



Flex



MANUAL

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Flex MANUAL

AbelCineTech

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Preliminary Edition

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With Special Thanks to Rick Robinson of Vision Research

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Flex Manual

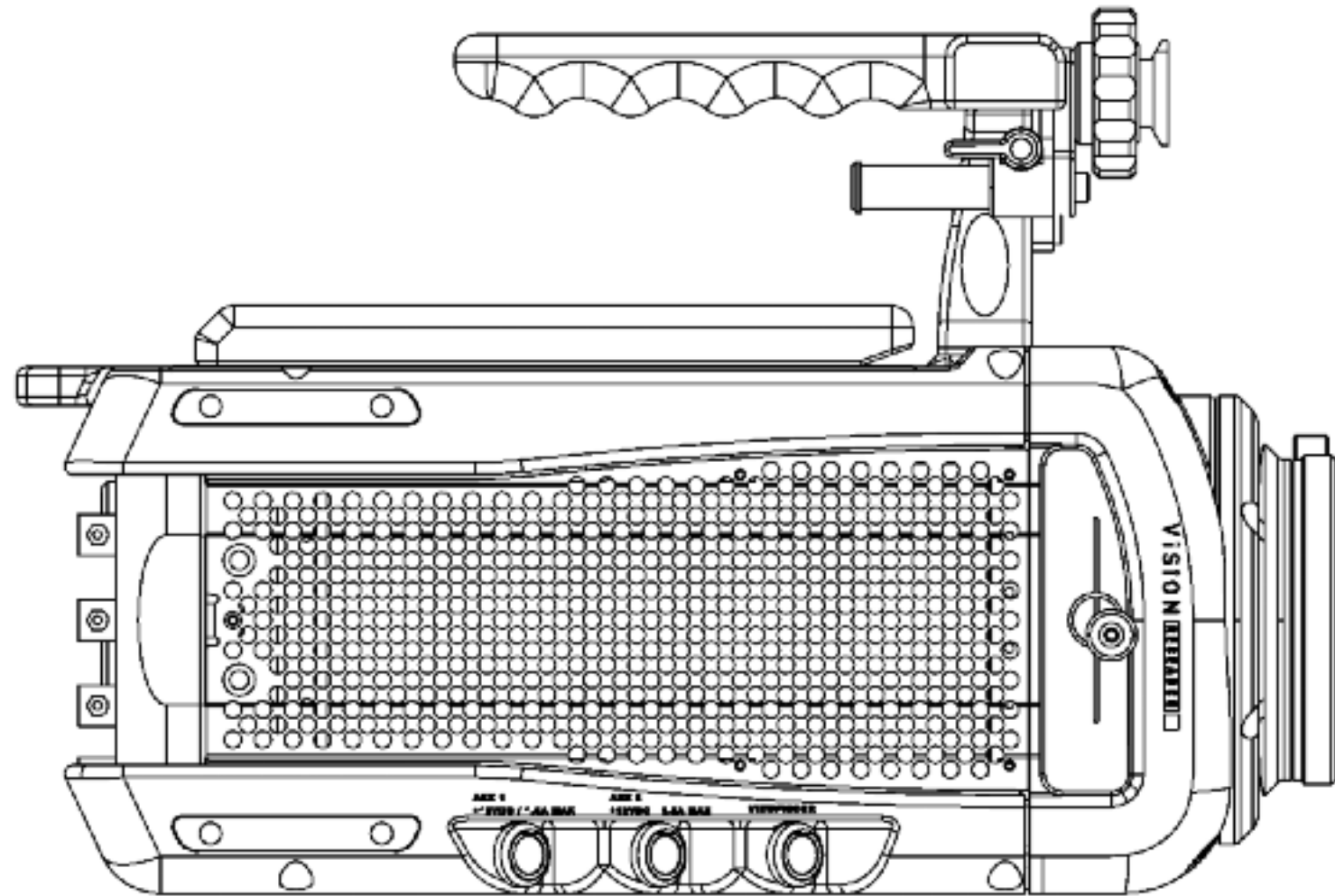
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specifications

- Up to 2,570 fps at 1920x1080 in Standard mode
- 1000 ISO (measured using ISO 12232 SaT method)
- HQ Mode provides ultimate in image stability under changing shooting conditions
- 2 x 4:2:2 HD-SDI video ports, can be configured as dual-link 4:4:4 video
- 2560x1440 scaled to 1920x1080 HD-SDI output
- Genlock for synchronizing video playback – essential for 3D video workflows
- Internal mechanical shutter for hands-free and remote Black Balance
- Global, electronic shutter to 1 μ s (shutter angles in HQ mode dependent upon frame rate)
- Phantom CineMag compatible, CineMag interface has field-replaceable pin array
- 12VDC, 1.5A auxiliary power outputs for powering external devices.
- External trigger signal through dedicated port and aux power connectors
- Advanced on-camera controls for camera modes, settings, playback, edit & save
- 12-bit pixel depth
- SDI Ready frame synchronization to external signal, allows multiple cameras to be synchronized





1

Introduction to Phantom Flex



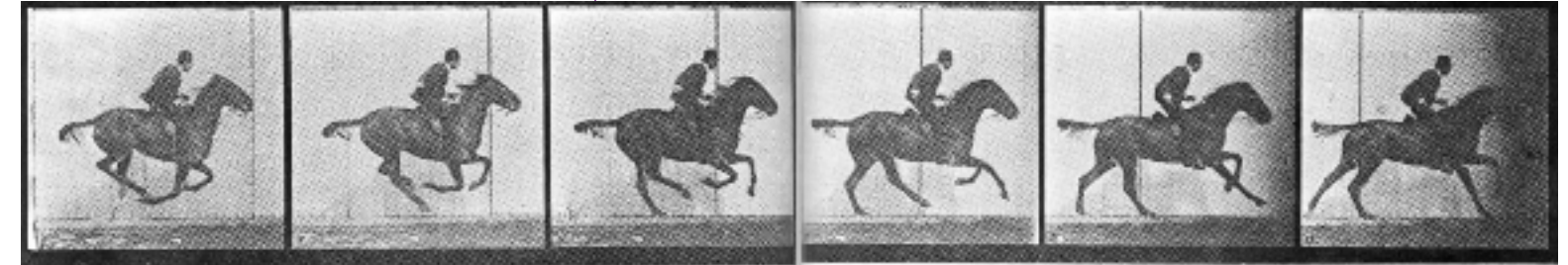
Camera Capabilities

The Phantom Flex offers unprecedented flexibility in all areas of high-speed image capture. The Flex is over two stops more sensitive than previous generation cameras at 1,000 ISO, making it the most sensitive high-speed camera in the production market. In terms of resolution, the camera goes beyond HD to support 4-megapixel imaging (2560x1600). Frame rates are increased to over 2500fps at 1920x1080 or more than 5,000fps at 1280x720.

A new proprietary image enhancement technology results in electronic image stability unprecedented in digital high-speed cameras: stable blacks, low noise, higher dynamic range, and repeatable shots over the full range of supported

2

From Muybridge to Phantom



Other New Features

- A Global Shutter, which ensures no artifacts on fast moving objects or strobes/flashes.
- An internal capping shutter, which makes for a more convenient black balance procedure.
- New connectors, improved buttons and streamlined user interface all make for a friendlier experience.

Lens Format

One way the Flex earns its name is by accommodating various format lenses. 35mm PL lens coverage is standard. The HDx2 optical adapter, available from Abel Cine Tech allows B4 mount lenses to be used. Super16 optics will work with (1080p) or without (720p) an adapter. Also available are Panavision, Nikon F and powered Canon EF mounts.

Multiple Workflows

The Phantom Flex supports multiple workflows: a raw digital workflow, a video workflow, or combination of both for maximum control and flexibility.

All of these features and more will be covered in the following pages, but first we take a quick look back at the history of high-speed photography and the evolution of Phantom camera technology.

More than 120 years ago, a galloping horse was the subject of one of the most well known early applications of high-speed imaging. In the 1870's Eadweard Muybridge sought a way to see whether a horse's hooves were ever all off the ground at the same moment in time. He used 12 cameras each triggered by a length of string stretched across the horse's path.

The Muybridge images clearly captured what hadn't been possible to see before. What surprised people around the world was that the feet were off the ground when under the belly of the horse instead of legs stretched forward and backward – so traditional in painting. Thus began the era of high speed photography, with its power to reveal what had never been seen.

Fifty years later high-speed photography was used by business and industry to analyze events too fast to see with the naked eye. Eastman Kodak developed a high-speed 16mm camera in the early 1930s that ran up to 1,000 frames per second. Some of the industrial uses included "cause of the breaking of threads when sewing leather goods." By the 1960's several companies were producing high-speed film cameras in 16mm, 35mm and even 70mm formats, including the predecessor of Vision Research.

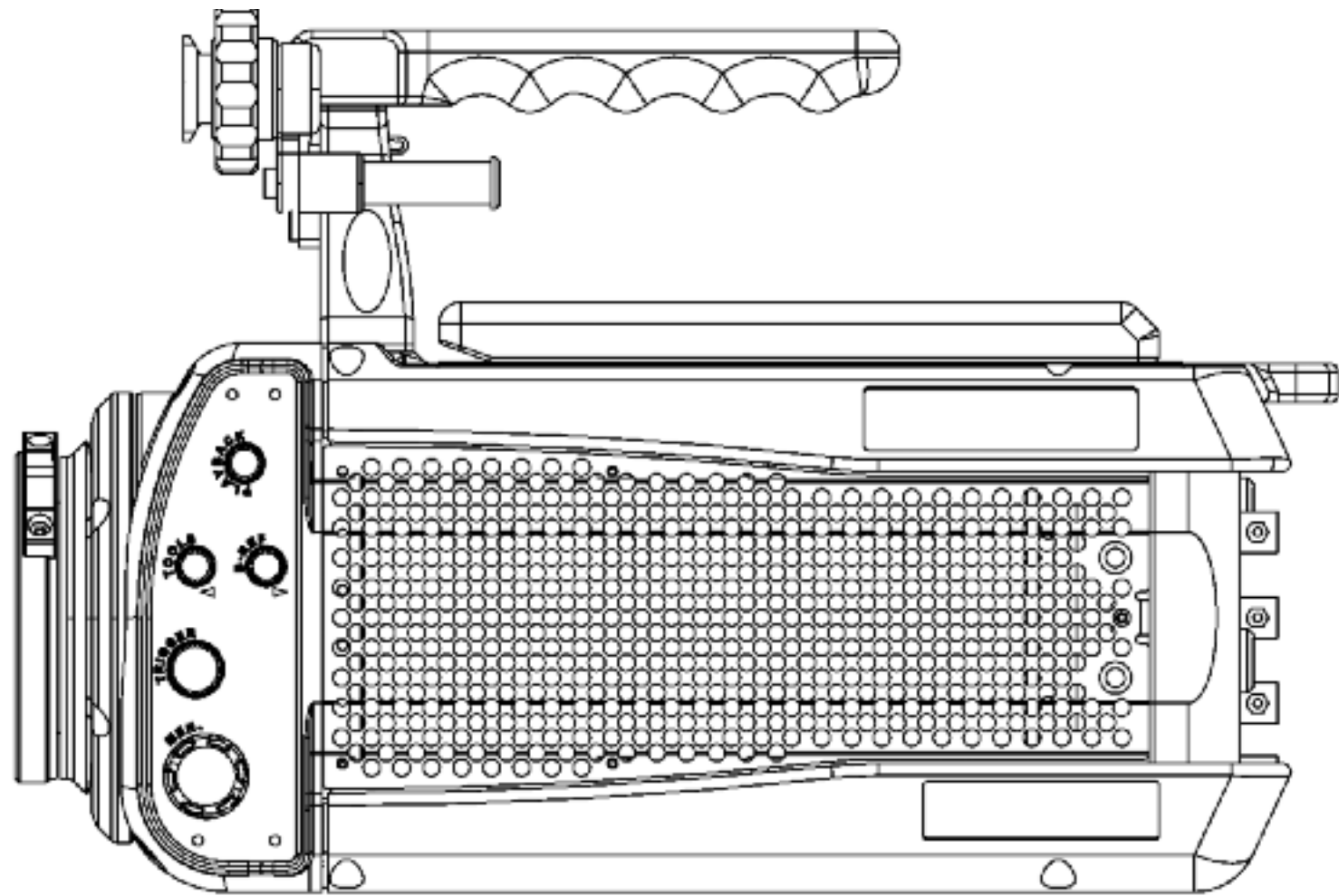
Vision Research, the manufacturer of Phantom high speed digital cameras, was founded in 1950 by a young, idealistic, engineer who quit his job at Fairchild Camera to form a brand new company named Photographic Analysis Company. The company's sales motto was "Research Through Photography". High speed photography was used as an engineering tool for industrial, scientific and military applications, and the film cameras were widely accepted.



In 1992 the company decided to form a separate entity that was to design and fabricate high-speed electronic imagers that did not rely on photographic film for imaging. That "spin off" became known as Vision Research® Inc. and their family of electronic imagers is currently marketed under the "Phantom®" trade mark.

Digital imagers combined with solid state memory solve many of the inherent limitations of film when it comes to size, weight, cost and perhaps most especially the flexibility of triggering the camera before, during or after an event. Eventually the quality of digital caught up with film and the rest, as they say, is history.

In 2007, Vision Research named Abel CineTech the exclusive North American reseller of Phantom products and introduced a high-speed, high quality camera for cinema and television – the Phantom HD. Since then, Vision Research and Abel CineTech have established the HD Gold as the standard for high speed imaging in the motion picture and television industries. The ability to reveal what had never been seen before could extend beyond the industrial, scientific and military realm into story telling and human emotion. The Phantom Flex brings that capability to a new plateau.



