PCC 3.9 Software User Manual

Phantom Camera Control (PCC) Version 3.9.805

4/19/2024

100 Dey Rd. Wayne, NJ 07470, USA | Tel: +1 973.696.4500

Table of Contents

What's New in PCC Version 3.9

1 What's New in PCC Version 3.9

This section outlines the new features and changes in PCC (Phantom Camera Control) Version 3.9, which has the look and feel of previous versions.

1.1 PCC 3.9 Release Notes

PCC Version 3.9 Changes

New Features & Enhancements

- A new image processing control has been added called "Bit Slider". This control is located in the Image Tools menu, at the top of the other adjustments, and allows fine control over the shadows and highlights by adjusting the black and white clip points of the image. After adjustment the image will have higher contrast, and a reduced number of detectable gray levels (which is a value shown on the slider bar).
  - Bit Slider replaces the control labeled "Sensitivity". Cine files that had the Sensitivity adjusted from an earlier version of PCC will still open with the adjustment in place, however any new adjustments from the Bit Slider will override the previous Sensitivity setting.
- File conversion (.mp4): The speed of conversion from the Cine file format to MP4 has been significantly improved - by 5X on average. The speed increase varies based on factors such as original file size, image resolution, color interpolation, and image source location. The resulting file size and bitrate of the .mp4 files will vary slightly between 3.8 and 3.9 due to the new method.
  - A control to enable the 'legacy' encoder is available in the advanced options of the MP4 conversion menu, for any potential situations that benefit from the 'old way'.
- New MME file export: During file save or conversion a MME 13499 file, in accordance with ISO 13499 standard, can be exported to provide metadata for particular 3rd party programs used for image analysis. MME files are saved with a .mii file extension and are formatted according to the standard.

PCC Program Changes

- PCC 3.9 has been updated to use Camera Configuration files to incorporate new features, particularly for future camera models. At the time of release there are no Configuration files distributed with the PCC installation, however the menu is now available to manually install these files when they become available.The interface is located in Nucleus.

Notable Fixes

- N/A

1.2 PCC Release Note Archive

Summary of the significant changes in each release of PCC starting with Version 3.0, to be used as a reference.

PCC 3.8 Changes

- New camera support: TE2010, T4040, T2540
- Added new feature to import a DAQ data file (CSV) and match it with a previously recorded Cine file.
- A separate installation of Microsoft .net framework is no longer needed
- Bug Fixes
  - Bug with Visible Cameras list has been corrected (Preferences menu / Camera tab). The bug was that a connected camera was seen as offline when entered in the 'visible" list.
  - When converting AVI files, the playback frame rate is now persistent (does not have to be set separately for every file)
  - Removed the 'PIV-mode' (aka 'shutter-off') option for cameras that do not support this feature

PCC 3.7 Changes

- New camera support: Miro C321, C211, VEO 610
- Translations updates for Spanish and Japanese, and added all-new Chinese (Simplified Chinese) language option
- Added zoom function for playback bar
- New Current Session Reference (CSR) features to set new CSR default for Miro C321 and other cameras without mechanical shutter. Applicable for current settings and works at camera's max resolution only. These functions are hidden by default and can be enabled in the User Configuration Manager by enabling "CSR options with right-click".
- Updates to User Configuration Manager including:
  - New function to assign and display what settings apply to groups, when cameras are group-locked
  - Add ability to change default white balance
  - Add ability to enable/disable top menu bar items
  - Add ability to choose to maintain current settings after mode switch
- Group lock improvements including:
  - Programmable I/O settings apply to group
  - Remove warning to cover cameras with a shutter
  - Make active camera more obvious by displaying camera name and allow user to choose border color for selected camera
- Program change: No more 32-bit installer included. Contact us if you still require a 32-bit version of PCC
- Bug fixes
  - Image correction for T1340, v1840, v2640 color cameras: When there is a bright flash or light source causing a flare these color cameras can show a slight grid or maze pattern. This version adds an option to correct for this artifact when converting the Cine to Cine RGB TIFF and AVI formats. Enable the correction in the save dialogue advanced settings
  - Binned mode tone curve no longer applies when a compatible camera switches to Binned mode
  - Direct record to CineMag can no longer be disabled when a Cine is still recording
  - Loading user profile from file now works with standard and binned modes

- Restart recording can be enabled for auto-save to flash and auto-play over video. It can not be enabled without choosing one of those auto- settings first.
- When using multiple cameras with group-lock only future changes apply to all cameras in the group

PCC 3.6 Changes

- New camera support: TMX 7510, 6410, 5010, T3610 & T2410
- User Configuration Manager introduced (customize the visible functions and defaults in PCC)
- Other new features in 3.6:
  - Focus Assist feature; controls to enable/disable OCC interface; Status for Quiet fans; Status for Auto Exposure; Controls for crosshair over video;
- Bug fixes
  - Restart Recording now limited to when auto-save is selected; continuous recording destination improvements and ability to save 8 bit files; border data improvements; Graphics Button display issue resolved; decimation save update allowing exact mark-in frame to be selected
- Program changes:
  - Documentation overhaul, consolidating all software documentation into one file
  - No more Phantom Multicam program distribution. Archived version still available upon request

PCC 3.5 Changes

- New camera support: T-1340, VEO 1310 & 1010
- Automatic File Naming introduced
- Synchronous Snapshot menu introduced
- Border Data: Timestamp display changes
- Nucleus: Updates to Firmware update and support functions
- Live display of the active refresh rate
- Timecode displays on the image window
- Simulated camera menu updates
- File conversion to AVI now includes cancel button

PCC 3.4 Changes

- New camera support: Miro C320, C320J
- Addition of NetConfig Utility
- DHCP Feature support
- Lens data support for the Canon CN20X50
- Silent Install support for PCC and associated programs
- Battery check function to apply local time to cameras with dead coin battery
- Bug fix for saving 8-bit Cines over 10Gb Ethernet

PCC 3.3 Changes

- New Camera Support: v2640, v1840, VEO4K-L, VEO-E310 and E340, 8TB CineMag V
- Addition of the P12L Cine file format (P12L requires minimum firmware phfw.112)
- Addition of Persistent Trigger Position in preferences

PCC 3.0 Changes

- New Camera Support: VEO4K, Flex4K-GS, Miro N5 & N-JB
- Nucleus: Added diagnostics & utility functionality
- Added Exposure Index functionality
- High-Voltage Trigger support, selectable in Signals menu
- Camera Enumeration implementation for improved multi-camera operation
- Continuous Recording mode remains active after reboot
- Multi-Cine trigger functionality improved to apply trigger when the signal falls in between segments (requires minimum phfw.100)

Overview

2 Overview

Phantom high-speed cameras are typically controlled with PCC software through a dedicated Ethernet network on a laptop or PC.

This Help file is intended to reduce the PCC learning curve and get you up and running with a new Phantom camera quickly. The document has been designed to be used on-screen. It is cross-linked so you can find more relevant information about the current topic. If you prefer reading printed manuals, you can print this PDF file, but you will probably find that the active hyperlinks, and cross-references make the on-screen version of the help more useful.

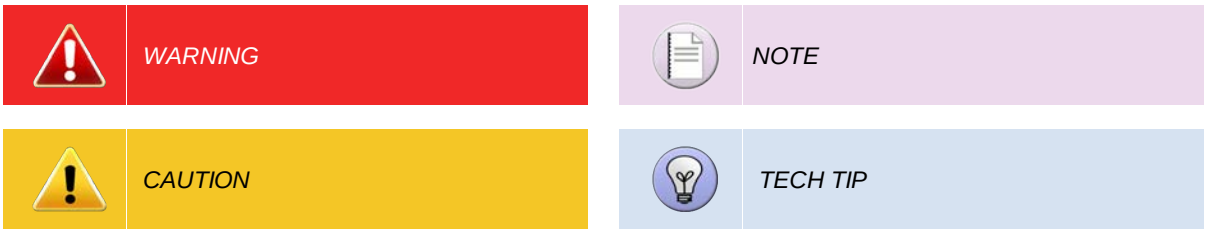
Download the latest version of PCC:
www.phantomhighspeed.com/pcc

To take advantage of camera control options outside of PCC, an SDK is available that supports C/C++, C#, MATLAB, LabView and Python 3.11. Contact Vision Research support to request the SDK.

2.1 Legends

2.1.1 PCC Help Legends

Look for the following symbols throughout this document to call out a warning, caution, note or tech tip relating to the current topic.



2.1.2 Camera Legends

Phantom cameras can be categorized as having ph16 (current) or ph7 (legacy) firmware. The 'ph' version refers to the operating protocol of the camera. Certain features in the camera may be specific to (or limited by) one of the versions, as described throughout this document.

ph16fw Cameras

- TMX-Series (TMX 7510, 6410)
- T-Series
- UltraHigh-Speed (vXX1X, vXX40)
- VEO Series
- Flex4K, Flex4K-GS
- Miro Midsize (Miro LC M, Lab, R)
- Miro C and N

ph7fw Cameras

- Legacy v-Series (vXXX, v10, vX.X)
- Legacy Miro (Miro3, EX, Miro AO)
- Flex (Flex2K)
- HD, P65

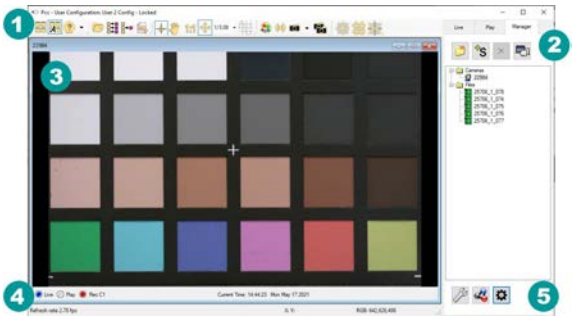
2.2 Recommended PC Configuration

For best performance, Vision Research recommends a system with the following minimum configuration.

	REQUIREMENTS
SYSTEM TYPE	Windows PC
OPERATING SYSTEM	Microsoft Windows 10 or 11, 64-bit
RAM MEMORY	8 GB Minimum
HARD DRIVE SIZE	Recommended to use NVMe SSD, 512 GB Minimum
ETHERNET	Gigabit Ethernet with Jumbo Frame support. If 10Gb Ethernet is to be used with a laptop, a Thunderbolt port with compatible 10Gb-Thunderbolt adapter is required.
REQUIRED SOFTWARE	Microsoft .Net Framework 3.5

2.3 PCC Interface Components

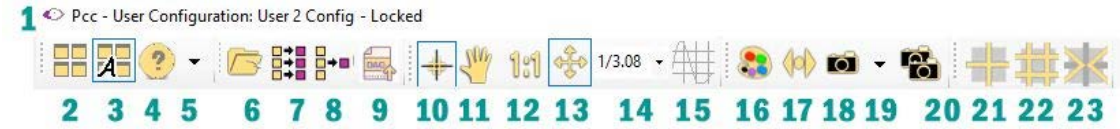
PCC software is a multi-layered program that includes the following work areas:



1. Toolbar
2. Control Tabs (Live, Play, Manager)
3. Image Preview / Playback Panel
4. Status Information
5. Program Preferences and Utilities

2.3.1 1. Toolbar

Toolbar buttons provide quick access to the most frequently used functions. Positioning the cursor over a Toolbar button displays the button's function. The availability of these buttons are dependent upon the active control panel.



1 **Title Bar** - Displays the current User Configuration profile as loaded by the PCC Configuration Manager. (new in PCC 3.6)

2 **Window Tile** - Instructs PCC to align all open panels side-by-side. This can be extremely useful when comparing Cine / image files, and judging the effectiveness of various image-processing techniques.

3 **Window Auto Tile** - Instructs PCC to automatically display any newly opened 'Preview / Play' panel side-by-side (tiled), along with any previously opened display panel.

4 **Help** - Open a copy of this .pdf help file.

5 **Help and About Pull-Down List** - PCC help is another way to access the .pdf help file. 'About' displays detailed version information of the PCC installation.

6 **Open File** - Opens a previously saved Cine file in the Play panel, and adds it under the 'Files' group in the 'Manager' tab.

7 **Batch Convert Files** - Select and convert a single or multiple Cine files to any 'supported file format'.

8 **Merge Images to Cine** - Import and convert a series of images (such as .tif, .bmp, etc.) to the Phantom Cine format. Useful to combine frames from multiple cameras or to edit and re-combine certain frames. This function works with files that have been converted from Phantom Cine files, and by including the .chd file that automatically gets saved with a file conversion, the metadata of the Cine is restored.

9 **DAQ Data Import Feature** (new PCC 3.8) - Import DAQ data from a formatted .CSV file, allowing the visualization of DAQ signal data with saved Cine images even when the data was not recorded by PCC

10 **Cursor** - Instructs PCC to use a 32 x 32 pixel 'cross-hair' cursor within the live display.

11 **Pan** - Instructs PCC to use a 'hand' cursor to quickly pan images larger than the display area by holding the mouse down and moving the cursor (image moves (pans) in same direction).

12 **Zoom Actual Size** - Sizes the displayed images to their recorded resolution, or a 1:1 pixel display ratio.

13 **Zoom Fit** - Resizes the displayed images to fit within the active image display window by digitally zooming in or out.

14 **Zoom** - Specify the digital zoom ratio between a minimum size of 1/16:1 to 16:1.The pull-down arrow provides common zoom levels within this range.

15 **Graphics** - Open a graphical display to the right of the playback panel for use with recorded or saved Cine files. This displays DAQ signals and/or tracking data of x, y coordinates present in the .Cine. The displayed values take into account the global measurement preferences for position / speed / acceleration.

16 **Image Tools** - Provides extensive controls over the look of the image, from color and contrast settings, to image orientation and crop settings; see Optimize Images (Image Processing)' for details on the supported 'Image Tools'.

17 **Video Out** - Opens the Phantom Video Player (PVP) application which controls only the camera's video outputs (HD-SDI and HDMI) as connected to a compatible monitor.

18 **SnapShot** - Instructs PCC to take a 'snapshot' of the active 'Preview/ Play' panel image and save to the location specified in the 'SnapShot File Name' pull-down to the right.

19 **SnapShot and AutoName Pull-down** - Provides options to locate the snapshot images, clean and organize the folder. Also used to set auto-name settings for Sync Snapshot and Continuous Recording features.

20 **Synchronous 'Sync' Snapshot** - Menu that, when open, saves synchronized still images from a series of cameras with each hardware trigger. This function is used to collect stereo calibration images for 3D measurements, ideal for 3D point tracking, digital image correlation (DIC), and/or particle image velocimetry (PIV).

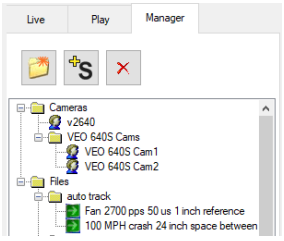
21 **CrossHair** - overlays a 'cross-hair' in the center of the image (not recorded with the image data).

22 **Grid Display** - overlays a 'grid' pattern over the image (not recorded with the image data).

23 **Focus Assist** - Applies an edge filter to the live image to clearly indicate when a detailed area of the live image is in focus. Only applicable for images from a live camera. (new in PCC 3.6)

2.3.2 2. Control Tabs

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



Manager - When PCC is first opened, the 'Manager' tab is selected. This is where:

a. connected cameras are displayed, grouped / ungrouped, selected for use.

b. connected cameras can be renamed.

c. saved Cine files can be selected, grouped and removed from the file list.

d. simulated cameras can be added for use when a Phantom camera is not present.

e. access to 'Application Preferences', the User Configuration Manager, and the 'Camera Repair and Upgrade (Nucleus)' application.

Live - All camera control and setting of capture parameters (frame rate, exposure time, etc.) is performed in the 'Live' tab.

Play - Used to review, edit, and save Cine files (either from the camera or from files on a local hard drive).

2.3.3 3. Preview / Play Panels

The Preview Panel displays exactly what the Phantom camera(s) are imaging, while the Playback Panel displays recorded Cine files for review and / or editing, saving, and / or analysis.

The panel type displayed varies based on the active 'control tab' as follows:

Live Tab

a. Also referred to as the 'Active Cine Window', the Preview Panel is the display from one or multiple connected Phantom cameras.

b. In addition to displaying the live images, each active Preview Panel also allows the user to perform automatic White Balance for color cameras and define an area (region of interest) when using the 'Auto Exposure', 'Image-Based Auto-Trigger', and / or 'Crop' features.

c. Each Panel is labeled with the active camera name (top) and its time code (bottom).

Play Tab

a. When the Play Tab is selected the Playback Panel is primarily used for Cine review and editing.

b. Multiple Playback Panels can be opened at once. One panel for each recorded Cine in camera RAM, Phantom CineMag, Flash card or previously saved Cine file.

c. The Playback Panel can also display 2D motion analysis as defined by the measurements and graphing function, and can allow the definition of an area (region of interest) when using the 'Crop' feature.

d. Each Panel is labeled with the current Camera name/Cine number or File name (top) and its time code (bottom).

Manager Tab

a. Displays a list of all connected Phantom cameras, as well as Cine files from the camera or files that were recently viewed for easy access.

b. Preview and Playback Panels can be displayed when the 'Manager' tab is active. In single camera environments, the Preview Panel of the connected camera can be displayed, and / or the user can open a Cine file stored in camera memory, in the attached Phantom CineMag and / or previously recorded Cine files each in their own independent Playback Panel.

c. Each of these panels can be viewed separately or simultaneously by selecting the 'Tile' button from the Toolbar.

2.3.4 4. Status Bars

PCC Status Bar - (located at the bottom of the interface) displays the following status information:

a. **Refresh Rate:** Indicates the actual refresh rate for playback of the live images.

A low refresh rate can explain choppy playback. Resolutions greater than 1Mpx, color cameras, multiple live preview images are all items that can lower the refresh rate.

b. **XY:** - Indicates (X,Y) coordinate of the pixel in the center of the 'cross-hair' cursor when placed over the active Preview / Playback panel image. The pixel in the upper left corner is pixel (1,1). The X-coordinate = column, while the Y-coordinate = row. When performing 'Coordinate' measurements, PCC will display the coordinates in a user-specified unit.

c. **RGB:** (Red, Green, Blue) indicates the color values of the pixel in the center of the 'cross-hair' cursor. The values are dependent on the pixel image bit-depth, the color interpolation algorithm, and the user-specified 'Pixel values' range in the 'Application Preference > General' window.

d. The following table represents the maximum values based on the pixel's bit-depth.

COLOR VALUE	PIXEL BIT-DEPTH	COLOR VALUE	PIXEL BIT-DEPTH
255	8-bit	4095	12-bit
1023	10-bit	16383	14-bit

e. **Lost Frame** - displays the 'Image number' of the frame(s) / image(s) containing lost track points when the 'Auto-tracking' feature is applied.

f. **Save / Conversion Progress Indicator**

Preview / Play Panel Status Bar - type of status indicators displayed varies based on the operational state of the camera, as follows:

INDICATOR	COLOR	DESCRIPTION
Live	Blue	Indicates the Preview Panel is displaying live images.
Rec	Red	Indicates the camera is displaying live images while recording image data to the camera's RAM. It deactivates when a trigger signal is detected and all the post trigger frames have been recorded. When recording post-trigger frames the indicator flashes.

Play	Green	Displayed when the Cine file (from RAM or elsewhere) is being played.

2.3.5 5. Preferences and Utilities

The manager tab includes three important sub-programs for the PCC interface:

1. **Application Preferences**

   This program allows for universal user settings to be applied such as exposure unit display, background color, bit depth display and language preferences.

2. **Nucleus (Camera Repair and Firmware Upgrade)**

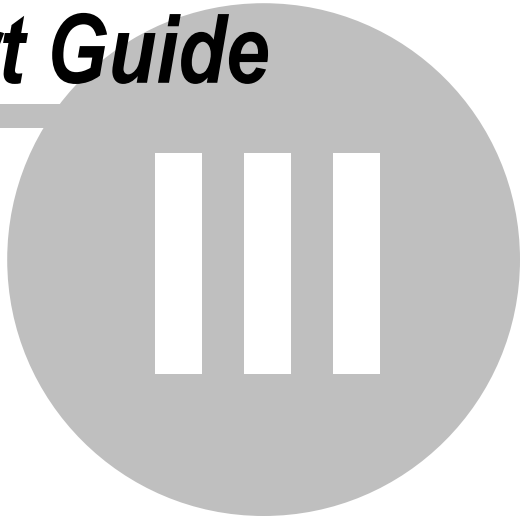
   This program allows the current firmware details to be displayed, and the latest camera firmware (downloaded from the Phantom Customer Community website) to be installed.

   Troubleshooting functions including the reloading of Factory defaults and formatting of flash memory are also accessed using this program.

3. **PCC Configuration Manager**

   New in PCC 3.6, the Configuration Manager allows a profile (or multiple profiles) to be configured to tailor the PCC menu display to the application needs. Hide or disable functions that you do not want to access. Unique PCC defaults can also be set for each profile.

Network Setup & Quickstart Guide



3 Network Setup & Quickstart Guide

The topics in this section provide recommendations and instructions for when:

1. Installing PCC software for the first time or on a brand new computer.
2. Upgrading to a new PCC software version.

3.1 PCC Software Installation

PCC 3.9 has been tested with the Microsoft Windows 10 64-Bit operating system. The installation requires Administrator Rights, and the Ethernet connection requires the Windows Firewall to be disabled.

STEP-BY-STEP PROCEDURES

1. **Locate the PCC Installer**
   - **a.** Download the latest software package from the phantomhighspeed.com/pcc website and extract the contents.
   - **b.** Alternatively, insert the PCC Installation disk into the media drive. If installer fails to start automatically, navigate to the drive containing the PCC Installation disk.
2. Select the executable **'PCC_3.9_MainMenu.exe'**

3. **Select Option to Install -** click 'Install' / 'View' / 'Browse' depending on selection.
   a. **PCC Installation** - installs Phantom Camera Control (PCC), Phantom CineViewer (CV), Phantom Video Player (PVP), and the Ph10G Driver (selected during install process), and all associated help documentation.

b. **CV Installation** - installs Phantom CineViewer (CV) software only. CV is for working with Cine files, and does not include the control features in the full PCC software.

c. **Ph10G Driver Installation** - installs Phantom 10G driver only. This option should only be used if the 10G driver failed to install correctly using the PCC Installation process.

d. **View Quick Start Guides** - opens a pdf copy of the Quick Start Guide included in this document.

e. **View Help File** - opens a copy of this pdf file.

f. **View Release Notes** - opens a pdf copy of the 'Release Notes' with a summary of the new features and fixes in this version of PCC.

g. **Browse Disk Contents** - View the content of the install disc in the Windows File Browser.

4. Define Destination Folders

a. **PCC Destination** - By default the software will be installed to the C:\Program Files\Phantom folder. If you prefer a different location, click browse and navigate to the desired location.

b. **Archive Destination Folder** - Enabling the Archive Current Version option copies the content of the current Phantom folder to a Phantom Archive folder, allowing for previous version of PCC to be saved on the control computer.

5. 10Gb Ethernet Driver Installation - This is only required if a 10Gb Ethernet connection is to be used between a Phantom camera or CineStation and the control computer.

6. Close Setup, and Exit the Installer

3.2 Network Setup for a Gigabit and 10Gb Camera Network

Connecting the camera using Ethernet requires the computer's Network adapter to detect the IP address range of Phantom cameras.

a. For Gigabit Ethernet the IP range always starts with 100.100...

i. Cameras supporting DHCP do not require a dedicated fixed 100.100 IP address when using a DHCP router between the computer and the camera. This is because the camera's secondary IP gets assigned by the router whenever a connection is established. More on this in the DHCP section.

b. For 10Gb Ethernet the IP range always starts with 172.16...

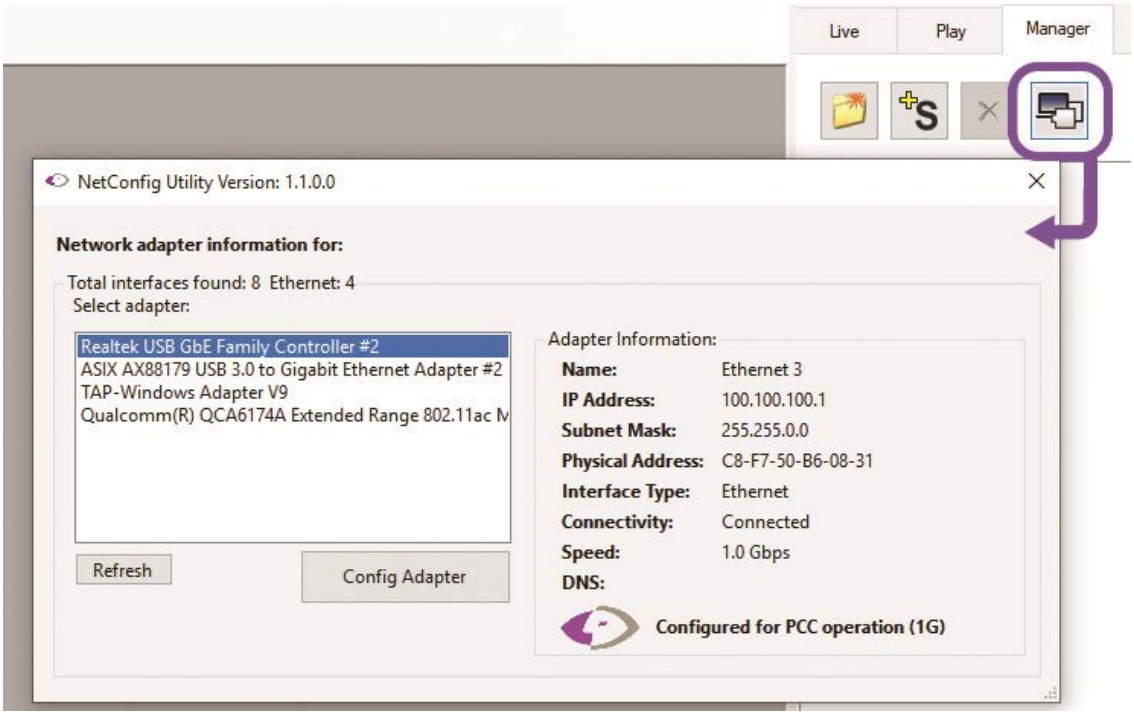
c. In both cases the Subnet mask of the camera is set to 255.255.0.0

The IP address that is assigned to the Network adapter must not be identical to the factory-assigned IP address of the camera or any devices on the network.

Example: If you are assigning a Gigabit Ethernet address and the camera's assigned IP is 100.100.56.789, the Network Adapter can be set to 100.100.100.1, with a Subnet mask of 255.255.0.0. This will instruct all cameras with an IP address beginning with 100.100 and a Subnet of 255.255.0.0 to be visible to PCC.

3.2.1 Network Setup with the PCC NetConfig Utility

PCC software includes a Network Configuration Utility which will launch automatically after the software is first installed, or it can be later launched from the PCC program itself.



The NetConfig Ultility will show all network interfaces currently installed in the PC.

1. Identify the one that will be physically connected to the camera (this process can be done with or without a camera connected at the time).

2. Click 'Config Adapter', and the utility will automatically adjust the IP Address and Subnet to the first one available within the 100.100 network that all Phantom cameras are pre-configured to work with.

3. Once configured, the **Phantom logo** will appear on the lower right with the "**Configured for PCC operation**" message.

Optional: Manually assign a GigE Camera Network

a. Alternatively, In the Windows 'Network and Sharing Center,' select the camera network. Change the Ethernet IP settings by selecting 'Properties,' then 'TCP/IPv4' 'Properties,' Select 'Use the following IP address.'

b. Enter IP address 100.100.100.1 and Subnet 255.255.0.0. Other settings should be blank.

3.2.1.1 Configure a 10Gb Ethernet Camera Network

Some Phantom cameras are configured with 10Gb Ethernet (10Gbase-T), in addition to the standard Gigabit Ethernet. 10Gb Ethernet allows for a much faster connection which results in a faster refresh rate and faster download of Cine files from RAM.

Cameras that support 10Gb Ethernet sometimes have a separate dedicated port, which makes it easy to decide whether you are using Gigabit or 10Gb Ethernet. UHS models and the CineStation IV have this dedicated port. However, others use a single port for both connections. This technology is known as "auto-negotiating" because it will decide whether to use the Gigabit or 10Gb Ethernet protocol based on how the network adapter is configured.

10Gb Ethernet is optional in several Phantom cameras including VEO and T-Series. Check if your camera supports this by looking at the printed IP label on the back of your camera. If the label says '10G' or if an 'XIP' is listed, this means your camera supports 10Gb Ethernet.

STEP-BY-STEP PROCEDURES

1. Identify Network Adapter

a. Identify a 10GBase-T network card or adapter for the computer. For desktop (tower) PCs, Vision Research specifically recommends Intel PCIe cards. Laptop computers must have a Thunderbolt port (see note) available in order to use one of the Thunderbolt 10GBase-T converters on the market. At the time of writing, confirmed compatible Thunderbolt 3 adapters are: OWC Part # OWCTB3ADP10GBE and StarTech Part # TB310G

Working with 10Gb Ethernet on a laptop is possible with a Thunderbolt port. A common mistake is that USB-C is mistaken for Thunderbolt-3, because they both use the same physical port. Thunderbolt ports have a lightning bolt graphic to distinguish them.

Additionally, it is recommended for the PC to have a 1TB or greater NVME SSD hard drive as the save location for the best performance.

2. Install Device Driver

a. The camera and network adapter, if applicable, should be powered on and connected during the driver installation.

b. Install the latest device driver from the manufacturer's website, then reboot the PC.A new, unidentified network should now be available, visible in the NetConfig utility or in the Windows 'Network and Sharing Center.'

3. Install PCC with 10Gb Phantom Driver

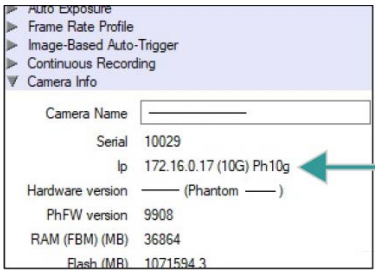
a. The latest version of PCC software should be installed from the disk that came with the camera or by running setup.exe within the package downloaded from the website.

b. Click through the prompts, and be careful to click 'YES' when the program prompts you to install the 10 Gigabit Ethernet Driver. The PCC installer also allows for the Phantom 10G driver to be installed on its own, without re-installing PCC.

4. Assigning the 10Gb Camera Network

a. The camera should be powered on and physically connected to the 10Gb network card or Thunderbolt adapter.

b. The 10Gb Ethernet network needs to be assigned to the 172.16 IP range. Use the **Phantom NetConfig Utility** as described in the previous section to detect the new network and assign the 10Gb IP address automatically.



Confirm that 10Gb Ethernet is in use by looking at the 'Camera Info' in the Live tab.

PCC will display the IP address in use, followed by '(10G) Ph10g' when both the 10Gb network is assigned and 10Gb driver is installed and operational.

Optional: Manually assign the 10Gb Ethernet Network

a. Alternatively, In the Windows ‘Network and Sharing Center,’ select the camera network. Change the Ethernet IP settings by selecting ‘Properties,’ then ‘TCP/IPv4’ ‘Properties,’ Select ‘Use the following IP address.’

b. Enter IP address: 172.16.0.1 and Subnet 255.255.0.0. Other settings should be blank.

3.2.2 DHCP (Dynamic Host Configuration Protocol)

Phantom cameras that support DHCP allow control devices to connect using a DHCP router which dynamically assigns the camera an IP address, instead of connecting to a dedicated 100.100 IP (or an assigned secondary IP) network.

By default, supporting cameras have this featured enabled. In the event it is disabled, a dedicated 100.100 network must be used to initially connect to the camera.

1. Once connected, open the 'Nucleus (Camera Repair and Upgrade)' program from the Manager Tab.
2. Select the camera from the 'Camera' selection list.
3. From the 'IP Address' tab, enable the 'Obtain an IP address automatically' feature, then click the 'Set' button.
4. Re-boot the camera.

DHCP is used with a Gigabit Ethernet connection only, it is not supported with the camera's 10Gb Ethernet network.

3.3 Quickstart Guide

Following the network setup, these steps will guide you through a simple capture and save process.

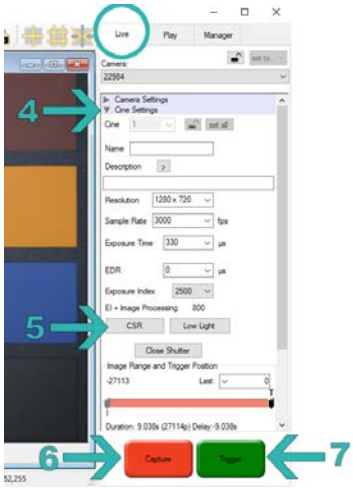
STEP-BY-STEP PROCEDURES

1. **Power on camera and connect Ethernet cable**
   - **a.** Connect the camera’s dedicated power supply to the Primary DC input. The camera is ready for operation when the red capture light and/or the red Trigger button is illuminated.
   - **b.** Connect the Ethernet cable from camera to the configured network port of the PC.
2. **Launch PCC software**
   - **a.** Double-click the PCC icon located on the desktop.
   - **b.** The first time a new version of PCC is initiated, the End User License Agreement (EULA) must be accepted. Read through, scroll to the bottom and hit 'Accept'.
   - **c.** The camera will be recognized immediately if connected and the network settings are correct.

3. Select camera for use

a. In the ‘Manager’ tab, select the Phantom camera to be used from the ‘Cameras’ group folder and then click the ‘Live’ tab.

4. Define recording parameters



a. Click ‘Cine Settings’ and define the following parameters by either selecting the value from the pull-down selection list or typing a value into the respective data entry field.

b. Set ‘Resolution’ to the required Width x Height.

c. Choose the required ‘Sample Rate,’ and ‘Exposure Time’

d. Set ‘Post Trigger’ to zero (0) by moving the ‘T’ (Trigger Position) slider to the right, or enter zero (0) into the ‘Last’ data entry field.

e. Click the ‘CSR‘ button to perform a Current Session Reference. A CSR is a black reference for that session. It is required before capturing the first cine or after changing any recording parameters.

f. Color cameras only: Perform a White Balance by right-clicking an area of the live image that is neutral gray or white, as long as it is not fully saturated.

5. Fine-tune settings

a. After CSR and White Balance are performed, adjust settings, aperture and/or lighting to get a good exposure. A CSR must be performed after any camera settings are adjusted.

6. ‘Arm’ camera

a. If the camera is capturing, the green 'Trigger' button at the bottom of the 'Live' panel will be available.

b. If the 'Trigger' button is not available, click the ‘Capture’ button to start recording to the camera’s internal RAM buffer.

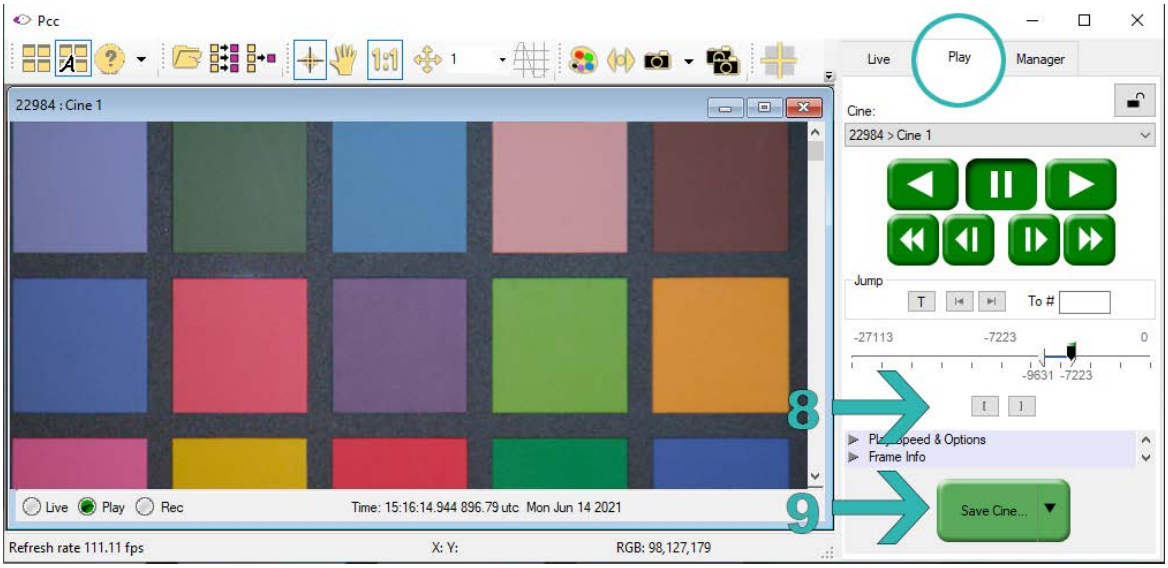
7. Trigger

a. At the

b. the action, click the ‘Trigger’ button at the bottom of the ‘Live’ panel, the button on the camera OCC, or provide an external trigger signal via the Trigger connector.

8. Playback and edit Cine

a. Click the ‘Play’ tab and scrub through the timeline or use the ‘Video Control’ buttons to locate the first image to be saved. Click the ‘Mark-in’ button. Locate the last image of the Cine to be saved and then click the ‘Mark-Out’ button.



9. Save to computer

a. Click the large ‘Save Cine...’ button on the bottom of the ‘Play’ panel and navigate to the folder where you want to save the Cine file.

b. Enter a file name and from the ‘Save as Type’, select the ‘Cine Raw, .cine’ file format.

c. Click the ‘Save’ button to begin downloading the Cine file from the camera.

10. Confirm file save

a. Click the ‘Open File’ button. Navigate to the folder and open the saved Cine file. Review the Cine file by scrubbing through the file and viewing the playback.

Camera Operations

4 Camera Operations

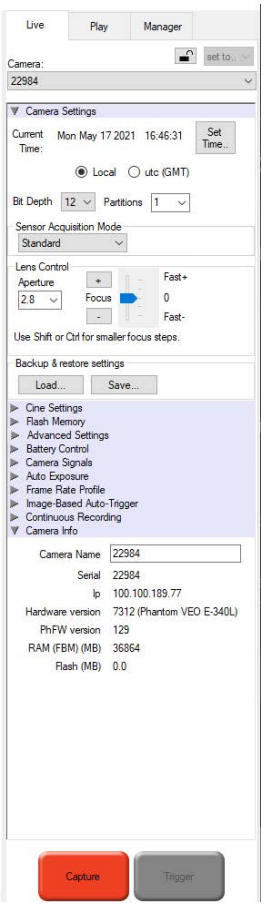
PCC provides four general ways to set, change, or adjust parameters:

1. Select a desired setting from a pull-down selection list.
2. Enter the required value into a data entry field.
3. Enable a feature / option using the enable check box or radio buttons.
4. Adjust a parameter using slider controls
   a. For fast adjustments: place the cursor over the slider and simultaneously hold down the mouse and move the slider.
   b. For fine-tuning adjustments: click the slider, then click the right / left arrow keyboard keys.

4.1 Live/Setup Interface

This section is a guide through all of the primary setup and capture parameters in the Camera Control menu structure.

4.1.1 Camera Settings



1. Current Time - displays the date and time in the following format: Weekday Month Day Year hh:mm:ss. This time stamp gets included with recorded images.

2. Set Time - opens the 'Set Camera Time' dialog window.

3. Local - sets the control computer's date and time settings as the time stamp reference.

4. utc (GMT) - adjusts the control computer's date and time reference to Coordinated Universal Time (UTC), formally Greenwich Mean Time (GMT), and appends 'utc' to the 'Current Time' information.

5. GPS (Global Positioning System) - the GPS information and a copy of the UUID (Universal Unique Identifier) field are kept inside the Cine file, and can be found in the Cine file header, at the end of Setup structure. Cameras supporting this feature display GPS Information in the 'Live / Camera Settings' and 'Play / Cine Info' selectors of various Phantom camera models.

6. Bit Depth - Displays the bit depth. Certain Phantom cameras allow the user to select the bit depth.

7. Partitions - specifies the number of memory segments (partitions) for the selected camera's RAM (internal circular buffer). The segments are evenly divided and have the same number of frames per partition. Increasing the number of partitions will decrease the amount of record time for each segment.

8. Sensor Acquisition Mode - applies only to cameras with 'sensor modes'. Select the sensor's acquisition mode.

a. **Standard** - indicates the 'standard' operating mode of the camera.

b. **HS** (High Speed) - available on certain cameras for increased throughput.

c. **Binned** - groups four pixels (2X2 square) to create one large pixel for increased throughput and/or sensitivity. Binning on a color camera results in monochrome image output.

d. **Rolling** - (Flex4K, VEO4K only) also referred to as a progressive-scan shutter, typically achieves higher dynamic range and lower noise than Global Shutter mode.

e. **Global** - (Flex4K, VEO4K only) also referred to as a 'snap-shot shutter'. In global shutter mode, the sensor exposes every pixel at the same moment in time. Most Phantom cameras work with a Global Shutter.

9. Lens Control - allows electronic control of an attached Canon EOS (EF mount) lens by adjusting:

– **Aperture** - adjusts the variable opening in the lens through which light passes to the sensor (measured in f-stops).

– **Focus** - allows control of the electronic focus interface of compatible lenses.The lens must be set to 'AF' mode to use the electronic focus control.

10. Backup & restore settings - used to save or load the camera's setup parameters.

a. **Load...** - restores a previously saved camera setup configuration.

1) Click the 'Load...' button under the 'Camera Settings' selector

2) Load the camera configurations from:

a) Non-volatile memory slot (1 - 6)

i. Select the non-volatile memory slot (1 - 6) and click the 'Load' button in the 'Camera Settings' popup window.

b) From file... (user specified drive / folder location)

i. Select 'From file...' option

ii. Navigate to the folder the camera configuration file has been saved to and select it and click the 'Open' button.

b. **Save...** - saves the present setup configurations to one of six camera non-volatile memory slots, or a user-specified drive location.

1) Click the 'Save...' button under the 'Camera Settings' selector.

2) Save the camera configurations to:

a) Non-volatile memory slot (1 - 6)

i. Select the non-volatile memory slot (1 - 6) which is marked with '(Empty)', and click the 'Save' button in the 'Camera Settings' popup window.

ii. Enter a name for the file in the 'Set Camera Settings Name' dialog window.

iii. Click 'OK' to save the configuration file name, or 'Cancel' to store the configuration file without a file name.

b) User specified drive / folder location (To file..)

i. Select 'To File...', and click the 'Save' button in the 'Camera Settings' popup window.

ii. Navigate to the folder the camera configuration file is to be saved to in the 'Save Camera Settings' dialog window.

iii. Enter the filename for the camera configuration file being saved in the File name: field. (By default PCC will assign the a filename consisting of the serial number of the camera, the

present resolution, sample rate, exposure time, and edr exposure setting. It will also automatically apply the .stp file extension to the filename.)

iv. Click 'Save' to save the configuration file, or 'Cancel' to stop the save process.

c. **Erase...** - deletes a previously saved camera configuration from its' stored memory slot or file location.

1) Click the 'Load...' or 'Save...' button under the 'Camera Settings' selector

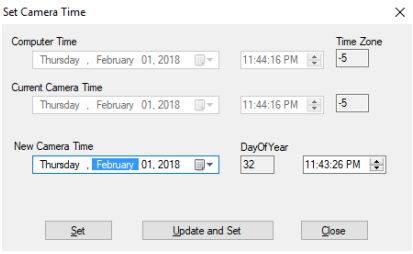
2) Select the non-volatile memory slot (1 - 6) of the configuration file to be deleted.

3) Click the 'Erase' button.

4.1.1.1 Set Camera Time

PCC displays the 'Current Time' in the following format: Weekday Month Day Year hh:mm:ss. The time is tagged to the end of each image recorded from the camera, this process is referred to as a 'time stamping'.

SETUP PARAMETERS



1. **Computer Time** - indicates the active camera / camera group is synchronized to the control computer's local time setting unless an IRIG-B time code is supplied. The information is displayed in the following format: (1) Weekday, Month Day, Year: (2) hh:mm:ss; (3): time difference from UTC (Coordinated Universal Time).
2. **Current Camera Time** - displays the selected camera's computer time.

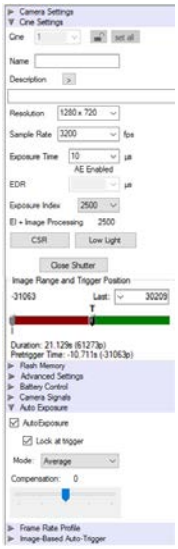
If an IRIG-B (Inter-Range Instrumentation Group) time code is not supplied to the camera the 'Current Camera Time' and 'Computer Time' should be synchronized. If an IRIG-B time code is supplied the 'Current Camera Time' should be synchronized to the IRIG-B time code and display the IRIG-B reference time.

2. **New Camera Time** - allows the user to change the 'Current Camera Time' which is activated when the 'Set' or 'Update and Set' buttons are selected.
3. **DayOfYear** - indicates the number of days from January 1.
4. **Set Button** - changes the 'Computer Time' date and time defined in the 'New Camera Time' fields and synchronizes the 'Current Camera Time'.
5. **Update and Set Button** - synchronizes and sets the camera's internal clock (Current Camera Time) to the control computer's local date and time (Computer Time).

If the camera is connected to an IRIG-B clock source the 'Current Camera Time' will immediately revert to the time code supplied by the IRIG-B signal when the 'Set' button is selected.

7. **Close Button** - closes the 'Set Camera Time' dialog window.

4.1.2 Cine Settings



1. **Cine** - activates when 'Camera Settings > Partitions' is set to a value greater than 1. By default 'Preview' mode is selected to provide a live image to the computer, and the ability to set recording parameters that can be applied to all partitions. The field automatically changes to the first available (unused) partition 'Cine (segment) Number' when the camera is placed into record mode.
   a. If a 'Cine number' is selected from the pull-down list, the camera will be placed into the capture / record mode and write image data into the select partition.
2. **Cine Group / Lock** (active with multiple partitions) - synchronizes setup changes to all partitions.
3. **Set All..** (active with multiple partitions) - applies present recording parameters to all unused partitions.
4. **Name** - used to assign a name to the Cine stored in the camera's RAM, and is written to the camera Cine structure meta-data. A counter will be added at the end of this name for each recorded cine. This name can be viewed in the 'Play > Cine Info' selector.
5. **Description** - enter up to 4,096 characters (including spaces and special characters) to describe the current Cine. This description is applied to all partitions. It is included in the Cine meta-data, however it cannot be edited after the Cine is captured.

