KRON TECHNOLOGIES
HIGH-SPEED IMAGING

# CHRONOS 4K12 USER MANUAL

Rev. C

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# Preface

## Thank you for choosing a Chronos high-speed camera!

This camera was designed to be accessible to everyone, and we hope that you will experiment, explore, and create.

Please share videos, pictures, publications, and details about your use-cases with our team at any time. We would love to see what you're creating, and perhaps share it with our audience on social media, monthly newsletter, or even our website if you would like!

This guide will help you operate, troubleshoot, and get the most out of your camera and its accessories. We also advise you to read the separate document, Terms of Sale and Warranty (see website). If you have any questions about either document, please contact info@krontech.ca.

# Supporting Contacts

## Direct Support

If you have questions or concerns regarding the hardware or software of your Chronos camera or its accessories, please don't hesitate to contact us at: support@krontech.ca.

## Website Links

| | |
|---|---|
| FAQ: | https://krontech.ca/faq |
| Shipping Policy: | https://krontech.ca/shipping-policy |
| Warranty & Return: | https://krontech.ca/warranty-return |

## User Forum

The User Forum is a great way to share questions with other Chronos users, as well as get support directly from Kron Technologies staff. Use the search function on the forum to find answers to your questions.

| | |
|---|---|
| User Forum: | https://forum.krontech.ca/ |

# Table of Contents


Preface 2

Supporting Contacts 3

**1.** Unboxing & First Look 7

What's included? . . . 7

First Look . . . 9

**2.** Setup 13

2.1 Lens Installation . . . 13

2.2 Powering Up the Camera . . . 13

2.3 Main Screen Functions . . . 14

2.4 Powering Down the Camera . . . 15

**3.** Getting Ready 16

3.1 Lighting Considerations . . . 16

3.2 Setting Bit Depth . . . 16

3.3 Setting Resolution & Frame Rate . . . 17

3.4 Setting ISO Sensitivity . . . 20

3.5 Setting Exposure / Shutter Speed . . . 21

3.6 Setting White Balance . . . 22

3.7 Assistive Features . . . 25

**4.** Recording 26

4.1 Ring Buffer Concept . . . 26

4.2 Recording Time . . . 27

4.3 Setting Record Length . . . 28

## 5. Playback & Saving 30

5.1 Playback Features . . . . . 30
5.2 Saving Overview . . . . . 31
5.3 Saved File Formats . . . . . 32
5.4 Text Overlays . . . . . 33
5.5 Saving Metadata . . . . . 34
5.6 File Browser Navigation . . . . . 35
5.7 Storage Devices . . . . . 35
5.8 Transferring Files . . . . . 35
5.9 Formatting Storage Devices . . . . . 36

## 6. Triggering & Synchronization 37

6.1 Signal Conditioning . . . . . 39
6.2 Trigger Modes . . . . . 40
6.2.1 Record End Trigger Delay . . . . . 41
6.2.2 Trigger Frame . . . . . 44
6.3 Frame Synchronization Modes . . . . . 46
6.3.1 Frame Sync Outputs . . . . . 46
6.3.2 Shutter Gating Mode . . . . . 46
6.3.3 Exposure Modes . . . . . 47
6.3.4 External Timing Requirements . . . . . 48
6.4 IRIG-B Timecode Synchronization . . . . . 49

## 7. Network Interface 52

7.1 Dynamic IP Address Configuration via DHCP . . . . . 52
7.2 Static IP Address Configuration . . . . . 52

**8.** Video Output 53

**9.** Camera System Settings 54

9.1 General Screen . . . . . 54
9.2 Storage Screen . . . . . 55
9.3 Network Screen . . . . . 56
9.4 About Screen . . . . . 56
9.5 Factory Screen . . . . . 57

**10.** Optics 58

10.1 Lens Mount & Adapter . . . . . 58
10.2 Lens Selection . . . . . 58
10.3 Back Focus Adjustment . . . . . 58

**11.** Installing Software Updates 59

**12.** Troubleshooting 60

**Appendix A.** Mechanical Drawing 61

**Appendix B.** Spectra Sensitivity 62

**Appendix C.** Adapter Bracket Locations 63

# 1. Unboxing & First Look

Figure 1.1. — Components Overview

***NOTE:*** *The camera ships with the lens mount plate of your choice pre-installed from the factory.*

*Unpack the camera and accessories, and check that all ordered accessories are included. If anything is missing or damaged, please notify us immediately at support@krontech.ca.*

## What's included?

The following items are included as standard with the Chronos 4K12 Camera:

| # | ITEM | SKU | QTY | DESCRIPTION |
|---|---|---|---|---|
| 1 | Chronos 4K12 High-Speed Camera | CN4K12-1.0 | 1 | 128 GB High-Speed Camera |
| 2 | 90W DC Power Supply | DCPW-90W | 1 | GlobTek 19V, 4.73A Locking Barrel Jack Power Supply P/N: GTM96900P9019-T3Z |
| 3 | Region-Specific Power Cord | Multiple | 1 | AC-Side Power Cord |
| 4 | D-Tap to Barrel Jack Cable | BJC-DTP | 1 | Allows a V Mount Battery to power the camera. |
| 5 | Trigger Switch Cable | TRIG-CBL | 1 | 3.5m (12ft) trigger switch cable for starting and stopping recordings remotely. |
| 6 | Triple BNC Breakout Adapter | BNC-ADPT35 | 1 | Allows for connection to an optional Trigger Switch Cable or other BNC signal input to achieve record triggering. |

| # | ITEM | SKU | QTY | DESCRIPTION |
|---|---|---|---|---|
| 7 | 3.5mm to 4-pin Terminal Block | TR35-BLK4 | 1 | Allows for connection of individual signal wires from an external switch or device to the camera to achieve record triggering. |
| 8 | 3.0mm Allen Key | N/A | 1 | A tool to remove the lens plate. |
| 9 | 32 GB Full-Sized SD Card | N/A | 1 | Complimentary SD card for enabling the convenient transferring of files from your camera to a PC. |
| 10 | Body Cap, E-Mount | CNE-BDYCP | 1* | A cap to protect the image sensor from dust or contamination when the camera is not in use. |
| 11 | Lens E-Mount Plate (Pre-installed on Body) | ACC-1.0-MNTCNE | | E-Mount Option as specified at the time of your camera order. Default shim is pre-installed. |
| 12 | Body Cap, MFT | CNMFT-BDYCP | | A cap to protect the image sensor from dust or contamination when the camera is not in use. |
| 13 | Lens MFT-Mount Plate (Pre-installed on Body) | ACC-1.0-MNTCNMF | | MFT-Mount Option as specified at the time of your camera order. Default shim is pre-installed. |
| 14 | Body Cap, EF-Mount | CNEF-BDYCP | | A cap to protect the image sensor from dust or contamination when the camera is not in use. |
| 15 | Lens EF-Mount Plate (Pre-installed on Body) | ACC-1.0-MNTCNEF | | EF-Mount Option as specified at the time of your camera order. Default shim is pre-installed. |
| 16 | Body Cap, F-Mount | CNF-BDYCP | | A cap to protect the image sensor from dust or contamination when the camera is not in use. |
| 17 | Lens F-Mount Plate (Pre-installed on Body) | ACC-1.0-MNTCNF | | F-Mount Option as specified at the time of your camera order. Default shim is pre-installed. |
| 18 | Body Cap, PL-Mount | CNPL-BDYCP | | A cap to protect the image sensor from dust or contamination when the camera is not in use. |
| 19 | Lens PL-Mount Plate (Pre-installed on Body) | CNPL-ADPT | | PL-Mount Option as specified at the time of your camera order. Default shim is pre-installed. |
| 20 | Body Cap, C-Mount | CC-BDYCP | | A cap to protect the image sensor from dust or contamination when the camera is not in use. |
| 21 | 4K12 Adapter Kit , C-Mount | ACC-1.0-MNTCNC | | C-Mount Option as specified at the time of your camera order. Default shim is pre-installed. |
| 22 | Adapter Brackets Kit | CN-ALBRKT | 1 | Allows for connecting accessories to the camera. Includes two adapter brackets and four M4 screws. Refer to Appendix C for recommended mounting locations. |
| 23 | USB-C to 2.5G Ethernet Adapter | CN-ETHAD | 1 | Connects directly to the camera's USB-C port, enabling high-bandwidth data transfers and low-latency remote operation over a wired connection. |
| 24 | Lens Mount Shim Kit | ACC-1.0-MNTSHM4 | 1* | A series of spacers to adjust the back-focus distance for your selected lens mount. |
| 25 | Nanuk 920 Carrying Case | CNCAR-CA Chronos 12 Carrying Case | 1 | A hard-case with foam cut specifically to safely house your Chronos 4K12. |

* One lens mount plate of your choice is included as standard. Additional options can be ordered separately and may arrive in the same kit.

If you have ordered lenses and other accessories, please check your package contents against the invoice to make sure that your order is complete.

# First Look

Figure 1.2. — Buttons Overview

### 1.1 LED Status Camera Indicator Colors:

- Green: Camera ready to record
- Red: Recording in progress
- Blue Flashing: Saving in progress
- Orange Flashing: Camera over temperature warning

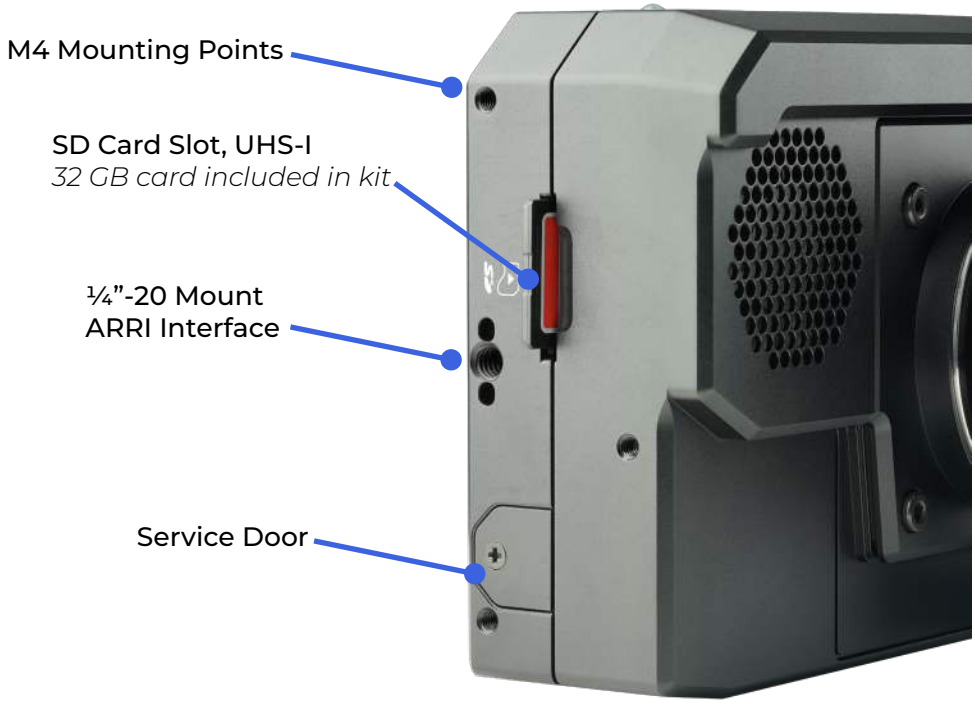
**1.2 Power Button:** When first applying power to the camera via the DC Input port, the power button LED will flash rapidly for 2 seconds. This denotes that the power management system is initializing. The power button can be pushed to start the camera after the LED stops flashing.

To prevent unintended shutdowns, the power button must be held for several seconds to request a shutdown.

***NOTE:*** *Allow the camera to finish shutting down before disconnecting the power supply.*

***NOTE:*** *If the power button is pressed within the first two seconds of supplying power to the DC Input port, the camera will boot into a mode intended for PMIC Updates. The power button will continue to flash repeatedly while in this state. The camera will automatically shut down after the PMIC Update finishes.*

Figure 1.3. — SD Cards




**1.3 Service Door:** An industrial-grade 32GB microSD card containing camera operating software is located behind the service door. Do not remove unless to reflash the card in the event of a new software update.

**1.4 ¼"-20 Mount + ARRI Interface:** The ¼"-20 mount is aligned to the vertical center of the image sensor and may be used for mounting accessories using either a ¼"-20 screw or ARRI ¼" Pin-Lock Interface.

***NOTE:*** *The ARRI ¼"-20 Pin-Lock Interface specification was revised in 2023. Accessories leveraging the previous specification have incompatible pin lock positions for use on the 4K12. However, the included Adapter Brackets Kit will make older specification accessories compatible.*

**1.5 M4 Mounting Points:** There are a total of eighteen M4 mounting points distributed around

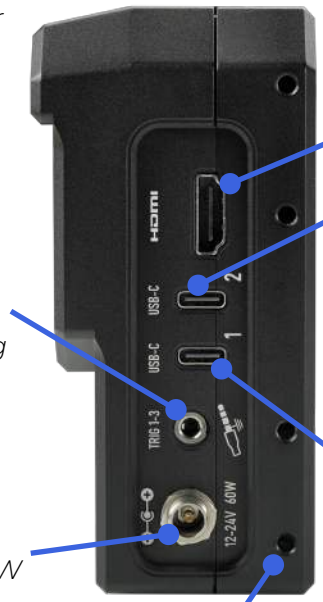
the top, right, bottom, and left sides of the camera, which are intended for supporting the camera or rigging accessories. The included Adapter Brackets Kit (KT0298-1) may be used to adapt pairs of M4 mount points with alternative mounting options, such as 1/4 20 or 3/8.

Figure 1.4. — LCD Touchscreen

### 1.6 Jog Wheel:

- Multi-functional depending on which screen is displayed
- Adjusts exposure level in live mode
- Seeks frames in playback mode
- Push wheel in (towards camera) to toggle between fine and broad sweeping while rotating
- Push wheel in (towards camera) without rotating it to “click” on a UI component in focus

Figure 1.5. — Side Panel Components




**Trigger & Sync In / Out**

*4-pin 3.5mm TRRS Connector (3 Channels + Common Ground)*

*Adjustable input threshold: 0 – 6.6 Volts*

*Frame Strobe Output & IRIG-B DCLS Timecode Input Supported*

*Refer to Chapter 6 (Triggering & Synchronization) for more information*

**HDMI**

*Video output in all common resolutions*

*Refer to Chapter 8 (Video Output) for more information*

**USB-C Port 2**

*3.2 Gen 2x2, Up to 20 Gbps*

*Host Mode Only (SSDs, Network Adapters)*

*Refer to Chapter 5 (Playback & Saving) for more information*

**USB-C Port 1**

*3.2 Gen 1, Up to 5 Gbps*

*Host Mode (SSDs, Network Adapters) or Device Mode (Direct to PC)*

**Power**

*12 - 24 Volts DC, 60 W*

*5.5 / 2.5mm Locking Barrel Jack, Positive tip*

**4 x M4 Screw Holes**

*For mounting various accessories*

***TIP:*** *AC adapters for the Chronos 1.4 and 2.1 models do not supply enough power for the 4K12; however, the 4K12's AC adapter may be used to power a Chronos 1.4 or 2.1 camera.*

**1.7 Power Supply:** Always ensure an appropriate power supply is used with the camera that is able to provide a sufficient voltage within the range of 12–24 Volts, and a minimum total power supply of 60 Watts.

**1.8 Operating Temperature:** Due to the throughput of data and the overall performance of the camera, it is normal for the camera to feel warm to the touch when in use. The camera will protect itself from overheating and warn the user (via message and flashing orange LED) if temperatures exceed operating ranges. This is only likely to occur when the exceeding ambient air temperature is 40°C / 104°F or above.

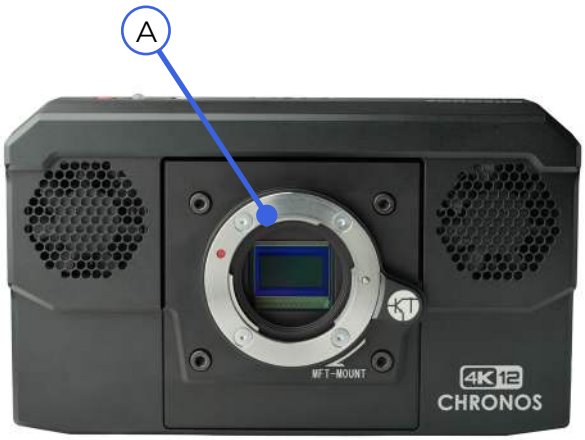
**1.9 Environmental Hazards:** The camera is not intended for use in severe environmental conditions, such as high-moisture and high-shock applications.

# 2. Setup

## 2.1 Lens Installation

The lens mount plate of your choice has been installed onto your Chronos camera body at the factory. Remove the body cap and install your lens by gently rotating the lens until it has been secured to the lens mount (A).