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Camera Theory & Operation

What the Flex Does in a Nutshell

The key to the Flex's capabilities as a high-speed camera is the ability to move vast amounts of video information from the camera's sensor to some form of storage extremely quickly. The Flex can read over 5 billion pixels (over 6 gigabytes of data) per second. (In comparison, a typical 1080P HD camera reads only 62 million pixels per second.) At this rate a 1-terabyte hard drive could be filled in under 3 minutes. There doesn't yet exist any permanent, portable storage that can record at these speeds. The one form of storage able to keep up with this torrent of data is RAM.

When shooting at the highest frame rates, images go straight to RAM. RAM acts as a circular buffer – new frames push out older frames. This limits the length of a shot (it can only be as long as what fits in RAM), but allows great flexibility in capturing fast events. The camera can be left continuously recording without consuming any permanent storage. At the critical moment the camera can be triggered before, during or even after, the event, stopping recording and allowing the shot to be played back or saved to permanent storage.

The primary factor determining the maximum frame rate of the camera is memory bandwidth. There is a fixed number of pixels that can be pushed from the sensor to RAM per second. One way of increasing the maximum frame rate is to reduce the resolution of the recorded images. The same number of pixels per second will give more frames of lower resolution. The Flex can be cropped both horizontally and vertically, either of which will both increase the maximum frame rate as well as the number of frames that will fit in memory.

One other factor that affects the maximum frame rate is a new camera mode

introduced with the Flex called HQ mode. HQ mode captures some extra information in between frames, which increase the signal to noise ratio of the camera as well as eliminates the need for black balancing the camera. The trade off is that the maximum frame rate and shot length are reduced to about half of what they would otherwise be.

From the temporary storage of RAM, there are a few paths to permanent storage. These include HD-SDI out, data out over Ethernet and saving to a CineMag. The simplest is to record the HD SDI output of the camera with a tape or data recorder. This results in a deliverable that doesn't require any specialized equipment or software to use for editing or color correcting. The quality of the video image is excellent, especially when shooting using the full resolution of the sensor, but there are a few downsides to this workflow. It is necessary to wait for each take to play back before shooting the next take — this can take several minutes. While the quality is very good, still better quality and higher resolution can be obtained by converting Uncompressed RAW images in post, which is also the only way to retain all of the metadata such as the shooting time, frame rate and shutter info.

There are a few ways of recording the RAW sensor output with the Flex. Clips can be downloaded over Ethernet after every shot. This results in high quality images but is slow. Downloading the entire contents of RAM can take 20 minutes. A faster way to save clips is to trim and save them to a CineMag.

The CineMag is one of the great advantages to shooting with a Phantom — there is no faster storage device. Clips that would take several minutes to output over Ethernet or to play out over SDI can be saved to a CineMag in a few seconds.

Another flexibility that using a CineMag affords is the ability to record directly to it without the limitations of what fits in RAM. It is possible to record Uncompressed RAW 1080P footage at 24 fps to a 512GB CineMag continuously for over two hours, or at 360 fps for more than eight minutes.

Getting the Shot

Of course eventually footage needs to be saved from a CineMag to permanent storage. Using a CineStation with a 10G Ethernet connection to a workstation with fast storage, it is possible to download an entire 512GB CineMag in under an hour. Another alternative is to use the CineMag / CineStation to output HD SDI to a tape or data recorder.

One of the great challenges of shooting high-speed film was timing. The camera needed to start and come up to speed before the action happened, but not so long or else the film would run out. This was tenable for studio shooting, but made many documentary subjects impossible to shoot. Imagine trying to predict when lightning is about to strike, or a whale about to breach!

One of the most liberating aspects of shooting digital high-speed with a Phantom is the circular buffer. Now the camera can be recording constantly, waiting for the action — you just need to hit the trigger at the right time.

What happens when you trigger the camera depends on how the trigger point is set. You can trigger the end of the shot, in which case the frames already in memory preceding the trigger will be kept. This is common for very fast subjects.

You can also move the trigger to an earlier point in the shot. Triggering the middle of a shot might be useful if you want to preserve the maximum number of frames both before and after an event.

Moving the trigger to the beginning of a shot might be useful when recording an event of indeterminate length where it is most important to record the beginning of the action.

Triggering the camera is a skill, and you should practice to get a feel for how to best capture different events. Get comfortable with a single trigger point —

Lighting

don't think about starting and stopping recording. It is not unusual to leave the camera recording for a great deal of time – especially in a documentary situation – before triggering the event.

For some, usually lower frame-rate shots, it is desirable to record continuously for a time. With a CineMag this is possible. Direct recording to a CineMag is the perfect solution for moderate frame-rate shooting without any extra effort dedicated to trigger points or manually trimming and saving shots. When recording to a CineMag directly, one starts and stops the capture similarly to a traditional camera.

Lighting for high-speed cinematography can be a challenge. The two major issues have been the intensity of light needed and flicker. With the high sensitivity of the Phantom Flex the light needed is much less of an issue; but many lighting sources that work perfectly for low frame-rate shooting will cause flicker problems when used for high-speed work. In fact, you will find that very many light sources that appear continuous to our eyes actually flicker at a rate that we (and most cameras) don't perceive. Any lighting unit that flickers at the line frequency will generally be acceptable for use when filmed at double the line frequency (120 or 100 fps, in North America and Europe respectively.) Above these speeds special care needs to be taken to avoid flicker

Small tungsten incandescent lights will flicker at double the line frequency (i.e. at 120Hz in North America and 100Hz in Europe) as the tungsten filament heats up cools during the different phases of the AC cycle. This affects both practical lights as well as smaller, professional tungsten fixtures. Due to their larger filaments, tungsten lamps of 2K watts or higher generally are acceptable in 60Hz-land, and 5K watts or higher in the 50Hz world. If available, tungsten lights in the 5K or 10K range are the 'safest' illumination for high-speed work. Note that lights with multiple smaller lamps (such as nine-lights) will generally flicker – what matters is the size of the individual lamps.

Household or office fluorescent lights will flicker at the line frequency, but many fluorescents made for film or video use (such as most Kino-Flo's) have high-speed ballasts that allow use for high-speed shooting.

HMI's, even those with electronic ballasts, may flicker. Due to the differences in individual ballasts and lamps that affect the refresh rate and evenness of illumination of a fixture, it will generally be necessary to test individual lamps and ballasts to be sure.

Most un-dimmed LED lights designed for production use will not flicker, but dimming will usually introduce flicker.

Most DC-powered lights will not flicker. There are several DC-powered xenon lights manufactured by Luminys that will not flicker.

If you wish to use an unfamiliar light, it is best to test it before committing to its use.

4

Camera Set Up

Building the Camera

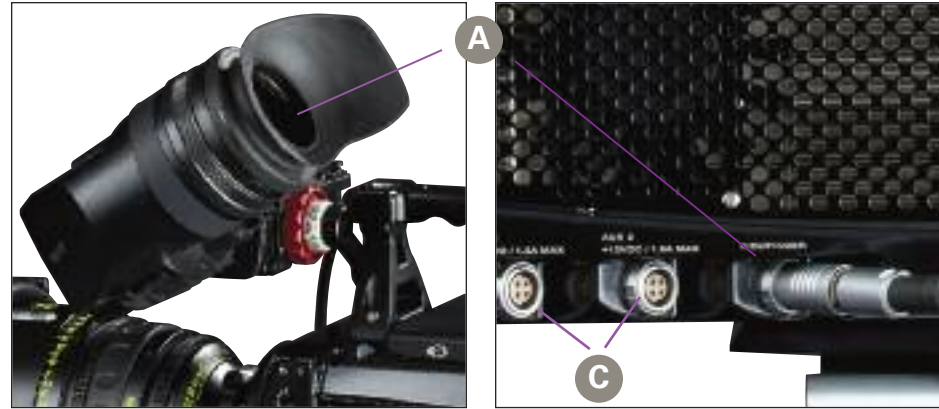
- A Viewfinder**
Mount the viewfinder on the bracket at the front of the camera's handle. Connect the viewfinder cable to the viewfinder socket on the right side of the camera.
- B Powering the Camera**
Connect a 24v power source to either of the inputs on the back of the camera. There is no power switch; the camera will turn on when power is connected.
- C Powering 12v accessories** – Two 12v accessory outputs are provided on the side of the camera. Each provides up to 1.5A (approx 18 watts).
- D Remote trigger**
Any closed contact switch can be used as a trigger through this BNC connector. Momentary closed contact switch can be used for trigger in loop mode; a continuous closed contact switch is required for recording in run/stop mode.

Connecting a Computer

- E** To be controlled by a computer, the Phantom Flex needs to be on the same Ethernet network as the computer. All Phantoms are preset with permanent IP addresses on the same subnet. A computer needs to be on the same subnet to communicate with the camera. To ensure this, set the computer's address to 100.100.100.1 with a subnet mask of 255.255.0.0.

Monitoring

- F** There are 2 HDSDI outputs on the rear of the camera. In 4:2:2 mode, output 1 is always a clean feed, with no characters. The characters can be enabled or disabled on output 2 by enabling the SDI OSD (On Screen Display) in the PVP software. (See chapter 6). When the camera is set to output 4:4:4, outputs 1 and 2 become the A and B links of a single dual-link output.



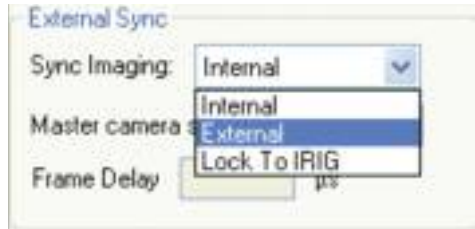
Quick Start

NOTE This is a brief overview of getting up and running with the camera, covering the basic operations that need to be performed to get usable shots. Due to the number of different ways that the camera can be used, you should read the rest of this manual and practice using the camera before using the Flex in a commercial environment.

The viewfinder output provides component video and 12V power to a viewfinder, but can alternately feed a monitor via a component breakout cable. The OSD can be enabled with the Analog OSD control in the PVP software. The viewfinder output and SDI outputs always output the same video format. This affects the video output only.

Genlock **G** The camera will genlock to an external tri-level sync signal connected to the genlock connector on the rear of the camera. The sync signal must be exactly the same format as the output video format of the camera.

Syncing Multiple Cameras **H** Two cameras can be synchronized by connecting the F-SYNC signals to each other, and running time code out of one camera to time code in of the other. In the Phantom software one camera must be set to external sync. This will ensure that both cameras are capturing images at exactly the same time and will be recording with identical time code.



NOTE Adding the serial number of a camera in the "Master camera serial" field will ease camera control with the Phantom software by causing some settings to automatically be transferred from the master camera to the slave.

To synchronize the triggers of the two cameras, a BNCT-connector can be used to bridge the trigger inputs of the two cameras to a single external trigger.

When time-code is being properly fed from one camera to another, there will be an "S" after the time-code display on the OSD of the slave camera.

On a camera set to external sync, if there is no proper sync signal feeding the camera, there will be a frozen image output. Proper F-SYNC can be verified by the presence of a moving image on the video output.

Power Up the Camera

The camera will power up as soon as a 24V power source is connected to one of the 2 power inputs on the back of the camera. The camera should fully power up in under 30 seconds.

Setting a Video Format

If you don't see an image on the viewfinder, you probably need to change the video format. See **Phantom Software** Chapter.

Attaching a CineMag

If you will be recording to a CineMag, mount it now. For more information on CineMags, see **The CineMag** Chapter.

Choosing HQ or SQ mode

For continuous shooting at lower frame rates, you may want to enable HQ mode to reduce the need for black balance. Press the "Settings" knob on the operator side of the camera to enter the menu, turn the knob to select the HQ Mode setting on page 1. Push in the knob to edit the value, twist until you have selected the value you wish, then push the knob again to lock in the value.

Choosing R/S or Loop mode

For recording directly to the CineMag, change the "Capture" setting in page one of the menu to "R/S". For the highest possible frame rates, use the camera's RAM buffer by changing this setting to "Loop".

Setting the Resolution

Set your desired resolution by changing the horizontal and vertical values of the RES setting. If the resolution you choose is higher than the resolution of the output format, the image will be scaled to fit the video format. Keep in mind that the lower the resolution selected the higher the achievable frame-rate.



Recording Parameters

On page 1 of the camera menu:

Frame Rate and Shutter

Change SPEED and SHUTTER to your desired values.

Trigger point

If in LOOP mode, set the trigger point visually by changing the position of the “T” on the line of the “TP” setting. Moving the “T” to the right moves the trigger point closer to the end of the shot.

Performing Black Balance

When all other settings are where you want them, black balance the camera by either choosing “BLACK REFERENCE” in page 2 of the menu, or holding the “bref” button of the camera for a few seconds. The internal capping shutter of the camera will close while the camera performs a black balance.

Performing White Balance

Highlight the “AUTO WHITE BAL” setting on page 2 of the menu. Hold in the Menu button and rotate clockwise until the red box appears in the center of frame. Keep holding the Menu button & point the red box towards a white area of the image.

Beginning Recording

The color of the Phantom logo in the upper left corner of the viewfinder image indicates the current mode of the camera. If you haven’t recorded an image since the camera was powered up, the logo will be blue. Press the Trigger button to begin recording – the logo will turn red, indicating that frames are being written to RAM (or to the CineMag if the camera is in R/S mode.)

If the logo is green, there is already a clip in RAM. In this case, pressing and holding the trigger button for a few seconds will erase this clip and begin recording.

Triggering / Ending Recording

Pressing the trigger button (or an external trigger plugged into the trigger connector on the rear of the camera) will stop recording. If the trigger position is at the end of the clip, recording will stop instantly – otherwise recording will continue until the portion of the clip after the trigger point is completed.