1. **Resolution** - set the dimensions (width x height) of the images (camera dependent). Reducing the 'resolution', to match the dimensions of the subject of interest, provides higher 'sample rates', or longer recording times at the same rate. There are several options in the pull-down menu, alternatively type in a value and the closest valid resolution will be set.
2. **Sample Rate** - sets the acquisition frame rate in frames-per-second (fps). The range of speeds is dependent on the 'Resolution' setting, and will determine the maximum 'Exposure Time' available.
3. **Exposure Time** - sets the exposure time, which is the length of time the sensor is exposed to light per frame. This is represented in microseconds (µs), percentage, or degrees (dependent on 'Preferences' setting). If the required exposure time is not listed, a value in one-microsecond increments between the minimum and maximum values listed may be entered.
   a. The amount of light that reaches the sensor is proportional to the exposure time, by default the maximum exposure is nominally the reciprocal of the sample rate less 20 µs of overhead. If defined in degrees (shutter angle) 360º equals full shutter; 180º is a half (or 50%) shutter.
   b. When Auto Exposure is on this overrides the fixed exposure setting and the message 'AE Enabled' appears
4. **EDR** (Extreme Dynamic Range™) - When enabled, this feature sets a threshold value to the pixel level. In essence, once the pixel value reaches that threshold level, additional incident light has no effect on the pixel value. Then, toward the end of the exposure period, the pixel become active to light for the EDR-time. This aids in avoiding oversaturation and works on a per-pixel basis. This is often called dual-slope exposure. .

EDR should not be used on Phantom cameras that use an intensifier.

- *Vision Research recommends EDR be set no higher than 1/2 the Exposure time.*
- *EDR cannot be used in conjunction with the 'Auto Exposure' feature.*
- With color cameras a false color cast will occur on the areas of the image which EDR is applied.
- *EDR is not available with all Phantom camera models. Refer to the product data sheet for confirmation.*

5. **Exposure Index** - sets the exposure index (Effective ISO) of the image, by loading preset tone curves to increase the effective ISO of the camera up to 5x the base value.

The Exposure Index changes to 'Custom..' when changes to the gamma, toe, gain, tone curve, and other settings of the camera are set using the 'Image Tools' dialog window, see 'Optimize Images (Image Processing)' for adjusting the settings.

6. **EI + Image Processing** - indicates the reference value for the ISO level at the current image settings. The effective EI (Exposure Index) value is referenced after the image processing (Image Tools) settings are specified.

7. **CSR** (Current Session Reference) - performs a black reference that calibrates the image for current 'Cine Settings' parameters by adjusting pixel offset.

   a. While pixel corrections are handled by the factory calibration, the camera must compute the offsets and gains specific to the currently defined parameters to obtain a precise compensation of the pixel errors, resulting in the best image possible.

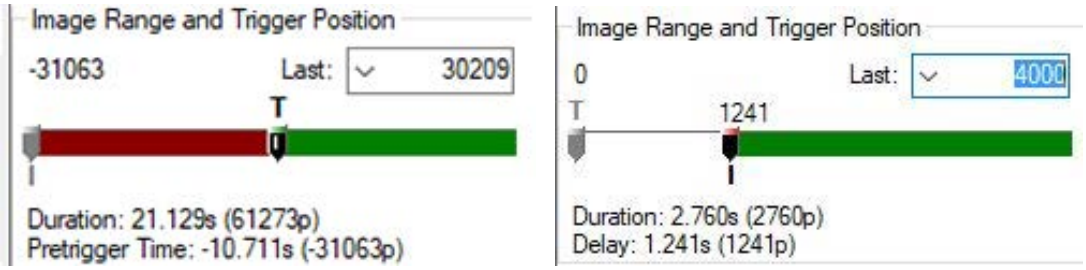
   b. Vision Research recommends performing a CSR prior to each recording to ensure the capture of best quality images.

- *Sensor must be devoid of light when performing a CSR. For cameras with mechanical shutters, the shutter will close automatically. Others will be prompted to cover the lens port.*
- *Before performing a CSR ensure Image-Based Auto-Trigger features are disabled.*

8. **Low Light** - available in Preview/Idle mode only (not Capture). Temporarily reduces the 'Sample Rate' and increases the 'Exposure Time' to a pre-defined level based on the 'Auto Exposure' settings. This feature can be useful for setting up in low light conditions where illumination will be provided at the time of the event.

9. **Close Shutter** - closes the internal / external shutter (if applicable) for the selected camera, and any camera assigned to its associated group (if applicable). This feature is extremely useful when a lens change is required in dusty environments. The shutter can be reopened by pressing the 'Open Shutter' button in the new 'Shutter Closed' window.

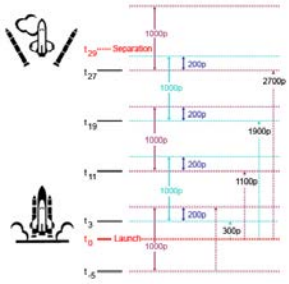
IMAGE RANGE & TRIGGER POSITION



1. **Image Range & Trigger Position** - is a double-cursor slider bar that represents the memory buffer of the camera, and the amount of memory used to store 'Pre-trigger' frames (red), Post-trigger' frames (green), or a user-specified 'Trigger Delay' (white).
   a. **Last** (pull-down selection list /entry field) - used to set the 'Post-trigger' or 'Image Range (delay) value from a list of common values or a user-specified value.
   b. **T** (Trigger Position slider) - sets the number of image / frames to be saved after a trigger has been detected, and automatically changes the value in the 'Last' entry box. Since the camera memory is a FIFO (First-In First-Out) circular memory buffer, the Post Trigger value also sets the reciprocal number of 'Pre-trigger' frames captured.
   c. **I** (Image Range slider) - used to add a delay between trigger detection and the stored image range by overwriting the memory buffer until the user-specified number of frames has been satisfied. This Trigger delay is represented with a white bar.
   d. **Duration** - indicates the length of time, in seconds, to fill the camera RAM (memory buffer), followed by the quantity of frames (p) available as determined by 'Resolution' and memory size.
   e. **Pretrigger Time** - indicates the length of time (and quantity of pretrigger frames) that will be stored in RAM prior to the trigger frame.

4.1.2.1 Image Delay Application Example

In this example, the application requires 35 seconds to record an event. Based on the memory size and recording rate of the camera, each camera can only record for a duration of 10 seconds. In the example shown there are five identically configured (hardware and software) synchronized cameras configured to record different portions of the event when a hard-trigger is simultaneously applied.



CAMERA NUMBER	POST-TRIGGER / IMAGE RANGE	EFFECTIVE TRIGGER DELAY	RECORDED TIME FRAME	STORED IMAGE RANGE
1	500	-5.0 sec.	-5 to +5 sec.	-500 - +500
2	800	3.0 sec.	+ 3 to +11 sec.	300 - 1100
3	1600	11.0 sec.	+9 to +19 sec.	900 - 1900
4	2400	19.0 sec.	+17 to +27 sec.	1700 - 2700

5	3200	27.00 ec.	+25 to +35 sec.	2500 - 3500

Phantom cameras can only store a finite number of images into its' memory buffer based on the 'Resolution', 'Bit Depth' settings, and the size of RAM.

4.1.3 Capture/Trigger

The label and function of the Capture and Trigger buttons change only when working with R/S mode for direct recording to a Phantom CineMag.

Capture - places the camera into the recording mode. Recording image data in an endless loop (continuously), to the camera's RAM (circular buffer) until the camera receives a trigger signal.

Record - (R/S mode) instructs the camera to start recording image data directly to an attached Phantom CineMag.

Abort Recording - PCC changes the 'Capture' button to the 'Abort Recording' button when the camera is in the 'recording' mode.

Stop Recording - (R/S mode) instructs the camera to stop recording image data directly to an attached Phantom CineMag.

Trigger - provides a “soft” trigger instructing the camera(s) to stop capturing and recording image data to the internal buffer once the camera records the number of images equal to the post trigger frames value set in 'Live > Cine Settings'.

Trigger - removed in R/S mode. In R/S mode, the number of post trigger frames is always 1 (image 0).

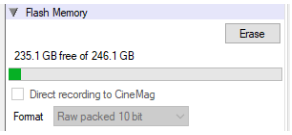
Using the Trigger button is one the possible ways to trigger the Phantom cameras, others include:

- Press 'Ctrl T' on the keyboard.
- Press the physical Trigger button on cameras with on-camera controls (OCC).
- Provide a dry switch closure or a low TTL pulse to the BNC connector marked Trigger on the rear panel of the camera, or capture cable (using a Pickle Switch for example).
- Using the Image-Based Auto-Trigger feature.
- Using a pulse generator, function generator, high-voltage output from experiment and others

Ensure all cameras being synchronized are supplied a shared external 'hard' trigger. Vision Research cannot guarantee that the cameras will remain synchronized if a soft-trigger is used to trigger the cameras.

All cameras associated with the locked camera group will be placed into the capture mode and triggered even if the camera is not displayed in a Preview Panel.

4.1.4 Working with Flash Memory (optional)



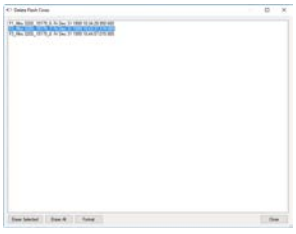
1. **Erase** - purges all Phantom CineMag / internal non-volatile Flash memory Cines. When selected with Cameras supporting Phantom CineFlash the 'Delete Flash Cines' dialog window opens allowing the user to specify specific Cines to delete.
2. **Flash Memory Usage Status Bar** - indicates the amount of used and free non-volatile Flash memory of the active camera and display a memory gauge (green used / gray free).
3. **Direct Recording to CineMag** - instructs the camera to write image data directly to the installed Phantom CineMag.
   a. When 'Direct recording' is enabled this is referred to as R/S (Run/Stop) Mode, which records directly to the CineMag at limited frame rates. In this mode, when the camera is capturing it is writing images directly to the CineMag.
   b. When 'Direct recording' is disabled and a CineMag is installed this is known as 'Loop mode' where the camera writes the image data into the RAM image buffer, like normal. After trigger these images can be reviewed and saved to CineMag from the Play tab.
4. **Format** (Flex4k cameras only) - specifies the format Cines will be saved to the CineMag in (Raw packed 10 bit (default) or ProRes HQ 10bit).

4.1.4.1 Delete Flash Cines

When erasing Cine files from a Phantom CineFlash / CFast2.0 card, PCC provides the ability to delete individual Cine files.

Selecting 'Erase' with a Phantom CineMag removes all Cine files stored in the CineMag. It is not possible to delete individual files in a CineMag.

SETUP PARAMETERS / PROCEDURES



1. Erase Selected - purges selected CineFlash / CFast 2.0 card Cines.
2. Erase All - removes all Cines from installed non-volatile memory.
3. Format - formats a Phantom CineFlash / CFast 2.0 card with the NTFS file system.

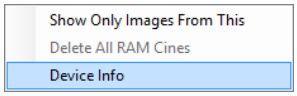
The Preview/Playback Panels will display an Erasing Flash message along with an Erasing Flash progress indicator. Any Cine file stored in the selected camera's Flash memory will be removed from the 'Cameras' group in the Manager Control Panel.

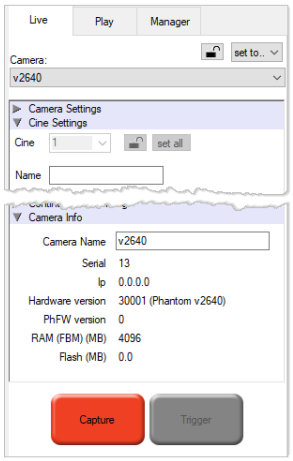
Removing Cine files from a CompactFlash Type I card must be performed in Microsoft Windows using a CF card reader.

4.1.5 View Camera Information

'Camera Info' can be accessed a variety of ways in PCC.

SETUP PARAMETERS / PROCEDURES





1. From 'Manager' tab
   a. Right-click the camera
   b. Select 'Device Info' in the 'Camera Info' pop-up window.
2. From 'Live' tab (requires camera to be open in a 'Preview' panel) click 'Camera Info' selector to display:

– **Camera Name** - indicates the name presently assigned to the camera. This field can also be used to change the name of the selected camera.

– **Serial** - the serial number of the camera.

– **Ip** - the Vision Research assigned IP Address.

– **Hardware version** - indicates the Vision Research syntax used to identify the camera model type. Camera type is displayed in the parentheses.

– **CineMag version** - the CineMag firmware version installed in the Phantom ph7 camera.

– **PhFW version (ph16) / Firmware version (ph7)** - indicates the camera dependent firmware version file installed in the camera. Firmware is the programs/data structures that internally control the various electronic components of the camera.

– **FPGA version** - is the ph7.bin (camera dependent) firmware version file installed in the camera. An FPGA (Field Programmable Gate Array) is a type of logic chip that can be programmed to perform complex functions via the support thousands of gates hardwired in the chip sets to produced faster performance.

– **Kernel version** - displays the kernel version installed in the Phantom ph7 camera. An operating system kernel is the piece or pieces of software that is responsible for servicing resource requests from applications and the management of resources. A kernel has facilities to receive resource requests and grant access to resources such as allocating space for a new file or creating a network connection.

– **RAM (FBM) (MB)** - displays the size of the FBM (Frame Buffer Memory) of the camera in megabytes (MB).

– **Flash (MB)** - displays the size of flash memory of the camera in megabytes (MB).

4.2 Focus & Exposure Tools

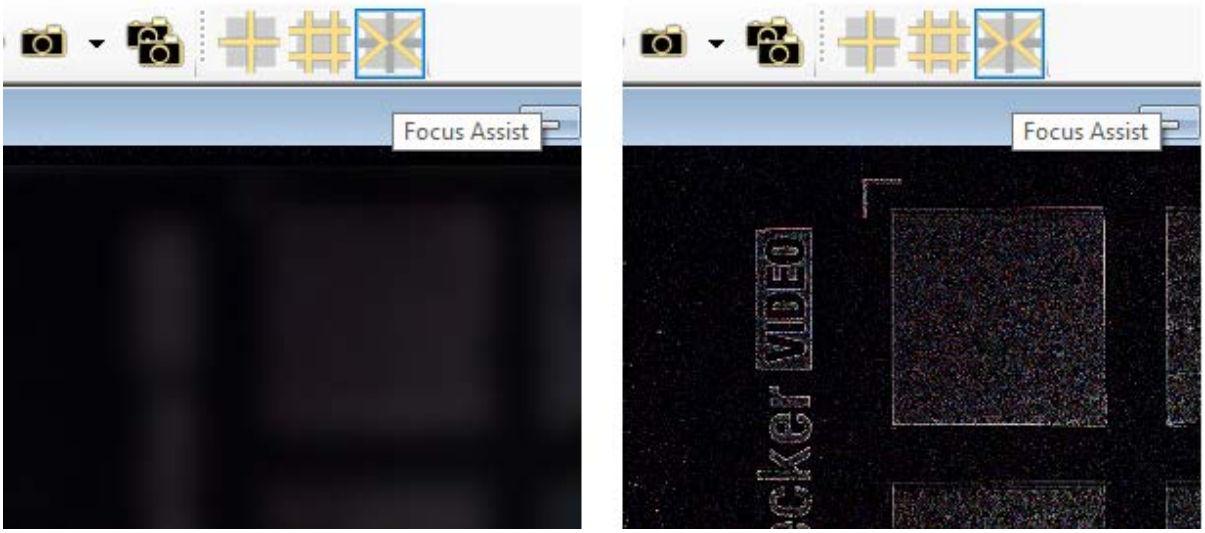
PCC includes several useful features to assist in composing the imagery within the frame, ensuring the subject is focused and properly exposed.

4.2.1 Focus Assist

First, it is recommended to digitally zoom into the image when focusing, whether or not using the focus assist function.

The Focus Assist function is located on the PCC Toolbar next to the Cross and Grid overlay functions.

- The **Cross** and **Grid** icon place an overlay on the Image Panel to ensure the subject is centered or placed appropriately in the frame.
- **Focus Assist**, when enabled, applies a filter to the Live image.
  - While the image will look extremely dark, as it comes into focus the edges are outlined with extreme contrast. It is easy to tell when the image is properly focused.
  - Once focused, disable the Focus Assist icon for a normal image preview.



4.2.2 Exposure Tools

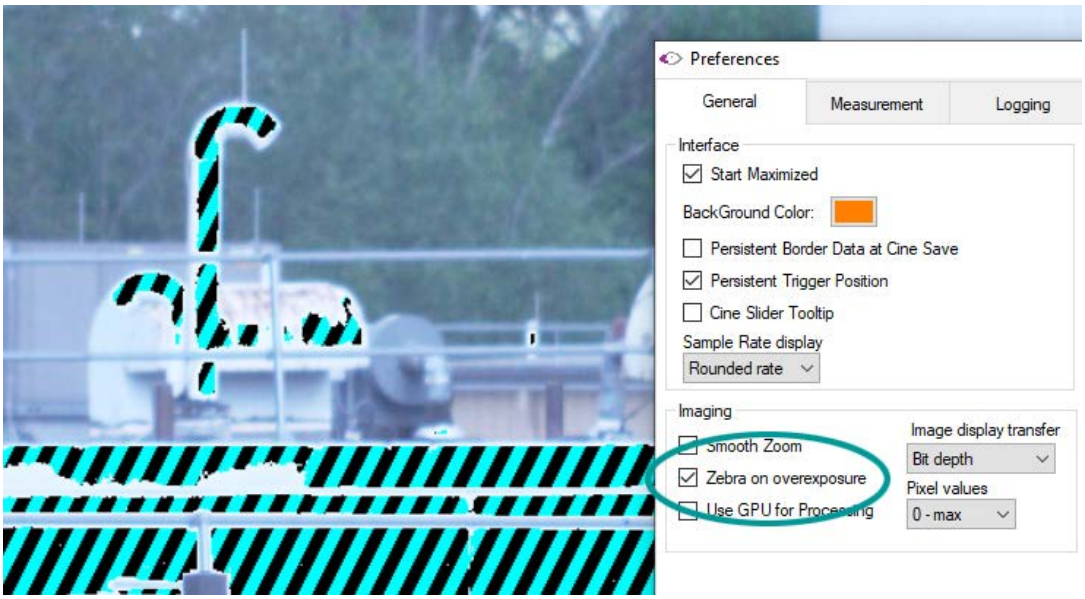
It is good practice to avoid over-saturation of bright highlights in digital imaging.

Many events have changing light conditions and/or bright flashes to compensate for during the capture. For these events PCC offers control over the camera's built-in Auto-exposure and EDR functions (available on select cameras only).

4.2.2.1 Zebra overlay

An effective way to set the exposure is to visually mark the saturated areas of the image and then change the lighting, aperture, or exposure time accordingly so that no large area of the frame is overexposed.

In the PCC Application Preferences, the function 'Zebra on overexposure' accomplishes this by applying a moving striped pattern to make it easy to see the over-saturated areas even in a bright environment where judging exposure can be difficult.



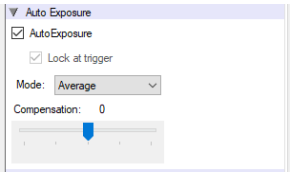
4.2.2.2 Auto Exposure

'Auto Exposure' is useful when there are changing or unpredictable lighting conditions, such as capturing outdoors where clouds may change the scene brightness. The system will automatically adjust the 'Exposure Time' using the information from the setup parameters.

Auto Exposure is a relatively 'slow' feature, where the response at very high frame rates might not keep up with the brightness changes in the scene. In addition to high frame rates, the larger the auto-exposure area is, the slower the process becomes.

Phantom ph16 cameras (see Camera Legends) run on a protocol which enables a particular method of setting Auto Exposure. The control is simple with fewer variables.

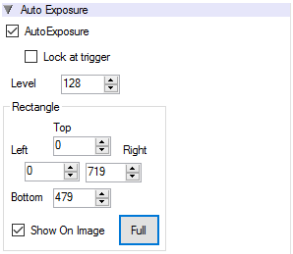
PROCEDURE FOR PH16 CAMERAS



1. **AutoExposure** - enables Auto Exposure feature and activates the 'Mode' parameters. When enabled, 'AE Enabled' will appear under the Exposure Time.
2. **Lock at Trigger** - locks the calculated exposure when a trigger signal is detected by the camera.
3. **Mode** - specifies the 'area' used to calculate the light level of exposure.
   - **Average** - Averages the full image to calculate the exposure value.
   - **Spot** - averages a small area in center of image to calculate the exposure value.
   - **Center Weighted** - averages a slightly larger area in the center of the image to calculate the exposure value.
4. **Compensation** - defines the average gray scale level for the specified 'Mode' area, to be realized. For example, a compensation of 0 would be an average 50% grey level. The compensation can effectively be adjusted to +2 or -2 f/stops.

Phantom ph7 cameras (see Camera Legends). Unlike ph16 models the Auto Exposure area needs to be defined manually.

PROCEDURE FOR PH7 CAMERAS



1. **AutoExposure** - enables Auto Exposure feature and parameters.
2. **Lock at Trigger** - locks to calculated exposure value when a trigger signal is detected by the camera.
3. **Level** - specifies a user-estimated average gray scale level to adjust to based on the calculated light value of the user-defined area ('Rectangle'). Example: if the auto exposure area is expected to darken, set the level to brighten. The higher the value the brighter the adjustment, the lower the value the darker.
4. **Rectangle** - specifies an area used to calculate the light level of exposure.
   a. **Top / Left / Bottom / Right** - specify the x, y coordinates of the pixels representing the upper-left / bottom-right corner of the area rectangle, respectively.

The 'Top', 'Left', 'Bottom', and 'Right' data-entry fields will populate automatically by drawing a rectangle around the area and select 'Auto Exposure' from the popup window.

   b. **Show On Image** - overlays a red box indicating the region of interest (specified by the user) the auto-exposure calculates the average pixel level. This overlay is not recorded with the image data.
   c. **Full Button** - instructs PCC to use the entire image area to calculate the exposure level, up to a maximum of 1024 x 1024 pixels.

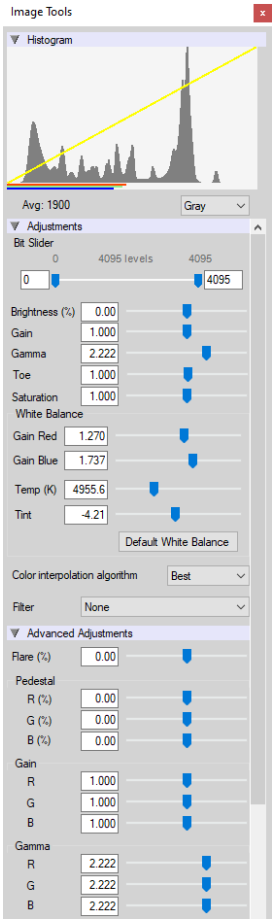
Auto Exposure should not be used on Phantom cameras that use an intensifier.

4.3 Image Tools

The Image tools menu, available from the application toolbar, is available for Live images as well as to make adjustments to recorded Cine files. Several image processing options are available to apply to the entire recording alone or in combinations to bring out hidden features and details. The available menu items will depend on the camera model, particularly if the camera has a color or monochrome sensor.

Not all image processing techniques are appropriate for every image. Vision Research recommends experimenting with image tools to find optimal results.

4.3.1 Optimize Images (Image Processing)



Histogram - a graphical representation of the distribution of luminance values in an image. Each of the values appear on the horizontal axis from dark to light, (left to right), as shown in the Histogram graphics below. The vertical axis indicates the number of pixels of that value at each point. At a point where there are many pixels of a value, the corresponding line spikes; where there are no pixels, it lies at the bottom of the graph.

Bit Slider - new in PCC 3.9. The maximum value displayed (upper right) represents the available gray levels which varies based on the bit depth of the camera or Cine file. These levels can be finely adjusted from each side of the slider to raise the black point (clipping the shadows) and/or bring down the saturation point (clipping the highlights). After each adjustment the resulting amount of levels being displayed is displayed above the line.

Brightness - used to adjust the brightness of monochrome or color images. The factory default value is set to 0.00. Selectable Range: -10.00 to 10.00

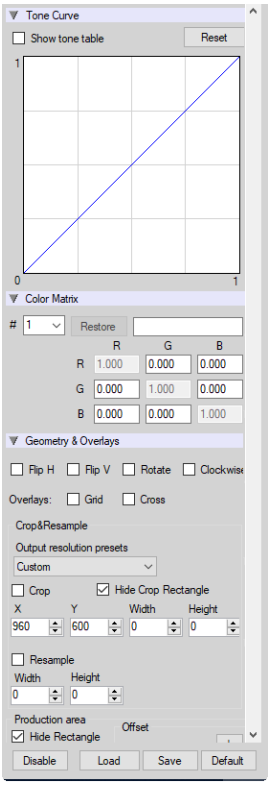
Gain - used to adjust the gain (contrast) of monochrome or color images. The factory default value is set to 1.000. Selectable Range: 0.100 to 10.000

By increasing the gain setting the noise level will increase as well, so only increase as much as necessary to get a satisfactory image.

Gamma - used to adjust the gamma correction of monochrome or color images. The factory default value is set to 2.222. Selectable Range: 0.100 to 10.000

Toe - adjusts the lower portion of the gamma curve only. Lowering the toe value will lift the shadow detail without affecting the highlights. By default, this setting is 1.0, however a change in Exposure Index (E.I.) can change this value, so it will commonly display a value between 0.1 and 1.0. The factory default value is set to 1.000. Selectable Range: 0.100 to 2.000

Saturation (color cameras only) - used to adjust the color saturation of the images being displayed. The factory default value is set to 1.000. Selectable Range: 0.100 to 2.000



White Balance (Color Cameras Only) - performing a white balance on ph16 camera Cine files modifies the color temperature in Kelvin (Temp (K)), and (Tint). Performing a white balance on ph7 camera Cine files modifies only the red and blue color components. The Default White Balance button will reset the white balance settings back to the factory default settings.

a. An Automatic White balance is performed in the Live Preview Pane by right-clicking on an unsaturated white or gray area of the image

Color Interpolation Algorithm (Color Cameras Only) - To reconstruct a color image from the data collected using a color filter array (CFA), interpolation is needed to fill in the blanks. This process is called demosaicing, which reconstructs a full-color image from the spatially under-sampled color channel's output from the CFA.

a. PCC has five preset algorithms for this (Best, Good, Medium, Fast, Fastest) from the pull-down list in addition to 'None' which turns off the CFA correction. The selected algorithm will be applied to live camera images and saved Cine files.

b. Like the names suggest, the algorithm selected does affect the refresh rate of the images in PCC. 'Best' is the PCC default and will typically give the most detailed, sharp looking images, however certain subjects may benefit from a different algorithm depending on the level of detail.

c. The setting is persistent, so the next time PCC is open this setting will be retained for a live camera. If an individual Cine file was saved with a different algorithm, that algorithm will be retained for that Cine.

d. Vision Research does not publish the Color Interpolation (demosaic) Algorithm equations found in PCC. Third parties that work with Cine Raw files apply their own demosaicing.

Filter - PCC provides the following image filtering algorithms:

- **None** -used to display the images as they were originally recorded, prior to applying any of the other filtering techniques to the images.
- **Smooth Gauss 3x3 or 5x5** - used to blur or “smooth” the images based on a 3x3-, or 5x5-pixel Gaussian filter.
- **Sharpen** - used to emphasize the edges within an image. The result is that the image appears to have increased sharpness.
- **Edge Hipass 3x3 or 5x5** - used to enhance or isolate 3x3-, or 5x5-pixel transition areas, or 'edges,' in an image by enhancing the high-frequency detail.
- **Edge Laplacian 3x3 of 5x5** - is a convoluted mask to approximate the second derivative, unlike the Sobel method which approximates the gradient. And instead of two 3x3 Sobel masks, one for the x and y directions, Laplacian uses one 5x5 mask for the 2nd derivative in both the x and y directions. Because these masks are approximating a second derivative measurement on the image, they are very sensitive to noise.
- **Edge Prewitt Horizontal or Vertical** - calculates the maximum response of a set of convolution kernels to find the local edge orientation for each pixel. Each of the resulting kernels are sensitive to an edge orientation ranging from 0° to 315° in steps of 45°, where 0° corresponds to a vertical edge. This edge detection method is also called edge template matching, because a set of edge templates is matched to the image, each representing an edge in a certain orientation. The edge magnitude

and orientation of a pixel are then determined by the template that matches the local area of the pixel the best.

The Prewitt edge detector is an appropriate way to estimate the magnitude and orientation of an edge. Although differential gradient edge detection needs a rather time-consuming calculation to estimate the orientation from the magnitudes in the x- and y-directions, the Prewitt edge detection obtains the orientation directly from the kernel with the maximum response.

– **Edge Sobel Horizontal or Vertical** - the Sobel filter is a discrete differentiation operator, computing an approximation of the gradient of the image intensity function. The operator calculates the gradient of the image intensity at each point, giving the direction of the largest possible increase from light to dark and the rate of change in that direction. The result shows how 'abruptly' or 'smoothly' the image changes at that point, and therefore, how likely it is that part of the image represents an edge, as well as how that edge is likely to be oriented.

  Mathematically, the gradient of a two-variable function (here the image intensity function) is at each image point a 2D vector with the components given by the derivatives in the horizontal and vertical directions. At each image point, the gradient vector points in the direction of the largest possible intensity increase, and the length of the gradient vector corresponds to the rate of change in that direction. This implies that the result of the Sobel filter is that in a region of constant image intensity is a zero vector, and at a point on an edge is a vector which points across the edge, from darker to brighter values.

The edge filters in PCC are used for visualizing and performing measurements on edges of motion within the image.

Flare (%) - used to adjust the Flare video adjustment. Flare in this context is a sensor artifact where a contrasty scene, typically a dark subject surrounded by white, results in the shadow areas being pushed below 0. This ultimately causes a color shift to the shadow areas of the image. This flare image setting can help compensate for the color shift.

Pedestal (Color Cameras Only) - adjust the baseline black level of the Red, Green, and Blue channels independently. A default of 0.00 should produce images with black at 0 on a waveform. Pedestal can be raised or lowered to a value of 10.00 on each channel.

Gain RGB (Color Cameras Only) - used to increase or decrease the individual R G, B, levels to fine tune the color response for each channel. There is not a common need for this.

Gamma RGB (Color Cameras Only) - adjusts the gamma curve for individual Red Green and Blue channels independently. By default, the Primary Gamma value will populate each field - then the gamma curve can be fine tuned for each channel. There is not a common need for this - this option exists primarily for video engineers to match the video output across multiple camera types.

Tone - is a lookup table that is applied to all three color (R, G, B) components that allow the user to convert any input value to any output value to create a tone curve applied to the images being outputted from the camera. The horizontal input is on the X axis while the vertical input is on the Y axis. Both inputs are assumed to have conventional values set from 0.0 to 1.0, (1.0 correspond to the maximum pixel value, i.e., 255 on 8-bits or 4095 on 12-bits.

The user needs to specify a few intermediate points to create a unique tone curve. The software fills the intervals between the points using spline functions. As the point coordinates are entered into a table, the software updates the tone curve and provides the user with visual feedback of the tone curve shape.

The Exposure Index function utilizes preset tone curves to increase the effective sensitivity or ISO. These preset tone curves can be adjusted and saved in an image adjustments file, however the Exposure Index curves are recalled from camera's factory settings and can not be overwritten.

Color Matrix (Color Cameras Only) - a maximum of four custom color matrices can be created or edited. The matrix drop-down is used to select a matrix. The associated G-R, B-R, R-G, B-G, R-B, and G-B fields, below the matrix number field, are the specific color matrix variables. G-R represents green into red, B-R represents blue into red and so forth.

Flip H - displays the image as a mirrored image, the image flips horizontally.

Flip V - displays the image upside-down, the image flips vertically.

Rotate - rotates and displays the image 90° counter-clockwise from the original image.

Clockwise - rotates and displays the image 90° clockwise from the original image.

Grid - places a grid pattern over the image. This pattern is not recorded with the image data.

Cross - places a cross-hair over the center of the image. The cross-hair will not be recorded with the image data.

Crop - used to remove the outer parts of an image to improve framing, accentuate subject matter or change aspect ratio. Cropping can be accomplished by:

a. Enter the X Y coordinates of the rectangle's top left pixel, then check the Crop enable box, or

b. While the 'Image Tools' window is open, place the cursor over the image, hold down the mouse, and draw a rectangle over the image area of interest. Select the 'Crop' option from the pop-up selection window.

Resample - used to resample the size of the image data by:

a. Entering the desired Resample Width and Height into the entry fields, then check the Resample enable box, or

b. Click the down arrow to the right of the custom entry field and select a predefined resample size from the pull-down selection list.

- *Crop and Resample, like all Image Tools settings, are applied as 'metadata' to the Cine Raw file, so that these settings can be removed or further adjusted.*
- *When converting to another (non raw) file format these settings get 'baked in'. It is an extremely useful function when converting Cine files, but this is why when using the crop feature on a Cine Raw file the file size is no different, until the file has been converted.*

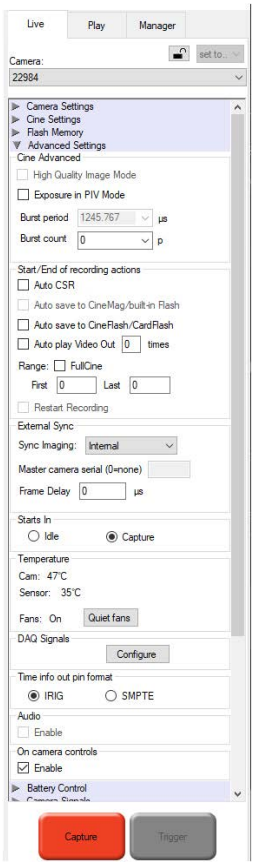
Disable - temporarily turns off any image adjustments associated with the Cine; click again to re-enable the image adjustments.

Save - used to save the image adjustment settings to a file (.adj) which can be applied to other cameras for matched settings, or to quickly switch between settings on an individual camera or saved Cine file. All image tools settings will be applied when saving and loading this file.

Load - recalls the image tools settings that have been saved to the .adj file.

Default - resets all Image Tools settings, other than White Balance, to PCC factory defaults, or the defaults associated with the current User Configuration Profile (settable in the User Configuration Manager).

4.4 Advanced Settings Menu



1. **High Quality Image Mode** (Phantom Flex-2K only) - instructs the camera to use a proprietary multi-sampling technology to enhance each frame.
   a. High Quality Image Mode reduces maximum frame rates, and each frame requires twice the internal camera memory.
2. **Exposure in PIV Mode** - reduces duration between frames (frame 'straddle' time / inter-frame gap) required for Particle Imaging Velocimetry (PIV) applications.
   a. With PIV Mode enabled the camera is always exposing the frames for the maximum possible duration.
3. **Burst Period** - sets the interval (in µs) for each frame / image captured as a burst of images captured with each frame clock pulse. Technically it is the time between successive falling edges of 'Strobe' signal.
4. **Burst Count** - sets the number of frames / images captured in a burst, (zero disables Burst Mode Acquisition). Technically it is the number of images that can be taken between successive falling edges of F-Sync (frame clock) signal. See Burst Mode Acquisition for a functional description of this feature.

Start/End of recording actions

3. **Auto CSR** - when enabled a CSR (Current Session Reference) will be performed whenever the camera, with an Internal Automatic Mechanical Shutter, is placed into the 'Capture' (recording) mode. Recording to a Phantom CineMag in R/S mode is delayed until the black reference operation has completed.
4. **Auto save to CineMag/built-in Flash** - instructs the camera to write the image data, stored in the camera's RAM (circular buffer), to a mounted Phantom CineMag or internal non-volatile Flash memory automatically when the recording process has been completed.
5. **Auto save to CineFlash/CardFlash** - instructs the camera to write the image data, stored in the camera's RAM, to a Phantom CineFlash memory cartridge, CFast 2.0 or Type I Compact Flash card automatically when the recording process has been completed.
6. **Auto play Video Out** - instructs the camera to automatically play the recorded image data, in the camera's RAM buffer, to an attached monitor when the recording process has completed.
7. **Times** - specifies the number of times the recorded Cine file is to playback (loop) to an attached monitor. Entering a 0 (zero) instructs the Cine file to loop indefinitely. Requires 'Auto play Video Out' to be enabled.
8. **Range** - specify the range of image to automatically save to Flash memory or display on an attached monitor.
   a. **FullCine** - saves / displays the entire Cine, stored in RAM, when the recording process has been completed. It also disables the 'First' and 'Last' image range fields.

   b. **First / Last** - define the Mark-in / Mark-out points, of the Cine to be saved to Flash / reviewed on an attached monitor when the recording process has been completed, by entering the first / last image numbers in their respective data entry fields.

9. **Restart Recording** - immediately places the camera back into the capture (recording) mode once all the specified 'Start/End of Recording Actions' have completed. It is available only when an 'Auto save' is enabled. *Feature not compatible with Continuous Recording.*

10. **External Sync** - See **Camera Synchronization** section

11. **Starts in**

    a. **Idle** - on camera power up camera provides 'live' images to control computer / attached monitor, however no image data is being recorded to camera RAM, and requires the camera to be placed into the recording mode by supplying a 'pre-trigger' signal ('capture' button or TTL pulse)

    b. **Capture** - on camera power up camera provides 'live' images to control computer / attached monitor along with recording image data to camera RAM.

12. **Temperature**

    a. **Cam:** - displays the operating temperature of the camera. If the temperature of the camera exceeds the camera's factory set threshold the camera's cooling system will work harder to reduce the camera's operating temperature.

    b. **Sensor:** - displays the current temperature of the sensor.

    c. **Quiet Fans:** - instructs the camera to turn off the fans or set it to its' minimum speed. The fans will automatically start once the camera temperature threshold is reached (varies by camera).

13. **DAQ Signals** - See **Data Acquisition** section

14. **Time info out pin format**

    a. **IRIG** - instructs the camera to output an un-modulated IRIG (Inter-Range Instrumentation Group) time code from the 'Time Code' interface.

    b. **SMPTE** - instructs the camera to output a SMPTE (Society of Motion Picture and Television Engineers) linear time code from the 'Time Code' interface

15. **Audio** - Flex4K only - enables digital audio signal acquisition during the image acquisition for selected cameras. The files are downloaded as a separate 48KHz, 24-bit, uncompressed .wav files which can be matched with the video in post processing.

16. **On camera controls**

    a. Enable and disable the camera's on-camera control (OCC) buttons.

4.5 Camera Model-Specific Functions

4.5.1 Frame Rate Profile

Frame Rate Profile, compatible only with legacy ph7 cameras, allows the user to define different frame rates (user-defined) that automatically change, at specified points, during the capturing process of post trigger frames. The number of profiles varies based on the camera model, the amount of memory associated with the camera, the resolution the images will be recorded at, and the number of post-trigger frames defined. The first profile is the profile defined in the 'Live>Cine Settings' selector. The remaining profiles will be applied to 'post trigger' frames only.

Frame Rate Profile will only be applied to 'post trigger' frames only, and is not supported by all Phantom camera models

Some Phantom camera models, by default, 'Ramp' (change gradually) to the next defined frame rate profile but not all. Other camera models, by default, 'Step' (maintain the frame rate changes until the next rate change) to the next frame rate profile. Cameras that 'Ramp' frame rates can be configured to 'Step' however, cameras that 'Step' frame rates cannot be configured to 'Ramp'.

SETUP PARAMETERS / PROCEDURES

1. **Active** - used to turn the Frame Rate Profile feature on and off.
2. **PT Duration** - indicates the post trigger recording time. This duration is based on the amount of memory in the camera, along with the resolution and rate settings and post trigger value. This field will change based on these variables.
3. **Image# / Time Header** - selects the desired variable used to define the rate change profile(s):
   - Image# - specifies the image number the frame / sample rate changes.
   - Time(s) - specifies the time from trigger (in seconds) the rate change is to occur.
   - Image% - specifies a percentage of images between rate changes.
   - Time% - specifies the percentage of time (in seconds) between rate changes.

If the header variable is changed for the first column the remaining values will be updated according to selected variable. Small changes can occur, because of the rounding process, when switching from, then back to the Image# option.

4. **PT Duration** - displays the recording duration based on the user-defined profiles.
5. **ImageNr /Time /ImNrPerc / TimePerc** - sets when the frame rate is to occur.
6. **Rate** - sets the desired recording rate staring with the associated 'ImageNr /Time /ImNrPerc / TimePerc'. The rates will be updated in order to be compatible with the exposure value set in 'Live > Cine Settings'.

When configuring a 'Ramp' camera to 'Step' frame:

1. Enter the header (image or time) variable, and the frame rate the camera is to maintain the rate at in the date-entry fields of the last row (indicated by the asterisk). Repeat this step until all the profile changes have been defined.
2. Repeat the previous step, however slightly increase the header image / time variable (a few frames / hundredth of a second, respectively), and enter the frame rate the camera will change to in the date-entry fields of the last row (indicated by the asterisk).
3. Repeat the last two steps unitl all the required frame rates have been defined.
4. Set the frame rate of the 'last' image or time variable, on the row indicated with a right arrow, and set the frame rate to match the last frame rate entered.

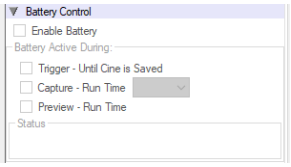
7. **Graph** - displays an active graphical representation of the defined profiles.The yellow line indicates the defined frame rates for each of the profiles. The starting point of the line represents the Sample Rate set, and used by Profile 1, under 'Live > Cine Settings'. The white dotted lines represent the beginning of the specified Image or Time variables starting with Profile 2.

4.5.2 Battery Control

Select Phantom Miro-C cameras have an internal, non-removable battery designed to provide back-up power to complete an operation and safely save a Cine in the event of power loss to the camera. The battery is UNDOT 38.3 qualified and has a total capacity of 8.4 volts. When the battery activates, it's ready to provide power in the event DC power is lost.

The following conditions must be met for battery to activate: (1) Camera has DC power and is fully booted; (2) Battery is charged to at least 8.0 volts; (3) "Enable Battery" is checked (Default) via PCC.

SETUP PARAMETERS / PROCEDURES



1. **Trigger mode** - (default mode, always selected) battery activates when camera is triggered. In the event of DC power loss, the battery will supply power to the camera until any of the following conditions are met:
   - All auto save operations of Cines in RAM memory have been completed.
   - All Cines in RAM memory have been deleted.
   - The reset button on the back of the camera has been pressed.
   - The battery voltage has reached the full discharge limit.
   - The camera then automatically turns off.

2. **Capture Mode** (selectable for C210, C320 only) - allows camera to operate in 'Capture' (recording) mode for up to 10 minutes without power. The battery becomes active when the camera is placed in capture mode. In the event of DC power loss, the battery will supply power to the camera for either 3, 5 or 10 minutes (selectable). If the camera triggers within this time span, the battery operation mode automatically switches to 'Trigger' mode to protect the data (C210J, C320J only). In the event of a power loss to the Miro JBox, the camera will automatically trigger itself and switch to Trigger mode to protect the data. (Capture mode is disabled in the C210J and C320J).

3. **Preview Mode** (selectable) - provides a 2-minute window to disconnect and reposition cameras during set-up without the need to re-boot the cameras. Battery activates when camera is placed in 'Preview' mode. If the camera is disconnected from DC power, the battery will supply power for up to 2 minutes. If the camera is not reconnected to DC power within 2 minutes, the battery automatically deactivates and turns off the camera.

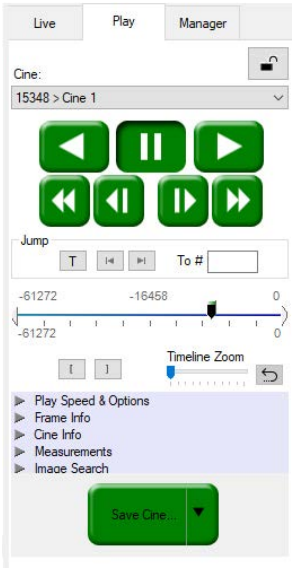
Battery operation mode does not automatically change to 'Capture' when the camera is placed in the recording mode.

Cine Review and Saving

5 Cine Review and Saving

5.1 Cine Review

The 'Play' tab is used to review, edit, and / or save recorded Cine files, specify the user-preferred playback options, perform measurement analysis, and / or quick search through a Cine file.

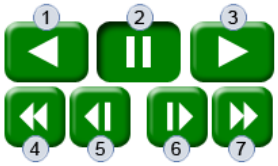


Cine - displays a list of the Cine files the user can select from to review, edit, and/or save. The list contains all the Cine files listed under the:

- **Cameras Group Tree** - contains a list of connected Phantom cameras. A list of Cines will also be displayed under any connected Phantom camera that has a Cine stored in the RAM or in the Flash/CineMag memory of the camera.
- **Files Group Tree** - contains a list of all open and / or previously opened Cine files.

Cine Group / Lock - instructs PCC to simultaneously control all Cine files' playback associated with the first group that contains the currently selected file.

5.1.1 Control Buttons



1. Rewind - play Cine file in reverse at the rate specified via the Play Speed & Options.

2. Pause - stops / pauses playback.

3. Play - plays the Cine file forward at the rate specified via the Play Speed & Options.

4. Fast Rewind - quickly rewinds (decrements the total number of frames/1000; no less than 10 frames, auto adjusting to Cine size).

5. Step Backward - rewinds one image (frame) only.

6. Step Forward - steps forward one image (frame) only.

7. Fast Forward - quickly increments (the total number of Cine frames/1000, no less than 10 frames, auto adjusting to Cine size) the images being reviewed.

5.1.2 Locking Cine Files Together

SETUP PARAMETERS / PROCEDURES

Play tab / Cine - select from a list of the Cine files to review, edit, and/or save. The list contains all the Cine files listed under the:

– **Cameras Group Tree** - contains a list of connected Phantom cameras. A list of Cines will also be displayed under any connected Phantom camera that has a Cine stored in the RAM or in the Flash/CineMag memory of the camera.

– **Files Group Tree** - which contains a list of all open and / or previously opened Cine files.

 **Cine Group / Lock** - instructs PCC to simultaneously control playback of all Cine files' associated with the root group that contains the currently selected file.

– Under the Play tab, with the 'Camera: Lock' button unlocked:

Method 1:

1. Select the desired group option from the Play>Cine pull-down selection list. The already open Playback Panel, for each Cine file associated with the selected group will be placed into the Locked (Group) state, indicated by a red border around the Preview Panel.

Method 2:

1. Select a Playback Panel of a Cine file associated with the specific group, then
2. Click the Cine: Lock button.

The Playback Panels for each opened Cine file associated with the selected group will be placed into the Locked (Group) state, indicated by a red border around the Preview Panel.

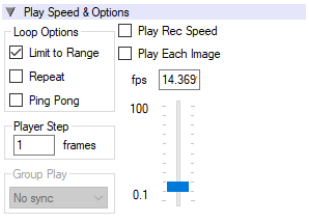
Method 3:

1. From the Manager tab right mouse click on the Group/Sub-group folder containing the files to be open.
2. Select the 'Show Only Images From...' command in the associated pop-up window. PCC displays the Playback Panels for each Cine file associated with the selected group only, all other opened panels will be closed.
3. Click the Play tab and select the desired Files group from the Cine: list. The associated Cine files are placed into the Locked (Group) state, indicated by a red border around the Playback Panel

Locking cameras allows the review, editing and saving of Cine files, stored in the camera's memory, which are displayed in a 'Preview Panel' regardless of their assigned group simultaneously.

