation, therefore command execution will take a lot longer when auto-save is enabled. For this reason, auto-save is disabled by default and manual saving is recommended for a responsive user experience.

**Note:** For usage with **CyanView RCPs** auto-save should always be disabled as the RCP manages all settings internally and enabling auto-save in the camera has no benefit.

# 7 Command Reference

The following chapters document all commands in detail. Each sub-section describes a command group.

Notes regarding the command tables:

- If a command has no alias, it will be indicated by a forward slash (/)
- Commands that have a “Getter Function” reply with their command name first if they are called with no parameters or the required number of parameters for the getter function. Commands that do not have a getter function either reply with a special string (without sending the command name first) or do not produce any output at all despite the final `OK` / `FAIL` delimiter. See chapter 5.2.3 for details.
- Most commands that change a setting have a Default value. This is the value which the setting is reset to when calling the `settings reset` command.
- In the command syntax parameters are written in angle brackets, e.g. `<parameter name>`, and optional parameters are additionally wrapped in round brackets like `(<optional parameter>)`.

## 7.1 General Commands

These commands are called without any parent command. They control basic shell functionality or print help messages.

### 7.1.1 alias

Command	alias		
Alias	/	Getter Function	No
Description	Print a list of all available command aliases.		

### 7.1.2 clear

<b>Command</b>	clear		
<b>Alias</b>	/	<b>Getter Function</b>	No
<b>Description</b>	Clear screen / terminal. Only works in interactive mode.		

### 7.1.3 help

<b>Command</b>	help		
<b>Alias</b>	/	<b>Getter Function</b>	No
<b>Description</b>	Print the top-level help message which lists basic help instructions and a list of the top-level commands.		

### 7.1.4 history

<b>Command</b>	history		
<b>Alias</b>	/	<b>Getter Function</b>	No
<b>Description</b>	Print a list of the recently used commands.		

### 7.1.5 rem

<b>Command</b>	rem		
<b>Alias</b>	/	<b>Getter Function</b>	No
<b>Description</b>	Ignore the following command. Can be used when running a script to comment out single lines. When using this in controller mode, "rem " must be added in front of the address.		

### 7.1.6 resize

<b>Command</b>	resize		
<b>Alias</b>	/	<b>Getter Function</b>	No
<b>Description</b>	Resize terminal output to current terminal window width. Only works in interactive mode.		

## 7.2 Settings Commands

These commands control the handling of camera settings. They are called with the `settings` command prefix.

### 7.2.1 settings save

<b>Command</b>	settings save		
<b>Alias</b>	save_settings	<b>Getter Function</b>	No
<b>Description</b>	Save current device settings to persistent storage.		

### 7.2.2 settings load

<b>Command</b>	settings load		
<b>Alias</b>	load_settings	<b>Getter Function</b>	No
<b>Description</b>	Load device settings from persistent storage and apply them.		

### 7.2.3 settings reset

<b>Command</b>	settings reset <all>		
<b>Alias</b>	reset_settings	<b>Getter Function</b>	No
<b>Description</b>	Resets all settings to the default value. To save settings afterwards use the <code>save</code> command (not needed when auto-save is enabled). By default, only non-critical settings are reset. If all settings shall be reset (including RS485 configuration) call the command with <code>all</code> as shown below. For a full list of all critical settings see chapter 6.1. <div style="display: flex; justify-content: space-between; margin-top: 10px;"> <div>settings reset</div> <div>Reset non-critical settings.</div> </div> <div style="display: flex; justify-content: space-between; margin-top: 10px;"> <div>settings reset all</div> <div>Reset all settings.</div> </div>		

**Note:** For a full list of settings that are reset by the `reset all` command, see chapter 6.1.

## 7.2.4 settings auto\_save

<b>Command</b>	settings auto_save <enable>		
<b>Alias</b>	auto_save	<b>Getter Function</b>	Yes
<b>Description</b>	Enable automatic saving of settings after each change. Saving settings is a slow operation, that means commands will take a lot longer to execute with auto-save enabled. This makes interacting with the camera slower, therefore auto-save is disabled by default and manual saving is recommended. Turning auto-save on or off immediately saves the settings.		
<b>Parameter</b>	enable		
<b>Type</b>	Boolean		
<b>Description</b>	Enable or disable auto-save.		
<b>Default</b>	Off		

## 7.3 System Commands

These commands control basic system functionality like:

- RS485 configuration
- Temperature monitoring
- Audio
- Timecode
- Status LEDs
- ...

They are called with the `system` command prefix.

### 7.3.1 system info

<b>Command</b>	system info		
<b>Alias</b>	version	<b>Getter Function</b>	No
<b>Description</b>	Get system information. If called via the alias <code>version</code> this command prints the information in a style that can be parsed by ProVideo protocol compatible controllers.		

Example Output:

```
platform           : vega
device name        : Proton Cam
serial number      : DF-61-9C-58-CB-66-51-2A
video processor version : v1.0-253
software version   : v1.0.0+0
resolution mask    : 00000000-000007FF-00000000
```

Example Output when called via the `version` alias:

```
platform           : vega
device name        : Proton Cam
system-id          : DF-61-9C-58-CB-66-51-2A
hw revision        : 0001000000000253
system validity    : LICENSED
feature mask HW    : 00000000
feature mask SW    : 00000000
resolution mask    : 00000000-000007FF-00000000
loader version     : Unknown
sw-release-id      : v1.0.0+0
sw-release-date    : Unknown
sw-build-date      : Unknown
```

As you can see most of the extra fields in the ProVideo compatible output are blank as they are not used / supported by PROTON OS.

Notes on the provided information:

- `platform`: The platform string is unique for each PROTON device. It can be used by a controller to determine which device type it is talking to. It is also included in the `system identify` command.
- `device name`: Can be set by the user with the `system name` command.
- `serial number`: Unique device serial number.
- `video processor version`: Version of the programmable video processor.
- `software version`: PROTON OS version.
- `resolution mask`: Shortened list of all supported video modes where each bit represents one mode, see table below.

Table 5: Resolution Mask.

Bit	HD Modes (Left Block)	FHD / 2K Modes (Middle Block)	UHD / 4K Modes (Right Block)
1	720p60	1080p30	UHDp30
2	720p50	1080p25	UHDp25
3	720p59	1080p24	UHDp24
4		1080p23	UHDp23
5		1080p29	UHDp29
6		1080p50	UHDp50
7		1080p60	UHDp60
8		1080i60	UHDp59
9		1080i50	UHDp48
10		1080i59	UHDp47
11		1080p59	4Kp30
12		2Kp30	4Kp25
13		2Kp25	4Kp24
14		2Kp24	4Kp23
15		2Kp23	4Kp29
16		2Kp29	4Kp50
17		2Kp50	4Kp60
18		2Kp60	4Kp59
19		2Kp59	4Kp48
20		2Kp48	4Kp47
21		2Kp47	

**Note:** A controller may use the resolution mask to determine which modes are supported by a camera. Alternatively use the `video mode list` command to list all supported video modes.

### 7.3.2 system name

<b>Command</b>	<code>system name &lt;name string&gt;</code>		
<b>Alias</b>	<code>name</code>	<b>Getter Function</b>	Yes
<b>Description</b>	Set device name. The name string may contain up to 5 words which in total and including white spaces have a length of 32 characters.		
<b>Parameter</b>	<code>name string</code>		
<b>Type</b>	String		
<b>Description</b>	Device name to set, max 32 characters.		

### 7.3.3 system runtime

<b>Command</b>	<code>system runtime</code>		
<b>Alias</b>	<code>runtime</code>	<b>Getter Function</b>	Yes
<b>Description</b>	Print device runtime since boot in seconds. Counter gets reset by a power cycle or reboot.		

### 7.3.4 system reboot

<b>Command</b>	<code>system reboot</code>		
----------------	----------------------------	--	--



<b>Alias</b>	reboot	<b>Getter Function</b>	No
<b>Description</b>	Reboot the device.		

### 7.3.5 system update

<b>Command</b>	system update		
<b>Alias</b>	update	<b>Getter Function</b>	No
<b>Description</b>	Put device into firmware update mode. In update mode the device will respond to firmware update requests. Additionally, video processing is stopped to increase the performance of the update process. The device will respond to commands as usual, but video and camera related commands will fail. Firmware update mode can only be left via a reboot.		

### 7.3.6 system identify

<b>Command</b>	system identify		
<b>Alias</b>	identify	<b>Getter Function</b>	No
<b>Description</b>	Print essential system information (platform, RS485 configuration, device name) with a delay depending on the RS485 device address. Can be used to quickly identify all devices on an RS485 bus by sending it to the fail-safe address 100. Maximum delay: $99 * 10\text{ms} \approx 1\text{s}$ (99 is the maximum RS485 address). Output: id <platform> <dev_addr> <bc_addr> <is_master> <dev_name>		

Example for an RS485 bus with 3 cameras of which the cameras with the device IDs 20 and 21 are part of broadcast group 2 and camera 20 is the broadcast master (has the `is_master` flag set):

```

→ 100 system identify
← id: vega 1 0 0 Camera Left After 10ms
← OK
← id: vega 20 2 1 Wide Angle After 200ms
← OK
← id: vega 21 2 0 Top View After 210ms
← OK
  
```

### 7.3.7 system error

<b>Command</b>	system error		
<b>Alias</b>	error	<b>Getter Function</b>	No
<b>Description</b>	Print error log. In case no errors are logged it only returns OK. The status LED blinks red when an error was logged.		

### 7.3.8 system volatile

<b>Command</b>	system volatile <value>		
<b>Alias</b>	volatile	<b>Getter Function</b>	Yes
<b>Description</b>	Set a 32 bit runtime variable which will keep its value until a reboot is performed. Can be used by a controller to store arbitrary information or check if camera got rebooted (volatile value got reset to 0).		
<b>Parameter</b>	value		
<b>Description</b>	Volatile value to set.		
<b>Min</b>	0		
<b>Max</b>	4294967295 = 0xFFFFFFFF		
<b>Default</b>	0		

### 7.3.9 system rs485

<b>Command</b>	system rs485		
<b>Alias</b>	rs485	<b>Getter Function</b>	No
<b>Description</b>	Setup RS485 console interface, see subcommands for details. If called without arguments prints a summary of the current settings.		