Playing Back a Clip

Press the “Playback” button to bring up the SELECT page on the on-screen display. Use the “Menu” knob to pick the clip you want to play – if the camera is in Loop mode, the clip will be called “RAM 1.” If the camera is in “R/S” mode, turn the knob to the right to get to the last clip in the CineMag – “MAG n” where n is the clip number. To begin playing, press the “B-REF” button. Pressing the B-REF button again will pause playback. Pressing the “TOOLS” button will cause the clip to play in reverse. Turning the MENU knob will step through the clip frame-by-frame.

Trimming and Saving a Clip to the CineMag

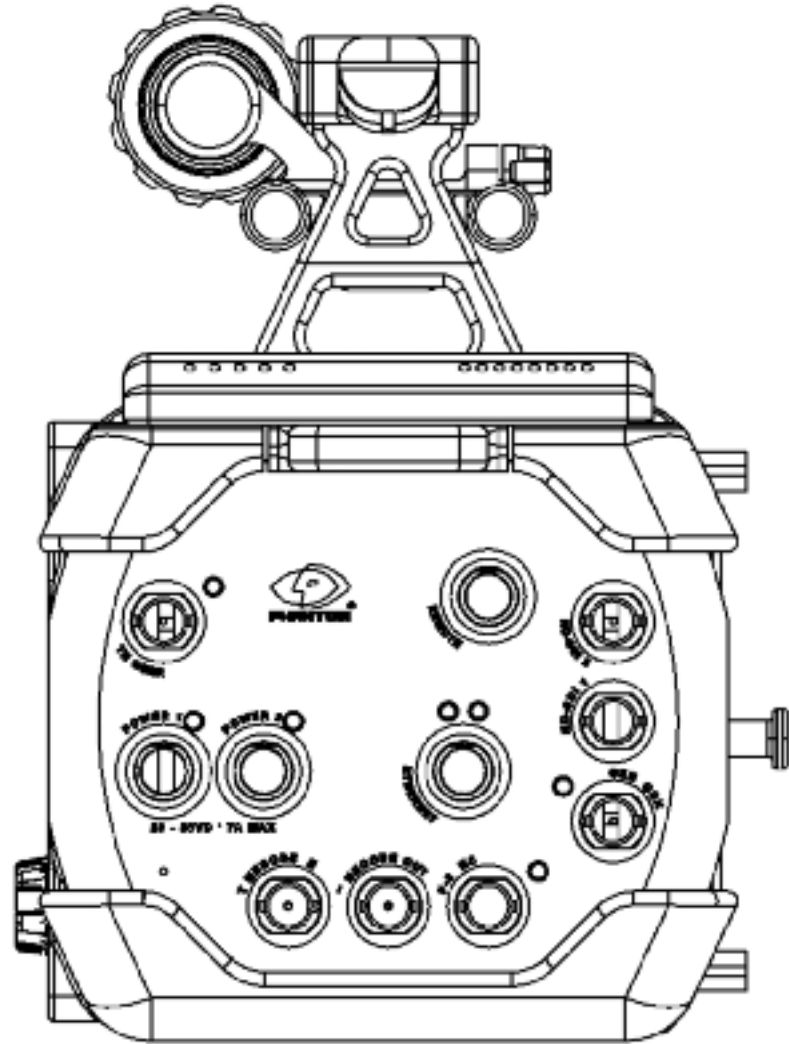
If the camera is in LOOP mode, you can mark an in and out point in the clip, then save it to the CineMag. Navigate to the frame you wish to mark as the in point, then press and hold the MENU knob – you will see the word “Edit” appear on the bottom left corner of the screen. While holding, turn the knob to the right, until the words “Set In” appear, then release. To mark an out point, press and turn the “MENU” knob to the right again until the words “Set Out” appear, then release. Save the clip by pressing and turning the knob to the left until the “Save” appears, then release. It will take a few seconds to save the clip to the CineMag. For more information on operating the camera using the on-board controls, please see **On Camera Control Buttons** Chapter.

Downloading a Clip to a Computer

To save a clip from the camera to a hard drive, run the PCC software and navigate to the “Play” tab. To choose the clip to download, select it from the “Cine” pull-down menu. A clip in the camera’s RAM will be numbered 1, while the clips in the CineMag have numbers preceded by the letter ‘F’. The most recently recorded clips will be at the end of the list. Save the clip by clicking the “Save Cine...” button. In the Save dialog box that appears, ensure that the format “Cine Raw” is selected in the “Save as Type” selector. Navigate to the folder where you wish to save the clip and click the “Save” button. For more information on operating the camera with PCC, please see **Phantom Software** Chapter.

Beginning the Next Clip

To prepare for recording the next clip, press the TRIGGER button for a few seconds to return to the live view. Press and hold the TRIGGER button again to erase the clip in RAM and begin recording the next shot.



Power & Connectors

Power In:

Connectors: 2 x Fischer 3-pin Male
Spec: 20-36V DC, 6.2A Max, 5A typical

2 power inputs are provided to enable hot swapping between power sources

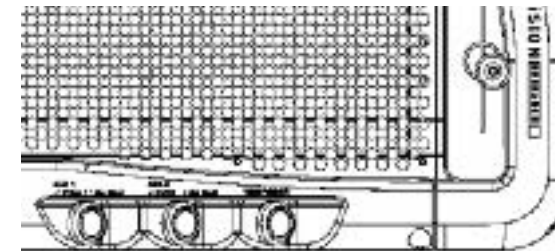
Power Out:

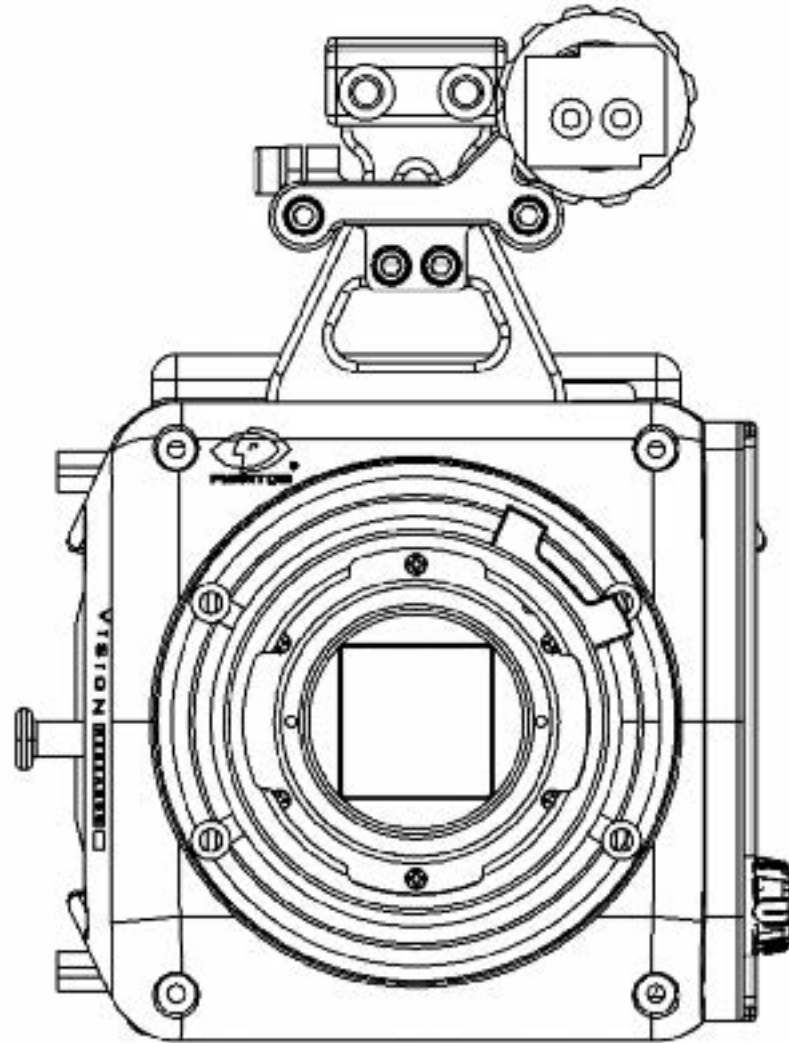
Connectors: 2 x Fischer 4-pin Female
Spec: 12V accessory power, 1.5A Max

Power Draw:

Min: 80W in standby mode with no CineMag
Max: 150W with CineMag, recording at high frame rate
Typical: 110W

Power draw increases with frame rate and while actively recording





6

Optics

A wide choice of lens formats helps define the Phantom Flex.

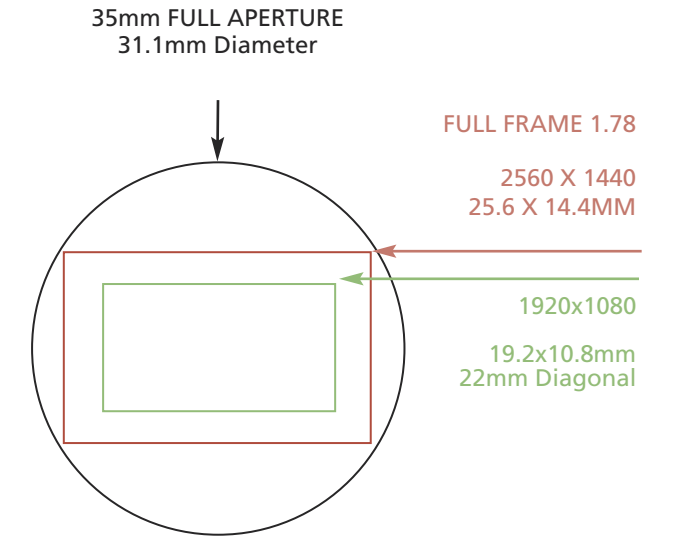
35mm PL

The standard 35mm PL mount can be used full frame at full resolution (2560x1600) or an extraction can be taken out of the full frame. When used at full resolution the new automatic scaling function will output 1920x1080P. Any resolution below 2560x1600 can be extracted including standard 1920x1080 or 1280x720. When a 1080P extraction is used, the equivalent focal length of the lens will slightly 'longer' (see chart on right).

FLEX

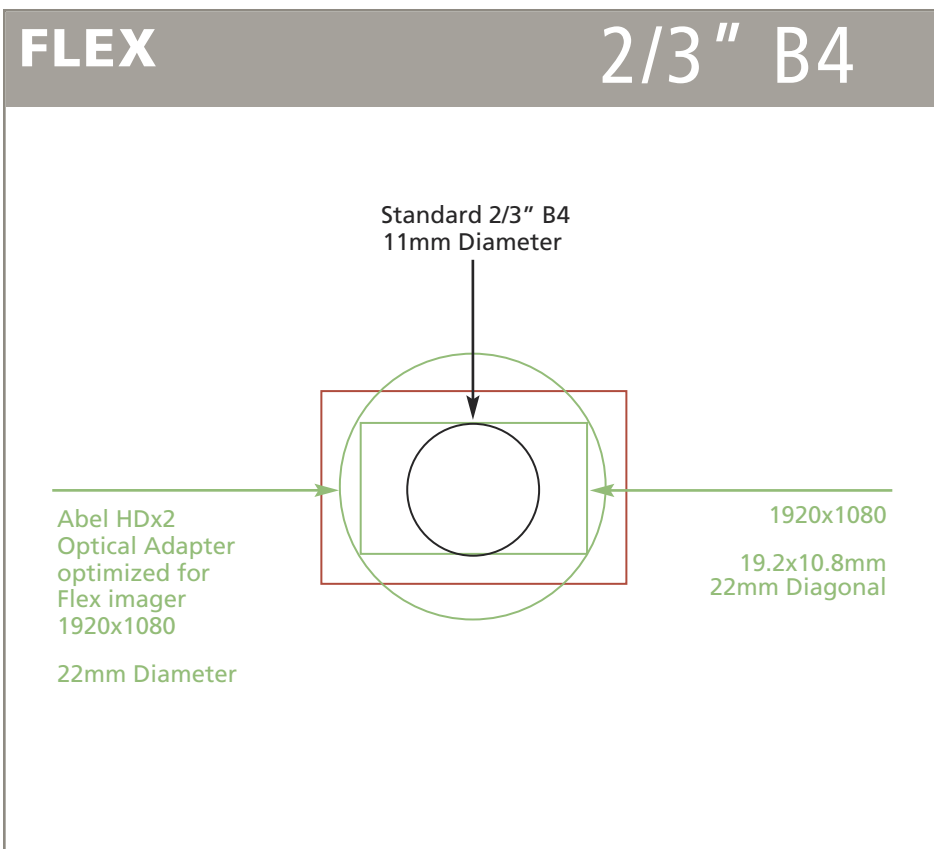
35mm PL

| equiv AOV (1.28) | FOCAL LENGTH | equiv FL (x1.28) |
|------------------|--------------|------------------|
| 11 mm | 14 mm | 18 mm |
| 39 mm | 50 mm | 65 mm |
| 58 mm | 75 mm | 96 mm |
| 77.5 mm | 100 mm | 129 mm |



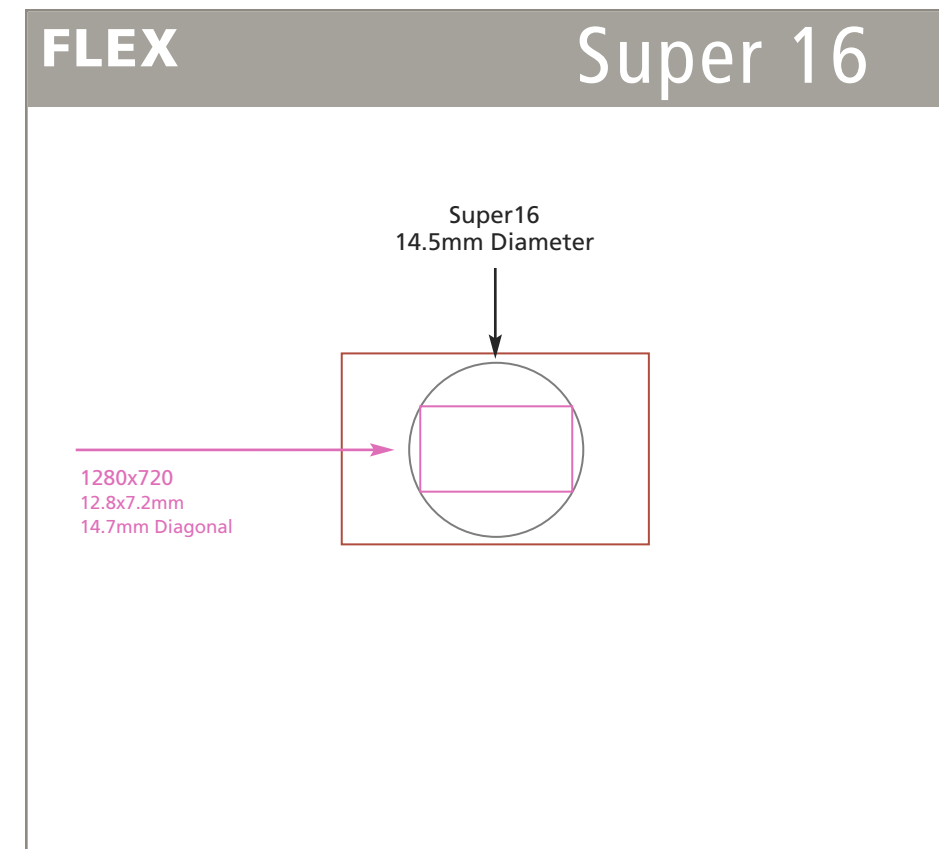
2/3" B4

The Abel HDx2 adapter converts B4 mount lenses to PL mount. The 11mm diagonal coverage of the B4 lens is 'blown up' by a factor of "x2" to 22mm. The angle of view is the same as it would have been if the lens were placed directly on a 2/3" B4 camera but the depth of field will be shallower and closer to a PL/35mm depth of field.



