# KRON TECHNOLOGIES
## HIGH-SPEED IMAGING

# CHRONOS 4K12 USER MANUAL

## Software Version 1.6.0

# 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/

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# 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 | 3.5mm to Dual-BNC Adapter Block | 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 | Lens Mount Shim Kit | ACC-1.0-MNTSHM4 | 1* | A series of spacers to adjust the back-focus distance for your selected lens mount. |
| 24 | 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

Record Button

*Start or Stop Recording*

Camera Status Indicator

Power Button

¼"-20 Mount + ARRI Interface and M4 Mounting Points

Air Intake Cooling Fan

Air Output Cooling Fan

*Do not obstruct cooling fans airflow*

4 x M4 screw holes for attaching a Lens Mount Plate

## 1.1 LED Status Camera Indicator Colors:

- Green: Camera ready to record

- Red: Recording in progress

- Blue Flashing: Saving in progress

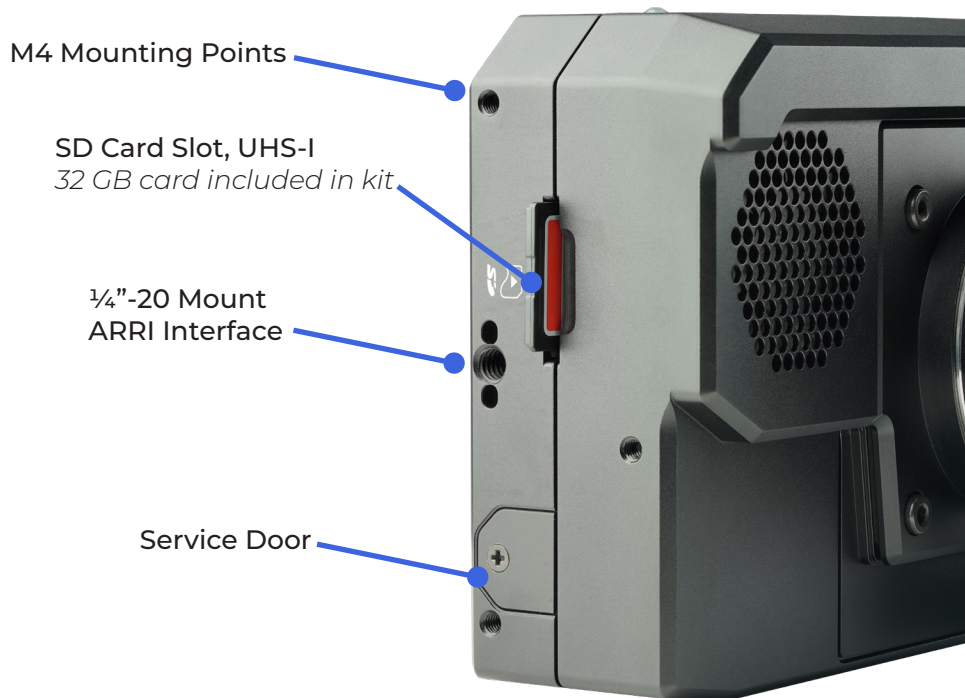- Orange Flashing: Camera over temperature warning

**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



M4 Mounting Points

SD Card Slot, UHS-I
*32 GB card included in kit*

¼"-20 Mount
ARRI Interface

Service Door

**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

5 in. (127mm) Capacitive
LCD Touchscreen

Jog Wheel

## 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)*

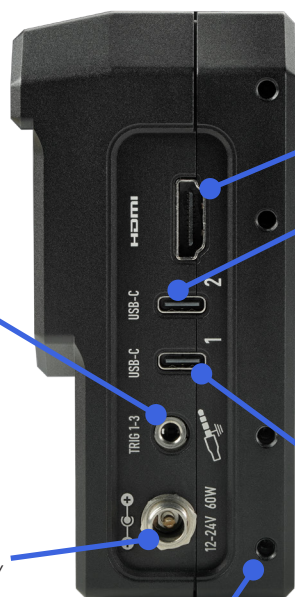*Adjustable input threshold: 0 – 6.6 Volts*

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

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

**Power**

*12 - 24 Volts DC, 60 W*

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

**HDMI**

*Video output up to 4K @ 30 FPS*

*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)*

**4 x M4 Screw Holes**

*For mounting various accessories*

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**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
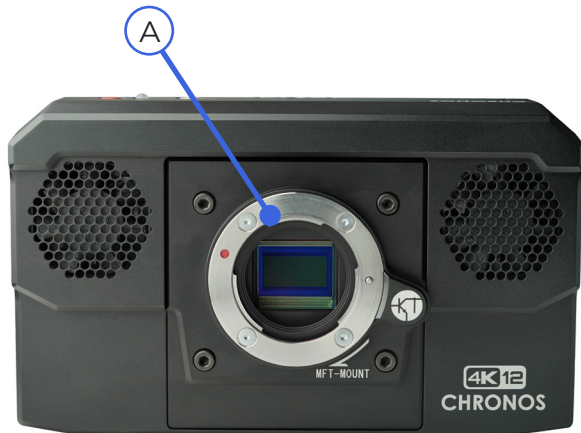


> **NOTE:** *The camera comes with a 1mm shim pre-installed underneath the lens mounting plate; however, the selection of shims may need to be modified in order to achieve focus at infinity with your desired lens. Refer to Section 10.3 for more information*

> **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
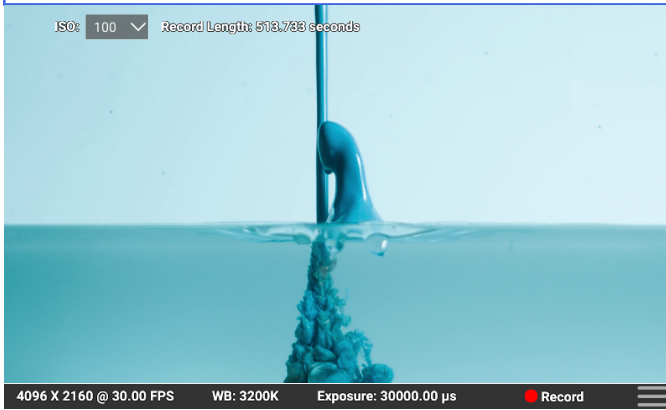
# 2.3 Main Screen Functions



Figure 2.3. — Main Screen Functions
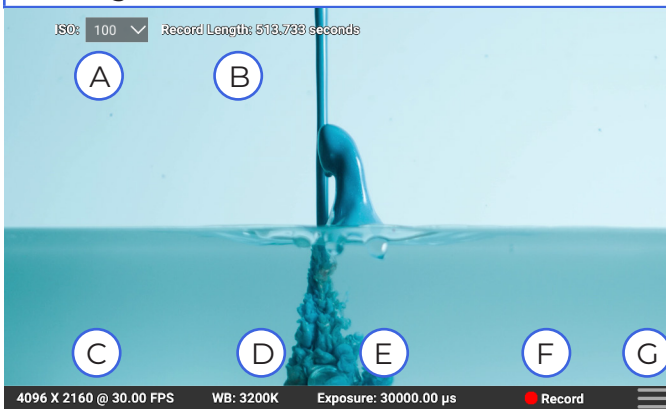
**Top Row Left to Right**

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

**(G)** ≡ **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/
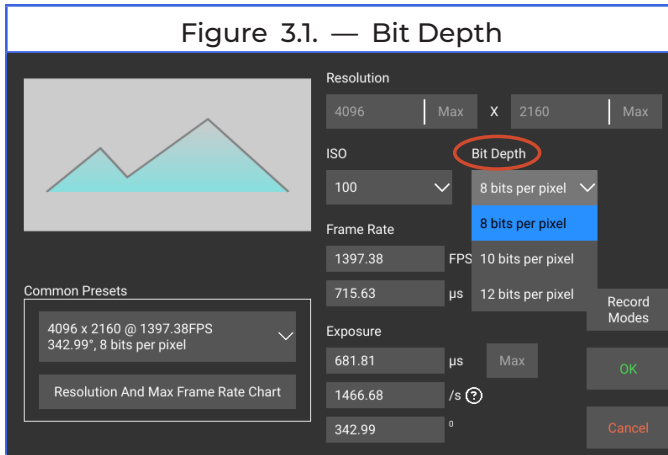
## 3.2 Setting Bit Depth

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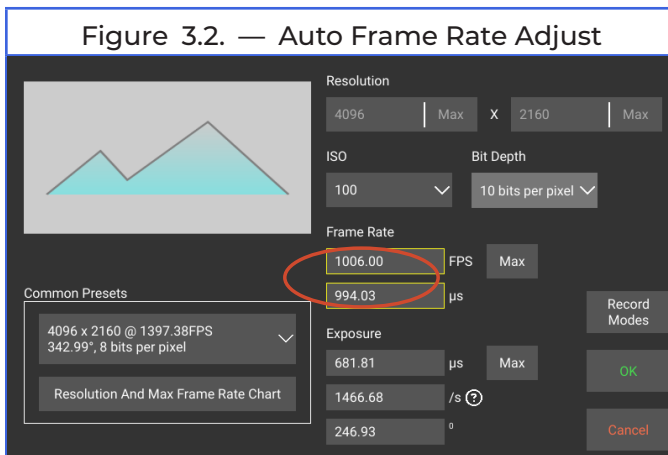
Press OK to confirm the Bit Depth adjustment and exit the Record Settings screen.