Figure 2.1. — Lens Installation




***NOTE:*** *The camera comes with a 1mm shim pre-installed underneath the lens mounting plate; however, the selection of shims may need to be modified in order to achieve focus at infinity with your desired lens. Refer to Section 10.3 for more information*

***NOTE:*** *Certain lenses may have the side effect of not covering the entire sensor, which will create a black ring around the periphery of the image. The phenomenon is also known as "vignetting." Please see Chapter 10 (Optics) for additional guidance on lens selection.*

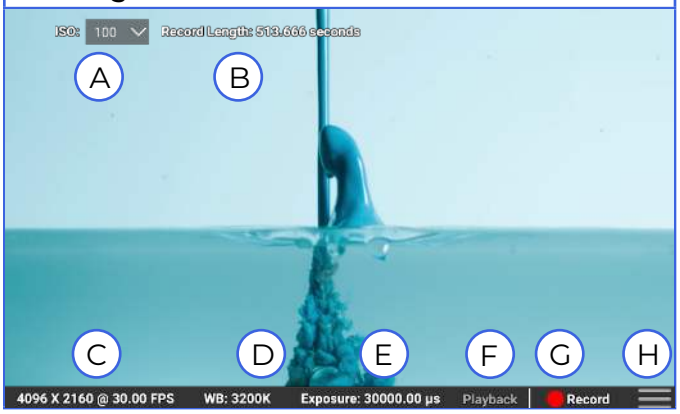
## 2.2 Powering Up the Camera

When first applying power to the camera via the DC Input port, the power button LED will flash rapidly for 2 seconds. This denotes that the power management system is initializing. After the LED stops flashing, press and release the power button to start the camera. Allow about a minute for the camera to boot and initialize itself. When the process is complete, you will be greeted by the screen shown in Figure 2.2.

Figure 2.2. — First Screen After Powering Up

## 2.3 Main Screen Functions

Figure 2.3. — Main Screen Functions




**Top Row Left to Right**

**(A) ISO Shortcut:** Quickly adjusts sensitivity. The higher the ISO, the more sensitive the camera is to light.

**(B) Record Length:** A countdown of the record time remaining. Displays a circular icon if old footage is now being overwritten.

> ***TIP:*** *Tap anywhere in the video display area to hide / show the top row indicators.*

**Bottom Row Left to Right**

**(C) Current Resolution & Frame Rate:** Tap to quickly enter the Record Settings screen.

**(D) Current White Balance Setting (Color Cameras Only):** Tap to adjust color temperature or sample a live reference.

**(E) Exposure Indicator:** Tap to adjust the exposure level. Alternatively, use the Jog Wheel to adjust the exposure. Push the scroll wheel in to toggle between fine and broad exposure adjustment.

**(F) Playback:** Will appear gray when there is no footage recorded, and turns blue when there is footage available to playback.

**(G) Record:** Start or stop a recording. Alternatively, use the red button on the top of the camera to start or stop a recording.

**(H)** ☰ **Menu Icon:** Display / hide additional menu functions and settings via the sidebar.

## 2.4 Powering Down the Camera

To turn off the camera, hold the power button for 4 seconds. This is to prevent unintended shutdowns during operation.

> ***NOTE:*** *Always ensure the power button LED indicator has turned off prior to removing the power supply / plug.*

# 3. Getting Ready

## 3.1 Lighting Considerations

High-speed cameras require much more light than conventional video cameras. Sufficient lighting is one of the most important prerequisites to high-quality slow motion footage.

> ***CONSIDER THIS:*** *A conventional video camera with a frame rate of 30 frames per second will expose, or allow light to enter the image sensor, for 1/30 of a second, or 33 milliseconds per image frame captured.*
>
> *By comparison, a high-speed camera with a frame rate of 1,000 frames per second will expose, or allow light to enter the image sensor, for 1/1000 of a second, or 1 millisecond per image frame captured.*

Therefore, it is important that the subject of the high-speed recording is illuminated by flicker-free lighting. The amount of light required for a high-speed capture will depend heavily on the desired frame rate and shutter duration, as well as the type of lens used. Kron Technologies recommends consulting with our support team at support@krontech.ca for best lighting practices with regards to your specific application.

Lights can also be purchased directly from Kron Technologies at https://www.krontech.ca/product-category/camera-lights/

## 3.2 Setting Bit Depth

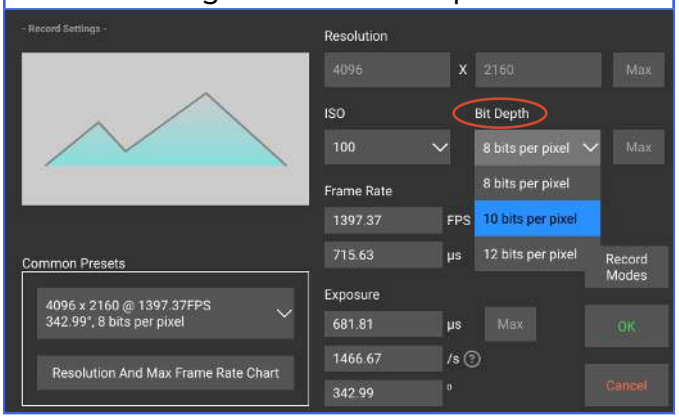
The camera's bit depth (also known as color depth) setting determines how precisely the image sensor is able to differentiate between different levels of light. A lower bit depth allows for faster frame rates in exchange for less differentiation between shades of grey or colors since less data needs to be processed. A higher bit depth allows for more differentiation between shades of gray or colors in exchange for a decrease in the maximum frame rate. See the table below as an example.

| BIT DEPTH | AVAILABLE GREYS | AVAILABLE COLORS |
|---|---|---|
| 8 bits per pixel | 256 | 18.6 million |
| 10 bits per pixel | 1024 | 1.07 billion |
| 12 bits per pixel | 4096 | 68.7 billion |

The desired bit depth may be selected from the Record Settings screen.

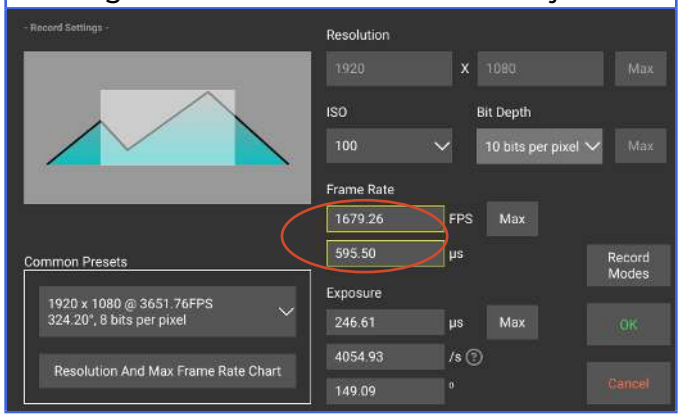
Select either 8, 10, or 12 bits per pixel from the Bit Depth dropdown menu.

Figure 3.1. — Bit Depth




When the Bit Depth is changed, the Frame Rate and Frame Period may also change to settings which are within the range supported by the newly selected Bit Depth. A yellow border indicates settings which the camera adjusted automatically.

Figure 3.2. — Auto Frame Rate Adjust




Press OK to confirm the Bit Depth adjustment and exit the Record Settings screen.

## 3.3 Setting Resolution & Frame Rate

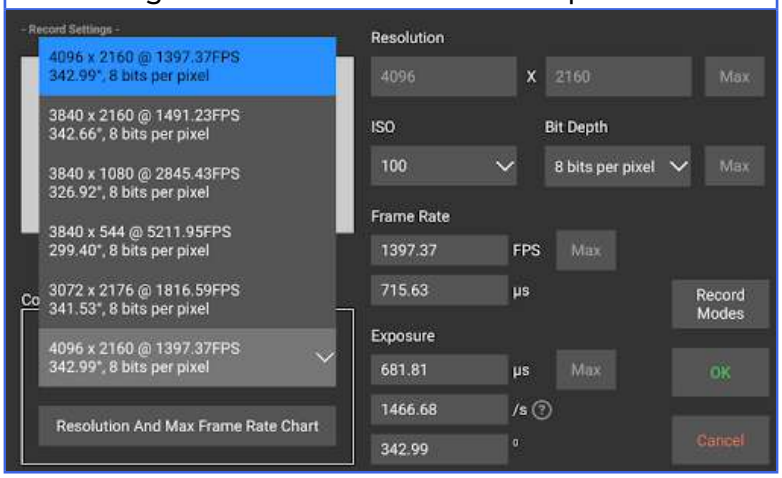
Chronos high-speed cameras allow lower resolutions to be selected in exchange for higher frame rates, and vice-versa, as long as they are within the pixel rate limitations of the system (approximately 12 Gigapixels per second).

The pixel rate can be calculated by: (Horizontal Resolution) x (Vertical Resolution) x (Frame Rate)

The desired resolution and frame rate may be selected from the Record Settings screen.

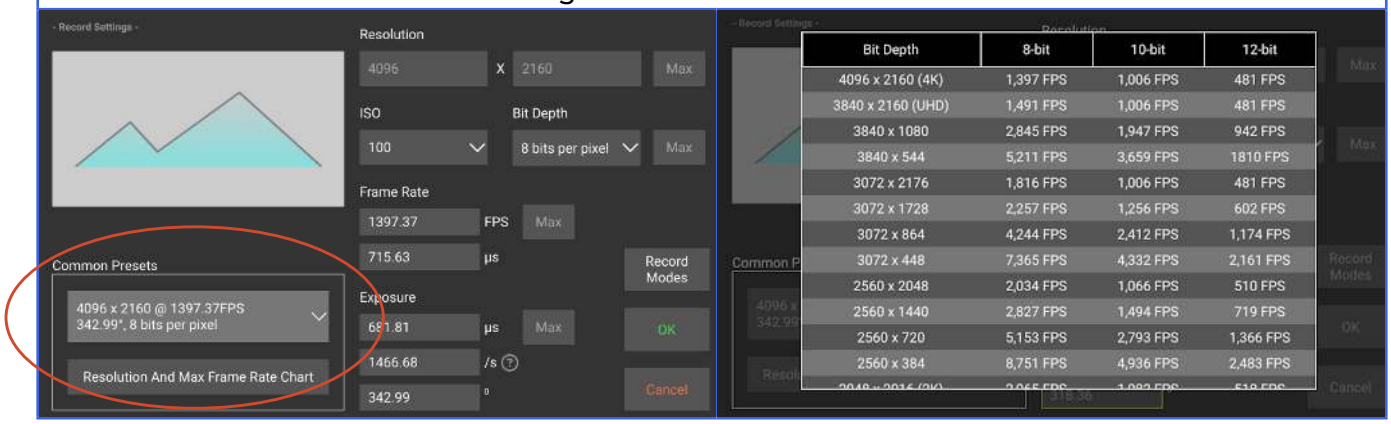
Use the Common Presets Dropdown to select a resolution and the corresponding maximum frame rate. Swipe upwards to scroll down the list of available options.

Figure 3.3 - Common Presets Dropdown




All possible resolutions and their corresponding maximum frame rates may be viewed in a table by tapping on the Resolution And Max Frame Rate Chart button. Maximum frame rates are organized in columns by Bit Depth. See Section 3.2 for more information on Bit Depth.

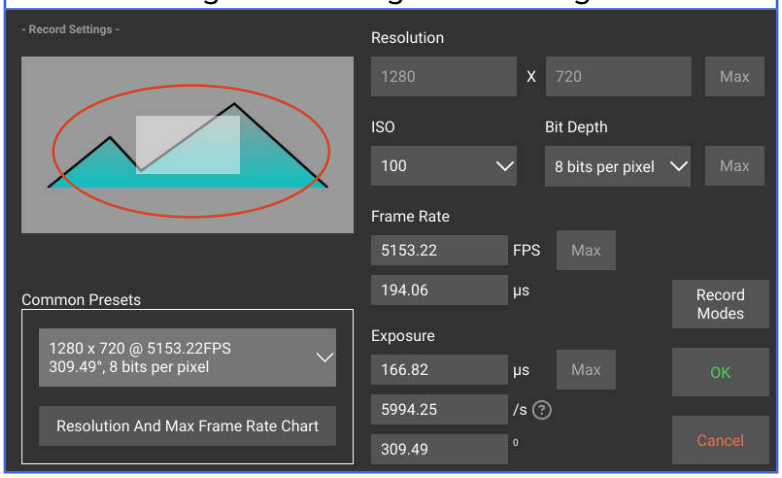
Figure 3.4 - Max Frame Rate Chart




| Bit Depth | 8-bit | 10-bit | 12-bit |
|---|---|---|---|
| 4096 x 2160 (4K) | 1,397 FPS | 1,006 FPS | 481 FPS |
| 3840 x 2160 (UHD) | 1,491 FPS | 1,006 FPS | 481 FPS |
| 3840 x 1080 | 2,845 FPS | 1,947 FPS | 942 FPS |
| 3840 x 544 | 5,211 FPS | 3,659 FPS | 1810 FPS |
| 3072 x 2176 | 1,816 FPS | 1,006 FPS | 481 FPS |
| 3072 x 1728 | 2,257 FPS | 1,256 FPS | 602 FPS |
| 3072 x 864 | 4,244 FPS | 2,412 FPS | 1,174 FPS |
| 3072 x 448 | 7,365 FPS | 4,332 FPS | 2,161 FPS |
| 2560 x 2048 | 2,034 FPS | 1,066 FPS | 510 FPS |
| 2560 x 1440 | 2,827 FPS | 1,494 FPS | 719 FPS |
| 2560 x 720 | 5,153 FPS | 2,793 FPS | 1,366 FPS |
| 2560 x 384 | 8,751 FPS | 4,936 FPS | 2,483 FPS |

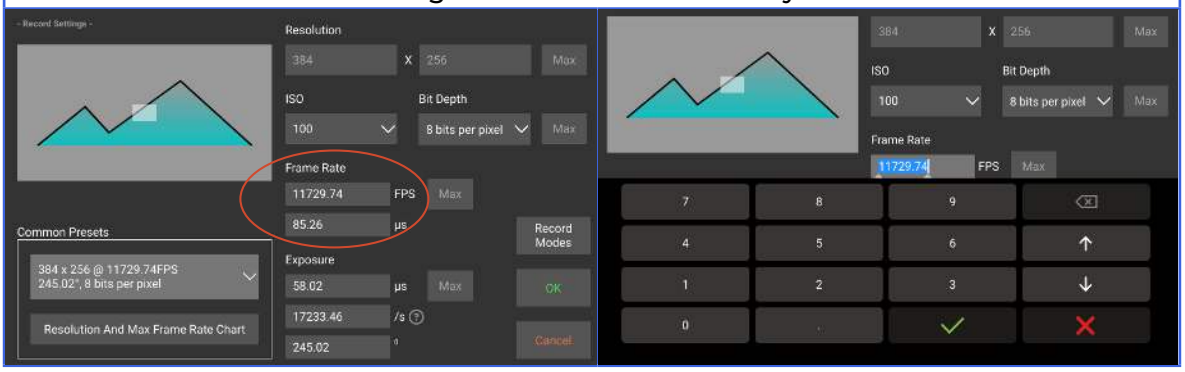
Once a preset resolution and frame rate have been selected, the diagram in the upper left corner of the Record Settings screen will change to depict the area of the image sensor in which pixels will now be active for the selected preset.

Figure 3.5 - Image Sensor Diagram



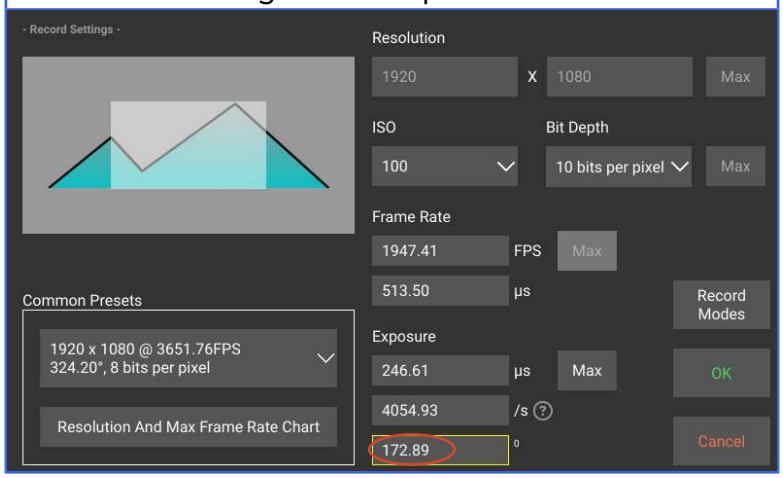

The frame rate or frame time (1 / frame rate) can also be entered manually by selecting either the FPS or µs numeric entry boxes.

Figure 3.6 - Frame Rate Entry Boxes




Changing the frame rate may also change the range of supported exposure settings. If the exposure setting is not within the range supported by the newly selected frame rate, the camera will automatically adjust the exposure and draw a yellow box around the updated settings. The Max button can be selected to update the exposure value to the maximum achievable setting. See Section 3.5 for additional details on Exposure / Shutter Duration.

Figure 3.7 - Exposure Value




Press OK to apply the preset and exit the Record Settings screen.