A red border will be placed around the 'Preview' panel of Cine files that are locked.

5.1.3 Play Speed & Options (optional)



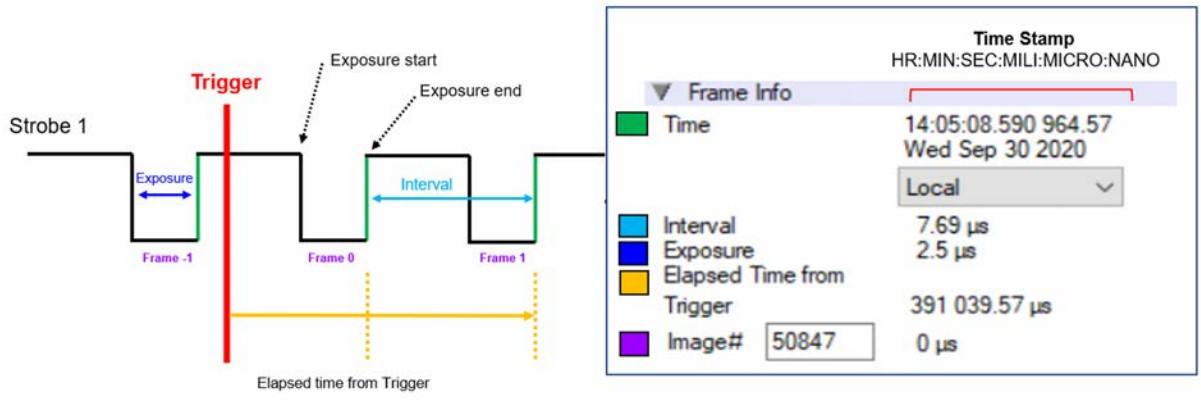
1. **Loop Options** - specify how the Cine file is to be reviewed.
   a. **Limit to Range** - forces the playback controls to play only the images between the 'Mark-In' and 'Mark-Out' entry points specified by the user.
   b. **Repeat** - allows the Cine file to be played in an endless loop. If 'Limit to Range' is also selected, the loop will be limited to the range specified during the edit Cine process.
   c. **Ping Pong** - instructs the software to play the selected Cine file forward and then backward repeatedly.

The software allows for multiple options to be selected at the same time.

2. **Play Rec Speed** - instructs PCC to play the Cine at the rate is was recorded at, essentially 'real time'.
3. **Play Each Image** - instructs PCC to display every frame (image) in the Cine file. Selecting this option may restrict the playback rate.
    a. **fps** (frames per second) - either the entry field or slider can be used to adjust the speed of the Cine playback. This adjustment only applies when the 'Standard Play Forward' and 'Standard Rewind' buttons have been selected. The fps entry field allows the user to specify a playback frame rate within the minimum / maximum range indicated on the fps slider.
4. **Player Step** - jumps Cine playback the user-specified number of frames / images.
5. **Group Play** - Cines can be played back in PCC application using one of the three sync options specified via the pull-down selection list. Options include:
    a. **No sync** - plays all Group (Lock) Cine files simultaneously, non-synchronized.
    b. **Frame# sync** - forces the locked Cine files to play an identical range of frames simultaneously.
    c. **Time sync** - plays each Cine so that the time stamp for each Cine is the closest possible to the current image in the active window. This allows Time sync playback on Cine files with different interval values. If any of the Cine files in the selected group are not compatible (non-valid range) a red warning symbol will be displayed meaning 'Not a valid Cine range intersection.'

5.1.4 Frame Info

The **'Frame Info'** fields are used to display timing information of the frame / image displayed in the active 'Playback' panel.



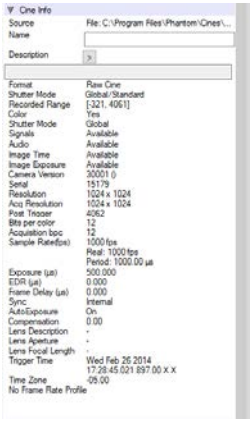
1. **Time** - select the type of 'Time' information displayed form the pull-down selection list (below the 'Time' display field):
    a. **Local** - displays the absolute time and date (the time stamp generated by the attached Phantom control computer's date and time reference) the image was recorded, displayed in hh:mm:ss.ms µs.ns; Day Mon dd yyyy. A tag may be appended to time displays, as follows:
        i. E - Provided as an 'event' marker.
        ii. S - Designates that the time displayed was synchronized to a time source.
    b. **utc (GMT)** - displays the date and time reference adjusted to utc (Universal Time Clock), formally referred to as GMT (Greenwich Mean Time). The adjustment will be the time difference from the date and time settings of the computer to utc. The utc (GMT) option appends utc to the time stamp reference.

c. **Time Code** - displays the Cine's time code converted to SMPTE. The SMPTE time code output is generated based on the trigger frame of each recorded Cine. For detailed description on the 'SMPTE Time Code', see: Functional Descriptions>SMPTE Time Code in Phantom Cameras.

2. **Interval** - indicates the image interval (duration of a frame) of the image being displayed in the active 'Play' panel (displayed in micro-seconds).
3. **Exposure** - indicates the exposure time of the image being displayed in the active 'Play' panel (displayed in micro-seconds). This is the amount of time each frame collects light for.
4. **Elapsed Time From** - used to perform various timing measurements:
   a. **Trigger** - indicates the elapsed time of the image being displayed in the active 'Play' panel, and trigger (displayed in micro-seconds).
   b. **Image#** - indicates the elapsed time of the specified image number in the data entry field and the image currently being displayed in the active 'Play' panel (displayed in micro-seconds).
5. **Azimuth** (visible with Range Data) - indicates the angle of horizontal deviation, measured clockwise, of a bearing from a standard direction, as from north or south and
6. **Elevation** (visible with Range Data) - indicates the altitude of a place above sea level or ground level values for Cines that have 'range data'. For details on Range Date see DAQ Signals>Range Data Interface.

5.1.5 Cine Info

Click the 'Cine Info Selector' to display the following information for the active / selected Cine:



a. **Source** - indicates the camera name or file path of the Cine file.
b. **Name** - indicates the information found in, or specify to, the camera's Cine structures meta-data, that was defined in 'Live>Cine Settings'.
c. **Description** - displays the text entered in the 'Live>Cine Settings>Description' field.
d. **Format** - displays the file format of a saved Cine file. If the Cine is from the camera's RAM memory, PCC displays N/A (not available).
e. **Saved Range** - indicates the first / last image numbers of the edited Cine file.Recorded Range - indicates the first / last image number of the recorded Cine file.
f. **Color** - indicates if the Cine was captured using a color sensor (Yes) or a monochrome sensor (No).

a. **Signals** - indicates if any external analog or binary signal measurements, sampled by a National Instruments USB X or M Series Data Acquisition Unit, are 'Available' / 'Not Recorded'
b. **Audio -** (Flex4K only) indicates if 'Audio', for the Cine file, is 'Available' or 'Not Recorded'.
c. **Image Time** - indicates if the image timing information, for the Cine file, is Available or N/A (not available).
d. **Image Exposure** - indicates if the image exposure information, for the active Cine file, is Available or N/A (not available).
e. **Camera Version** - displays the camera 'Hardware Version' number for the '(Camera Model)' used to capture the Cine file.
f. **Serial** - specifies the serial number of the camera used to 'Rec' (record) the Cine file or Cine 'Mag' if applicable.
g. **Resolution** - displays saved image size (width x height). If the images contain 'Border Data' the 'Resolution' may be greater than 'Acq. Resolution'.

h. **Acq. Resolution -** displays the size (width x height) the images were recorded at (acquisition resolution).

i. **Post Trigger** - indicates the number of Post Trigger frames recorded.

j. **Bits per color** - displays the pixel bit-depth of the Cine.

k. **Acquisition bpc** (bits per color) - displays the pixel bit-depth the Cine was recorded at.

l. **Sample Rate** (fps) - displays the rate in fps (frames per second), the Cine was recorded at, including:

   i. **Real** - the actual frame rate (fps) the images were recorded at.

   ii. **Period** - the time (ms) required to record each of the images.

m. **Exposure** (ms) - displays the 'Exposure Time' setting at the time the Cine was recorded at.

n. **EDR** (ms) - indicates the 'EDR' (Extreme Dynamic Range) exposure time setting the Cine was recorded with. 0.000 indicates EDR was disabled.

o. **Frame Delay** (ms) - indicates the amount of time (user specified) each image is delayed from the frame rate clock pulse before it was recorded.

p. **Sync** - indicates the 'Sample Rate' clock source the Cine was recorded with.

q. **Auto Exposure** - indicates whether or not the 'Auto Exposure' feature was used during the recording process.

   i. **Compensation** (ph16 camera models only) - displays the 'Auto Exposure' compensation level (-2 is equivalent to closing down the aperture two (2) f-stop; 2 is equivalent to opening the aperture two (2) f-stops).

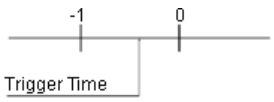
   ii. **AutoExp. Level** (ph7 camera models only) - displays the 'Auto Exposure' grayscale level defined by the user.

   iii. **AutoExp. Rect** (ph7 camera models only) - displays the the user specified rectangular area (in pixels) used to base 'Auto Exposure' adjustments on.

r. **Lens Description** (Lens info is for electronic Canon EF-mount lenses only) - indicates the lens model of the Canon EOS (or compatible) lens used to record the Cine

s. **Lens Aperture** - indicates the aperture setting, defined via the Live Panel>Camera Settings>Lens Control>Aperture setting, of the Canon EOS (or compatible) lens used to record the Cine.

t. **Lens Focal Length** - indicates the focal length of the Canon EOS (or compatible) lens used to record the Cine.



ab. Trigger Time - indicates that moment in time just after the last pre-trigger image (-1) and before image 0 as shown here in the graphical representation.

   i. **Time Zone** - displays the time difference from utc (Universal Time Code) formally referred to as GMT (Greenwich Means Time) in hours.

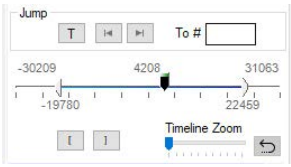
   ii. **Frame Rate Profile** (ph7 camera models only) - displays the 'Frame Rate Profile' setting defined by the user during the Cine files' capture process. If the feature was not used this field will be left blank.

5.2 Edit Cine

Editing the Cine after capture file will remove the frames outside of the mark-in and mark-out range to create smaller files, reduced save times, and make viewing the Cine file more interesting.

5.2.1 Editor Bar

An 'Edited' Cine refers to the Cine after a mark-in and mark-out point has been set, removing unnecessary images from the beginning and end prior to saving the Cine file. The Cine 'Editor Bar' is used to set the in and out points.



The blue portion of the Cine editor bar line represents the edited Cine.

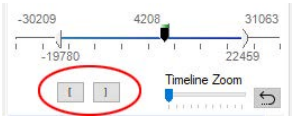
The numbers displayed above the far left and right sides of the Cine editor bar displays the frame number of the first and last images of the unedited Cine.

The number centered above the editor bar indicates the frame number of the play head, presently being displayed in the playback panel. Image 0 (zero) is the 'trigger frame', which is the first image after the moment of trigger was detected by the camera. Negative numbers represent pre-trigger frames and positive numbers represent post trigger frames

The numbers below the editor bar indicate the first and last image numbers of the edited Cine file, respectively.

5.2.2 Mark-In / Mark-Out

Locate the first and last image to save and use the following buttons respectively:

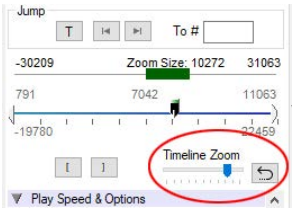


Mark-In - defines the new starting point of the selected Cine file.

Mark-Out - defines the new end point of the selected Cine file.

5.2.3 Timeline Zoom

The 'Timeline Zoom' function is useful when there are a large quantity of recorded frames, such as the case with reduced resolution or a large RAM buffer. It provides the ability to zoom into the area of interest and better define mark-in and out points.



1) Activate the Timeline Zoom function by adjusting the blue handle, zooming into the current position of the playhead. When activated a second bar will appear showing the area that is zoomed into including the quantity of frames now represented in the Timeline. The playhead is meant to always be contained within the zoomed range.

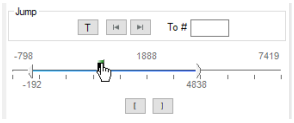
2) Mark-In and Mark-Out points can be set and adjusted like normal.

3) Click the reverse arrow next to the Timeline Zoom control to back out of this quickly and display the full timeline.

5.2.4 Quick Search (Jump / Scrub / Image Search)

There are several techniques to quickly jump / search through the active / selected Cine file.

5.2.4.1 Jump Options



Editor Bar - clicking the 'editor bar' advances the active Cine to the respective image / frame.

Jump to Trigger - instructs the software to jump to the recorded image when the trigger signal was detected by the camera, the T0 frame, if available.

Jump to Start - returns the Cine file to the beginning of the selected Cine file.

If 'Limit to Range' is selected, in 'Play Speed & Options', the Cine file returns to the 'Mark-In' point, specified by the user during the edit Cine process. If not selected, the Cine file immediately returns to the first image of the unedited Cine file.

Jump to End - jumps to the end of the selected Cine. Similar to 'Jump to Start', if the Limit to Range mode is selected, the Cine file will jump to the 'Mark-Out' point specified by the user during the edit Cine process. If not selected, the Cine file immediately jumps to the last image of the unedited Cine file.

 # (Image) - this data entry field is used to enter an image number to jump to.

5.2.4.2 Scrub Through

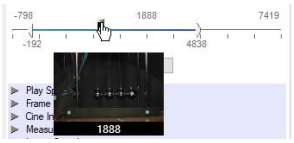


Image Locator - dragging the 'Image Location' slider right or left allows the user to scrub the active Cine.

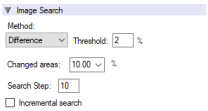
If the 'Cine Slider Tooltip' feature is enabled via the 'Manager > Preferences > General' dialog window the image associated with the cursor's location will be displayed. PCC only displays the 'Tooltip' images inside the 'Mark-In' and 'Mark-Out' points.

5.2.4.3 Image Search

This feature can reduce the time it takes to locate an event of interest that, in some cases, may be difficult to find within a recording by manual search. This feature can be used to search through a Cine stored in the camera's RAM, attached CineMag, or Cine files that have been previously saved.

The goal is to find an image change in the recording, based on the difference between image content from frame to frame, triggered by the change of a certain percentage of the pixels. A pixel is considered changed if its value in the current image is different from the value in the reference image by an amount called threshold. This allows the search to tolerate a certain amount of image noise.

Besides image content changes, 'Image Search' can look for images that are tagged as event images based on a change in the Event binary input signal. In addition, of course, one can jump directly to the first image recorded after the camera was triggered (Image 0).



Difference Method - compares the difference between two images to calculate the image's, user-specified, modified area called the Change Area. A pixel is considered modified when the difference between its values in the two images is greater than a Threshold value, which is also user defined.

Correlation Method - is based on the Normalized Cross Correlation (NCC) coefficient between two images. NCC has values between 0.0 and 1.0. This

coefficient measures image similarity. When NCC is 1.0, the current image matches exactly the reference image. The stop condition is NCC being below a threshold. To have a parameter similar to first case we define the image difference as: (1 - NCC)*100%. When the difference between two images is greater than this value a stop condition will be generated.

The search results are based on the following user-specified parameters:

Threshold percentage value - specifies the amount a pixel value must change in order to be counted as a changed pixel. The value is calculated as a percentage from the maximum possible pixel value. A higher value for this parameter is useful for noisy images. 8-bit images require a higher threshold than 16-bit images.

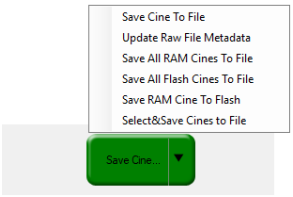
Changed areas percentage value - specifies the percentage of image pixels that must change in order to recognize an image change and generate a player stop condition.

Search Step - specifies the difference between the image numbers to be compared when running the search. This parameter helps to accelerate the search by processing fewer images.

Incremental search - if disabled, unchecked, the search is done by comparing the current image with the reference image, the image that was displayed when you initiated the search. If enabled, the comparison will be done between the current image and the previous image, (separated by the step increment).

5.3 Save Cine

The available 'Save' options vary based on hardware employed in the camera and the area of the 'Save' button selected. The following is a brief description of these options:



1. **Save Cine...** - when the main portion of the 'Save' button is selected it instructs PCC to save the selected Cine file to a hard drive, typically the control computer drive.
2. **Save Cine.. down-arrow** - when selected, a pop-up selection window displays used to specify the save option to use:
   a. **Save Cine to File** - used to save image data recorded in a camera's RAM to a user-specified location, (for example, your system's hard drive).
   b. **Update RAW File Metadata** - instructs the software to update the active Cine file with any changes in it's metadata - image adjustments in particular.

c. **Save All RAM Cines to File** - used with MultiCine (partitioned RAM) to save all Cines recorded in camera RAM to a specified location (for example, your system's hard drive or a peripheral drive. PCC will save the Cine files from each of the memory segments, of the selected camera, with a user-specified file name along with an appended extension (Cine#) for each of the Cine files.

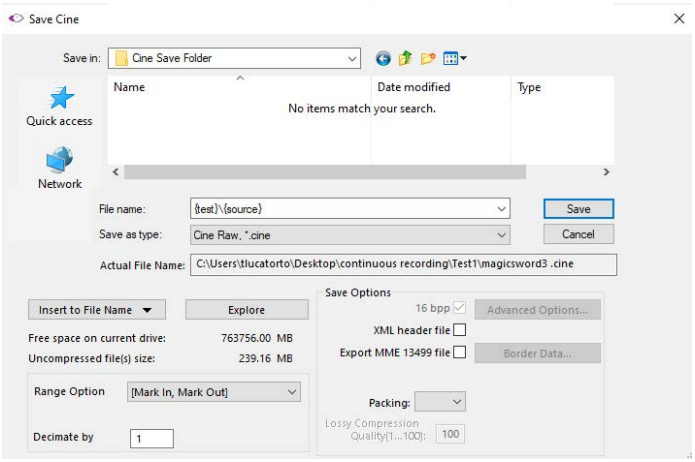
d. **Save All Flash Cines to File** - used to save all Cine files stored in an attached CineMag, CFast, CineFlash or installed Flash drive of the selected camera. The files are saved with a user-specified file name along with an appended extension, (camera_name_FlashCine#.ext), to a specified location.

e. **Save RAM Cine to Flash** - used to save image data recorded in a cameras' RAM to the attached CineMag, CFast, CineFlash or installed Flash drive.

f. **Select&Save Cines to File** - select specific RAM Cines, or Cines stored in Flash/CineMag memory, from one or more attached Phantom cameras to save.

5.3.1 Save Cine Dialog

The **Save Cine Dialog Window** displays once 'Save' is selected from the Play dialog (big green button), or any of the multi-Cine save options. The dialog also opens when setting up the Continuous Recording function.



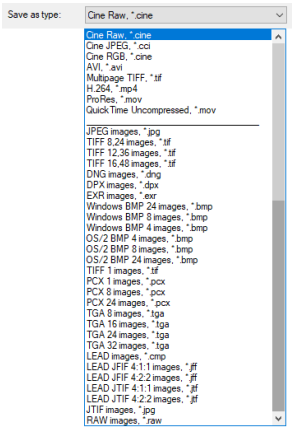
SETUP PARAMETERS / PROCEDURES

1. Initiate the File Save with

1. **Navigation Buttons**- used to specify the destination folder of the Cine file being saved.

2. **Save in:** - displays the folder location the saved Cine file will be saved in and can also be used to help navigate to the destination folder.

3. File name: - specifies a name for the Cine file being saved, for details about Automatic File Naming and the 'Insert to File Name' function, see Automatic File Naming.



4. **Save as type**: - defines the format the Cine file is to be saved as. The formats above the line are movie-like formats while the formats below the line contain a single image per file.

*Vision Research recommends the **Cine RAW** format be used when saving from the camera, for the highest quality and most efficient (fastest) file save.*

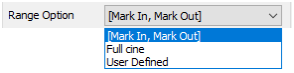
The chosen format is persistent, which means that if you change the save option the program will remember this choice next time PCC opens.

5a. **Insert to file name**: - several options, including suggested presets, for automatic name generation and file management. Applies a syntax string to the 'File Name' dialog.

5b. **Explore:** - navigate to the folder used in the automatic file name string.

6a. **Free space on current drive:** - indicates the amount of available storage space for the selected destination drive.

6b**. Uncompressed file(s) size**: - specifies the size the saved file will create.



7. **Range Options** - used to define the range of images to save via the pull-down selection list.
   a. **[Mark-In, Mark-Out]** - save the edited Cine images..
   b. **Full Cine** - saves all frames in camera RAM (memory buffer).
   c. **User Defined** - saves a user-defined range of images in the [first , last] fields. These fields specify the [first, last] image numbers to be saved. For example, if the event begins at image number -507 and ends at 10,832, any images prior to -507, and / or after 10,832 will be discarded (unsaved).

   d. **Decimate by** - used to reduce the number of images saved by the specified factor, for details about this option refer to Save Cine > Decimate Factor.

8. **Save Options** - the following briefly describes the various 'Save Options'.
   a. **16 bpp** - automatically enabled when bit depth is greater than 8-bits. Disable to save an 8-bit file

a. **XML header file** - creates an XML file, which can be used as a source of data for other applications. It contains the metadata of the recording.

b. **Export MME 13499 file** - creates a file containing cine metadata in the format specified by MME 13499, for use with 3rd party programs that use these files.

c. **Wav audio file** - visible for Flex4K cameras only - an audio.WAV file will be saved along with the files from RAM or CineMag, if audio was captured with during recording.

d. **Packing** - Cine file (from a ph16 camera, Phantom CineMag, CineFlash or 10Gb connected camera) will be saved in a Packed RAW Cine file format. Available options vary based on the source data.

e. **Lossy Compression and Quality (1... 100)** - these fields are used to specify the compression quality when saving a Cine file in one of the following file formats; Cine JPG, JPEG, LEAD, LEAD JFIF, LEAD JTIF, JPEG, or JTIF.

f. **Advanced Options** - only available if the file format selected is interpolated (other than RAW). It allows the user to select one of five color interpolation algorithms (Best, Good, Medium, Fast, Fastest) to apply to the Cine file during the save process.

Once a Cine file has been saved with a interpolated format (non-RAW) another algorithm cannot be re-applied to it by saving it again, as a result this setting is ignored.

h. **Border Data** - when enabled, information about the Cine file being saved / converted is placed into a border area outside the Cine(s). This option is available for interpolated image formats (non Cine Raw) only. See 'Border Data' for details.

i. **Multihead Options** - applicable for the legacy Phantom v6 Series camera only. When saving Cine files from v6 Series cameras the system will (by default) save the images from all four imaging heads into a single Cine file. Unique Cine files, for each of the imaging head, can be saved by selecting which camera 'Head(s)' to save in the Mutlihead Options dialog window.

5.3.2 Decimate Factor

The decimation factor is an integer number greater than or equal to 1, configured from the Save Cine dialog window, under the Range Option. It results in the reduction of the number of images that will be saved to file by the specified factor. The default, neutral value is 1. It means each image from the

specified range will be saved to file. A decimation factor of 2 means that one in two consecutive images will be saved to file, the other one will be dropped.

The table below shows which images will be selected to be saved to file for various decimation factors and for the input range [0, 18]. The red numbers correspond to frames which will be dropped. For example, if using the decimation factor 3, the images that will be saved to file will be images with numbers: 0, 3, 6, 9, 12, 15, 18.

DECIMATION FACTOR	IMAGE NUMBERS																		
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
2	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
3	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
6	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

Image Numbering for the Decimated Cine Files

Consecutive Cine images are always identified by consecutive image numbers. The same rule applies to decimated files. For non-neutral decimation factors, some images will be dropped during the save to file operation. Therefore a new method of numbering the images must be employed.

The basic rule is: ***input image number i will have number i / decimation on output*.** In other words, the images of the destination file are numbered based on the following rules:

- the numbering begins from input image 0
- the input image 0 corresponds to the output image 0
- the first input image to the right of image 0 that will be selected considering the decimation factor will have the number 1
- the second input image to the right of image 0 that will be selected considering the decimation factor will have the number 2
- similar to the left of image 0 (-1, -2, etc)

The following table illustrates how the destination file images will be numbered.

DECIMATION FACTOR		-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	SRC IMG NUMBER
	2	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	Selected Img Number
			-4		-3		-2		-1		0		1		2		3		4		Destination Img Number
	3	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	Selected Img Number
		-3			-2			-1			0			1			2			3	Destination Img Number
	4	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	Selected Img Number
			-2				-1				0				1				2		Destination Img Number
	5	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	Selected Img Number
						-1					0					1					Destination Img Number

PCC 3.6 and later will start the decimated file with the first frame specified in the save range. In previous versions of PCC the first frame will shift from the mark-in point until frame 0 is included in the save range.

5.4 Automatic File Naming

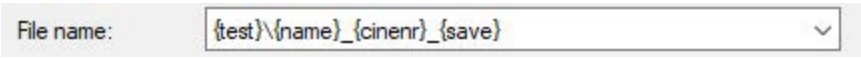
Automatic file naming gives you the option to have a series of images, cine files or snapshots named sequentially using functions that you choose. Parameters such as save number, trigger time, serial number can be included in the file name and appended sequentially to save time and to make organization and analysis of images easier. These new functions replace special characters that were used in previous versions of PCC. Functions are more intuitive and offer more options.

Special characters @ for save count, $ for camera serial number, ~ for time and ! for image number have been replaced by powerful FUNCTIONS.

How It Works - Overview

PCC provides a default file name for the recording. The default file name is displayed as selected (video inverse). You can type a file name to overwrite this default and the selected text will disappear, allowing you to specify your own file name. The default name is intended to help you generate file names that will be unique, so that you will not overwrite files.

The file name initially defaults to this:

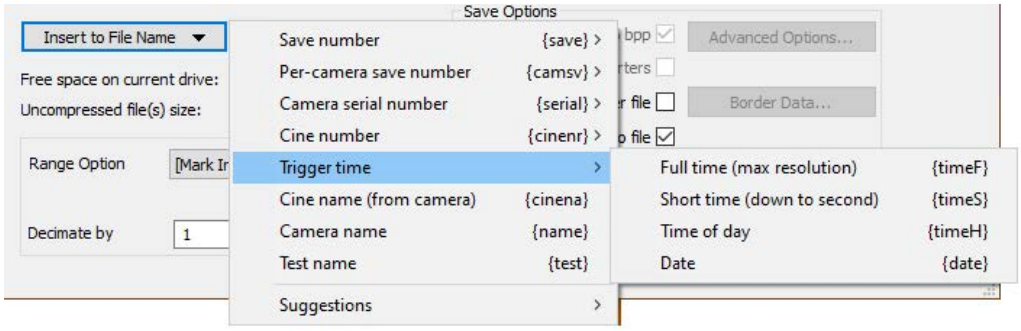


The default name is intended to help you generate file names that will be unique, so files will not be overwritten.

If you want to use the automatic file naming feature, you can accept the name, and the default input text will generate paths and file names that are unique, based on the information that you choose to be included in the file name. These functions shown in curly brackets { } will be replaced with their values. All the functions are described in the section "Understanding Save Options with Functions"

Understanding Save Options with Functions

Definitions of the save options with descriptions of each function follow.



These functions in brackets { } will be replaced with their values. There is no restriction on the size of the individual strings used for test, camera name, or other functions. However, the total size of the file name and path must be below 260 characters (recommended 250).

Save Option Function	Description	Common Use & Example
{test}	It is a string of characters with name of the test, experiment, project.	It can be included to create a folder or as part of the file name. Example: Falcon9Launch
{source}	It is used with conversions, when it is replaced with the name of the source file.	Batch saving and converting
{timeF}	Full precision time in a compact and sortable format. Numbers following the decimal point are fractions of a second. YyyyymmddHhhmmss.xxxxxxxxx	Example: Y2020531123455.00000001
{timeS}	A subset of full time without the fractions of a second: YyyyymmddHhhmmss	With recordings, as sub-second timing is not often a requirement. Example: Y202006040803
{timeH}	A subset of time that include only the time of day. Hhhmmss	When full timing is not desired Example: H114622
{date}	The date in a sortable format Yyyyymmdd	Example: Y20200516
{save}	The save number is incremented after the initiation of each save. It's persistent when the application is closed. It has positive values and can be resent to 1 or any positive value in "Auto-name settings..." dialog. Has the minimum width feature. It can have an optional final digit from 0 to 9.	This method allows you to name your files sequential after each save.
{camsv}	This is a collection of counters, separate for each camera, incremented at save to camera. It has positive values and can be reset to 1 or any positive value in "Auto-name settings..." dialog. It can also be reset to 1 for all cameras that were ever connected to a given instance of PCC.	If you include the camera name in the file name, it may be more convenient to use these counters instead of {save}.
{snap}	The snapshot number is incremented after each snapshot request. It has positive values and can be reset to 1 or to any positive value in "Auto-name settings..." or in Synchronous snapshot.../Snapshot at Trigger..." It is persistent when the application is closed.	For DIC applications, where a global snapshot number will ensure file uniqueness.

Save Option Function	Description	Common Use & Example
	Has the minimum width feature. It can have an optional final digit from 0 to 9.	
{cal}	Calibration number is intended to be used with {snap}. It has positive values and can be reset to 1 or to any positive value in "Auto-name setttings..." or in Synchronous snapshot.../Snapshot at Trigger..." dialogs. Has the minimum width feature. It can have an optional final digit from 0 to 9.	Intended to be used with {snap} to produce multiple groups of calibration images in separate folders. It is needed when stereo systems work with multiple optical systems during a test
{name}	Camera name. If not set, a name is built using the serial number.	
{serial}	Serial is the unique identifier for each camera. Has the minimum width feature. It can have an optional final digit of 5.	
{cinena}	Cine name is a string store in the camera for each cine. If not initialized in the camera, it will remain void.	
{cinenr}	Cine number is from 1 to n in camera RAM and for F1 to Fm where n is the number of partitions and m is the number of cines from flash. Has the minimum width feature. It can have an optional final digit from 0 to 4.	
{image}	Signed (+/-) image number as used in Phantom SDK and applications. It can be positive or negative.* Has the minimum width feature. It can have an optional final digit from 0 to 9.	
{+image}	Image number that is translated to positive. Must be used with a final digit to generate a fixed width number and align the file name with the needs of third party applications.* Has the minimum width feature. It can have an optional final digit from 0 to 9.	

* Note that if neither {image} nor {+image} are included, and a save to multiple images is required, a final digit will be inserted in the software, at the end of the file name and before the file extension.

*These characters are not allowed in the file name or have special functions: . / \ : * ? " < > |*

If a wrong character is used, you will get an error message. Once you acknowledge with OK, you will be returned to the Save Dialog.

You will also get an error if you select a custom range that is not included in the cine range of images when using function {cinenr}.

If camera name {name} or cine name {cinena} contain any of these characters, they will be replaced with an underscore '_'.

Minimum Width Feature for Functions

For the following functions, a minimum width feature is supported. .

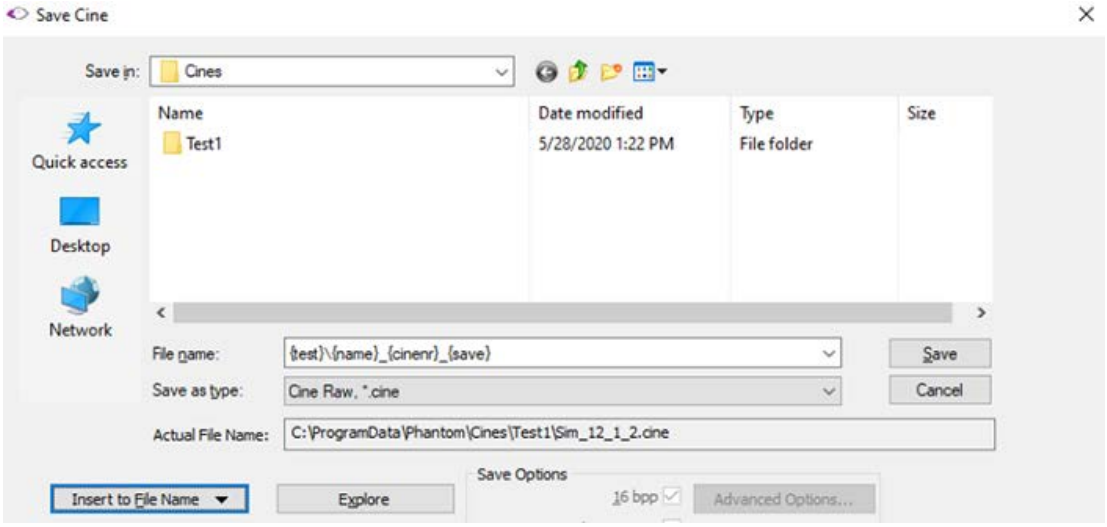
{image} {+image} {cinenr} {serial} {snap} {cal} {save} {camsv}

These functions accept a terminal digit from 0 to 9 that will force the representation of the value to a minimum number of digits with leading zeroes. If the value does not fit in the specified width, the width will be enlarged and the value will be correctly represented. Note that the alignment of the file names will be lost and you may have issues importing the images into other applications.

Fixed and Variable Paths

This is considered the base path, or "fixed path". Path segments or subfolders can be created beneath this "fixed path" and are considered the "variable path". The full path is a concatenation of the fixed and variable paths.

When the saved dialog box is opened, the fixed path will be displayed in the "Save in:" section of the dialog box. The variable path is displayed in the "File name:" edit/combo control.



The preceding screen shows that the last segment of the fixed path is “Cines” and the variable path is {test}\{name}_{cinenr}_{save}

The folders and files from the variable path do not exist with names as they appear with brackets!
You do not have to create folders or files - they will be created automatically.

When you save a recording, PCC automatically creates the variable path with the actual file name. PCC creates this name by replacing the functions with their current value, and creates all missing path segments before creating the file.

Note that the the path can be relative (to a base folder) or absolute (when starts with \ or C:\). You can even type absolute paths in "File name:" and ignore the path that is selected in "Save In:". If the segments in your path exist, they will be used. If not, they will be created at the time the file will be written.

If you type your own file name without functions, it will not be persistent.
At next time you save, the dialog box will contain the last name with functions you used.

How to Create Your Files

"Insert to File Name ▼" opens a menu with parameters you can insert if you want to customize the file name that is created. You can also enter the function names manually if you want and insert text to make the names more clear to you. Any function that is not recognized will remain in the file name as typed; characters '{' and '}' are accepted in the file name.

The suggested variable path and the macros available are dependent on context. We have 5 scenarios:

1. Snapshot images
2. Recording(s) in camera to be saved as single file
3. Recording(s) in camera to be saved as multiple image files
4. Cine file(s) to be converted to single file destination
5. Cine file(s) to be converted to multiple image files

There is an "Actual name" displayed by the software. It will be the name that will be used for the next file save.
Handling the extension is automatic. You do not have to type it in the File name field. The system will fill it and you can see it in the actual name. If you fill an extension, it will be used.

If you fill a name without any function, it will be used but will not be persistent. Next time, you will get the last name with functions that was stored.

Safety Net To Prevent Overwriting

For unattended operation, it is necessary to suppress the dialogs that confirm files being overwritten. Without these dialogs, there is the risk of overwriting an existing file and losing an important recording. To avoid any risk, before creating a new file, PCC checks if a file with that name already exists in the selected folder. If positive, the file name is changed by appending a numeric suffix starting with (2). If the appended file still exists, the number is increased to (3), (4) … To work correctly, the path and file names need to be shorter than the maximum size (260 characters). If they are 250 characters there is a reserve of writing 100 million duplicate files with the 8 digit available.

This provision is normally not needed but may be used in simple naming schemes for consecutive numbering of the files from each camera by including only the name of the camera in the file name.

Use Cases for Automatic File Naming

Based on your project, automatic file naming may be a necessity, as in the case of unattended operation with continuous recording. Phantom cameras and PCC software have long supported unattended operation with automatic file naming. Version 3.5 improves and enhances our existing file-naming language significantly. The following use cases for automatic file naming will allow you to understand and take advantage of the new Save Options based on your application.

Unattended Operation and Continuous Recording

There are projects where high-speed cameras operate unattended for weeks or months. Common examples are recording lightening striking a tall building or recording a rocket launch. In these cases a naming scheme can easily organize the image files.

In this example, there are two (2) cameras with names Camera1, Camera2 and with serial numbers 123 and 124 respectively.

By specifying the automatic file name as:

C:\PhantomCines\{name}_{serial}\Cine_{save3}

The files after each recording and before saving will have file names as follows:

For Camera1 with serial number 123:			
C:\PhantomCines\Camera1_123\		(folder)	${name}_{serial} is replaced with Camera1_123
	...Cine_001.cine	(file)	{save3} creates the save number with 3 digits
	...Cine_003.cine	(file)	
	...Cine_00n.cine	(file)	Where n will be the next odd number
For Camera2 with serial number 124:			
C:\PhantomCines\Camera2_124\		(folder)	${name}_{serial} is replaced with Camera2_124
	...Cine_002.cine	(file)	
	...Cine_004.cine	(file)	
	...Cine_00m.cine	(file)	Where m will be the next even number

PCC creates the file paths or folders, even if more than one, and writes the files in those folders.

The function Save number {save} is global for all cameras in the pool.

Saving Images to Single Image Files

To make recordings available in third party software used for measurements or image enhancement, cameras must be able to provide compatible file formats. PCC supports the creation of single image files in TIF and JPG formats. Since recordings contain thousands and sometimes millions of separate files, automatic file saving is a necessity.

Phantom cameras and PCC determine image numbering in relation to the trigger, with the images before the trigger being negative and the image after trigger being zero or positive, Many applications are not able to deal with negative image numbers, so PCC provides functions {+image} and {image} to allow the flexibility for either positive or signed (+/-) image numbers. An example follows:

By specifying the automatic file name as:

C:\PhantomCines\{name}_{serial}\Img_{+image4}.tif

The files after each recording and before saving will have file names as follows:

For Camera1 with serial number 123:			
C:\PhantomCines\Camera1_123\		(folder)	${name}_{serial} is replaced with Camera1_123
	...Img_0000.tif	(file)	{+image4} creates the image number with 4 digits
	...Img_0001.tif	(file)	
	...Img_000n.tif	(file)	Where n will be the next image number
For Camera2 with serial number 124:			
C:\PhantomCines\Camera2_124\		(folder)	${name}_{serial} is replaced with Camera2_124
	...Img_0000.tif	(file)	{+image4} creates the image number with 4 digits
	...Img_0001.tif	(file)	
	...Img_000m.tif	(file)	Where m will be the next image number

Batch Save and Batch Convert

Using cameras configured with a large number of partitions may require a large number of save operations. PCC offers batch save operations like saving all cines from:

1. Camera partitions (All cines from RAM)
2. Camera Flash (All cines from Flash)
3. Selected files from all cameras' RAM and Flash.

A meaningful approach is to use camera name with function {name} and cine number {cinenr} in the file name to have information about the original location of the recording.

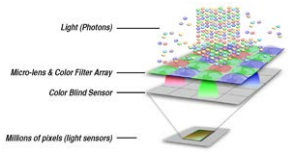
The files from saved recordings can then be converted and processed to other formats. This is a time consuming operation and is usually run unattended. The best choice for destination names is to use the source names with the {source} function.

Snapshots

Saving an image file from a live stream video or from a recorded video is called a snapshot. It is possible to save image files from multiple cameras at the same time. A particular case is the synchronous snapshot when there is a request to obtain the images at exactly the same time. To do that, the cameras operate in stereo mode (have connected F-Sync signals, hardware triggers, and the time is synchronized). The sync snapshot is taken when hardware is triggered.
Naming snapshot files is always automatic and similar to saving recordings to individual images. A global “snapshot number” was added to define each operation and avoid overwriting files. This is function {snap}.

5.5 File Formats

IMPORTANT DEFINITIONS



Bayer Color Filter Array

Color interpolation (Demosaicing) - Single-sensor color CMOS-based cameras incorporate a Color Filter Array (CFA) to reconstruct a full color image in the image pipeline. The CFA is a grid that selectively filters the light by wavelength range using the Bayer filter configuration.

RAW images from a color sensor contain an array of values which represent a specific color level per pixel (red, green and blue). In order to obtain a full-color image a process is required called 'color interpolation' or 'demosaicing'. Analyzing each pixel and its neighbors, a color interpolation algorithm basically reconstructs the missing color components and produces the desired color image.

PCC provides five preset color interpolation algorithms in the Image Tools menu. This setting gets applied to the live images, the playback images and file conversions.

Monochrome sensors do not include this CFA or the processing associated with it. All file formats available in PCC are compatible with both color and monochrome sensors.

The term “RAW” generally refers to something unprocessed, unrefined.

- A RAW file generally stores an image as a stream of bytes without using any compression or special techniques. Metadata, including camera settings and time code, gets stored in a file header.
- Phantom cameras employ Packing (explained below) to increase efficiency when working with Cine RAW files.

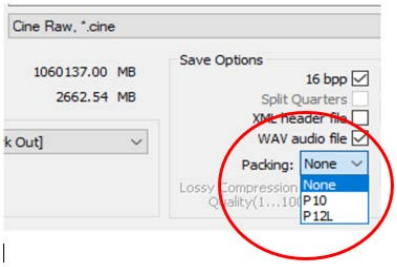
CINE FILE FORMATS

Cine Raw, *.cine - the default, proprietary native format for all Phantom cameras.

Advantage - Cine RAW files contain all the settings and timing information stored within the file. It will store 8 or 16-bit images with or without 'packing'. The images stored on 16 bits can have a smaller number of used bits: 10, 12 or 14, which depends on the camera model. The images are saved as read from the sensor and the format is very compact. The save time is the best of all the formats offered in the Phantom application.

Disadvantage - Color Cine RAW files are un-interpolated and each image needs to be interpolated on the fly during playback. The colors are computed by interpolating each pixel's neighbor colors, according to the selected color interpolation algorithm in Image Tools, so the playback speed is often slower than other formats. Third party video editing programs may not be compatible with the Cine Raw format due to the processing required. Another disadvantage is that Border Data can not be applied directly to Cine RAW, until it is converted to a different format.

Packing explained



Cine RAW Packed 'None' - Cine Raw files are saved as either 16-bit (with padding for 12-bit images) or 8-bit.

- With Packing set to “None” and the 16 bpp checked, 10 or 12-bit cine files are saved as padded 16-bit images. This results in larger files and longer downloads with no loss in image data.
- With Packing set to “None” and the 16 bpp unchecked, files are saved as 8-bit. This results in smaller files and in most cases a noticeable loss in image quality.
- Third party software may not be fully compatible with unpacked Cine files.

Cine RAW Packed 'P10' - This format was developed to transfer 12-bit images more efficiently, packing them to 10 bits using a defined log curve that sacrifices only the lowest bits.

- File sizes are 16% smaller than packed 12-bit linear files.
- This is the primary documented file format for third party software

Cine RAW Packed 'P12L' - A linear format that enables the faster download of 12-bit sensor data by efficiently “packing” every two 12-bit pixels into three bytes, rather than utilizing a full two bytes (16-bits) for each pixel. This is a 25% gain in bandwidth utilization.

- This option is useful for a situation where 12 linear bits of an image need to be downloaded for data analysis.
- Available only when saving files out of RAM. This is not available when saving files from a CineMag or Flash.
- File sizes are 20% larger than P10 Cine files.
- Third party software may not be compatible with P12L Cine Raw files.

Phantom CineMag and other flash media stores Cine data in the Packed 10 'P10' format, therefore Packed 10 is the only option for files saved from flash.

You can not change the bit packing method and re-save as a Cine Raw. The bit packing options are only available when downloading from RAM.

Cine JPEG, *.cci - Advantage - the Cine JPEG format uses a lossy compression routine to compress the images from the Cine file while retaining the timing and other information within the file. It will store only 8 bit images. It results in the smallest file size but there is a loss in the image quality, depending on the quality factor you chose at save.

Disadvantage - it takes a bit more time to save the Cine file as the JPEG compression is performed. Not all third party software analysis packages will work with this format, image is altered and some details can be lost.

Cine RGB, *.cine - Advantage - the Cine format is a Vision Research proprietary file format very similar to the Cine RAW format except that the colors are interpolated and every pixel holds all three color components RGB. It will store 8 or 16-bit images. Border Data can be applied to Cine RGB and is the closest format to Cine RAW that allows this. The playback speeds are faster than Cine RAW because the colors are already interpolated.

Disadvantage - it is usually about three times the size of Cine RAW file and takes longer to save.

ADDITIONAL SUPPORTED FILE FORMATS

AVI (*.avi) - Advantage - the Audio Video Interleaved (AVI) format uses the AVI CODECS to save the file in a universal format used by several video playback packages. This universal format makes it easy to share for viewing since almost every PC has a viewer built into the operating system. The timing and setting information (“metadata”) is stored in a separate file known as the Cine header file (.chd) or in a XML file. The AVI file can be played back within the Phantom application with the information intact.

Disadvantage - files saved in the AVI format are converted to 8-bit.

In previous PCC versions the Windows 32-bit installation of PCC included additional video options including AVI CODECS not available to the 64-bit program due to Windows compatibility. It is possible to run a 32-bit version of PCC in addition to the 64-bit program to gain access to these formats. Contact Vision Research for more information.

CHD files (.chd) are automatically saved along with each non-Cine file format when files are saved or converted. This is the "Cine Header" file which contains metadata that includes the cine settings and timing information important for measurements and when using PCC software.

During file conversion a .XML can be saved for the same information in a different format.

Multipage TIFF (*.tif) - Advantage - some industries require the multipage TIFF format and there are third party software packages that use this format for image analysis. The TIFF file can be played back within the Phantom application with the information intact. The file size is the same as the Phantom Cine RGB format.

Disadvantage - the Multipage TIFF format has a 2 gigabyte file size limit, so on large memory cameras the customer will need to save the large Cine files in segments. Files saved in the multipage TIFF format are converted to 8 bits.

H.264 (*.mp4) - Advantage - H.264 video encoding provides efficient compression, delivering considerably more detail at a lower bit-rate compared to other compression methods. MP4 is a popular choice for video conversion and delivery.

ProRes (*.mov) - Apple ProRes-encoded quicktime files can be played on Windows and Mac with a compatible video player (not all video players are compatible). This is a great option when the converted videos will be edited with a professional video editing program. Five different Prores options are available to choose from and ProRes 4:2:2 HQ is the default.

QuickTime (*.mov) - a universal file format with predictable results in third party applications.The file size is the same as the Cine RGB format. Only the uncompressed version of this format is implemented, and the files are converted to 8-bit. The MOV format will not play back in the Phantom application.

The following are single-image formats that are used to convert a Cine sequence into an "image stack" or folder of files

JPEG (*.jpg) - a universal file format that allows for control on the compression quality. This means that you can opt for a smaller image with less detail or a larger image with more detail.