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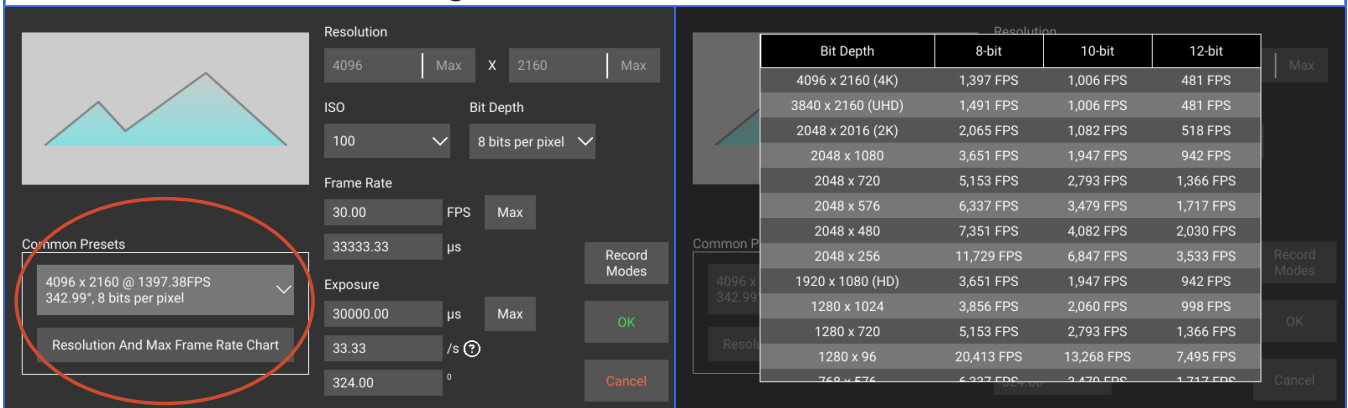
Use the Common Presets Dropdown to select a resolution and the corresponding maximum frame rate. Swipe upwards to scroll down the list of available options.

Figure  3.3.  —  Common Presets Dropdown
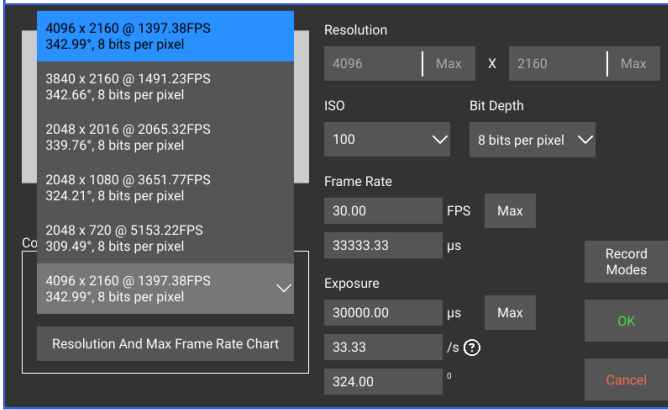
All possible resolutions and their corresponding maximum frame rates may be viewed in a table by tapping on the Resolution And Max Frame Rate Chart button. Maximum frame rates are organized in columns by Bit Depth. See Section 3.2 for more information on Bit Depth.



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 |
| 2048 x 2016 (2K) | 2,065 FPS | 1,082 FPS | 518 FPS |
| 2048 x 1080 | 3,651 FPS | 1,947 FPS | 942 FPS |
| 2048 x 720 | 5,153 FPS | 2,793 FPS | 1,366 FPS |
| 2048 x 576 | 6,337 FPS | 3,479 FPS | 1,717 FPS |
| 2048 x 480 | 7,351 FPS | 4,082 FPS | 2,030 FPS |
| 2048 x 256 | 11,729 FPS | 6,847 FPS | 3,533 FPS |
| 1920 x 1080 (HD) | 3,651 FPS | 1,947 FPS | 942 FPS |
| 1280 x 1024 | 3,856 FPS | 2,060 FPS | 998 FPS |
| 1280 x 720 | 5,153 FPS | 2,793 FPS | 1,366 FPS |
| 1280 x 96 | 20,413 FPS | 13,268 FPS | 7,495 FPS |
| 768 x 576 | 6,337 FPS | 3,479 FPS | 1,717 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
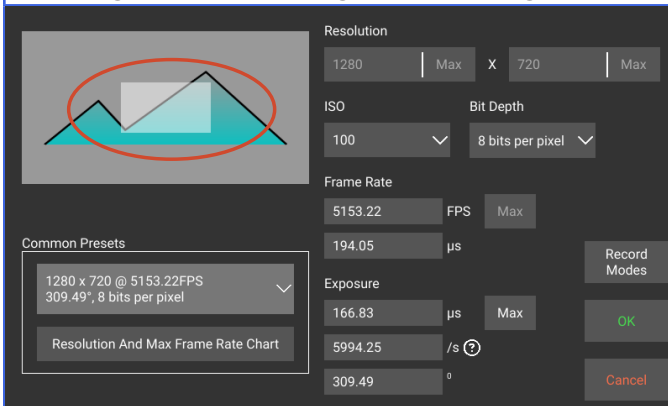
The frame rate or frame time (1 / frame rate) can also be entered manually by selecting either the FPS or μs numeric entry boxes.

Figure 3.6. — Frame Rate Entry Boxes
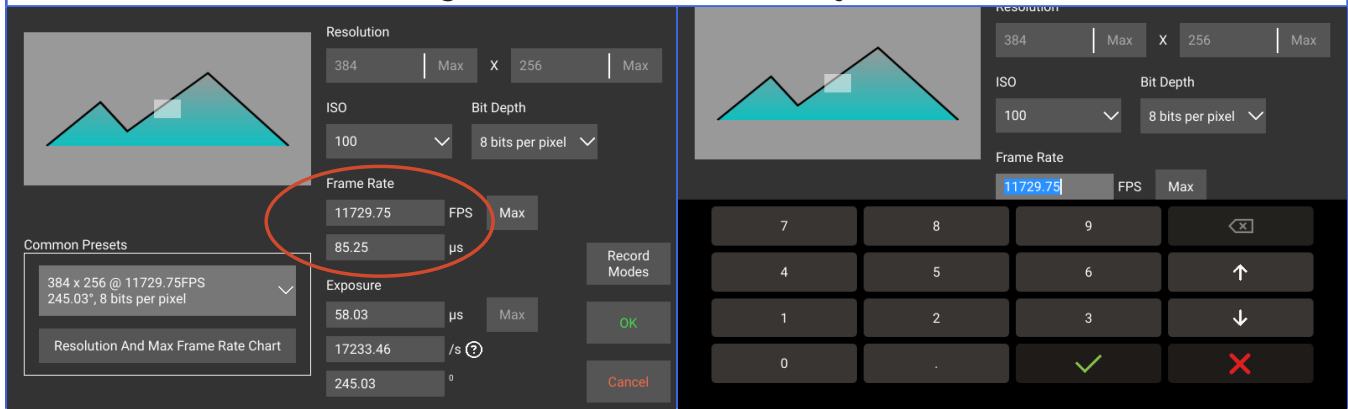
Changing the frame rate may also change the range of supported exposure settings. If the exposure setting is not within the range supported by the newly selected frame rate, the camera will automatically adjust the exposure and draw a yellow box around the updated settings. The Max button can be selected 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
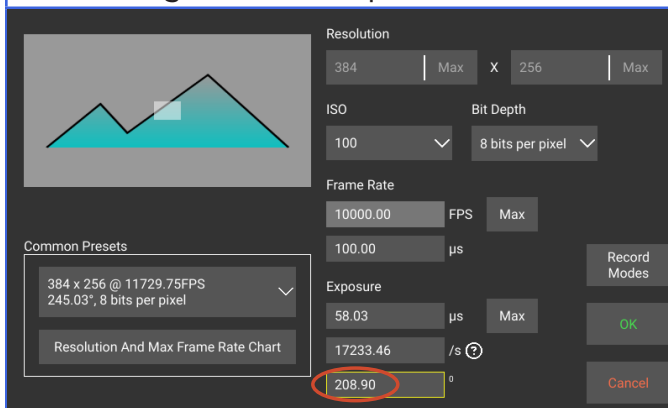
Press OK to apply the preset and exit the Record Settings screen.

# 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
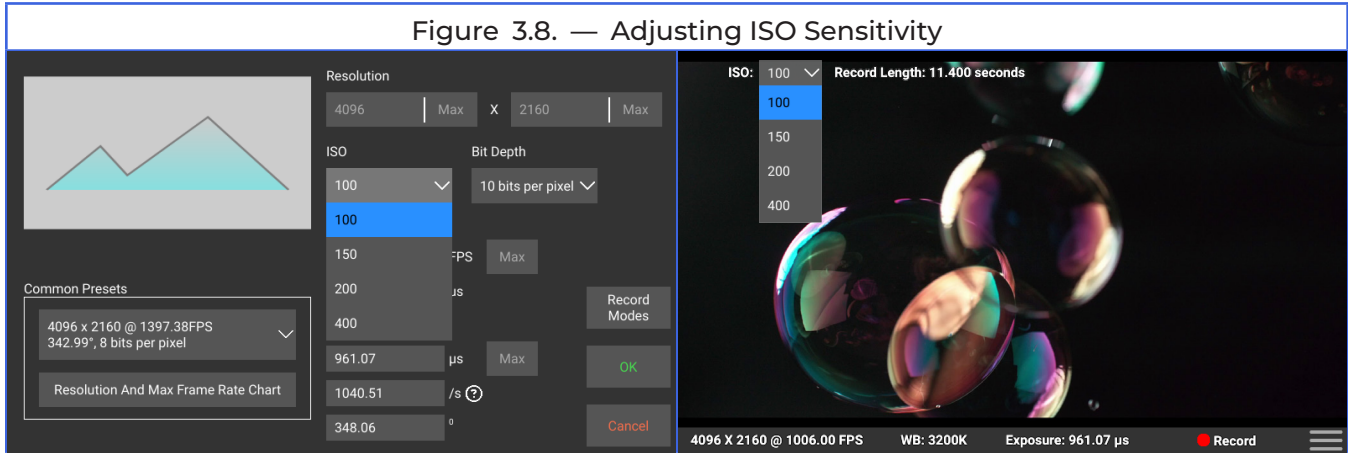
## 3.5 Setting Exposure / Shutter Speed

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 Display
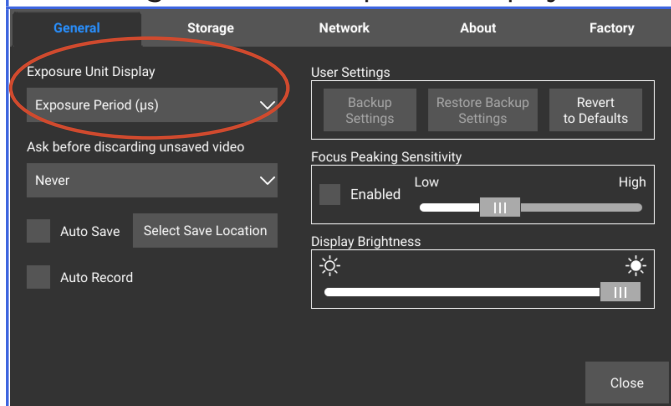
# 3.6 Setting White Balance

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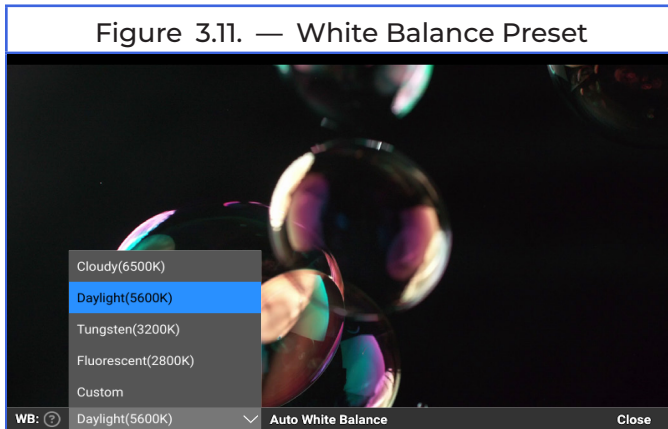
To select a pre-set, tap the dropdown menu and select the preset that matches the color temperature of your lighting.