Super 16

The Flex can accommodate Super 16 PL mount lenses.





7

On-Camera Controls

The Phantom Flex cameras can be controlled via their On-Camera Controls

Trigger Button

The Trigger button is used to start and stop recording. If there is a clip in the camera's RAM, holding the trigger button for several seconds will erase the clip and begin recording. Pressing the button while the camera is recording ends recording either instantly, or after a delay (depending on the "TP" setting.) The Trigger Button can also be used to exit the Camera Menu.

Menu Button / Knob

The Menu Button / Knob is used to display the Settings menu and to navigate/select recording parameters. In Playback mode it can be used to select and scroll through clips which have been recorded.

Tools Button

When the camera is outputting a live image, the tools button is used to toggle between live preview, zoom, and threshold modes.

NOTE

The zoom mode provides a 1:1 pixel view.

Threshold mode provides an exposure aid by coloring over-exposed portions of the image.

When the camera is in playback mode, the Tools button is used to play and/or stop the playback of the recorded/stored cine file in reverse.

B-REF

In LIVE mode, pressing & holding the B-REF button performs a black balance. In Playback mode, this button is used to start & stop playback.

LIVE Display Screens

The LIVE PRE, (live image preview), mode is the operational state the camera will be in when it is first powered up. The camera will display a live image on the monitor or viewfinder screen, but is not yet recording any image data or frames to the camera memory buffer or Phantom CineMag.

In this state, the user can:

- View a live image to focus on the subject.
- Zoom in to 1:1 pixel view to assist in focus.
- Define the recording parameters.
- Determine if any image area is over exposed.
- Examine the recording duration time and the number of frames that will be recorded within the recording time frame.

On-Screen Display

A Camera State Designators

B Time Indicator

C w/ PHANTOM CINEMAG
Phantom CineMag State Indicator
Number of Takes
Memory Usage/Size

D Resolution

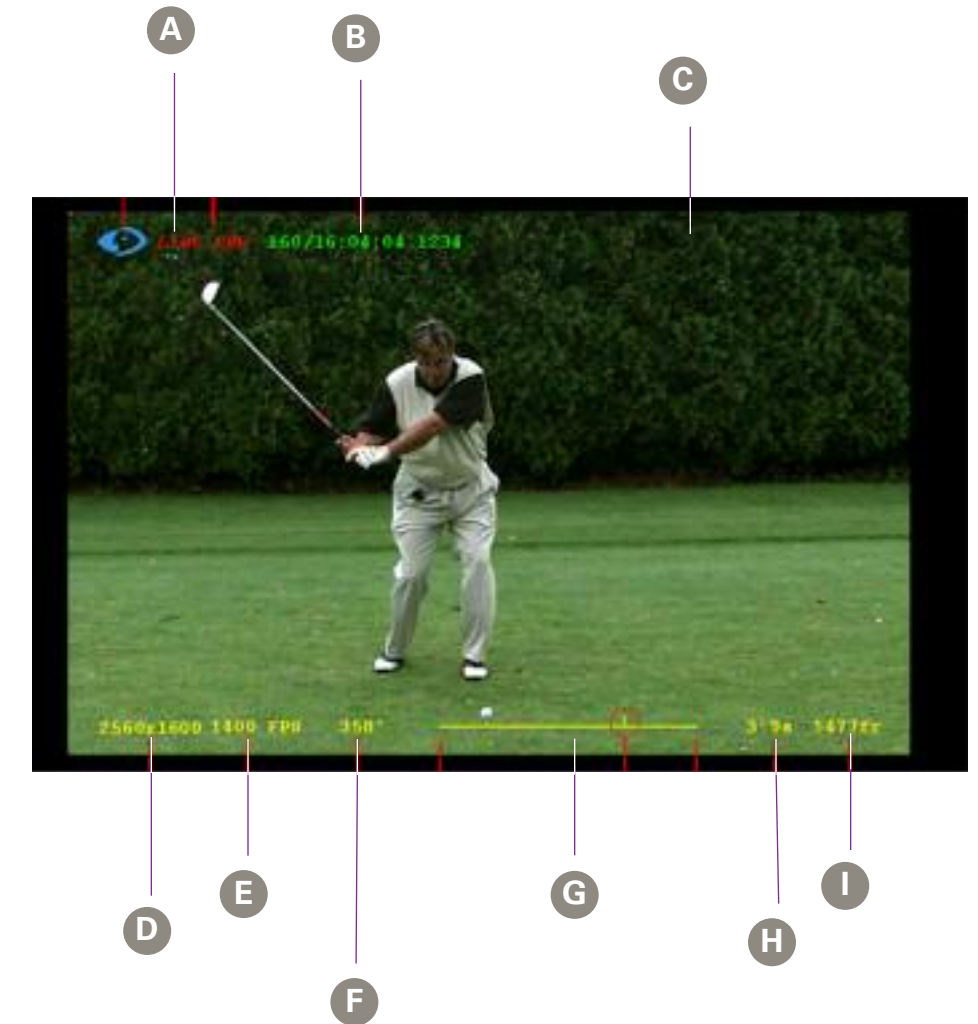
E Sample Rate

F Shutter Angle

G Memory Buffer Graphical
Representation

H Maximum Recording Time










I Maximum Recording Frames



A Camera State Designator

Below is a brief description of the information that could be displayed in the display screen:

The color of the Phantom logo will change based on the state of the camera.

| | |
|---|--|
|  | LIVE PRE: In this state the camera is in LOOP mode and will display a live image from the video output. The camera is not recording. |
|  | LIVE WT1: The camera is in LOOP mode and will display a live image from the video output. The camera is currently recording to RAM and awaiting a trigger signal. |
|  | LIVE CST: The camera is in LOOP mode and will display a live image from the video output: there is a clip stored in the RAM. |
|  | LIVE TR1: The camera is in LOOP mode and recording to the RAM. It has received a trigger signal is currently recording the post trigger frames. |
|  | LIVE: The camera is in R/S mode and will display a live image from the video output. The logo will be green if there is a clip stored in RAM, and blue if not. |
|  | LIVE REC: The camera is in R/S mode and will display a live image from the video output. If attached, it is recording to the cinemag. |
|  | PLAY PRE: The camera is in playback mode and there are no clips stored in RAM. |
|  | PLAY CST: The camera is in PLAYBACK mode and there is a clip stored in RAM. |
|  | SELECT: The camera is in PLAYBACK mode and a clip can be selected to playback. The logo will be green if there is a clip stored in RAM, and blue if not. |

B Time Indicator

The Time indicator indicates; day number/hour:minute:second:microsecond.

C Phantom CineMag Status Indicator

The CineMag Status Indicator shows the operation state of the camera. Various state designators include:

Mag Off

Indicates the Phantom CineMag is presently in the Off state. A Phantom CineMag will remain in the Off state until it initiates its power up diagnostic routine.

MagInit

Indicates the Phantom CineMag has been detected either during camera power-up, or when a Phantom CineMag has been inserted onto the camera.

MagScan

Indicates that the Phantom CineMag is running through its power-up, self-diagnostics routines.

Mag Ready

It indicates that the Phantom CineMag has passed its power-up, self-diagnostics routines and is ready to record a cine.



Mag Recording Tn

It indicates that a cine is presently being saved into the Phantom CineMag. The Tn indicates the "take" number being recorded to the Phantom CineMag.



MagErase

It indicates that the Phantom CineMag has been instructed to erase its contents, and is performing the erasure procedure.



Number of Takes

26T

This field indicates the number of takes recorded to the Phantom CineMag. As takes are recorded the Number of Takes field increments.

Memory Usage/Size

94/528G

The Usage field indicates the amount of Gigabytes used to store recorded frames. As the takes are recorded the Memory Usage field increases, while the Size field indicates the total number of bytes, or the memory size, of the Phantom CineMag.

2560x1440 000 FPS 100° 7.0s 000Gfr

D Resolution

2560x1440

This field indicates the active pixel area, (Width x Height), of the sensor defined by the user.

E Sample Rate

800 FPS

This field specifies the rate the Phantom camera will capture or record image data, (frames), into the camera's memory.

F Shutter Angle

100°

This field shows the current, user defined, Shutter Angle or exposure setting of the camera.

G Memory Buffer Graphical Representation



This is a graphical representation of the camera's memory buffer. It acts as a memory gauge that consists of two basic components. The first component, of the graphical representation is the line which represents the total frames that can be stored in the camera's buffer. The second component is a "T" on top of the line. The "T" represents a trigger point that is defined by the user. Any frames that are captured after a trigger signal is detected by the camera are referred to as Post Trigger frames, and the frames recorded prior to the trigger signal are referred to as Pre-Triggered frames.

H **Maximum Recording Time**



This field indicates the total length of recording time. The recording duration is based on the amount of memory in the camera, along with the resolution and sample rate settings. This field will change based on these variables.

I **Maximum Recordable Frames**



This field indicates how many images or frames will be recorded within the Duration time. This field will also change based on how the amount of memory in the camera, and how the resolution, and sample rate are set and will change accordingly.

Menu for Setup and Recording Parameters

Step-by-Step Procedures

There are five Camera display screens used to define the operating parameters of the Phantom Flex camera. Following is a brief description of each of these display screens and the Step-by-Step Process to define each of the Camera parameters, including:

Selecting the Parameter to be Defined

1. From any of the LIVE display screens:
 - a. Press the Settings button one time, then
 - b. Rotate the button to the desired Camera parameter to be specified. The field will change from yellow to red indicating the field has been selected for change.
2. Once the desired Camera field has been selected:
 - a. Hold in the Settings Setup button, then
 - b. Rotate the button to the desired operational setting and release.
3. To exit the Camera Setup Display Screens press the Trigger button one time.

NOTE

The above step is required to define all subsequent Camera parameters.



Camera

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Speed (Frame Rate)

Speed, (Frame Rate), is the rate at which images are recorded. The Speed field selection list will change according to the Resolution selected, the larger the selection area the lower the maximum frame rate.

NOTE

Set the Resolution before setting the Speed. To set high Frame rates, or increase the recording time, reduce the selected Resolution (Width x Height).

1. To increase the Speed, (Frame Rate), hold in Settings button and rotate clockwise.
2. To decrease the Speed, (Frame Rate) hold in and rotate counter clockwise.

Shutter (Angle)

Adjusting the shutter angle affects the amount of time that sensor is exposed to light. A larger shutter angle may result in an increased motion blur on moving objects.

1. To increase the Shutter Angle hold in Settings button and rotate clockwise.
2. To decrease the Shutter Angle hold in and rotate counter clockwise.

TP (Trigger Point)

The Trigger Point or Post Trigger value represents how many frames will be recorded after the trigger signal is detected by the Phantom camera. Since the memory is scrolling memory, the Post Trigger value also sets the number of pre-trigger images captured.

When a Post Trigger value is defined in the Phantom Camera Control software, the camera will continue to record and store, to the camera's DRAM buffer, image data after a trigger signal is detected for n frames, where n is the number of post trigger frames specified.

After the trigger signal is detected by the camera, recording continues for an exact number of frames, n, and stored in the image buffer, then recording stops; n will depend on the number of post trigger frames defined by the user.