## 3.4 Setting ISO Sensitivity

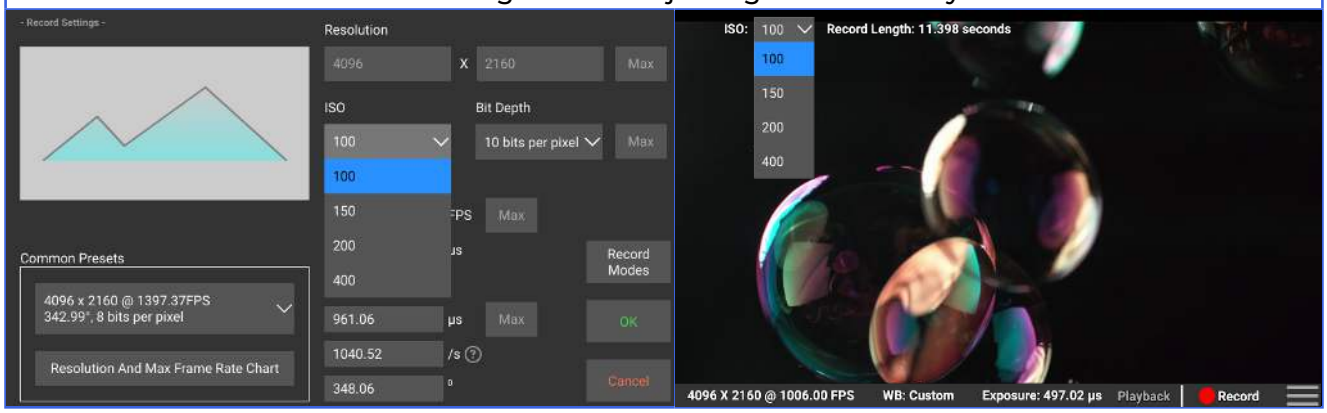
The ISO Sensitivity of a camera controls its sensitivity to light. The higher the ISO value, the more sensitive the image sensor becomes to incoming light, with the condition that more noise (or grain) may be introduced to the image.

- Increasing the ISO Sensitivity allows for the Exposure / Shutter Duration to be decreased while maintaining the same brightness in the scene.
- Increasing the ISO Sensitivity allows for the aperture of the lens to be reduced to increase the depth-of-field (the area of the image that is in focus) while maintaining the same brightness in the scene.

| CHRONOS 4K12 COLOR | CHRONOS 4K12 MONO |
|---|---|
| 100 | 160 |
| 150 | 250 |
| 200 | 400 |
| 400 | 800 |

To adjust the ISO Sensitivity, enter the Record Settings screen via the sidebar, or the shortcut in the upper-left corner of the Main Screen (see Figure 3.8).

Figure 3.8 - Adjusting ISO Sensitivity



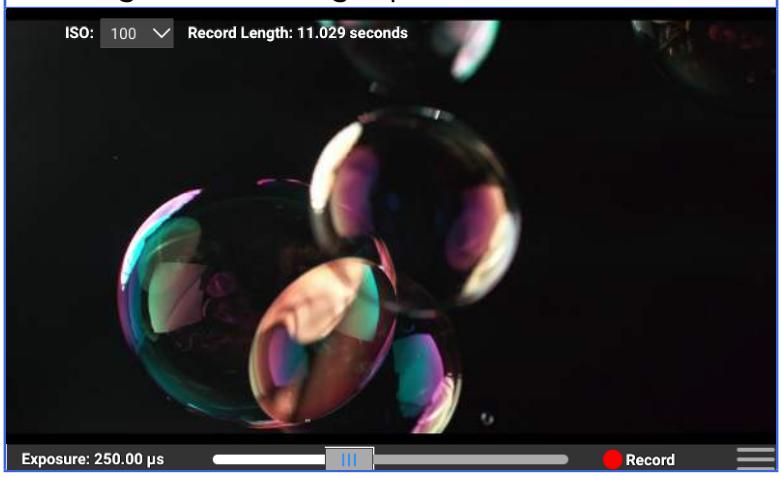

## 3.5 Setting Exposure / Shutter Speed

The exposure setting of a camera controls the duration that the shutter is open during the capture of a frame.

The exposure time will affect both the brightness of the image, and the motion blur of the subject you are recording. A longer exposure time will result in better light sensitivity, but more motion blur. Conversely, a shorter exposure time will result in reduced light sensitivity, but less motion blur.

Adjusting the exposure duration can be done in the Record Settings screen or by tapping the Exposure display on the main screen to bring up the adjustment slider. Tap and drag the slider to adjust the exposure, or use the Jog Wheel.

Figure 3.9 - Setting Exposure / Shutter Duration

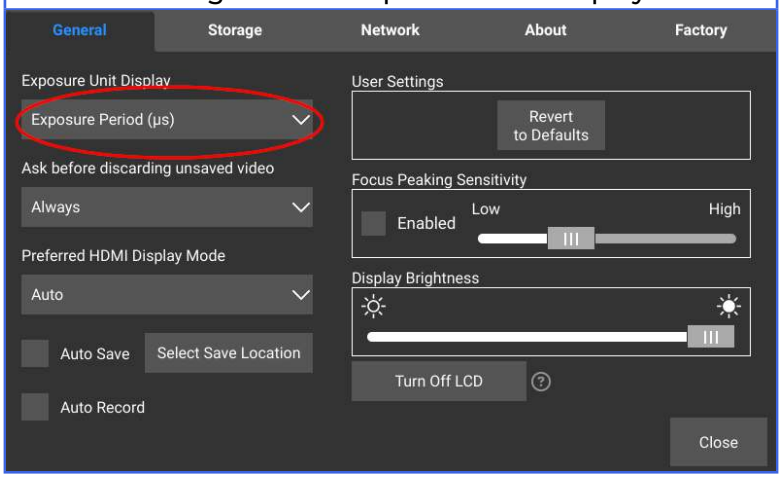


Exposure duration can be displayed in several units depending on your preference.

- Microseconds (µs) = Exposure Period: The duration each frame is exposed for, measured in microseconds.
- Reciprocal time (1/s) = Exposure Fraction: The duration each frame is exposed for, measured as a fraction of one second. Commonly used by photographers.
- Degrees (°) = Shutter Angle: The duration each frame is exposed for relative to the selected frame rate, measured in the degrees of an angle between 0 and 360. Commonly used by cinematographers.

To set the exposure display unit, go to the System Settings **>** General tab, and select your desired unit from the dropdown.

Figure 3.10 - Exposure Unit Display




## 3.6 Setting White Balance

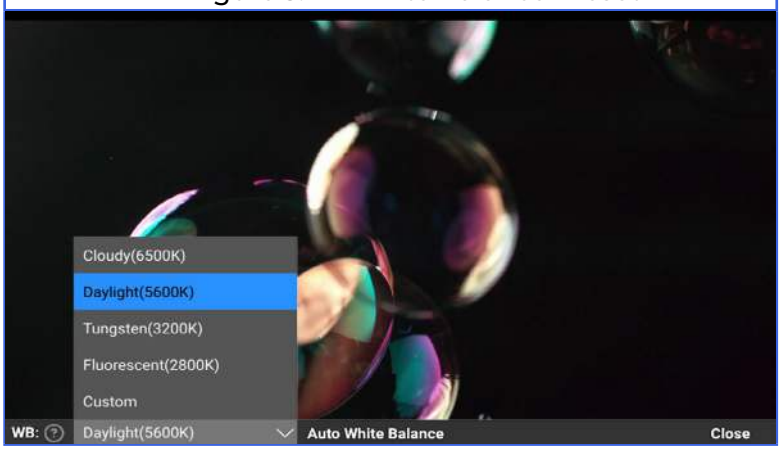
Cameras are much more sensitive to changes in lighting color than the human eye, so the camera must have a reference for the lighting color. White Balance is used to correct for lighting color temperature.

There are three ways to set White Balance:

- Selecting from a pre-set
- Sampling a reference white object (auto white balance)
- Typing a custom numerical value in the White Balance dropdown menu (temperature value inputed must be in Kelvins)

To set White Balance, tap the White Balance indicator at the bottom of the main screen (see Figure 3.11).

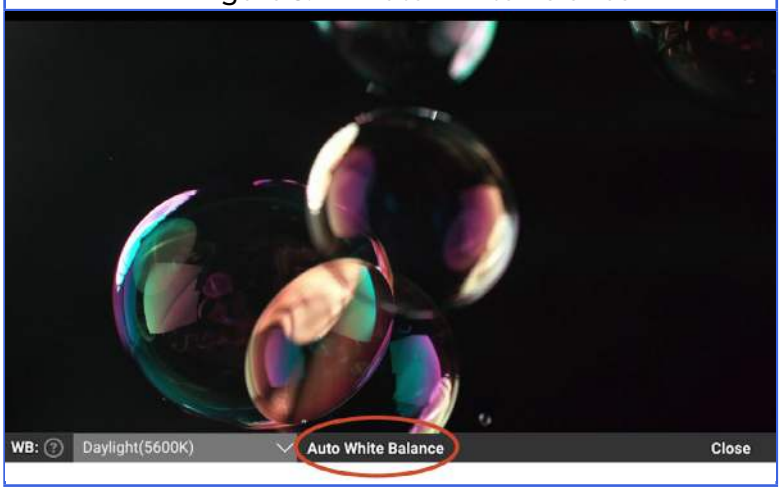
Figure 3.11 - White Balance Preset




To select a pre-set, tap the dropdown menu and select the preset that matches the color temperature of your lighting.

To sample a White Balance reference, place a white object in the center of the frame, and tap the Auto White Balance button.

Figure 3.12 - Auto White Balance




Auto White Balance requires that a sufficiently illuminated reference, such as a grey card, is placed within the center of the camera's field of view. A black rectangle in the center of the screen indicates the region of the image to be referenced when the Auto White Balance button is pressed. If the pixels sampled within that region are over or under exposed, an error message will pop up; otherwise, the successfully calculated Custom white balance will be applied.

***NOTE:*** *The sampled region will always be the 64x32 pixels in the center of the sensor. Therefore, the black rectangle will appear larger with lower resolutions*

> ***TIP:*** *The White Balance settings may be adjusted from Playback Mode after the recording has stopped. Select the White Balance option from the sidebar and carefully adjust the settings to be used for saving and playback. This may be especially useful when shooting in varying lighting conditions.*

You may also enter a custom numerical value in the White Balance dropdown menu. See the reference table below for how the image changes based on the preset White Balance markers.

| | |
|---|---|
| **Cloudy**<br>6500K | |
| **Daylight**<br>5600K | |
| **Tungsten**<br>3200K | |

| | |
|---|---|
| **Fluorescent**<br>2800K | |

## 3.7 Assistive Features

The Chronos 4K12 offers several assistive features to assist the camera operator. All three assistive features may be quickly toggled as desired through the side menu during live or playback camera states.

> ***NOTE:*** *None of the assistive features are applied to the HDMI output.*

1. **Overexposure Indicator:** The overexposure feature visualizes areas of the image which are being clipped due to excess brightness. Overexposed regions are visualized by animated diagonal lines, also known as “zebras.”
2. **Focus Peaking:** The focus peaking feature visualizes detected edges in order to assist the camera operator with focusing the lens. The sensitivity threshold for Focus Peaking may be adjusted from the System Settings screen.
3. **Histogram:** The histogram feature will visualize the distribution of brightness. A small graph is overlaid with lines plotted from left (dark) to right (light). The height of the lines plotted correlate to the quantity of pixels.

# 4. Recording

The start or end of a recording may be triggered using either the red button located on the top of the camera, the record button displayed on the main screen, or with an external trigger. See Chapter 6 (Triggering & Synchronization) for more information on external triggers.

> ***NOTE:*** *Trigger delays do not apply to the record button. Pressing the button while recording will start / stop the recording immediately, regardless of any pre-set trigger delay.*

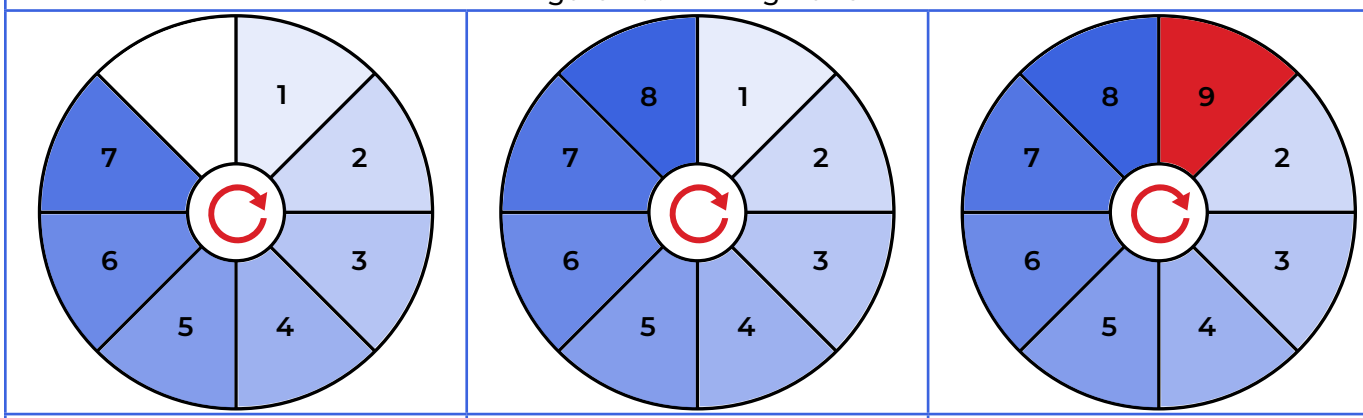
## 4.1 Ring Buffer Concept

In a high-speed camera, a buffer refers to a region of memory where image frames are stored temporarily. The camera captures each image frame and stores it in its buffer.

Considering that the camera needs to capture an immense amount of data in a very short timeframe, the quantity of very fast memory is limited. Hence, it is essential to manage that memory properly to mitigate the loss of frames after the camera has been set to record.

In order to capture all these image frames, the Chronos camera records to what is called a ring buffer in the internal high-speed RAM (Random-Access Memory). The ring buffer is a data structure that holds frames of recorded video. Once it is full, the oldest frames are overwritten as new frames are captured. This allows the camera to record for unlimited periods, but only the most recent frames are kept.

Figure 4.1. — Ring Buffer



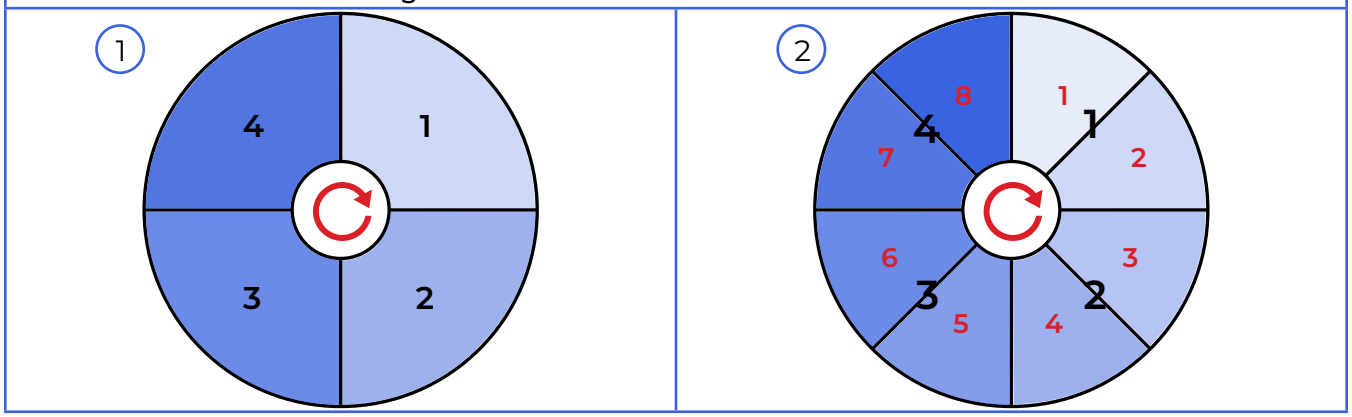

| | | |
|---|---|---|
| 7 frames of video recorded into an 8 frame Ring Buffer. | 8 frames of video recorded into an 8 frame Ring Buffer. | 9 frames of video recorded into an 8 frame Ring Buffer.<br>*The 9th frame has now replaced the 1st frame.* |

The length of the ring buffer depends on the Record settings (see Section 4.2). Reducing the frame rate below maximum will increase the record time proportionally.

***EXAMPLE:***
If the maximum frame rate for your resolution is 3000fps (frames per second), setting the rate to 1000fps will result in 3x the record time available at maximum frame rate.

Alternatively, another way to record for longer is to record a lower resolution video. If 4 frames of 800×600 video fit into a ring buffer (1), then 8 frames of 800×300 video will fit into the same ring buffer because the total resolution is halved (2).

Figure 4.2. — Lower Resolution Frame Rate




Once image frames are stored in the Ring Buffer, they must be offloaded to a non-volatile storage medium since RAM is volatile, meaning it will be erased when the camera is powered off. Please see Chapter 5 (Playback & Saving) for additional information on these concepts.

## 4.2 Recording Time

The camera attempts to maximize recording time automatically based on the current resolution and frame rate settings (see Section 3.3 for details).