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
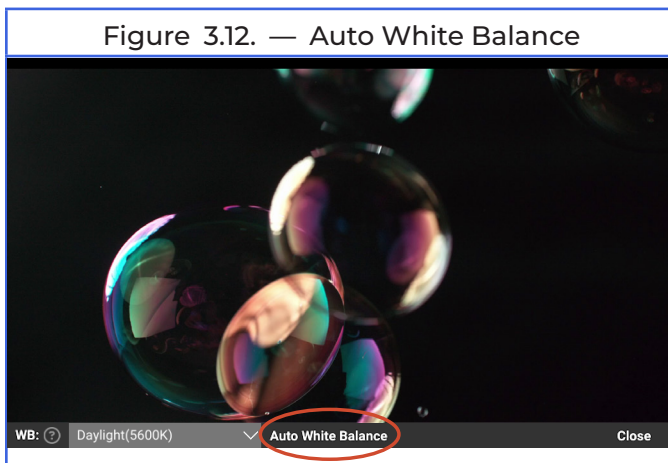
Auto White Balance requires that a sufficiently illuminated reference, such as a grey card, is placed within the center of the camera's field of view. A black rectangle in the center of the screen indicates the region of the image to be referenced when the Auto White Balance button is pressed. If the 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**
2800K
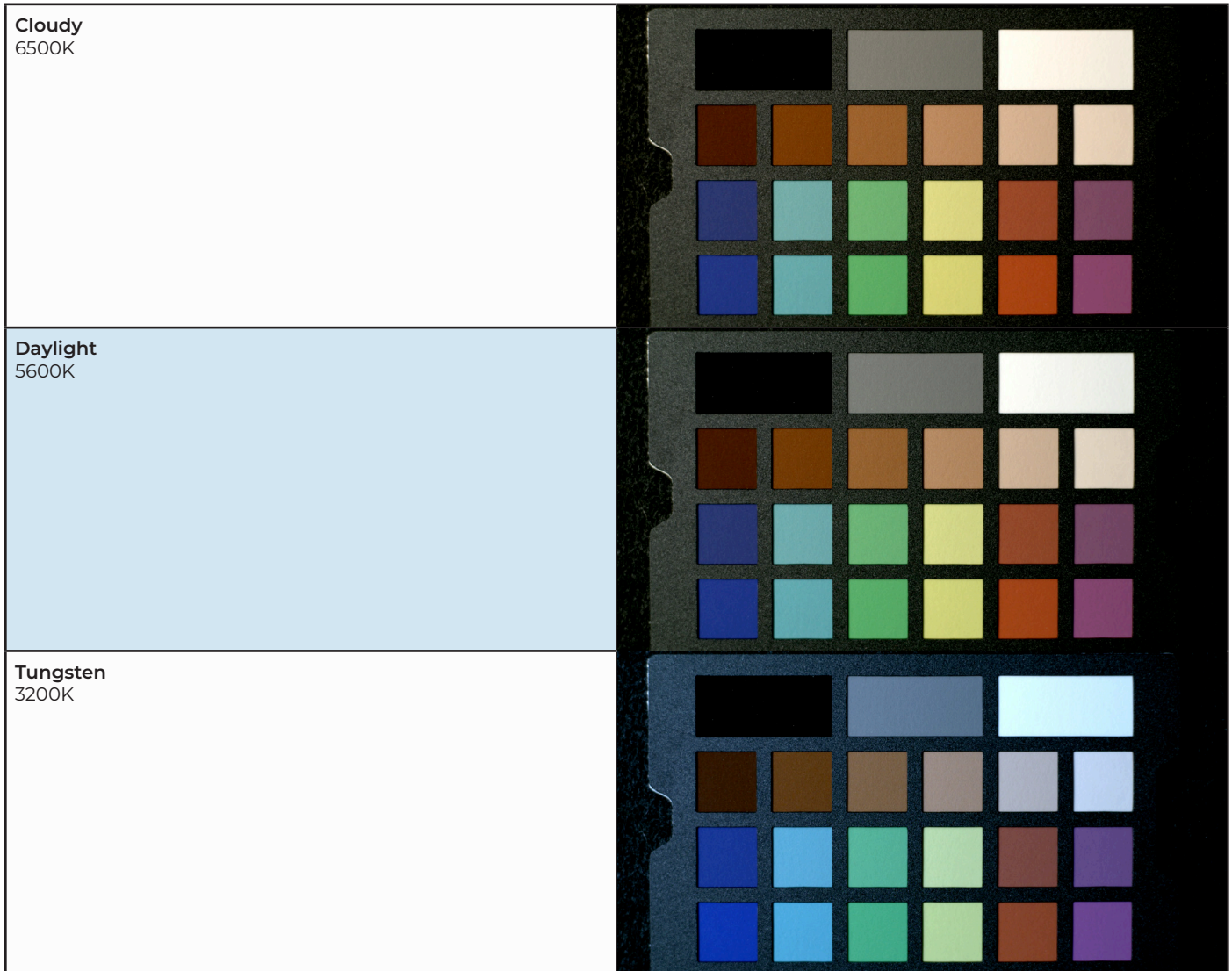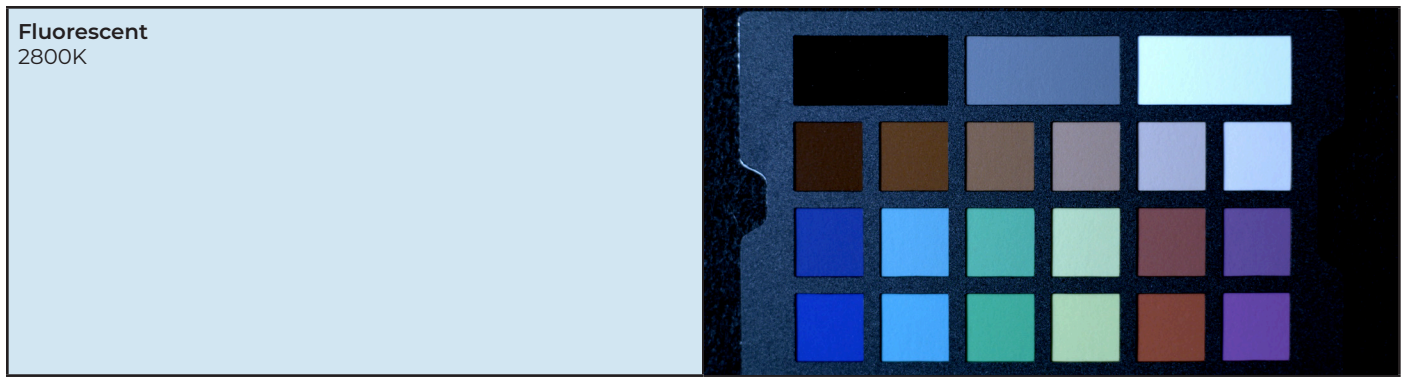
# 3.7 Assistive Features

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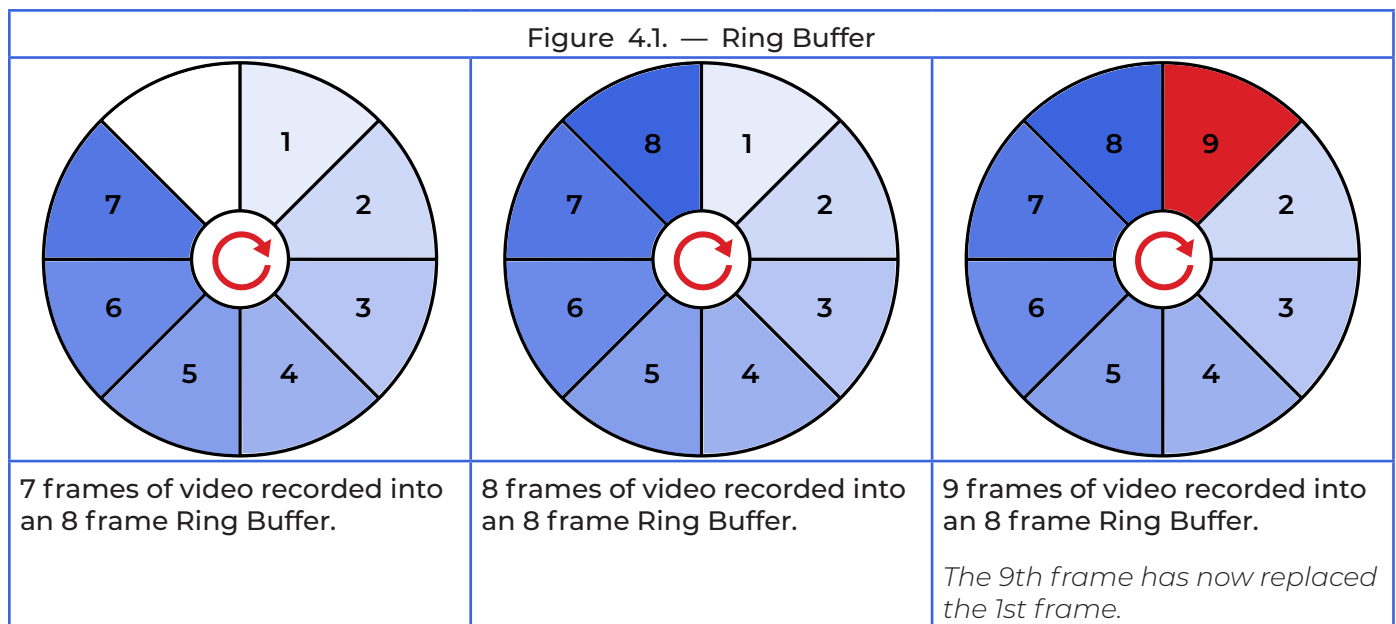
> **NOTE:** *Trigger delays do not apply to the record button. Pressing the button while recording will start / stop the recording immediately, regardless of any pre-set trigger delay.*