### 7.3.9.1 system rs485 mode

<b>Command</b>	system rs485 mode <mode>		
<b>Alias</b>	prompt	<b>Getter Function</b>	Yes
<b>Description</b>	Set RS485 operational mode: 0 = Controller Mode: Shell addressing is enabled, to allow multiple devices on the same RS485 bus. Prompt and echo are disabled. 1 = Interactive Mode: Shell addressing is enabled, to allow multiple devices on the same RS485 bus. Prompt and echo are disabled.		
<b>Parameter</b>	mode		
<b>Type</b>	Unsigned Integer		
<b>Valid Values</b>	0 = Controller Mode 1 = Interactive Mode		
<b>Alias</b>	controller → system rs485 mode 0 interactive → system rs485 mode 1		
<b>Default</b>	0 = Controller Mode		

### 7.3.9.2 system rs485 device\_address

<b>Command</b>	system rs485 device_address <dev_addr>		
<b>Alias</b>	rs485_addr	<b>Getter Function</b>	Yes
<b>Description</b>	Set RS485 device address. Cannot be identical to broadcast address. The address 100 is the fail-save address, the device will always respond to that address.		
<b>Parameter</b>	dev_addr		
<b>Description</b>	Device address to set.		
<b>Min</b>	0		
<b>Max</b>	99		
<b>Default</b>	1		

### 7.3.9.3 system rs485 broadcast\_address

<b>Command</b>	system rs485 broadcast_address <bc_addr>		
<b>Alias</b>	rs485_bc_addr	<b>Getter Function</b>	Yes
<b>Description</b>	Set RS485 broadcast group address. Cannot be identical to the device address. The device will process commands received on the broadcast address but not reply to them unless it is the broadcast master.		
<b>Parameter</b>	bc_addr		
<b>Description</b>	Broadcast address to set.		
<b>Min</b>	0		
<b>Max</b>	99		
<b>Default</b>	0		

### 7.3.9.4 system rs485 broadcast\_master

<b>Command</b>	system rs485 broadcast_master <dev_addr>		
<b>Alias</b>	rs485_bc_master	<b>Getter Function</b>	Yes
<b>Description</b>	Set RS485 broadcast master. The device with the given address becomes the broadcast master. Should be send to a broadcast group to ensure there is only one active master. Only the master will reply to commands received on the broadcast address, all other devices are silent. To disable the broadcast master, use the special device address -1. When called without arguments this command will not return the address of the current broadcast master but a flag indicating if this device is currently the master.		
<b>Parameter</b>	dev_addr		
<b>Description</b>	Device address of the device which shall become master of the broadcast group.		
<b>Min</b>	-1 (disable broadcast master)		
<b>Max</b>	99		
<b>Default</b>	-1 (disabled)		

For an example see chapter 5.1.1.2.

### 7.3.9.5 system rs485 baudrate

<b>Command</b>	system rs485 baudrate <rate>		
<b>Alias</b>	rs485_baud	<b>Getter Function</b>	Yes
<b>Description</b>	Set RS485 baud rate. To get supported rates use the baudrate list subcommand.		
<b>Parameter</b>	rate		
<b>Description</b>	New RS485 baud rate to set.		
<b>Valid Values</b>	9600, 1440, 19200, 57600, 115200, 230400, 250000		
<b>Default</b>	115200		

#### 7.3.9.5.1 system rs485 baudrate list

<b>Command</b>	system rs485 baudrate list		
<b>Alias</b>	/	<b>Getter Function</b>	No
<b>Description</b>	List all supported baud rates of the RS485 interface.		

Example:

```
→ 1 system rs485 baudrate list
← 9600
← ...
← 115200
← OK
```

### 7.3.10 system status\_led

<b>Command</b>	system status_led <brightness>		
<b>Alias</b>	status_led	<b>Getter Function</b>	Yes
<b>Description</b>	Set brightness off the status LED from 0 to 10, set to 0 to turn it off.		
<b>Parameter</b>	brightness		
<b>Description</b>	Status LED brightness.		
<b>Min</b>	0 (off)		
<b>Max</b>	10 (100%)		
<b>Default</b>	10 (100%)		

### 7.3.11 system tally

<b>Command</b>	system tally <brightness>		
<b>Alias</b>	status_led	<b>Getter Function</b>	Yes
<b>Description</b>	Set brightness off the tally light in %, set to 0 to turn it off. The tally light is only controlled by the user, it is not turned on automatically.		
<b>Parameter</b>	brightness		
<b>Description</b>	Tally light brightness in %.		
<b>Min</b>	0 (off)		
<b>Max</b>	100 (100%)		
<b>Default</b>	0 (off)		

### 7.3.12 system temp

<b>Command</b>	system temp (<sensor_idx>)		
<b>Alias</b>	temp	<b>Getter Function</b>	Yes
<b>Description</b>	List all supported temperature measurements in °C, the number of temperature sensors varies between camera models. To get a single temperature value specify the optional sensor_idx parameter. For temperature logging see subcommands. Output: <sensor_idx> <temperature> <description>		
<b>Parameter</b>	sensor_idx		
<b>Description</b>	Optional index of the sensor		
<b>Min</b>	0 (off)		
<b>Max</b>	100 (100%)		

Examples:

```
→ 1 system temp
```

```

← system temp 0 63.5 CPU
← system temp 1 57.8 Case
← OK
→ 1 system temp 0
← system temp 0 67.2 CPU
← OK
  
```

### 7.3.12.1 system temp max

<b>Command</b>	system temp max		
<b>Alias</b>	max_temp	<b>Getter Function</b>	Yes
<b>Description</b>	<p>Show maximum logged system temperature. It prints the following values:</p> <p>max_temp_user: User resettable maximum temperature in °C since boot. It can be reset with the 'temp reset' command or via a power-cycle or reboot.</p> <p>max_temp: Maximum temperature in °C since boot which can only be reset via power-cycle or reboot.</p> <p>shutdown_temp: Shutdown temperature in °C. When the shutdown temperature is reached, the device enters a safe state and tries to cool down. Video processing is restarted when it is cooled sufficiently.</p> <p>Whenever the shutdown temperature is reached an over temperature event is logged (see temp_count command).</p> <p>Output: &lt;max_temp_user&gt; &lt;max_temp&gt; &lt;shutdown_temp&gt;</p>		

### 7.3.12.2 system temp reset

<b>Command</b>	system temp reset		
<b>Alias</b>	max_temp_reset	<b>Getter Function</b>	No
<b>Description</b>	<p>Reset the user resettable maximum logged temperature (see temp_max command) to the current system temperature.</p> <p>The temperature is also reset when the camera is power-cycled or rebooted.</p>		

### 7.3.12.3 system temp count

<b>Command</b>	system temp count		
<b>Alias</b>	over_temp_count	<b>Getter Function</b>	Yes
<b>Description</b>	<p>Show number of logged over temperature events. This is the number of times the device had to shut down because the temperature reached the shutdown temperature (see temp_max command).</p> <p>This counter is persistent and cannot be reset.</p> <p>Output: &lt;over_temp_count&gt;</p>		

## 7.3.13 system audio

<b>Command</b>	system audio <enable>		
<b>Alias</b>	audio_enable	<b>Getter Function</b>	Yes
<b>Description</b>	<p>Enable stereo audio. If enabled 2 channels of audio will be embedded into the SDI signal. To change audio volume, see subcommands.</p>		
<b>Parameter</b>	enable		
<b>Type</b>	Boolean		
<b>Description</b>	Enable or disable SDI audio.		
<b>Default</b>	On		

### 7.3.13.1 system audio gain

<b>Command</b>	system audio gain <factor>		
<b>Alias</b>	audio_gain	<b>Getter Function</b>	Yes
<b>Description</b>	<p>Set audio gain. Gain is given as a 4.12 fixed point number, range [0.0, 16.0) with a default of 1.0 = 4096.</p> <p>Setting a gain of 0 will mute (but not disable) the audio output.</p>		
<b>Parameter</b>	factor		
<b>Type</b>	Unsigned 4.12 Fixed Point Number		
<b>Description</b>	Audio gain factor to set.		
<b>Min</b>	0.0 = 0		
<b>Max</b>	15.999 = 65535		

Default	0.5 = 2048
---------	------------

### 7.3.14 system timecode

Command	system timecode <enable>		
Alias	timecode_enable	Getter Function	Yes
Description	Enable SDI time code insertion. Disabling the time code resets the value to 0. To set or pause the time code, see subcommands.		
Parameter	enable		
Type	Boolean		
Description	Enable or disable SDI time code.		
Default	On		

#### 7.3.14.1 system timecode value

Command	system timecode value <hour> <minute> <second>		
Alias	timecode	Getter Function	Yes
Description	Set time code to given value or get current value. New value is applied with the next frame. If time code insertion is currently disabled, setting a value has no effect and the new value is ignored. When setting the time code, the frame counter is always reset to 0.		
Parameter	hour	minute	second
Type	Unsigned Integer	Unsigned Integer	Unsigned Integer
Description	Hour value.	Minute value.	Second value.
Min	0	0	0
Max	23	59	59

#### 7.3.14.2 system timecode pause

Command	system timecode pause <enable>		
Alias	timecode_hold	Getter Function	Yes
Description	Pause time code. While paused the transmitted time code is no longer incremented which can be used to control an external SDI recorder. Internally the counter keeps running so when pause is released the transmitted time code value jumps to the current time. This setting is not stored in the persistent storage, so pause is always disabled when the camera is powered on.		
Parameter	enable		
Type	Boolean		
Description	Pause timecode at current value.		
Default	Disabled		

#### 7.3.14.3 system timecode drop

Command	system timecode drop <enable>		
Alias	timecode_drop	Getter Function	Yes
Description	Enable 'drop frame' mode for fractional video modes. This feature is enabled by default and causes the camera to occasionally skip frame numbers in the frame counter for fractional video modes to ensure that the time runs as close to a real clock as possible. This setting has no effect for non-fractional (integer) video modes.		
Parameter	enable		
Type	Boolean		
Description	Use 'drop frame' mode for fractional video modes.		
Default	Enabled		

## 7.4 Camera Commands

These commands control the image sensor (gain and exposure). They are called via the `camera` command prefix.

### 7.4.1 camera gain

Command	camera gain <value>
---------	---------------------

<b>Alias</b>	<code>cam_gain</code>	<b>Getter Function</b>	Yes
<b>Description</b>	Set camera gain as (linear gain * 1000), use <code>info</code> command to get range. To set gain to minimum or maximum value pass <code>min</code> or <code>max</code> as <code>value</code> .		
<b>Parameter</b>	<code>value</code>		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	Linear gain scaled by 1000 (see examples below).		
<b>Min</b>	1.0 = 1000		
<b>Max</b>	Depends on camera model, use <code>camera info</code> command to get range.		
<b>Default</b>	1.0 = 1000		

This command sets the linear gain scaled by 1000 for fine-grained gain control. Examples:

```
→ 1 camera gain 1000    # Set gain to 1.0
← OK
→ 1 camera gain 5237    # Set gain to 5.237
← OK
```

To convert linear gain to ISO, use the `camera info` command to get the ISO at gain 1.0 and then simply multiply that value with the gain:

$$gain_{ISO} = ISO_{1.0} * gain_{linear}$$

## 7.4.2 camera exposure

<b>Command</b>	<code>camera exposure &lt;value&gt;</code>		
<b>Alias</b>	<code>cam_exposure</code>	<b>Getter Function</b>	Yes
<b>Description</b>	Set camera exposure in microseconds, use <code>info</code> command to get range. To set exposure to minimum or maximum value pass <code>min</code> or <code>max</code> as <code>value</code> .		
<b>Parameter</b>	<code>value</code>		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	Exposure time in $\mu$ s.		
<b>Min</b>	Depends on camera model, use <code>camera info</code> command to get range.		
<b>Max</b>	Depends on video mode, use <code>camera info</code> command to get range.		
<b>Default</b>	Maximum value for default video mode.		