The theoretical maximum record time may also be determined with the formula below:

**Record Time = Ring Buffer Capacity / Capture Rate**

***EXAMPLE:***
Ring Buffer Capacity: 128 GB = 137,438,953,472 Bytes

Capture Rate: Horizontal Resolution x Vertical Resolution x Frame Rate x (Bit Depth / 8 bits per Byte)

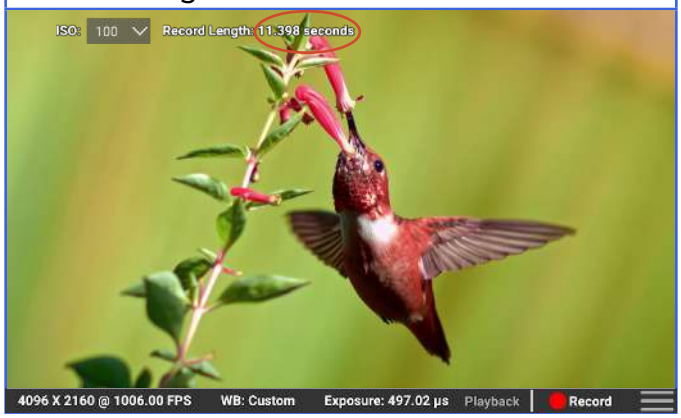
Record Time = 137,438,953,472 Bytes / (4096 x 2160 x 1397.38 x 8/8)

= 137,438,953,472 Bytes / 12,363,123,916.8 Bytes per second

= 11.11 seconds*

** As seen in the example below, the actual time may differ slightly as a small region of buffer space is used for camera operations and frame metadata.*

Figure 4.3. — Record Time

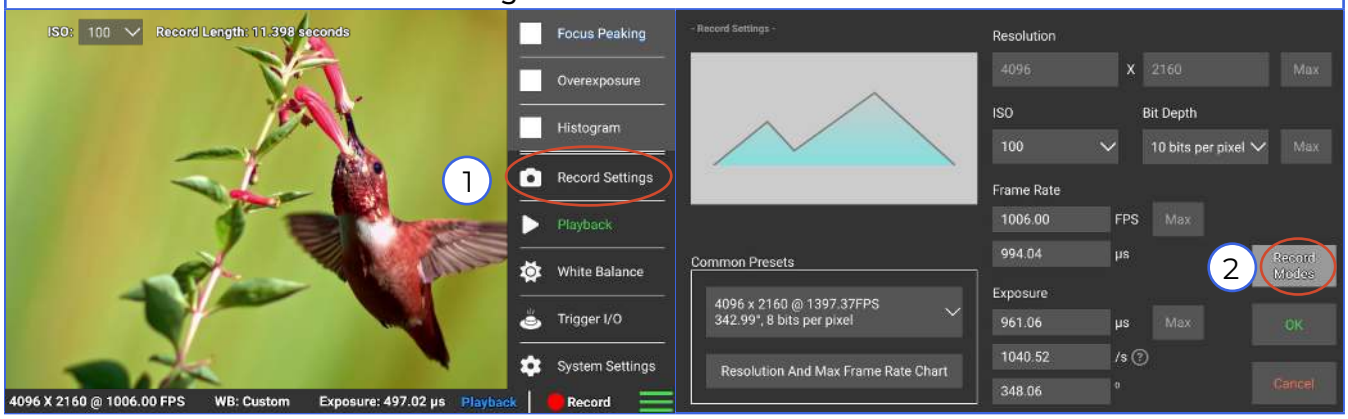



## 4.3 Setting Record Length

In the event that an exact number of recorded frames or record time is desired, a record length can also be entered manually in terms of time or frames. This adjusts the size of the ring buffer.

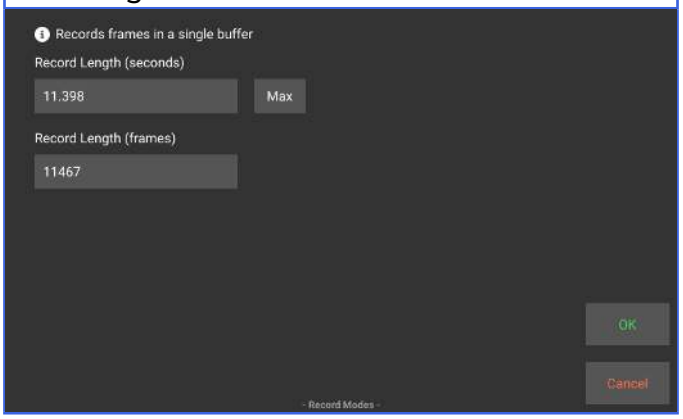
To adjust record length, enter the Record Settings screen (1), then tap the Record Modes button (2).

Figure 4.4. — Record Modes



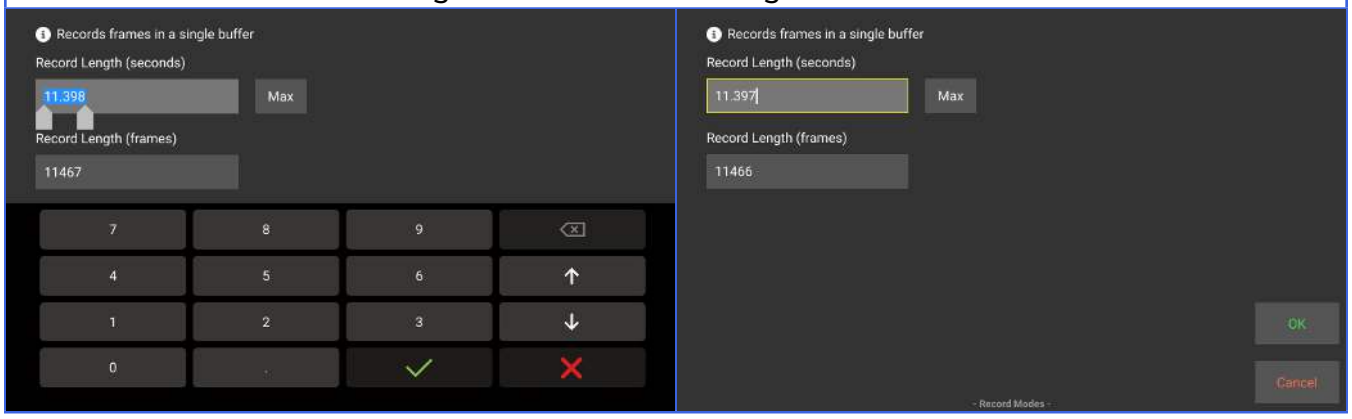

Either Record Length (seconds) or Record Length (frames) may be entered. Please see Figure 4.5 for reference.

Figure 4.5. — Record Modes Menu




Tap the green checkmark button to confirm the number entry. The yellow border signifies that after 15.5 seconds was entered, the camera automatically adjusted the record length time to align to the nearest frame. Press OK to exit the Record Modes menu.

Figure 4.6. — Record Length Selection



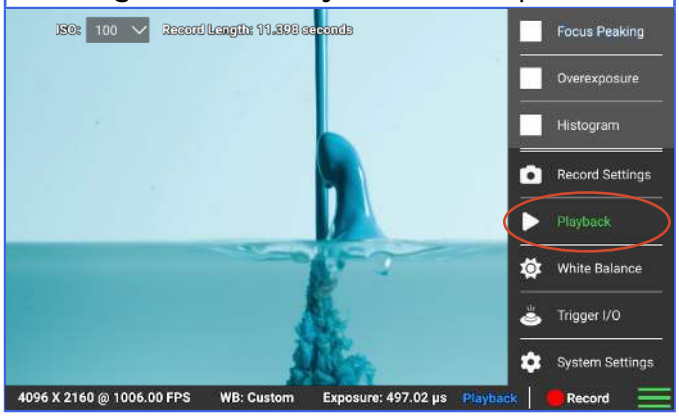
# 5. Playback & Saving

## 5.1 Playback Features

After recording video with the camera, select the Playback screen via the sidebar to view and replay the footage.

> ***NOTE:*** *The Playback button will be disabled (greyed out) as shown in Figure 5.1 when there is no video footage to review, e.g., when the camera is first booted up. The Playback button will turn green when footage has been captured but not yet reviewed, and White when the footage has been both previously captured and reviewed.*

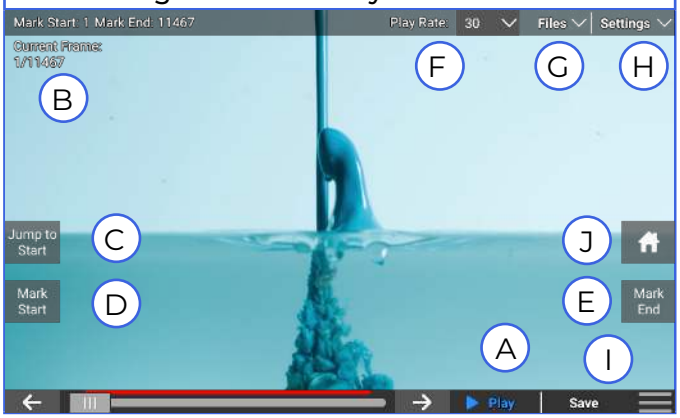
Figure 5.1. — Playback Menu Option




You can view the whole recording by pressing the Play button (A). The arrows on either side of the slider will move the footage one frame forward or backward. Alternatively, dragging the slider or scrolling with the Jog Wheel will also cycle between frames. The current frame being viewed can be seen on the upper left portion of the screen (B). Clicking on the Jump to Start button takes you back to the first frame (C).

Since not every frame in the video is necessary when finalizing footage, you can mark the start and end of the video using the Mark Start button (D) and Mark End button (E). This trims the video to just the frames that you want to keep.

Figure 5.2. — Playback Screen



The Play Rate drop down menu (F) changes the speed at which the video plays. The 4K12 supports six different playback frame rates: 10, 24, 25, 30, 60, and 120. Six negative playback frame rates are also supported for playing the video backwards. The Home button (J) will take you back to the live screen.

> ***NOTE:*** *The negative playback frame rates may appear hidden by default. Scroll to the top of the drop down menu to reveal the negative settings*

> ***NOTE:*** *Play rate presets are used to control the frame rate of video playback. This is an assistive feature for controlling the playback speed of the most recently captured footage. This assistive feature does not have any effect upon saved videos.*

The Files drop down menu (G) opens the Playback file browser where you may select the storage location for the recorded video footage, as well as delete past recordings. See Section 5.4 (File Browser Navigation) for more information.

When you are satisfied with the marked range of video frames, tap on the Settings drop down menu (H) to ensure you have the desired save options selected before pressing the Save button (I) to begin writing video data to the storage location. See the following sections for more information and Figure 5.3 for reference.

## 5.2 Saving Overview

During recording, video frames are written to the internal 128 GB volatile memory. If video frames are not saved to a non-volatile memory device prior to a new recording, or if the camera is shutdown prior to saving, those video frames will be permanently deleted.

After recording video, a selection of frames may be saved to a non-volatile storage device. Saving is initiated from the Playback screen.

In the context of saving, the “Mark Start” and “Mark End” buttons are used for specifying the range of video frames to be saved, in addition to their other responsibility of specifying the range of frames displayed during Playback mode.

From the Playback screen, use the navigation controls and Mark Start / Mark End buttons to select the region of video you want to save (see Figure 5.2). The desired save region is marked by a colored bar.

The Chronos 4K12 includes a 1TB sized NVMe solid state drive built-in; however, it also supports a variety of alternative saving destinations.

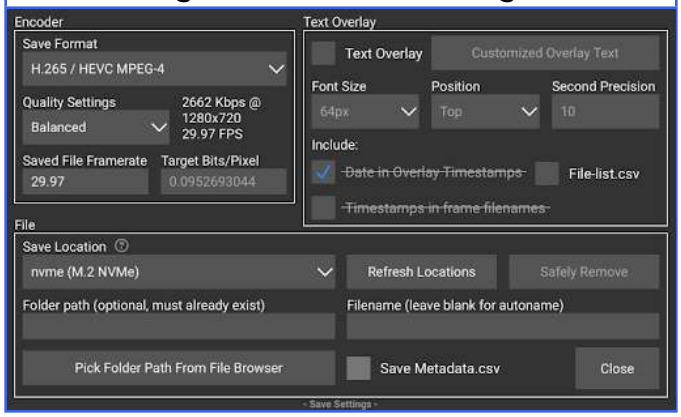
Video may be saved to removable storage devices plugged directly into either of the camera’s two USB-C ports, or the SD card slot. The speed of the saving operation will depend on the storage destination selected.

For the fastest saving speeds, set the destination to either the internal SSD or a high-speed storage device connected to USB-C Port 2.

> ***NOTE:*** *The USB-C Port 1 mode must be set to "Host" in order for the camera to recognize a storage device plugged into it.*

The Chronos 4K12 may also save video directly to NFS or SMB network servers while it's connected using a network adapter. After successfully configuring a connection with a network share, it will appear within this list of Saving Location options. Please refer to Chapter 7 (Network Interface) for more information on configuring network share connections.

Figure 5.3. — Save Settings




> ***NOTE:*** *The internal NVMe will most likely always be the fastest saving destination option; however, it's possible to connect something faster to USB-C Port 2.*

## 5.3 Saved File Formats

Video can be saved in either raw or compressed formats. Each format has its own advantages and disadvantages.

1. **CinemaDNG**

- Maximum original camera data is saved
- White balance and color matrix is metadata, which may be modified or discarded during post-processing (easier to color-correct)
- Requires the longest saving durations
- Does not support text overlays

2. **H.264 & H.265**

- Only 8-bits per pixel is saved
- White balance and color matrix is applied to pixels (difficult to color-correct)
- Supports text overlays
- Offers the fastest saving speeds

3. **TIFF Image Sequence**

- Only 8-bits per pixel is saved
- On color cameras, image quality is slightly lower than CinemaDNG because built-in debayer and color corrections are performed
- Supports text overlays
- Compatible with a wide variety of software applications and can be opened on PCs without the need for extra software

## 5.4 Text Overlays

An overlay can be displayed over top of the video in several save formats. The overlay contains metadata about each frame, including:

- Frame ID
- Frame timestamp and optionally the date, if the “Date in Overlay” checkbox is checked
- Relative frame ID and timestamp to the trigger event if Record End trigger mode was used during recording
- User-defined text which can be configured by pressing the “Customized Overlay Text” button

Figure 5.4. — Text Overlay Example

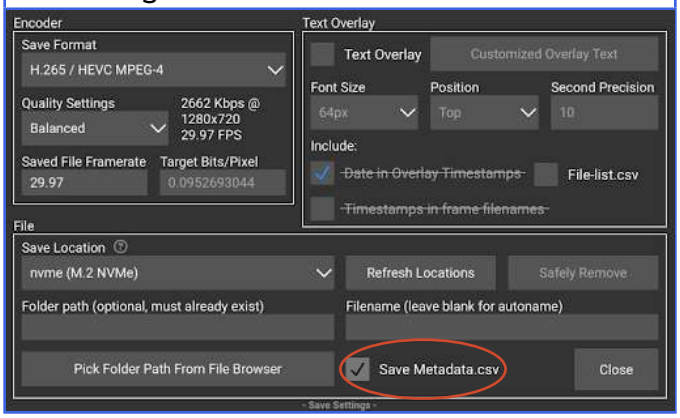
The overlay may be positioned at the top, bottom, or underneath the frame. The size of the font can also be adjusted to an appropriate size for the resolution of the image. Note that for resolutions 4096x2160 and 3840x2160, if the overlay is positioned underneath the frame, only font sizes 8px and 16px can be selected.

If you do not wish to overlay metadata on top of the footage but still want to save the metadata, select the “File-list.csv” checkbox. This saves a CSV file along with the footage that contains all the relevant metadata for each frame. This feature can also be used for save formats that do not support text overlays.

For save formats that save a sequence of images, such as CinemaDNG or TIFF, the timestamp of each frame may also be added to the filename of each image.

# 5.5 Saving Metadata

Figure 5.5. — Save Metadata.csv




Selecting the Save Metadata.csv option in the file options box enables the camera to save a CSV file containing recording configuration information used to capture the footage, as well as parameters used to save the footage to a file. The CSV metadata file shares the same name as the footage being saved.

Metadata included in this CSV file:

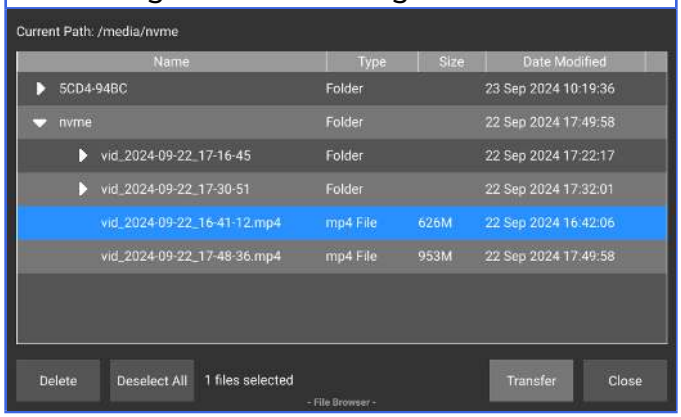
- Core camera metadata, such as camera model and serial number
- Temporal and synchronization data indicating the status of I/O and trigger channels at the time of recording
- Environmental data, such as CPU temperature
- Optical and imaging data, including bitrate and codec used for saving
- File properties, such as the footage save time and applied overlays

***NOTE:*** *Selecting the Save Metadata.csv option stores recording configuration and relevant file parameters in a CSV file. For a complete list and description of all metadata fields, refer to the* ***Chronos 12 Platform Metadata List*** *available* ***here****.*

## 5.6 File Browser Navigation

By default, video will be saved to the root directory of the selected destination. Alternatively, a subdirectory of the saving destination may be selected using the “Pick Folder Path” button. This method is recommended to help ensure the requested directory exists. However, the path to an existing directory may also be specified manually through the “Folder Path” input.

Figure 5.6. — Storage Selection




## 5.7 Storage Devices

The Chronos 4K12 supports a wide variety of storage devices beyond its internal solid state drive. One key advantage to using an external storage device is the camera doesn’t need to be powered on in order to access the saved video.

- SD cards are easy to swap between the Chronos camera and mobile / desktop platforms. H.264 or H.265 formats work best with this saving destination due to their compressed size and the wide compatibility of their output.