It's important to note that the camera can only store a finite number of images into the memory buffer based on the resolution, sample rate, and the memory

| | |
|-----------------------------------|---|
| | <p>size. When a post trigger value has been defined the camera will only store the maximum image count allowed for the particular capture settings. The camera will only display the frames stored in the memory buffer, the last x images, where x is the total number of images recorded or stored in the image buffer.</p> <ol style="list-style-type: none"> To move the TP, (Trigger Point), to the right, decreasing the number of PostTrigger frames to be recorded, hold in Menu button and rotate clockwise. To move the TP, (Trigger Point), to the left, increasing the number of Post Trigger frames to be recorded, hold in and rotate counter clockwise. |
| Resolution | <p>Resolution refers to the shape of the captured area in pixels. It represents the number of pixels enabled to capture an image. For example, if 2560x1600 is set (W x H), the full sensor space available, it is called 'Full Frame'. The Resolution setting allows the user to change the dimensions, or aspect ratio, of the sensors active pixel area. The aspect ratio is the width to height ratio of the image being recorded.</p> <p>Changing the Resolution settings to match the dimensions of the subject of interest allows the user the option of recording at higher frame rates, or longer recording times at the same frame rate. Smaller resolutions 'crop' the capture image by enabling a subset of pixels, this allows you to customize the shape of the capture area to the application.</p> <ol style="list-style-type: none"> To increase the Resolution hold in Menu button and rotate clockwise. To decrease the Resolution hold in and rotate counter clockwise. RESULT: The image aspect ratio will be displayed with the defined Resolution setting. |
| Capture (Operational Mode) | <p>This field selects whether the camera is to run in either Loop or Run/Stop Mode.</p> <ol style="list-style-type: none"> Hold in the Menu button, and rotate to the desired parameter: <ol style="list-style-type: none"> Loop - In the Loop Mode the camera stores the recorded image data into |

| | |
|---|---|
| | <p>the camera's DRAM buffer. In this mode, after a cine file is recorded into the camera's DRAM frame buffer, you can manually save it into the CineMag.</p> <ol style="list-style-type: none"> Run/Stop - In Run/Stop Mode the image data is recorded directly into the Phantom CineMag. |
| HQ Mode | <p>High Quality Mode reduces the need to black balance, as well as increase the signal to noise ratio in the image. In LOOP mode, the maximum frame rate will be reduced by approx half when this is switched on.</p> <ol style="list-style-type: none"> To turn on HQ MODE, hold in Menu knob and rotate clockwise. To turn off HQ MODE, hold in Menu knob and rotate counter clockwise. |
| Auto BREF | <p>Automatic black reference or black balance. When this function is switched on, the camera will automatically black balance as soon as the recording starts.</p> <ol style="list-style-type: none"> To turn on AUTO BREF, hold in Menu knob and rotate clockwise. To turn off AUTO BREF, hold in Menu knob and rotate counter clockwise. |
| GenLock | <p>Genlock allows 2 or more cameras to synchronize their video outputs. This is necessary when outputting to a switcher or 3D monitor.</p> <ol style="list-style-type: none"> To turn on GENLOCK, hold in Menu knob and rotate clockwise. To turn off GENLOCK, hold in Menu knob and rotate counter clockwise. |
| Maximum Recording Time (Non-Selectable) | <p>This field indicates the total length of recording time. The recording duration is based on the amount of memory in the camera, along with the resolution and frame rate settings. This field will change based on these variables.</p> |
| Maximum Recordable Frames (Non-Selectable) | <p>This field indicates how many images or frames will be recorded within the Duration time. This field is based on the amount of memory in the camera, and how the resolution is set, and will change accordingly.</p> |



Image

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Auto White Bal

This will set the white balance under the current lighting conditions.

1. To set the Auto White Balance, hold in the Menu button and rotate clockwise until a red box appears in the center of frame. Keep holding the Menu button & point the red box towards a white area of the image.
2. Release the Menu button and the white balance will set instantly.

Black Reference

Also known as black balance, is required to be performed when resolution, frame rates or shutter angle is changed. This should also be done when there are any visible image artifacts, such as vertical banding.

1. To set the black balance, hold in the Menu button and rotate clockwise until OK appears.
2. Release the Menu button. The built-in mechanical shutter will activate and a countdown will be visible. After approx 5 seconds, the black balance will be set.
3. Black balance can also be performed by holding in the B-REF button for approx 2 seconds while in the LIVE mode.

EI (Exposure Index)

Also known as ISO or ASA, represents the sensitivity of the camera. Increasing EI adds gain to the video outputs. It is recorded as metadata in the clip, but doesn't affect the RAW data.

1. To increase the Exposure Index hold in Settings button and rotate clockwise.
2. To decrease the Exposure Index hold in and rotate counter clockwise.

Gamma

Gamma is the nonlinear relationship between signal level and brightness output of pixels, (a small signal level change at low voltage produces a larger variation in brightness than the same change in level at high voltage); gamma correction for monitors is the compensation for this nonlinearity.

The default camera setting is 2.2

1. To increase the Gamma value hold in Settings button and rotate clockwise.
2. To decrease the Gamma hold in and rotate counter clockwise.

Black

Also known as Pedestal, is an offset to the black level in the camera's video output.

1. To increase the Pedestal, hold in the Menu button and rotate clockwise.
2. To decrease the pedestal, hold in the menu button and rotate counter clockwise.

PA (Production Area)

The camera will highlight the production area specified by under exposing the area outside the production area by 1-stop, and changing it to be monochrome. This production area can be thought as the area of the captured image that will be used in the final production, but can be used for any purpose. It is not recorded in teh RAW data.

1. To increase the Production Area hold in Menu button and rotate clockwise.
2. To decrease the Production Area hold in and rotate counter clockwise.

PAO

This will offset the above described Production Area box left, right, up or down.

1. To move the box either left or right, hold in the Menu button on the first 0 and turn the button either clockwise or anti clockwise.
2. To move the box either up or down, hold in the Menu button on the second 0 and turn the button either clockwise or anti clockwise.

UNIT ZOOM

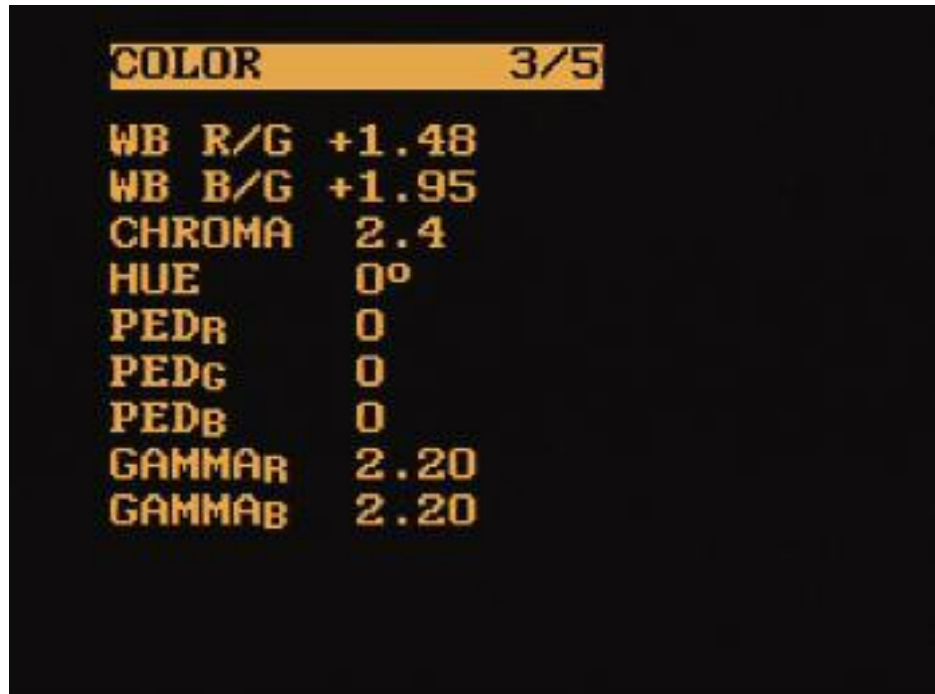
This function allows you to see the LIVE video output at a 1:1 ratio (pixel for pixel)

1. To turn on the Unit Zoom, hold in the Menu button and rotate clockwise until ON appears.
2. To turn off the Unit Zoom, hold the Menu button and rotate counter clockwise until OFF appears.

COLOR BARS

These are SMPTE Color bars, which can be generated through the SDI output and is useful for setting up a monitor.

1. To turn on the Color bars, hold in the Menu button and rotate clockwise until ON appears.
2. To turn off the Color bars, hold the Menu button and rotate counter clockwise until OFF appears.



Color

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WB R/G

This is the amount of red relative to green. When a white balance is performed, this value is automatically changed. This value can also be changed manually.

1. To increase the red relative to green amount, hold in Menu button and rotate clockwise.
2. To decrease red relative to green amount, hold in and rotate counter clockwise.

WB B/G

This is the amount of blue relative to green. When a white balance is performed, this value is automatically changed. This value can also be changed manually.

1. To increase the blue relative to green amount, hold in Menu button and rotate clockwise.
2. To decrease blue relative to green amount, hold in and rotate counter clockwise.

Chroma

Chroma is the color component of the video signal.

1. To increase the Chroma value hold in Menu button and rotate clockwise.
2. To decrease the Chroma hold in and rotate counter clockwise.

Hue

The hue angle is adjustable both in a positive & negative value.

1. To turn the Hue more positive, hold in Menu knob and rotate clockwise.
2. To turn the Hue more negative, hold in the settings knob and rotate counter clockwise.

PEDR, PEDG, PEDB

The pedestal can be adjusted in three separate color channels, red, blue & green.

1. To increase the red, green or blue channel, hold in Menu button and rotate clockwise.
2. To decrease red, green or blue channel, hold in and rotate counter clockwise.

GAMMA_R, GAMMA_B

The gamma can change be changed in individual red & blue channels.

1. To increase the red or blue amount, hold in Menu button and rotate clockwise.
2. To decrease red or blue amount, hold in and rotate counter clockwise.



Color Matrix

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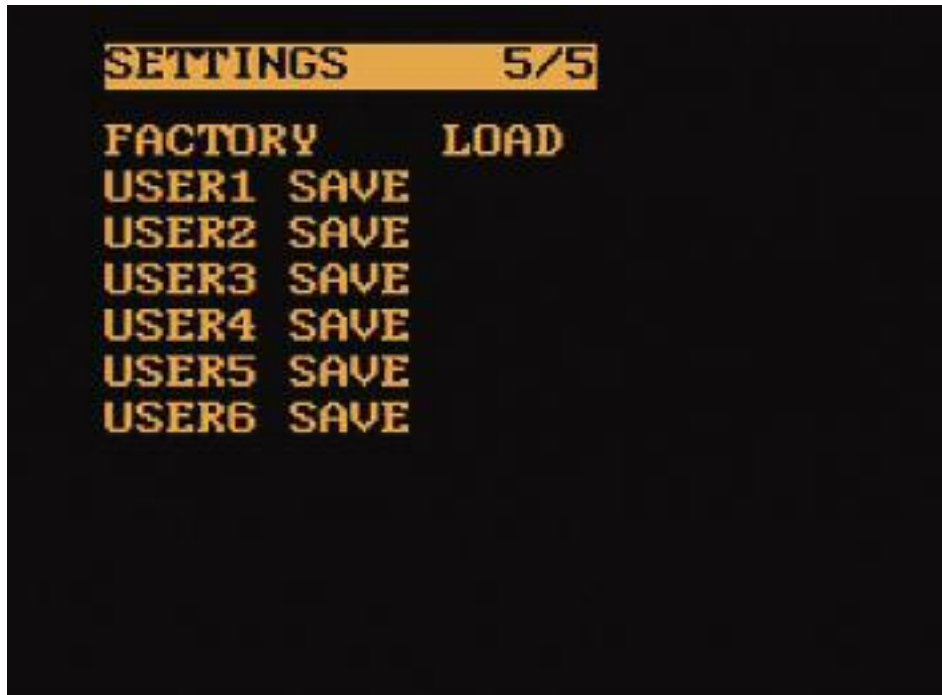
G-R, B-R, R-G, B-G, R-B, G-B, & Sat(Saturation)

The color matrix settings (G→R to G→B) affect the color reproduction of the camera's video output. By using a calibrated chart (such as a DSC Labs' "Chroma Du Monde") and a vector scope, the color reproduction of various cameras can be closely matched by adjusting the Matrix settings.

Up to four matrices can be set and individually selected by changing "#0 (off)" to values from 1 to 4.

Sat will increase or decrease the overall color saturation with the value "0.00" being a completely desaturated (black and white) image, 1.00 being the default value, and values over 1.00 being hyper-saturated.

1. To increase any of the above options, hold in the Menu knob and rotate clockwise.
2. To decrease any of the above options, hold in the Menu Knob and rotate counter clockwise.



Settings

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To Load Factory Settings

This menu allows the user to load factory default settings and save 6 different custom user files.

1. Highlight LOAD, which is immediate right of FACTORY.
2. Push & hold the Menu Knob, while turning clockwise until OK appears.
3. Release Menu Knob. The default factory settings will load.

User 1-User 6

6 different user files can be created which save all the user adjustable options in the menu.

To Save a User file

1. Select which user file to save (USER 1-6) & highlight SAVE
2. Push & hold the Menu Knob, while turning clockwise until OK appears.
3. Release the Menu Knob. LOAD will now appear immediately right. The user file will now be saved into memory.

To Load a Saved User File

1. Select which user file to load (USER 1-6) & highlight LOAD
2. Push & hold the Menu Knob, while turning clockwise until OK appears.
3. Release the Menu Knob. The user file will now be loaded onto the camera settings.

To playback a clip from RAM or CineMag

- Press the playback button which will bring up the SELECT page.
- To scroll through clips, turn the Menu knob in a clockwise or counter-clockwise direction. Each clip is stored sequentially and each clip has its own label "RAM 1, MAG 1, MAG 2, etc"
- To playback a selected clip, press the "B-REF" button. The frame numbers on the top right of image will appear and start to roll. To pause the playback, press the "B-REF" button while playing back. To playback in reverse, press the "TOOLS" button.
- To step through the clip frame by frame, turn the "MENU" knob.
- To go back into "LIVE" mode, press the "TRIGGER" button.

To save a RAM clip to the CineMag

- Select & playback the clip as described above.
- To save an entire clip to the CineMag, push & hold the "MENU" knob. "Edit" will appear on the bottom left of image. While pushing and holding the "MENU" knob, turn it counter-clockwise until "Save" appears & then release the knob. "Mag Recording" will show on the top of the image while the saving is in progress. It takes approx 30 seconds to transfer an entire 32GB RAM clip.