## 7.4.3 camera low\_light

<b>Command</b>	<code>camera low_light &lt;enable&gt;</code>		
<b>Alias</b>	<code>low_light</code>	<b>Getter Function</b>	Yes
<b>Description</b>	Activate low light mode. In low light mode the base gain of the image sensor is increased for improved visibility. This changes the ISO value at gain 1.0, the updated value can be read using the <code>camera info</code> command		
<b>Parameter</b>	<code>enable</code>		
<b>Type</b>	Boolean		
<b>Description</b>	Enable or disable low-light mode.		
<b>Default</b>	Disabled		

By default, the camera is configured with low-light mode disabled which results in a good gain range for operation in normally lit environments. For dark environments low-light mode can be enabled to boost the base gain of the sensor.

## 7.4.4 camera info

<b>Command</b>	<code>camera info</code>		
<b>Alias</b>	<code>cam_info</code>	<b>Getter Function</b>	Yes
<b>Description</b>	Prints the capabilities of the image sensor: <code>gain_min</code> : Minimum gain setting, fixed. <code>gain_max</code> : Maximum gain setting, fixed. <code>exp_min</code> : Minimum exposure setting, fixed. <code>exp_max</code> : Maximum exposure setting, depends on video mode.		

base\_iso: ISO at gain 1.0 (= 1000), depends on low-light setting.  
 Output: <gain\_min> <gain\_max> <exp\_min> <exp\_max> <base\_iso>

### 7.4.5 camera auto

<b>Command</b>	camera auto <enable>		
<b>Alias</b>	aec	<b>Getter Function</b>	Yes
<b>Description</b>	<p>Enable or disable automatic exposure control.            For setup of the auto exposure mode and other parameters see subcommands.            Settings that are currently controlled by the auto exposure (e.g. gain or exposure) cannot be set manually, but you can use their getter functions to check the value that have been applied by the AEC.            When called via the aec alias the command behaves according to the ProVideo protocol that means either 1 parameter (enable) or 10 parameters can be passed (see below). The clm_tolerance and cost_apt settings from the ProVideo protocol are not supported and the passed values are ignored. For gain control set cost_gain &gt; 0 and cost_tint = 0, for exposure control vice versa. If both are enabled or enabled combined gain and exposure control is used.            For detailed examples, see below.</p>		
<b>Parameter</b>	enable		
<b>Type</b>	Boolean		
<b>Description</b>	Enable or disable automatic exposure control.		
<b>Default</b>	Enabled		

When called via the full syntax the command is only used to enable or disable the AEC:

Command: camera auto <enable>

→ 1 camera auto 1  
 ← OK

For all other settings, see the subcommands in the following sections.

#### ProVideo Protocol Compatibility

For ProVideo protocol compatibility the command can also be called via the aec alias. In that mode it either supports 1 or 10 parameters. With 1 parameter the behavior is identical to the camera auto command and only the enable state is changed:

Command: aec <enable>

→ 1 aec 1  
 ← OK

When called with 10 parameters the ProVideo protocol settings are converted to PROTON OS settings:

Command: aec <enable> <set\_point> <speed> <clm\_tolerance> <const\_gain>  
 <cost\_tint> <cost\_apt> <taf> <max\_gain> <use\_custom\_weights>

ProVideo Paramater	Value Range	Related PROTON OS Command
enable	[0, 1]	camera auto
set_point	[256, 3000]	camera auto target, range gets converted to [0, 1000]
speed	[3, 30]	camera auto speed, range gets converted to [0, 100]
clm_tolerance	[10, 500]	None, value is ignored, getter always returns 50
cost_gain	0 + [250, 8000]	If set greater 0: camera auto mode 0, getter returns 0 when disabled and 8000 when enabled.
cost_exp	0 + [250, 8000]	If set greater 0: camera auto mode 1, getter returns 0 when disabled and 8000 when enabled.

<b>cost_apt</b>	0 + [250, 8000]	None, value is ignored, getter always returns 0
<b>taf</b>	[5000, 20000]	camera auto anti_flicker, if set to 10000: 50 Hz anti-flicker is used, if set to 8333: 60 Hz anti-flicker is used, for all other settings anti-flicker is disabled.
<b>max_gain</b>	Camera specific	camera auto max_gain
<b>use_custom_weights</b>	[0, 1]	camera auto custom

**Note:** If both `cost_gain` and `cost_exp` are set to 0, or both are enabled (>0), gain control mode is used.

The following example shows the returned default settings:

```
→ 1 aec
← 1 1170 17 50 8000 8000 0 0 32000 0
← OK
```

Example to enable AEC in exposure control mode:

```
→ 1 aec 0 1170 17 50 0 8000 0 0 32000 0
← OK
```

#### 7.4.5.1 camera auto mode

<b>Command</b>	camera auto mode <mode>		
<b>Alias</b>	aec_mode	<b>Getter Function</b>	Yes
<b>Description</b>	Set auto exposure mode. To get supported modes use the <code>mode list</code> subcommand.		
<b>Parameter</b>	mode		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	Auto exposure mode to set.		
<b>Valid Values</b>	0 = gain control: Gain is set automatically; exposure can be set manually using the <code>camera exposure</code> command 1 = exposure control: Exposure is set automatically; gain is set manually using the <code>camera gain</code> command		
<b>Default</b>	0 = gain control		

##### 7.4.5.1.1 camera auto mode list

<b>Command</b>	camera auto mode list		
<b>Alias</b>	/	<b>Getter Function</b>	No
<b>Description</b>	List all auto exposure modes.		

This command is mainly intended for interactive use. A controller can expect all modes to be available for every camera model.

#### 7.4.5.2 camera auto target

<b>Command</b>	camera auto target <brightness>		
<b>Alias</b>	aec_target	<b>Getter Function</b>	Yes
<b>Description</b>	Set target brightness for the auto exposure algorithm. Valid range [0, 1000] which equals [0.0, 1.0] or [0%, 100%]. The default is 333 = 0.333 = 33.3%.		
<b>Parameter</b>	brightness		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	Relative brightness in percent multiplied by 10 for higher resolution.		
<b>Min</b>	0 = 0%		
<b>Max</b>	1000 = 100%		
<b>Default</b>	333 = 33.3%		

#### 7.4.5.3 camera auto speed

<b>Command</b>	camera auto speed <speed>		
<b>Alias</b>	aec_speed	<b>Getter Function</b>	Yes
<b>Description</b>	Set auto exposure control speed in range [1, 100] which equals [1%, 100%]. Bigger values result in a faster reaction to scene brightness changes. The default is 50 = 50%.		
<b>Parameter</b>	speed		



<b>Type</b>	Unsigned Integer
<b>Description</b>	AEC control speed (reaction speed to brightness changes).
<b>Min</b>	0 = 0%
<b>Max</b>	100 = 100%
<b>Default</b>	50 = 50%

#### 7.4.5.4 camera auto max\_gain

<b>Command</b>	camera auto max_gain <value>		
<b>Alias</b>	aec_max_gain	<b>Getter Function</b>	Yes
<b>Description</b>	Set the maximum gain that the AEC algorithm is allowed to use. The gain range is identical to the camera_gain command and can be fetched with the camera_info command. To set the maximum gain to the minimum or maximum value pass min or max as value.		
<b>Parameter</b>	value		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	Maximum linear gain that the AEC algorithm is allowed to use.		
<b>Min</b>	1.0 = 1000		
<b>Max</b>	Depends on camera model, use camera_info command to get range.		
<b>Default</b>	Maximum gain.		

#### 7.4.5.5 camera auto anti\_flicker

<b>Command</b>	camera auto anti_flicker <mode>		
<b>Alias</b>	aec_anti_flicker	<b>Getter Function</b>	Yes
<b>Description</b>	Set the anti-flicker mode for the combined (gain and exposure) auto exposure mode. In all other modes this setting has no effect. When anti-flicker is enabled the auto exposure algorithm tries to use only exposure times that allow for a flicker free output image when using artificial light sources. To get supported modes use the anti_flicker_list subcommand.		
<b>Parameter</b>	mode		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	Auto exposure anti-flicker mode to set.		
<b>Valid Values</b>	0 = disabled 1 = 50 Hz (EU) 2 = 60 Hz (US)		
<b>Default</b>	0 = disabled		

##### 7.4.5.5.1 camera auto anti\_flicker list

<b>Command</b>	camera auto anti_flicker list		
<b>Alias</b>	/	<b>Getter Function</b>	No
<b>Description</b>	List all auto exposure anti-flicker modes.		

This command is mainly intended for interactive use. A controller can expect all modes to be available for every camera model.

#### 7.4.5.6 camera auto custom

<b>Command</b>	camera auto custom <enable>		
<b>Alias</b>	aec_custom	<b>Getter Function</b>	Yes
<b>Description</b>	Enable to use custom weights for the 25 measurement areas of the auto exposure algorithm. Weights can be configured with the auto_weight command. If disabled (default), all measurements are weighted equally with a weight of 1.		
<b>Parameter</b>	enable		
<b>Type</b>	Boolean		
<b>Description</b>	Enable or disable usage of custom weights for the measurement areas.		
<b>Default</b>	Disabled		

#### 7.4.5.7 camera auto weight

<b>Command</b>	camera auto weight <index> (<weight>)		
<b>Alias</b>	aec_weight	<b>Getter Function</b>	Yes
<b>Description</b>	The AEC algorithm measures the brightness in an evenly split 5x5 grid. Each area of the grid has a weight which determines how much this area shall influence the		

algorithm. A higher weight results in a stronger focus on that area, a weight of 0 completely ignores the measurement for that area.

The index parameter selects the measurement area for which the weight is set. Index 1 is the top-left measurement area while 25 is bottom-right:

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

When the command is called only with the index parameter the weight for that index is printed. If it is called without parameters all weights are printed.

These weights are only used if custom weights are enabled with the `auto custom` command, otherwise all areas are weighted equally.

<b>Parameter</b>	index	weight
<b>Type</b>	Unsigned Integer	Unsigned Integer
<b>Description</b>	Index of the weight to set.	Weight for selected measurement window.
<b>Min</b>	1	0 = Ignore this area
<b>Max</b>	25	25 = Very strong focus on this area
<b>Default</b>	/	1

## 7.5 Video Commands

These commands control the video processing features of the camera. They are called with the `video` command prefix.