TIFF (*.tif) - one of the most popular and flexible of the current public domain raster file formats. TIFF's main strengths are a highly flexible and platform-independent format that is supported by numerous image processing applications. PCC supports 8, 12 and 16-bit TIFF single-image formats.

DNG (*.dng) - DNG (Digital Negative) is a non-proprietary file format developed by Adobe Systems and used for storing RAW images. DNG is TIFF/EP standard compatible. A DNG file contains unprocessed, uninterpolated data.

DPX (*.dpx) - Digital Picture Exchange (DPX) is a common file format for digital film work and is an ANSI/SMPTE standard (268M-2003). The file format is most commonly used to represent the density of each color channel of a scanned negative in a 10-bit log format where the gamma of the original camera negative is preserved as taken by a film scanner.

EXR (*.exr) - Recommended for use only with the Flex4K and VEO4K sensor, in rolling shutter mode. Raster image stored in the OpenEXR format, a high dynamic-range (HDR) image file format developed by Industrial Light & Magic; supports multi-layer images, lossy and lossless compression.

Windows BMP (*.bmp)/ OS/2 BMP (*.bmp) - Bitmap (or raster) images are made up of pixels in a grid, and are seen in Windows as maps of the grid of pixels and their color assignments. BMP supports only 8 bits per pixel (24 bits per pixel on color images).

PCX (*.pcx) - one of the oldest raster formats. PCX can be used for graphic data operations. Due to its inefficient compression scheme and the advent of other image formats, PCX has lost some of its popularity.

TGA (*.tga) - this format (Targa or TGA) supports any image dimensions and color depth of 1 to 32 bits. The TGA format is a format for defining raster or bitmap images. Targa supports color maps, alpha channel, gamma value, postage stamp image, textual information and developer-definable data. Targa images exist in both compressed and uncompressed formats. The 32-bit Targa format contains 24 bits of color data and 8-bits of transparency data. Color support ranges from black and white, indexed and RGB color. Some applications may treat any TGA file as 24-bit. A 16-bit image will be up-graded to a 24-bit image while a 32-bit image will be downgraded to a 24-bit image.

LEAD (*.cmp) - The LEAD CMP format was created by LEAD Technologies, Inc., and it utilizes the patented CMP compression. CMP compression delivers a much smaller file size and better image quality than other compression techniques.

LEAD JFIF (*jff) / LEAD JTIF (*.jtf) - Refer to LEAD and JTIF.

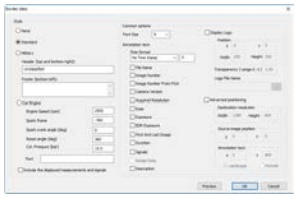
JTIF (*.jpg) - JTIF (JPEG File Interchange Format) is just a file format for a compressed JPEG image. TIFF can actually store its pels compressed in a wider variety of ways, including JPEG. JTIF is the common JPEG file format seen in *.jpg files.

RAW (*.RAW) - Images saved using the RAW file format contain only an array of pixel values. There is also an option whereby the user may create a header file that contains dimensions and bit depth information. RAW files can be written as binary values or ASCII text values (readable in MS Notepad). They cannot be read in PCC. This tool allows the user to decode any binary file into an image and allows the user, for example, to look into fragments of Cine files to find the image dimensions and the images themselves. In general, the RAW format was designed for users that write their own applications.

5.6 Border Data

When saving images to any format other than Cine Raw, the option to add border data is available. Border data consists of capture and timing information, in addition to the overlay of your company logo.

SETUP PARAMETERS



1. **Style**
   a. **None -** no border data is displayed.
   b. **Standard** - displays the specified 'Common Options' **below** the image area.
   c. **Military** - displays the specified 'Common Options' to the **right** of the image area, along with the option to add Header and Footer information.
   d. **Car Engine** - displays the specified 'Common Options' **above** the image area, along with user requested parameters for automotive applications.

2. **Include the displayed measurements and signals** - any 'collect point' (tracking) measurements or signal (Range Data / Data Acquisition Unit) values associated with the file will be saved as a 'Graphic' chart. This option is available even with "None" selected.

3. **Common Options**
   a. **Font Size** - specifies the font size the 'Annotation Text' fields will be displayed.
   b. **Annotation Text** - specifies the information included in the border data when selected.
      1) **Time Format** - indicates the type of time stamp information to be displayed:
         a) **No Time Stamp** - no time stamp information will be displayed.
         b) **Absolute Time** - display date and time (to the nano-second) the image was recorded.
         c) **From Trigger** - displays time difference from when displayed image was recorded to when the camera was triggered.
         d) **From Image** - displays time difference from when displayed image was recorded to the image number specified in the 'From First Image' data entry field (by default the first full image after trigger, the trigger (t0) frame).
         e) **From First Image** - displays the time difference from when the displayed image was recorded to when the first image of the Cine was recorded.
         f) **Absolute Time & From trigger** - displays the time in both formats.
         g) **Absolute Time & From image** - displays the time in both formats.
         h) **Absolute Time & From first image** - displays the time in both formats.
      2) **File Name** - displays the name of the file / image specified in the 'File Name' data entry field, in the 'Save Cine' dialog window.
      3) **Image Number** - indicates the image number of the image being displayed.
      4) **Image Number From First** - indicates the number of images from the first image being saved to the image being displayed.
      5) **Camera Version** - indicates the 'Hardware Version' (camera model) used to record the file being saved.
      6) **Acquired Resolution** - displays the width x height the file was recorded at.
      7) **Rate** - indicates the 'Sample Rate' setting the displayed image was recorded at.
      8) **Exposure** - indicates the 'Exposure' setting the displayed image was recorded at.
      9) **EDR Exposure** - indicates the 'EDR' (Extreme Dynamic Range) exposure setting the displayed image was recorded with.
      10) **First and Last Image** - indicates the 'first / last' image numbers of the images contained within the saved file.

11) **Duration** - indicates the duration of the saved file.

12) **Signals** - displays the values of all signals sampled by an attached Data Acquisition Unit for the displayed image.

13) **Range Data** - displays range data (i.e, azimuth / elevation) information embedded in the file being saved.

14) **Description** - displays the description originally entered in the 'Live>Cine Settings>Description' field.

c. **Display Logo** - used to embed a 'Logo Image File' (watermark) to the images being saved.

1) **Position** - specifies the X - Y coordinates (placement) of the 'Logo File Image'.

2) **Transparency (range 0 - 1)** - specifies the degree of 'Transparency' of the 'Logo File Image'.

3) **Logo File Name** - used to specify the location / name of the 'Logo File Image'.

c. Advanced Positioning

1) **Destination Resolution** - specifies the Width x Height (size) of the final image that includes the 'Border Data' window.

2) **Source Image Position** - specifies the X - Y coordinates (placement) of the images in the final image that includes the 'Border Data' window.

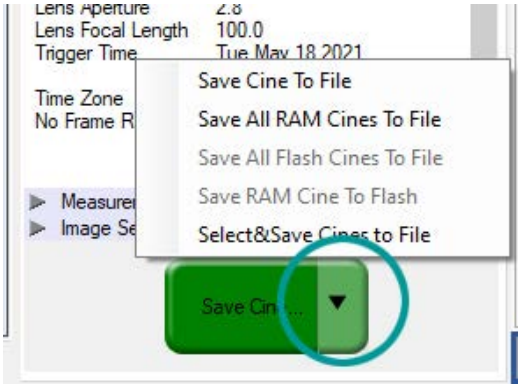
3) **Annotation Text** - specifies the X - Y coordinates (placement) of the selected 'Annotation Text' fields in the final image that includes the 'Border Data' window.

3. **Preview** - click the 'Preview' button to display a preview image of the final image that includes the 'Border Data' settings.

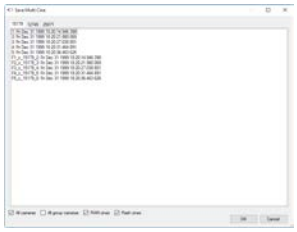
4. **Ok / Cancel** - click the 'OK' button to apply save the 'Border Data' with the file(s) being saved.

5.7 Save Multi Cine Dialog Window

Save multiple files from connected cameras, RAM segments and Flash Cines using the additional options found when selecting the arrow next to the green 'Save Cine' button.



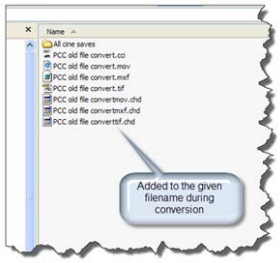
These options are useful when working with CineMags or to select specific Cine files to save when using the Partition memory feature.



1. **Display options** - enabling the following determines which cameras / files the end-user can select to save:
   a. **All cameras** – display a camera tab for all connected to Phantom cameras.
   b. **All group cameras** – displays a tab for all cameras associated with the selected group.
   c. **RAM Cines** - RAM Cine files will be displayed in the camera's tab window.
   d. **Flash Cines** - Cine files stored on the camera's attached CineMag, CineFlash, CFast 2.0 card, or internal Flash will be displayed in the camera's tab window.
2. **Cine Select** - for each camera highlight the Cine to be saved.
3. Click the **OK** button.

5.8 Measurement Functions

PCC includes the ability to perform basic motion analysis on Cine files for timing measurements including distance-speed and angle-angular speed, collect and track points, and generate report files.



For measurements with a converted file format, when converting Cine files into any other non-Phantom Cine format a .chd file is also created, which contains the 'Cine Header' information so PCC can display all the header information when playing it back. The .chd must be retained in the folder when using those files for measurements in PCC.

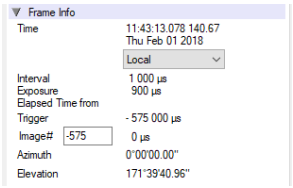
Cine files converted with a PCC version prior to PCC 2.0 have a known issue where the .chd is missing information to import correctly, resulting in incorrect measurements. This does not affect native Cine formats.

5.8.1 Timing Measurements

Vision Research embeds a time stamp at the end of the strobe of every frame captured. The time stamp, (date and time), clock source can be the control computer's, IRIG-B, or a GPS clock / signal (camera dependent).

Typically, timing measurements' are used to measure the time difference between two frames (start / end of event), or from a known point in the event to trigger (t0 frame) automatically. Unlike 'distance' and 'speed' measurement, timing measurements do not require a defined calibration scale to perform these measurements.

PROCEDURES



1. **Frame Info** - displays the following information about the present frame:
   a. **Time** - select the type of 'Time' information displayed form the pull-down selection list (below the 'Time' display field:)
      1) **Local** - displays the absolute time and date (the time stamp time stamp generated by the attached Phantom control computer's date and time reference) the image was recorded, in hh:mm:ss:ms:µs; Day Mon dd yyyy. A tag may be appended to time displays, as follows:

         E - Provided as an 'event' marker.

         S - Designates that the time displayed was synchronized to a time source.

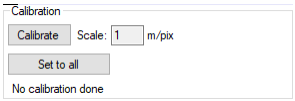
      2) **utc (GMT)** - displays the date and time reference adjusted to utc (Universal Time Clock), formally referred to as GMT (Greenwich Mean Time). The adjustment will be the time difference from the date and time settings of the Phantom control computer to utc (Universal Time Clock). The utc (GMT) option appends utc to the time stamp reference.
      3) **Time Code** - displays the Cine's time code converted to SMPTE. The SMPTE time code output is generated based on the trigger frame of each recorded Cine. For detailed description on the 'SMPTE Time Code', see: Functional Descriptions>SMPTE Time Code in Phantom Cameras.
   b. **Interval** - indicates the image interval (duration of a frame) of the image being displayed in the active 'Play' panel (displayed in micro-seconds). This value is equal to 1/fps and it is different than the exposure time.
   c. **Exposure** - the duration of time a pixel is open to collect light per frame (displayed in micro-seconds).
   d. **Elapse Time From** - used to perform various timing measurements:
      1) **Trigger** - indicates the elapsed time of the image being displayed in the active 'Play' panel, and trigger (displayed in micro-seconds).
      2) **Image#**: indicates the elapsed time from the specified image number in the data-entry field and the image currently being displayed.
   e. **Azimuth** - indicates the angle of horizontal deviation, measured clockwise, of a bearing from a standard direction, as from north or south.
   f. **Elevation** - indicates the altitude of a place above sea level or ground level values for Cines that have 'range data.

5.8.2 2D Scaling & Calibration

Since a Cine file is typically recorded and viewed at some reduction in size to the original scene, you must establish the reduction value or perform a calibration to measure actual distances, speeds, or accelerations. A measurement scale is required to set a specified number of pixels in the image equal to a scale unit size, such as millimeters, meter, inches or feet.

To define a measurement scale, typically you need to select two points in the image of a known scale then specify the object size. Ideally, the scale used for calibration should be in the same motion plane as the target for greatest accuracy. A scale in front of, or behind the target will result in a less accurate measurement.

Once calibrated, all measurements are computed and displayed using the scale unit. If no measurement scale exists, the default scale will be 1 unit = 1 pixel.

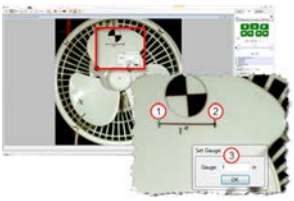


Calibrate: - selecting this button starts the process to specify a calibration 'scale'.

Scale: - indicates the calculated scale value based on user-specified points.

Set to all: - selecting this button instructs PCC to apply the user-defined scale to all open Cine files.

PROCEDURE



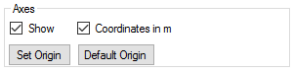
After the measurement units have been defined (see Application Preference > Measurement to specify the measurement 'Units') calibrate a measurement scale by:

1. Click the 'Calibrate' button
2. Click one end of the known scale
3. Click the other end of the scale
4. Specify the size of the scale

If the scale value (unit per pixel)is known the value can be entered in the 'Scale' data entry field.

5.8.3 Origin Definition / Coordinate Analysis

Coordinate measurements are calculated from an 'Origin' point pixel, (by default the top-left corner pixel of image); however, the Origin can be changed to perform measurements. Each coordinate consists of two numbers (x_1, y_1) indicating the position of a pixel in the image on the two-dimensional plane from the Origin point



Show: - instructs PCC to overlay a blue cross-hair on the image (not recorded) with the center-point being the 'origin'.

Coordinates in <unit value>: - displays the x, y position of the pixel selected in the 'Status' bar.

Set Origin: - allows the user to define a new 'origin' point.

Default Origin: - replaces the 'origin' back to the default upper-left (1,1) position.

PROCEDURE

After the measurement unit preferences and calibration scale have been defined:

1. Click the 'Coordinates in [distance unit]' button in the Axes' options under the 'Measurement' selector.
2. Placing the cursor over an x, y pixel shows the distance in [distance unit] from the origin instead of absolute x, y pixel numbers.

5.8.4 Instant Measurements

Instant Measurements consists of four unique motion analysis tasks, including:

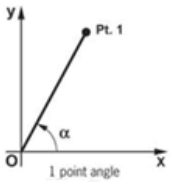
- Distance & Angle & Speed: Origin + 1Point
- Distance & Angle & Speed: 2Points
- Angle & Angular Speed: 3Points
- Angle & Angular Speed: 4Points

All 'Instant Measurements' can be used in conjunction with a 'Report File' or without. With a report opened, the image number, elapsed time from trigger, unit of measurement, distance (or dimension) speed and any comments are automatically saved in the open report file. Report files are saved are identified by the file extension .rep. You can use any of the 'Instant Measurement' options without opening a report file whenever you want to measure just a few key points in a Cine quickly. It will not be possible to attach comments, and these measurements will not be saved to a file.

The measurement results will be displayed in the 'Results' field of the 'Instant Measurements' options.

5.8.4.1 Distance & Angle & Speed: Origin + 1 Point

The Distance & Angle & Speed: Origin + 1Point option can be used to measure the distance and speed of linear motions with respect to a fixed point of origin, the angle formed with respect to the x-axis, or the speed of a rotational motion (computed with respect to the horizontal axis of the picture screen), when only one point is known.



Distance and Angle and Speed: Origin + 1 point measures:

- Distance from the origin point to a selected point.
- Angle made by the selected point with Origin and Ox axis.
- Speed *(s = d / ⊿time)*, where d = measured distance, *⊿ time* = [time of the point frame] – [time of the origin frame] if point and origin are on different frames.
- Angular Speed *(as = a / ⊿time)*, where a = measured angle, *⊿ time* = [time of the point frame] – [time of the origin frame] if point and origin are on different frames.

PROCEDURE

1. Select the 'Distance & Angle & Speed: Origin + 1point' option from the pull-down selection list
2. Optionally, create or open a Report File to record the measurements, see the 'Create / Open a Report File'.
3. Using the Playback buttons, advance/rewind the Cine to the image you wish to measure the distance, speed, angle, and angular speed measurement on.
4. Click on the point to be measured.
5. The results are located in the 'Instant Measurement > Results' field; d=distance, a=angle, and s= speed. The software also displays a graphical representation of the angle measured (magenta) over the image in the Playback panel.
6. Repeat steps until all additional distances, angles, or speeds for the current image have been measured. Then advance the to the next image to continue.

7. Once all measurements have been performed; disable (uncheck) the 'Querry for Comments' option and close the Report File, then
8. Disable (uncheck) the Instant Measurements > Active option.

To close the Report File, see the 'Closing a Report File or a Collect Point File' topic later in the course.

5.8.4.1.1 Create / Open a Report File

In addition to measurement data files, a comma-separated text-delimited report file can include information about the test event such as camera, camera position or station, lens and f-stop, the name of the analyst or team that recorded the test, and the Cine file name. The report file will also include the day, date, and time of the test, unit of measurement, scale factors, and the (x y,) coordinates if the origin. Finally, the report file format allows you to include a description or comment about each point selected for measurement.

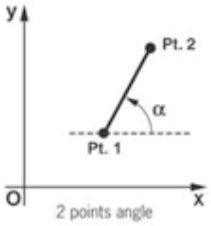
The contents of a report file can be viewed in many text editors and word processor programs; some additional formatting may be required.

PROCEDURE

1. Click on the '...' button to the right of the 'Report File Path' data entry field.
2. In the Open dialog window:
   a. Navigate to the folder the Report File is to be, or has been saved in.
   b. Enter the filename of the Report File in the 'File Name' entry field, then
   c. Click on the 'Open' button.
4. In the 'Setup for Measurement Report File' dialog window, enter the report files header information:
   a. 'Title' of the report
   b. Name of the 'Analyst'
   c. 'Station' or camera used to record the images being analyzed.
   d. 'Camera' model used to record the images
   e. Information about the 'Lens' used, i.e., manufacture, type, f-stop, etc.
   f. Click the 'OK' button.
5. Optionally enable (check) the 'Query for Comments' to enter a comment for each measurement taken.

5.8.4.2 Distance and Angle and Speed: 2points

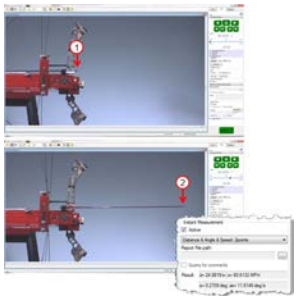
The Distance & Angle & Speed: 2Points option can be used to measure the dimensions of an object or space, the displacement and speed of an object in one image with respect to its new position in any subsequent image, angular speed (computed with respect to the horizontal axis of the picture screen), or the speed of a rotational motion, when two points are known.



1. Distance between the two selected points.
2. Angle made by the line formed by the two selected points with Ox axis.
3. $speed = \frac{\triangle distance}{\triangle time}$, where *distance* = measured distance; ⊿ *time* = [time of the second point frame] – [time of the the first point frame] if the two points are on different frames.
4. $angular\ speed = \frac{\triangle angle}{\triangle time}$, where *angle* = measured angle, ⊿ *time*= [time of the second point frame] – [time of the the first point frame] if the two points are on different frames.

Distance & Angle & Speed: 2 Points with both points on same frame (Image: 1034).

PCC automatically calculates and displays the distance (length) and angle (degrees) of the user-selected points (1) Point 1 – feather end of the arrow; (2) Point 2 – tip of the arrow.



Distance & Angle & Speed: 2 Points Example

Top image shows user-selected (1) Point 1 (tip of the arrow) on the start of event frame (Image: 985). The bottom image shows the Cine advanced a few frames (to Image: 1034 with the user-selected (2) Point 2 (again the tip of the arrow) to measure.

PCC automatically calculates and displays the distance (displacement), speed, angle, and angular speed of the arrow.

PROCEDURE

Common Steps

1. Click on the Measurements selector and calibrate the Measurement Scale.
2. Enable, check, the Active enable box under the Instant Measurements options.
3. Optionally, create or open a Report File to record the measurements.
4. Click the down arrow to the right of the Select Measurement... field, and select the Distance & Angle & Speed: 2points option.
5. Using the Playback buttons, locate the first Cine image on which a measurements scale can be performed on.

For Distance and Angle Measurements Only:

6. Select a point on the object being measured.
7. Move the cursor to a second point and click the mouse key.
8. If you checked the Query for Comments, a comments dialog box will appear now. Enter your description or comment in the box (approximately 40 words). Click OK to accept the command.

For Distance, Angle, and Speed Measurements:

6. Select a point on the object being measured.
7. Using the Playback buttons, advance the Cine to the next image you wish to perform the measurement on and move the cursor to the same point on the object being measured and click the mouse key.
8. If you checked the Query for Comments, a comments dialog box will appear now. Enter

The results are located in the Instant Measurement>Results field; d=distance, and a=angle. The software also displays a graphical representation of the angle measured, (magenta), over the image in the Playback panel.

The software also displays a graphical representation of the angle measured, (magenta), over the image in the Playback panel.

your description or comment in the box (approximately 40 words). Click OK to accept the command.

The results are located in the Instant Measurement>Results field; d=distance, a=angle, and s=speed. The software also displays a graphical representation of the angle measured, (magenta), over the image in the Playback panel.

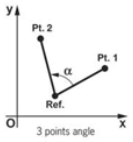
The software also displays a graphical representation of the angle measured, (magenta), over the image in the Playback panel.

Once all measurements have been performed:

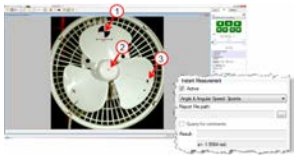
9. Repeat these steps until all additional measurements have been taken.
10. Disable the Querry for Comments option.
11. Close the Report File.
12. Disable the Instant Measurements>Active option.

5.8.4.3 Angle and Angular Speed: 3points

The Angle & Angular Speed: 3Points option can be used to measure angles when the vertex and the two end points of the angle are visible (the most common angle description).

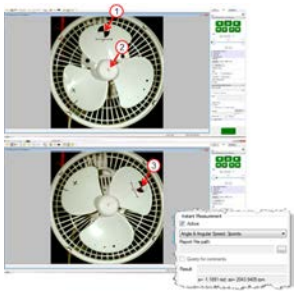


1. Angle formed by three points.
2. $angular\ speed = \frac{\triangle angle}{\triangle time}$, where angle = measured angle, $\triangle$ *time* = [time of the last point frame] – [time of the first point frame] if first and last points are on different frames.



Angle and Angular Speed: 3 Points Example with all three points on same frame (Image: -7875).

PCC automatically calculates and displays angle made by the user-selected (1) Point 1 (center of large target), (2) Reference Point (center of fan motor), and (3) Point 2 (the largest of the three dots).



Angle & Angular Speed: 3 Points Example

The top images (Image: -7875) shows the user-selected Point 1 (center of large target) and Reference Point (center of fan motor), and the bottom image shows Cine advanced a few frame (Image: -7860) with the user-selected Point 2 (again the center of the large target) to measure.

PCC automatically calculates and displays the angle (length), and angle speed made by the two points with respect to the reference point.

PROCEDURE

Common Steps

1. Click on the Measurements.
2. Enable, check, the Active enable box under the Instant Measurements options.
3. Optionally, create or open a Report File to record the measurements.
4. Click the down arrow to the right of the Select Measurement... field, and select the Angle & Angular Speed: 3points option.
5. Using the Playback buttons, locate the first Cine image on which a measurements scale can be performed on.

For Angle Measurements Only:

6. Select Point 1 on the object being measured.
7. Move the cursor to the Reference Point and click the mouse key.
8. Move the cursor to Point 2 and click the mouse key.
9. If you checked the Query for Comments, a comments dialog box will appear now. Enter your description or comment in the box (approximately 40 words). Click OK to accept the command.

   The result will be located the Instant Measurement>Results field; a=angle.

For Angle and Angular Speed Measurement:

6. Select a specific point on the object being measured.
7. Advance the Cine to the next image you wish to perform the measurement on, move the cursor to the Reference Point and click the mouse key.
8. Using the Playback buttons, advance the Cine to the next image you wish to perform the measurement on.
9. Move the cursor to the same point on the object being measured you selected in Step 110 and click the mouse key.
10. If you checked the Query for Comments, a comments dialog box will appear now. Enter your description or comment in the box (approximately 40 words). Click OK to accept the command.

    The results will be located in the Instant Measurement>Results field; a=angle and as=angular speed.

Once all measurements have been performed:

10./11. Repeat these steps until all additional measurements have been taken.

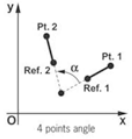
11./ 12. Disable, uncheck, the Querry for Comments option.

12./ 13. Close the Report File.

13./ 14. Disable, uncheck, the Instant Measurements>Active option.

5.8.4.4 Angle & Angular Speed: 4 Points

The Angle & Angular Speed: 4Points option can be used when the vertex or the center point of rotation are unknown or lay outside the image area; the angular speed can be found by comparing the position of an object in one image to its position in the next image.



1. Angle formed by two lines: Pt.1Ref.1 and Ref2Pt.2.
2. $angular\ speed = \frac{\triangle angle}{\triangle time}$, where angle = measured angle, $\triangle$ *time* = [time of the last point frame] – [time of the first point frame] if first and last points are on different frames.

PROCEDURE

Common Steps

1. Click on the Measurements.
2. Enable, check, the Active enable box under the Instant Measurements options.
3. Optionally, create or open a Report File to record the measurements.
4. Click the down arrow to the right of the Select Measurement... field, and select the Angle & Angular Speed: 4points option.
5. Using the Playback buttons, locate the first Cine image on which a measurements scale can be performed on.

For Angle Measurements Only:

6. Select the Point 1 of the objects being measured.
7. Move the cursor to the Reference Point 1 of that object and click the mouse key.
8. Move the cursor to a Reference Point 2 of the second object and click the mouse key.
9. Select the Point 2 of the object being measured.
10. If you checked the Query for Comments, a comments dialog box will appear now. Enter your description or comment in the box (approximately 40 words). Click OK to accept the command

    The result will be located the Instant Measurement>Results field; a=angle.

6. Select the Point 1 on the object being measured.
7. Move the cursor to the Reference Point 1 for that object and click the mouse key.
8. Move the cursor to Reference Point 2 (the same reference point selected in Step 12) and click the mouse key.
9. Select the Point 2 (the same point on the object selected in Step 11).
10. If you checked the Query for Comments, a comments dialog box will appear now. Enter your description or comment in the box (approximately 40 words). Click OK to accept the command.

    The results will be located in the Instant Measurement>Results field; a=angle and as=angular speed.

Once all measurements have been performed:

11. Repeat these steps until all additional measurements have been taken.
12. Disable, uncheck, the Querry for Comments option.
13. Close the Report File.
14. Disable, uncheck, the Instant Measurements>Active option.

5.8.5 Collect Points (Tracking)

Point data for up to 99 points-per-image can be collected and tracked. This feature creates a separate data file for point coordinates, speed and / or acceleration files that can also be imported by third party programs. The point data can be collected two ways:

- Manually - used to track point positions (coordinates) from one image to the next once its starting point is defined for up to 99 points per image manually.
- Automatically - used to track point positions (coordinates) from one image to the next once its starting point is defined for up to 99 points per image automatically. Auto Tracking is done during the play of the Cine (step forward, step backward, play forward, play reverse). It is very important that the images be in succession; Auto tracking will self-disable if they are not. To avoid this from occurring 'Play Speed & Options>Play each image' is forced on. It will also disable itself when jumping from the last image to the

first. However, the points will remain attached to those areas in the image as they are stored in the user-specified '.pps' (Points Position File) file. This allows the user to reopen Cine and / or pictures-per-frame file to overlay the points, or export the file to a spreadsheet (i.e., Microsoft Excel).

It is recommended to rename the .pps file as a .csv (comma separated values) by changing the extension to .csv. This will allow the file to be recognized in Excel. Alternatively, in Excel search for 'All Files' instead of 'Only Excel' files to open the .pps

A limitation to be aware of is that PCC does not do sub-pixel tracking. If the movements are small from frame to frame, the algorithm does not see movement and calculates 0 for distance and speed. Then on the next frame calculates a larger value since the movement was twice as far over two frames. This can result in a choppy graph.

PROCEDURE

After the measurement units, calibration scale, and origin point have been defined:

1. Locate the first frame with the points to be tracked.
2. Click the '...' button in the 'Collect Points' options under the 'Measurements' selector.
3. Navigate to the folder the '.pps' file is to be, or has been, saved in; enter the name of the file in the 'File Name' data entry field, then click on the 'Open' button.
4. Specify the number of points to be collected (tracked) in the 'PPS' field (99 maximum).
5. Enable (check) the 'Active' enable box.
6. Click the center of the point(s) to be tracked.
   a. Delete - to delete a point; select the point from the 'Current Point' pull-down selection list, and click the 'X' button just to the right.
   b. Relocate - to relocate a point; select the point from the 'Current Point' pull-down selection list, and click the center of the point.

Manual Track

7. Manual Track: Repeat 'Step 6' until all points, on all images, have been manually specified. If the 'Auto Advance to Next Image During Collect Points' has not been enabled (checked) in the 'Preferences>Measurement tab you will need to advance the file to the next image.

Auto Track

7. Click the 'Options' button to define the point (displayed in the 'Current Point' field) tracking parameters:
   a. Autotrack Active - turns on (check) / off (uncheck) tracking of the selected point. Note: the checkbox only applies to the selected point.
   b. Show Rectangles - displays the 'Target Area' and 'Search Area' rectangles for the point. The region sizes are defined by the 'Template Area Size' and 'Search Area Size' parameters.
   c. Draw Point Trajectory - turns on (check) / off (uncheck) the ability to graph and display the track point path over the image area.
   d. Template Area Size - defines the width and height (in pixels) of the of the 'Template Image' to search for and track. The center of the 'Template Image' was determined when the point was specified (Step 6). The center of the template can be adjusted by click-hold-dragging the point.

e. Search Area Size - defines how large of an area to search, in the next image, for 'Template Image' matches. Essentially this is a percentage of the defined 'Template Area Size'. A value equal to the 'Template Area Size' indicates that the tracking algorithm should search in a region as large as the initial template image region size. Larger values will result in larger search areas, which will take a longer time to search.

Typically these values are set to two to three times the size of the initial image template (defined in pixels).

f. Tracking Sensitivity - defines the acceptable level of difference between the template and the occurrence in the new image. A strict matching algorithm is used to avoid false matches; however this may lead to more frequent loss of targets during tracking. To compensate for this, you can adjust the 'Tracking Sensitivity' to be more tolerant.

g. Template Image - displays an image of the tracking template. Templates can be dedicated markers (crosses, quarter of circles in opposition black- white, white-black) or any objects in image that has something different on two orthogonal directions. The middle of the straight line is not good but an isolated spot, a corner or an angle are ok.

h. Set to All Points Button - used to apply the above settings to all currently defined points.

8. Close the 'Point Options' dialog window.
9. Enable (check) 'Autotracking' to turn the feature on. In the event a 'Template Image' (tracking point) can not be tracked or is lost the 'Autotracking' feature will disable itself. Additionally, this check box enables/disables Autotrack for all points at once. If the Autotrack checkbox in Step 7a above was checked, this box does not need to be.
10. Optionally, enable 'Update Template' to change the 'Template Image' to the image (point) presently marked by the 'Template Area Size' rectangle. Due to rotations, shadows, etc. the point can be lost.
11. Optionally, click the 'Graphics' toolbar button to view a chart of the tracked points; see 'Collect Point Graphics' for chart use / details.
12. Play the Cine using the video play buttons. In the event a tracked point is lost:
    a. Step backwards to the image the point first disappears.
    b. Select the lost point from the 'Current Point' pull-down selection list.
    c. Reselect the point in the image.
    d. Play the Cine.

Finishing Steps

8/13. Deactivate (uncheck) Collect Points.

9/14. Click the 'Save' button to :

a. Save the 'Collect Points' (.pps) file.

b. Compute / save a 'Speed' (.psp) file.

c. Compute / save an 'Acceleration' (.pac) file.

(Navigate to the destination folders and enter the file names to complete b. and c.)

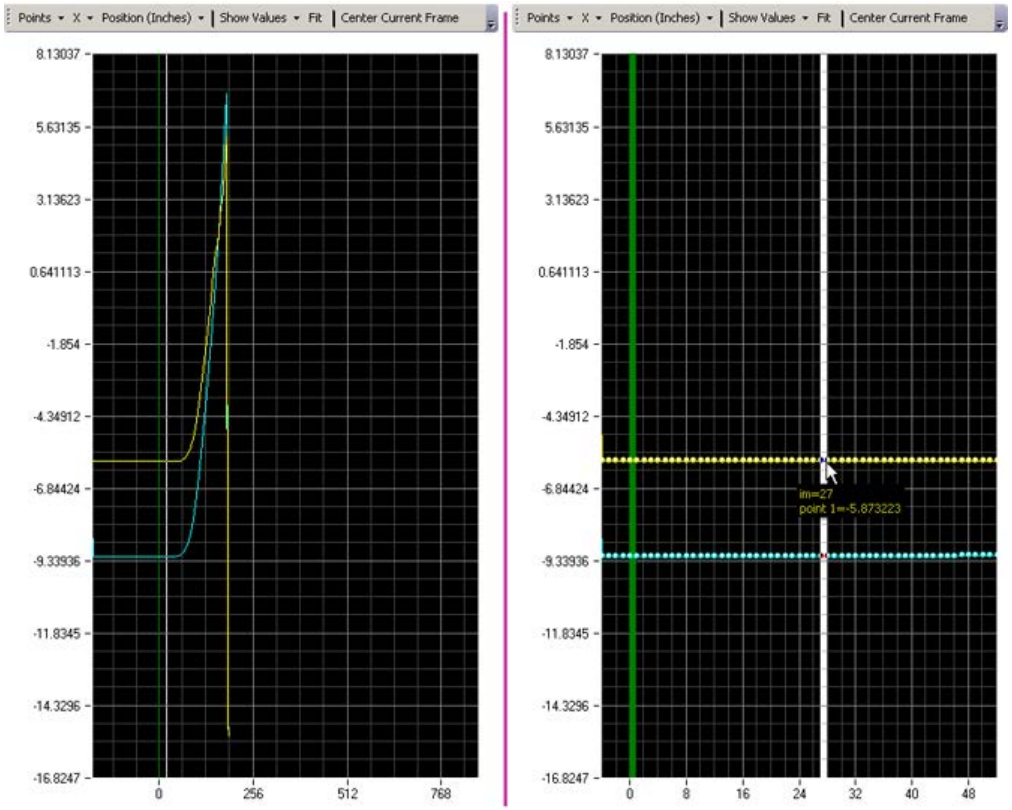
If the 'Collect Points' file is not saved when PCC is closed, PCC will display 'There is unsaved data for Collect Points file <path\file name>' dialog window when the application is closed. You will need to specify whether to save the file or not before PCC will close.

5.8.5.1 Collect Point Graphics

Represents signals that are present (recorded) in the Cine file. It is used to display signal acquisition information or position / speed /acceleration and the coordinate X or Y of tracked collect points (user-selectable). The displayed values take into account the global measurement preferences for position / speed / acceleration.

By default the chart displays a graph of all measurement values for all collected track points specified by the user in the Play>Measurement>Collect Points group. The software assigns each tracked point a unique color. The numbers below the chart are the frame numbers of the Cine file, the numbers to the right represent the tracked point values (defined in the Manager>Application Preferences>Measurement>Units Group). The green line, visible in the zoomed view, represents the position of the trigger frame; the white line is the current frame position. The dots are the tracked points. Placing the cursor over a tracked point displays the following information:

- im (image) - indicates the image number the reference point of the signal is associated with.
- point (number) - indicates the associated tracked point value dependent on the chart type (position / speed / acceleration).



Collect Points Chart displaying two 'X' coordinate points (left); zoomed view (right)

1. Click the Points pull-down selection list to select the Tracked Point(s) to be displayed (by default all tracked points are displayed).
2. Click the X or Y pull-down selection list and select the coordinate (X / Y) of the Tracked Point(s) to be displayed.
3. Click the Position or Speed or Acceleration pull-down selection list and select the type of chart to display:

a. Position
b. Speed
c. Acceleration

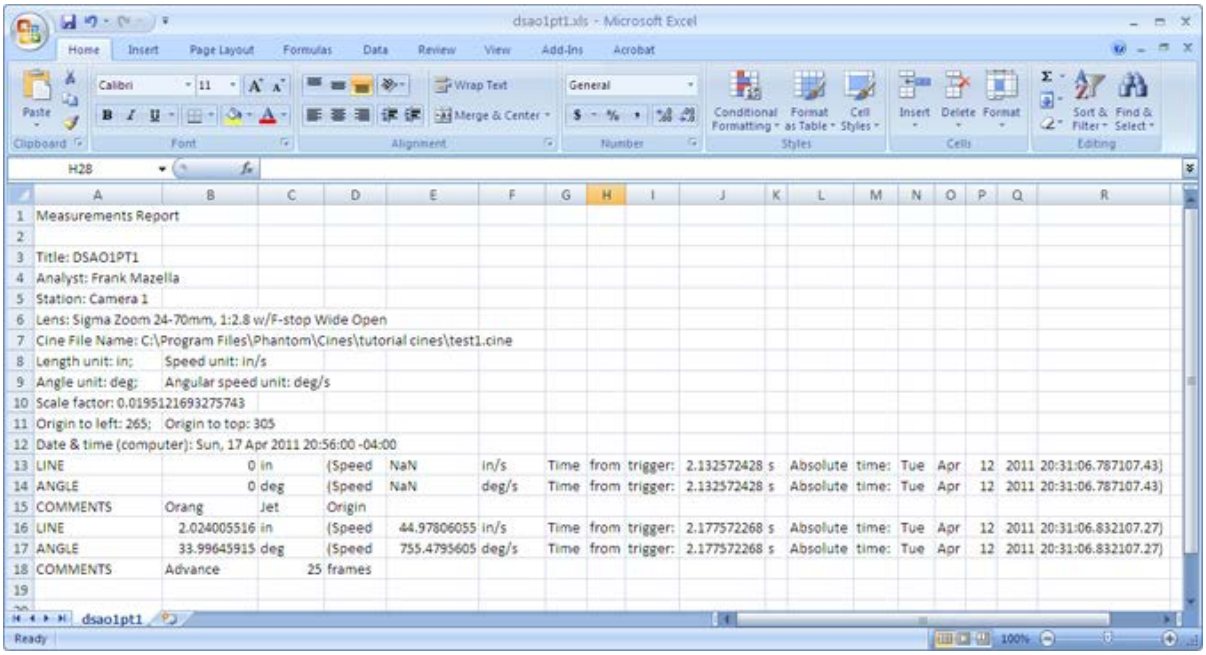
4. Click Show Values / Zoom pull-down selection list to:
   a. Show Values - used to display a collect point value by moving the cursor over the point in the chart.
   b. Window / Horizontal / Vertical Zoom - used to drill down into the graphical display to view measurement points.
   c. Zoom In Around Point / Zoom Out Around Point - used to zoom in to / out of the display by holding down the mouse until the desired level of zoom is reached or right mouse click on display and select the 'Zoom In / Out Around Point' one time.
   d. Pan - moves the chart around by holding down the mouse and moving it in the direction you wish to move the chart.
5. Click 'Fit' to resets the display window to its' original size to display the entire signal range for all frames.
6. Click 'Center Current Frame' to center the chart so the current frame is displayed in the center of the chart.
7. Click 'Save' to create a comma separated text file and select the type of file to be saved from the pull-down selection list:
   a. All - creates a report file for all the analog channels visible or not.
   b. Visible - creates a report file for the visible analog channels only.
8. In the 'Save Signal(s) dialog window navigate to the folder the report file is to be saved to.
9. Enter a filename for the report file being saved in the 'File name:' field (software will automatically add the .cvs file extension).
10. Click 'Save' to create file; 'Cancel' to abort.

5.8.6 Report Review

The contents of a report file can be viewed in many text editors and word processor programs; some additional formatting may be required.

In addition to measurement data files, a report file can include information about the test event such as camera, camera position or station, lens and f-stop, the name of the analyst or team that recorded the test, and the Cine file name. The report file will also include the day, date, and time of the test, unit of measurement, scale factors, and the (x y,) coordinates if the origin. Finally, the report file format allows you to include a description or comment about each point selected for measurement.

5.8.6.1 Distance & Angle & Speed: Origin + 1point



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Measurements Report																	
2																		
3	Title: DSAO1PT1																	
4	Analyst: Frank Mazella																	
5	Station: Camera 1																	
6	Lens: Sigma Zoom 24-70mm, 1:2.8 w/F-stop Wide Open																	
7	Cine File Name: C:\Program Files\Phantom\Cines\tutorial cines\test1.cine																	
8	Length unit: in;	Speed unit: in/s																
9	Angle unit: deg;	Angular speed unit: deg/s																
10	Scale factor: 0.0195121693275743																	
11	Origin to left: 265;	Origin to top: 305																
12	Date & time (computer): Sun, 17 Apr 2011 20:56:00 -04:00																	
13	LINE	0	in	(Speed	NaN	in/s	Time	from	trigger:	2.132572428	s	Absolute	time:	Tue	Apr	12	2011	20:31:06.787107.43)
14	ANGLE	0	deg	(Speed	NaN	deg/s	Time	from	trigger:	2.132572428	s	Absolute	time:	Tue	Apr	12	2011	20:31:06.787107.43)
15	COMMENTS	Orang	Jet	Origin														
16	LINE	2.024005516	in	(Speed	44.97806055	in/s	Time	from	trigger:	2.177572268	s	Absolute	time:	Tue	Apr	12	2011	20:31:06.832107.27)
17	ANGLE	33.99645915	deg	(Speed	755.4795605	deg/s	Time	from	trigger:	2.177572268	s	Absolute	time:	Tue	Apr	12	2011	20:31:06.832107.27)
18	COMMENTS	Advance	25	frames														
19																		

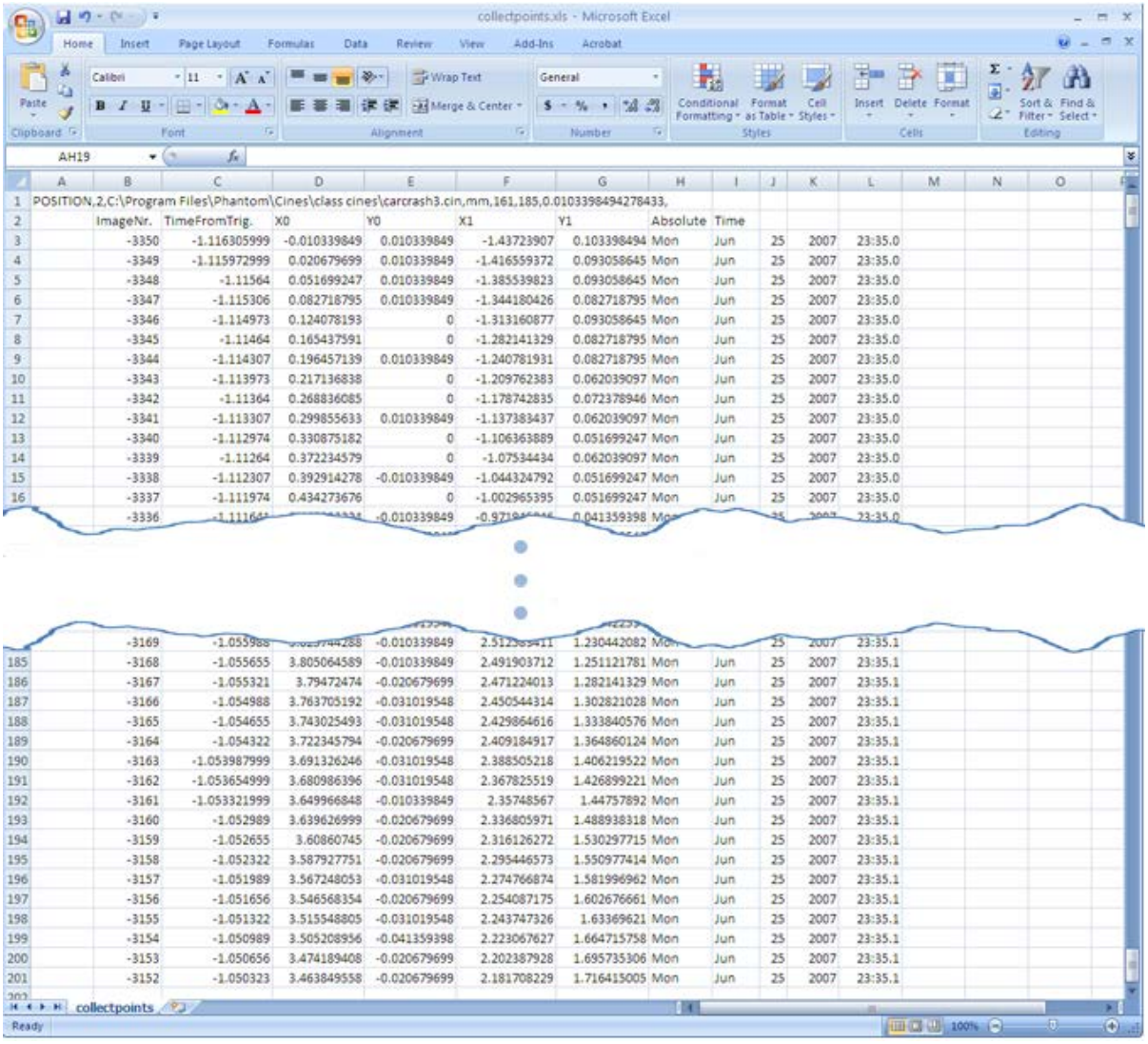
The above example of a Distance & Angle & Speed: Origin +1point Report File provides the following information:

Line	Displayed Information
1	Indicates the type of report file this is.
2	Blank
3	Displays the title of the report entered during the Create Report File process.
4	Displays the analyst who performed the measurements entered during the Create Report File process.
5	Display station information, (camera name or number), of the camera used to create the Cine file measurements are being performed on, entered during the Create Report File process.
6	Displays lensing information, about the lens used during the Cine capture, that was entered during the Create Report File process.
7	The Cine File Name specifies the path and name of the file the report file was generated on when performing motion analysis on the file.
8	Displays the length and speed units of measure specified during the Defining the PCC Application Preferences>Measurement Preference procedure.
9	Displays the angle and angular speed units of measure specified during the Defining the PCC Application Preferences>Measurement Preference procedure.
10	Indicates the scale factor that was used to calculate the measurements. The scale factor was calculated during the Calibrating a Measurement Scale procedure.
11	Specifies the location of the origin point in the number of pixels to the left of, and number of pixel down from the upper-left pixel of the image, (the first image pixel). This origin was specified using the Set Origin process.
12	The Date and Time indicate where the time reference came from and what the Day, Date and Time was the report file was generated. It also displays the time difference from utc (GMT).
13	Display the Line (Distance) of the first measurement point from the origin and the Speed at which the software has calculated the point has moved from the origin. In this example, the analyst selected the origin point of the object being measured, so the point on the object being measured had not yet moved. This line also reports the Time from Trigger this image was recorded (in seconds), and the Absolute time (Day of Week, Month, Day, Year, hh:mm:ss down to the nano-second); the image was capture.
14	Display the Angle of the first measurement point from the origin and the Angular Speed at which the software has calculated the point has moved from the origin. In this example, the analyst selected the origin point of the object being measured, so the point on the object being measured had not yet moved. This line also reports the Time from Trigger this image was recorded (in seconds), and the Absolute time (Day of Week, Month, Day, Year, hh:mm:ss down to the nano-second); the image was capture.
15	Displays the analyst comment, he/she entered, about the measurement reported in the line above. In this example, the measurement was of the origin point of an orange toy jet.
16	Display the Line (Distance) of the second measurement point from the origin and the Speed at which the software has calculated that point has moved from the origin. In this example, the analyst had advanced the Cine file 25 images so that the object has moved some distance from the origin, at some speed. Notice the PCC software has calculated that the object had moved 2.024005516 inches from the origin at a speed of 44.97806055 inches per second. This line also displays the Time from Trigger this image was recorded (in seconds), and the Absolute time (Day of Week, Month, Day, Year, hh:mm:ss down to the nano-second); the image was captured.