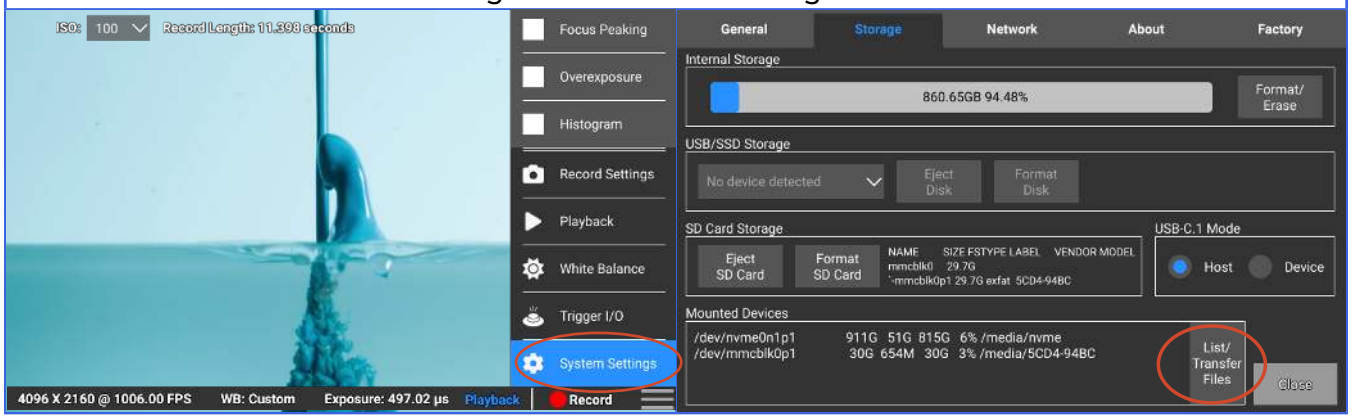
- USB-C attached mass storage devices offer the same advantages as SD cards but with speeds similar to saving in uncompressed formats (i.e., CinemaDNG).

- Network storage devices may be used when an Ethernet to USB-C adapter is connected.

## 5.8 Transferring Files

When video is only saved to the internal solid state drive, the camera will need to be powered on in order to access it. Video may be transferred from one device to another using the “List / Transfer Files” feature, located in the Storage tab of the System Settings. A file system tree will be presented where a selection of files and/or directories may be specified for transfer.

Figure 5.7. — Transferring Files




***NOTE:*** *Transferring files will copy, but will not delete, the original files.*

***NOTE:*** *When transferring files, overwrite warning will not be given.*

***NOTE:*** *The Transfer operation can only be used for copying files from the internal storage to an external storage device.*

## 5.9 Formatting Storage Devices

exFAT is the recommended file system for optimal transfer speeds. SD cards or USB-C connected storage devices may be formatted from the Storage tab of the System Settings screen.

***WARNING:*** *If the selected device's file system is configured with multiple partitions, ALL partitions will be replaced with a single partition when using either the Format Disk or Format SD Card functions. The type of file system used while formatting will match the type of the first partition of the selected device's originally presented file system.*

***NOTE:*** *In addition to exFAT file systems, the 4K12 also supports FAT32, EXT2, EXT3, EXT4, and NTFS. However, in order to change the file system type, equipment such as a personal computer is required.*

# 6. Triggering & Synchronization

This section describes how to set up and use Chronos 4K12 camera's input/output (I/O) channels for external triggering, frame synchronization, and timecode integration.

You will learn about the available trigger modes, signal conditioning options and synchronization features. In addition, you will be able to optimize your camera's performance in complex setups requiring external timing, coordinated triggering, or exact frame referencing.

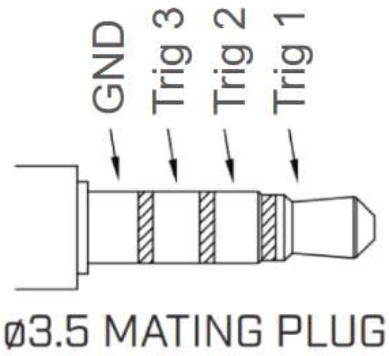
Chronos 4K12 cameras have three input / output channels that enable triggered recording and synchronization with external devices. Settings may be configured from **the Trigger I/O screen** while the camera is not busy recording.

By default, all three I/O channels are disabled. Each channel can only be used in one mode at a time, but some modes allow the use of multiple channels simultaneously. When any of the I/O channels are enabled, an indicator is overlaid in the top right corner of the main screen.

Figure 6.1. — Triggering Channels

All three I/O channels are consolidated within the 3.5mm TRRS connector located above the power input. As outputs, these channels support a 5V TTL level output. As inputs, these channels support up to +/- 30V DC or AC RMS and +/- 50V peak. Any inputs exceeding those ratings may damage the camera hardware.

Figure 6.2. - Pinout of TRRS connector




A voltage threshold from 0 - 6.6V may be configured per input channel. Any input voltage higher than this threshold is considered logic level high, and any input voltage lower than this threshold is considered logic level low. For proper operation, ensure the voltage threshold is set appropriately for your input signal. If the threshold value is too close to the peak of the input voltage, you may experience inconsistent triggering.

Two accessories are provided to enable use of the I/Os:

- **Push-Button Trigger Cable:** Intended to be used with Toggle and Record End trigger modes.
- **Triple BNC Breakout Adapter:** Breaks out the camera's trigger channels 1, 2 and 3 to BNC connectors; can be used for any trigger or synchronization mode.

## 6.1 Signal Conditioning

Several options are provided for signal conditioning of the I/O channels:

1. **Pull Up:** When enabled, the default state of the I/O channel is pulled up, bringing the voltage level to ~4.3V with no input connected. This setting should be used alongside an input that provides no source, like the push-button trigger cable. When the button is pressed, the input is pulled to ground, causing a trigger event to occur.

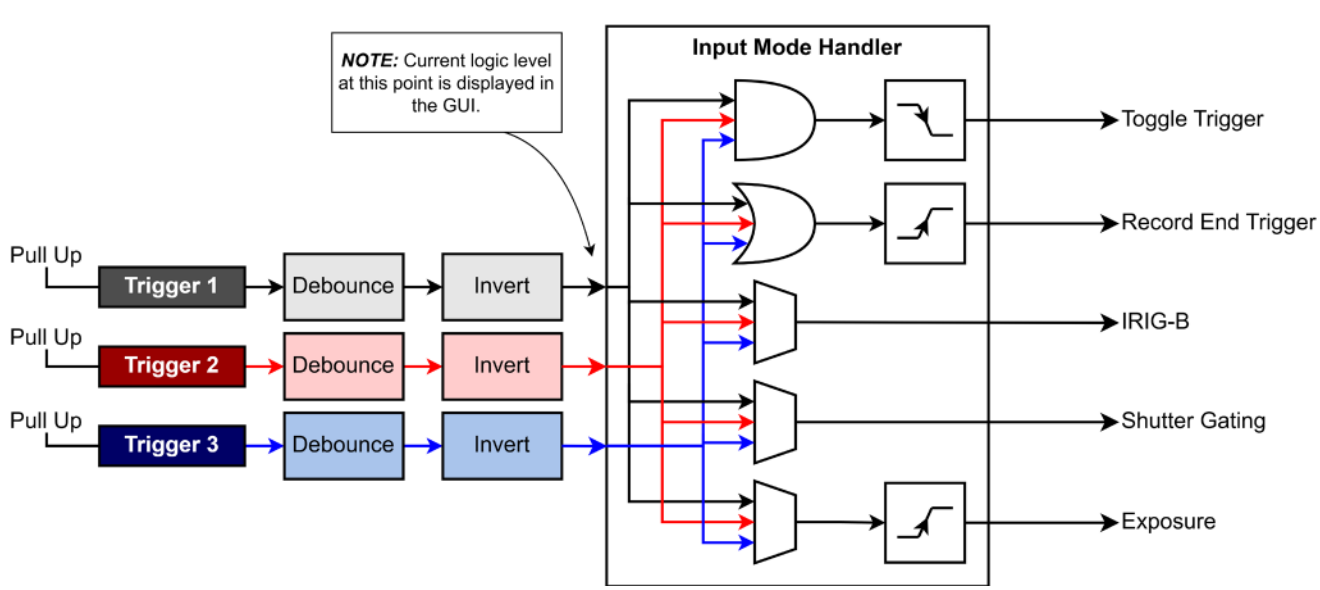
   This setting has no effect when used with an output I/O mode.

2. **Invert:** This setting inverts the logic level of the channel; it may be used for both input and output I/O modes. For input modes, the signal is inverted before it is passed to the logic that handles the input signal. This is important to keep in mind when more than one channel is configured to the same trigger mode.

3. **Debounce:** When enabled, the input channel is sampled at the specified duration. It is recommended to enable this setting when using a physical button or switch as the trigger source to avoid glitches due to mechanical contact bounce. The debounce duration can be set up to 200,000 microseconds. This setting has no effect when used with an output I/O mode.

The following diagram shows how the three channels are connected inside the camera when used as inputs. Note that the current logic level per channel before it enters the Input Mode Handler can be viewed in the GUI at the top of the Trigger I/O screen. This can be used to troubleshoot issues with the trigger cable, as trigger events have no effect while the Trigger I/O screen is open.

Figure 6.3. - Input Mode Schematic Diagram



## 6.2 Trigger Modes

Two trigger modes can be used to start or stop recording. Both trigger modes can be enabled at the same time, and both trigger modes allow the use of one or more trigger channels simultaneously.

These trigger modes may be selected from the Input rows of settings corresponding to the desired channel within the Trigger I/O screen.

1. **Toggle Trigger:** Upon a falling edge transition of the signal exiting **the Input Mode Handler**, the recording state is toggled. This trigger mode behaves the same as the red button on top of the camera or the Record button on the GUI main screen. The purpose of this trigger mode is to be able to start and stop recording while not being physically next to the camera.

   Note that the timing certainty between the trigger event and the camera responding to the event cannot be guaranteed. If you need precise timing, use Record End trigger mode instead.

   When more than one channel is set to Toggle Trigger mode, these channels are logically AND'ed together after the signal conditioning settings are applied to each channel.

   While pressing the red button on the camera body will not start/stop recording unless the main screen is displayed, a toggle trigger event will. No footage overwrite warning will be given when a toggle trigger event occurs.

2. **Record End Trigger:** Upon a rising edge transition of the signal exiting the Input Mode Handler, this trigger mode will only ever end an on-going recording. In this mode, a recording must be started from the camera prior to being stopped with the external trigger.

   This trigger mode has the benefit of stopping the recording with precise timing relative to when the trigger event occurred. The relative timing can be configured from **the Trigger Delay screen**.

   When more than one channel is set to Record End mode, these channels are logically OR'ed together after the signal conditioning settings are applied to each channel.

***USER TIP:*** *When using more than one channel in the same trigger mode, consider the default state of each channel and how the channels are logically combined for that trigger mode.*

*For example, if push buttons are used on more than one channel configured to Record End mode, those channels need to be inverted so that the default state of the signals is low. Otherwise, if the default state of the signals is high, when they are logically OR'ed together, the resulting signal will remain high if only one button is pressed, and no trigger event will occur.*

## 6.2.1 Record End Trigger Delay

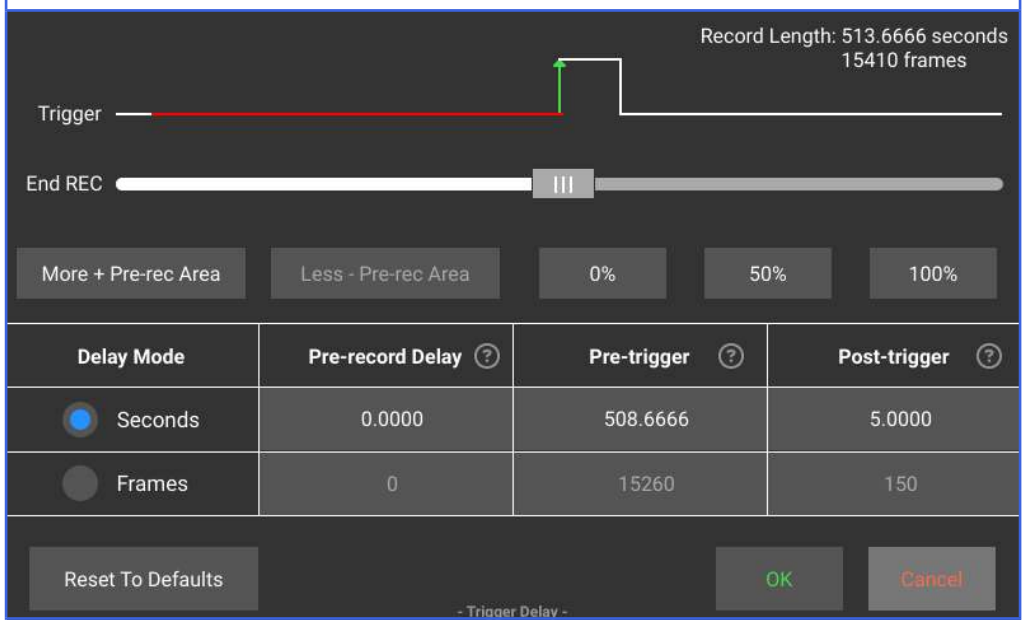
The **Trigger Delay screen** allows configuration of when the recorded video is captured relative to an external trigger. This screen is only accessible once at least one I/O channel is configured to Record End mode.

While the length of the recording is controlled from **the Record Modes screen** (see section 4.3), the end of the recording relative to the rising edge of the trigger is controlled through the settings on this screen.

At any point when using **Record End trigger mode**, the recording may be stopped early through the red button on top of the camera, the Record button in the GUI, or another I/O channel configured to Toggle trigger mode.

This can be done before **the Record End trigger** occurs or after, if a post-trigger delay is currently on-going. In this case, the footage that was captured before the recording was cancelled, is made available for playback.

Figure 6.4. - Trigger Delay Screen



### Trigger Delay Screen Controls and Functions

The table below describes each control option available on the Trigger Delay Screen and how it impacts trigger behavior.

| CONTROL | FUNCTION |
|---|---|
| Slider | Drag the slider to change when the recording ends relative to the trigger. The trigger delays in each text box below are automatically adjusted as the slider is moved. |
| More Pre-Record Area | Increase the amount of space in the diagram after the trigger to provide more room for moving the slider beyond the trigger event.<br><br>This enables a larger pre-record delay to be set using the slider. |
| Less Pre-Record Area | Decrease the amount of space in the diagram after the trigger to provide less room for moving the slider beyond the trigger event.<br><br>This reduces the pre-record delay that can be set using the slider. |
| Pre-Trigger Percentage (0%, 50%, 100% Buttons) | Quickly change the percentage of the recording that is captured before or after the trigger event.<br><br>A value of 0% means that all recorded video is captured after the trigger event. A value of 100% means that all recorded video is captured before the trigger event. |
| Pre-Record Delay | Sets the amount of time or frames to wait after the trigger event before starting the recorded segment. |
| Pre-Trigger Delay | Sets the amount of time or frames before the trigger event that should be included in the recorded segment. |
| Post-Trigger Delay | Sets the amount of time or frames after the trigger event before the end of the recorded segment. If both pre-record and pre-trigger delays are 0, the post-trigger delay is equal to the record length. |
| Reset to Defaults | Sets the pre-record and post-trigger delays to 0, and sets the pre-trigger delay equal to the record length. |
| OK Button | Applies the trigger delay changes and closes the window. |
| Cancel Button | Discards the trigger delay changes and closes the window. |

The Trigger Delay settings can be accessed from the Trigger I/O menu. They can can be configured in units of either time or frames. When the camera drives the sensor timing internally, there is a defined relationship between the two. Both units are displayed for convenience.

Please note that the trigger delay settings are only available for Record End mode. This option is greyed out when Toggle, Exposure or Shutter Gating mode is enabled. This is because the camera does not know the frame timing in advance.

### When the Recorded Length Does Not Match the Setting

There are a few cases where the actual length of recorded footage will not match the specified record length:

1. **When using a pre-trigger delay**, if the trigger event occurs before the pre-trigger delay has elapsed then there will be fewer pre-trigger frames captured than desired. For example, if the pre-trigger delay is set to 5s and the trigger occurs 1s after starting the recording, there is only 1s of footage available before the trigger event.
2. **When using a post-trigger delay,** the recording may be stopped early by pressing the red button on the camera or the Stop button in the GUI. For example, if the post-trigger delay is set to 10s and the recording is cancelled 3s after the trigger event occurs, there is only 3s of footage available after the trigger event.
3. **If the sensor is being driven externally** but there is no input signal to the camera when the recording is either started or stopped, one or more frames are added to the start and end of the recording. This is a side effect of the camera handling the transition between recording states while no frames are being captured by the sensor.