### 7.5.1 video mode

<b>Command</b>	<code>video mode &lt;mode&gt;</code>		
<b>Alias</b>	<code>video_mode</code>	<b>Getter Function</b>	Yes
<b>Description</b>	<p>Set image format of the video pipeline. This will stop video processing, reconfigure for the new format and restart processing.          To list supported modes, use the <code>mode list</code> subcommand or evaluate the resolution mask from the <code>system info</code> command.          If the current exposure setting is bigger than the maximum of the new mode it will be clipped.</p>		
<b>Parameter</b>	<code>mode</code>		
<b>Description</b>	Video mode ID.		
<b>Valid Values</b>	Depends on camera model, see Table 6 below.		
<b>Default</b>			

The following table lists the supported video modes and the default video mode for each camera model:

Table 6: Supported Video Modes.

ID	Mode	PROTON CAM
4	1080p30	✓
5	1080p25	✓
6	1080p24	✓
7	1080p23	✓
8	1080p29	✓
9	1080p50	✓ Default
10	1080p60	✓
11	1080i60	✓
12	1080i50	✓
13	1080i59	✓
14	1080p59	✓

#### 7.5.1.1 video mode list

<b>Command</b>	<code>video mode list</code>		
<b>Alias</b>	/	<b>Getter Function</b>	No

<b>Description</b>	List all supported video modes.
--------------------	---------------------------------

This command can be used by a controller to check which video modes are supported by the device (instead of evaluating the resolution mask from the `system info` command or hardcoding the values).

Each mode is printed in a separate line. Example:

```
→ 1 video mode list
← 4
← 5
← ...
← 14
← OK
```

## 7.5.2 video flip

<b>Command</b>	video flip <mode>		
<b>Alias</b>	flip	<b>Getter Function</b>	Yes
<b>Description</b>	Flip output image. To list all modes, use the <code>flip list</code> subcommand.		
<b>Parameter</b>	mode		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	Flip mode to set.		
<b>Valid Values</b>	0 = normal 1 = vertical 2 = horizontal 3 = rotated (h+v)		
<b>Default</b>	0 = normal		

### 7.5.2.1 video flip list

<b>Command</b>	video flip list		
<b>Alias</b>	/	<b>Getter Function</b>	No
<b>Description</b>	List all flip modes.		

This command is mainly intended for interactive use. A controller can expect all modes to be available for every camera model.

## 7.5.3 video black\_sensor

<b>Command</b>	video black_sensor <red/all> (<green> <blue>)		
<b>Alias</b>	black_sensor	<b>Getter Function</b>	Yes
<b>Description</b>	Set all sensor black level offsets. All values are 17 bit signed integers with a range of [-65536, 65535]. The offsets are subtracted, that means a negative offset results in an addition. Usually, positive values will be programmed to subtract the sensor black level from the image signal. If only one value is given, all offsets are set to the same value. Otherwise, all three values must be given. Changing the sensor black level is usually not recommended, use the flare compensation or master black level instead. To set a single offset value use the subcommands.		
<b>Parameter</b>	red/all	green	blue
<b>Type</b>	Signed Integer		
<b>Description</b>	Red or all components black level offset.	Optional green offset.	Optional blue offset.
<b>Min</b>	-65536		
<b>Max</b>	65535		
<b>Default</b>	0		

### 7.5.3.1 video black\_sensor auto

<b>Command</b>	Video black_sensor auto <enable>		
<b>Alias</b>	timecode_hold	<b>Getter Function</b>	Yes

<b>Description</b>	Enable automatic black level measurement and subtraction. Enabled: The camera automatically measures the base black level and compensates it (recommended). Disabled: The base black level is fixed to the default black level of the image sensor. In both cases offsets can be programmed which are added to the measured or default base level using the <code>black_sensor</code> command or the <code>red</code> , <code>green</code> and <code>blue</code> subcommands.		
<b>Parameter</b>	enable		
<b>Type</b>	Boolean		
<b>Description</b>	Enable or disable automatic black level subtraction.		
<b>Default</b>	Enabled		

#### 7.5.3.2 video black\_sensor red

<b>Command</b>	video black_sensor red <offset>		
<b>Alias</b>	black_red	<b>Getter Function</b>	Yes
<b>Description</b>	Set red black level offset as 17 bit signed integer.		
<b>Parameter</b>	factor		
<b>Type</b>	Signed Integer		
<b>Description</b>	Red component black level offset.		
<b>Min</b>	-65536		
<b>Max</b>	65535		
<b>Default</b>	0		

#### 7.5.3.3 video black\_sensor green

<b>Command</b>	video black_sensor green <offset>		
<b>Alias</b>	black_green	<b>Getter Function</b>	Yes
<b>Description</b>	Set green black level offset as 17 bit signed integer.		
<b>Parameter</b>	factor		
<b>Type</b>	Signed Integer		
<b>Description</b>	Green component black level offset.		
<b>Min</b>	-65536		
<b>Max</b>	65535		
<b>Default</b>	0		

#### 7.5.3.4 video black\_sensor blue

<b>Command</b>	video black_sensor blue <offset>		
<b>Alias</b>	black_blue	<b>Getter Function</b>	Yes
<b>Description</b>	Set blue black level offset as 17 bit signed integer.		
<b>Parameter</b>	factor		
<b>Type</b>	Signed Integer		
<b>Description</b>	Blue component black level offset.		
<b>Min</b>	-65536		
<b>Max</b>	65535		
<b>Default</b>	0		

#### 7.5.4 video lsc

Command	video lsc <enable> (<k> <offset> <slope>)			
Alias	lsc	Getter Function	Yes	
Description	<p>Configure lens shading correction. The parameters k, offset and slope are optional and given as 2.30 fixed point numbers. If any of the 3 parameters shall be changed, all 3 must be specified!</p> <p>For details on how to calibrate LSC for a specific lens see below.</p> <p>To set a preset for an officially supported lens use the <code>lsc preset</code> subcommand.</p>			
Parameter	enable	k	offset	slope
Type	Boolean	Unsigned 2.30 Fixed Point Number		
Description	Enable or disable correction.	Natural vignetting correction factor.	Artificial vignetting correction offset.	Artificial vignetting correction slope.
Min	0 (Off)	0.0 = 0	0.0 = 0	0.0 = 0
Max	1 (On)	2.0 = 2147483648	1.0= 1073741824	2.0 = 2147483648

Default	Off	0.0 = 0	0.0 = 0	0.0 = 0
---------	-----	---------	---------	---------

Due to the physical properties of the lenses used in optical imaging a reduction of the luminescence occurs from the middle of the image sensor to its borders. This is commonly known as vignetting. This effect can be separated into natural and artificial vignetting, both can be corrected using the lens shading correction function.

Please note that this is an advanced feature that requires the right measurement equipment to be setup correctly (see setup instructions at the end of this chapter). The lens shading correction uses a correction function to increase the gain in the outer image areas. The parameter `k` configures the natural vignetting compensation (cos4 compensation), a higher value will result in a higher compensation. The parameters `offset` and `slope` configure the artificial vignetting compensation. If the value for `offset` is increased, the radius where the compensation starts will be increased (moved to the image border). The higher the `slope`, the stronger is the compensation.

To setup the lens shading correction, follow these steps:

1. Point the camera at a homogeneous light source.
2. Connect the camera to a wave monitor and select a line in the middle of the image, you should see a decrease in luminescence towards the edges of the image.
3. Enable lens shading correction, start with the parameters `k`, `offset` and `slope` set to 0.
4. Now turn up the `k` factor, this should correct the lens shading in the middle area of the image, the edges will probably still be not ideally illuminated. Make sure to not overcompensate, this will create a wavelike appearance of the luminescence on the monitor.
5. Set the `offset` to 0.5 and set to `slope` to a high value like 1.5, you should now clearly see where the compensation starts. Now adjust the `slope` until you hit the point where the luminescence starts decreasing. Finally decrease the `slope` until the result is not overcompensated anymore.
6. Make fine adjustments until you are satisfied with the result. Please note that, depending on the optical lens used, the aperture and focal length have influence on the lens shading, so you should use your default setup for configuring the compensation. Also, it might be helpful to turn of the auto exposure during the setup, see `camera auto` command.

Each PROTON camera comes pre-calibrated for officially supported lenses. To select a calibrated lens preset, use the `lsc preset` command described below.

#### 7.5.4.1 video lsc preset

Command	video lsc preset <idx>		
Alias	lsc_preset	Getter Function	Yes
Description	Apply preset for selected lens. Setting a preset automatically enables the lens shade correction. Use the <code>preset list</code> subcommand to show all supported lenses and their corresponding indices. When called as a getter the index of the currently configured preset is returned. If a custom LSC configuration is used -1 is returned.		
Parameter	idx		
Type	Unsigned Integer		
Description	LSC preset to set.		
Valid Values	Depend on camera model, use <code>preset list</code> subcommand to get list.		
Default	-1 (no preset configured)		

##### 7.5.4.1.1 video lsc preset list

Command	video lsc preset list		
Alias	/	Getter Function	No
Description	List all available LSC presets.		

The available presets depend on the camera model and new firmware versions may add new calibration presets to the list. It is guaranteed that the index of a preset does not change between firmware releases (that means new entries are always appended to the list, the list is not reordered).

Each entry of the list consists of the preset's index followed by:

- Horizontal angle of aperture in degree
- Focal length in mm
- Aperture in F-stops
- Length of the lens in mm
- The PROTON reference number.

The following example shows the supported presets for a PROTON CAM with firmware v1.1.1:

```
→ 1 video lsc preset list
← 0 - 124 degree: 2.2mm, F/2.2, 24mm length (PCI-LENS-22-22)
← 1 - 110 degree: 2.7mm, F/2.8, 22mm length (PCI-LENS-27-28)
← 2 - 97 degree: 3.2mm, F/2.3, 22.5mm length (PCI-LENS-32-23)
← 3 - 88 degree: 3.9mm, F/2.8, 22.2mm length (PCI-LENS-39-28)
← 4 - 85 degree: 4.2mm, F/1.9, 30mm length (PCI-LENS-42-19)
← 5 - 68 degree: 6mm, F/1.7, 31.3mm length (PCI-LENS-60-17)
← 6 - 52 degree: 7.8mm, F/2.0, 34.4mm length (PCI-LENS-78-20)
← 7 - 35 degree: 12mm, F/2.0, 24mm length (PCI-LENS-120-20)
← OK
```

## 7.5.5 video wb

<b>Command</b>	video wb		
<b>Alias</b>	wb	<b>Getter Function</b>	No
<b>Description</b>	Run auto white balance once and adjust color temperature at the next frame end. Has no effect if continuous auto white balance is currently enabled. For manual white balance and configuration of the auto white balance, see subcommands.		