To edit a RAM clip prior to saving it to a CineMag

- Select & playback the clip as described above.
- To edit the clip, push & hold the "MENU" knob. "Edit" will appear on the bottom left of image. While pushing & holding the "MENU" knob, turn it clockwise until "Set in" appears & then release the knob. To set the out point, keep turning the "MENU" button until "Set Out" appears & then release. This will set the in and out point on the frame that is currently selected at the time.
- To save the edited clip from the RAM to the CineMag, follow the above step.

NOTE

A clip saved or recorded to the cinemag cannot be edited.



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Overview

The CineMag

The CineMag is a high-speed solid-state data recorder that clips into the top of the Phantom Flex or a CineStation. It records raw, 10-bit log-encoded footage. Although similar in concept to a traditional hard drive or solid-state disk, it differs in operation in a couple of critical ways. First, there is no file system on a CineMag. Secondly, data is recorded sequentially and continuously on the mag, with no gaps. This is all done to guarantee a high and consistent write speed on the CineMag. Unlike with a hard drive, it is possible to record at the highest speed no matter how many clips are already recorded without ever dropping a frame.

Due to the nature of how the CineMag works, the use of the CineMag differs slightly from a hard drive recorder. Because all frames are and must be recorded contiguously, it is not possible to delete individual clips off the CineMag. It is important to take this into consideration when saving clips — once the CineMag is full, you can only re-record on it by completely deleting its contents.

The CineMag doesn't mount on your computer's desktop like a hard drive. The clips are downloaded over Ethernet (either 1Gb or 10Gb) using the Phantom software and written as raw cine files to an attached drive.

CineMag and CineMag II

There have been two generations of CineMags. The newer CineMag II is thinner and lighter than the first generation CineMags. The functionality of the two is identical.



The Erase Protect Switch

When the erase-protect switch is in the lock position, the CineMag cannot be erased. Recording to the mag is still possible. It is recommended to enable this switch when you begin shooting to avoid accidentally erasing a CineMag



Attaching a CineMag

The CineMag clips into the MagMate of the Phantom as shown in the illustration.

All of the power and data connections are made between the pins on the MagMate and the pads of the CineMag.

Please be careful when attaching or removing the CineMag that you don't damage the pins on the camera. Avoid dragging the tabs on the front of the CineMag across the pins.



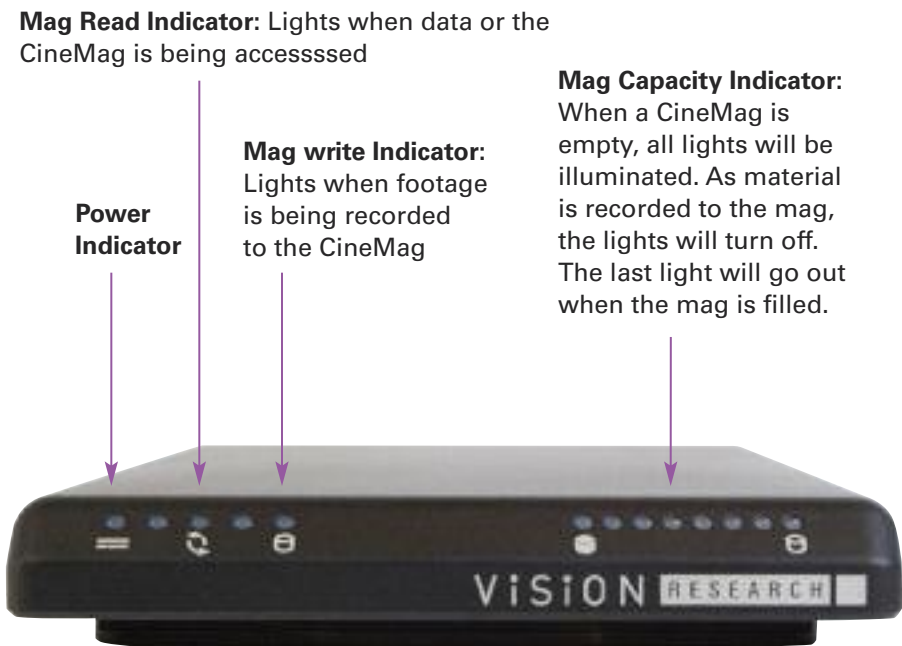
Removing a CineMag

To remove the CineMag, pull the red tab on the back of the camera and lift the mag, being sure not to damage the pins on the camera.



CineMag Indicators

On the back of the CineMag are a number of LED indicators that show the current mag status.



Downloading from a CineMag


While it is possible to save clips from a mag in a number of different formats, almost always you will want to save them as Cine Raw files, as this format will be the fastest and best quality format to save, as well as being the only format that will preserve all of the metadata of the clips (such as frame rate, shutter speed, timestamps, etc.).

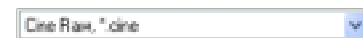
Traditionally the Phantom Cine Raw files were defined as containing 16 bit, linear data, and this is still the default format. Clips saved this way will take up 60% more data on disk than on the CineMag, so plan your storage requirements accordingly.

It is possible to save the clips with the same 10 bit log data that is on the CineMag by checking the “Packed” check box in the Save dialog box. Files saved this way will be smaller and faster to save than the 16 bit files, but there is still limited third-party support for these files. Make sure that your post-production tools are compatible with these files before creating them.

Downloading individual clips from a CineMag

From the “Play” tab in PCC, select the cine you want to save from the “Cine:” pull down menu. You will see all clips in the RAM as well as the CineMag in this list. Once you’ve selected a clip, you can mark an in and out point if desired by clicking the “[” and “]” buttons respectively.

 Then click the green “Save Cine...” button.

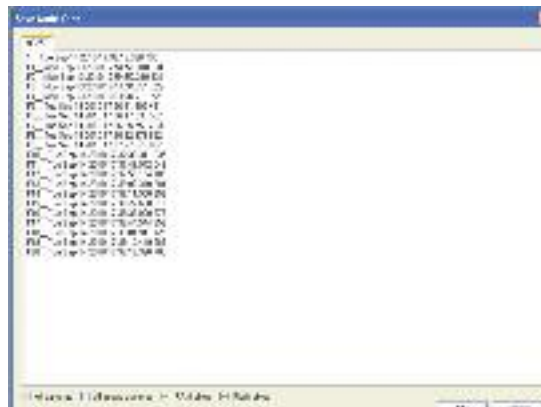


In the “Save Cine” dialog box, choose “Cine Raw” as the file format, navigate to the folder where you wish to save the clip and click “Save.”

Downloading all clips from a CineMag



Downloading selected clips from a CineMag



NOTE In the PlayTab, click the triangle to the right of the “Save Cine...” button, and from the popup menu choose “Save All Flash Cines To File.” Alternately, from the “Cine” menu, choose “Save All Flash Cines To File.” In the subsequent save dialog, navigate to the folder where you wish to save the clips, and choose the appropriate file format (generally Cine Raw). Choose a name for the clips and click the “Save” button.

In the PlayTab, click the triangle to the right of the “Save Cine...” button, and from the popup menu choose “Select&Save Cines to File.”

Alternately, from the “Cine” menu, choose “Select&Save Cines to File.” In the popup window, select the cines you wish to save. Use the shift key to select a range of clips, or the control key to add individual clips. When you’ve selected the cines you want to save, click “OK.” In the subsequent save dialog, navigate to the folder where you wish to save the clips, and choose the appropriate file format (generally Cine Raw). Choose a name for the clips and click the “Save” button.

NOTE “_Flashcine#” will be appended to the file name of all batch-saved clips, where “#” represents the number of each clip in the CineMag.

Erasing a CineMag

To erase a CineMag, mount the mag on a camera or CineStation and connect a computer running the Phantom Camera Control software. From the “Camera” menu choose “Erase Flash Memory”, and confirm that you wish to delete all clips. It will take a few minutes to erase the CineMag.



If you find it impossible to erase a CineMag, check that the Erase Protect Switch is not enabled on the bottom of the mag.

Care of CineMags

Do not get the CineMag wet.

Do not drop a CineMag or otherwise expose it to excessive shock.

Always protect the electrical contacts on the bottom of the CineMag. If they get dirty or corroded, clean them with denatured alcohol before mounting the mag to a camera or CineStation.

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Phantom Software

Programs installed by the PCC1.1 installer



NOTE

Note: There are two versions of Phantom software that are installed with a single installer. As of this writing, they will appear on your desktop as "Phantom 689" and "PCC 1.1". This manual covers only the newer PCC (Phantom Camera Control) software. The older Phantom software will work, though there are a few features of the Phantom Flex that are only accessible through the PCC software.

Before Running the Software

The Phantom control software runs on Microsoft Windows, and is currently certified to be compatible with Windows XP and Windows Vista. While not yet certified for Windows 7, testing indicates that it works when run in XP compatibility mode.

The computer connects to the camera via Ethernet. To get acceptable speeds downloading clips from the camera, the connection should be 1Gb/sec (1000-BaseT) running in full duplex. If the computer is only going to be used for control, a 100-BaseT connection is acceptable.



In order for the software to communicate with the camera, they must be on the same sub-network. All Phantom cameras have preset IP addresses on the same subnet — 100.100.x.x with subnet mask 255.255.0.0. It is customary to assign the controlling computer the IP address 100.100.100.1/255.255.0.0.

Overview of Phantom Camera Controller (PCC)



The main window of PCC is divided into 3 tabs: Live, Play and Manager.



When the software is first started, the Manager tab will be selected. From here any cameras on the local network can be seen. If a new camera is connected, pressing the reload button will make the software look for it. Clicking on the name of a camera will allow you to rename the camera. This can be useful when working with multiple cameras, such as on a 3D rig.

All camera control and setting of shooting parameters (frame rate, shutter, etc.) is performed in the Live tab.

The Play tab is used for reviewing and saving clips (either from the camera or from files on the local hard drive) on the computer screen.



To the left of the tabs is an area used for viewing images. At the top of this area are a series of icons for saving clips, changing viewing options, and starting the video output program PVP.

There are several menus which will be covered in detail later in this section. Note now the Help menu, which leads to several help documents which provide valuable reference information about the software and different camera models.

NOTE

In Phantom terminology a clip is called a "Cine." A cine can exist in the memory of a camera, in a CineMag, or on a hard drive as a .cine file.

Overview of Phantom Video Player (PVP)

The PVP software can either be launched directly from the desktop, or by clicking the “Video Out” icon in the PCC software. All video output functions, such as setting the video output format and parameters (gain, gamma, etc.) as well as actually playing back a cine over the camera’s video output are performed in the PVP software.



Controlling the Camera with PCC

PCC can use different units for certain camera parameters. If this is your first time running PCC, select the units you wish to use by “Preferences” from the “Tools” menu. The most important unit to set is “Exp,” which sets what unit to use when setting the exposure time. You probably will want this set to degrees. The other unit to set is PTF which stands for “Post Trigger Frames.” We’ll cover what this is later in this section, but for now set it to “Percent.”

All the camera parameters that effect your shooting are set in the Live tab. In order for the controls to be active, you must select the camera you want to control from the “Camera:” pull-down menu. If you have multiple cameras connected on the same network, they will all appear in the pull-down menu.



The large frame at the bottom left part of the window when in the Live tab shows the current image being captured by the camera. The image should look similar to the image being output over SDI by the camera, but will always differ somewhat due to the differing natures of video monitors and computer screens.



Clicking on the “ImageTools” icon above this frame shows the Image Processing popup window. From here you can change gain, gamma, and a few other options. This will affect both the computer display as well as the video output of the camera. The “Default” button restores all parameters except white balance to their default values. The “Default White Balance” restores white balance to the default (which under most typical lighting will produce a green image.) Keep in mind that all changes made in the ImageTools window affect the meta data of the cine file only, not the raw data. If you are recording the camera’s video output however, it is important that these be set to values that produce the image you wish to record.

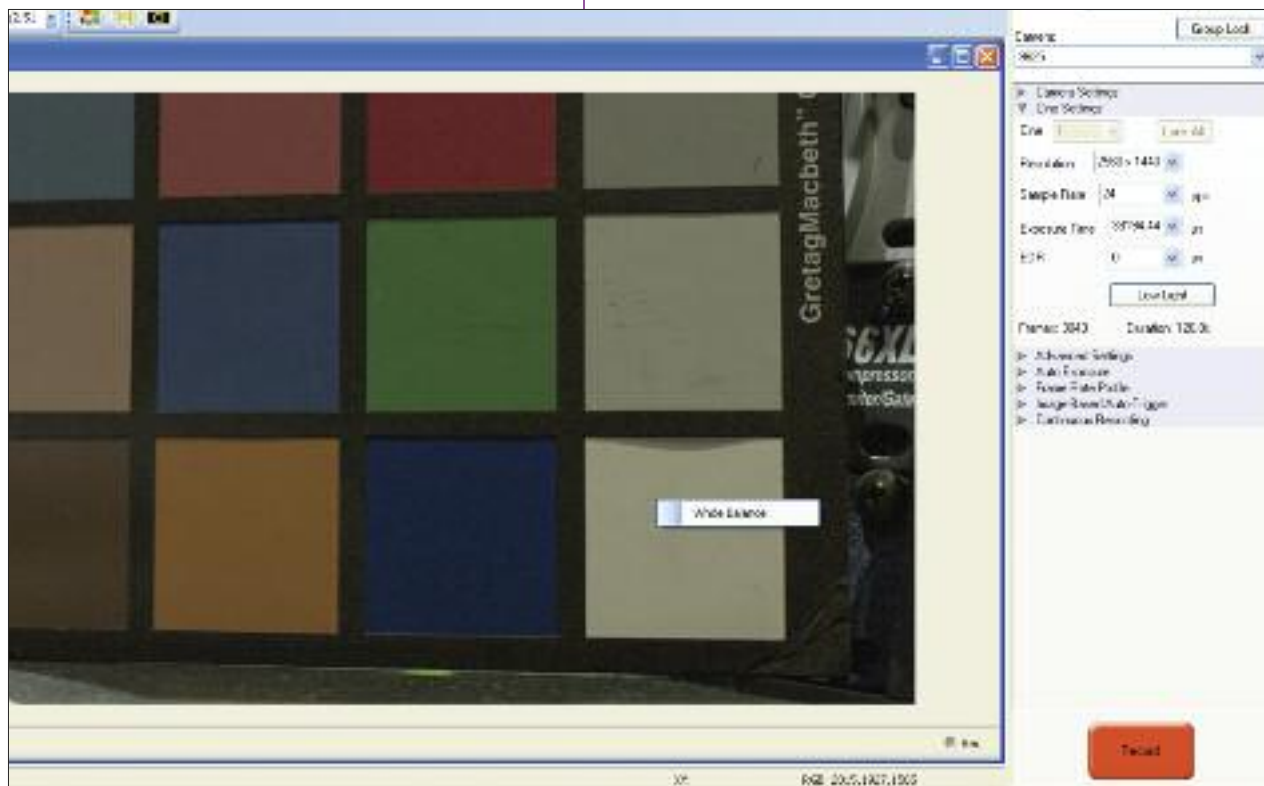


The “Zoom Actual Size” icon zooms the camera image to pixel-to-pixel mode. This is a good view for checking focus or otherwise evaluating image quality.