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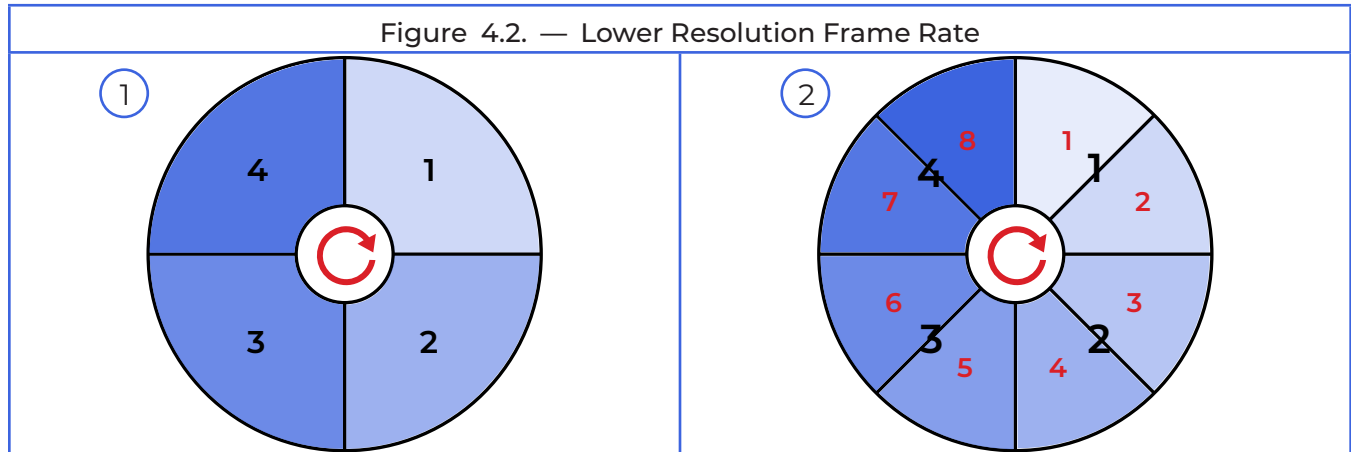
Once image frames are stored in the Ring Buffer, they must be offloaded to a non-volatile storage medium since RAM is volatile, meaning it will be erased when the camera is powered off. Please see Chapter 5 (Playback & Saving) for additional information on these concepts.

# 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.*
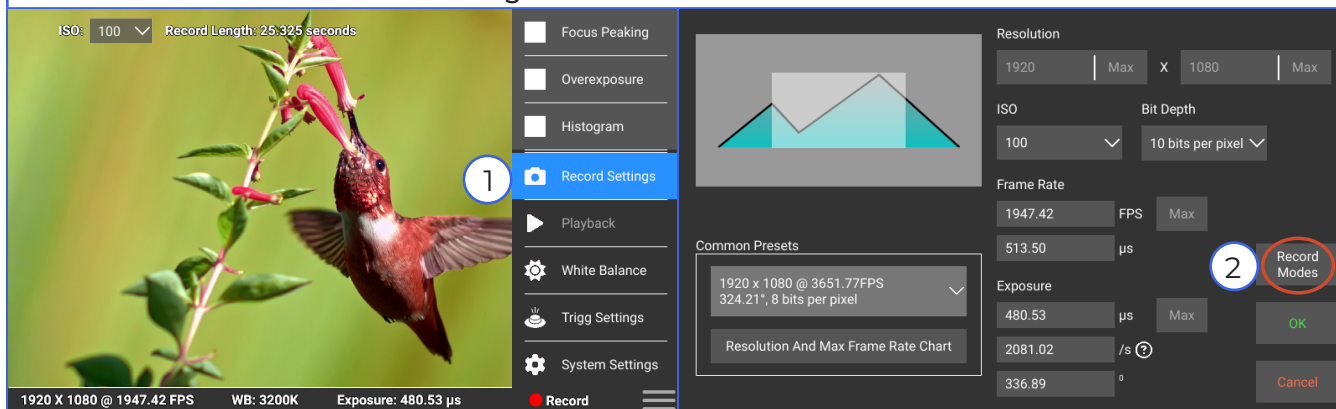


Figure  4.3.  —  Record Time
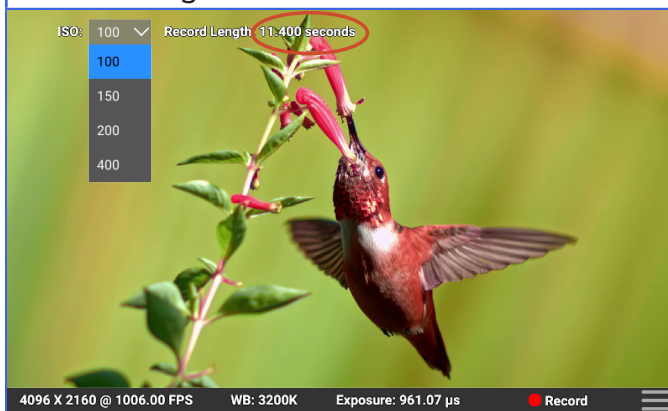
# 4.3 Setting Record Length

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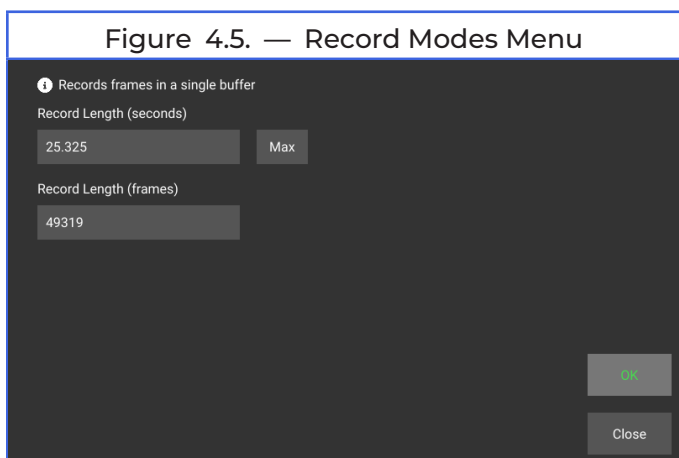
To adjust record length, enter the Record Settings screen (1), then tap the Record Modes button (2).

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
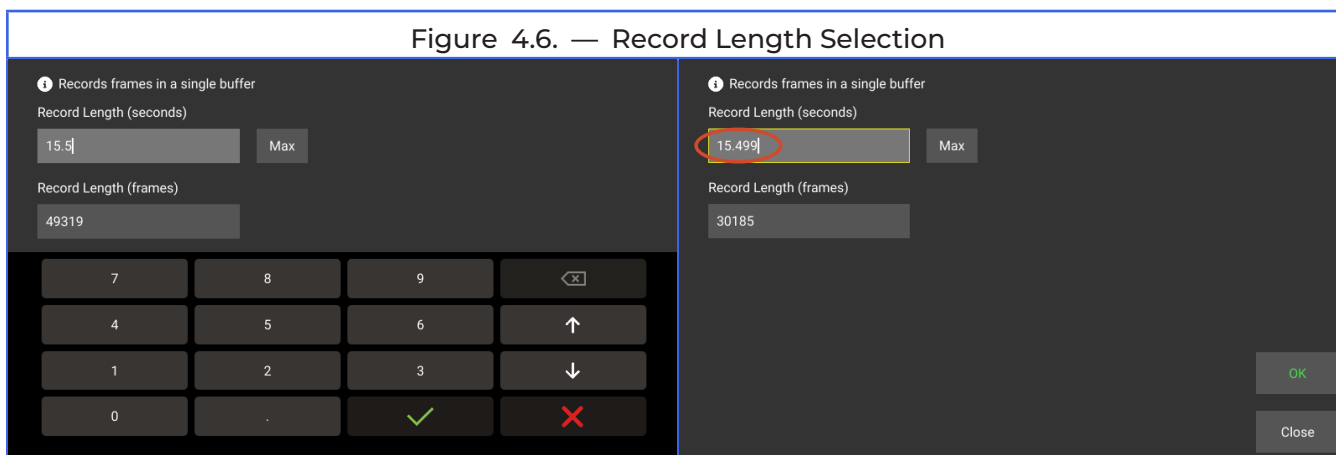
# **5.** Playback & Saving

## 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
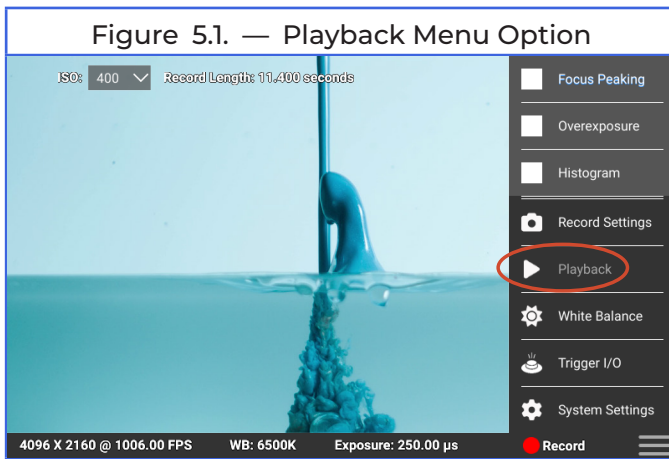
You can view the whole recording by pressing the Play button (A). The arrows on either side of the slider will move the footage one frame forward or backward. Alternatively, dragging the slider or scrolling with the Jog Wheel will also cycle between frames. The current frame being viewed can be seen 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 crops the video to just the frames that you want to keep.