17	Display the Angle of the second measurement point from the origin and the Angular Speed at which the software has calculated the point has moved from the origin. In this example, the analyst had advanced the Cine file 25 images so that the object has moved at an angle from the origin, at some angular speed. Notice the PCC software has calculated that the object had moved 33.99645915 degrees from the origin at an angular speed of 755.4795605 degrees per second. This line also reports the Time from Trigger this image was recorded (in seconds), and the Absolute time (Day of Week, Month, Day, Year, hh:mm:ss down to the nano-second); the image was capture.
18	Displays the analyst comment, he/she entered, about the measurement reported in the line above. In this example, the measurement was taken on the same point of an orange toy jet 25 frames later.

Similar measurement reports are available for 'Distance & Angle: 2-points' and 'Angle & Angular Speed 3 & 4 points'.

5.8.6.2 Collect Points - Points File



The above example of a 'Collect Points' File provides the following information:

Line	Displayed Information
1	Indicates the type of report file this is, the number of points per image being tracked, the location of the file the measurements are being performed on, the unit of measure, the origin coordinates, and a scale factor used to calculate the results. The scale factor was calibrated when the analyst performed the calibrating a measurement scale process.
2	Indicates the column headers, including; the ImageNr. (image number) the tracking points were taken on, the TimeFromTrig. (time from trigger) the image was taken, the x, y position of the first point (X0, Y0), the x, y position of the second point (X1, Y1, and the absolute time the image was recorded.
3	The remaining lines specify image number, time from trigger, the calculated position of the track points from the analyst specified origin point, and the time the image was recorded.

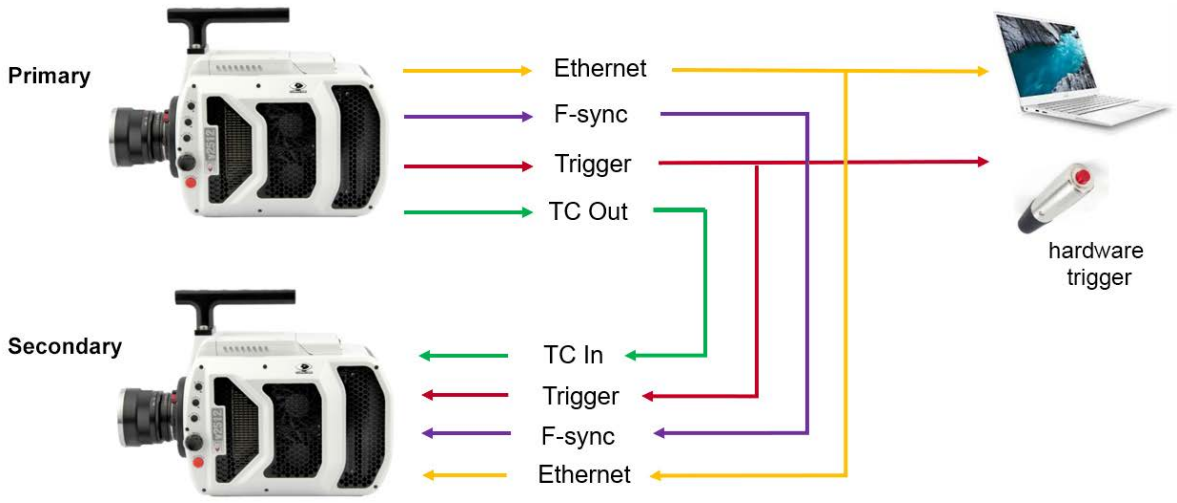
Advanced Workflows

6 Advanced Workflows

6.1 Working with Multiple Cameras

6.1.1 Two-Camera Sync Setup

A simple synchronized 2-camera setup looks like this:



1. **Ethernet** from both cameras are fed into the control computer running PCC.
    a. This can be achieved using an Ethernet switch or plugging directly into multiple ports available on the computer.
2. **F-Sync signal** between both connectors need to be connected using a standard BNC cable.
    a. In PCC, Live > Advanced Settings > Sync Imaging, the 'Primary' camera remains as 'Sync: Internal', where the 'Secondary' camera is set to 'Sync: External'.
    b. Enter '0' (the default value) as the Primary camera serial number

> Entering the actual primary camera serial number (anything other than zero) is no longer recommended in most situations. The trigger signal can become duplicated, and it will cause the secondary camera to detect multiple trigger signals when using an external hardware trigger.

3. **Trigger signals** between both cameras need to be connected, using BNC cables and a BNC T-Connector to an external "hardware trigger" like a pickle switch or pulse generator.
    a. For synchronized images a parallel hardware trigger is required, instead of using the software trigger button in PCC.
    b. Ensure that the cameras have the same trigger setting (i.e., 'rising' or 'falling edge').
4. For Timestamps to match, **Timecode Out** from the Primary camera must be connected to **Timecode In** on the Secondary camera, using another BNC cable.

The timestamp occurs at the end of an exposure period. Even though cameras are synchronized and have the same frame rate it is possible that the timestamps don't match. This can occur due to dissimilar exposure times, different camera models, cable length, and frame delays set in the software. This can be corrected by checking a matched frame from both cameras and modifying the frame delay feature in the camera with the latest timestamp value.

6.1.2 Additional Multiple Camera Networks

There are additional methods of networking multiple cameras for synchronization, including when cameras need to be synchronized with dissimilar frame rates. In each case, the following rules apply:

a. **Camera Restriction / Working Distance** - the maximum number of cameras that can be synchronized using F-Sync is four, and the maximum distance of the cameras (end-to-end) is limited to 10 meters (32.81 feet). However if IRIG-B is supplied to each camera independently (as the sync source) the only restriction to working distance is the distance the receiver can transmit the timecode without degrading, and the number of cameras that can be synchronized expands to sixty-three maximum.

b. **Signal Access:** Depending on the camera model the signaling interface connectors are accessible from the rear of the camera, capture cable, or a break-out-box (BoB).

c. **Trigger Mechanism** - all cameras must be supplied an external **hardware trigger**. If a software trigger is used, the cameras will not be triggered simultaneously. The reason this happens is Ethernet only allows one device to transmit on the medium at any one time. Therefore each camera would receive the trigger command individually and thus at different times. This is an Ethernet rule; 'only one device is permitted to transmit on the medium at any one time'.

d. **Sample Rate Requirements** - Sample / frame (recording) rates must be set prior to selecting the F-Sync clock source to the same frame rate of the 'primary' camera in all cameras. This ensures that the camera will fall back to the F-Sync (internal) clock source, set to the same rate as the IRIG-B Timecode rate, in the event it is lost.

    i. When using IRIG-B as the Sync Source the frame rate must be set in multiples of 100.

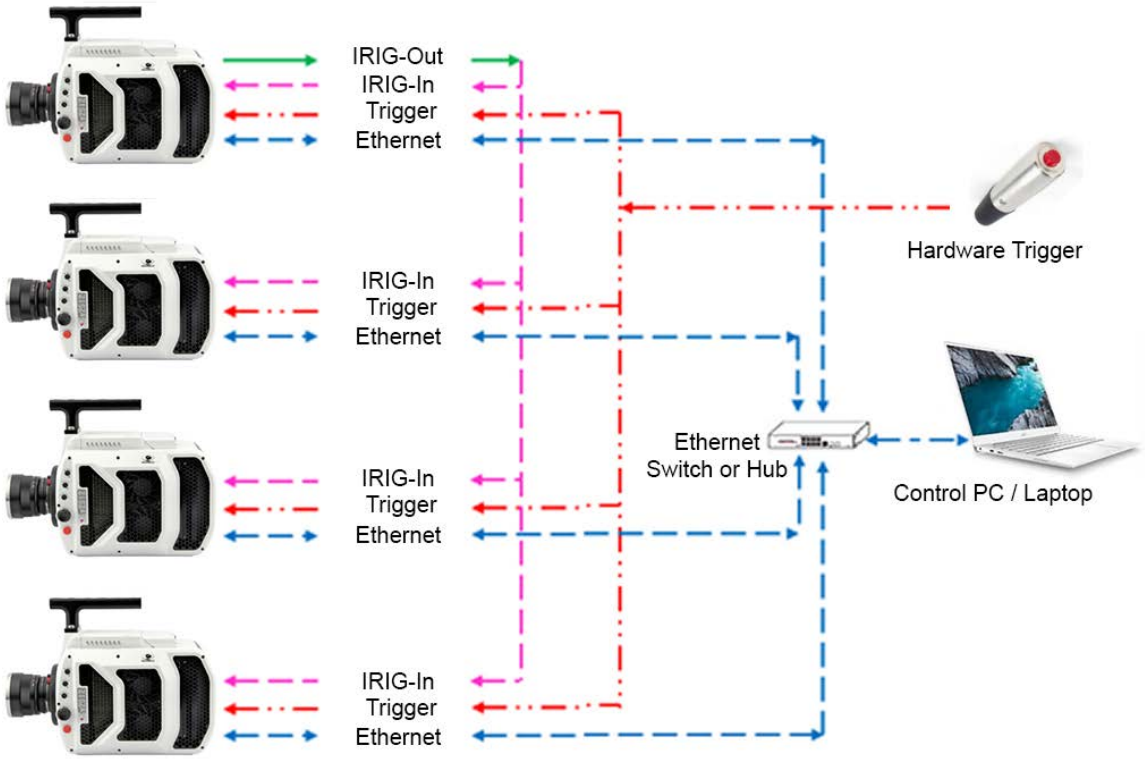
e. **Frame Delay** - defines a delay to the sync reference moment and the start of exposure, in ns.

When using an external source for synchronization, frame rate can be driven by a TTL signal generator or an IRIG timecode generator.

a. **TTL** is a square wave that has an input signal defined as "low" when 0V and "high" when 5V. The rise and fall time of the TTL signal can be on the order of tens of nanoseconds.

b. **IRIG-B** utilizes pulse width coding provided by GPS to supply the camera a frame clock in multiples of 100. More on IRIG in the next section.

Setup 1: Sync multiple cameras to the **primary camera's internal IRIG clock**

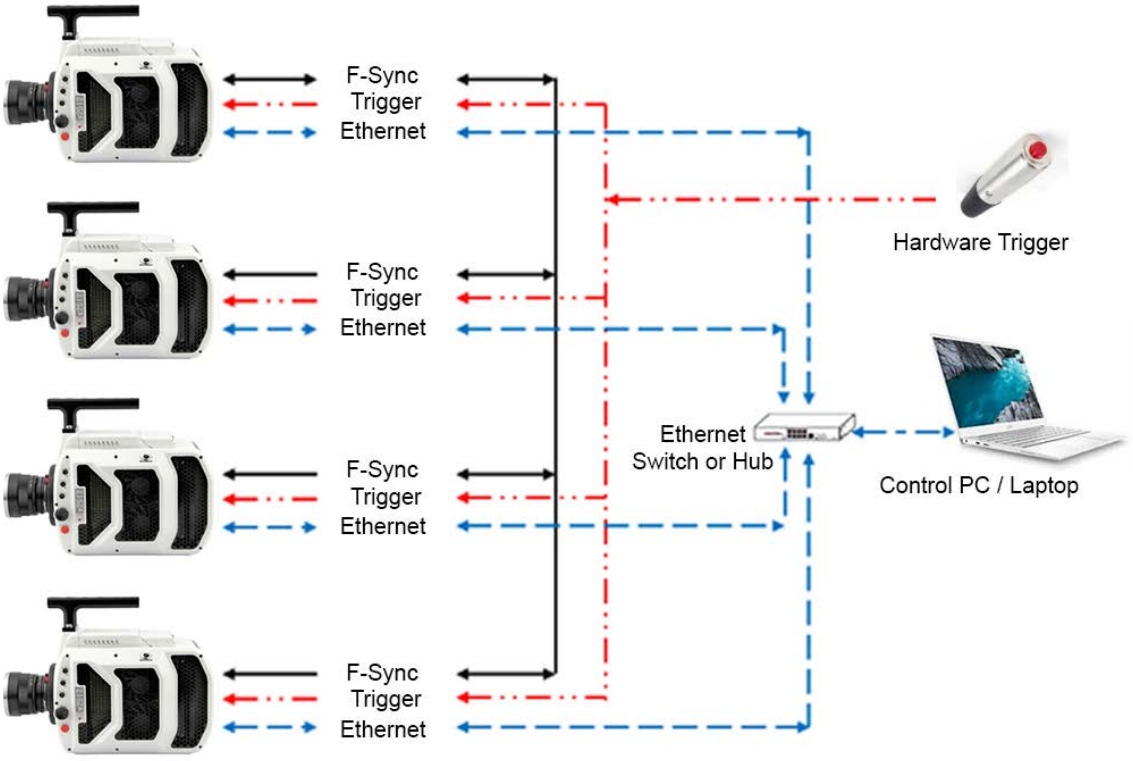


Cabling Architecture - using BNC 'T-adapters', cable each camera as follows:

1. Cable the Primary camera's 'Timecode-Out' / 'IRIG-Out' connector to the 'Timecode-In' /' IRIG-In' BNC interfaces all of cameras, including back to itself.
2. Cable all 'Trigger-In' BNC interfaces to an external (hardware) trigger.
3. Cable all 'Ethernet' RJ45 (straight-thru) connectors to an Ethernet HUB, Layer 2, or Layer 3 switch.

External Sync Requirements - set all cameras to 'LockToIrig' via the 'PCC > Live > Advanced Settings > External Sync > Sync Imaging' pull-down selection list.

Setup 2: Sync multiple cameras to the **primary camera's internal clock**



Cabling Architecture - using BNC 'T-adapters', cable each camera as follows:

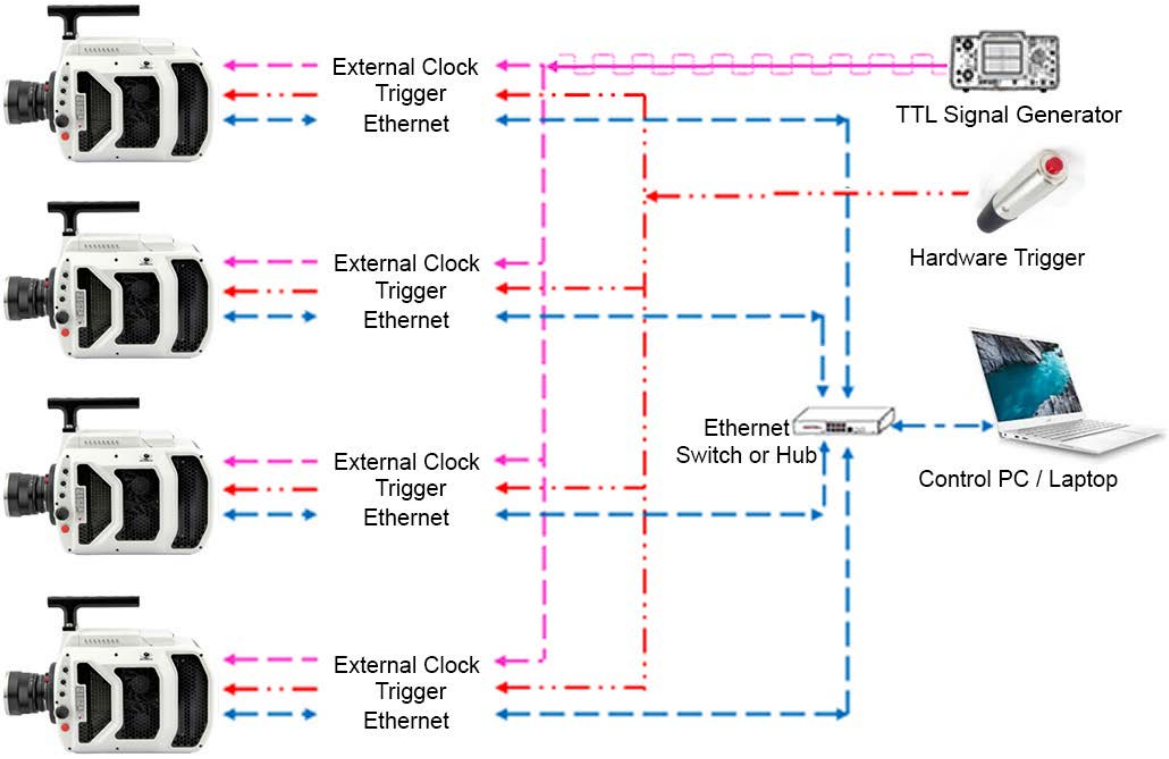
1. Cable all 'F-Sync' BNC interfaces together.
2. Cable all 'Trigger-In' BNC interfaces to an external (hardware) trigger.
3. Cable all 'Ethernet' RJ45 (straight-thru) connectors to an Ethernet HUB, Layer 2, or Layer 3 switch.
4. Optional (not shown): For matching timestamps the Timecode-out from the Primary should be connected to the Timecode-in of the Secondary cameras.

External Sync Requirements - for this application, via the 'PCC > Live > Advanced Settings > External Sync > Sync Imaging' pull-down selection list, set:

a. Primary (clock source) camera to Internal, and all Secondary (clocked) cameras to External.

b. Primary camera serial - this data entry field is used to designate the serial number of the primary camera and must be entered for all cameras.

Setup 3: Sync multiple cameras to an **external source (non IRIG)**



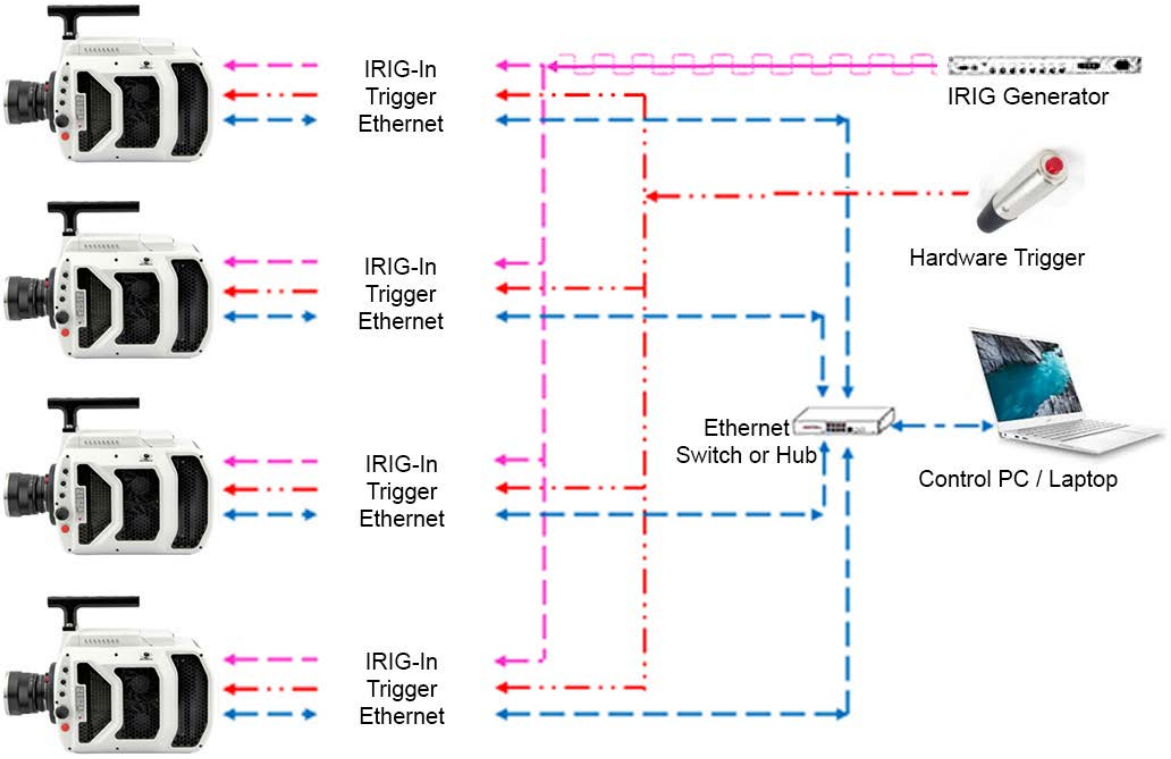
When set to External mode the camera uses an externally supplied pulse to drive the camera's sample rate. The external input must be a TTL square wave, with a frequency up to the maximum sample rate for the defined resolution.

Cabling Architecture - using BNC 'T-adapters', cable each camera as follows:

1. Cable the 'external' clock generator to the 'F-Sync' connector on all cameras.
2. Cable all 'Trigger-In' BNC interfaces to an external (hardware) trigger.
3. Cable all 'Ethernet' RJ45 (straight-thru) connectors to an Ethernet HUB, Layer 2, or Layer 3 switch.

PCC External Sync Requirements - set all cameras to 'External' via the 'PCC > Live > Advanced Settings > External Sync > Sync Imaging' pull-down selection list, and enter '0' (zero) in the 'Primary' camera serial (0=none) data-entry field (all cameras).

Setup 4: Sync multiple cameras to an **external IRIG clock source**



When set to Lock to an IRIG-B time code signal the camera utilizes pulse width coding provided via GPS, to supply a camera with a frame clock in multiples of 100 fps. It is typically distributed as a DC level shift (DCLS), pulse-width coded signal ("unmodulated IRIG-B") or as an amplitude-modulated signal based on a sine-wave carrier at a frequency of 1kHz ("modulated IRIG-B").

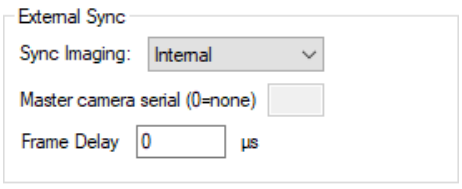
Cabling Architecture - using BNC 'T-adapters', cable each camera as follows:

1. Cable the 'TimeCode-In / IRIG-In' interface of all cameras to the IRIG-B Timecode receiver.
2. Cable all 'Trigger-In' BNC interfaces to an external (hardware) trigger.
3. Cable all 'Ethernet' RJ45 (straight-thru) connectors to an Ethernet HUB, Layer 2, or Layer 3 switch.

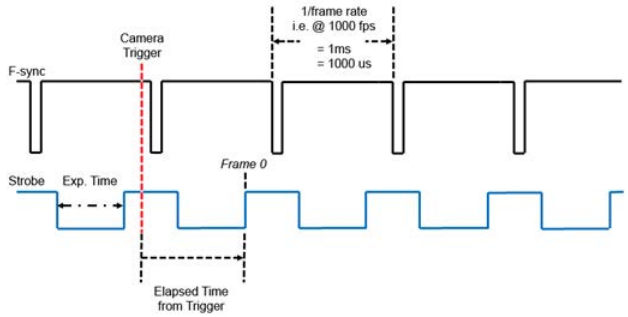
PCC External Sync Requirements - set all cameras to 'LockToIrig' via the 'PCC > Live > Advanced Settings > External Sync > Sync Imaging' pull-down selection list.

6.1.3 Sync Imaging - Signal Details

When working with an individual camera, **Sync Imaging** (located in the Advanced Settings menu) is usually set to **'Internal'**



The camera's internal frame rate generator (crystal oscillator) outputs a 4 µs negative pulse on F-Sync to initiate acquisition of image frames. 3-4 µs after a negative edge is detected at F-Sync, integration starts ('Strobe[1]' low). Typically, a new exposure cannot start until 3-7 µs (camera dependent) after the previous one has ended.



The illustration shows an F-Sync clock generated from an internal oscillator. Notice 'Frame 0' (t_0 frame) is marked at the end of the next full frame, therefore the elapsed time from trigger will vary from shot to shot based on the moment trigger is detected.

The timestamp of Frame 0 will never be negative. Frame 0 occurs at the first frame that has a rising edge strobe after the trigger is detected.

If a F-Sync pulse is detected before an exposure can start, it is latched and a new frame will start at the earliest possible opportunity. Additionally, an exposure cannot end until the previous frame was completely read out from the sensor. If such a case occurs, the integration period is extended until the readout has completed, overriding the exposure time setting.

[1] Strobe is a pulse generated by the camera synchronous with the sample (frame) rate, which remains low for duration of the exposure. It is an isolated open collector output, with 1k pull-up. When asserted (low) the camera integrates (shutter is open).

6.1.3.1 External Sync

Sync Imaging: External - selected when an external source is supplied to drive the camera's sample rate. The external input must be a TTL square wave signal with a frequency up to the maximum sample rate allowed for the specified 'resolution' setting.

The TTL input must be connected to the BNC connector marked F-Sync or Sync on the back of the camera, capture cable or breakout box.

When 'External Sync' is selected the Sample Rate option will be disabled.

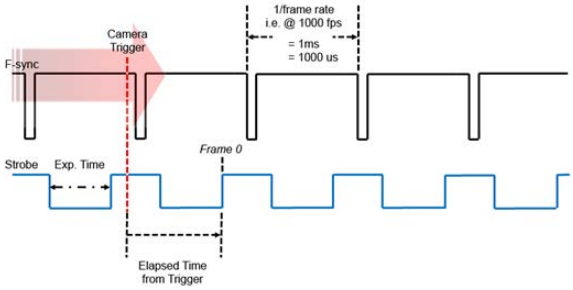
Options for External Sync:

1. **Primary camera serial (0=none**) - specifies the serial number of the Phantom camera providing the frame sync clock source to other Phantom cameras. This field must be defined when synchronizing multiple Phantom cameras using one Phantom camera as the primary clock source.
2. **Frame Delay µs** - defines a shift in the phase of the strobe signal to delay the sync reference moment and the start of exposure, in ns.

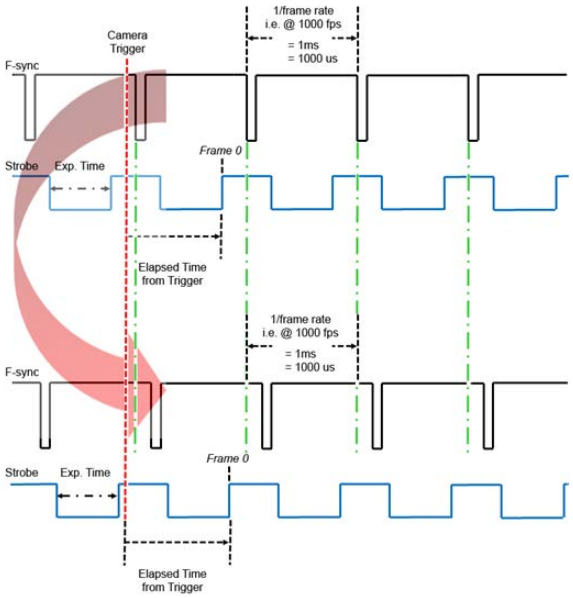
More on External F-Sync

The external input signal must be a TTL (Transistor-to-Transistor Logic) square wave, with a frequency up to the maximum sample rate. This can be supplied by a primary camera's internal oscillator, or an external clock source to generate a TTL square wave pulse source.

External TTL generator providing F-Sync clock to camera:



Primary camera providing the external F-Sync clock to a Secondary camera:



The illustrations show both options; an external clock generator providing an F-Sync clock to a camera, and a primary camera providing an external F-Sync clock (generated from internal oscillator) to a Secondary camera. Notice when cameras are being controlled by a primary camera there is a short delay between the F-Sync clocks; this 'Frame Delay' is adjustable in PCC.

This type of clock source is commonly used to synchronize multiple cameras to a primary camera's internal clock, or synchronize several cameras, typically located within close proximity of one another, to an external clock source.

6.1.3.2 Lock to IRIG Timecode

Sync Imaging: Lock to IRIG - selected when an IRIG-B Timecode signal is supplied, to frame clock the camera, through the marked IRIG Input BNC connector or the Timecode-In (TC IN) connector on the rear of the camera, capture cable or breakout box.

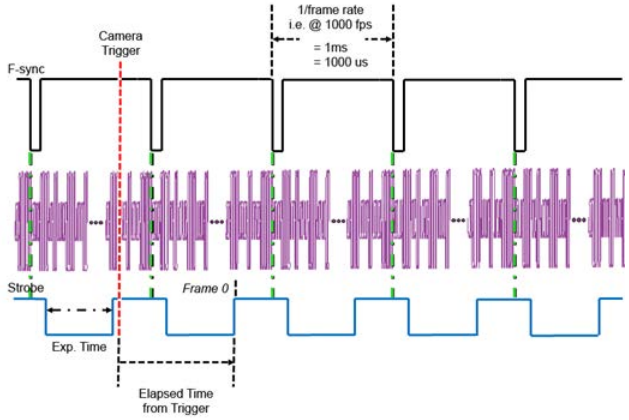
IRIG-B Timecode limits the frame rates to multiples of 100. The exact IRIG-compatible frame rates may differ depending on camera model.

More on Lock to IRIG

Inter-Range Instrumentation Group (IRIG) time codes are standard formats for transferring timing information. A camera's F-Sync clock can be locked to an IRIG-B Timecode, by either the internal (IRIG-B equivalent) oscillator or externally supplied via an IRIG-B receiver.

An IRIG-B time code signal, utilizes pulse width coding provided via GPS, to supply a camera with a frame clock (in multiple of 100 fps). It is typically distributed as a DC level shift (DCLS), pulse-width

coded signal (“unmodulated IRIG-B”) or as an amplitude-modulated signal based on a sine-wave carrier at a frequency of 1kHz (“modulated IRIG-B”). Modified Manchester modulation is also specified in the standard but is less common.



The signal itself has a pulse rate of 100 pulses-per-second with an index count of 10 milliseconds over its one-second time frame.

Once an IRIG signal is detected the signal will automatically over-ride the cameras’ internal crystal-oscillator frame clock (equivalent to IRIG). However, if the IRIG time code is lost the camera oscillator will immediately provide the frame clock to the camera until the IRIG signal re-syncs with the camera.

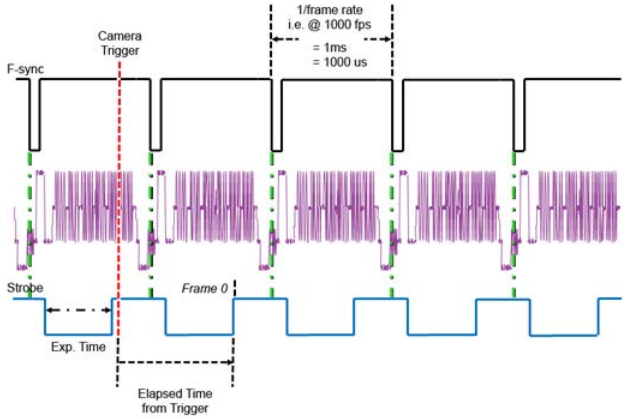
This type of clock source is commonly used to synchronize multiple cameras, normally positioned at significant distances from one another, to a single clock source.

6.1.3.3 Lock to Video

Sync Imaging: Lock to Video (ph16 camera models only) - the capture of frames is triggered by F-Sync pulses generated by the video raster generator at a rate that is a multiple of the video frame rate. This setting allows certain cameras to capture at the 'fractional' frame rates of 23.976, 29.97 (and their multiples) which results in the live output of the camera maintaining a stable phase in relation to frame capture.

More on Lock to Video

This setting forces the camera to capture frames at a rate that is a multiple of the video frame rate, with a defined phase relationship with the video signal. The capture of frames is triggered by F-Sync pulses generated by the video raster generator. The first F-Sync pulse of a video frame is coincident with the start of vertical sync, and further pulses are spread through the frame at equal intervals in order to obtain the desired frame rate.



The camera will only accept frame rates that are a multiple of the video frame rate. If other values are requested, they will be rounded to the nearest multiple. For example, if the camera is set to 1080 psf 23.98, and a frame rate of 100 fps is requested, the camera will round the 100 fps to 96 (the nearest multiple of 24). The true frame rate of the camera will be 95.904 fps, four times 23.976.

Some Phantom cameras have a minimum frame rate of 50 or 100 fps. This minimum frame rate still applies in Lock to Video mode.

6.1.3.4 Sync to Trigger

Sync Imaging: Sync to Trigger (not available with all camera models) - allows temporally consistent and replicable start of acquisition frames (exposures) in relation to the trigger signal actuation. The user can be sure, in a series of multiple tests; that 'Frame 1' of each Cine file occurs at the same time after a trigger; and therefore, frames numbers of each Cine file can be viewed with assurance that the image is comparable.

More on Sync to Trigger

This setting re-aligns the frame exposure start point (Fstart) to fall as soon as possible after a trigger signal has been recognized. Without 'Sync to Trigger' there is no specific relation between the trigger signal and F-Sync.

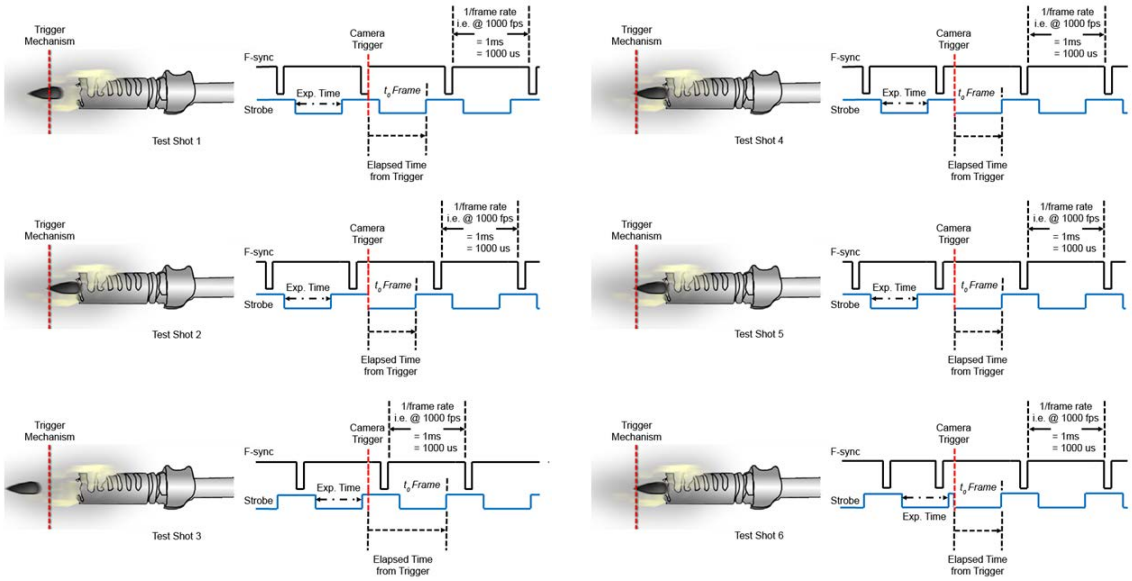
The benefit of the feature is as follows; in many applications, a series of tests are performed which require comparisons with each other. When these tests are performed the camera trigger can fall at a repetitively and accurate time within the event sequence, providing a baseline from which to make comparisons.

Without 'Sync to Trigger' the issue is that the Fstart can follow at any time within the next 1/frame rate cycle. The trigger has occurred at the expected moment, but the first frame after the trigger may not show the same moment in time (elapsed time from trigger) as the test before or after it.

Example application: 'Small arm projectile testing'.

a. As a projectile (bullet) moves into frame the camera is triggered by an optical mechanism at a certain duration after it passes pixel x (trigger position).

b. The user wants to see the bullets' trajectory, position, azimuth, etc. at exactly the same moment after the trigger between tests. Without 'Sync to Trigger', he / she cannot reliably say that the bullet has moved by x amount, at n microseconds (µs) after the trigger, as you can see in the illustration on the left.



This occurs because the camera detects the trigger signal, for each test shot, at a different moment in time with relationship to the frame synchronization (F-Sync) pulse, thereby causing the 'elapsed time from trigger' to be different for each shot resulting in capturing the bullets in a different position for their t0 (Frame 0) frames.

The 'Sync to Trigger' function timing allows Fstart to fall at a repetitively accurate duration after the trigger, as shown in the illustration on the right.

If you look carefully you'll notice the moment trigger is detected a 'new' F-Sync timer begins, forcing the next F-Sync pulse to be exactly one interval (1/frame rate) later. This results in the exposure and elapsed time from trigger to be consistent for all repetitive shots.

Pre-trigger frames cannot be present for this triggering mode. Sync to Trigger is only suitable for applications where pre-trigger frames are not important.

While elapsed time from trigger remains consistent, the accuracy of the Sync to Trigger trigger point can have an error up to approximately 6 µs.

6.1.4 Camera Groups in PCC

A group / sub-group can contain multiple Phantom cameras to be controlled simultaneously via the 'Live' tab. The 'Group' feature allows for control of user-defined group(s) of cameras to:

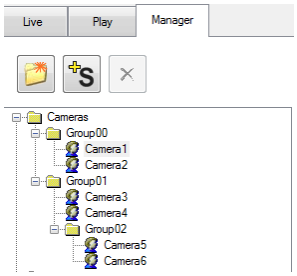
- Define the capture (recording) parameters of a group of cameras.
- Place a camera group into the capture (recording) mode.
- Trigger a group of cameras.
- Apply image adjustments via PCC's Image Tools options.

When working with Groups there are features available in the User Configuration Manager that can be helpful to understand what settings apply to all grouped cameras. Starting with PCC 3.7, the default behavior is to always **BOLD** the parameters in the Live menu that will apply to all cameras in the group

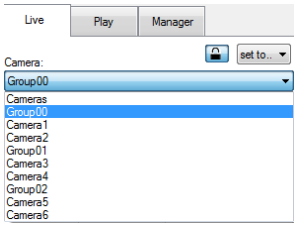
after an adjustment. This behavior can be changed in the User Configuration Manager to highlight the parameters for better visibility.

Additionally, a unique Profile can be setup with custom settings for the individual parameters to NOT apply to the group when that is not the desired behavior. Those settings would then need to be set manually for each camera by selecting the desired camera window and changing the setting.

Phantom cameras cannot be associated with multiple groups at the same time.

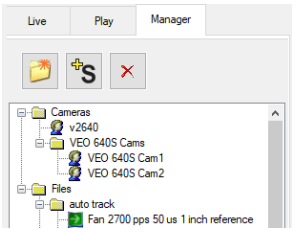


For the example shown here all cameras, by default, are associated with the ‘Cameras’ group and all user created groups are a sub-group of the root ‘Cameras’ group. This includes ‘Group00’ which consists of ‘Camera1’ and ‘Camera2’, and ‘Group01’ consisting of ‘Camera3’, ‘Camera4’, and ‘Group02’ (which is a sub-group) made up of ‘Camera5’ and ‘Camera6’.



Therefore, if the ‘Cameras’ group is selected, via the ‘Live > Camera’ pull-down selection list, all six cameras will be locked (displayed with a red border around the Preview Panel) and controlled simultaneously. If ‘Group00’ is selected, only ‘Camera1’ and ‘Camera2’ will be locked. However when ‘Group01’ is selected, not only are ‘Camera3’, and ‘Camera4’ locked but ‘Camera5’ and ‘Camera6’ will also be locked even though they are under the ‘Group02’, since ‘Group02’ is a sub-group of ‘Group01’. Lastly, selecting ‘Group02’ locks only ‘Camera5’ and ‘Camera6’.

6.1.4.1 Create / Remove Camera Group

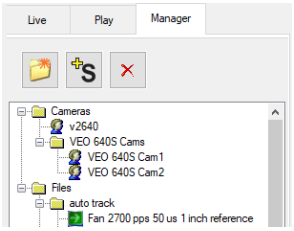


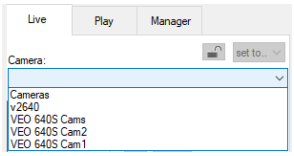
1. **Create Camera Group**
   a. Highlight the 'group' folder the new group is to be a sub-group of.
   b. Click the "New Group' button to place a new group folder under the 'Cameras' group.
   c. Assign a group name to the new 'group' folder (optional).
   d. Drag cameras to be grouped into their respective 'group' folder.

2. **Remove Camera Group**
   a. Highlight the 'group' folder to be removed.
   b. Click the 'Remove from tree' button.

Removing a camera 'Group' folder does not remove the associated cameras from PCC. The cameras will be reassigned to the 'Cameras' group.

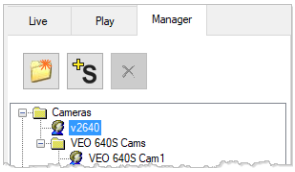
6.1.4.2 Camera / Camera Group Selection

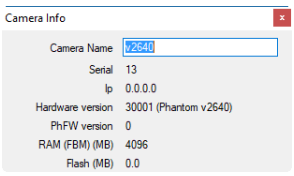


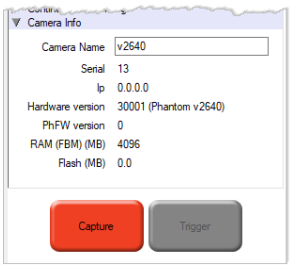


1. **Select Individual** - opens 'Preview' panel for selected camera only.
   a. From the 'Manager' tab
      1) Double-click the camera to control, or
      2) Right-click the camera, and select 'Show Only Images From This' from the pop-up window.
   b. From the 'Live' tab
      1) Click down-arrow right of the 'Camera:' field.
      2) Select the camera to control.
2. **Select Camera Group** - opens 'Preview' panel for every camera, specified to the group by the user, of the selected group.
   a. From the 'Manager' tab
      1) Right-click the camera group folder containing the cameras to controlled.
      2) Select 'Show Only Images From This' from the pop-up window.
   b. From the 'Live' tab
      1) Click down-arrow right of the 'Camera:' field.
      2) Select the camera group containing the cameras to controlled.

6.1.4.3 Rename Camera / Camera Group







1. From 'Manager' tab
   a. Cameras Group List
      1) Highlight the camera / group to be renamed
      2) Enter the desired name
      3) Click 'OK' in the 'Change Name?' pop-up window
   b. From 'Device Info'
      1) Enter the desired name in the 'Camera Name' field.
      2) Click 'Enter' key to activate

2. From 'Live' tab - with he camera open in a 'Preview' panel
   a. Click 'Camera Info' selector
   b. Enter the desired name in the 'Camera Name' field.
   c. Click 'Enter' key to activate.

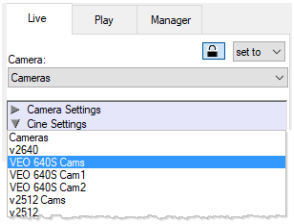
Saved Cine files cannot be renamed from the PCC Manager interface.

6.1.4.4 Lock Cameras (optional)

Locking cameras together allows the user to control / configure multiple Phantom cameras simultaneously. Locking cameras does not copy current settings from one camera to the other (see step 3 below), but changes made from that point forward will apply to the locked group.

Cameras display a red border around their 'Preview' panel when 'locked'.

SETUP PARAMETERS / PROCEDURES



1. **Camera:** - selects / displays the 'Cameras Group' (folder) to lock. Only cameras assigned to that camera's group, along with any sub-group camera of the selected camera's group, will be locked .
2. **Lock** (button) - lock cameras assigned to multiple group or no group together.
   a. Click the 'Preview' panel of a specific camera, then
   b. Click the 'Camera: Lock' button.

3. **set to..** (button) - copies and applies all settings of the active camera to other individual or group cameras.

Locked cameras will follow changes to synchronization settings (in addition to most other parameters), unless set differently in the active User Configuration Profile. It is recommended to UNLOCK the cameras when changing Sync settings and verify sync settings prior to recording.

Locking a camera associated with a 'Cameras' group will apply any changes made not only to the grouped camera opened (in a 'Preview' panel) but all the cameras associated with that camera's group / subgroup even if those cameras are not opened in a 'Preview' panel.

6.2 Burst Mode Acquisition

Burst Mode increases the effective frame rate of a camera, for a short duration, by having the camera take multiple exposures within one F-Sync (frame clock) cycle and works in 'internal' and 'external' sync modes, as well as in shutter off modes. The best implementation of the feature involves providing an external F-Sync pulse, thereby triggering a specific number of images at a frame rate greater than the external F-Sync rate.

To maintain good image quality, there are a couple rules for how burst mode operates. The rules involve the camera's maximum frame rate, the burst count and the burst period.

In the example shown here a Phantom camera which has a maximum frame rate at full resolution (1280 x 800) of 6273 fps, has been set as follows:

- Resolution: 1280 x 800
- Frame Rate: 1000 fps

– Exposure: 50 µs

Rule 1: For any given resolution, the burst period cannot exceed a camera's maximum frame rate (i.e., Max Frame Rate or Min Burst Period = 1/6273 = 159.41 µs)

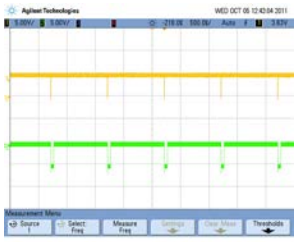
Rule 2: The maximum burst count for a given frame rate is the integer value of the maximum frame rate of the camera resolution divided by frame clock rate.

As a result of the rules, burst mode only works at frame rates that are less than or equal to the maximum frame rate for a given resolution because you cannot get a burst count of less than 1. In the example, burst mode is available at all frame rates from 24 fps to a maximum frame rate of 3136 fps. By knowing the max frame rate and the number of burst counts you calculate the burst period.