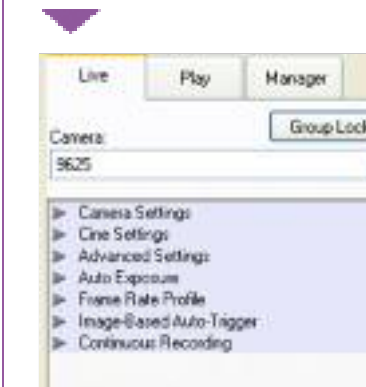


The “Zoom Fit” icon scales the image to fit the current window size. This is the best view for checking framing. The image can also be zoomed to a specific magnification ratio by selecting a number from the pull-down menu to the right of the Zoom Fit icon.

Right-clicking on a point on the displayed image brings up a white balance popup. It is not necessary to fill the frame with white – a small target can be used.



Beneath the Camera selector are a series of expandable headers which contain groups of related camera settings.



NOTE

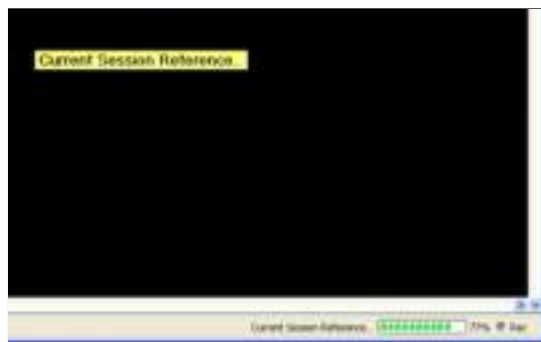
We will cover the most commonly used settings in this manual. For explanations of more rarely-used settings, please select "Pcc Help" from the "Help" menu.



From the Camera Settings section you can set the time of the internal clock in the camera. This will affect the time stamps that are embedded in the recorded cines. The simplest way to set the time is to click the "Set Time..." button, then in the resultant pop-up window click the "Update and Set" button. This will set the camera's time to the computer's time.

The Phantom Flex always operates in 12 bit mode - no other option will be available in the "Bit Depth" pull down selector.

You can partition the RAM of the camera by changing the number in the “Partitions” pull-down menu. This lets you record more than one clip in the camera’s memory at a time. It is rare that you will need to do this, especially if working with a CineMag. Generally this should be set to 1.



By far the most common operation performed in Camera Settings is CSR, which stands for “Current Session Reference.” This is the Phantom software’s term for black balance. When not running in HQ mode, it is necessary to perform a CSR after changing frame rate, shutter or resolution. After pressing this button, the camera’s internal capping shutter will close, and you will see a progress meter in the bottom of the image window. When the CSR completes the shutter opens and the camera is ready for shooting.

NOTE

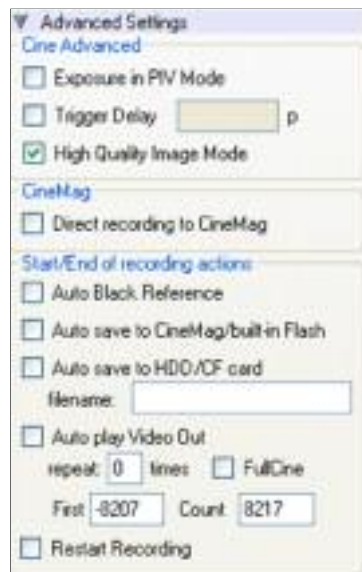
If you don’t black balance the camera, you may see shifted colors in the image as well as vertical bands. You should get into the habit of performing a CSR after any parameter change.



The most common shooting parameters are set in the “Cine Settings” section. Resolution, Sample Rate (i.e. frame rate) and Exposure Time (i.e. shutter) can be set by choosing a setting from the appropriate pull-down menu. If you wish to use a setting that doesn’t appear in the menu, type in the value you wish to use. If you type in a value that isn’t supported by the camera, the software will round the value to the closest supported value.

In addition to the pulldown menu, the trigger position can also be set in a third way, by dragging the selector in the slider to the left of the numerical indication left or right to visually represent where the trigger occurs in the shot. This representation closely matches the on-screen display of the camera.

The length of the shot in frames and seconds at the current settings is always displayed at the bottom of this section.



There are a number of settings available in the “Advanced Settings” section. Here are some key ones:

- “High Quality Image Mode” enables and disables HQ mode.
- “Direct recording to CineMag” enables recording directly to the mag. It is the equivalent of choosing “R/S” mode using the camera’s on-board controls.
- Enabling the options under “Start/End of recording actions” add procedures that are performed automatically by the camera at the beginning or end of a shot. The most common ones are “Auto save to CineMag/built-in Flash” which saves the marked portion of a clip to the mag immediately after recording and “Auto play Video Out” which begins playback after recording. The range marked under “Auto play Video Out” affects both playback and saving to the CineMag. If “Restart Recording” is checked, recording will start automatically after the auto actions are performed.

! There is no user confirmation before the clip is erased from RAM and recording begins when “Restart Recording” is enabled.
■ This feature should be used with care!



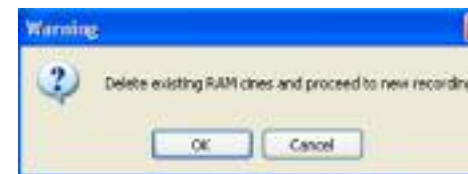
When working with a single camera, “Sync Imaging” should be set to “Internal.” For information on syncing two cameras, such as in a 3D rig, please read the chapter “Camera Setup.”



Once the camera is set, click the red “Capture” button to begin recording. If the camera is in Loop mode, this will begin recording to the camera’s RAM.

If the camera is in “Direct Recording to CineMag” (AKA R/S) mode, this will begin recording to the CineMag.

NOTE If there is already a clip in the camera’s memory, you will be asked if you are sure you wish to delete it before continuing. If you are sure, click “OK.”





Once the camera is recording, the red button changes to “Abort Recording” and the green “Trigger” button is enabled.

In loop mode, the Abort Recording button will stop recording, leaving the camera’s RAM empty. In Direct to CineMag mode, Abort will stop recording but the footage already recorded to the CineMag will remain in the CineMag.

The Trigger button will stop recording leaving the recorded clip in RAM. In loop mode, the “Trigger Position” set in “Cine Settings” will determine whether recording stops immediately upon triggering the camera (post trigger at 0%), or if the camera continues recording for a while. The “Post Trigger” percentage is the amount of the RAM buffer that is used to record after the trigger point.

When the camera is in Direct to CineMag mode, recording always stops immediately on triggering.

NOTE

For the most accurate triggering, we recommend using either the trigger button on the camera or an external trigger connected to the camera’s trigger port.

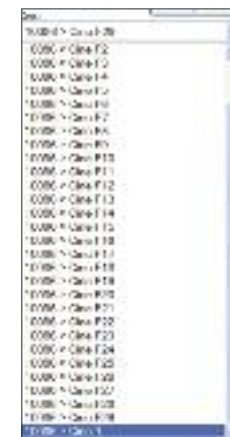
Reviewing Clips in PCC

After triggering a shot, you can review it by entering the “Play” tab in PCC.

In the Play tab, you can review any shot currently in the camera’s RAM, in an attached CineMag, or even off your computer’s hard drive.

Select a cine from the “Cine:” pull-down menu,

or open a saved cine file by choosing “Open File” from the “Cine” menu.

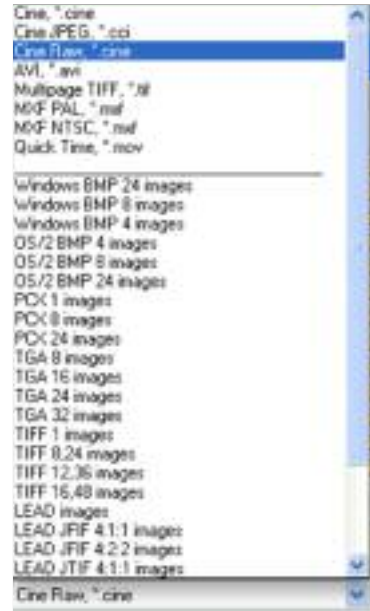


Once you are viewing a clip, you can change the viewing options with “ImageTools.” All clip metadata is visible in the “Frame Info” and “Cine Info” sections. You can scroll through individual frames of the clip using the timeline, and mark an in and out point with the “[” and “]” buttons.

After trimming a clip, you can save it to the local hard drive by clicking the “Save Cine...” button. You can save it to a CineMag by clicking the triangle on the right of the “Save Cine...” button and selecting “Save RAM Cine to Flash.”

For further instructions on working with CineMags, please read the “CineMags” chapter.

File Operations



It is possible to use the PCC software to convert cine files to a number of other formats.

A **single cine file** can be converted by opening it from the “Cine” menu, then saving it using either the “Save CineTo File” option on the “Cine” menu or clicking the “Save Cine...” button in the “Play” tab.

There is a long list of formats in the “Save as Type” selector. The formats above the separator line are clip-per-file formats (meaning the entire clip gets saved as a single file) while those below are frame-per-file formats (meaning clips get saved as frame sequences.)

NOTE

It is even possible to resave a clip in the “Cine Raw” format. This is useful for creating sub-clips with no loss in image quality or meta-data.

Saving a clip in a **clip-per-file** format is quite straightforward. Simply choose the format, navigate to a destination folder, name the clip and save.

Saving to a file sequence requires one extra step to ensure that the individual files are properly named with sequential frame numbers. When specifying the file name, add one of the following annotations to the end of the name: “!5” or “+5”.

Example: image_!5.jpg

The ‘!’ annotator will cause the software to append the cine’s image number (relative to the trigger point) to the file name. If the first frame in the clip is -

100, then the first converted frame will have the name: image_-00100.jpg. The ‘+’ annotator will add frame numbers starting from 1.

Example: image_+5.jpg

This will cause the first converted frame to have the name: image_00001.jpg.

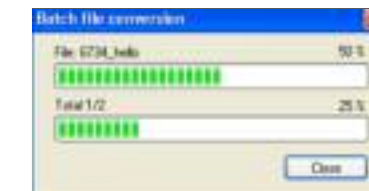
NOTE

Once clips are converted to any non-raw format, any metadata (gain, gamma, saturation, etc.) will be permanently “baked in” to the images. Before converting clips, make sure that you are applying appropriate image corrections for your use.



Batches of cine files can be converted by choosing “Batch Convert Files...” from the “Cine” menu. In the “Open Cine(s)” dialog that opens, select the clips you want to convert. Use the shift and/or control keys to select multiple files and click the “Open” button. In the “Multifile Convert Destination” dialog that follows, navigate to a destination folder and choose a file format as you would if converting a single file. Choose a file name in the same manner, but make it somewhat generic since it will apply to all of your source files.

Upon clicking the “Convert” button, a progress window will appear. Each converted clip will end up in its own folder named after the original cine file.



Using PVP



PVP (the Phantom Video Player) can be opened directly from the desk top or by clicking the “Video Out” button in the PCC software.



The video output parameters are set by opening the “Settings...” window. There the video format is set, as well as video controls such as gain, gamma and saturation.

Video playback control is performed from the main PVP window. Switch to the desired clip to view by selecting it in the “Cine:” pull-down menu. Clips from the CineMag are preceded by the letter ‘F’. To return to the live output, select “Live.”



Scrub through a clip by dragging the play head back and forth on the timeline. Use the playback controls to play forward and in reverse. Use the speed slider to change the playback speed.

You can use the “[” and “]” buttons to mark in and out points. After trimming a clip, press the “Save to Flash” button to save it to the CineMag, or “Save to File...” button to download it to the computer. The same file save dialog familiar from the PCC software will appear.

It is also possible to erase a CineMag from PVP by clicking the “Erase All...” button.



10 The CineStation

When connected to a computer running the Phantom software, a CineStation behaves almost identically to a camera, except that no capture functions will be enabled. Playing back and downloading clips from a CineMag works identically whether the CineMag is mounted on a camera or a CineStation.

The one major functional difference between a camera and CineStation is the availability of a 10G Ethernet connection on the CineStation. To establish a 10G connection between a CineStation and a computer, the devices must be put onto the same physical network, and the 10G interface of the computer must be assigned an IP address on the same subnet as the CineStation. The recommended IP address to use is 172.16.0.1 with subnet mask 255.255.0.0. The Phantom software will automatically detect the IP address of the CineStation. If you need to manually connect to the CineStation, its IP address is printed on the side of the device, label XIP.