***USER TIP:*** *You can identify the extra frames by checking the timestamps or watching for jumps or gaps in the footage.*

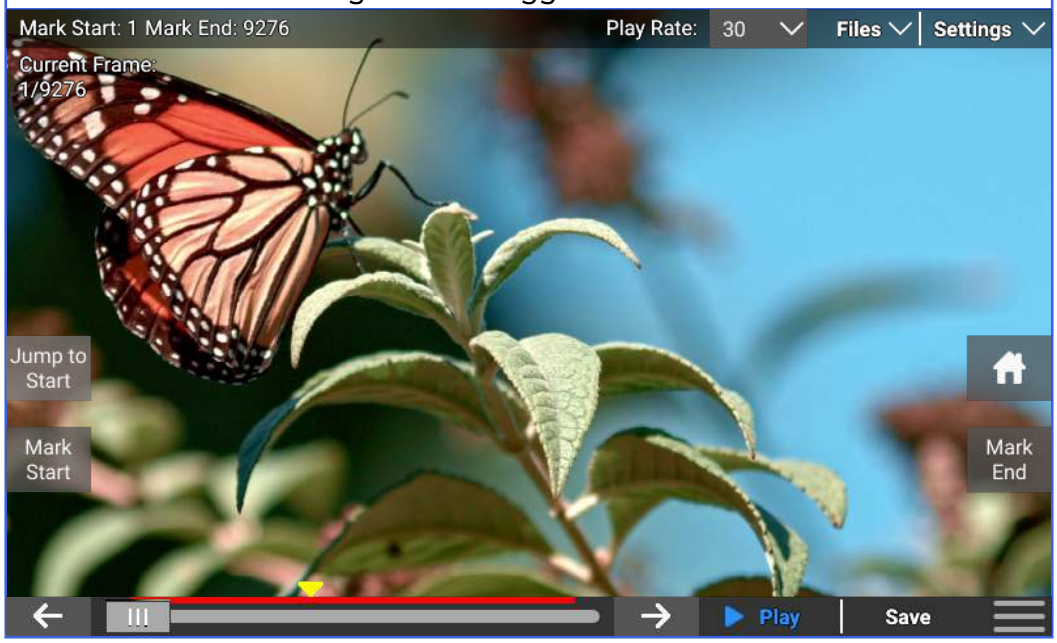
## 6.2.2 Trigger Frame

The **trigger frame** is defined as the frame that is being captured at the time of the trigger event, or the frame immediately prior to the trigger event if the sensor is not actively exposing at that time. After capturing footage using Record End mode, there are several ways to determine where the trigger occurred relative to the recording.

Each frame is assigned a frame number relative to the trigger, with the trigger frame being frame 0, as well as a relative timestamp from the start of its exposure to the trigger event. This information can be viewed by enabling the text overlays from the Playback screen, or in the CSV file saved with the footage.

Additionally, a marker is present on the Playback screen identifying the trigger frame. Note that the marker is only visible when the trigger frame is part of the recording, which is only true when the pre-trigger delay is not 0 (see examples on the next page).

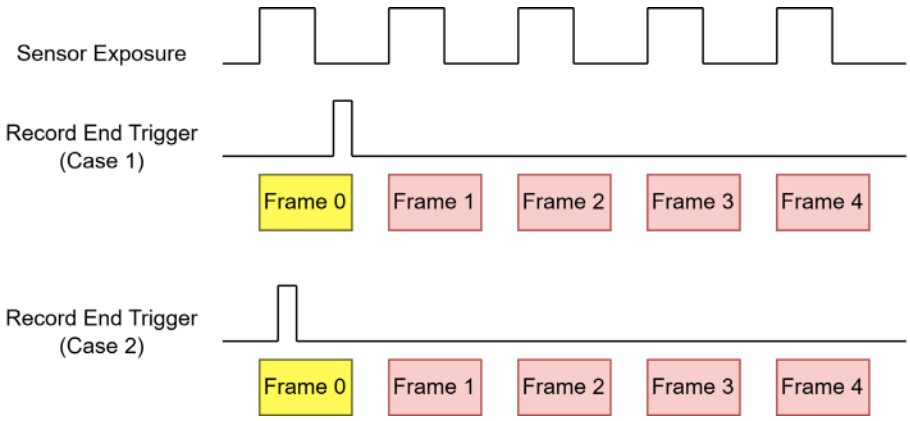
Figure 6.5. - Trigger Frame Marker



***EXAMPLE 1:*** Consider the following trigger delay settings:

- Pre-trigger = 0
- Pre-record = 0
- Post-trigger = 4 frames

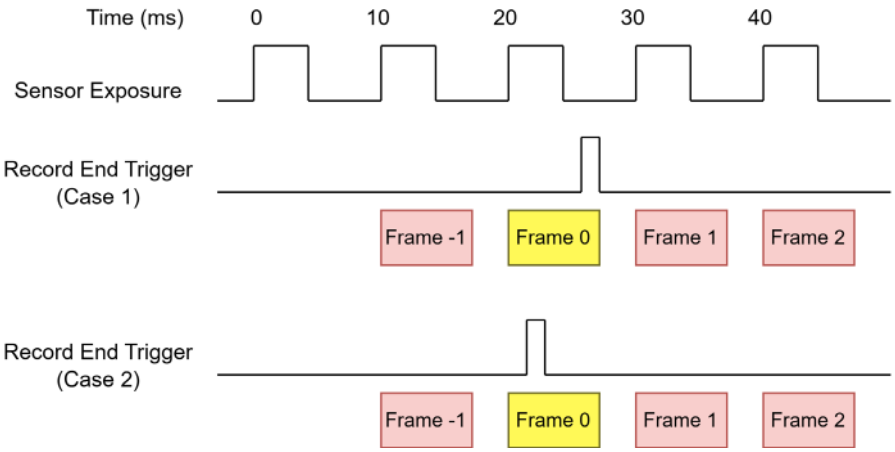
The trigger event can occur either while no frame is actively exposing or in the middle of a frame. Both cases are shown in the diagram below. In both cases, the trigger frame is not included in the recording. Only the four frames that follow the trigger event are in the recorded footage.




***EXAMPLE 2:*** Consider the following trigger delay settings:

- Pre-trigger = 20ms
- Pre-record = 0
- Post-trigger = 20ms

Assume the frame rate of the camera is 100 FPS, so the frame period is 10ms. In both cases, the frame that starts at time 0 is not included in the recording because its start of exposure occurs before the trigger event minus the pre-trigger delay. The remaining 4 frames, including the trigger frame, are included in the recording.



## 6.3 Frame Synchronization Modes

There are three I/O modes provided for frame synchronization with external devices. Two of the I/O modes, **Shutter Gating and Exposure**, enable control of the sensor shutter so that the frame capture of the camera is synchronized to some external source. The third I/O mode, **Frame Sync Output**, enables synchronization of an external device to the camera's frame capture.

### 6.3.1 Frame Sync Outputs

The frame sync output signal provides an indicator of when the image sensor is exposing. This signal can be enabled regardless of if the sensor is being driven internally or externally.

By default, the frame sync output signal directly reflects the signal that is sent to the sensor to trigger the exposure. However, this sensor undergoes an 8 microsecond shutter delay before the exposure starts. To get the frame sync output signal to reflect when the sensor is actually exposing, select the "Delay" checkbox to delay the output signal by 8 microseconds.

When synchronizing to an external device that needs to know exactly when the sensor is exposing, such as a Chronos 1.4 or 2.1-HD camera, this delay should be enabled. The main case in which this delay should be disabled is when synchronizing to another Chronos 4K12 camera.

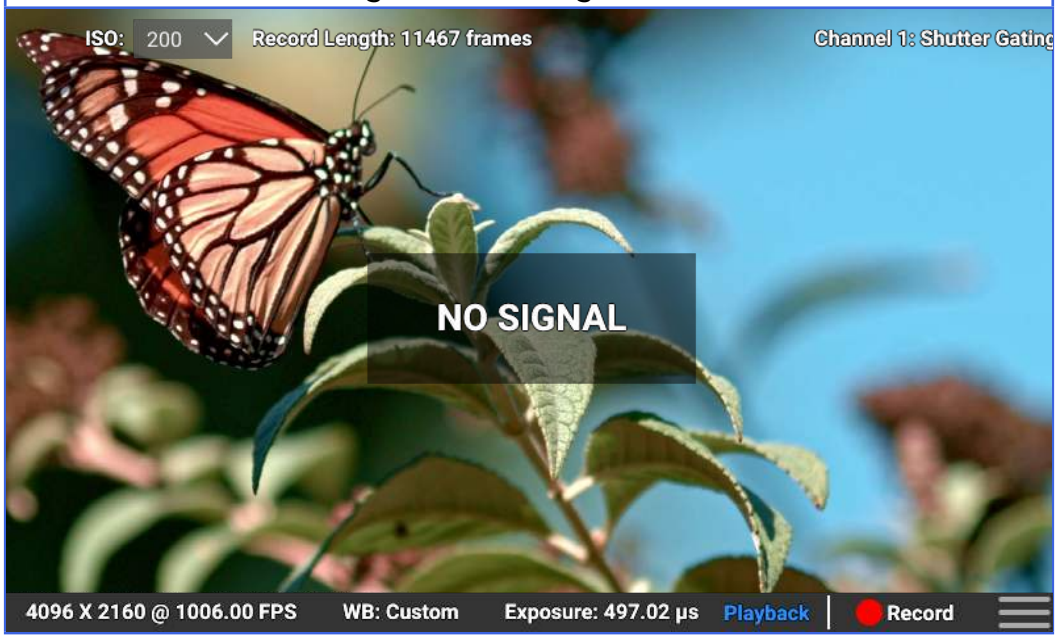
### 6.3.2 Shutter Gating Mode

In Shutter Gating mode, the shutter of the sensor is directly controlled by an external signal input to one of the I/O channels. The sensor trigger is active high, so the **Shutter Gating** signal exiting the Input Mode Handler in Figure 6.3 must also be active high. The exposure occurs for as long as the trigger is active. Note that due to the sensor shutter delay, the sensor exposure is actually 8 microseconds delayed from the input signal.

> ***USER NOTE:*** *Only one I/O channel may be set to either Shutter Gating or Exposure mode at a time.*

If the camera is set to **Shutter Gating mode**, but no signal is present on that input channel, a "NO SIGNAL" message is displayed on the main screen. The same behaviour occurs in **Exposure mode**. As soon as an input signal is detected on the respective I/O channel, this message disappears and the sensor starts capturing frames (refer to figure 6.6 on the next page).

Figure 6.6. - No Signal Indicator




## 6.3.3 Exposure Modes

In Exposure mode, the start of exposure is triggered by a rising edge in the Exposure signal exiting the Input Mode Handler, but the duration of the exposure is controlled by the camera settings.

To ensure that an appropriate exposure duration is set for the frequency of the external signal, use the following procedure:

1. In the Record Settings screen, select the desired resolution and frame rate. The frame rate should match the maximum expected frequency of the Exposure trigger signal. This ensures the allowed exposure range is valid for the expected capture frame rate.
2. Enable Exposure mode from the Trigger I/O settings screen.
3. The exposure can be safely modified across using the slider on the main screen.

If the frequency of the external signal exceeds the configured camera frame rate, there may be inconsistent behaviour. A frame is skipped if a rising edge of the Exposure trigger is observed while another frame is currently exposing. In other cases, the live preview of the frames may appear to be frozen. This is an indication that the exposure duration is too long for the frequency of the input signal.

***USER NOTE:*** *When using either Shutter Gating or Exposure mode, if the record length is specified in units of time, the maximum record length is calculated using the current frame rate setting in the Record Settings screen.*

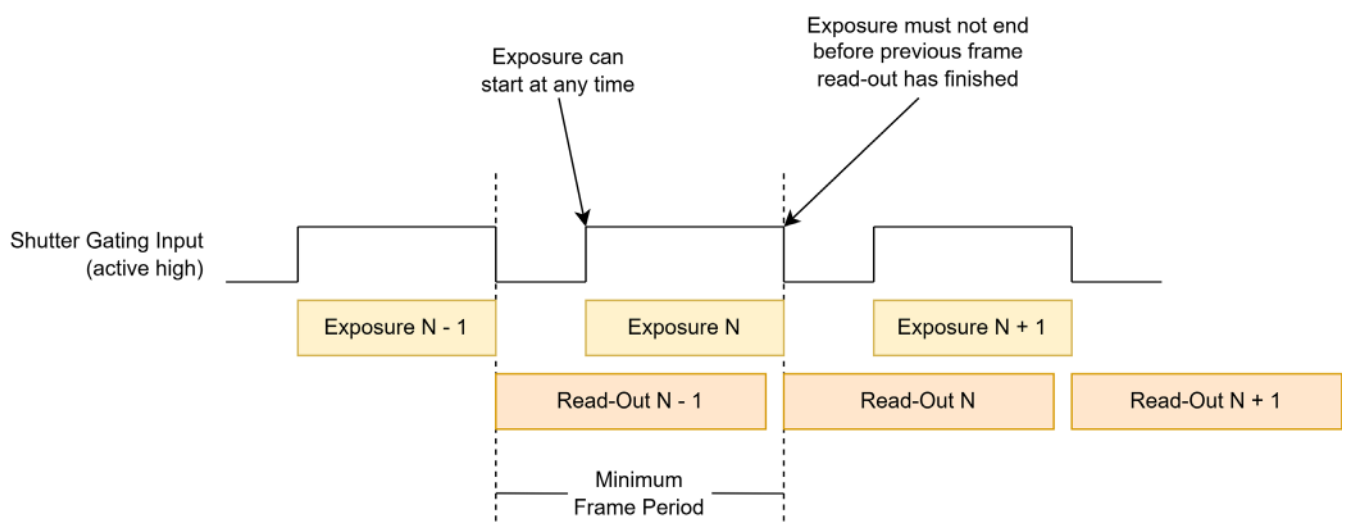
*If the frequency of the external signal does not match the current frame rate setting, then this maximum record length is not valid for the desired configuration. When in Exposure mode, adjust the frame rate to match the desired capture frame rate. When using Shutter Gating, adjust the frame rate setting of the camera appropriately before enabling this mode. This ensures the record length is always accurately specified.*

### 6.3.4 External Timing Requirements

There are several restrictions placed on the input signal in Shutter Gating and Exposure modes:

1. In **Shutter Gating mode**, a minimum exposure of 1us must be maintained. Undefined behaviour may occur with a pulse width shorter than 1us. This restriction is already met in **Exposure mode** because the exposure duration is controlled by the camera.
2. In either mode, enough time needs to be allowed for the sensor to complete read-out of the previous frame. The time between the end of exposure of consecutive frames must be at least equal to the minimum frame period (equivalent to 1 / maximum frame rate) of the current sensor configuration. The maximum frame rate of the current configuration can be determined from the Record Settings screen.

Figure 6.7. - Shutter Gating Timing Requirement



If at any point this requirement is not respected, the camera extends the exposure of the frame so that the sensor is never driven with invalid timing. This may cause the following frame(s) to be skipped or, in the case of Shutter Gating, cause the exposure of the next frame to start late.

## 6.4 IRIG-B Timecode Synchronization

The camera can receive an IRIG-B standard DC level shift (DCLS) timecode signal on any one of the trigger channels. Only one I/O channel may be set to this mode at a time. Ensure that the voltage threshold on the selected channel is appropriate. A threshold of 2.5v works well for this use case, where the input is a 0 - 5v pulse-width-modulated signal.

There is an internal high-speed real-time clock (HS-RTC) that is used to timestamp captured frames and trigger events. On camera startup, the HS-RTC is initially set using the camera's date and time configured in the Factory tab of the System Settings.

When IRIG-B timecode reception is enabled, the HS-RTC is synchronized to the decoded timecode once per second. A message on the main screen is displayed indicating whether the camera currently has a lock on the IRIG-B signal. If the camera loses a lock on the signal, this message is updated to indicate the duration since the last lock. The HS-RTC continues to increment based on the last IRIG-B timestamp it received, but its timestamp may gradually drift and become less accurate over a longer period of time.