Figure 5.2. — Playback Screen
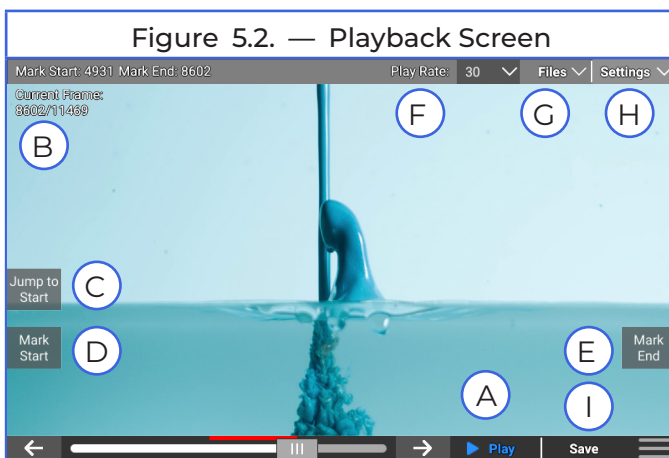
The Play Rate drop down menu (F) changes the speed at which the video plays. The 4K12 supports six different playback frame rates: 10, 24, 25, 30, 60, and 120. Six negative playback frame rates are also supported for playing the video backwards.

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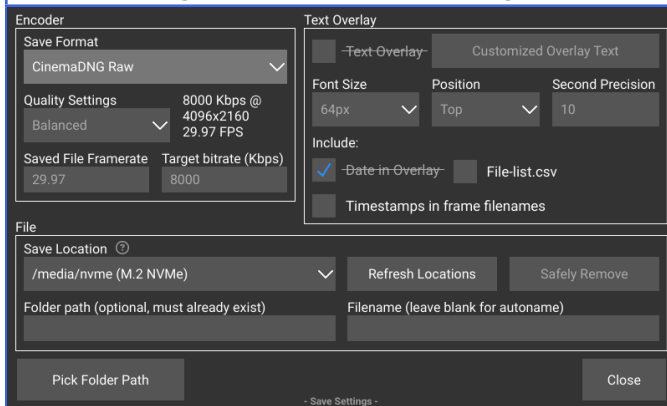
> **NOTE:** *The internal NVMe will most likely always be the fastest saving destination option; however, it's possible to connect something faster to USB-C Port 2.*

# 5.3 Saved File Formats

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

**Raw Formats**

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

**Compressed Formats**

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

## 5.4 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 5.4. — Storage Selection
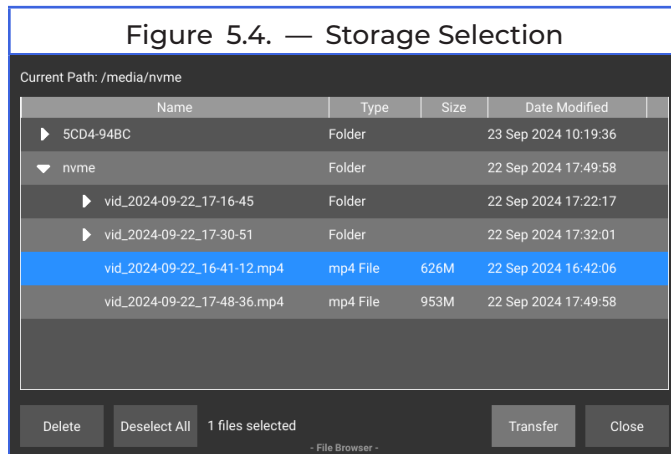
## 5.5 Storage Devices

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.

# 5.6 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 5.5. — Transferring Files
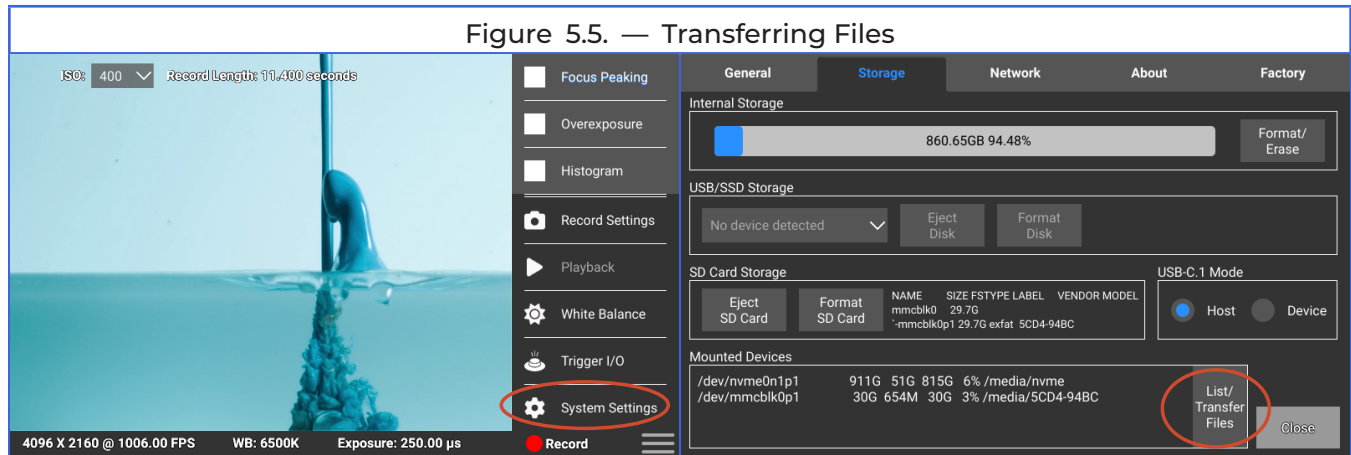
NOTE: *Transferring files will copy, but will not delete, the original files.*

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

# 5.7 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

Chronos 4K12 cameras support triggered recording, as well as synchronization through any of its three I/O channels. Settings for this may be configured from the Trigger I/O screen while the camera is not busy with other operations.

All three I/O channels are consolidated within the 3.5mm TRRS connector located above the power input. Up to 6.6 volts may be sent to any of these three channels for indicating to the camera those inputs are "high" or "low" (i.e., "on" or "off").

The voltage threshold option is used to specify how many volts are required for an input channel to be considered high. The default threshold is 2.5 volts.



Figure 6.1. — Triggering Channels

| | | Channel 1: Lo | Channel 2: Lo | Channel 3: Lo |
|---|---|---|---|---|
| | Disabled | 🔵 | 🔵 | 🔵 |
| INPUT | ⑦ Threshold | 2.50    Volts | 2.50    Volts | 2.50    Volts |
| | Toggle | ⚪ | ⚪ | ⚪ |
| | Record End | ⚪ | ⚪ | ⚪ |
| | IRIG-B | ⚪ | ⚪ | ⚪ |
| OUT | ⑦ Frame Sync Output | ⚪ Delay | ⚪ Delay | ⚪ Delay |
| CONFIG | Pull Up | ☐ | ☐ | ☐ |
| | Invert | ☐ | ☐ | ☐ |
| | ⑦ Debounce | ☐ 1000.00 µs | ☐ 1000.00 µs | ☐ 1000.00 µs |
| Adjust Trigger Delay | | | OK | Cancel |

- Input/Output Settings -

> **NOTE:** An individual I/O channel may only be used for one or the other (input or output), but not both at the same time.

By default, all three I/O channels are disabled. When any of the I/O channels are enabled, an indicator will be overlaid in the top right corner of the main recording screen.

The included push-button trigger cable is intended for use with the Toggle or Record End modes. The included trigger Y-splitter cable may be used for both triggering and synchronization.

## 6.1 Signal Conditioning

A variety of settings are configurable for conditioning input signals. These settings are grouped together within the "CONFIG" rows.

1. **Pull Up:** When a Pull Up is enabled, a 20mA current is driven into the channel, and the logic level rises. A Pull Up will bring the voltage level to 4–5V, with no load. The Pull Up box should be checked when using the included push-button trigger cable. When the I/O mode is set to an output mode, the Pull Up setting has no effect.

2.**Invert:** This setting will flip the edge detection and can also be applied to the output modes (i.e., Frame Sync Output mode). When the Invert check box is checked, the falling edge of an input signal will be considered high instead of its rising edge.

3.**Debounce:** While debounce is enabled, the input channel will be sampled at the specified duration. This option is commonly used to avoid spurious triggers with a physical switch, such as the included push-button style trigger cable. The debounce duration may be configured to sample up to 200,000.00 microseconds. The debounce option must be checked in order to customize its duration. When the I/O mode is set to an output mode, the Debounce setting has no effect.

## 6.2 Trigger Modes

Toggling recording start or end may be triggered through any of the three input channels. 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, the recording state is toggled between start and end of recording. Extra precaution should be taken with this mode to ensure video isn't accidentally flushed by toggling back into recording mode.

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

When more than one channel is set to Toggle Trigger mode, these channels are logic AND'ed inside the camera after invert / debounce / pull-up are applied. Alternatively, when more than one channel is set to Record End Trigger mode, these channels are logic OR'ed inside the camera after invert / debounce / pull-up are applied.

> *EXAMPLE:* As an example, if you use push buttons for Record End on more than one channel, then you will need to invert those channels so that the default state of the trigger signals is low. Otherwise, if the default state of the signals is high, when they are logic OR'd together, the resulting signal will remain high and you will not see any trigger occur if one of the buttons is pressed.