Data or Video

11

Post Flow & File Formats

Captured images are recorded as raw files and can be output in two basic ways, as either HD Video or as native RAW files.

HD Video is available as either single link (4:2:2) or dual link (4:4:4) HD-SDI. Playback can be directly from the camera or from the CineStation.

The RAW files are recorded on the camera's internal RAM or onto a CineMag and are uncompressed. The format is a Vision Research proprietary file structure called a Cine file. These Cine files can be converted to industry standard DPX, TIFF, JPEG, DNG or CinemaDNG files with software provided by Vision Research. IRIDAS Speedgrade and FrameCycler can also convert and color correct Cine files. GlueTools Phantom CineToolkit can make Cine files available to any Mac program that uses QuickTime along with full Final Cut Pro integration. Hardware systems which support Cine files include FilmLight's Baselight and the Quantel Pablo, with others in development.

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Maintenance & Troubleshooting

There are fixed black spots on the image, particularly at small apertures.

This is caused by dust particles stuck on either the sensor surface or filter assembly. If the black spots are somewhat out of focus & do not appear to have a hard edge to them, then they are most likely on the filter assembly. You can try dislodging them with a hand blower bulb or with a cleaning swab & solution.

If the black spots look in focus & have sharp edges, then they are most likely on the sensor surface. This requires the lens mount & filter assembly to be removed. It is recommended that only qualified bench technicians do this.

There is a MAG Err 0 or MAG Err 1 showing on the video output.

Try releasing & reseating the CineMag back into place. Ensure the red latch has clicked into the lock position. If after three attempts you still see the Err warning, clean the gold contact pads on the CineMag with a Q-tip & alcohol. Also check for any damage on the pogo spring-loaded pins on the camera side.

The Phantom software is not connecting to the camera or CineStation.

First check all the Ethernet cables & connections, and then ensure the computer is seeing a connection via Ethernet. Check the IP address & subnet mask are set correctly. Also see if in the Phantom controller software that the “connect only to” box does not have any IP addresses listed.

The camera keeps switching back to LIVE mode when trying to playback via the camera controls while connected to the laptop.

If you have the Phantom Video Player software open & it's set to LIVE, this will cause the camera to switch back to LIVE mode when trying to playback. The software must be closed for playback to work from the camera controls.

There is an image from the SDI output but no image in the viewfinder.

I cannot see any on screen display from the SDI-1 output, even when I switch on the OSD.

I cannot set the maximum frame rate I'd expect to have at this resolution.

Check the video output format. The Sony viewfinder will only work with 1080i & 1080psf, not with any 720p formats.

The SDI-1 BNC connector will only output a clean signal, meaning it will not overlay any menu features on top of the video image. SDI-2 has the option to switch the menu characters on or off.

The camera could be set to R/S mode (direct recording to magazine). The Flex has the option to capture in HQ mode, which can also reduce the maximum frame rate.

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Phantom Flex FAQs

What is the resolution of the camera?

The maximum sensor resolution is 2560x1600. The record resolution is selectable for the given application, which in turn expands options on record time and frame rates. The camera uses a single CMOS sensor and a 35mm film format PL lens mount. (Other available lens mounts include Nikon & B4 using an adapter) Common resolution choices are 1920x1080 (aka 1080p) and 1280x720 (720p). Other resolutions are also available for Digital Cinema or broadcast use. The resolution is selectable in eight pixel increments for custom framing options.

The Flex can record RAW file at 2560x1440 and then output via HD-SDI at 1920x1080 without cropping the image area. This oversampling technique results in higher quality video.

What is the size of the sensor?

The full size of the sensor (2560x1600) is 25.6mm x 16mm, which is slightly larger than 3-perf Super35 film. When shooting at 2560x1440 (16:9 ratio) & using the oversampling method on the Flex, the sensor size is 25.6mm x 14.4mm. At 1920x1080 without using oversampling, the image area is 19.2mm x 10.8mm. In 1280x720, the image area used is 12.8mm x 7.2mm.

What is the fastest frame rate?

Frame rates are dependent on the choice of resolution & bit depth. At full resolution (2560x1600) in SQ mode, the max frame rate is 1455fps. In HQ mode, it is 725fps. At 1920x1080 in SQ mode, it is 2570fps. In HQ mode, it is 1275fps. The maximum frame rate when recording at 256x8 pixels, is a whopping 280,000fps! For a detailed list of all available frame rates, go to: [\(insert link\)](#)

What is the difference between HQ & SQ mode?

HQ mode is a new proprietary recording mode introduced by the Phantom Flex that greatly reduces the need for black balancing the camera, as well as increasing the signal to noise ratio of the camera. It involves reading extra

What type of shutter does the camera use, and what is a “capping shutter”?

information from the sensor between exposures, and as such imposes some limitations on the camera's settings. The maximum camera frame rate is reduced to about half of what it would be in SQ mode, and there are limitations on the minimum and maximum exposure times. It is ideal for lower frame rate shooting, especially directly to a CineMag, as it eliminates the need to stop between takes to black balance the camera.

The Phantom Flex uses an electronic Global shutter, where it captures all of the information from every photosite on the sensor at once.

The “capping shutter” is a built-in mechanical cap directly in front of the sensor used for black balancing only. When a black balance is performed (only necessary in SQ mode), the shutter automatically closes to achieve 100% darkness.

How big is the camera?

The Phantom Flex body weighs 10.5 lbs (4.5 kilograms). When a viewfinder, riser, CineMag and other standard accessories are added, the camera weighs approximately 20 lbs. The Phantom Flex body alone is approx 12” x 8” x 5.5” or 30.6cm x 20.1cm x 14.2cm (LxHxW). It is by far the smallest HD high speed camera available & can easily fit inside underwater housings, mount on Steadicams and lightweight jibs, and with its ability to frame sync can be used in motion control and 3D rigs.

How light sensitive is the camera?

The Phantom Flex is rated at approximately 1000 ISO. It has a dynamic range of exposure of approximately 11 stops.

How much power does the camera use?

The camera runs natively on 20-36V DC with an ideal voltage being 24V or 28.8V, which is common to many battery packs. Power draw is approx 100 watts when in standby mode & up to 150 watts when recording directly to a CineMag.

How long can it shoot?

The most common versions of the Phantom Flex are equipped with 32G of internal RAM. Runtime is determined by resolution, as a given resolution will

How can I view the shot?

yield a given number of frames that will fill this memory. So at 2560x1440 in HQ mode, the memory can hold 3076 frames, which translates to 4.2 seconds when shooting at 725fps (max frame rate). Played back at 30p (common for NTSC video use) this translates to 102 seconds of material. At 24p, this would be 128 seconds of material. In SQ mode at 2560x1440, the memory can hold 6214 frames.

16G internal RAM is also available as an option. If the Phantom Flex you are using is a 16G model, the frame and time length capabilities described above would be halved. Longer shots can be achieved by recording directly to a CineMag (see below).

For a complete list of memory capacity & frame rates for RAM & CineMags, please use the link below:

<http://www.visionresearch.com/Tools/TimeCalc/>

The Phantom Flex has an HD-SDI port, which can feed directly to a standard HD field monitor. It also has an analog output for use with most Sony or Panasonic HD color & mono viewfinders. Material is immediately available for playback at selectable frame rates with no additional rendering or processing delay. Shots in the camera's internal memory or saved to a CineMag (see below) are available for immediate playback.

What do I do with the material once it is captured on the camera?

Captured material can leave the camera in three ways. The camera has two HD-SDI ports (single wire, 4:2:2 & dual-link 4:4:4), which can be used to feed directly to an HD deck in a variety of formats. Using the laptop computer controller or on-board camera controls, some basic color correction can be performed on the image output over the HD-SDI. Downloading in this manner is in real-time, so a full file of 2560x1440 material played at 1080/30p would take 102 seconds.

The second way to output material is by direct data transfer. The camera captures in Uncompressed RAW, which is considerably more information than any video format can handle. This is excellent for complicated post-grading and effect work and offers the richest material for Digital Cinema production.

What are the CineMag and CineStation?

To copy this material, the files are downloaded from the camera's internal RAM via Gigabit Ethernet through the laptop computer controller to a hard drive. Downloading Uncompressed RAW is not a real-time operation; it takes more than 10 min to transfer the entire memory buffer from the camera. However, there are ways to make this process more efficient (see below). The third & most common method is to transfer data to a CineMag, a portable flash memory device that clips to the top of the Phantom Flex. A 32G RAM memory in the camera takes just 30 seconds to transfer to the CineMag, which can then be downloaded later. The CineMag is available in 128G, 256G and 512G models. The CineMag stores or "packs" data differently from the internal RAM using a 10-bit Log structure rather than a 12-bit Lin one. By doing this, a 512G CineMag can hold 76 minutes of 2560x1440 footage when played back at 24fps. The CineMag can be later downloaded using the camera or through a CineStation docking station. When downloaded and returned to Linear files, the RAW material will unpack to approximately 850G, so Abel suggests planning to use a one terabyte hard drive for each 512G CineMag of footage. For more on the CineMag and CineStation, see below.

The Phantom is limited by its internal RAM recording capabilities, but it is also able to record to 128G, 256G and 512G capacity CineMags, which are interchangeable flash-based memory magazines that clip to the top of the camera. The 512G CineMag can record up to 76 minutes of Uncompressed RAW footage at 24fps (2560x1440). There are two ways to work with the CineMags. One can record directly to them, but the capture speed capability is less than that of the internal memory, so the top frame rate at 2560x1440 is 222fps. It takes approximately 8 minutes to fill an entire 512G CineMag at this resolution and frame rate.

The CineMag fills its memory sequentially, so a shot cannot be "thrown away." Instead the entire CineMag must be cleared all at once, akin to exposing a roll of film. The other method is to capture to the Phantom's internal RAM and then transfer to the CineMag. One advantage to this is that

the shot can be trimmed quickly and easily at the camera before transfer. Even if an entire 32G shot is transferred, this process only takes 30 seconds to complete. This is by far the most efficient system for shooting, as bad takes need not be saved and only the valuable parts of good takes are saved, saving both time and memory space.

The CineStation is a downloading dock for the CineMags. The Flex camera can be used to download the files, however it is limited to Gigabit Ethernet speed, and this also ties up the camera. The standard CineStation has component HD, single link 4:2:2 HD-SDI & dual-link 4:4:4 HD-SDI outputs, as well as Gigabit Ethernet connectivity. An optional module upgrades the CineStation to 10 Gigabit Ethernet (10GE) output. With a standard laptop computer and a reasonably fast portable hard drive, a 512G CineMag will download over Gigabit Ethernet in approximately seven hours. Using a 10GE CineStation with an optimized workstation and hard drive array that same 512G CineMag can download in about one hour (depending on other conditions).

Using a pair of CineMags and a CineStation, the Phantom Flex can be used in a style similar to a standard production film camera. One need not fill an entire CineMag before downloading it. To limit the amount of downloading needed at the end of the production day, a few shots may be captured to a CineMag, before swapping it with another CineMag on the Phantom. The first CineMag may then be downloaded at the CineStation.

All cameras come with Vision Research's Phantom software (PC only), which can convert RAW files to DPX, TIFF, JPEG, or DNG or formats. This software is free to use.

Glutools Phantom CineToolkit (Mac only) is a QuickTime plug-in which allows CINE files to be used natively by Compressor or Final Cut. Glutools also has a product called Cineon/DPX Pro which, together with the Phantom Cine toolkit will convert RAW files in compressor to DPX.

What do I do with the Uncompressed RAW files?

Sensor Cleaning

IRIDAS Speedgrade or FrameCycler, Quantel Pablo & Baselight (FilmLight) also have support for Phantom RAW files.

The sensor on the Phantom Flex is a very expensive item. We do not recommend cleaning it without special tools and training. If any dust should land on the surface of the sensor, it can be blown off using a hand-squeezing bulb syringe. Never use compressed air, lens cleaning fluid or lens cleaning cloths on a sensor.

Lighting for High-Speed

Lighting issues are not specific for the Phantom cameras but for high frame rate photography in general. Even with the great sensitivity of modern cameras, be prepared to use a considerable amount of light, the Phantom Flex, however, has made this easier with its sensitivity of 1000ISO. Beyond illumination, the largest issue in high-speed lighting is flicker. Tungsten lights actually have a flicker rate. When powered by alternating current (AC) electricity, the power cycles 50 or 60 times per second (depending on the country and its power system). During the down cycle the tungsten lamp filament can dim slightly, causing flicker. The amount of dimming is related to the type of bulb, wattage and physical size of filament. In general, we have found that lamps larger than 2000 watts use tungsten filaments so large that they do not have time to cool and dim before the power cycles back up. Therefore, we recommend using 2K or greater tungsten light fixtures when shooting above 120fps in 60hz countries and 5K or greater when shooting above 100fps in 50hz countries.

Be aware that a unit such as a nine-light is NOT a large fixture but is actually an array of smaller lights and as such can flicker. Some additional recommendations are to use DC power for tungsten lights, which eliminates flicker entirely. HMI and fluorescent lights are generally fine for speeds under 120fps, as long as they use electronic ballasts. Magnetic ballasts should not be used. HMI lights can suffer from "arc wander," whereby a plasmatic "hot spot" can move about within the bulb, causing an amorphous shifting movement in the

light output. LED lights are subject to the electronic circuits driving them which can create a vast array of refresh rates, but generally we have found that LED fixtures designed for the production community will not flicker as long as they are not dimmed.

Finally, the shutter angle on the Phantom can affect flicker as well, since a greater shutter angle allows for a longer response time from the light. When shooting extremely high frame rates, it may no longer be necessary to retain a 180-degree shutter to capture the motion generally preferred for a filmic look. A 360-degree shutter allows both more light sensitivity and reduced flicker possibilities.

For further technical questions, feel free to contact Sean Coles in AbelCineTech's Los Angeles office at scoles@abelcine.com or Jamie Alac in their New York office at jamie@abelcine.com.