Figure 6.8.a - IRIG-B Status Messages

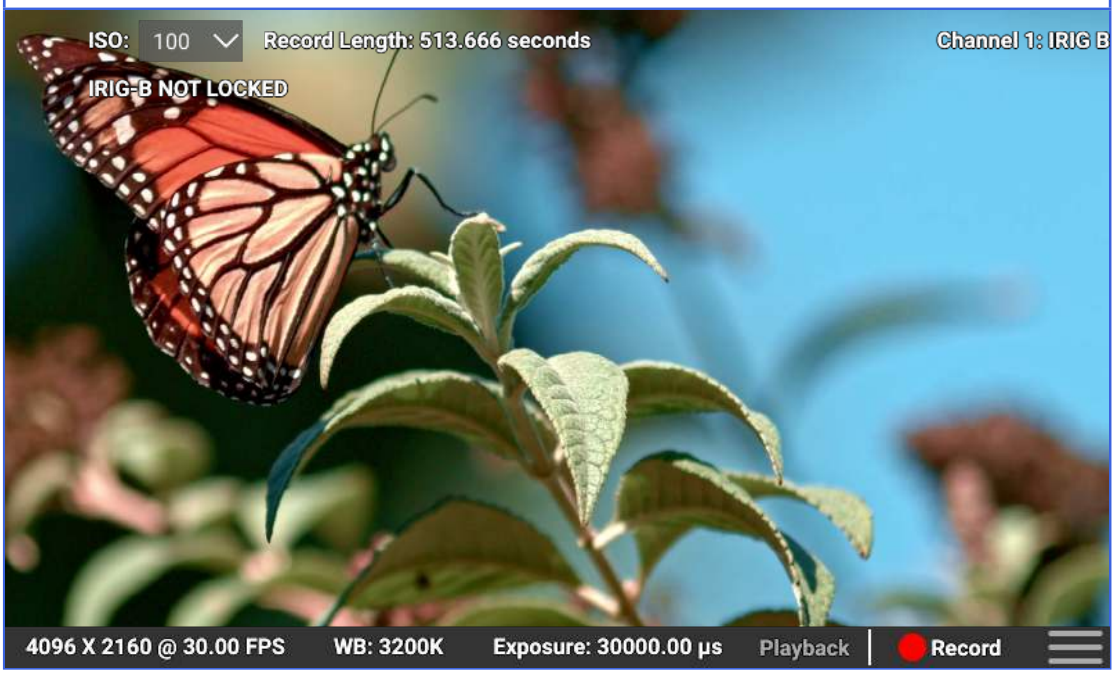


Figure 6.8.b - IRIG-B Status Messages

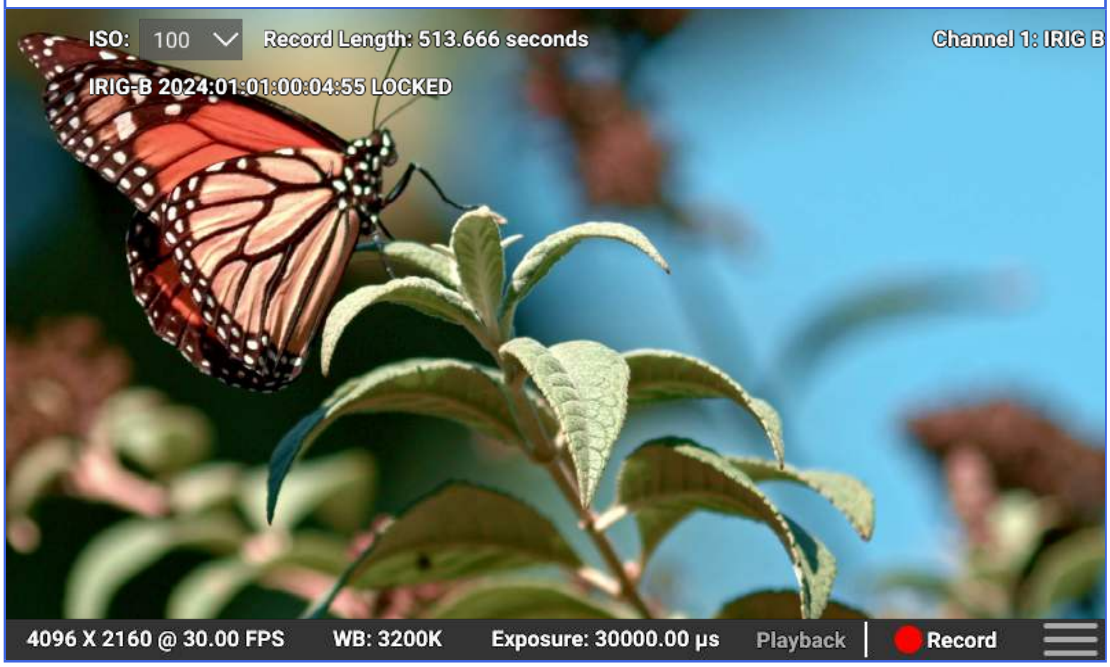
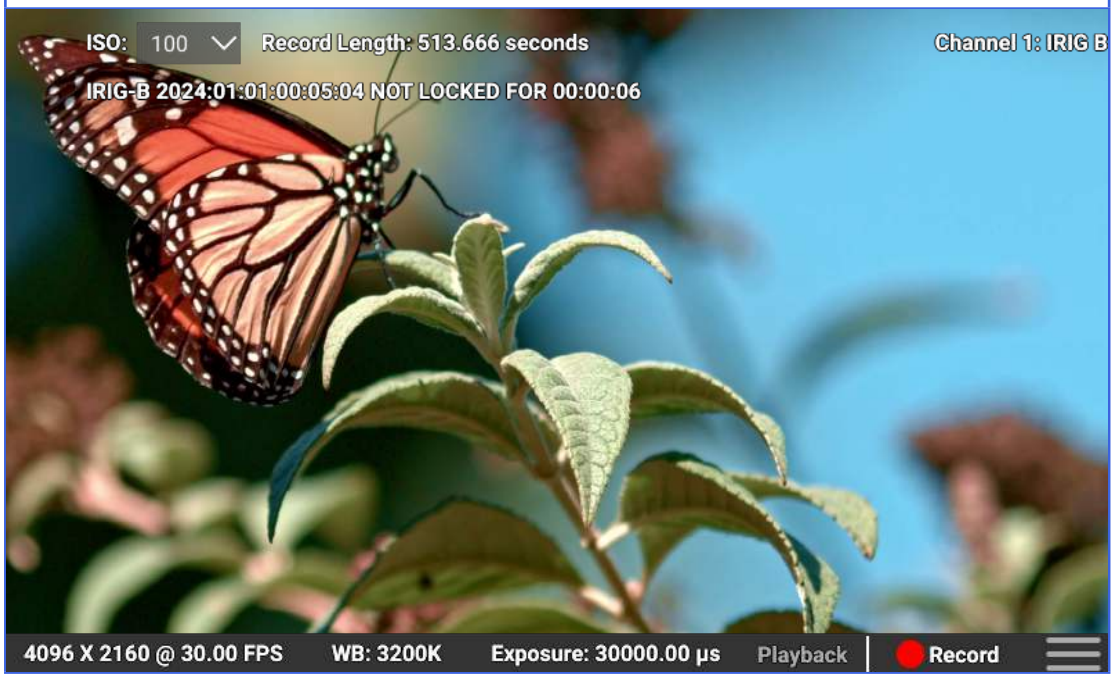



Figure 6.8.c - IRIG-B Status Messages



Once IRIG-B mode is disabled from the Trigger I/O screen, the HS-RTC is once again synchronized with the camera's internal timestamp.

***USER NOTE:*** *Frame timestamps can be enabled in the Playback Settings menu and can be viewed in several ways:*

1. *Overlay embedded on or below the video (H.264/H.265 and TIFF save formats)*
2. *CSV file saved alongside video (all save formats)*
3. *Embedded in the file name (DNG)*

# 7. Network Interface

The functionality of the 4K12 may be expanded with a USB-C to Ethernet adapter. Network shares leveraging the NFS or SMB protocols may be connected using the Network tab of the System Settings.

After entering the network share connection information, press the Apply button to save the changes, and then press the Test button to confirm the settings will yield a connection. When a connection is successful, the network share will appear as a destination option in the Save Settings screen. Once applied, the camera will automatically attempt to reconnect to the network share upon startup and save footage to the designated network location.

Figure 7.1. — Network Screen

## 7.1 Dynamic IP Address Configuration via DHCP

The camera can automatically acquire an IP address via DHCP (enabled by default). To enable DHCP, ensure that the DHCP checkbox is checked (enabled). **The acquired IP address will be shown in the Network Status box once it successfully connects.**

## 7.2 Static IP Address Configuration

The camera can be configured with a static IP address. To enter a static IP address, fill in the fields for the IP, Netmask, and Gateway. To use a static IP address, the DHCP checkbox must be cleared (disabled).

> ***NOTE:*** *The network interface allows for camera control via a REST API. For detailed information on the API interface, refer to the* ***Chronos 4K12 REST API Manual*** *available* ***here****.*

# 8. Video Output

The 4K12 camera supports HDMI output during live feed, recording, and playback.

The camera supports **three different output video modes**:

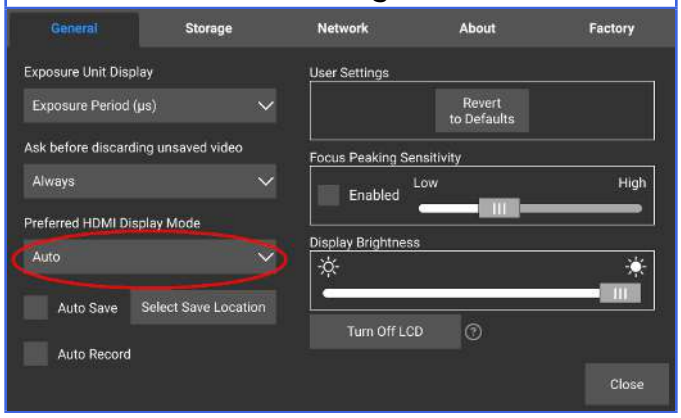
- 4096 x 2160 at 30 FPS
- 3840 x 2160 at 30 FPS
- 1920 x 1080 at 60 FPS

Which mode is used depends on the preferred display mode field on the Settings screen. When set to Auto, the native video mode of the monitor is used if it is one of the three supported options. If that is not the case or the monitor's native video mode could not be determined, the mode with the highest resolution that is also supported by the monitor is used.

The video mode can also be forced to any one of the three options by selecting it in the dropdown. Note that if the monitor does not support the forced video mode, then the procedure described above is used to select a different video mode.

If the monitor does not support any of the three video modes, an error pop-up is displayed on the Main screen. A monitor that supports at least one of these modes must be used.

Figure 8.1. — HDMI Preferred Display Mode Setting

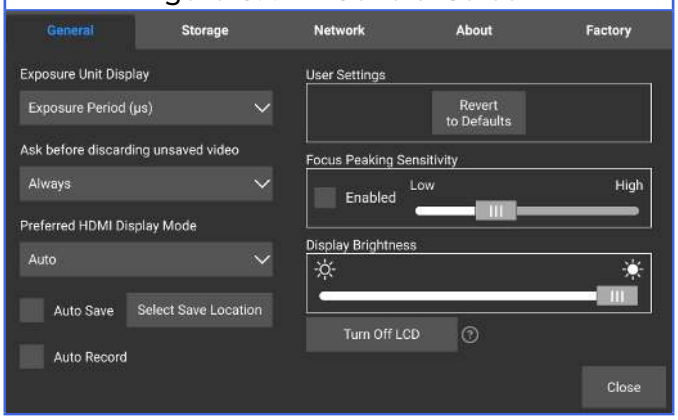


# 9. Camera System Settings

Here is the overview of the camera's System Settings, which allow users to customize core functions and manage device behavior. These settings are organized into five main tabs: General, Storage, Network, About, and Factory. Here are the detailed descriptions of each setting, provided in the following sections:

## 9.1 General Screen

Figure 9.1. — General Screen



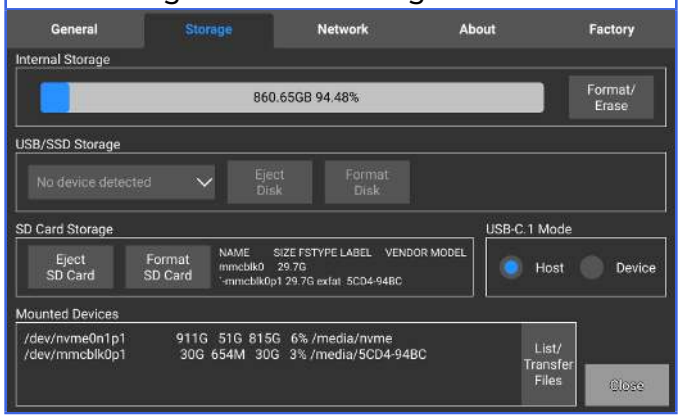

The General tab of the System Settings screen contains settings and information about the camera. Refer to the table below for details on the various functions.

| CONTROL | FUNCTION |
|---|---|
| Focus Peaking Sensitivity | Enables Focus Peaking, which highlights objects that are in-focus. You can adjust the sensitivity using the Jog Wheel or the touchscreen LCD. |
| Display Brightness | Adjusts the brightness of the touchscreen LCD. You can adjust the sensitivity using the Jog Wheel or directly on the screen by sliding the value bar. |
| Exposure Unit Display | Sets the units in which Exposure is displayed and controlled on the main screen. This can be set to either Exposure Period (µs), Shutter Angle (°), or Exposure Fraction. |
| Ask Before Discarding Unsaved Video | While set to "Always," an alert will pop up and must be accepted before the camera can discard the unsaved video and begin a new recording.<br><br>While set to "Never," previously recorded video will be flushed and replaced with new video data without any confirmation required. |
| Preferred HDMI Display Mode dropdown | This setting determines which HDMI display mode is used based on the "Preferred Display Mode" option on the Settings screen. When set to Auto, the system attempts to use the monitor's native video mode, provided it matches one of the three supported options.<br><br>The camera supports three different output video modes:<br>• 4096 x 2160 at 30 FPS<br>• 3840 x 2160 at 30 FPS<br>• 1920 x 1080 at 60 FPS<br><br>If the native mode isn't supported or can't be detected, the system defaults to the highest supported resolution available on the monitor. |

| CONTROL | FUNCTION |
|---|---|
| Auto Save | When a recording ends, the camera automatically saves the entire recording using the most recently selected save settings and destination. If Auto Record is selected as well, the camera will record and save in a continuous loop, which can be interrupted by tapping any of the Main screen buttons (except for Record), and then choosing to stop the recording.<br><br>Prior to enabling Auto Save, set a save location manually in Select Save Location. It is not necessary to set a filename, as videos will be named automatically with the date and time upon saving. |
| Auto Record | Automatically starts a recording after the camera has booted and again whenever it finishes saving video to an external storage device. |
| Select Save Location | Opens a pop-up window allowing you to select the Auto Save destination. Press OK when done. |
| Revert to Defaults | Sets the camera's settings back to the factory default. |
| Turn off LCD | Disables the built-in LCD display to minimize light emission during low-light or dark shooting scenarios, helping preserve the ambient lighting of the scene. The system remains fully operational, and the display can be reactivated at any time by tapping anywhere on the screen. |
| Close Button | Returns to the Main screen. Settings are applied automatically as they are changed. |

## 9.2 Storage Screen

Figure 9.2. — Storage Screen




The Storage tab contains settings and information about the camera's storage features. Refer to the table below for details on the various functions.

| CONTROL | FUNCTION |
|---|---|
| Internal Storage | Shows the amount of data saved to the camera's internal NVMe SSD. Selecting the Format/Erase button will open up a new pop-up screen requesting that you type "Erase" to erase all data on the device. This action is not reversible. |
| USB / SSD Storage | Allows you to select an external device to save recorded video after connecting to the camera's USB-C ports. The dropdown will list storage devices recognized through either of the two USB-C ports. Although there are only two USB-C ports, a USB hub could be connected to either port, thereby allowing for an array of different storage devices to become accessible to the camera as saving destinations. As a best practice, press the Eject Disk button before removing the USB connection to prevent any loss of unwritten data. |

| CONTROL | FUNCTION |
|---|---|
| Eject SD Card | Finishes any outstanding writes to the selected storage device and unmounts the file system from the camera's control. This is equivalent to the "Safely Remove" option on PCs, and protects against the loss of unwritten data. |
| List / Transfer Files | Opens a file browser window to display files and folders on each connected storage device that has been recognized by the camera. |
| Close Button | Returns to the Main screen. Settings are applied automatically as they are changed. |

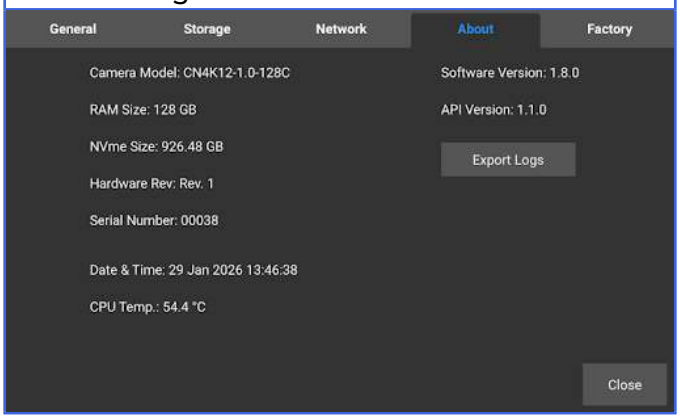
## 9.3 Network Screen

Figure 9.3. — Network Screen

Please refer to Chapter 7 (Network Interface) for more information on how to operate these features.

## 9.4 About Screen

Figure 9.4. — About Screen



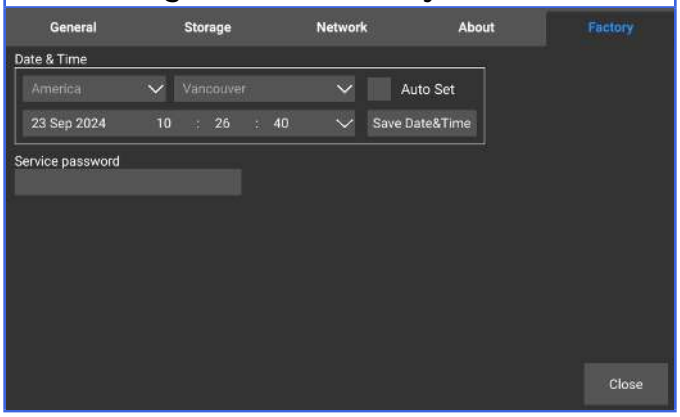

The About tab contains information about the camera's hardware, software, and current operating conditions. In the event that support from Kron Technologies is required, it is useful to provide a photo of this screen with your support ticket.