## 6.3 Setting Trigger Delay

The Trigger Delay page lets the user configure when video is captured relative to an external trigger. The delays configured in this screen only apply to the Record End Trigger and do not apply to recordings started by the record button on the top of the camera and the record button on the display.
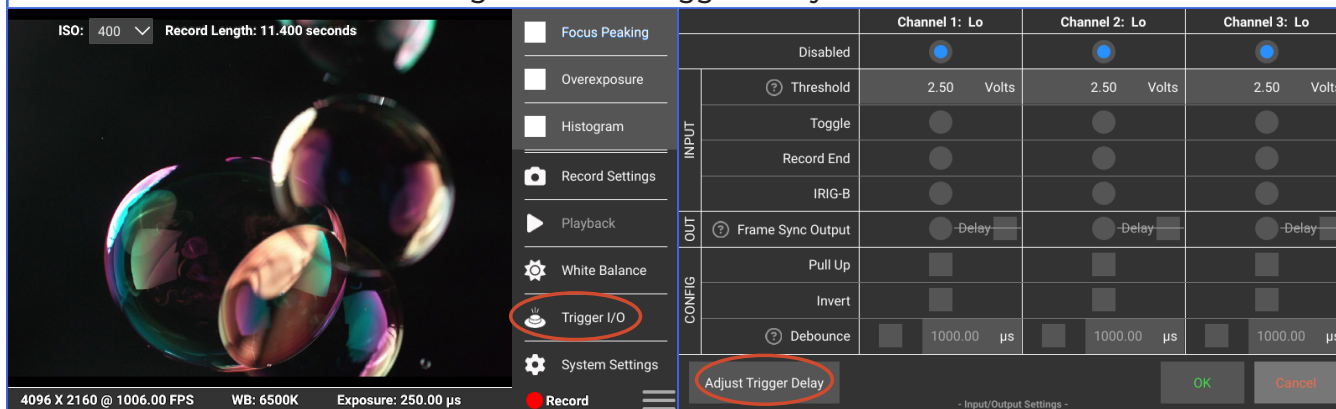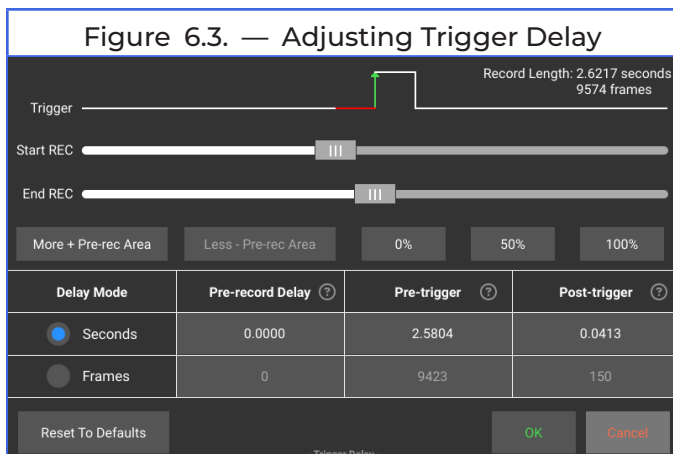
Figure 6.2. — Trigger Delay Menu



Figure 6.3. — Adjusting Trigger Delay

| CONTROL | FUNCTION |
|---|---|
| 0%, 50%, 100% | Move the slider to the start, middle, or end of the red "Recording This" region. This sets the pre-record delay, pre-trigger, and post trigger values.<br><br>A value of 0% means that all video saved will be saved after the trigger (post-trigger mode). A value of 100% means that all video saved will be saved before the trigger (pre-trigger mode). |
| Slider | Drag to set when the saved video starts and stops relative to a trigger. The time and frames in each text box below will automatically change as the slider is adjusted. |
| Pre-Record Delay | Sets the amount of time to wait after a trigger occurs, but before filling the record buffer. When the waiting period ends, the record buffer will fill and then finish.<br><br>This delay can be specified in seconds or frames.<br><br>Example: If a 0.5 second recording is being made, and the pre-record delay has been set to 0.2 seconds, the camera will wait for 0.2 seconds after being triggered, then fill the record buffer (0.5 seconds), and then stop a total of 0.7 seconds after the trigger was initially activated. |
| Pre-Trigger | Sets the amount of time kept in the record buffer from before a trigger occurs.<br><br>Example: If a 5000 frame recording is being made, and the pre-trigger is set to 2000 frames, when the trigger occurs the camera will keep 2000 frames from before the trigger, and then the rest of the record buffer (3000 frames) after the trigger. |

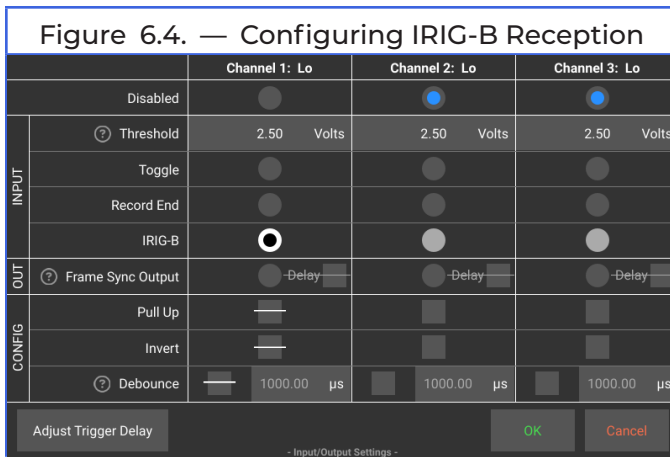| CONTROL | FUNCTION |
|---------|----------|
| Post-Trigger | Sets the amount of time between a trigger and its actual effect. If both pre-record delay and pre-trigger are 0, post-trigger is the total length of the recorded video.<br><br>Example: If a 0.5 second recording is being made, and the post-trigger delay is set to 0.3 seconds, then the pre-trigger delay will be 0.2 seconds.<br><br>Example: No matter the length of a recording, if the post-trigger delay is set to 2.0 seconds while using a Record End Trigger, the camera will keep recording for 2.0 seconds after activating the input trigger (flipping a switch) and then stop. |
| More Pre-Record Area | Add or increase margin to the left of the record region, represented in red, to set a delay between the trigger and the beginning of the recording. |
| Less Pre-Record Area | Subtract or decrease margin to the right of the record region, represented in red, to set a delay between the trigger and the beginning of the recording. |
| Reset to Defaults | Sets pre-record delay to 0, post-trigger to 0, and pre-trigger to either the maximum record time for the given Chronos model, or the maximum record length as set in Record Modes. |
| OK Button | Applies the trigger delay changes and closes the window. Changes will still be applied even if OK is not selected in the Record Settings window. |
| Cancel Button | Discards the trigger delay changes and closes the window. |

# 6.4 Synchronizing to External Sources

The 4K12 may synchronize to external sources using the included Trigger Y splitter cable. Connect the external source to one of its two BNC connectors.

**Frame Sync Output Display:** Checking this box will delay output by 8 microseconds to compensate for the sensor's internal 8µs delay from shutter control to the shutter actually opening. After selecting the Frame Sync Output button for the desired channel, be sure to select the check box next to the word "Delay" to initiate the Frame Sync Output delay. This setting should always be enabled when syncing to an external device such as a Chronos 1.4 or 2.1-HD camera. When syncing to another 4K12 camera, you should deselect the Frame Sync Output delay.

**IRIG-B Synchronization:** The camera can receive IRIG-B standard DC level shift (DCLS) time code signals on the trigger inputs. When IRIG-B timecode reception is enabled, an internal high-speed real-time clock (HS-RTC) is synchronized to the IRIG-B timecode presented on the selected trigger input. Captured frames are timestamped based on the HS-RTC. Only one I/O channel can be set to IRIG mode at a time.

On camera startup, the HS-RTC is initially set using the camera's date and time configured within the Factory tab of the System Settings. The HS-RTC is updated continuously when IRIG-B reception is enabled and the camera is successfully receiving a signal.

Figure 6.4. — Configuring IRIG-B Reception

| | | Channel 1: Lo | | Channel 2: Lo | | Channel 3: Lo | |
|---|---|---|---|---|---|---|---|
| | Disabled | ● | | 🔵 | | 🔵 | |
| INPUT | ⓘ Threshold | 2.50 | Volts | 2.50 | Volts | 2.50 | Volts |
| | Toggle | ● | | ● | | ● | |
| | Record End | ● | | ● | | ● | |
| | IRIG-B | ◉ | | ⚪ | | ⚪ | |
| OUT | ⓘ Frame Sync Output | Delay | | Delay | | Delay | |
| CONFIG | Pull Up | ▬ | | ▢ | | ▢ | |
| | Invert | ▬ | | ▢ | | ▢ | |
| | ⓘ Debounce | ▬ | 1000.00 μs | ▢ | 1000.00 μs | ▢ | 1000.00 μs |

| Adjust Trigger Delay | | OK | Cancel |
|---|---|---|---|

- Input/Output Settings -

If there is no IRIG-B signal presented to the camera, a message will be displayed indicating that the IRIG-B receiver is unlocked, and if it was previously locked, the duration of unlock. The HS-RTC will continue to count based on the last IRIG-B timestamp it received (or the camera's date and time if no reception has occurred), but will drift off time and become less accurate gradually.

As soon as IRIG-B mode is disabled from the I/O settings screen, the HS RTC goes back to being synchronized with the camera's internal timestamp.


Figure 6.5. — IRIG-B Not Locked
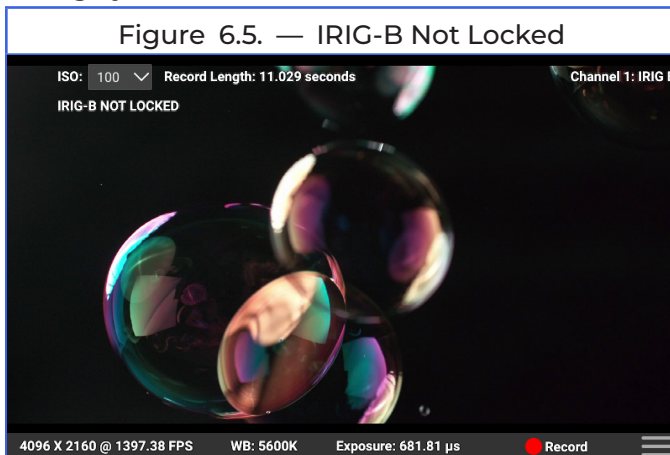
Frame time stamps can be set in the Playback Settings menu and can be displayed in several ways:

- Overlay embedded on or below video (H.264/H.265 formats)

- CSV file written alongside video (all formats)

- Embedded in 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.
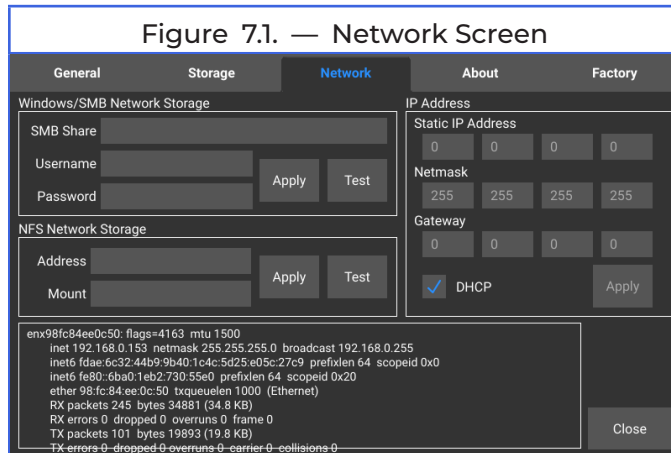


## 7.1 Dynamic IP Address Configuration via DHCP

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).