### 7.5.5.1 video wb gain

<b>Command</b>	video wb gain <red> <green> <blue>		
<b>Alias</b>	wb_gain	<b>Getter Function</b>	Yes
<b>Description</b>	Set RGB white balance gains. All values are in 4.8 fixed point format with a range of [0.0 = 0, 15.999 = 4095] (1.0 = 256). The gain values will be overridden when a color temperature or white balance preset is set. To set a single gain value use the subcommands. When auto white balance is enabled, this command returns the currently configured gains and setting it is not possible.		
<b>Parameter</b>	red	green	blue
<b>Type</b>	Unsigned 4.8 Fixed Point Number		
<b>Description</b>	Red gain.	Green gain.	Blue gain.
<b>Min</b>	0.0 = 0		
<b>Max</b>	15.999 = 4095		
<b>Default</b>	Values for color temperature 6500K, depends on camera calibration.		

#### 7.5.5.1.1 video wb gain red

<b>Command</b>	video wb gain red <gain>		
<b>Alias</b>	gain_red	<b>Getter Function</b>	Yes
<b>Description</b>	Set red white balance gain in 4.8 fixed point format (1.0 = 256).		
<b>Parameter</b>	gain		
<b>Type</b>	Unsigned 4.8 Fixed Point Number		
<b>Description</b>	Red white balance gain.		
<b>Min</b>	0.0 = 0		
<b>Max</b>	15.999 = 4095		

<b>Default</b>	Value for color temperature 6500K, depends on camera calibration.
----------------	---

#### 7.5.5.1.2 video wb gain green

<b>Command</b>	video wb gain green <gain>		
<b>Alias</b>	gain_green	<b>Getter Function</b>	Yes
<b>Description</b>	Set green white balance gain in 4.8 fixed point format (1.0 = 256).		
<b>Parameter</b>	gain		
<b>Type</b>	Unsigned 4.8 Fixed Point Number		
<b>Description</b>	Green white balance gain.		
<b>Min</b>	0.0 = 0		
<b>Max</b>	15.999 = 4095		
<b>Default</b>	Value for color temperature 6500K, depends on camera calibration.		

#### 7.5.5.1.3 video wb gain blue

<b>Command</b>	video wb gain blue <gain>		
<b>Alias</b>	gain_blue	<b>Getter Function</b>	Yes
<b>Description</b>	Set blue white balance gain in 4.8 fixed point format (1.0 = 256).		
<b>Parameter</b>	gain		
<b>Type</b>	Unsigned 4.8 Fixed Point Number		
<b>Description</b>	Blue white balance gain.		
<b>Min</b>	0.0 = 0		
<b>Max</b>	15.999 = 4095		
<b>Default</b>	Value for color temperature 6500K, depends on camera calibration.		

#### 7.5.5.2 video wb color\_cross

<b>Command</b>	video wb color_cross <c0> ... <c8>		
<b>Alias</b>	color_cross	<b>Getter Function</b>	Yes
<b>Description</b>	Manually set color cross-talk matrix. The matrix consists of 9 coefficients which are in signed 4.12 fixed point format with a range of [-8.0 = -16384, 8.0 = 16383]. Usually, the matrix is set automatically by selecting a white balance temperature or preset. When auto white balance is enabled, this command returns the currently configured matrix and setting it is not possible.		
<b>Parameter</b>	c0 ... c8		
<b>Type</b>	Signed 4.12 Fixed Point Number		
<b>Description</b>	Natural vignetting correction factor.		
<b>Min</b>	-8.0 = -16384		
<b>Max</b>	7.999 = 16383		
<b>Default</b>	Values for color temperature 6500K, depends on camera calibration.		

The cross-talk matrix is applied in RGB domain:

$$red_{out} = red_{in} * c_0 + green_{in} * c_1 + blue_{in} * c_2$$

$$green_{out} = red_{in} * c_3 + green_{in} * c_4 + blue_{in} * c_5$$

$$blue_{out} = red_{in} * c_6 + green_{in} * c_7 + blue_{in} * c_8$$

To disable the cross-talk module completely, the identity matrix must be programmed:

$$\begin{matrix} c_0 & c_1 & c_2 & 1.0 & 0 & 0 & 4096 & 0 & 0 \\ c_3 & c_4 & c_5 & 0 & 1.0 & 0 & 0 & 4096 & 0 \\ c_6 & c_7 & c_8 & 0 & 0 & 1.0 & 0 & 0 & 4096 \end{matrix}$$

Example:

```
→ 1 video wb color_cross 4096 0 0 0 4096 0 0 0 4096
← OK
```

### 7.5.5.3 video wb temp

<b>Command</b>	video wb temp <color_temp>		
<b>Alias</b>	wb_temp	<b>Getter Function</b>	Yes
<b>Description</b>	Set white balance temperature in Kelvin. When a custom color temperature is configured by manually changing the white balance gains or color cross-talk matrix a color temperature of 0 will be returned. When auto white balance is enabled, this command returns the currently configured temperature and setting it is not possible.		
<b>Parameter</b>	color_temp		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	Color temperature in Kelvin.		
<b>Min</b>	2400		
<b>Max</b>	10000		
<b>Default</b>	6500		

### 7.5.5.4 video wb preset

<b>Command</b>	video wb preset <id>		
<b>Alias</b>	wb_preset	<b>Getter Function</b>	No
<b>Description</b>	Set white balance preset. To get supported presets call command without arguments. This command is for compatibility with the ProVideo protocol, it is recommended to use the wb_temp command instead which allows for continuous white balance control. Setting a preset is not possible when auto white balance is enabled.		
<b>Parameter</b>	id		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	White balance preset ID.		
<b>Valid Values</b>	0 = Tungsten 2800 (2800K) 1 = Tungsten 3200 (3200K) 2 = Fluorescent TL84 (4200K) 3 = Flash (5000K) 4 = Daylight D55 (5500K) 5 = Daylight D60 (6000K) 6 = Daylight D65 (6500K) 7 = Shady (7500K) 8 = Cloudy (8500K) 9 = Blue Sky (10000K)		
<b>Default</b>	6 = Daylight D65 (6500K)		

When called without arguments it prints a list of all supported white balance presets:

```

→ 1 wb_preset
← 0= Tungsten 2800 (2800K)
← ...
← 9= Blue Sky (10000K)
← OK
  
```

Note that the command name is not printed (it is not a typical getter command) and that there are no spaces in front of the “=” and between the description and the “(“. This is according to the ProVideo protocol.

### 7.5.5.5 video wb auto

<b>Command</b>	video wb auto <enable>		
<b>Alias</b>	awb	<b>Getter Function</b>	Yes
<b>Description</b>	Enable continuous auto white balance. The camera will automatically determine the current color temperature and adjust the white balance gains and color cross matrix accordingly. The detected color temperature and resulting settings can be read back using the wb_temp, wb_gain and wb_color_cross commands, it is not possible to set them manually while the automatic is enabled. When auto white balance is switched from on to off the color temperature stays at the last measured value. To run single-shot white balance or configure AWB behavior, see subcommands.		



<b>Parameter</b>	enable
<b>Type</b>	Boolean
<b>Description</b>	Enable or disable continuous auto white balance.
<b>Default</b>	Enabled

#### 7.5.5.5.1 video wb auto speed

<b>Command</b>	video wb auto speed <speed>		
<b>Alias</b>	awb_speed	<b>Getter Function</b>	Yes
<b>Description</b>	Set control speed of the auto white balance algorithm: 0: Slow (default) 1: Medium 2: Fast		
<b>Parameter</b>	speed		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	Auto white balance control speed.		
<b>Allowed Values</b>	0: Slow 1: Medium 2: Fast		
<b>Default</b>	0: Slow		

#### 7.5.5.5.2 video wb auto offset

<b>Command</b>	video wb auto offset <offset>		
<b>Alias</b>	awb_offset	<b>Getter Function</b>	Yes
<b>Description</b>	Set color temperature offset in Kelvin which is added to the color temperature which is measured by the auto white balance algorithm. A negative offset results in a blueish output image, a positive offset in a reddish image. The default is 0 (neutral).		
<b>Parameter</b>	offset		
<b>Type</b>	Signed Integer		
<b>Description</b>	Color temperature offset in Kelvin.		
<b>Min</b>	-2000		
<b>Max</b>	2000		
<b>Default</b>	0		

### 7.5.6 video bpc

<b>Command</b>	video bpc		
<b>Alias</b>	bpc	<b>Getter Function</b>	Yes
<b>Description</b>	Show current bad pixel calibration status: 0: Uncalibrated 1: Calibrated		

PROTON cameras do not have an on-the-fly bad pixel detection mechanism as these typically find a lot of false positives which degrades the image quality. Instead, a static calibration is used.

Each camera is calibrated during production. If new defects become visible during operation, you can re-run the calibration anytime using the `video bpc calibrate` command described below.

#### 7.5.6.1 video bpc calibrate

<b>Command</b>	video bpc calibrate		
<b>Alias</b>	dpc_auto_load	<b>Getter Function</b>	No
<b>Description</b>	Run automatic bad pixel calibration. For correct results this must be done with the lens cap installed! The calibration data is considered critical, so it is not cleared by the <code>settings reset</code> command.		

**Caution:** For the calibration to work properly it is crucial that the lens cap is installed, otherwise the detected bad pixels will not be correct!

**Note:** Although `dpc` would be a legal shorthand of the `dpc_auto_load` alias (since it is unambiguous) the camera will not accept it to avoid confusion with the `dpc` command from the ProVideo protocol which is not supported by PROTON OS.