The lower left-hand side of the display shows live information pertaining to the camera's internal systems. The table below describes these parameters in more detail.

| CONTROL | FUNCTION |
|---|---|
| Date & Time | Shows the current date and time the camera is referencing. |
| Export Logs | Exports an information log which may help the customer support team troubleshoot issues with the camera. |
| CPU Temperature | The internal temperature at a more central point inside the camera. This value typically equalizes close to that of the Sensor Temperature. |

## 9.5 Factory Screen

Figure 9.5. — Factory Screen




The Factory tab of the System Settings screen is used for manually specifying the date & time.

| CONTROL | FUNCTION |
|---|---|
| Date & Time | Manually updates the Date, Time, Region, and City. |
| Service Password | Enters service mode.<br><br>**INTENDED FOR USE WITH CUSTOMER SUPPORT ONLY.** |
| Auto Set | Tap the box next to the text "Auto Set" to have the date and time update automatically. This function requires that the camera be connected to the Internet to work and is relative to the selected Region / City. |

# 10. Optics

## 10.1 Lens Mount & Adapter

The Chronos 4K12 may be fitted with a variety of mounts to accommodate your desired lens. The mount may be removed after unscrewing the four M4 screws attaching it to the front of the camera body. Due to varying flange focal distances, a Shim Kit is included to help calibrate the focus of your desired lens. Shims of varying thickness may be placed underneath the lens mounting plate to increase or decrease the flange.

## 10.2 Lens Selection

Each lens you choose to mount to the 4K12 may also have a uniquely sized image circle. That is, a circle of light which is transmitted from the front optical element to the rear optical element of the lens, and projected onto the 4K12's image sensor. This image circle must be at least 20.74mm x 9.79mm diameter in order to cover the entire 4K12 image sensor at its maximum resolution. However, lenses transmitting a smaller image circle may be still be useful, especially in combination with windowed resolutions.

> ***NOTE:*** *There are no electronics actively interfacing between the camera and your desired lens. Therefore, the camera's focus, aperture, and stabilization depend on manual camera operations and/or third-party accessories.*

## 10.3 Back Focus Adjustment

Back focus adjustments are intended for calibrating your desired lens to focus at infinity while attached to your 4K12.

Flange focal distances will vary between the types of lenses and/or adapters mounted to the 4K12. Therefore, shims are provided to increase or decrease the flange. These shims behave similar to "extension tubes," where greater distances (i.e., greater extensions) enable "near-sighted" focus. Fewer shims enable wider fields of view within focus.

The perfect combination of shims for your desired lens will depend on your intention. However, to achieve the behavior intended by the manufacturer of your desired lens, the back focus should be adjusted as close as possible to achieving focus at infinity. Set the focus of your mounted lens to infinity, and check the 4K12's live view to ensure the image is in focus.

The use of a tripod, and enabling the camera's Focusing Aid feature, could be very helpful during the back focus adjustment process.

# 11. Installing Software Updates

The following section provides a step-by-step description of the 4K12's online software update procedure.

1. Download the software update package provided in the Kron Technologies Help Center.

2. For Windows, Mac, and Linux, download and install the "Raspberry Pi Imager" software from https://www.raspberrypi.com/software/

3. Ensure the camera is powered off. Use a Phillips screwdriver to remove the Service Door on the side of the camera to access the microSD card.

> ***NOTE:*** *The microSD card for should have a minimum capacity of 32GB.*

4. Press the microSD card inwards to eject it, and then remove it from the camera.

5. Insert the microSD card into your computer's SD card slot. A microSD to SD card adapter might be required for this.

6. Launch the Raspberry Pi Imager program.

7. Click the "CHOOSE OS" button, and select the "Use custom" option at the bottom of the list.

8. Select the software update file downloaded in step #1.

9. Click the "Choose Storage" button, and then select the microSD card.

10. Click the "Next" button, and then select the "No" button in the popup labeled "Use OS customisation?"

11. Click "Yes" to begin writing the update to the microSD card. This process will typically require 15 to 30 minutes to write and verify. The verification step is optional but recommended.

12. A "Write Successful" popup will appear when the Raspberry Pi Imager is completed. Remove the microSD card from your computer and re-insert it into the camera.

13. Reattach the Service Door removed in step #3, and then reconnect the power supply to the camera.

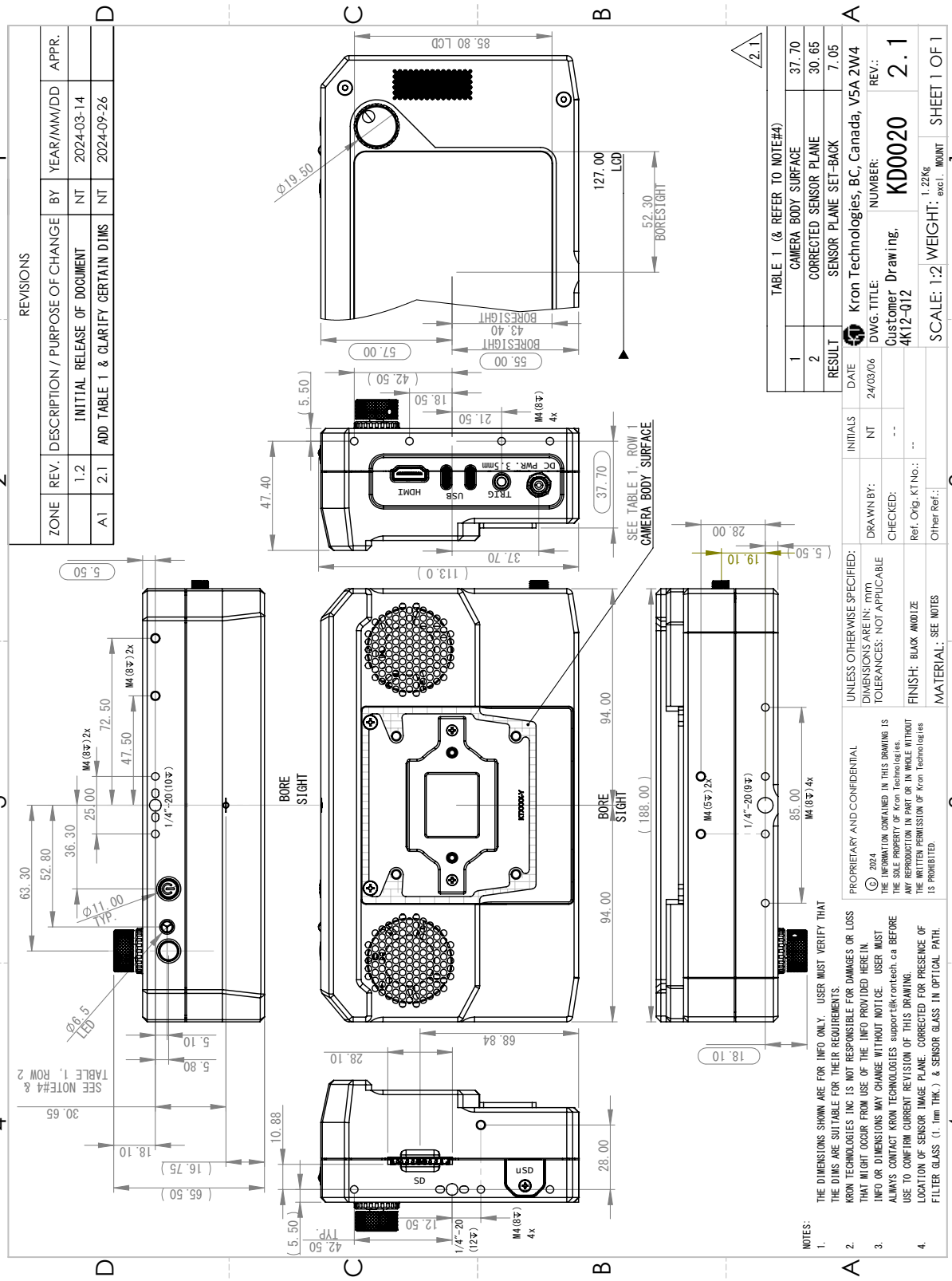
14. Verify the camera starts up successfully. In the About tab of the System Settings screen, the Software Version should now read 1.8.0.

# 12. Troubleshooting

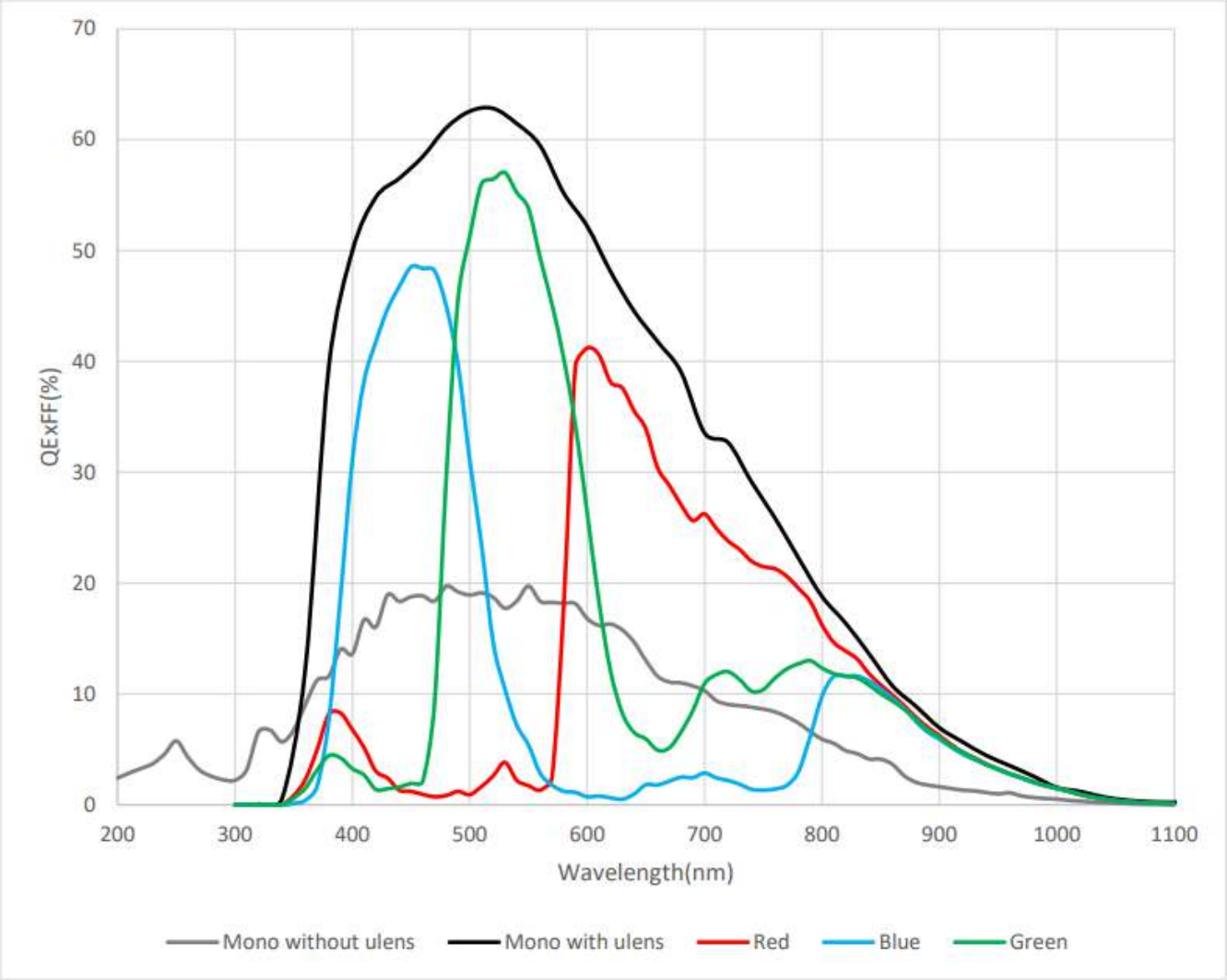
Please refer to the table below for common troubleshooting issues and solutions.

| SYMPTOM | POSSIBLE PROBLEM | SOLUTION |
|---|---|---|
| Camera won't power on | No power | Insert the supplied AC Adapter into the Locking Barrel Jack (see Figure 1.5). |
| | Crash | Remove the AC Adapter for 10 seconds, then reconnect and power on. |
| | Wrong AC Adapter voltage | Ensure that the AC Adapter is providing between 12–24 Volts, positive tip. |
| Power status indicator flashes red / green continuously | Power controller in recovery mode | Turn the camera off and disconnect the AC adapter for 10 seconds. When reconnecting power, ensure the power button is not pressed until after the LED flashing stops. |
| | Power controller firmware corrupt | If the above solution doesn't fix the problem, contact Kron Technologies at support@krontech.ca. |
| Can't trigger recording end | IO screen has extra pullup on | Confirm that the only Pull Up enabled is the one for the trigger that is in use. |
| | Trigger Delay is set to a long time | On the camera, navigate to Trigger/IO Settings > Adjust Trigger Delay, press "Reset To Defaults," and press "OK." |
| Focus slightly wrong, proper focus out of range | Back Focus mis-adjusted | Re-adjust Back Focus. Please see Chapter 10 (Optics) for more details. |
| | Lens limitation | Some lenses, especially lower-end lenses, transmit a relatively soft image through their maximum aperture. Reduce the aperture to sharpen the focus. |
| Lens doesn't maintain consistent focus while zooming | Back Focus mis-adjusted | Re-adjust Back-Focus. Please see Chapter 10 (Optics) for more details. |
| | Lens is not parfocal | Some lenses do not maintain focus during zoom, so focus needs to be adjusted after zooming. |
| Black ring around image / Corners of image are dark (Vignetting) | Lens is too small for the sensor | Some lenses do not cover the image sensor. Change to a different lens with a larger image circle. |
| HDMI is connected to a monitor but no output is displayed | Monitor does not support at least one of the video modes listed in Section 8 | Use a different monitor that is known to support one of the other video modes |

# **Appendix A.** Mechanical Drawing

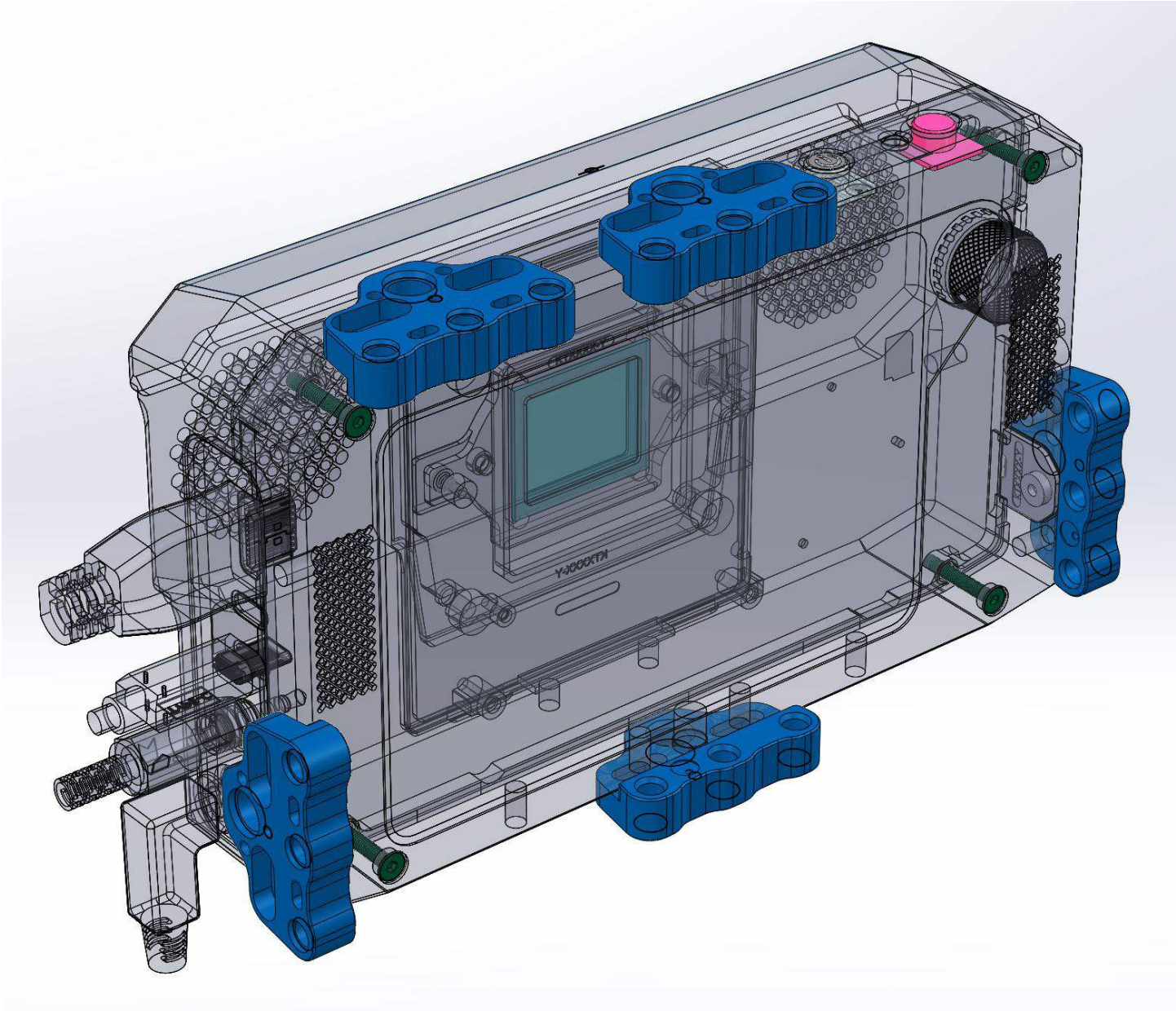


# **Appendix B.** Spectra Sensitivity




Spectra sensitivity characteristics

# **Appendix C.** Adapter Bracket Locations



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