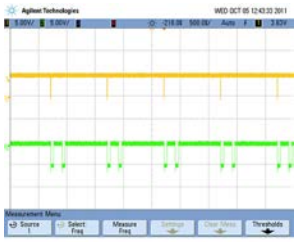
Using the Phantom v12.1 example and setting the camera's frame rate to 1000 fps results in a maximum burst count of six, (6273/1000 = 6). Thereby allowing the user to choose a burst count value from 0 to 6. 0 will disable burst mode and there is no burst period. As the burst count decreases the burst period increases.

The following figures, taken using an oscilloscope, show the effects of the parameters of burst mode:

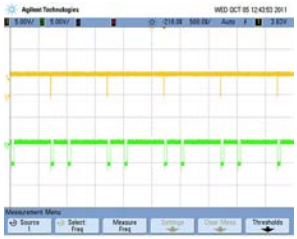
– Resolution: 1280 x 800
– Frame Rate: 1000 fps
– Channel 1 is F-Sync
– Channel 2 is Strobe



Sync	Frame Rate (fps)	Exposure (µs)	Burst Count	Burst Period (µs)	Comments
Internal	1000	50	0	N/A	Burst Mode disabled using internal frame rate generator

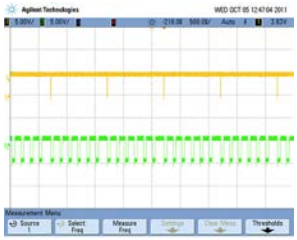


Sync	Frame Rate (fps)	Exposure (µs)	Burst Count	Burst Period (µs)	Comments
Internal	1000	50	2	200	Two image burst using internal frame rate generator. Each burst has a 50 µs exposure and the burst images are at an effective frame rate of 5000 fps.

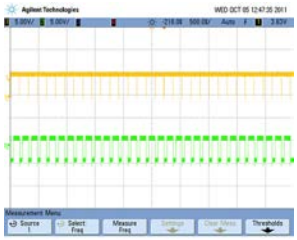


Sync	Frame Rate (fps)	Exposure (µs)	Burst Count	Burst Period (µs)	Comments
Internal	1000	50	2	300	Two image burst using internal frame rate generator. Each burst has a 50 µs exposure and burst images are at an effective frame rate of 3333 fps.

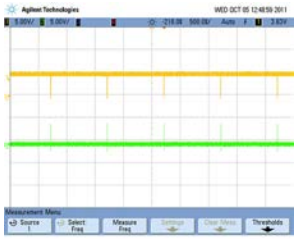
Sync	Frame Rate (fps)	Exposure (µs)	Burst Count	Burst Period (µs)	Comments
Internal	1000	50	3	200	Two image burst using internal frame rate generator. Each burst has a 50 µs exposure and the burst images are at an effective frame rate of 5000 fps.



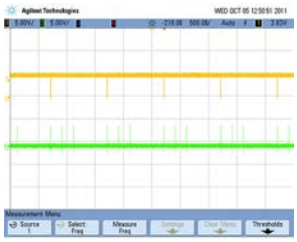
Sync	Frame Rate (fps)	Exposure (µs)	Burst Count	Burst Period (µs)	Comments
Internal	1000	50	6	159.41	Six image burst using internal frame rate generator. Each burst has a 50 µs exposure and the burst images are at an effective frame rate of 6273 fps.



Sync	Frame Rate (fps)	Exposure (µs)	Burst Count	Burst Period (µs)	Comments
Internal	6273	50	0	0	Burst Mode Disabled using internal frame rate generator at a frame rate of 6273 fps.



Sync	Frame Rate (fps)	Exposure (µs)	Burst Count	Burst Period (µs)	Comments
Internal	1000	PIV	0	N/A	Burst Mode Disabled in PIV mode using internal frame rate generator.



Sync	Frame Rate (fps)	Exposure (µs)	Burst Count	Burst Period (µs)	Comments
Internal	1000	PIV	3	N20	Three image burst using internal frame rate generator, Camera is in PIV mode and burst images are at an effective frame rate of 5000 fps.

6.3 Image-based Auto Trigger

The Image-Based Auto-Trigger (IBAT) feature allows selected Phantom camera models to trigger themselves when the image changes in a selectable region of the frame. For select v-Series models there is also a mode which allows this feature to generate a hardware trigger signal for multi-camera installations.

A few user definable parameters allow the auto-trigger behavior to be adjusted to operating conditions, filtering out unintended triggers due to vibration, changes in illumination, slow-moving shadows, etc. The Auto-Trigger operation begins by the user selecting a rectangular area within the image, this is the reference image for the Auto-Trigger region. As each frame is captured, the image in the Auto-Trigger region is compared to the reference image. After the comparison is made, the image in memory is updated to the current image, to be used in the future. This is done at a rate defined by the 'Check Interval'. The result of the comparison determines if a trigger is generated.

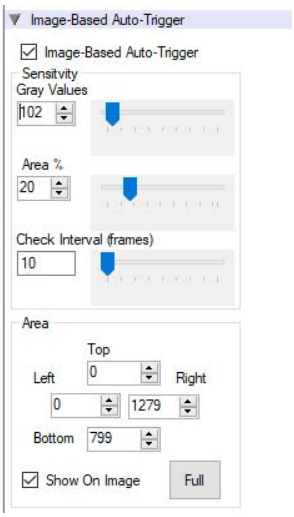
A pixel being compared is considered “active' if its level has changed (brightened or darkened), by more than a preset threshold. This threshold goes from 0-100 where a value of 100 would be equal to a change of the maximum value / 2. For a 12-bit image the maximum value is 4095, so the "changed" pixel would have to have a delta pixel value of ~2048.

The number of active pixels for a given frame are counted, and if it exceeds a set number, a trigger is generated. The required number of active pixels is specified as a percentage of the area of the Auto-Trigger region. When an Auto-Trigger condition is detected, the Auto-Trigger signal of the camera is pulled low.

Ultimately, when enabled and all IBAT criterion are met, the camera will generate an auto-trigger signal (which can be used to trigger other cameras) and trigger itself. If the auto-trigger signal is pulled low by an external device, the camera will be triggered. When multiple cameras are used to capture an event, it is usually desirable to trigger all cameras simultaneously. Therefore, connect the auto-trigger signal of all

cameras together.to allow all the cameras to be triggered when either of the cameras detects an auto-trigger event.

SETUP PARAMETERS / PROCEDURES



1. **Image-Based Auto-Trigger** - enables the Image-Based Auto-Trigger feature and options.
2. **Sensitivity** - sets the criteria that instructs the camera to trigger auto-trigger.
   a. **Gray Values** - specifies the level that a pixel value must change in order to be counted as an active pixel for auto-trigger purposes. A value of 2048 would require a change of approximately half of the full swing of a 12-bit camera. A typical threshold setting is a lower value, it is recommended to start at ~100.
   b. **Area %** - specifies the percentage of the auto-trigger region that must be active in order for an auto-trigger event to be generated. A typical percentage value is 10.
   c. **Check Interval (frames)** - specifies how often the reference image is updated.
3. **Area** - specifies an area / region required to meet the user-defined 'Sensitivity' parameters auto-trigger the camera(s).
   a. Top / Left / Bottom / Right - specify the x, y coordinates of the pixels representing the upper-left / bottom-right corner of the area 'Area', respectively.

The 'Top', 'Left', 'Bottom', and 'Right' data-entry fields will populate automatically by drawing a rectangle around the area and select 'Auto Trigger' from the popup window.

   b. **Show On Image** - displays a yellow dotted box indicating the auto-trigger region (specified by the user) IBAT monitors to validate 'Sensitivity' values. This overlay is not recorded with the image data.
   c. **Full Button** - instructs the PCC software to analyze the entire image, or maximum allowed (up to 1 megapixel).

Before using the Image-based Auto trigger for the first time, PCC will display this message which must be acknowledged:

The Image-Based Auto-Trigger feature should never be used in applications where missed or false triggers cannot be tolerated or where a false trigger could cause harm to people or property. The hardware signaling available in some Image-Based Auto-Trigger modes should be used only to synchronize multiple Phantom cameras together and should never be used to trigger or control any other external device or event.

CONSEQUENCES RESULTING FROM SYSTEM FAILURE, FALSE TRIGGERING OR MISUSE OF THIS FEATURE ARE THE SOLE RESPONSIBILITY OF THE USER.

6.4 Continuous Recording

The Continuous Recording function increases the efficiency and security of a high-speed imaging workflow by automatically saving captured Cine files immediately after trigger. The entire RAM buffer or segment can be saved, or a defined number of frames can be set in advance.

When used with Multi-Cine, Continuous Recording can completely eliminate downtime between shots. This is useful for long duration tests where numerous (sometimes several hundred) events are to be captured. This technique is often referred to as “buffer balancing” which allows the top frame rates to be used in combination with tests that last much longer than the camera’s limited RAM buffer allows.

It can also be used with Image-Based Auto-Trigger (IBAT) to provide a completely autonomous high-speed image capture and save workflow.

Application examples include

- High-speed events that occur in fast succession, including repeated impact studies, where several recordings are required with limited downtime between shots.
- Missions that require data redundancy for added security in the event of power loss after the shot
- Unattended operation where the camera receives an external or auto-trigger

SETUP PARAMETERS / PROCEDURES

Start by setting all recording parameters, including multi-Cine if desired.

Because this function results in several saved files, it is recommended to specify a Test Name and ensure the ‘Save cine number’ starts at 0 or number of your choosing. This number increments as files are saved. These naming functions are found in the ‘**Auto-Name Settings’** menu, starting with PCC version 3.5 as shown.

Next, expand the ‘Continuous Recording’ menu found under the ‘Live’ tab of PCC and define the required parameters per descriptions below. At minimum, the Cine file name and path must be specified to enable the feature.

Active – Enables the Continuous Recording feature. Check this box after all other parameters are set.

Once Active, the Capture button will gray out and Trigger button illuminates green every time a new recording is ready to be triggered.

Cine file path & Save parameters – Displays the full save location and programmed name of the files to be saved. This field will be populated once the **'Browse**...' button is selected and information has been specified in the 'Save Cine' dialog.
File type and Range is also specified in the ‘Save Cine’ dialog, which starts with the first frame number and ending with the last frame for each file. Remember the trigger frame is always zero.

Auto Trigger - Instructs PCC to automatically trigger the camera immediately following the saving of the last recorded Cine. This is used when leaving the camera unattended, with the goal to capture as many Cines as possible to a large amount of external drive space, within that period of time. This can only be disabled by un-checking the Continuous Recording ‘Active’ box.

Note: The Continuous Recording Auto Trigger function is different than the Image-Based Auto-Trigger (IBAT) feature.

Firmware Ordered Recording - Used to reduce the time between takes by instructing a Phantom camera to erase a MultiCine segment upon save completion immediately making it available for recording again.

Minimal GUI Refresh - Used to accelerate the save process by disabling progress indicators within the program. Enabling this also instructs PCC to stop displaying live images in the Preview panel.

Save Count - Counts the files saved in the current session.

Error Count & Log - Reports the number of errors that rarely occur while using the feature. The log avoids immediate user intervention, instead the errors are collected in a log file for review later.

PCC ensures that files will never be overwritten when using Continuous Record. It is a good idea to keep an eye on hard drive space, as that can fill up quickly using this function.

Earlier versions of PCC included a Calibration Snapshot function in Continuous Recording for DIC. This function has been moved to the Sync Snapshot menu starting with PCC version 3.5.

6.5 Snapshot and Synchronous Snapshot for Calibration Files

Saving an image from a video camera is called a snapshot. The image is either the current live image or an image from a recorded Cine. The saved image will look like the displayed or played-back image so it will include all processing done for display. The name of the file is generated automatically, usually based on a continuously increasing counter.

For a single camera, an image file is saved when you press the single-camera Snapshot button. Enhancements to this basic operation have been added to configure the image file format, its path and name using our enhanced File Name Language. Detailed information on this enhancement can be found in the Automatic File Naming section

For multiple cameras, including synchronized cameras meant to generate calibration images for stereo applications such as Digital Image Correlation (DIC), there is a menu dedicated to acquiring these 'synchronous snapshots'.

In both cases, the acquired snapshot images can be found by navigating the down-arrow icon and clicking 'Explore Snapshots'.

Understanding a Sync Family

Image acquisition in Phantom cameras can be synchronized very precisely in hardware using the F-Sync signal. One of the cameras is the 'Primary' and uses its internal clock for acquisition, all other cameras are considered secondary and use the clock from the primary camera. It's important to recognize that cameras cannot provide synchronized live images, this is why triggering synchronized cameras with a hardware trigger is required for this function.

With PCC, a group of synchronized cameras is defined by setting the 'Primary Camera Serial' parameter for each secondary camera to the serial number of the primary. The primary camera itself must have this parameter set to 0. All cameras share the same frame rate but the exposure can be different.

PCC refers to a 'Sync family' as a group of two or more synchronized cameras. The pool of connected cameras may include one or more Sync families and a few independent (not synchronized) cameras.

Synchronous Snapshots

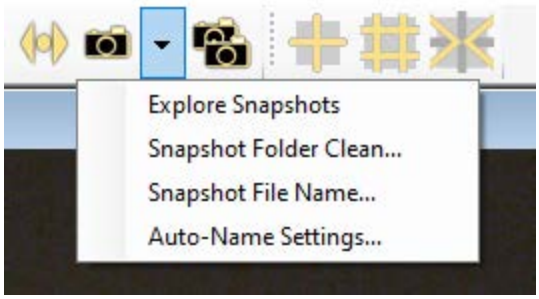
For each sync snapshot, you get an image from each camera of the sync family. For precise synchronization of the snapshots from multiple cameras, each camera is set to record a temporary cine with one post trigger image. All the cameras in the sync family are hardware triggered from the same signal. To record this temporary cine, each camera needs to have at least one empty partition. After triggering and finishing the recording, the image 0 from the sync family is saved to a file and the recording is restarted in preparation for a next snapshot.

The snapshot files are named using 'Snapshot Number', a positive number increased at each snapshot event. Sync Snapshots are enabled with PCC's File Naming Language. More details about the function {snap} and other functions can be found in the section ***Automatic File Naming***

If your test includes multiple recordings that need different sets of calibration images, you can use the 'Calibration Number' in the file name and include it in a path segment, to have a separate folder for each calibration set. See section ***Automatic File Naming*** for details on the use of functions {cal} and {snap}.

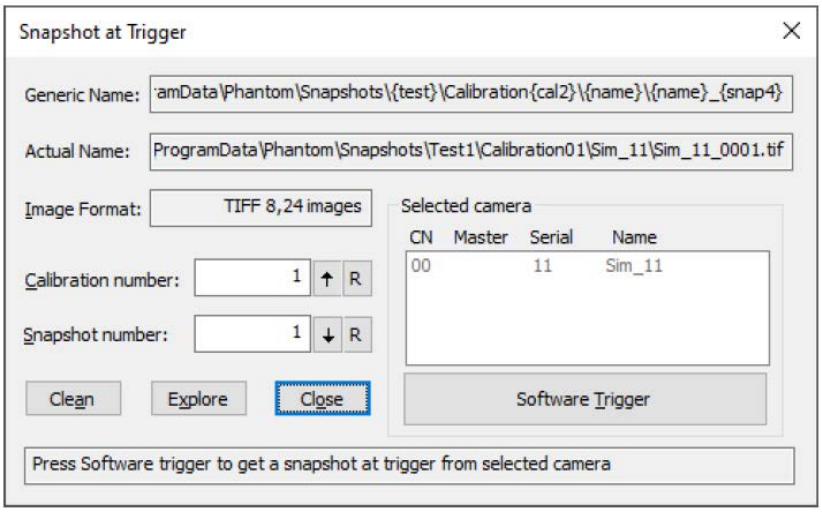
How to Use

The double camera icon allow access to configuration of the file format, folder and name and to special services like Snapshot folder cleanup or starting Windows Explorer to see the snapshot images. Use this menu, to use the sync snapshot functionality from all cameras of the selected sync family.



With a Single Camera

a. The operation of the snapshot extensions depends on the selected camera. If the selected camera is not member of a sync family, the sync snapshot feature is not available.
b. The table of cameras displayed in the dialog changes the name to 'Selected camera' and has only one member.
c. You can define snapshot parameters for the single camera and obtain a snapshot.



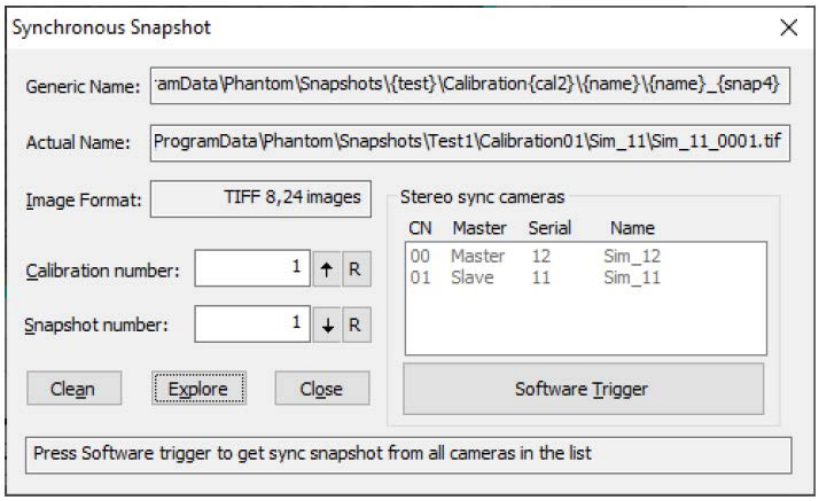
The software checks if there is an empty partition in the selected camera and initiates recording of the temporary cine. Each hardware trigger will cause the end of the recording of the temporary cine, saving image 0 to file, deleting the recording and initiating a new one.

You need at least one empty camera partition for this procedure otherwise you will get a warning message and dialog will not open.

With a Sync Family

a. If the selected camera is a member of a sync family (whether it's the primary or one of the secondary cameras), it is assumed the sync family is selected.
b. The table of cameras changes name to 'Stereo sync cameras'.
c. The list of cameras will always have at least two members.

The dialog box is prepared for you to obtain a set of synchronized snapshot images from the sync family. After each trigger, the snapshot number is increased.



d. The software trigger button is shown only if the selected camera is a simulated camera. For real cameras, only the hardware trigger can be used to acquire precisely synchronized images.

Calibration or snapshot numbers are disabled if {cal} or {snap} are not part of the file name.

e. There is a dedicated down arrow button to decrease the snapshot number and re-take the last set of images if you desire. Similarly, if you use calibration number and you want to acquire the next set of calibration images, you can click the up arrow to increment the calibration number.
f. Reset buttons 'R' return the numbers to 1.
g. The 'Explore' button launches File explorer on the Snapshot folder and 'Clean' deletes all files from snapshot folder after a warning and a report.

Organizing Your Snapshots

To change the format, path and name of the file, you have the 'Snapshot file name' option in the drop menu of the Snapshot button that opens a Save File dialog box with the available options.

a. Use the 'Insert to File Name' button to build a convenient name and path for the snapshot file. If you are familiar with the File Name Language, you can type the function yourself in the 'File name' field. Please note this 'File name:' field can include not only the file name but a few segments of the path so you can organize the files as you want.
b. Do not enter any extension, the software will choose the default extension for each file type.
c. Choose the file format from 'Save as type' drop-down menu.

Making Use of Automatic File Naming with Sync Snapshot

The 'Auto-Name Settings' from the Snapshot drop menu offers a centralized place to see all the parameters used in automatic file naming, both for snapshots and for cine saves.
You can see the names and paths used in different save contexts and you can force all names and paths to their factory default values.

6.6 Data Acquisition

A Phantom camera can utilize an National Instruments (NI) USB X or M Series Data Acquisition Unit to save signal data (of post-trigger frames), sampled via a data acquisition unit (DAQ), to PCC application memory. This mechanism is an extension of the time stamp storage system; and is treated very much like time stamps and event signal.

Beginning with PCC 3.8 a new DAQ Data Import feature has been added to allow data (in the form of a .CSV file) to be applied to a pre-existing CINE file for graphical display. Refer to the DAQ Data Import Feature section for details.

A detailed walk-through of the Data Acquisition feature is available from the Phantom Communities Support site (Link)

Signal data is saved to the PCC application memory and is not stored with the image data in the camera's RAM. If the PCC application is closed prior to saving the cine to a local disk or exporting the data to a CSV file via PCC, then it will be lost. Signal data cannot be saved to cines stored on any of the camera's flash media, i.e., CFast media, CineMags, or internal camera Flash storage.

The signal acquisition feature cannot be used in conjunction with partitioned RAM.

6.6.1 DAQ Signals

As of this writing the following National Instruments USB X or M Series Data Acquisition Unit models supported are:

NI (NATIONAL INSTRUMENTS) USB X SERIES DATA ACQUISITION UNITS	NI (NATIONAL INSTRUMENTS) USB M SERIES DATA ACQUISITION UNITS
NI USB-6341	NI USB-6212 BNC
NI USB-6343	NI USB-6216 BNC
NI USB-6351	NI USB-6218 BNC
NI USB-6353	NI USB-6221
NI USB-6356	NI USB-6221 BNC
NI USB-6361	NI USB-6229
NI USB-6363 BNC	NI USB-6229 BNC
NI USB-6366	NI USB-6225
	NI USB-6251 BNC
	NI USB-6259 BNC

Prior to using the 'DAQ Signals' features ensure that the appropriate device drivers and National Instruments software has been installed, and all relevant connections have made.

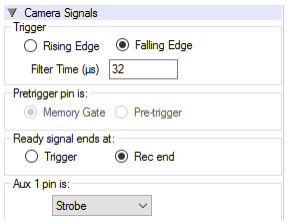
It is good practice to ensure the DAQ is working properly within the National Instruments software first, using the NI Test panels interface, before going into PCC.

The following process only describes the steps necessary to define the Phantom (PCC) Camera Control application signal inputs; for National Instruments software, device driver installation, and cable connection information refer to the Phantom Feature Document on this subject.

6.6.1.1 Signal Acquisition

The 'DAQ Signals' feature requires the pre-trigger RAM buffer to be full before triggering, otherwise an error message will occur.

SETUP PARAMETER / PROCEDURE

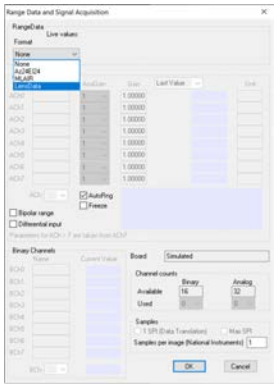


To utilize the DAQ Signal Acquisition feature the following parameters must be set via the ' Camera Signals' selector :

1. **Ready Signal Ends At:** - set to 'Rec end'

Cameras supporting Programmable I/O Ports no longer provide the 'Ready Signal Ends At:' option, therefore, the user must change the 'Ready' signal port to 'Recording'. This will instruct the camera to provide a 'Ready' signal until the recording process has completed.

2. **Aux Pin Is / P#** - set one of the auxiliary' or 'programmable' ports to 'Strobe'



3. **Range Data** - specifies / displays values of user select format.
   a. **List values** - displays the values supplied
   b. **Format** - specifies the required Range Data protocol. For details on the Range Data protocol see 'Range Data Interface'.
      1) Az24EI24 - A 24-bit serial Azimuth and Elevation FDRS format, used by third-party tracking mounts.
      2) MLAIR - A format implemented for use with a particular third-party tracking instrument.
      3) Lens Data - support is presently implemented for the Canon CN20X50 only, using a special adapter for VEO cameras. Contact Vision Research for more details.

4. **Analog Channels** - specifies the analog channel parameters.
   a. **Bipolar range** - instructs the system to capture a value defined by two inputs, (positive and negative value samples).
   b. **Differential** - instruct the system to capture a differential input.
   c. **ACh 0- 7** - represents the analog channel inputs (ACh0 - ACH7).
   d. **AChn** - represents the analog channel inputs (ACh 8 - ACh32).
   a. **Name** - defines a nomenclature to channels ACh0 through ACh7 (Analog Channel 0 through Analog Channel 7) for ease of reference.
   b. **Analog Gain** - adjusts the analog gain value from a list of preset values in a pull-down selection list for the corresponding analog channel. This effectively modifies the full scale range of the DAQ. To see what the full scale range is refer to the DAQ product manual. The higher the analog gain, the smaller the full scale range and the finer the voltage values you can measure.
   c. **Gain** - scalar multiple to the DAQ signal to adjust the value typically to meet the specifications of the device performing the measurements.
   d. **Current Value** - displays the measured value sampled for the associated analog channel.
   e. **Unit** - used to specify the 'unit of measure' (voltage, psi, mph, etc.)
5. **Binary Channels** - specifies the binary channel parameters.
   a. **BCh 0-7** - represents the binary channel inputs (BCh0 - BCH7).
   b. **BChn** - represents the binary channel inputs (BCh 8 - BCh16).
   c. **Val** - displays the measured value sampled for the associated binary channel.
6. **Board** - displays the board (DAQ model) providing the measured data acquisition samples.
7. **Channel Counts** - specify and display the number of channels:
   a. **Available** - displays the number of binary and analog input signals available for use.
   b. **Used** - specifies the number of binary and analog input signals to be used).
8. **Samples** - specify and display the number of samples per post-trigger image. The total effective sample rate is defined by the DAQ unit in use.
   a. **1 Sample per image (Data Translation)** - directs the system to capture1 sample per image.
   b. **Max samples per image** - directs the system to capture the maximum number of samples to each image possible.

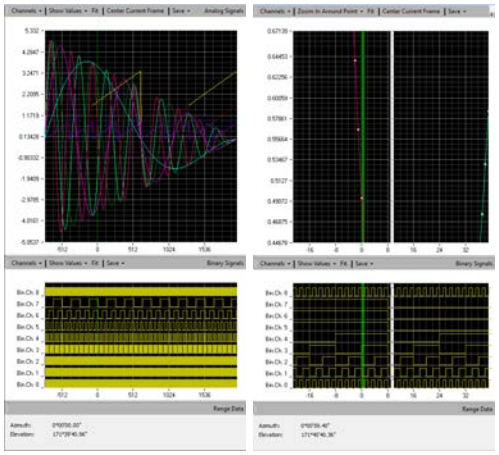
c. **Samples per image (national Instruments)** - displays the number of measured DAQ samples (up to the maximum (255) allowed) that will be tagged to each post-trigger frame (image).

The maximum number of 'Samples per image' will vary based on the 'Sample Rate' specified and the hardware sampling the measurements.

RANGE DATA / SIGNAL ACQUISITION GRAPHICAL DISPLAY

Most Phantom cameras provide the ability to gather range data, analog, and binary signal information. The gathered information is translated and stored for each image and can be displayed with the captured images during playback.

By default the chart displays a graph of all measurement values for all analog signals specified by the user in the 'Live > Advanced Settings > DAQ Signals' dialog window. The software assigns each channel a unique color. The numbers below the chart are the frame numbers of the Cine file; numbers to the right represent the measurement value. The green line, visible in the zoomed view, represents the position of the trigger frame; the white line is the current frame position. The dots on each channel are the acquired signal values (measurements).



Channels - used to turn off / on channels to display.

Show Values - provides various methods to zoom in / out of the signals, and pan the signal display area. It can also be selected o displays a popup window, containing the following information, when the cursor is placed over an analog channel sample point:

- **im** (image) - indicates the image number the specified reference point of the signal is associated with.
- **smp** (sample) - indicates the sample number of the specified reference point for the associated image.
- **ch** (number) - indicates the associated value (dependent on what the signal represents) of the reference point.

Fit - resets the display window to its' original size to display the entire signal range for all frames.

Center Current Frame (Analog Channels Only) - centers the chart so the current frame is displayed in the center of the chart.

Save - create a comma separated text file and select the type of file to be saved:

- **All** - creates a report file for all the analog channels visible or not.
- **Visible** - creates a report file for the visible analog channels only.

6.6.1.2 Range Data Interface

Introduction

Some Phantom cameras provide a mechanism that can be used to tag image frames with data supplied over the range data interface. This mechanism is of the time stamp storage system; range data tags are treated very much like timestamps and the event signal. While primarily intended for acquisition of altitude/azimuth/range information from tracking mounts, the range data input does not impose any

formatting on the actual data recorded; as such, it can be used to record arbitrary digital data, of up to 128-bits/frame.

The following contains a preliminary description of the interface, and is subject to change.

Electrical Interface

The range data interface consists of 2 differential pairs. The differential pairs use RS422 signaling levels, and are intended to be used in point-to-point connections. The signals are:

SIGNAL	FUNCTION	DESCRIPTION
corrp+, corrp-	Correlation pulse output	A 4 µs correlation pulse is output at the end of each exposure, synchronous with the time acquisition pulse.
data+, data-	Serial data input.	A 100 Ω termination resistor is placed across the serial data input pair.

The signals are made available on a 6-pin circular connector, with the pin out as shown in the table below:

PIN	SIGNAL
A	Correlation pulse output.
B	Serial Data Input +
C	Serial Data Input -
D	Correlation Pulse Output +
E	Correlation Pulse Output -
F	Signal Ground

Interface Timing

Correlation Pulse: At the end of the exposure of each frame (the moment time stamps are taken), a pulse is output on the corrp signal. The pulse is 4 µs in duration and has positive polarity.

Data Input: The data input carries an asynchronous data stream with the following characteristics:

PIN	SIGNAL
Data Rate	5 MHz
Bit Encoding	NRZ (Non-Return to Zero)
Bit Sequence	LSB (Least Significant Bit) transmitted first
Logic Levels	Positive

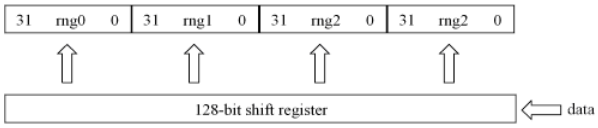
After the end of correlation pulse, the camera expects the data line to be in the idle state for a period not exceeding 100 µs, followed by a 32 or 64 bit preamble and 128 bits of data.

The preamble consists of between 31 and 63 contiguous '1' bits, followed by a single '0' bit. The falling edge of the preamble's '0' bit is used to synchronize the receiver clock.

After the preamble is detected, the 128 data bits following are shifted into a shift register. At the rising edge of the next correlation pulse, the data from the shift register is combined with the current time, and sent to the recording system. After that, the shift register is cleared and made ready for shifting in more data.

Data Storage

The range data acquired for each frame is stored in four 32-bit words inside the time stamps. The current value can be obtained by examining the variables irig.rng0 ... irig.rng4. The serial data stream is mapped to these variables as shown in below:



The 128 data bits recorded typically contain time, azimuth, elevation, range and status information. The camera does not interpret the data fields in any way.

The range data stamp stored for each frame is the one that has been clocked since the end of exposure of the previous frame. If no data is clocked for a specific frame, the range data words will all be zero.

The space for storing range data stamps is allocated when the camera memory is partitioned. For some combinations of camera memory size and resolutions, storage limitations may make storage of range stamps impossible: this will happen when the largest sizes of camera memory (e.g. 8Gb) are used with small frame sizes. In these cases, because of the excessive storage requirements, range data recording will be disabled.

6.7 DAQ Data Import Feature

The DAQ Data Import feature is designed to allow Phantom users to import DAQ data (in the form of a .CSV file) into a pre-existing CINE file for graphical display within PCC. Ideally, the imported DAQ-data (binary or analog) should have been collected synchronously with the frames by having utilized a common timing signaling (*i.e.*, f-sync signal / strobe / 5V TTL) between camera and DAQ (described below).

The collected data points are saved on a per-frame basis and users may upload 255 data-points per frame, and up to 64 channels.

DAQ and Camera Synchronization

Before collecting the high-speed video and DAQ data together, it is critical to ensure that both systems share a common clock signal, and are thus temporally synchronized. Typically, users choose to use the cameras f-sync ***or*** strobe signal to synchronize external systems (*i.e.*, camera, DAQs, instrumentation), see Section 7 for more information about these camera signals.

Other users may choose to run both the camera and DAQ system from function or waveform generator, this is also a viable option. It is important to recall where the timestamp is placed relative to the integration period. Refer to Figure 6A to see that a frame is stamped at the end of the integration period (*i.e.*, the rising edge of the strobe signal). Therefore, if you plan to use the camera to trigger the DAQ system, the rising edge of the strobe is recommended.

If you want to temporally position a datapoint directly in the middle of the integration period (for example) then the falling edge of the strobe can be used together with a delay of (exposure time/2), refer to Programmable IO for more information.

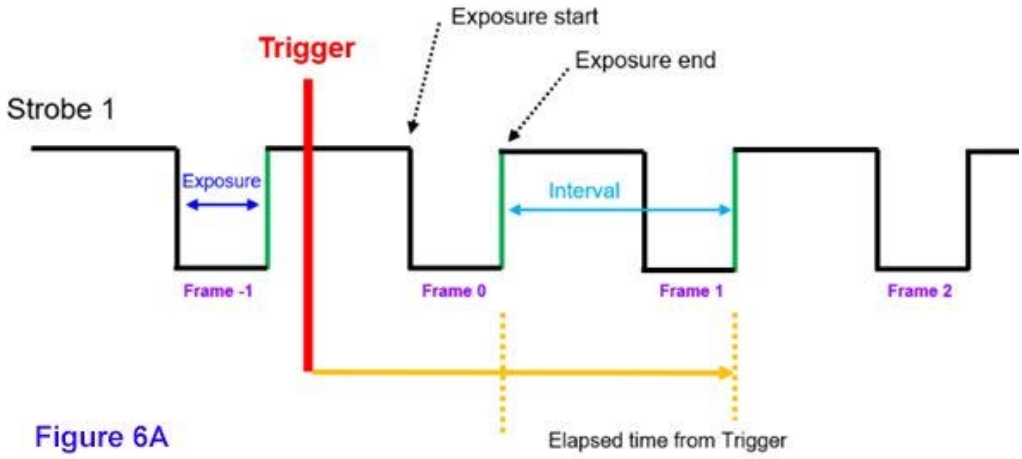
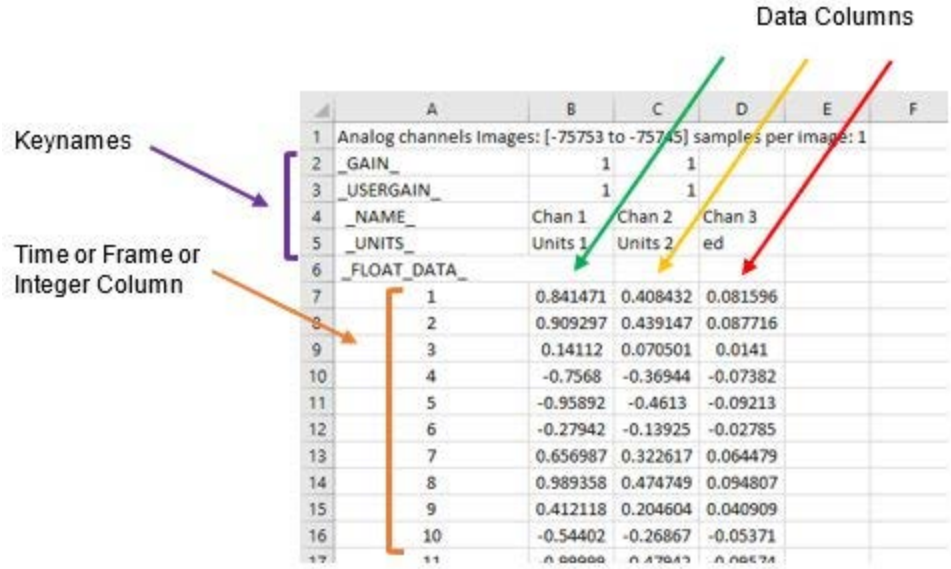


Figure 6A

6.7.1 Formatting the CSV File Prior to Import

The CSV file containing the DAQ data should be properly formatted before attempting to import it into a CINE file. If it does not follow the guidelines below, an error message will likely appear. There are two main 'formatting' sections to the CSV file: ***Configuration Information for the CSV*** and ***DAQ data positioning***.

CONFIGURATION INFORMATION FOR THE CSV



When configuring the CSV file for import, it is important to have a 'domain' column that represents time or frame. While the actual data within this column is not used for frame alignment, the import feature will skip it. This is because the DAQ data import feature will take the position of the DAQ data point in the CSV

array (or column) and align them to the frame number, aligning the first data point to the first frame and so on. If the CSV contains non-numeric characters, non-KeyNames, and/or blank rows, they will be ignored.

Each row within the CSV file should start with a KeyName. These KeyNames should be typed within the CSV file as to define the configuration of the DAQ. KeyNames are not required and will be set to default values if absent. Samples of formatted CSV files can be provided through Phantom support.

Values in the CSV file must be separated using commas. Non-USA versions of Excel may default to semicolon (or other) when saving the CSV, and therefore not import properly. Before importing these files in PCC 3.8 or PCC 3.9 these files must be updated to have each value separated with commas.

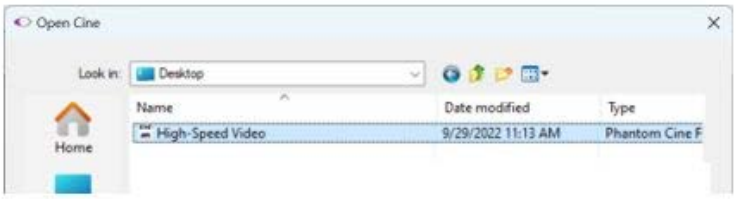
6.7.2 KeyName Definitions

NAME	Comma separated list used to define the name of each analog or binary channel. The names are maximum 10 characters. You can only define the names of the first 8 channels. All channels after 8 will have the same name as the eighth channel. The default name is “AnaChan_X” for analog data and “binChan_X” for binary data, where X = 1..8. This name will be shown in the graphic display in PCC.
UNITS	Comma separated list used to define the units of each analog channel. The unit names are maximum 5 characters. You can only define the units of the first 8 channels. All channels after 8 will have the same units as the eighth channel. The default value is “volts” This value will be shown in the graphic display in PCC
_16BIT_DATA_	Used to define the analog data as 16-bit signed integer values. The standard internal value for DAQ data is a 16 bit values which can range from -2048 (0xF800) to 2047(0x07FF)
_FLOAT_DATA_	Used to define the analog data as float point values. An additional “full scale” parameter can be added to define the max scale value. This is needed to correctly store the data in the cine file. The data in the cine file is saved as 16-bit signed integer values. This is the default DAQ data type. The default full scale value is 10.00 volts
_FALLING_EDGE_STROBE_ **_RISING_EDGE_STROBE_**	Indicates when data was saved, either the falling edge (default) or rising edge of strobe. This is just documentation and does not affect actual data. This selection will be shown in the graphic display in PCC
DESCRIPTION	up to 128-character string shown on the PCC graphic display for analog data.

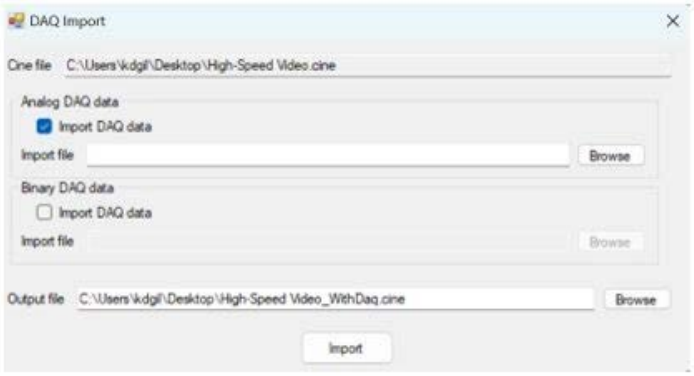
6.7.3 How to use within PCC

1. Click the DAQ Data Import Button, located in the PCC banner:

2. Select the .CINE file you want to import DAQ-data into



3. Click the check box for the type of DAQ data type you would like to import (Analog or Binary), and then define the Output file location and name (Note: Your initial .CINE file will be unchanged).



4. The DAQ data file type should be .CSV, and formatted properly for seamless import. The CSV files will have the designations for “KeyNames” and “data channels” to define key numerical data to be imported into PCC. The CSV formatting definitions are below:

The data in the time/frame column are ignored, and the data will be aligned to the frames based on their position within the column. The data points at the top of the list will be plotted from the earliest frame forward. If there are not enough data points, zeroes will be filled into the rest of the frames.

DAQ Data Points per Frame

DAQ data may be collected at a frequency greater than the frame rate. A good example is when the DAQ is collecting at 3 kHz, and the camera is running at 1 kHz. In this case, you can still import the DAQ data and have it be synchronized. To do this, after selecting the formatted CSV you wish to import, you must modify the “Sample per image” to 3, see below for representative DAQ Import prescan menu (see below).

Note that PCC stores the DAQ data per frame. Therefore, when the DAQ data is imported, it will display the data in an equally spaced manner. With this knowledge, it is important to consider which aspect of the sync signal you choose to utilize to perform synchronization.

6.7.4 Summary of the Different Import Scenarios

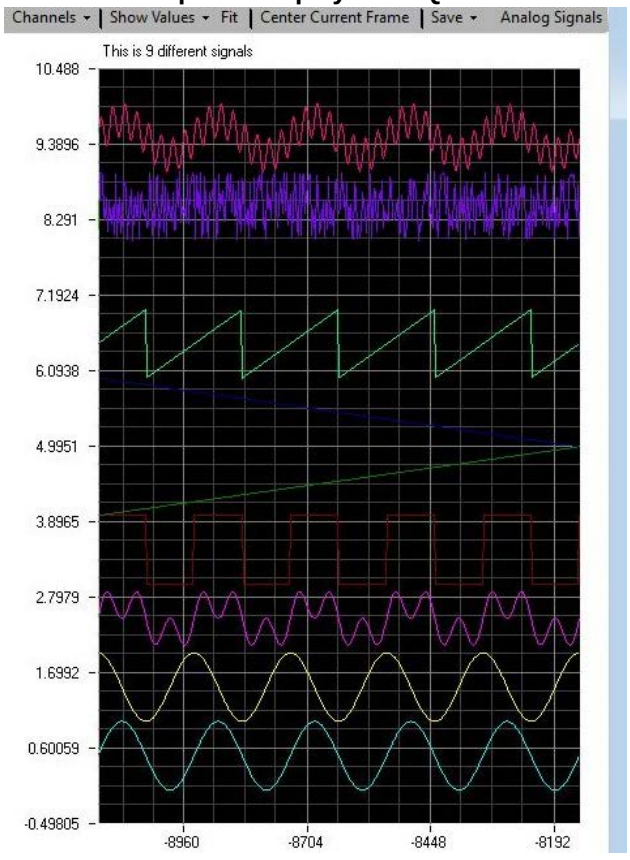
1. **Total DAQ Data Points = Total images:**There is one DAQ sample for each Image.
2. **Total DAQ Data Points > Total images:**This indicates there are more than one sample per image. There are a couple of scenarios:
   a) Have 200 data points but only 100 images. The **samples per image** would be 2 and would show two DAQ samples on each image.

   b) Have 154 samples but only 100 images. This is a possible importing issue. The **Samples per Image** must be an integer; Therefore, the result returned from the pre-scan would be 1.

   i. With a **Samples per Image** of 1, PCC would only import the first 100 DAQ samples and the additional 54 DAQ samples would not be used.

   ii. Another option is to change **Samples per image** to 2 (or more). This results in 77 images with two DAQ samples per image. The last 23 images would have two samples per image, but those samples would be zero.
3. **Total DAQ Data Points < Total images:** The DAQ sample buffer will be filled with “0” to create a complete DAQ buffer. For example:
   a) Have 54 samples but 100 images. The **samples per image** would be 1. 54 images will have a DAQ sample and the last 46 images will show zero.

Example of Displayed DAQ Data:



6.8 Advanced File Conversion

Converting a single Cine file into a variety of file formats is straight-forward, as described in the Save Cine section.

This topic covers working with multiple cameras, batches of Cine files, and also merging images into the Cine file format.

6.8.1 Batch Convert Procedure

The Batch Convert button can be used to convert a single saved Cine or multiple Cine files to any of the supported file formats. Cine files may also be parsed out as a series of still images for analysis. Many third party imaging applications can import a series of individual images for use in the image analysis process. This option provides a means to convert Cine files created with Phantom cameras to any of the supported image formats such as .bmp, tif, .gif etc.

PROCEDURE

1. Click on the Batch Convert toolbar button.
2. In the Open Cine(s) dialog window navigate to the folder containing the file(s) to be converted, and select the Cine file(s) to be opened; individually (highlight file). consecutively (select first file,; hold shift ket; select last file), non-consecutive (highlight first file; hold CTRL key; select additional files), or drag the mouse pointer to create a selection around the files to include, then click the Open button.
3. In the Multifile Convert Destination dialog window, navigate to the folder the file(s) are to be saved into.
   a. Enter a filename in the 'File' data entry field.

PCC will replace the name entry with the original file name of the file being converted.

   b. Select the file format from the 'Save As Type' pull-down selection list. For details on the various supported file formats see Supported File Formats, including:
      1) Compressed (Cine JPEG):
         a) Select 'Cine JPEG, *.cci' from the 'Save As Type' pull-down selection list. Phantom uses a JPEG compression method that allows you to choose either loss-less compression, or compression with some loss of detail. Use a Lossy compression, (1-99%), if an even more compact file is required. The default value of 100% quality compresses the file with no loss of detail; a quality value of 75% compresses the file 25% while retaining 75% of the original details.
         b) Specify the compression 'Quality (1...100)' under the 'Save Options'. The value entered represents the amount of quality retained in the compressed images, not the amount of reductions in file size. The reduction in file size will vary depending on the image contents.
      1) Movie Format (AVI, Multipage TIFF, H264, ProRes, QuickTime Uncompressed): If the AVI, *.avi file format has been selected, you will need to specify the following options in the 'AVI Options' dialog window specify the 'Frame Rate', 'Video Compressor', and 'Compression Quality'.

Some video codecs (coder/decoder) can be further configured by clicking on the Configure button in the 'Video Compressor' dialog window, if available. This user-manual does not detail the various video compressors or their specifics.

2) Image Stack (Windows BMP, OS/2 BMP, PCX, TGA, TIFF, LEAD, LEAD JIFIF, LEAD JTIF, JPEG, JTIF, RAW, DNG, DPX, EXR)

c. Select the 'Range Option' from the pull-down selection list: [Mark-In, Mark-Out], Full Cine, User Defined

d. Specify the desired 'Save Options'

e. Click the 'Convert' button. The system will display a Batch File Conversion window indicating the progress of the conversion process. When completed the Batch File Conversion window will read 100%.

If the 'Close' button is depressed before the file has finished being converted, the system will display the Abort? dialog window. If Yes is selected the conversion process will cease, however any portion of the file that has been process will be converted to the specified location.

6.8.2 Converting Grouped Files

This option is used to batch convert all Cine files form a group or sub-group.