### 7.5.7 video flare

<b>Command</b>	video flare <red/all> (<green> <blue>)		
<b>Alias</b>	flare	<b>Getter Function</b>	Yes
<b>Description</b>	Set RGB flare compensation values. All values are 16 bit unsigned integers with a range of [0, 65535]. If only one value is given, all offsets are set to the same value. Otherwise, all three values must be given. To set a single value use the subcommands.		
<b>Parameter</b>	red/all	green	blue
<b>Type</b>	Unsigned Integer		
<b>Description</b>	Red or all components compensation value.	Optional green compensation value.	Optional blue compensation value.
<b>Min</b>	0		
<b>Max</b>	65535		
<b>Default</b>	0		

#### 7.5.7.1 video flare red

<b>Command</b>	video flare red <offset>		
<b>Alias</b>	flare_red	<b>Getter Function</b>	Yes
<b>Description</b>	Set red flare compensation value as 16 bit integer.		
<b>Parameter</b>	factor		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	Red component flare compensation value.		
<b>Min</b>	0		
<b>Max</b>	65535		
<b>Default</b>	0		

#### 7.5.7.2 video flare green

<b>Command</b>	video flare green <offset>		
<b>Alias</b>	flare_green	<b>Getter Function</b>	Yes
<b>Description</b>	Set green flare compensation value as 16 bit integer.		
<b>Parameter</b>	factor		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	Green component flare compensation value.		
<b>Min</b>	0		
<b>Max</b>	65535		
<b>Default</b>	0		

#### 7.5.7.3 video flare blue

<b>Command</b>	video flare blue <offset>		
<b>Alias</b>	flare_blue	<b>Getter Function</b>	Yes
<b>Description</b>	Set blue flare compensation value as 16 bit integer.		
<b>Parameter</b>	factor		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	Blue component flare compensation value.		
<b>Min</b>	0		
<b>Max</b>	65535		
<b>Default</b>	0		

### 7.5.8 video color\_space

<b>Command</b>	video color_space <id>		
<b>Alias</b>	color_space	<b>Getter Function</b>	Yes
<b>Description</b>	Set color space. To list all color spaces, use the <code>color_space list</code> subcommand. Depending on the color space the RGB-to-YUV color conversion matrix is set.		
<b>Parameter</b>	id		

<b>Type</b>	Unsigned Integer
<b>Description</b>	Color space to set.
<b>Valid Values</b>	0 = BT.709 (HD / SDR) 1 = BT.2020 (UHD / HDR)
<b>Default</b>	0 = BT.709 (HD / SDR)

#### 7.5.8.1 video\_color\_space list

<b>Command</b>	video_color_space list		
<b>Alias</b>	/	<b>Getter Function</b>	No
<b>Description</b>	List all color spaces.		

This command is mainly intended for interactive use. A controller can expect all modes to be available for every camera model.

### 7.5.9 video\_sdi\_range

<b>Command</b>	video_sdi_range <range>		
<b>Alias</b>	sdi_range	<b>Getter Function</b>	Yes
<b>Description</b>	Set SDI output range: 0 = Limited or Legal range: SDI standard. Y values are limited to the range [64, 940] and chroma values to [64, 960]. 1 = Full range: Maximum dynamic. Y and chroma values are limited to the range [4, 1019]. Note that the output range is forced to full range if the lut_mode is set to S-Log3 as the standard requires it. You can still change the output range, but the setting will only be applied once S-Log3 mode is deactivated.		
<b>Parameter</b>	range		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	SDI range to set.		
<b>Valid Values</b>	0 = Limited (SDI Standard) 1 = Full (Maximum Dynamic)		
<b>Default</b>	0 = Limited		

### 7.5.10 video\_filter

<b>Command</b>	video_filter <enable>		
<b>Alias</b>	filter_enable	<b>Getter Function</b>	Yes
<b>Description</b>	Enable detail (sharpening) and denoise post processing filters (0 = bypass, 1 = enabled). To achieve bypass behavior with the filter enabled, the detail level must be set to 10% and the denoise level to 0%.		
<b>Parameter</b>	enable		
<b>Type</b>	Boolean		
<b>Description</b>	Enable or bypass post processing filters.		
<b>Default</b>	On		

#### 7.5.10.1 video\_filter\_detail

<b>Command</b>	video_filter_detail <level>		
<b>Alias</b>	filter_detail	<b>Getter Function</b>	Yes
<b>Description</b>	Set detail (sharpening) level of the post processing filter from 0 to 100%.		
<b>Parameter</b>	level		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	Detail level in %.		
<b>Min</b>	0		
<b>Max</b>	100		
<b>Default</b>	10		

#### 7.5.10.2 video\_filter\_denoise

<b>Command</b>	video_filter_denoise <level>		
<b>Alias</b>	filter_denoise	<b>Getter Function</b>	Yes
<b>Description</b>	Set denoise level of the post processing filter from 0 to 100%.		

<b>Parameter</b>	level
<b>Type</b>	Unsigned Integer
<b>Description</b>	Denoise level in %.
<b>Min</b>	0
<b>Max</b>	100
<b>Default</b>	0

### 7.5.11 video mcc

<b>Command</b>	video mcc <enable>		
<b>Alias</b>	mcc	<b>Getter Function</b>	Yes
<b>Description</b>	Enable multi matrix color correction (0 = bypass, 1 = enabled).		
<b>Parameter</b>	enable		
<b>Type</b>	Boolean		
<b>Description</b>	Enable or bypass multi matrix.		
<b>Default</b>	Off		

For details on how the multi matrix color correction works, see description of the `mcc mode` and `mcc phase` commands below.

#### 7.5.11.1 video mcc mode

<b>Command</b>	video mcc mode <mode>		
<b>Alias</b>	mcc_opmode	<b>Getter Function</b>	Yes
<b>Description</b>	Set MCC operating mode which defines the number of active phases. To get supported modes use the <code>mcc mode list</code> subcommand.		
<b>Parameter</b>	mode		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	Set MCC mode which defines number of active phases.		
<b>Valid Values</b>	0 = 12 phases 1 = 16 phases 2 = 24 phases 3 = 32 phases		
<b>Default</b>	2 = 24 phases		

The multi matrix module splits the color of the input image into equally sized parts depending on the hue which we call phases. Below are examples for 12 and 24 phases. The numbers in the segments are the IDs of the according MCC phases.

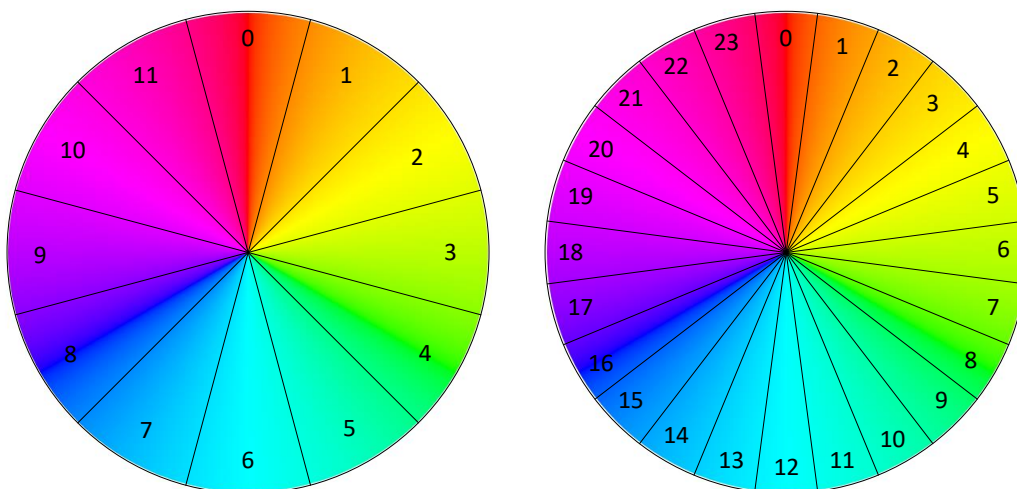


Figure 2: Example of 12 and 24 MCC Phases.

Note that phase 0 is always at the top in the red part of the color circle.

#### 7.5.11.1.1 video mcc mode list

<b>Command</b>	video mcc mode list
----------------	---------------------

<b>Alias</b>	/	<b>Getter Function</b>	No
<b>Description</b>	List all MCC operational modes.		

This command is mainly intended for interactive use. A controller can expect all modes to be available for every camera model.

#### 7.5.11.2 video mcc phase

<b>Command</b>	video mcc phase <id> (<saturation> <hue>)		
<b>Alias</b>	mcc_set	<b>Getter Function</b>	Yes
<b>Description</b>	Set one phase of the multi matrix consisting of a saturation and a hue value. The number of phases that can be set depends on the currently configured MCC mode. The saturation is an unsigned fixed point integer in 2.14 format, range [0.0 = 0, 3.999 = 35535], default: 1.0 = 16384. The hue is a signed fixed point integer in 1.15 format, range [-1.0 = -32768, 0.999 = 32767], default: 0.0 = 0. When saturation and hue are not specified the phase with the given ID is printed. When no parameter is given all active segments are printed.		
<b>Parameter</b>	id	saturation	hue
<b>Type</b>	Unsigned Integer	Unsigned 2.14 Fixed Point Number	Signed 1.15 Fixed Point Number
<b>Description</b>	ID of the phase to configure.	Saturation factor of given phase.	Hue angle of given phase.
<b>Min</b>	0	0.0 = 0	-1.0 = -32768 → -180°
<b>Max</b>	(Number of Phases) – 1 Example: 23 for 24 phases	3.999 = 65535	0.999 = 32767 → 179.999°
<b>Default</b>	/	1.0 = 16384	0.0 = 0 = → 0°

Each phase controls one of the pie segments shown in Figure 2. The number of segments depends on the `mcc mode` setting.

For each phase / segment the saturation and hue can be adjusted independently. The saturation value is a factor by which the saturation is either increased (if >1.0) or decreased (if <1.0). The hue specifies the angle by which the color in the selected phase is shifted. Negative values shift the color counterclockwise, positive values clockwise. A value of +1.0 or -1.0 result in a +/- 180° rotation. The example below shows how the hue works for phase 0:

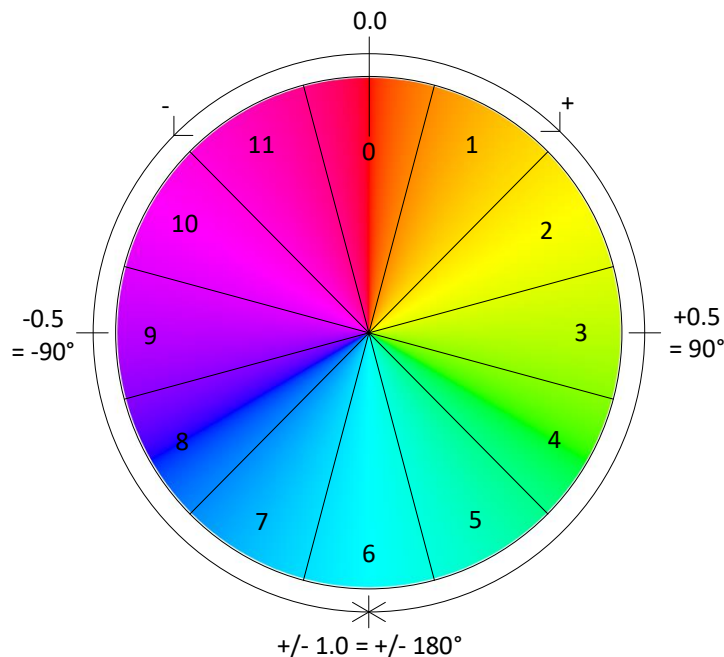


Figure 3: Hue Example for Phase 0.