# **8.** Video Output

The 4K12 currently supports HDMI video output for 4K, UHD, and common lower resolutions.

> **NOTE:** *Some resolution/frame rate/bit depth combinations are currently unsupported. Support for more configurations will be added in a future software release.*

| CAMERA CONFIGURATION | HDMI OUTPUT CONFIGURATION |
|---|---|
| 4096 x 2160◊ | 4096 x 2160 @ 30 FPS |
| 3840 x 2160◊ | 3840 x 2160 @ 30 FPS |
| 2048 x 1080 | 2048 x 1080 @ 60 FPS |
| 1920 x 1080 | 1920 x 1080 @ 60 FPS |
| 1280 x 720 | 1280 x 720 @ 60 FPS |

**◊When the sensor is configured to 8 bits per pixel, the frame rate must be less than 1301 FPS for the HDMI output to work.**

When connected to a monitor via HDMI, the camera will automatically output a video signal during live recording, but not during playback or saving. HDMI output is unscaled, thus the HDMI monitor must support the exact record resolution.

> **NOTE:** *The HDMI monitor must be disconnected in order to playback recorded video. The camera's live view will freeze on its LCD as soon as a monitor is connected to the HDMI port and instead display on the connected monitor. Likewise, disconnecting the monitor will restore the live view on the camera's LCD.*

> **NOTE:** *Gamma corrections are not applied to the video signal output via HDMI.*

# 9. Camera System Settings

## 9.1 General Screen


Figure 9.1. — General Screen
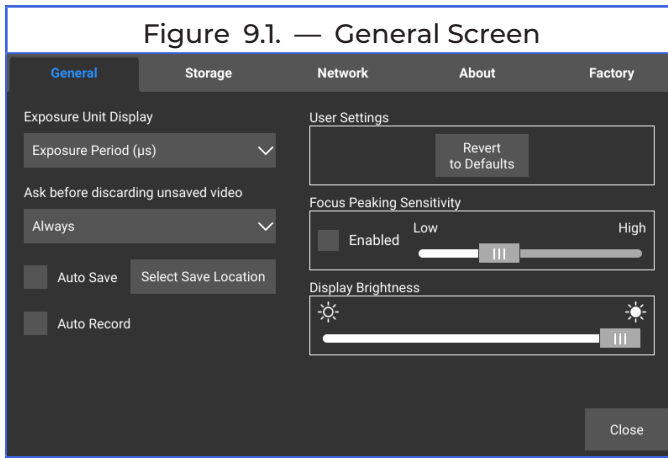
The General tab of the System Settings screen contains settings and information about the camera. Refer to the table below for details on the various functions.

| 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. |
| 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. |
| Close Button | Returns to the Main screen. Settings are applied automatically as they are changed. |

# 9.2 Storage Screen



Figure 9.2. — Storage Screen
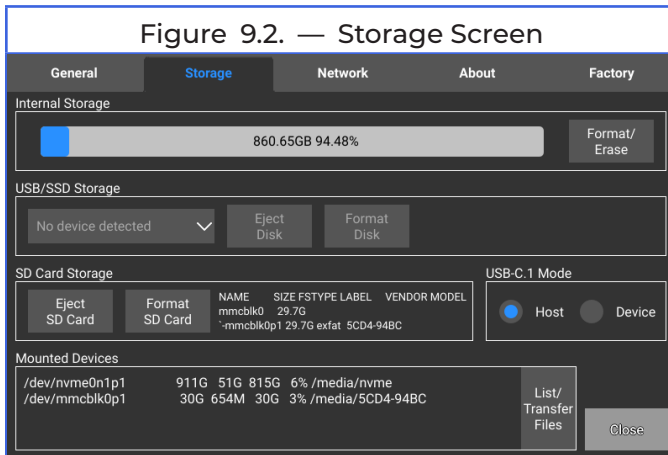
The Storage tab contains settings and information about the camera's storage features. Refer to the table below for details on the various functions.

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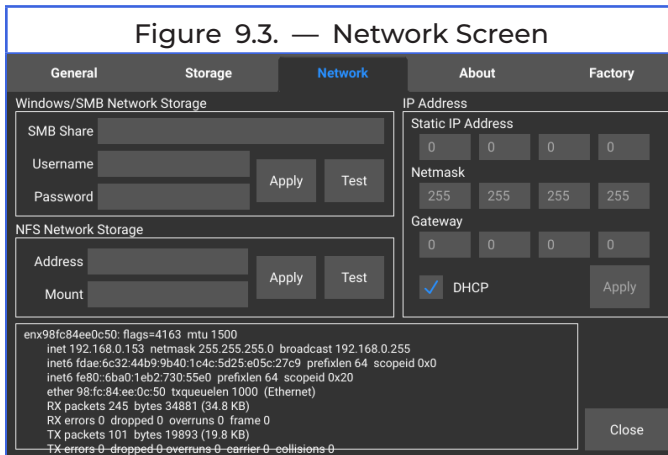
Please refer to Chapter 7 (Network Interface) for more information on how to operate these features.

## 9.4 About Screen



Figure 9.4. — About Screen
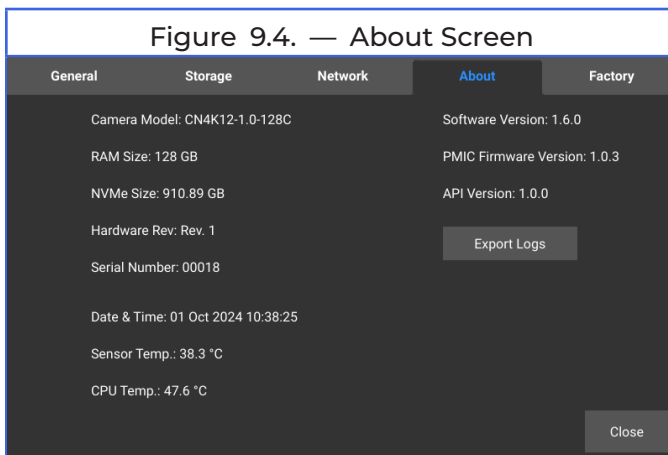
The About tab contains information about the camera's hardware, software, and current operating conditions. In the event that support from Kron Technologies is required, it is useful to provide a photo of this screen with your support ticket.

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. |
| Sensor Temperature | The surface temperature of the image sensor inside the camera. Typical values at room temperature are between 40 and 55 degrees Celsius (104 to 131 degrees Fahrenheit). |

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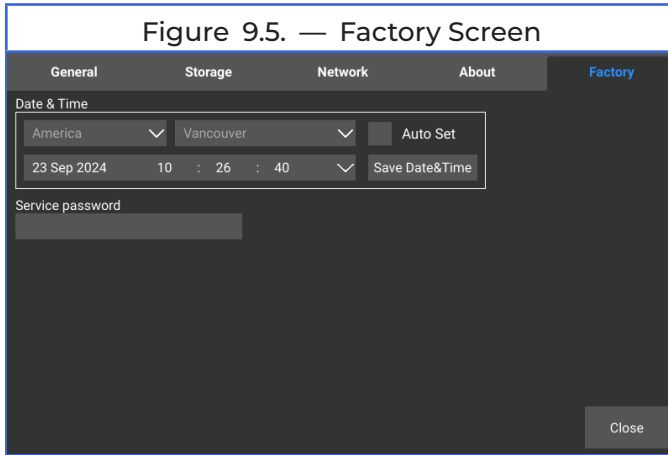
The Factory tab of the System Settings screen is used for manually specifying the date & time.

| 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 version 1.6 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 1.6.0.

# 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. |
| Video is frozen on the touchscreen LCD (as expected), but there is no output signal from the HDMI cable | Random signal disruption and/or setting failure | Restart the camera and ensure that the HDMI output configurations are supported. See Chapter 8 (Video Output). |
| Touchscreen LCD no longer displays video after connecting to HDMI connected monitor | HDMI output is not working properly | Video will appear on either the touchscreen LCD or the HDMI connected monitor, but never both at the same time. The camera is not broken if the LCD stops displaying video after connecting to HDMI. Simultaneous displays will be added in a future update. |