PROCEDURE

1. In the Manager tab right-click the group or sub-group containing the Cine files to be converted.
2. Select the 'Convert All File' command from the popup selection list.
3. In the Multi Convert Destination dialog window:
   a. Enter the full path (in the 'Save In' data entry field) of the folder the Cine is to be save in, or use the navigation buttons (right of the 'Save In' data entry field) to locate the folder.
   b. Enter a root 'Filename' for the Cine files being saved. PCC will automatically append the camera's name and Cine number to the root filename during the save process.
   c. Select the format from the 'Save as Type' pull-down selection list.
   d. Define the range of images / frames to save using the 'Range Option' ([Mark-In, Mark-Out] , Full Cine, or User Defined) pull-down selection list.
   e. Specify the 'Deminate by' factor.
   f. Define all desired 'Save Options'. If the 'WAV audio file' save option was enabled a .wav file will also be created. This option should only be selected if the audio in is available (presently used with Phantom Flex4K models only).
   g. Click the 'Convert button'. PCC displays a 'Batch File Conversion' progress window.
   h. Click the 'Close' button upon completion

6.8.3 Merging Images Into a Cine Procedure

The Merge Images to Cine toolbar button allows the user to import and convert a series of images such as .tif, .bmp, etc. to the Phantom Cine format. The images must be originally generated by a Phantom camera.

The Merge Images function does not work with every file format, including DNG files (for example).

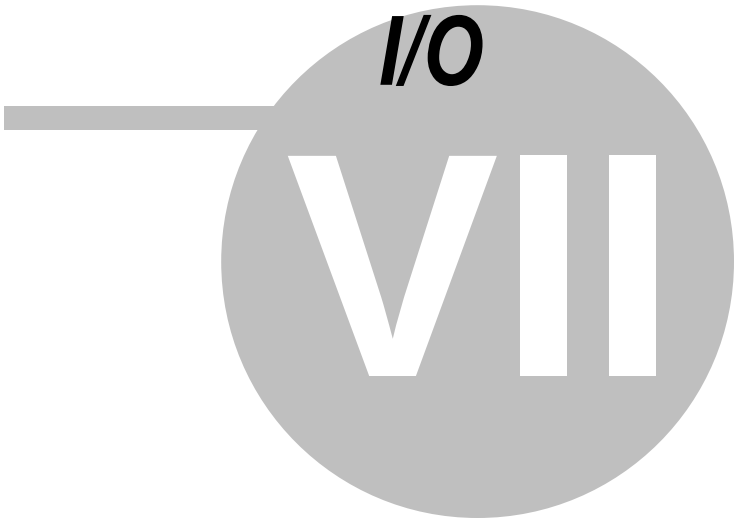
The image file names must be sequentially numbered from first to last for PCC to correctly merge the images to a Cine file. If they are not sequential they will be merged in the order

they are shown in the directory listing.

PROCEDURE

1. Click the 'Merge Images to Cine' toolbar button.
2. Navigate to the directory the individual images to be imported are stored in, from the 'Open Image File' dialog box, and highlight the first image file in the sequence.
3. Click the 'Open' button.
4. The system now prompts the user to specify whether or not to merge all image files (Yes) in the directory to the new Cine file, or only the images numbered in succession (No). Click Yes to proceed to the 'Merge and Resample Images' dialog box.
5. Define the 'Merge and Resample Images' dialog box parameters. The following is a brief description of the Merge and Resample dialog window:
   a. All Files Count - displays the number of individual files in the directory selected.
   b. Width & Height - Reports the dimensions of images in the selected directory.
   c. BPP (Bits Per Pixel) - Reports the bit depth of the images in the directory, usually 8BPP or 24BPP.
   d. Output File Name – indicates where the path to the first image being merged.
   e. Clip – allows the user to crop the image.
   f. Resample – specifies the aspect ratio size of the file being created.
6. If a header (.chd) file already exists within the specified directory the system prompts the user to specify if the existing header file is to be used.
7. Click Yes to create the new Cine file.

Signals & Programmable I/O



7 Signals & Programmable I/O

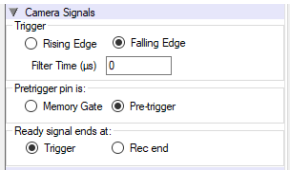
Phantom cameras have long employed discrete coaxial (BNC) connectors on the camera body, capture cable, or break-out-box to generate or accept a multitude of interface signals of various types.

Depending on the camera model the functions of these ports are either '**Dedicated**' (**fixed**), '**Assignable**' (**selectable**), or **'Programmable'**.

7.1 Dedicated (Fixed) Ports

Dedicated (Fixed) Ports are used to define the active Trigger edge, the associated Pre-trigger interface signal, and when to change the state of the camera's 'Ready' signal.

SETUP PARAMETERS



1. **Trigger** - Phantom cameras pull-up the trigger signal to 5 VDC (High).

Compatible methods to send the trigger signal:

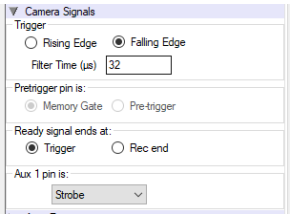
   a. 5V-TTL Pulse
   b. Contact Closure - for example when using a 'Pickle Switch'.
   c. High Voltage (HV) - when selected a signal between 6-32 VDC is required to trigger the camera. HV trigger is not compatible with all Phantom cameras, including for example the legacy v-Series, Miro eX and Miro 3.

2. **Rising / Falling Edge** - selects whether the leading edge or trailing edge of a supplied input trigger signal is used to trigger the camera(s). If 'Falling Edge is selected the camera will be triggered once the trigger pulse is held low for the duration set in 'Filter Time'. However, when 'Rising Edge' is selected the trigger pulse must be held low for a duration of 10x the 'Filter Time', then return high for the 'Filter Time' to be a valid signal.
3. **Filter Time** - this feature acts as a 'transient spike' filter, and the camera will ignore any trigger signals that are less then the set filter time. For example, if the filter time is 32 µs and the trigger pulse is 20 µs, the camera will ignore it.
4. **Pre-trigger Pin Is**: - specifies whether a supplied input signal is to be used to toggle 'Memory Gate', or as a 'Pre-trigger' input signal.
5. **Ready Signal Ends At:** - instructs the camera to toggle its READY signal from HIGH to LOW the moment a Trigger signal has been detected by the camera or when the allocated memory has completed capturing all the images to be recorded.

7.2 Assignable (Selectable) Ports

Cameras supporting 'selectable' ports use Auxiliary ports where one BNC port, can be assigned to one of a few signals. This is necessary due to the increasing number signals and a limited amount of physical space on the camera and / or pins on the capture cable. On those cameras, the port is labeled 'Aux' and the Camera Signals' menu in PCC is used to select the signal.

SETUP PARAMETERS



1. **Aux pin is:** - allows the user to specify the available I/O signal for the specific 'Auxiliary' port.

CAMERA MODELS	AUX 1	AUX 2	AUX 3
Miro (Legacy) Series [1]	Strobe / Event / Memgate / F-Sync	Ready / Strobe	N/A
Miro M / R / LC Series [2]	Strobe / Event / Memgate / F-Sync	Ready / Strobe	N/A
Miro C Series [3]	Strobe / Event / Memgate / F-Sync	Ready / Strobe	N/A
Miro LAB Series [4]	Strobe / Event / Memgate / F-Sync	Ready / Strobe	IRIG Out / Strobe
Phantom Flex 4k	Strobe / Event / Memgate / F-Sync	Ready / Strobe / AES Out	N/A

[1] Miro (Legacy) Series includes; Miro 1, Miro 2, Miro3, Miro 4, Miro eX1, Miro eX2, Miro eX4, Miro Airborne, Miro HD

[2] Miro (M / R / LC Series includes); Miro M / R / LC110, Miro M / R / LC310, Miro M / R / LC120, Miro M / R / LC320S, Miro M140, Miro M340

[3] Miro C Series includes; Miro C110, C210 and C320

[4] Miro LAB Series includes; Miro LAB110, Miro LAB310, Miro LAB3a10, Miro LAB120, Miro LAB320, Miro LAB140, Miro LAB340

ASSIGNABLE SIGNALS AND DESCRIPTIONS

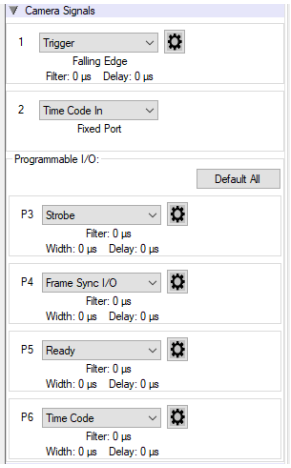
1. **F-Sync** (Frame Sync) - a switchable bi-directional (input / output) isolated signal with a threshold at +5V maximum, compatible with TTL levels and must be a properly terminated, (50-ohms). It enables the electronic shutter to operate in phase with an external timing signal.
   a. By default, the F-Sync port is an output (in Internal Sync mode), 0 to 5V pulse with a source impedance of 50 ohms. The reference edge of the pulse is the falling edge. The pulse will be low for about 300ns on each frame. The rising and falling edges are on the order of 5 ns. In External Sync mode, a falling edge of the F-Sync input will initiate a frame start event. If the camera doesn't receive F-Sync pulses, no images will be recorded, and the live image will not update (frozen on the last valid image).
   b. In external sync mode, F-Sync is TTL-compatible, with a 10k ohm input resistance to ground. The reference time is the moment the negative edge crosses the 1.35v threshold. The input has a hysteresis of 100mV, but should, nevertheless, be supplied with clean, reasonably fast edges (≤50ns).
2. **Strobe** - is an isolated open collector output signal, with 1k pull-up. When asserted (low) Strobe indicates that the camera integrates (the electronic shutter is open). Strobe is low for the duration of the exposure.
3. **Event** - the Event marker input default state is high (inactive). When the Event input is sampled low at the end of an exposure, the corresponding 'E' (Event) bit in the frame's time stamp is set.
4. **MemGate** - the default state is high (inactive). When the memory gate input is sampled low at the end of an exposure, the corresponding frame is skipped from storage to RAM. MemGate only works with post-trigger frames.

5. **Ready** - an isolated open collector output with 1k pull-up signal (active high). Ready is asserted when the camera goes into the capture mode (i.e. records into a cine) and is de-asserted either when the Cine is triggered, or when the Cine recording is completed. Ready changes synchronously with frame capture (at the end of each exposure), so in external sync mode it will not change until F-Sync (frame synchronization) pulses are received.
6. **IRIG Out** - the IRIG output is unmodulated IRIG-B, at RS-232 levels. When the IRIG output of one camera is connected to the input of another, their time basis will synchronize with 1-microsecond accuracy.
7. **AES Out** - Flex4K only - used to monitor the AES/EBU audio being input via the Sync connector.

7.3 Programmable I/O Ports

Interfacing of external equipment can sometimes be facilitated if the timing and polarity of the signals can be adjusted. Programmable ports allow the user to select a signal type from a pull-down selection list, and set the 'pulse processor control' (characteristics) for the signals.

SETUP PARAMETERS



1. **Default All** - instructs PCC to re-assign the factory-assigned defaults for the Programmable I/O signals.
2. **P(n)** - Programmable ports as available for the connected camera, allowing the signal to be selected from a pull-down selection list, and adjustments to the 'pulse processor control' (characteristics) for the signal; see the following table.
3. **Signal Settings Summary** - a summary of the current signal settings is found under the pull-down of each port.
4. **Gear** - opens the 'Pulse Control' dialog window for further configuration of the associated user-selected signal.

CAMERA MODELS	PORT / SIGNAL DEFAULT	PROGRAMMABLE / CORE SIGNALS	PULSE PROCESSOR CONTROL
The quantity of Programmable ports differ based on camera model. Phantom VEO-L cameras have 2 Programmable ports, where VEO-S, TMX and others have 4 Programmable ports. Not all Phantom cameras support Programmable I/O, please refer to the product data sheet to confirm.	1 / Trigger (Fixed)	N/A	Falling / Rising Edge, Falling / Rising Edge HV, Filter Time, Delay Time
	2 / TimeCode In (Fixed)	N/A	N/A
	3/P / Strobe	Strobe, Frame Sync, Ready, Time Code Out, Multi-Strobe, Auto Trigger, Sw Trigger, Recording, Event In. Memory Gate In, Pretrigger In, Runstop In, Auxtrigger In, Core Event, Core Memory Gate, Core Frame Sync, Core Pretrigger, Core Runstop, Core Auxtrigger, Core Trigger	Invert, Filter, Delay, Width
	4/P / F-Sync		
	5/P / Ready		
	6/P / TimeCode Out		

Reference the camera body for the P# and the default signal, which will correlate to the PCC control menu.

7.3.1 Signal Summary

All descriptions are the signal's default state prior to processing.

PROGRAMMABLE SIGNALS AND DESCRIPTIONS

1. **Ready -** An isolated open collector output with 1k pull-up signal (active high). Ready is asserted when the camera goes into capture mode and is de-asserted either when the Cine is triggered, or when the Cine recording is completed. Ready changes synchronously with frame capture (at the end of each exposure), so in external sync mode it will not change until F-Sync pulses are received.

Ready signal remains active until until a trigger signal is detected by the camera. Cameras not supporting 'Programmable I/O' select this signal in PCC under 'Camera Signals>Ready signal ends at:>Trigger'.

2. **Strobe -** An isolated open collector output signal, with 1k pull-up. When asserted (low) Strobe indicates that the camera integrates (electronic shutter is open).
3. **F-Sync -** Is the only signal can be set as an output or input. By default it is output (sync-internal). Output signal is a frame sync pulse from the camera's frame rate generator. A short (few hundred ns depending in camera model) negative pulse, with the falling edge used as timing reference. Input signal is active on falling edge (default state is high).

4. **TC Out -** Selectable under Advanced Settings as an unmodulated (dc-shifted) IRIG-B (at RS-232 levels), or SMPTE time code. It is recommended not to process the TC-Out, since a processed signal may no longer represent a standard or accurate time code.
5. **Auto Trigger -** Used to output a hardware trigger signal or pulse when Image Based Auto Trigger (IBAT) is initiated.
6. **Software Trigger -** An active high-output signal (pulse) generated as a result of the trigger protocol command.
7. **Recording -** An active high-output signal. Similar to 'READY' but always ends at Record End. When active, indicates the camera is recording into a RAM partition.

Recording signal remains active until recording process has completed, cameras not supporting 'Programmable I/O Ports selected this signal in PCC under 'Camera Signals>Ready signal ends at:>Rec end'.

8. **Event In -** If the input is sampled low at the end of an exposure, an ‘E’ (Event) bit in the frame’s time stamp is set.
9. **Memory Gate In -** If the input is sampled low at the end of an exposure, the corresponding frame is skipped from storage to RAM.
10. **Pre-Trigger -** An active low input (default high) signal. Keeping this signal low for enough time (10 - 500ms, or until ‘Ready’ signal goes high) will make the camera start recording if it has an available RAM partition.
11. **Aux Trigger -** Active on rising edge (default high). This is an alternative trigger input that can be processed through the programmable port pulse processors and assigned to different ports. Aux Trigger is not affected by the dedicated Trigger polarity, filter and delay variables.

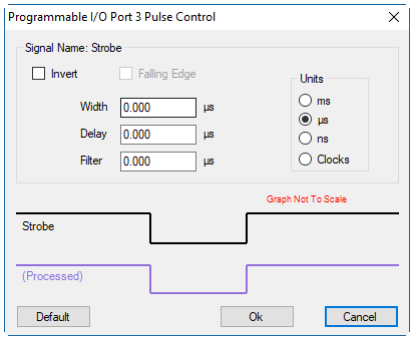
PROGRAMMABLE CORE SIGNALS AND DESCRIPTIONS

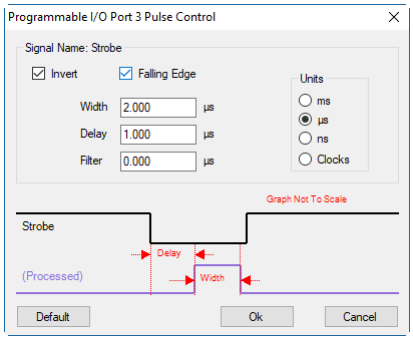
Core signals are copies of externally generated signals, routed through the camera and output to assigned ports. Core signals can be pulse-processed before being output. The current list of signals is:

1. **Core Event -** Feedback output from the Event In signal. The feedback is taken after any pulse processor for the output.
2. **Core Memory Gate -** Feedback output from the Memory Gate In signal. The feedback is taken after any pulse processor for the output.
3. **Core Frame Sync -** Feedback output from the F-Sync In signal. The feedback is taken after any pulse processor for the output, but before the delay element.
4. **Core Pretrigger -** Feedback output from the Pre-Trigger signal. The feedback is taken after any pulse processor for the input.
5. **Core Auxtrigger -** Feedback output from the Aux Trigger In signal. The feedback is taken after any pulse processor for the input.
6. **Core Trigger -** Feedback output from the main Trigger input. The feedback is taken before the trigger signal is affected by the trigger polarity, filter or delay settings. ‘Core Trigger’ can be used like a ‘Trigger Out’ signal.

7.3.2 Pulse Processor Control

After selecting the signal assignment, further configuration is possible by clicking the gear symbol next to each port. The Pulse Control menu is opened, as shown.





1. **Invert:** - inverts the signal at the output of the pulse processor.
2. **Falling:** - selects 'Falling Edge' mode for the pulse processor. This mode is only relevant if the 'Width' is also specified. When the 'Falling' token is present together with 'Width', the pulse processor will generate a negative pulse, triggered from the negative edge of the input signal.
3. **Width (Pulse Width):** - when a 'Width' token is present, a defined-length pulse is generated, which starts after the specified 'Delay', after the active edge of the 'input' signal. The length of the pulse is specified in microseconds (as a floating point number) and internally converted to pixel clock units. The maximum pulse width is at least 10 seconds. However, if the period of the 'input' signal is lower than the selected width, the latter is dynamically clamped to the signal period. The minimum pulse width is one pixel clock.
4. **Delay:** - delays the output pulse by the specified time in ms, µs or camera clock multiples. If the 'Width' token is not present, both edges of the signal are delayed by the same amount. If present, the delay is measured from the rising edge of the input* signal unless the 'Falling' token is present, in which case the delay is measured from the falling edge of the input. The delay time is specified in microseconds (as a floating point number), and is internally converted and routed to pixel clock units.
5. **Filter (Filter Time):** - when a 'Filter' token is present, the 'input' of the pulse processor is filtered through an edge filter of the specified time. The time of the filter can be between 0 and 1 second. In order for the output of the filter to be asserted, the 'input' signal must be continuously de-asserted for the same duration. The edges of the 'input' are thus delayed by the specified filter time (for a 'clean' input pulse). Filtering is applied before and independently of the delay and duration. The filter time is specified in microseconds (as a floating point number), and is internally converted and routed to pixel clock units.
6. **Units** - are the basic time interval (the period of the pixel clock) for all camera timing.

Please note that pulse processors can sometimes generate pulses that are too short for the output drivers to switch properly, and as such the processed signal should be verified with an oscilloscope before use.

7. **Signal Behavior Graphic Representation** - a graphic representation of the signal behavior is also displayed; however, this is not to scale and should just be used as a reference. Use of this feature requires an oscilloscope to truly visualize the signals and the subsequent changes with each adjustment.

7.4 Memgate (Memory Gate) Pickle Switch Activated

SETUP PARAMETERS / PROCEDURES

The following setup procedures can be used to capture images using Memory Gate signaling to the Phantom camera.

1. Attach a pickle switch to the Pre-Trigger/Memegte BNC on the Capture cable, Breakout box, or available Programmable I/O BNC.
2. If using a BoB, or Programmable I/O port, be sure that Memgate is assigned for that port"
3. Ensure the 'Camera Settings>Partitions> parameter is set to one (1). Segmented memory can not be used in this application.
4. Optional: Set the following 'Advanced Settings' options as follows:
   a. Enable 'Auto save to CineMag/built-in Flash' and 'Full Cine' under the 'Start/End of Recording Actions' options.
   b. Select the required frame clock source from the 'Sync Imaging' pull-down selection list from the 'External Sync' options.
   c. Enable 'Capture' under the Starts In' options.
5. Set the following 'Camera Signals' options as follows:
   a. Select 'Falling Edge' under the 'Trigger' options.
   b. Select the 'Memory Gate' radio button under the 'Pretrigger Pin Is' options..
6. Set the following 'Cine Settings':
   a. Resolution, Sample Rate, and Exposure Time as desired.
   b. Slide the 'Trigger Position' slider to the far left to define the Post Trigger value to the maximum frames allowed.
7. Click the 'Capture' button.

You must hold the pickle switch closed before performing the next step.

8. Apply a 'Trigger' signal to the camera. DO NOT RELEASE THE PICKLE SWITCH TRIGGER...
9. When you are ready release the pickle switch trigger to open the Memory Gate allowing images to be written to RAM.

As long as the pickle switch trigger is released, the camera will record images to RAM. However, this does not affect the trigger itself. Closing the pickle switch trigger closes the Memory Gate, stopping images from being recorded to RAM.

10. Continue to release the pickle switch trigger as necessary to record images to RAM, until the buffer is full. This will be indicated by the red capture indicator no longer being active.

- *If the images are to be saved into non-volatile Flash memory, the camera can write the contents from RAM to non-volatile FLASH memory once the buffer is full.*
- *When the save is finished the camera returns to the recording mode.*
- *There is no output on the camera that indicates the flash memory is full, you will need to keep track how many times you saved to it.*

11. Select the 'Save to File' command from the 'Cine Menu' to save the recorded image data.

PVP - Phantom Video Player

8 PVP - Phantom Video Player

The PVP (Phantom Video Player) application provides the ability to view live images from a Phantom Ethernet camera on an attached monitor or viewfinder. This simplified application can be used to capture, review, edit, and/or save a Cine recorded into the camera's RAM to a hard drive or an attached Phantom CineMag. PVP is a great option when used with the higher resolution cameras since most computer processors will not refresh the screen images quickly enough to produce a smooth visual display.

Once image data has been captured to the camera's memory, or Phantom CineMag, the user can play, edit, and/or save the Cine file directly from the camera using PVP.

Cines can be quickly edited by selecting the range of images to be played back using the video playback buttons. Furthermore, the user can assign image processing to the images being displayed, or adjust the playback speed through this easy-to-use application.

PVP is only accessible with Phantom Ethernet model cameras with video output.

8.1 PVP Camera Controls

PVP can be initiated using the Phantom Video Player desktop icon or the PCC **'Video Out'** toolbar button.

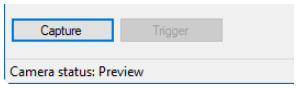
STEP-BY-STEP PROCEDURES

Capture a Cine

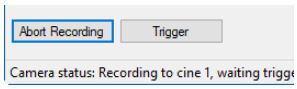
First the camera must be selected from the Camera drop-down list.

The recording process varies depending on the operational mode of the Phantom camera in use. The required recording parameters must be defined via the PCC application prior to performing the following procedures.

Loop Mode

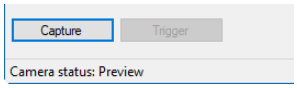


1. **Capture** - starts recording image data into the camera's internal memory buffer.. Notice the PVP application provides camera status information, (the operational state of the camera), at the bottom of the GUI (Graphical User Interface), just below the 'Abort Capture' button.

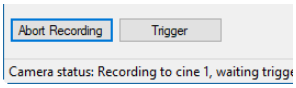


2. **Abort Recording** - stops the recording process.
3. **Trigger** - applies a soft-trigger to the camera.

R/S (Run/Stop) Mode



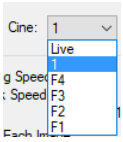
1. **Record** - starts recording image data directly to an attached Phantom CineMag. Notice the PVP application provides camera status information, (the operational state of the camera), at the bottom of the GUI (Graphical User Interface), just below the 'Record' button.

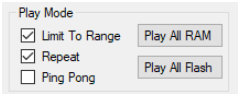


2. **Stop Recording** - attached instructs the camera to stop recording image data to the attached Phantom CineMag.

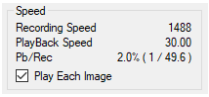
Once the recording process stopped, in either operational mode, the camera status will be set to Preview.

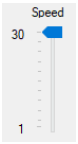
Review the Cine





1. **Cine** - allows user to select the Cine to be reviewed / edited / saved. Cines stored in the camera's memory buffer will be displayed as a number, (i.e., 1, 2, 3, etc.), while Cines being read from a Phantom CineMag, CineFlash, CFast 2.0 card, or CompactFlash Type 1 card will be displayed as Fn, (i.e, F1, F2, F3, etc.).
2. **Play Mode** - determines how the Cine are to be played back.
   a. **Limit To Range** - instructs the camera to play the range of images within the 'Mark-In' / 'Mark-Out' points only.
   b. **Repeat** - loops the playback of the selected Cine until instructed not to.
   c. **Ping Pong** - plays Cine forward then reverses playback continuously until instructed to stop.
   d. **Play All Ram** - instructs the camera to play back all Cine files save into its' memory buffer.
   e. **Play All Flash** - instructs the camera / CineStation to play back all Cine files save to the attached non-volatile Flash module (Phantom CineMag CineFlash / Cfast 2.0 card, or Type I CompactFlash card).

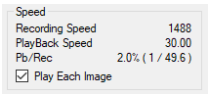




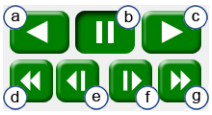
3. **Speed** - displays / determines the speed the Cine plays.
   a. **Recording Speed** - 'sample / frame rate' the Cine was recorded.
   b. **PlayBack Speed** - displays the frame rate the Cine will play back.

a. **Pb/Rec** (Playback/Record) - displays the ratio percentage of the playback rate to the recorded speed.

b. **Speed Slider** - used to adjust the frame rate the Cine will play. Drag the slider to change the playback rate, for finer adjustments use the up / down arrows of the control computer keypad.



4. **Speed** - displays / determines the speed the Cine plays.
   a. **Recording Speed** - 'sample / frame rate' the Cine was recorded.
   b. **PlayBack Speed** - displays the frame rate the Cine will play back.



5. **Video Control Button** - used to review selected Cine
   a. **Rewind** - play Cine file in reverse at the rate specified.
   b. **Pause** - stops / pauses playback.
   c. **Play** - plays the Cine file forward at the rate specified.
   d. **Fast Rewind** - quickly reminds (decrements the total number of frames/1000; no less than 10 frames, auto adjusting to Cine size).
   e. **Step Backward** - rewinds one image (frame) only.
   f. **Step Forward** - steps forward one image (frame) only.

g. **Fast Forward** - quickly increments (the total number of Cine frames/1000, no less than 10 frames, auto adjusting to Cine size) the images being reviewed.

Edit the Cine

1. **Timeline** - represent the image range of the selected Cine.
   a. **Top-Left Number** - indicates the number of the first image of unedited Cine
   b. **Top-Center Number** - represents the number of image being display.

   This number corresponds to the 'Timeline Image Location Slider'. Image number '0' (zero) represents the T0 frame / image; negative numbers represent pre-trigger frames, while a positive number represent post-trigger frames.

a. **Top-Right Number** - displays number of the last image of the unedited Cine
b. **Blue Timeline** - represents Cine image range to be saved.
c. **Gray Timeline** - represents portion of edited Cine not to be saved.
d. **Bottom Numbers** - represent the 'Mark-In' (left) / 'Mark-Out' (right) image numbers.

PROCEDURE

1. **Locate Images**
   a. Quick Search (Scrub) - drag 'Timeline Image Location Slider' to quickly find area of interest.
   b. Play - use the Video Control Buttons to locate the first / last images of the Cine to be saved
2. **Set Mark In / Out Points**

a. [**Mark In** - locate the starting point (first image) of the file being saved and click 'Mark-In' button.

b.] **Mark Out** - locate the point end (last image) of the file being saved and click 'Mark-Out' button.

Notice the 'Mark-In' / 'Mark-Out Points' move to the respective image numbers when selected.

3. **Verify Edited Cine**
   a. **Limit to Range** - enable to restrict playback of images between the user-specified 'Mark-In' / 'Mark-Out'' points only.
   b. **Play Each Frame** - enable to ensure all frames between the 'Mark-In' / 'Mark-Out' points will played back for review.

c. [**Jump to Start** - jumps the 'Timeline Image Location Slider' to the first frame of the edited Cine for review.

   d. **Video Control Buttons** - review the edit Cine.

Save the Cine

PVP supports two save options:

- Save to File - saves image data from the Phantom camera's memory buffer, or attached Phantom CineMag to a hard-drive.
- Save to Flash - saves the image range between the user-specified 'Mark-In' / 'Mark-Out' points to an attached CineMag or hard-drive.

PVP shares the same Save dialog with PCC software. Refer to Save Cine details for information about the Save menu and options

8.2 PVP Settings and Preferences

PVP Settings

1. **Video System:** - outputs a selected video format that matches the attached monitor or viewfinder.
2. **Zoom** - used to facilitate a focus operation
   a. Fit - fits image to the attached monitor or viewfinder
   b. 1 - displays a 1:1 image ratio to the monitor / viewfinder.
3. **Anamorphic Ratio** - displays a list of available ratios to select from.
4. **OSD** - the (On-Screen Display) parameters specify how the OSD information is to be outputted.
   a. **LCD OSD** - outputs digital OSD
   b. **Video OSD** - outputs analog OSD
   c. **OSD Opaque** - displays the OSD information inside a uniformed gray box

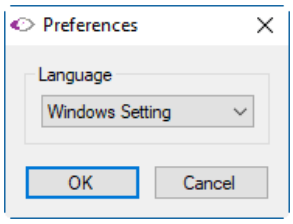
5. **Video Outputs** - defines the video feed mode, For details on each of these video-feed mode refer to the camera product manual. Not all camera models support dual-link and dual-feed modes.

   Use the following table to define the 'Video Outputs':

Video- Feed Mode	Video Outputs		
	4:4:4	All outputs play selected Cine	SDI2 plays selected Cine Analog / SDI1 play Live
Single-Feed Mode (4:2:2)	Disabled	Enabled	Disabled
Single Feed Mode with Dual-Link 4:4:4	Enabled	Enabled	Disabled
Dual-Feed Mode	Disabled	Disabled	Enabled
Dual-Feed Mode with 4:4:4	Enabled	Disabled	Enabled

6. **Production Area** - overlays either a 1920 x 1080 or 1280 x 720 rectangle, over the image area, that is used to show area of the image that will be in final production.
   a. **Offset:** - allows the user to adjust the location of the 'Production Area'. The X and Y coordinates are set in pixels.
   b. Certain cameras support a **cross-hair (or reticle) overlay** with additional color and thickness settings (instead of a rectangle).
7. **Other Options**
   a. **VF Mode** - Sets the zoom ratio of the camera's video output, or apply the threshold function to help set the exposure of a live image.
   b. **Test Image** - outputs a test pattern to the attached monitor / viewfinder.
8. **Genlock** - used to enable / disable Genlock on compatible cameras, along with displaying status information.

PVP Preferences



1. **Language:** - used to select the desired language the interface displays. Available options include:
   a. Windows Setting
   b. English
   c. Japanese
   d. Spanish
   e. Chinese (new in PCC 3.7)

8.3 Video Systems

Refer to the camera data sheet or product manual to confirm the video systems compatible with the camera.

The different types of video signal formats Phantom cameras will transmit to a monitor, include:

Analog NTSC - transmits the NTSC (National Television System Committee) video signal format; 59.94 half frames (called fields) per second and 525 lines per field, (480 lines in each field are the image, and the last 45 are the 'vertical blanking interval' (VBI), designed to give the electron gun time to reposition itself from the bottom of the last field to the top of the next), to an attach compatible monitor.

Analog PAL - transmits the PAL (Phase Alternating Line) video signal format; 25 fields per second and 625 lines per field, to an attached compatible monitor.

NTSC is the analog television system in use in Canada, Japan, South Korea, the United States, and some other places, mostly in the Americas.

PAL is the analog television system used in most of Western Europe, Australia and other countries

HDTV 720p60, p59.94, p50 - transmits 720 lines of vertical resolution, with a horizontal resolution of 1280 pixels and an aspect ratio of 16:9, implying a horizontal (display) resolution of 1280 lines and a frame resolution of 1280 × 720; progressively scanned, (non-interlaced); at a frame rate of 60Hz (or the frequency of the format displayed) to an attached HD compatible monitor.

HDTV 1080p30, p29.97, 25, 24, 23.976 - transmits 1080 lines of vertical resolution, with a horizontal resolution of 1920 pixels and an aspect ratio of 16:9, implying a horizontal (display) resolution of 1920 dots across and a frame resolution of 1920 × 1080; progressively scanned, (not-interlaced); at a frame rate of 30Hz (or the frequency of the format displayed) to an attached HD compatible monitor.

HDTV 1080 p60, p59.94, p50 - additional progressive scan formats, the camera requires 3G HD-SDI hardware to support these frequencies.

HDTV 1080i30, i29.97, i25 - transmits 1080 lines of vertical resolution, with a horizontal resolution of 1920 pixels and an aspect ratio of 16:9, implying a horizontal (display) resolution of 1920 dots across and a field resolution of 1920 × 1080; interlaced scanned, at a field rate of 30Hz (or the frequency of the format displayed) to an attached HD compatible monitor.

HDTV 1080psf30, psf29.97, psf25 - Progressive segmented Frame (PSF) is a High Definition video format used to store progressive content on interlaced media. Each progressive frame is segmented into two interlaced fields without inter-field motion, or 'combing'.

Cameras with HDMI use the same 3G HD-SDI signals as the SDI ports.

8.4 PVP Keyboard Shortcuts

Phantom Video Player Application - Main Screen					
Field	**HotKey**	**Field**	**HotKey**	**Field**	**HotKey**
About	Alt+B	Camera	Alt+M	Cine	Alt+C
End	Ctrl+End	Erase All	Alt+A	Fast Reverse<	Ctrl+<
Fast Forward	Ctrl+>	Help	Alt+H	Home	Ctrl+Home
Limit to Range	Alt+L	Mark In	Ctrl+[	Mark Out	Ctrl+]
Pause	Ctrl+Space Bar	Ping Pong	Ping Pong	Play	Ctrl+ -->
Play Each Image	Alt+E	Repeat	Alt+R	Rewind	Ctrl+ <--
Save to File	Alt+S	Save to Flash	Alt+F	Settings	Alt+I
Speed	Alt+D	Step Backward	Ctrl+Page Up	Step Forward	Ctrl+Page Down
Timeline	Alt+T				

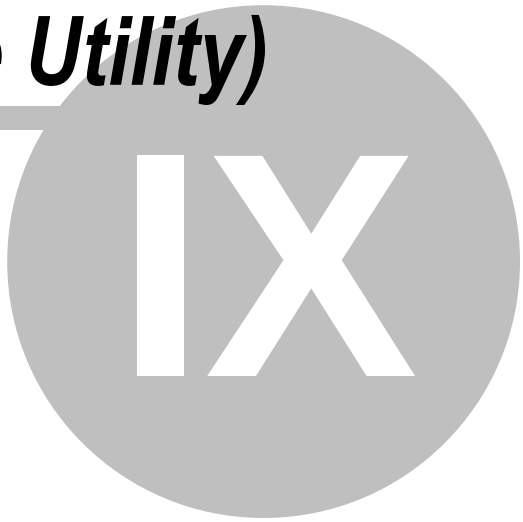
Phantom Video Player Application - Settings					
Field	**HotKey**	**Field**	**HotKey**	**Field**	**HotKey**
Adjust - Brightness [1]	Alt+B	Adjust - Gain [1]	Alt+G	Adjust - Gamma [1]	Alt+M
Adjust - Hue [1]	Alt+H	Adjust - Saturation [1]	Alt+S	Defaults	Alt+F
OSD - Analog OSD	Alt+A	OSD - Digital OSD	Alt+D	OSD - OSD Opaque	Alt+O
Test Image	Alt+T	Video System [2]	Alt+V	Zoom	Alt+Z

[1] Use Up/Down Keys to adjust setting.

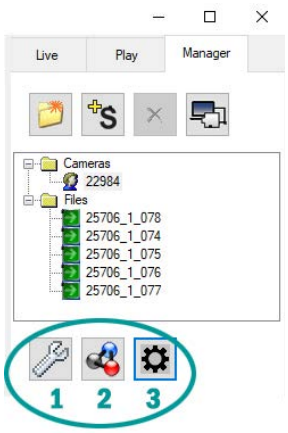
[2] Use Up/Down keys to scroll through available options.

In some operating systems, you may need to press the Alt+<hotkey> or Ctrl+<hotkey>, simultaneously. Some of the HotKeys associated with the Phantom Video Player use the CTRL key instead of the Alt key.

Nucleus (Camera Repair and Upgrade Utility)



9 Nucleus (Camera Repair and Upgrade Utility)



The lower portion of the Manager tab provides access to important program preferences and utilities:

1) **Application Preferences**

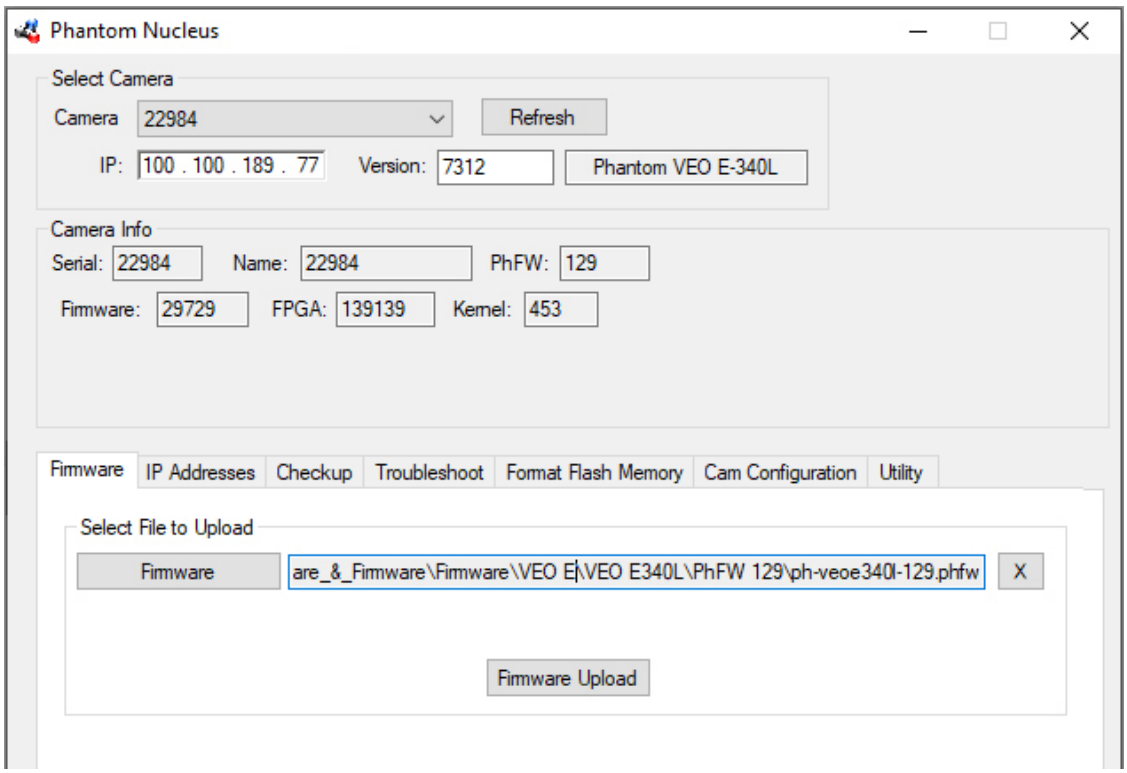
2) Phantom Nucleus (Camera Repair and Upgrade Utility)

3) **User Configuration Manager** (new in PCC 3.6)

This chapter covers the utilities and features found in Phantom Nucleus. The following chapter covers the Preferences and Configuration applications.

9.1 Nucleus Overview

The Nucleus application is used for viewing the current firmware level of the camera, for upgrading camera firmware, assigning a secondary IP and performing various troubleshooting tasks.



Before performing any tasks, the Camera must be selected from the Camera pull-down list at the top of the application.

The Select Camera and Camera Program sections stay active while working with the tabs in the lower section, this ensures the tasks being performed are being done to the selected camera.

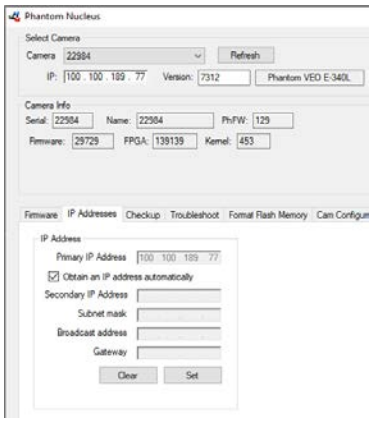
STEP-BY-STEP PROCEDURES

1. **Select Camera** - specifies the Phantom camera to use with the Nucleus application
   a. **IP and Version** will be populated automatically for a connected camera.
   b. In the event of a simulated camera, an IP address and camera version code can be added manually.
2. **Camera Info** - Read only fields that populate once the Phantom camera is selected.
   a. **Serial:** - factory assigned camera serial number.
   b. **Name:** - assigned name of the connected camera, by default the Phantom camera serial number.
   c. **PhFW** - firmware package version used for ph16 cameras.
   d. **Firmware, FPGA, Kernel:** - individual components of the firmware package.
3. **Select the tab** from the lower section based on the required function.

9.2 Updating Firmware

1. The latest camera firmware should first be downloaded from the Phantom Support Communities website, Product Support pages, which can be found by visiting phantomhighspeed.com.
2. Select the Firmware button, then navigate to the downloaded file.
   a. For ph16 cameras, the firmware file that gets loaded should have file extension .phfw
3. Select **'Firmware Upload'** to install the file to the camera.
4. **Follow all system prompts**, including to reboot the camera once indicated to do so.
   a. The camera can take up to several minutes to fully reboot after the firmware upload procedure.
   b. If the application cannot automatically identify the camera you are upgrading, you may need to enter the IP address and Camera Version ID to go further.

9.3 IP Addresses (Nucleus)



The IP Address Tab assigns and obtains all associated GigE / 10Gb / DHCP (Dynamic Host Configuration Protocol) camera IP addresses.

1. **IP address (Gigabit**)- specifies / displays the assigned IP Address Gigabit (GigE) Ethernet adapter.
   a. **Primary IP Address** - displays the assigned (GigE) IP address of the Phantom camera.
   b. **Obtain an IP address automatically** - instructs the camera to obtain its IP Address from a DHCP router.

2. Secondary IP Address - assigns a user-defined (GigE) IP address to the Phantom camera.
   a. **Subnet mask** - sets the IPv4 network the camera is associated with (typically this is 255.255.0.0)
   b. **Broadcast address** - typically is left blank.

c. **Gateway address** - sets a destination IP Address for all traffic not on the same subnet. Typically this is left blank.

3. XIP Address (10Gb) - specifies / displays the assigned XIP (10Gb) Address Ethernet adapter.

a. **Current IP Address** - displays the assigned XIP (10Gb) address of the camera.

b. **New IP Address** - assigns a user-defined 10Gb IP address to the Phantom camera.

c. **Subnet mask** - sets the IPv4 network the camera is associated with (typically this is 255.255.0.0)

d. **Broadcast address** - typically is left blank.

If 'Obtain an IP address automatically' is enabled the 'Secondary IP Address', 'Subnet mask', 'Broadcast address', and 'Gateway' fields will disable.

If the control unit does not detect the camera re-check the settings of the control computer, ensure it is on the same network as the Phantom camera. Setting the IP Address of a camera does not remove its default IP address. In the event you need to verify the camera's user defined IP Address, or made a mistake entering the information, simply reset the control unit's IP Address to 100.100.100.1, and reconnect to the camera making any necessary changes using the steps above.

9.4 Camera Configuration File

New in PCC 3.9, Camera Configuration files are used to provide PCC with specific feature sets to enable features and make the menus within the program work better for that particular camera model.

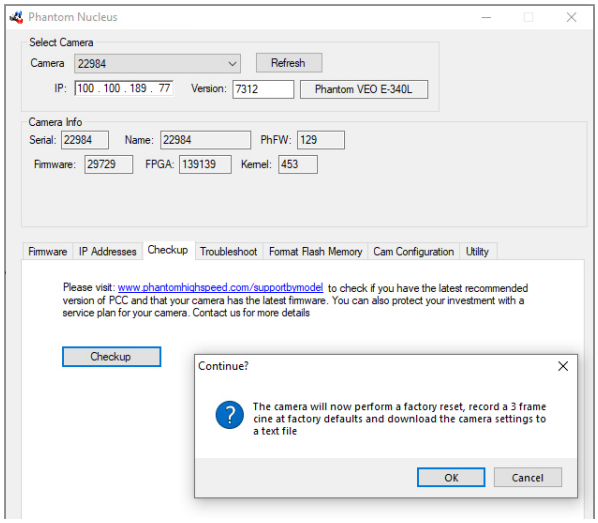
This feature was added in 3.9 to prepare for future camera models, following the release of this version of software.

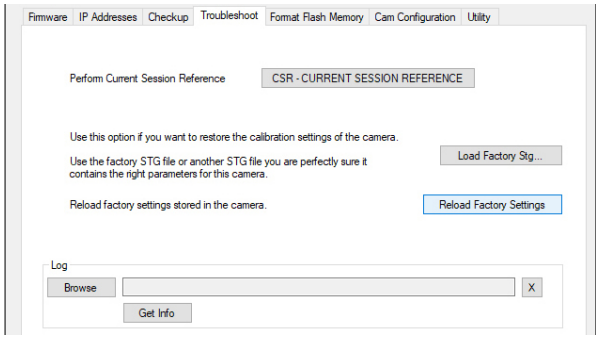
The dialog box for the configuration file in the top section of Nucleus will not appear when a file is not required and not in use. If the camera does benefit from a configuration file that is not present, a "file not found" message will appear in the upper section of Nucleus. If this is the case, PCC will still operate using defaults that apply to all camera models, but all features may not be available.

In the event a configuration file is updated after a release of PCC that includes it, the file can be downloaded from the product support page and loaded in the 'Cam Configuration' menu as shown here.