#### 7.5.11.3 video mcc blink

Command	video mcc blink <mask> (<period>)		
Alias	mcc_blink	Getter Function	Yes
Description	<p>Toggle blinking of masked multi matrix phases. Can be used to highlight areas in the image affected by certain phases.</p> <p>The mask parameter is a bit-mask where each bit represents one phase of the multi matrix.</p> <p>The optional period parameter defines the blink period in ms. The blink state will toggle every (period / 2) ms. If no period is specified, the default of 1s will be used, the minimum period is 100ms, the maximum 10s.</p> <p>This setting is not saved, that means after a reboot or power cycle blinking will always be disabled!</p>		
Parameter	mask	period	
Type	Unsigned Integer	Unsigned Integer	
Description	Each bit selects one phase for blinking.	Optional blinking period in ms.	
Min	0x00000000	100	
Max	Depends on number of active phases: 12 phases: 0x0000FFFF 16 phases: 0x0000FFFF 24 phases: 0x00FFFFFF 32 phases: 0xFFFFFFFF	10000	
Default	0	1000	

#### 7.5.12 video black\_master

Command	video black_master <red/all> (<green> <blue>)		
Alias	black_master	Getter Function	Yes
Description	<p>Set all master black offsets. All values are 12 bit signed integers with a range of [-2048, 2047].</p> <p>The offsets are added, that means positive values increase the black level and negative values decrease the black level.</p> <p>If only one value is given, all offsets are set to the same value. Otherwise, all three values must be given.</p> <p>To set a single offset value use the subcommands.</p>		
Parameter	red/all	green	blue
Type	Signed Integer		

Description	Red or all components master black offset.	Optional green offset.	Optional blue offset.
Min		-2048	
Max		2047	
Default		0	

#### 7.5.12.1 video black\_master red

Command	video black_master red <offset>		
Alias	black_master_red	Getter Function	Yes
Description	Set red master black offset as 12 bit signed integer.		
Parameter	factor		
Type	Signed Integer		
Description	Red component master black offset.		
Min	-2048		
Max	2047		
Default	0		

#### 7.5.12.2 video black\_master green

Command	video black_master green <offset>		
Alias	black_master_green	Getter Function	Yes
Description	Set green master black offset as 12 bit signed integer.		
Parameter	factor		
Type	Signed Integer		
Description	Green component master black offset.		
Min	-2048		
Max	2047		
Default	0		

#### 7.5.12.3 video black\_master blue

Command	video black_master blue <offset>		
Alias	black_master_blue	Getter Function	Yes
Description	Set blue master black offset as 12 bit signed integer.		
Parameter	factor		
Type	Signed Integer		
Description	Blue component master black offset.		
Min	-2048		
Max	2047		
Default	0		

#### 7.5.13 video knee

Command	video knee <enable> (<point> <slope>)		
Alias	knee	Getter Function	Yes
Description	Configure knee function for highlight limiting defined by the starting point in percent and the slope in degree. Until the starting point a 1:1 mapping of input to output value is used. After the starting point a root function is used. For a slope of 45° it also has a 1:1 mapping which equals bypass behavior. For angles <45° highlights get limited, for angles >45° highlights get boosted. If either point or slope shall be changed both must be specified, if only enable shall be changed both can be omitted.		
Parameter	enable	point	slope
Type	Boolean	Unsigned Integer	Unsigned Integer
Description	Enable or bypass knee module.	Knee starting point in percent.	Knee angle in degree.
Min	0 = Bypass	0	0
Max	1 = Enable	100	90
Default	0 = Bypass	85	45

The following figure visualizes how the knee function works:

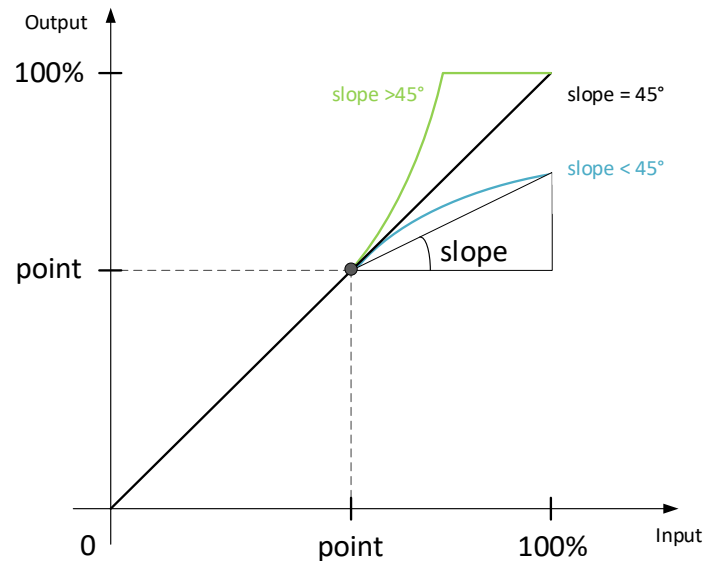


Figure 4: Knee Function Diagram.

Up to the knee `point` the output function is linear with a 1:1 mapping. From there on the function depends on the `slope` which describes the opening angle of the triangle that connects the knee point and output value at 100% input value.

- For a `slope` of  $45^\circ$  the output stays linear with a 1:1 mapping causing bypass behavior.
- The blue line shows a `slope`  $< 45^\circ$  which limits highlights and reduces the maximum output value.
- The green line shows a `slope`  $> 45^\circ$  which boosts highlights and causes big input values to get clipped to white.

Typical values for the knee `point` range from 60% to 90% while the `slope` is usually set to  $20^\circ$  to  $40^\circ$  for highlight limiting.

### 7.5.14 video lut

<b>Command</b>	video lut (<index>) <enable>		
<b>Alias</b>	lut_enable	<b>Getter Function</b>	Yes
<b>Description</b>	Enable gamma LUT (0 = bypass, 1 = enabled). The gamma LUT transforms the linear RGB signal into the gamma space that is expected by a monitor or recorder. If called via the alias <code>lut_enable</code> this function expects two arguments: Index and enable flag. Since only one LUT is supported, the index is always 0. This is done for compatibility with the ProVideo protocol.		
<b>Parameter</b>	index	enable	
<b>Type</b>	Unsigned Integer	Boolean	
<b>Description</b>	Optional LUT index for compatibility with ProVideo protocol.	Enable or bypass gamma LUT.	
<b>Valid Values</b>	0	0 / 1	
<b>Default</b>	/	1 = On	

Examples with and without the optional index that are functionally identical:

```
→ 1 video lut 1
← OK
→ 1 lut_enable 0 1
← OK
```



#### 7.5.14.1 video lut mode

<b>Command</b>	video lut mode <mode>		
<b>Alias</b>	log_mode	<b>Getter Function</b>	Yes
<b>Description</b>	Set LUT mode. To list all modes, use the <code>lut mode list</code> subcommand. Note that in S-Log3 mode the SDI output range (see <code>video sdi_range</code> command) is forced to full range as this is required by the standard. When a different mode is selected the previous SDI range setting is restored.		
<b>Parameter</b>	mode		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	Gamma LUT mode.		
<b>Valid Values</b>	0 = REC.709 1 = BT.2100 HLG 2 = BT.2100 PQ 3 Sony S-Log3		
<b>Default</b>	0 = REC.709		

For **SDR content** the default REC.709 gamma curve is used. For **HDR productions** you can select from HLG, PQ or S-Log3 gamma curves which have a higher dynamic compression.

While the HLG curve is fixed you can make adjustments in the other modes:

- REC.709: Adjust gamma value (`lut gamma` subcommand).
- PQ: Set maximum display brightness (`lut max_brightness` subcommand).
- S-Log3: Set master gain (`lut master_gain` subcommand).

##### 7.5.14.1.1 video lut mode list

<b>Command</b>	video lut mode list		
<b>Alias</b>	/	<b>Getter Function</b>	No
<b>Description</b>	List all LUT operational modes.		

This command is mainly intended for interactive use. A controller can expect all modes to be available for every camera model.

#### 7.5.14.2 video lut gamma

<b>Command</b>	video lut gamma <value>		
<b>Alias</b>	lut_fast_gamma	<b>Getter Function</b>	Yes
<b>Description</b>	Only applicable if <code>lut mode</code> is set to 0 = REC.709. Set gamma value of gamma curve. The value includes the scaling factor 1000 which results in a range of [1100, 3000] which equals [1.1, 3.0] in floating point numbers. The default is 2222 = 2.222 which results in a gamma curve according to the REC.709 standard. A bigger value results in a steep gamma curve, a smaller value in a flat curve.		
<b>Parameter</b>	value		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	REC.709 gamma value.		
<b>Min</b>	1.1 = 1100		
<b>Max</b>	3.0 = 3000		
<b>Default</b>	2.222 = 2222		

#### 7.5.14.3 video lut max\_brightness

<b>Command</b>	video lut max_brightness <value>		
<b>Alias</b>	pq_max_brightness	<b>Getter Function</b>	Yes
<b>Description</b>	Only applicable if <code>lut mode</code> is set to 2 = PQ. Set maximum display brightness of the PQ curve in cd/ m <sup>2</sup> . Valid range [100, 10000], default: 1000. The PQ curve uses an absolute mapping of output value to display brightness, that means the full SDI code range will be used for the maximum setting of 10000 cd/ m <sup>2</sup> . For lower settings the curve will be compressed so that highlights are mapped to the desired maximum brightness (which does reduce the used SDI code range!).		

<b>Parameter</b>	value
<b>Type</b>	Unsigned Integer
<b>Description</b>	Maximum display brightness in cd/m <sup>2</sup>
<b>Min</b>	100
<b>Max</b>	10000
<b>Default</b>	1000

#### 7.5.14.4 video lut master\_gain

<b>Command</b>	video lut master_gain <value>		
<b>Alias</b>	slog3_master_gain	<b>Getter Function</b>	Yes
<b>Description</b>	Only applicable if lut_mode is set to 3 = S-Log3. Set master gain of the S-Log3 curve in dB. Valid range [-6, 12], default: 0. The master gain compresses (or expands) the gamma curve to decrease or increase the output code values. The full SDI code range will be used for 10 dB but most workflows use 0 or -3 dB. For everything >10 dB highlights will be clipped.		
<b>Parameter</b>	value		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	S-Log3 master gain in dB.		
<b>Min</b>	-6		
<b>Max</b>	12		
<b>Default</b>	0		

#### 7.5.14.5 video lut mode\_compat

<b>Command</b>	video lut mode_compat <mode>		
<b>Alias</b>	lut_mode	<b>Getter Function</b>	Yes
<b>Description</b>	This command is only for compatibility with the ProVideo protocol to provide the lut_mode alias. The only allowed mode is '1' which is equal to "fast gamma" mode in the ProVideo protocol.		
<b>Parameter</b>	mode		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	ProVideo LUT mode for compatibility.		
<b>Valid Values</b>	1 = Fast Gamma		
<b>Default</b>	1 = Fast Gamma		

### 7.5.15 video post

<b>Command</b>	video post		
<b>Alias</b>	/	<b>Getter Function</b>	No
<b>Description</b>	Configure post processing, see subcommands for details.		