# Appendix A. Mechanical Drawing
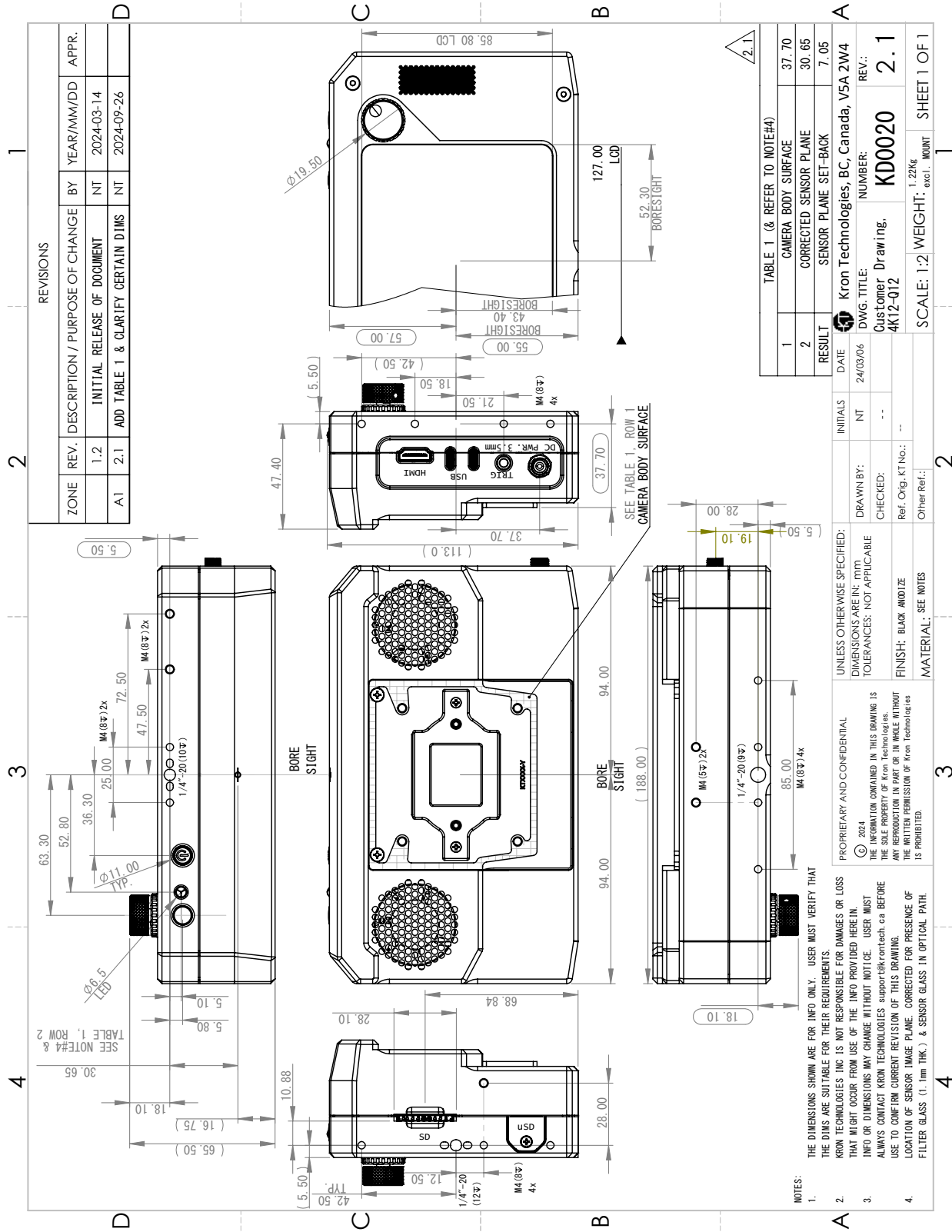
# **Appendix B.** Spectra Sensitivity
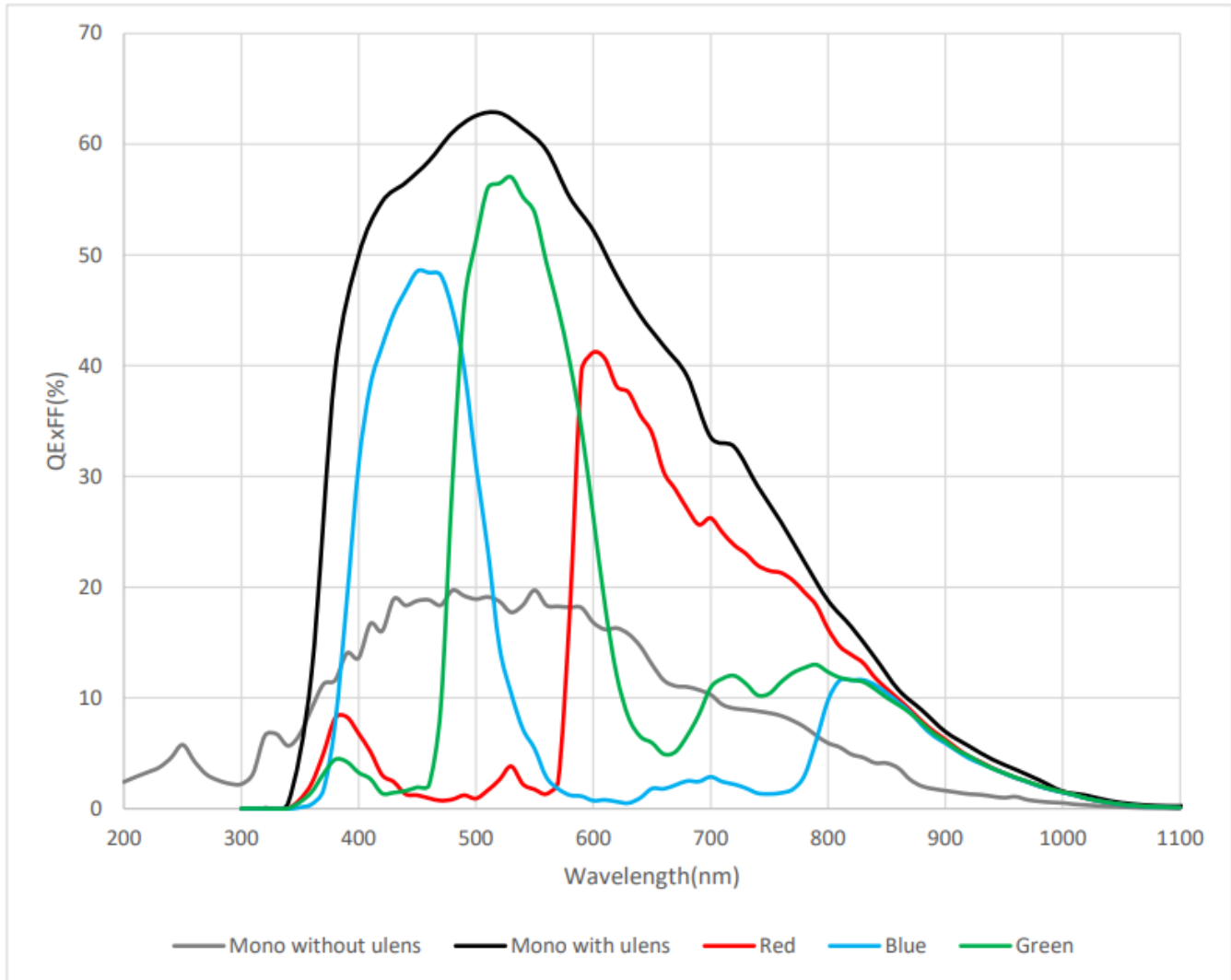


Spectra sensitivity characteristics

# **Appendix C.** Adapter Bracket Locations
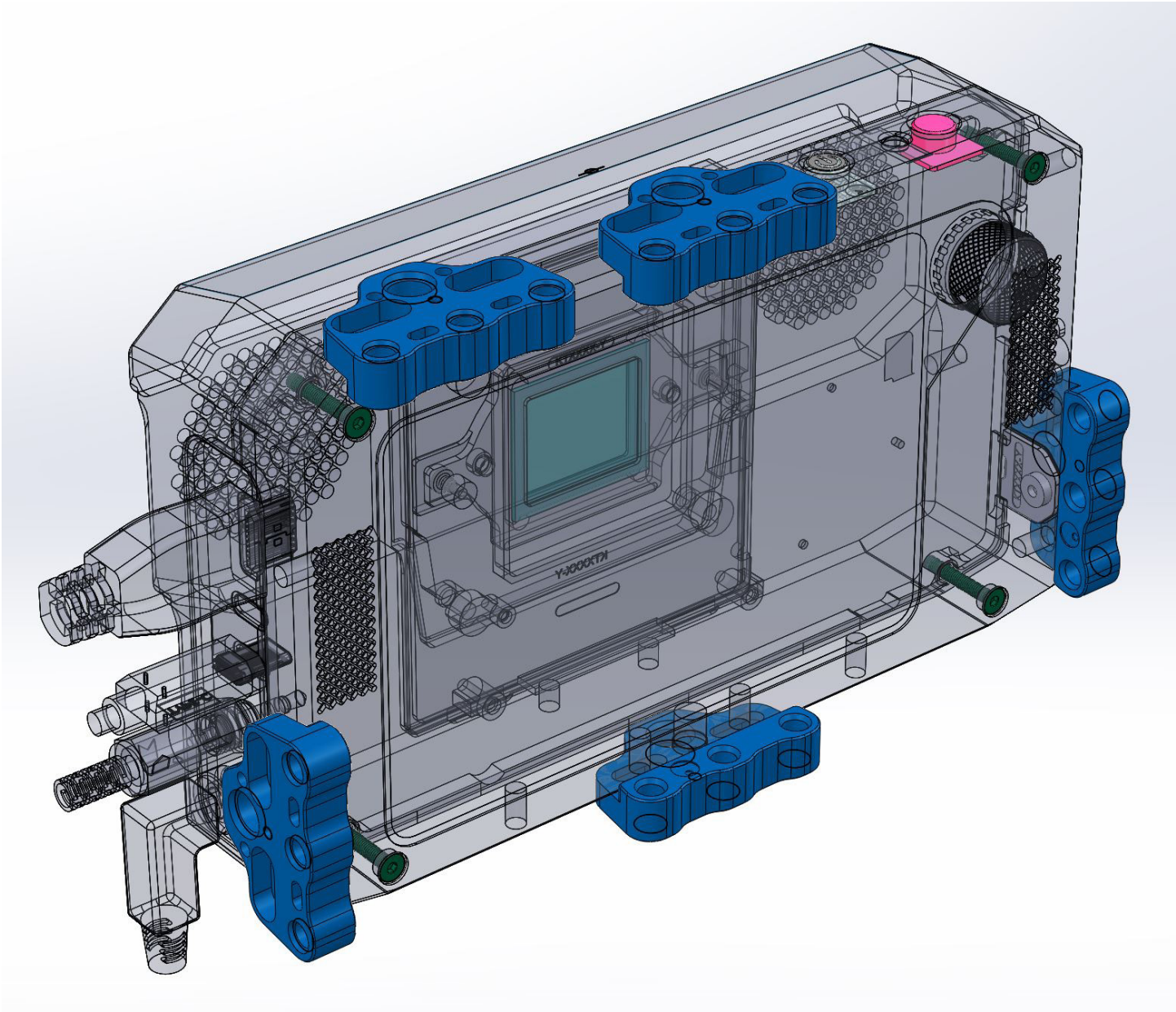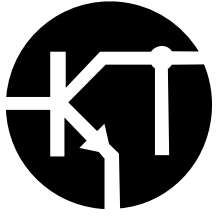
# KRON TECHNOLOGIES
## HIGH-SPEED IMAGING

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**KRON TECHNOLOGIES**

8337 Eastlake Dr Unit #113
Burnaby, BC V5A 4W2, Canada

Phone: +1 (778) 819-1182

Email: info@krontech.ca

Website: krontech.ca