This command has no functionality, it is only used to group the post-processing subcommands (see below).

#### 7.5.15.1 video post brightness

<b>Command</b>	video post brightness <value>		
<b>Alias</b>	post_bright	<b>Getter Function</b>	Yes
<b>Description</b>	Set post processing brightness value in signed 1.7 fixed point format. Valid range [-128, 127] = [-1.0, 1.0), default (neutral) is 0 = 0.0. Instead of changing the brightness during post processing it is recommended to change exposure or gain for improved image quality.		
<b>Parameter</b>	value		
<b>Type</b>	Signed 1.7 Fixed Point Number		
<b>Description</b>	Brightness factor.		
<b>Min</b>	-1.0 = -128		
<b>Max</b>	0.999 = 127		
<b>Default</b>	0.0 = 0		

#### 7.5.15.2 video post contrast

<b>Command</b>	video post contrast <value>		
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<b>Alias</b>	post_cont	<b>Getter Function</b>	Yes
<b>Description</b>	Set post processing contrast value in unsigned 1.7 fixed point format. Valid range [0, 255] = [0.0, 2.0), default (neutral) is 128 = 1.0. Instead of changing the contrast during post processing it is recommended to turn on the flare compensation for improved image quality.		
<b>Parameter</b>	value		
<b>Type</b>	Unsigned 1.7 Fixed Point Number		
<b>Description</b>	Contrast factor.		
<b>Min</b>	0.0 = 0		
<b>Max</b>	1.999 = 255		
<b>Default</b>	1.0 = 128		

#### 7.5.15.3 video post saturation

<b>Command</b>	video post saturation <value>		
<b>Alias</b>	post_sat	<b>Getter Function</b>	Yes
<b>Description</b>	Set post processing saturation value in 1.7 fixed point format. Valid range [0, 255] = [0.0, 2.0), default (neutral) is 128 = 1.0.		
<b>Parameter</b>	value		
<b>Type</b>	Unsigned 1.7 Fixed Point Number		
<b>Description</b>	Saturation factor.		
<b>Min</b>	0.0 = 0		
<b>Max</b>	1.999 = 255		
<b>Default</b>	1.0 = 128		

#### 7.5.15.4 video post hue

<b>Command</b>	video post hue <value>		
<b>Alias</b>	post_hue	<b>Getter Function</b>	Yes
<b>Description</b>	Set post processing hue value in signed 1.7 fixed point format. Valid range [-128, 127] = [-1.0, 1.0) = [-90°, 90°), default (neutral) is 0 = 0.0 = 0°.		
<b>Parameter</b>	value		
<b>Type</b>	Signed 1.7 Fixed Point Number		
<b>Description</b>	Brightness factor.		
<b>Min</b>	-1.0 = -128 → -90°		
<b>Max</b>	0.999 = 127 → 90°		
<b>Default</b>	0.0 = 0 → 0°		

### 7.5.16 video osd

<b>Command</b>	video osd <mode>		
<b>Alias</b>	osd	<b>Getter Function</b>	Yes
<b>Description</b>	Set on-screen display mode. To get a list of supported modes use the osd list subcommand.		
<b>Parameter</b>	mode		
<b>Type</b>	Unsigned Integer		
<b>Description</b>	Gamma LUT mode.		
<b>Valid Values</b>	0 = Disabled 1 = Show PROTON logo in top-right corner		
<b>Default</b>	0 = Disabled		

Note that while the command syntax is identical to the ProVideo protocol, the available OSDs modes differ.

#### 7.5.16.1 video osd list

<b>Command</b>	video osd list		
<b>Alias</b>	/	<b>Getter Function</b>	No
<b>Description</b>	List all OSD modes.		

This command is mainly intended for interactive use. A controller can expect all modes to be available for every camera model.

## 8 Alias Reference

This chapter lists all the available command alias which also provide compatibility with the ProVideo protocol. Note that some aliases are not part of the ProVideo protocol but have been added for convenience.

The list below can also be generated by the camera with the `alias` command.

Table 7: Command alias overview.

Alias	Full Command Name	ProVideo Command
<b>cam_gain</b>	camera gain	Yes
<b>cam_exposure</b>	camera exposure	Yes
<b>low_light</b>	camera low_light	No
<b>cam_info</b>	camera info	Yes
<b>aec</b>	camera auto	Yes
<b>aec_mode</b>	camera auto mode	No
<b>aec_target</b>	camera auto target	No
<b>aec_speed</b>	camera auto speed	No
<b>aec_max_gain</b>	camera auto max_gain	No
<b>aec_anti_flicker</b>	camera auto anti_flicker	No
<b>aec_custom</b>	camera auto custom	No
<b>aec_weight</b>	camera auto weight	Yes
<b>save_settings</b>	settings save	Yes
<b>load_settings</b>	settings load	Yes
<b>reset_settings</b>	settings reset	Yes
<b>auto_save</b>	settings auto_save	Yes
<b>version</b>	system info	Yes
<b>name</b>	system name	Yes
<b>runtime</b>	system runtime	Yes
<b>reboot</b>	system reboot	Yes
<b>update</b>	system update	No
<b>identify</b>	system identify	Yes
<b>error</b>	system error	No
<b>volatile</b>	system volatile	Yes
<b>rs485</b>	system rs485	No
<b>prompt</b>	system rs485 mode	Yes
<b>controller</b>	system rs485 mode 0	No
<b>interactive</b>	system rs485 mode 1	No
<b>rs485_addr</b>	system rs485 device_address	Yes
<b>rs485_bc_addr</b>	system rs485 broadcast_address	Yes
<b>rs485_bc_master</b>	system rs485 broadcast_master	Yes
<b>rs485_baud</b>	system rs485 baudrate	Yes
<b>status_led</b>	system status_led	No
<b>tally</b>	system tally	No
<b>temp</b>	system temp	Yes
<b>max_temp</b>	system temp max	Yes
<b>max_temp_reset</b>	system temp reset	Yes
<b>over_temp_count</b>	system temp count	Yes

Alias	Full Command Name	ProVideo Command
audio_enable	system audio	Yes
audio_gain	system audio gain	Yes
timecode_enable	system timecode	No
timecode	system timecode value	Yes
timecode_hold	system timecode pause	Yes
timecode_drop	system timecode drop	No
video_mode	video mode	Yes
flip	video flip	Yes
black_sensor	video black_sensor	No
black_auto	video black_sensor auto	No
black_red	video black_sensor red	Yes
black_green	video black_sensor green	Yes
black_blue	video black_sensor blue	Yes
lsc	video lsc	Yes
lsc_preset	video lsc preset	No
wb	video wb	Yes
wb_gain	video wb gain	No
gain_red	video wb gain red	Yes
gain_green	video wb gain green	Yes
gain_blue	video wb gain blue	Yes
color_cross	video wb color_cross	Yes
wb_temp	video wb temp	No
wb_preset	video wb preset	Yes
awb	video wb auto	Yes
awb_speed	video wb auto speed	Yes
awb_offset	video wb auto offset	No
bpc	video bpc	No
dpc_auto_load	video bpc calibrate	Yes
flare	video flare	Yes
flare_red	video flare red	No
flare_green	video flare green	No
flare_blue	video flare blue	No
color_space	video color_space	Yes
sdi_range	video sdi_range	Yes
filter_enable	video filter	Yes
filter_detail	video filter detail	Yes
filter_denoise	video filter denoise	Yes
mcc	video mcc	Yes
mcc_opmode	video mcc mode	Yes
mcc_set	video mcc phase	Yes
mcc_blink	video mcc blink	Yes
black_master	video black_master	Yes
black_master_red	video black_master red	No
black_master_green	video black_master green	No

Alias	Full Command Name	ProVideo Command
<b>black_master_blue</b>	video black_master blue	No
<b>knee</b>	video knee	Yes
<b>lut_enable</b>	video lut	Yes
<b>log_mode</b>	video lut mode	Yes
<b>lut_fast_gamma</b>	video lut gamma	Yes
<b>pq_max_brightness</b>	video lut max_brightness	Yes
<b>slog3_master_gain</b>	video lut master_gain	Yes
<b>lut_mode</b>	video lut mode_compat	Yes
<b>post_bright</b>	video post brightness	Yes
<b>post_cont</b>	video post contrast	Yes
<b>post_sat</b>	video post saturation	Yes
<b>post_hue</b>	video post hue	Yes
<b>osd</b>	video osd	Yes
<b>cam_gain</b>	camera gain	Yes
<b>cam_exposure</b>	camera exposure	Yes
<b>low_light</b>	camera low_light	No

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## “Fast Approx” Library

PROTON OS uses the “Fast Approx” C-code library by Paul Mineiro that provides approximated versions of popular math functions.

The source code is available for download here: <https://github.com/pmineiro/fastapprox/tree/master>

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## Appendix B: Document Revision History

Date	Revision	Chapter	Changes
29. May. 2024	v1.0.0	All	Initial release.
14. Jun. 2024	V1.0.1	3	Reworked firmware update chapter for usage of the new PROTON Updater GUI which is now described in the new chapter 3.3.
		6.1	Updated list of critical settings.
		6.2, 7.2	Updated auto-save chapter and descriptions for the <code>settings reset</code> and <code>auto_save</code> commands: Auto-save is now done immediately after changing a setting.
		7.3	Updated command descriptions for the <code>system runtime</code> , <code>temp max</code> , <code>temp reset</code> , <code>temp count</code> , and <code>error</code> commands: Runtime and temperature logging are no longer persistent.
		7.3.5	Added <code>system update</code> command description.
		7.3.13.1	Updated default <code>audio gain</code> from 1.0 to 0.5.
		8	Updated alias reference.
11. Jul. 2024	V1.1.0	2.3	Updated maximum temperature, is now 100°C.
		3.3	Updated firmware update GUI chapter.
		7.4.5	Added chapter for new auto exposure control commands.
		7.5.5	Added auto white balance commands in section 7.5.5.5 and updated <code>wb</code> , <code>wb temp</code> , <code>wb gain</code> , <code>wb color_cross</code> and <code>wb preset</code> commands descriptions.
		7.3.9.5	Added new supported baud rates: 230400 and 250000 baud.
		7.3.13.1	Changed default <code>audio gain</code> from 0.5 to 1.0.
		8	Updated alias reference.
22. Jul. 2024	V1.1.1	2.2	Improve description of error state.
		3	Updated firmware update chapter.
		5.2.4	Added description of error code “-140”.
		7.3.5	Updated description of <code>system update</code> command.
		7.5.4	Added <code>lsc preset</code> command to LSC chapter.
		8	Updated alias reference.
16.-Aug-2024	V1.1.2	All	Fixed typos, no major changes.