9.5 Support Features (Nucleus)

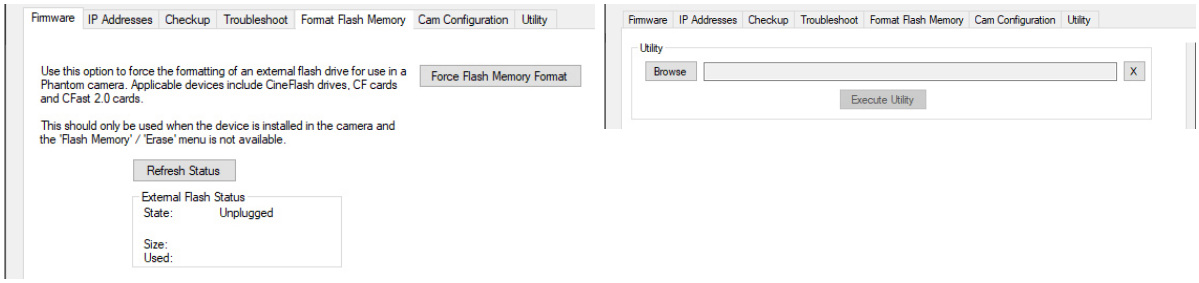
CHECKUP AND TROUBLESHOOT TABS (NUCLEUS)





1. **Checkup Tab -** This utility performs a sequence of events to reset the camera defaults and then saev a 3-frame .cine file to send to Phantom support, who will evaluate the package before providing recommendations on how to update or service the camera.
    a. Checkup - launches a prompt to complete the procedure.
    b. Click OK to proceed and follow prompts.
2. **Troubleshoot Tab -** This tab provides the steps required to restore the image and camera settings, as well as execute a Log file when requested by support to help troubleshoot an issue.
    a. **CSR - Current Session Reference** - this is the same function as exists in the Live menu, and is always step 1 to resolve a potential image issue.
    b. **Load Factory Stg** - applies to ph7 cameras only, to restore the camera calibration and settings file.
        i. If the factory .stg file has been misplaced, contact Vision Research Technical Support for a replacement.
    c. **Reload Factory Settings** - an important troubleshooting step is to restore all settings to the factory settings.
        i. To execute the factory reset, simply select this button and follow prompts. The camera can take up to 30 seconds for the factory settings to apply and the camera to become operational again.
    d. **Log -** used to optionally create a log file.
        i. **Browse** - opens the 'Camera Utility' dialog window used to navigate to the folder the log file will be written to. A file name must be specified for the Log file.
        ii. **X** - removes the path of last Log file saved.
        iii. **Get Info** - populates the Log file with all required information.
    e. Once the log file has been generated, it is ready to be sent to Vision Research Technical Support for evaluation.

FORMAT FLASH AND UTILITY TABS (NUCLEUS)

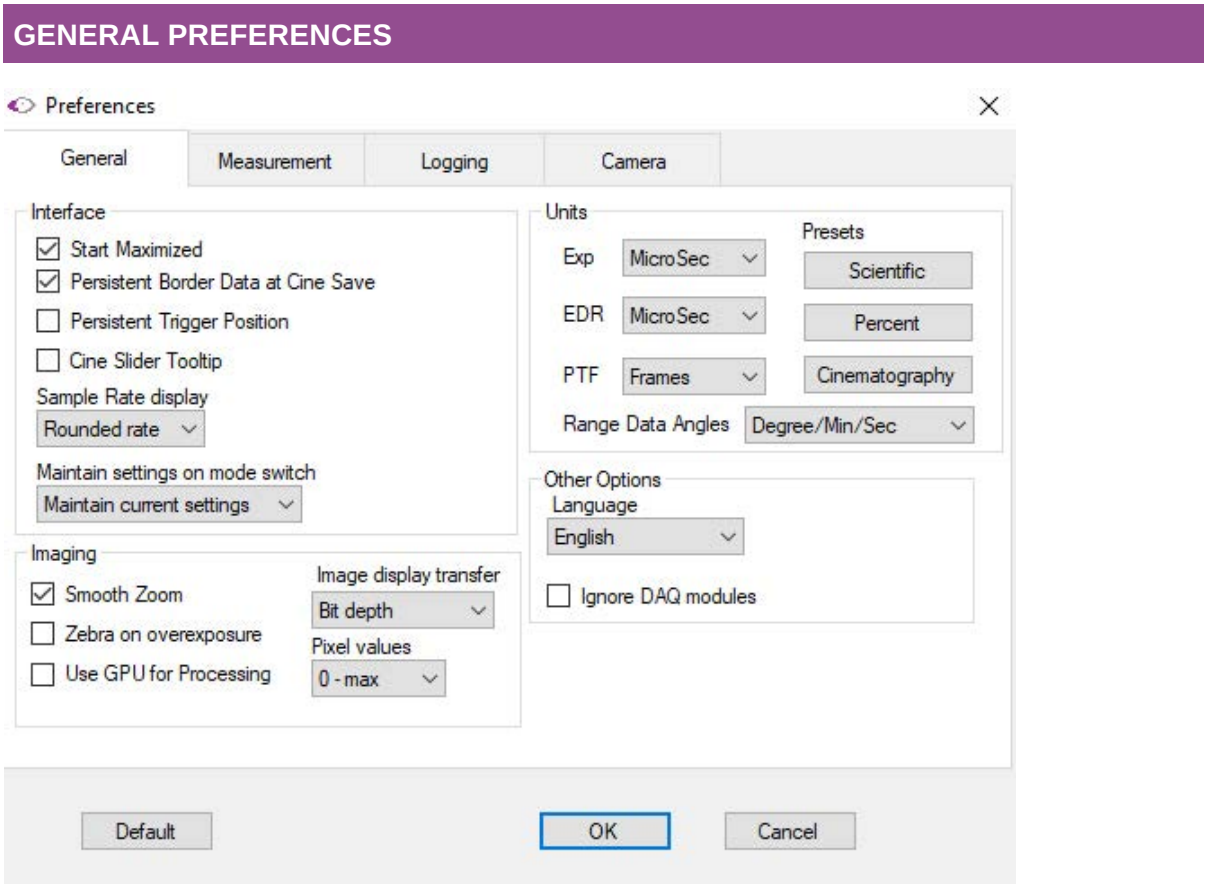


1. **Format Flash Memory -** This feature should be used when the device is installed in the camera and the 'Flash Memory' / 'Erase' menu is not available
    a. **Force Flash Memory Format** - initiates formatting of the attached flash drive (Phantom CineFlash, CF (CompactFlash Card), CFast 2.0 card).
    b. **Refresh Status** - updates the following status information:
        i. **State** - indicates the connection status of the flash memory device.
        ii. **Size** - displays the size of the flash memory device in Kilobytes (KB).
        iii. **Used** - shows the amount of flash memory used in Kilobytes (KB).
2. **Utility** - This feature is typically only used when instructed to by Vision Research Technical Support / Engineering. Vision Research will provide an 'Update.zip' file, its' download location, and instructions to download the file.
    a. The contents of the zip file must be expanded so that an .exe is the file that is executed.
        i. **Browse** - opens the 'Camera Utility dialog window where the user will need to:
        ii. Navigate to the location containing the extracted 'Utility.exe' file.
        iii. Select **'Execute Utility'** and confirm.
    b. Update progress will be displayed and it should not take more than 30 seconds.
    c. 'Update Success!' will be displayed when complete. Press any key to exit.

Preferences & User Configuration Manager

10 Preferences & User Configuration Manager

10.1 Application Preferences



1. Interface

a. **Start Maximized** - used to instruct the PCC software to open full screen, 'Start Maximized', or open in a standard window (disabled).

b. **Persistent Border Data at Cine Save** - border data set at Cine save will be persistent during the current and future sessions.

c. **Persistent Trigger Position** - maintains he user-defined trigger position when changes are made to the 'Camera Settings > Partitions' and / or 'Cine Settings > Resolution' parameters.

d. **Cine Slider Tooltip** - used to display a smaller image and its' image number below the image location pointer of the 'Cine editor bar'.

e. **Sample Rate display** - choose between 'Rounded Rate' and 'Real Rate' which is an exact multiple of the internal camera clock used to drive the frame rate. Often this results in frame rates that are not 'round' numbers, and for this reason PCC uses a rounded rate as the default method to show the Sample Rate (fps) in the Live tab. Note that the 'Real Rate' is always visible in the Cine Info of recorded Cine files.

f. **Maintain settings on mode switch** - Starting with version PCC 3.7 this defaults to Maintain current settings, alternatively this can be set to change the settings to factory default

2. **Units** - used to specify a parameters' setup value defined in the 'Live' tab.

a. Select the desired Units option from the pull-down selection lists or use the Presets buttons, (see following 'Units Presets Table'), to specify the parameters' setup value when defining the associated setting in the 'Live > Cine Settings'.

b. Range Data Angles (pull-down selection) - specifies how Range Data values (Azimuth and Elevation) will be displayed for a Cine containing Range Data information under the 'Play > Frame Info Selector'.

PRESETS	UNIT		
	EXP (EXPOSURE)	EDR (EXTREME DYNAMIC RANGE)	PTF (POST-TRIGGER FRAMES)
Scientific	Specified in microseconds; maximum value 1/Sample Rate	Specified in microseconds; maximum value equal to the defined 'Exposure'	Specifies in frames. maximum value depends on resolution, bit depth set / memory capacity.
Percent	Specified as percentage of lens f-stop setting	Specified as a percentage of the 'Exposure' setting	Specifies percentage of internal memory used to capture 'post-trigger' frames
Cinematography	Specified in degrees or 'shutter angle'; represents the degree of the open segment of the shutter. Maximum value (360°) corresponds to a full period of the frame.	Same as 'Percent'	Same as 'Scientific'

3. Imaging

a. **Smooth Zoom** - instructs PCC to apply a 'Smooth Gaussian' algorithm to every image pixel.

b. **Use GPU for Processing** - Feature not currently enabled.

c. **Zebra on overexposure -** when selected, a moving 'zebra' pattern will be overlaid on the oversaturated areas of an image. By enabling this feature, it helps control the highlight levels in the shot. The zebra pattern does not get saved to the Cine file.

d. **Image display transfer** - selects the "Bit Depth' used for transferring images from the camera. This option has effect only for images that are going to be displayed, it has no effect on Cine images being saved from camera to a file. Options include:

– Bit Depth - preserves the behavior from previous versions of PCC software.

– 8 /10P - reduces the data transferred and increase the transfer speed but will reduce or disable at the same time, the availability of the lower bits of pixels, to be used for increasing the apparent "Sensitivity" of the camera. (Used to reduce the image data size and to accelerate the image transfer on the network. The information stored in the camera and saved to Cine files is not affected.)

4. Other Options

a. **Language** - selects PCC interface language (Windows Setting, English, Japanese, Spanish and Chinese (new with PCC 3.7)); changes on PCC restart.

b. **Pixel Value**- specifies how the RGB (Red, Green, Blue) values are displayed in the 'Status Bar'.

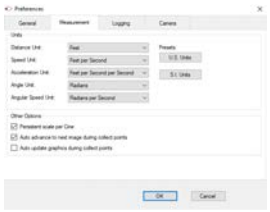
– 0-255 - displays the value between 0 (black) and 255 (saturated) regardless of the pixel bit depth

– 0.0 - 1.0 - displays the value between 0.0000 (black) and 1.0000 (saturated) regardless of the pixel bit depth

– 0 - max. - value displayed is dependent on the pixel bit depth, i.e., 0-255 (8-bits); 0-1023 (10-bits); 0-4095 (12-bits)

c. **Ignore data acquisition boards** - instructs PCC to ignore any attached signal acquisition capture boards and use simulated signals for capture.

MEASUREMENT PREFERENCES



1. **Units** - specifies how the motion analysis results will report. The measurement units can be specified individually (by selecting it from the associated pull-down selection list) or by using one of two 'Presets' as shown in the following Measurement Units Presets Tables

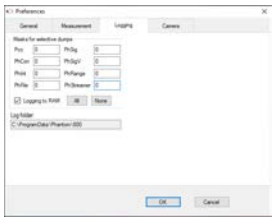
UNIT	U.S. UNIT SETTING	S.I. UNIT SETTING
Distance	Feet	Meters
Speed	Feet per Second	Meters per Second
Acceleration	Feet per Second per Second	Meters per Second per Second

2. **Persistent scale per Cine** - when enabled the user-defined calibration scale will be applied to all Cine files measurements will be performed on, If disabled the user will need to perform the calibration scale process on each file measurements are being taken on.

3. **Auto advance to next image during collect points** - automatically advances to next image once all the points, defined to be manually tracked, have been selected (tracked) for the displayed image.

4. **Auto update graphics during collect points** - displays a graphical trace of points being tracked when performing 'Collect Point' (tracking) measurements. Enabling this feature will slow down the tracking process.

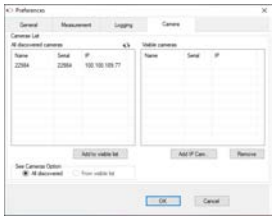
LOGGING PREFERENCES



Masks for selective dumps - defines the selective dumps the system will generate to a PhCon.log file. This is intended to only be used in conjunction with Vision Research Technical Support.

Vision Research's Technical Support Engineers will advise you how to use the feature and where to e-mail the results.

CAMERA (CONNECT) PREFERENCES



PCC uses a broadcast message on the network to detect connected cameras and their IP addresses automatically. In earlier versions of the software only the networked cameras that responded to the broadcast message would be available for use. This broadcast method utilizes UDP, (User Datagram Protocol) packets to deliver the broadcasting messages. However, some encrypting systems will not support the transfer of UDP packets.

Furthermore, some networking environments prohibit UDP packets from being transmitted across the network. When Phantom cameras are placed in these

types of networking environments the Camera Visibility - All Network Cameras List will not be able to populate the list with the camera name, serial number, and IP address of each of the cameras in the network. With these types of networking environments the user will need to essentially build a static IP address list of the cameras within the network and add them to the 'Visible Cameras List'.

In networking environments that allow UDP packets to be broadcast across the network the Camera Visibility - All Network Cameras List should automatically populate the list with the camera name, serial number, and IP address, of each of the cameras in the network.

PCC has been designed to:

- Allow access to Phantom cameras, without using the UDP broadcast method, by utilizing an 'Add to Visible List' button in the Camera tab in Manager > Preferences window, and
- Manage the list of Visible Cameras for each Phantom Control Unit computer, especially when there are multiple computers and cameras in the network, and you want to dedicate them. We will use the term “connect” referring to the logically connected cameras (visible) and not to the physically connected cameras.

When multiple controller units are networked together to control multiple Phantom cameras, each controller unit will display, in its' All Network Cameras List, all the Phantom cameras that replied to the broadcast poll process, even if a camera has been added to the Visible Cameras List of another Phantom Controller Unit.

The software will not provide any indication that another Phantom Controller Unit has already added the camera to its Visible Cameras List. Therefore, multiple Phantom Control Units could essentially add the same camera to their own Visible Cameras List.

SETUP PARAMETERS / PROCEDURES

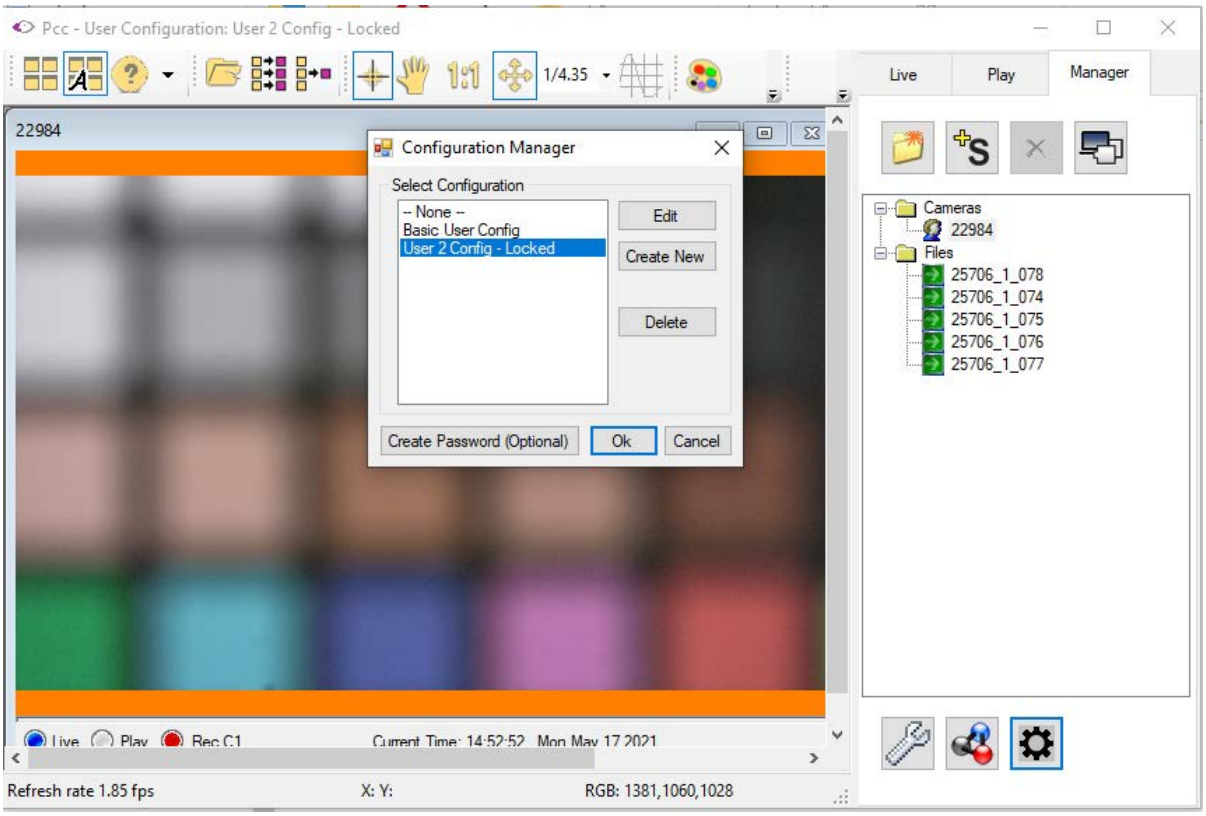
1. **All discovered cameras** (list**)** - Phantom cameras detected via the polling process automatically populate this list with the camera name, serial number, and IP address. Only cameras displayed in this list can be controlled via PCC when the 'All discovered' option is enabled.
2. **Visible cameras** (list) - displays the name, serial number and IP address of networked Phantom cameras connected to PCC. Only cameras displayed in this list can be controlled via PCC when the 'From visible list' option is enabled.**Add to visible list** (button) - places the user-selected camera, displayed in the 'All discovered cameras' list, into the 'Visible cameras' list.
   a. Verify all networked Phantom cameras have been detected via the polling process.
   b. Highlight the camera to be added from the 'All discovered cameras' list.
   c. Click the 'Add to visible list' button.
2. **Add IP Cam..** (button)- allows the user to manually add a Phantom cameras IP address into the 'Visible cameras' list. The 'Serial (number) and IP (address) field will populate upon connection to the camera.
   a. Click the 'Add IP Cam..' button.
   b. Enter the IP address of Phantom camera to be added in the 'Add Camera IP' dialog window.
   c. Click OK
3. **Remove** (button)- removes the user-selected IP address from the Visible cameras' list.

10.2 User Configuration Manager

The menu structure of PCC has been developed over several years, with features expanding over time. These menu items are visible to all users even if that item is not relevant to the camera model or application in use.

The **User Configuration Manger**, launched from the Manager tab, allows for the complete menu structure to be tailored for an individual user. As an overview, this menu provides the following features:

1. User Interface Control: Enable, Disable and Hide each menu item. Note that most PCC menu items in the Live interface are included, even for features that might not apply to a camera that is currently connected. Ultimately this lets you hide or disable functions that you do not want to be visible when you run PCC.
2. User Defaults Control: (Defaults Tab) This applies specific defaults to the menu items in the PCC interface that has a default associated with it, such as Image Processing Settings (change your default Gamma to 1.0 instead of 2.2 for example).
3. Multiple User Configurations can be saved and (optionally) password protected so that an administrator can set up a user configuration for a particular group of users. These profiles are managed within the User Configuration Manager menu
4. When a User Configuration profile is being applied, the top menu bar of PCC displays the name of the profile.



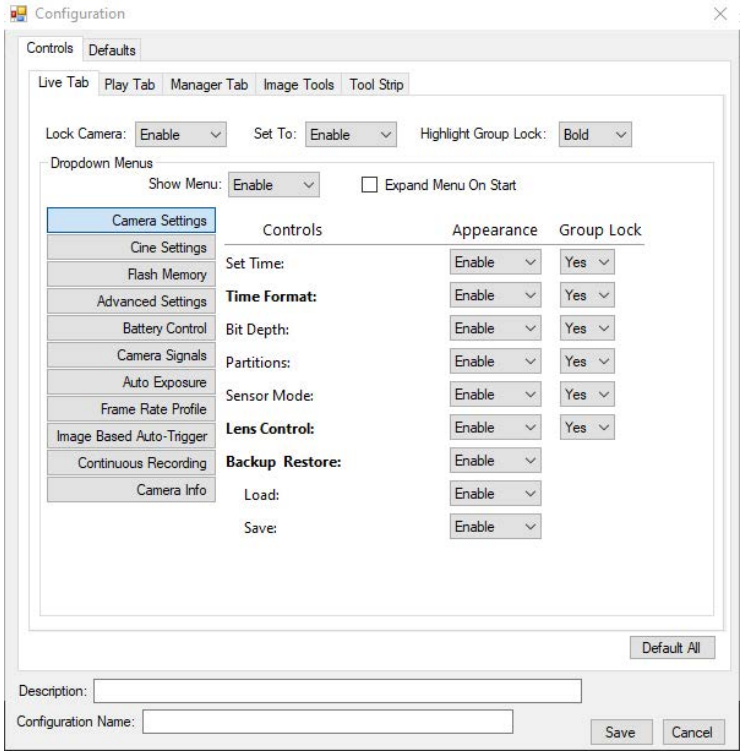
Once a configuration is selected, PCC will always start up with that configuration, and the top title bar of PCC displays the name of the profile in use. If there is no profile selected, and no name displayed on the top bar, then PCC is using the factory defaults for the program.

If desired, the Configuration Manager dialog can be **password protected**, which effectively makes the profile itself password protected. This is useful when an administrator wants to limit the controls available (or visible) in PCC for a group of users.

When a password is created, the user must enter the correct password to access the dialog.

10.2.1 User Configuration Controls

The Configuration Manager **Controls Tab** provides options for all menu items located in the **PCC Control Tabs (right side menu)** of the PCC interface, Image Tools and the top Tool Strip icons.



Each item in the control tab menu (Live tab, Manager tab and Play Tab) is included in the list. The item can be set to three different states:

a. Enabled - Normal operation
b. Disabled - The control is disabled
c. Hidden - The control is not shown

When working with multiple cameras in a group-lock configuration, various controls can be set whether or not it gets applied to each camera in the group locked. Also, on the top of the **Controls** Tab the user can choose to highlight the settings that do get applied to all cameras to grouped cameras to make this easy to see when changing settings. These features are new in version 3.7.

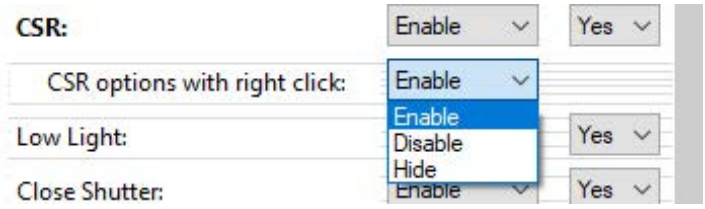
These menus ignore any connected cameras, so it does not take into account the features that are specific for an individual camera model. For this reason, settings that are not available for a connected camera will be visible in the menu.

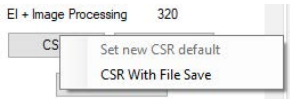
SETUP PARAMETERS / PROCEDURES

1. The **'Show Menu'** option allows control of the 11 drop down menus in the live tabs, without getting into the items under each menu category.
   a. Select the menu title and decide if PCC should Enable, Disable or Hide that menu.
   b. For example, you would use this function to hide the 'Battery Control' and 'Frame Rate Profile' menus from the list if they are not applicable for your camera.
2. **'Expand Tab On Start'** will expand the drop down menu on start of PCC, unless the menu is hidden.
   a. For example, if you use 'Continuous Recording' regularly, you can choose to have that menu expanded every time PCC is open.
   b. In the menu structure, some of the drop down menus have items contained within a 'group' (for example: 'Advanced Settings' / 'Start/End of Recording Actions'). In these cases the full group can be hidden or disabled, or the items can be controlled individually.
3. The **'Enable All'** button reverts all settings back to the original state.
4. **'Description'** is an optional field to be used as a reference when setting up the Configuration profiles.
5. The **'Save'** button saves the User Configuration of both the Control settings and Defaults settings combined, under the name of the entered Configuration Name

10.2.1.1 CSR Options

In the Configuration Manager, under Controls / Live Tab / 'Cine Settings' there are advanced options available for the CSR function. When Enabled, options that exist for this function become available by right-clicking the CSR button in the Live menu.





In PCC 3.7 there are two options for CSR:

1) **Set new CSR default** - This feature is for Phantom cameras with no built-in mechanical shutter, such as Miro C110 and C321. A default CSR can be set when the camera is being used at maximum resolution and consistently with a particular set of parameters (frame rate, exposure time). Each time the camera is booted it uses the new default CSR instead of the factory default, preventing the need for CSR every time the camera starts.

When using this feature ensure the camera is at full operating temperature and be aware that changes in temperature can cause slight shifts to the black level of the image.

2) **CSR With File Save** - Saves the CSR image data to an image file, with the intention to apply the CSR image to raw image data using 3rd party software. The images are not for use in PCC.

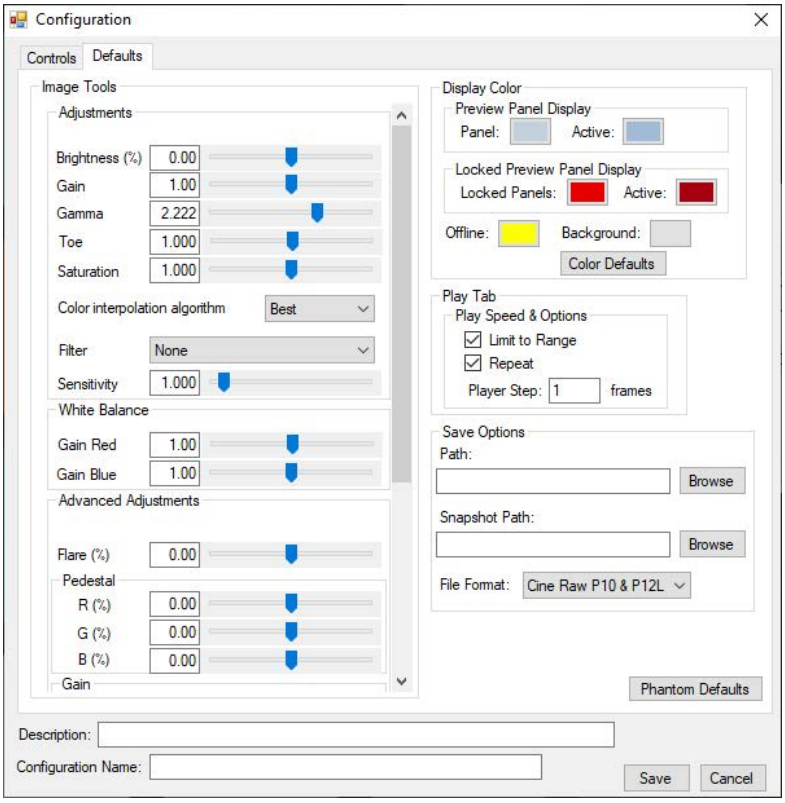
CSR images can be found in C:\ProgramData\Phantom\802\CSR

Unlike other parameters in the User Configuration Manager, CSR options are hidden by default.

10.2.2 User Configuration Defaults

The Configuration Manager **Defaults Tab** provides control of the elements in the PCC interface that have a default associated with it, such as Image Processing.

PCC Defaults are different than the camera defaults. Most camera operation parameters do not have a 'default' that can be adjusted using this menu.



1. **Image Tools** Defaults provide control of most settings in the Image Tools menu of PCC. These settings will apply when 'Default' button is selected at the bottom of the Image Tools menu.
    a. Example application: Motion analysis measurements sometimes require 1.0 gamma (linear) instead of the Phantom default of 2.2. Setting gamma to 1.0 here and saving a new User Configuration profile will now keep the Gamma at 1.0 when defaults are set.
2. **Display Color -** Change the background color of the program, and change the border panel color of locked and active windows for use with multiple cameras or multiple open Cines. A defaults button exists to the user can revert to the behavior in previous versions of PCC (prior to version 3.7)
3. **Play Tab** - sets how the available parameters are configured.
4. **Save Options** - allows a new default path for Cine saves and Snapshots (this can be further defined in the 'Snapshot File Name' and 'Save Cine' dialogs)

5. **File Format**

   a. Cine Raw P10 - only show P10 as an option when saving Cine files from the camera.

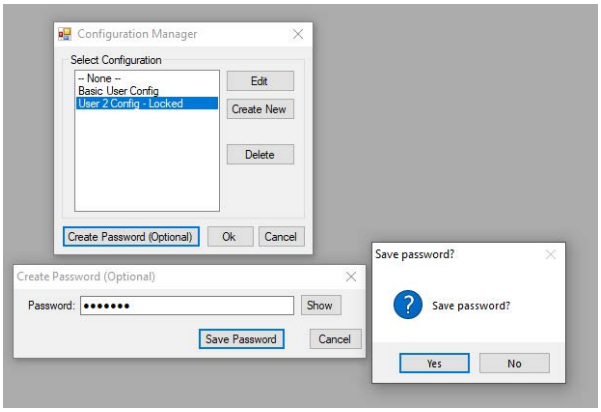
   b. Cine Raw P12L - only show P12L as an option when saving Cine files from the camera, unless the save is from a CineMag where P10 is the only option for Cine Raw.

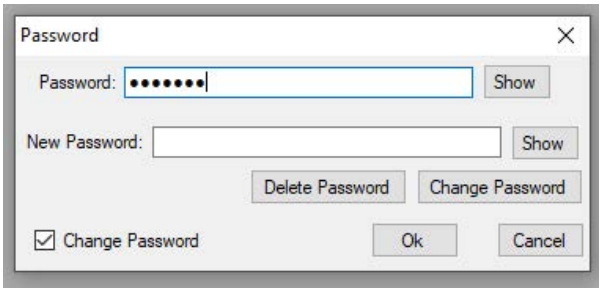
   c. Cine Raw P10 & P12L - shows both Packed settings.

These settings also apply to saved Cine Raw files. This means that if P12L is set and the file was saved as P10, the format will not be visible to the user. It does not change the format itself.

2. **Phantom Defaults** - resets all of these settings to PCC factory defaults.

10.2.3 User Configuration Password





1. Create a password by pressing the **'Create Password (Optional)**' button in the main Configuration Manager dialog. This button is only visible when there is no password currently set.

2. When a password is set it applies to the whole configuration menu, not the individual configurations. In this case, clicking the 'Gear' Icon from the Manager tab will launch the password dialog

3. The password can later be removed or updated. When prompted for the password, select 'Edit' to reveal the function to remove the password.

If you happen to forget the password, it is possible to manually override it by deleting the XML file accessed by PCC in the Windows User directory.

1. C / Users / username / AppData/ Local / Phantom
2. Find and delete PccPassword.xml

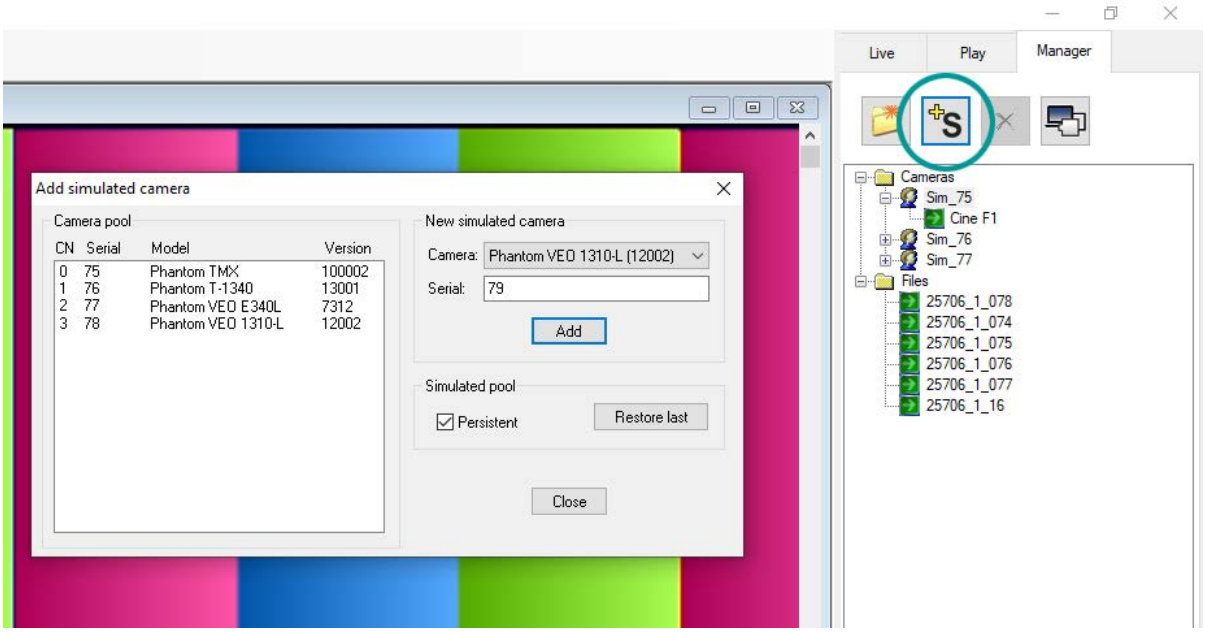
The other files in this folder can stay, or you can choose to delete them also. For reference: The user config used as the current PCC default is copied to “ConfigSettings.xml” and the various saved user configurations are in the “UserConfigSettings” folder

Appendices & Resources

11 Appendices & Resources

11.1 Camera Simulation

The 'Add Simulated Camera' button is used to specify Phantom camera models to simulate in order to test resolutions and frame rates and to practice using the software without a camera physically attached.



SETUP PARAMETERS / PROCEDURES

1. Click the  'Add Simulated Camera' toolbar button from the 'Manager' tab.
2. Select the desired camera from the list, and select "Add"
   a. The serial # will auto populate, and if there is information already stored on the PC for that serial number a dialog box will ask to replace it with the old information.
      i. Its usually best to click "No", or "Cancel" and enter a new serial #. Note that text is not valid in the serial # entry box.
   b. In the Manager tab, the Simulated cameras can be renamed to help distinguish them when working with multiple models.
3. Simulated pool
   a. "Persistent" will keep this simulated camera information next time PCC is open.
   b. "Restore Last" will restore the previous session of simulated cameras.
4. To remove a simulated camera, the 'Persistent' option must be unchecked, then exit the program.

Not all camera parameters are available when using camera simulation.

11.2 Camera Version Code Table

CAMERA MODEL	SYNTAX	CAMERA MODEL	SYNTAX
TMX	100002	v341	132
VEO 1310/1010/610-L	12001	v311/v310	125
VEO 1310/1010/610-S	12002	v211/v210	126
T-3610/2410	40001	v10 (Standard Mode)	10
T-1340	13001	v10 (Enhanced Mode)	101
Miro C321	2301	v7.3	73
VEO-E 340L	7311	v6.2e	62
VEO-E 310L	7301	v5.1	51
v2640, v1840	30001	v4.3	43
v2512, v2012, v1612	25001	C110, 210	2001
v1212	25001	C320	2201
v2511, v2011, v2010, v1611, v1610	16001	Miro M340 / R/341 / LAB40	8031
v1211/v1210	16002	Miro M140 / R141 / LAB140	8032
VEO4K Series	7501	Miro M310 / R310 / R311 / LC310 / LC311	8001
VEO S Series	7013	Miro M320S / R320S / R321S / LC320S / LC321S	8021
VEO L Series	7014	Miro Airborne HD	802
Flex4K, Flex4K-GS	4001	Miro Airborne, Miro eX, Miro 4	84
Flex	135	Miro 3 (800x600)	831
65	650	eX2/Miro 2	82
HD Gold/HD	660	eX1/Miro 1	81
v711/v710	122	Miro N-JB	2501
v641	131	CineStation	39
v611 /v12.1	120	CineStation-IV	3001

11.3 Legacy .stg (Serial Tag Number) File Installation (legacy ph7 cameras only)

Phantom cameras can be categorized into two types; ph16 and ph7 cameras, see Legends > Camera Legends for details .

ph16 Camera Models - Please ignore this topic as these cameras do not require the .stg (Serial Tag Number) file for the camera to operate. Therefore, there will be no Phantom .stg files associated with ph16 camera models. All factory settings, calibrations, and important system operating settings are stored into both an active and a backup non-volatile memory area of the camera.

ph7 Camera Models - Legacy ph7 Phantom camera models still require a unique .stg file to operate. The .stg file contains factory calibrations and settings essential for proper camera operation. The camera's .stg file can be found on the Phantom Installation disk supplied with the camera (new or serviced). The .stg file's information is also stored (duplicated) in the camera's non-volatile flash memory. Under normal camera operation, the .stg information is read by PCC each time the software is started or each time a camera is accessed over a network. When started, the application first tries to read the factory settings from the computer .stg file. If it doesn't find this it reads the settings from the camera and writes the .stg file on the controlling computer's hard drive using the file from the camera flash memory. When a camera first connects to the control PC the .stg file will automatically download to the default .stg file path, as shown in the following table:

WINDOWS OS	.STG AND PHCON.LOG COMMONAPPLICATIONDATA	USER SETTINGS LOCALAPPLICATIONDATA
Windows 10	ProgramData\Phantom\Phantom version	Users\Current user name\AppData\Local\Phantom

If for any reason the Phantom application cannot read the .stg information from the camera flash or from a file on the hard drive then the software prompts the user for intervention. If the proper .stg file is not available the application can load a default set of information. If the default information is written to the flash the camera will still operate but the image quality might be compromised.

Outdated or .stg files from other Phantom cameras should never be used, doing so may cause serious damage.

STEP-BY-STEP PROCEDURES

1. Copy the .stg file to the appropriate folder (see table) from disk or download link.
2. After it's copied to the hard drive right-click the <serial number>.stg file and Disable the 'Read-only' attribute.
3. Click OK in the files 'Properties' window.

Vision Research recommends making a backup copy of your camera's .stg file to store in a safe place in the event you need to restore the camera's factory calibration settings quickly. In the event the .stg file can not be located Vision Research keeps copies on record which can be obtained by contacting us at:

https://phantom-service.force.com/VisionResearchContactUsForm

11.4 SMPTE Time Code in Phantom Cameras

Introduction

The widely used SMPTE (Society of Motion Picture and Television Engineers) time code is deeply rooted in a broadcast environment where the frame rates are ever constant. The standard ways in which 'normal' cameras use time code does not have an obvious correspondent in the high-speed camera world, so a somewhat different way of using time code is required.

The implementation of SMPTE time code support in Phantom cameras tries to balance the \high-speed' characteristics of the cameras with the common use of time code, by working towards the following goals:

1. When the camera is used at a standard frame rate, the time code should work as expected from a 'normal' camera;

2. The resolution and precision of the camera's time stamps are retained for high-speed applications;
3. Even when the camera is used at high-speed, it will generate sequential time code on playback; the playback time code can be correlated back to the images in the files the camera saves.

Time System Structure

The time system of the camera consists of the following parts: a time code receiver that can accept SMPTE or IRIG time codes; a high-resolution internal time base, that can lock to the incoming time code; a time stamp system for recording the exact time, according to the internal time base, when each frame is captured; an output section.

The time code receiver accepts IRIG B (modulated or unmodulated), or SMPTE linear time code. The linear time code can be at 23.97, 24, 25, 29.97 or 30 fps, drop or non-drop. The receiver will automatically detect the type of time code that it sees at the input, and switch to the proper decoder.

When a proper time code, incrementing in the correct sequence is received, the internal time base of the camera will lock to the true 'wall clock' time implied by that time code, and follow that true time uniformly and with sub-microsecond precision.

When SMPTE time code is received, the 'true time' is calculated in the following way: for the given time code, the number of frames from the start of the day is calculated (taking drop frames into account of needed), then the number of frames is divided by the exact TC frame rate (23.97, 24, 25, 29.97 or 30 Hz). The resulting time is used as the reference to which the time base locks.

For 'round' frame rates, the time base will lock to the exact same time received (for instance, the reference moment of the frame with time code '01:00:00:00' will occur at the 01:00:00.000000 'true time').

When the fractional rates 29.97 and 23.97 are used, this correlation cannot exist, and the true time will lead the applied time code by 3.6 seconds every hour.

When a 29.97 drop time code is applied, the internal time is closer to the applied time code (within about 84ms / day), but will still wander from the applied time code, as it has to run uniformly, without the drop frame jumps.

The internal time base completely separates the input and output sides of the time system, so the camera can output SMPTE time while reading IRIG time or vice-versa. Furthermore, the input TC rate can be independent of the video system or frame rate - the camera is always 'gear-boxing' using 'wall clock' time as a bridge between input and output.

Time Code Outputs

The camera has an analog time code output that can generate either un-modulated IRIG, or SMPTE linear time code. When the time code output is set to IRIG, that output always follows the internal time base (as the IRIGout of all phantom cameras has always done).

In addition, the camera embeds SMPTE time code in the ancillary data of the HDSDI outputs. The same time code is replicated in the LTC, VITC1 and VITC2 areas. The embedded SMPTE time code is generated even when the TC output is set to IRIG. When the TC output is set to SMPTE, the time code that is output there and the one embedded in the HDSDI are always identical (both rate and content).

When the camera is showing a live picture, the SMPTE outputs contain a SMPTE representation of the 'true time' of the internal time base. The method used to convert SMPTE time code to true time in the receiver is used in reverse for this conversion.

The SMPTE time code output always runs at the same rate as the video output, and always in non-drop mode. The reference moment of the LTC is aligned with the vertical sync of the video signal, as specified by SMPTE12M. Since the internal time base runs independently of the video signal generator (and the

latter can also be genlocked), there can be a difference of up to 1 frame between the internal time base, and the SMPTE output even when the two are supposed to output the same data.

Time Code Output in Playback

When playing back recorded images, the SMPTE time code output is generated based on a reference moment of each recorded Cine. A particular time code is assigned to frame #0 (the trigger frame) of each Cine when the respective recording ends. This 'trigger time code' is calculated based on the true time of that frame, the playback rate (determined by the video mode), and the camera's capture frame rate.

When the capture frame rate equals the playback rate, the assigned time code is the equivalent of the true time of the trigger frame (rounded to the nearest frame number). This makes the camera output the same time code that was input at the time of the recording if running at a standard rate. When the capture rate is different from the capture frame rate (i.e. there is a speedup or slow down on playback), the time code of the trigger frame is more or less arbitrary (see the calculation method below).

Whenever a Cine is played back, the time code outputs will be at N frames from the trigger time code, where N is the frame number being played back). A playback a '1x' speed, i.e. one which outputs recorded frames sequentially will result in sequential time code being output. Any 'trick mode' play back (reverse, reduced speed, stop frame, etc) will generally show non-sequential time code, as the time code will follow the displayed image number. If a Cine is played back several times, even if from a different in point, or from a different device (say, from a cinestation), then as a given frame is output, the time code will be the same as on the other playbacks.

The trigger time code follows the Cine in the cinemag recording and in the file metadata, so a recording of the camera's output that included the SMPTE time code can be correlated back to frame numbers in the Cine files.

The trigger time code is calculated as follows: from the true time (the time stamp) of the trigger frame, the number of frames from the start of the current day, at the camera's capture frame rate is calculated. This number of frames is converted to a time code at the video output rate, modulo 1 day. So if, for instance, is the camera is capturing at 120 fps and playing back at 30, and the time of the trigger frame is 01:00:00.000000, the assigned trigger time code will be 04:00:00.00.

11.5 PCC Keyboard Shortcuts

SETUP PARAMETERS / PROCEDURES

PCC has incorporated select keyboard shortcuts ('hotkeys') according to the table below.

1. Ensure the cursor is not in one of the data editing fields, then
2. Press the or CTRL+ <hotkey> or ALT + <hotkey> simultaneously (Windows Operating System dependent)

TOOLBAR	MANAGER TAB	LIVE TAB	PLAY TAB
CTRL+ I - Image Tools	CTRL+ A - Add Simulated Camera	CTRL+ R - Record / Abort Recording	CTRL+S - Save
CTRL+ N - Snapshot	CTRL+ G - New Group	CTRL+ T - Trigger	
CTRL+ O - Open File	CTRL+ I - Image Tools		

CRTL+ P - Video Out (PVP)	CTRL+ N - Snapshot		
	CTRL+ O - Open File		
	CRTL+ P - Video Out (PVP)		
	CTRL+ Delete - Remove From Tree		

11.6 Help & Support Resources

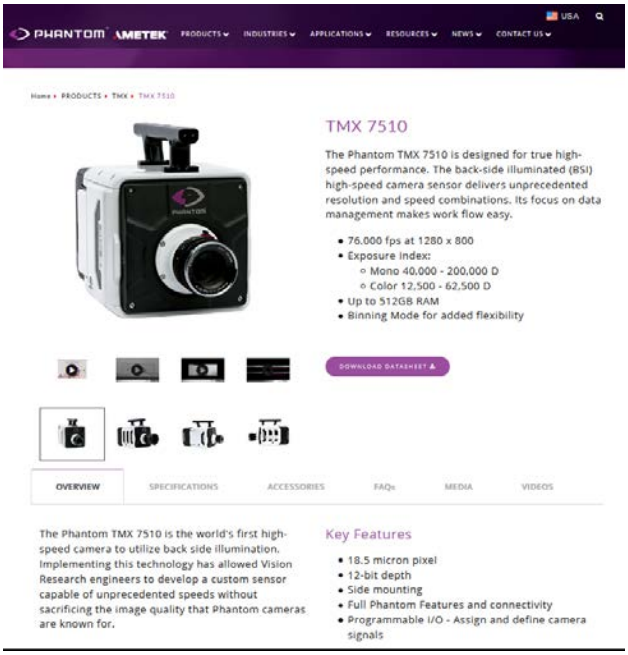
11.6.1 Vision Research Website

Plenty of resources are available at www.phantomhighspeed.com including product info, application information, case studies, news on product releases and

PHANTOM PRODUCT PAGES

The individual product pages are a key resource to learn everything about your camera including:

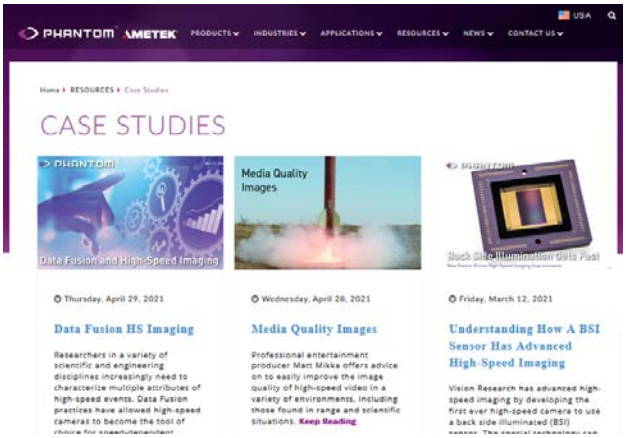
1. Product Data sheets
2. Camera specifications
3. Mechanical Drawings
4. Spectral Response Curves
5. The latest product manual, which includes camera-specific features and hardware documentation



SOLUTIONS AND CASE STUDIES

Additional resources on the phantomhighspeed.com website include:

1. Calculators for:
    a. Frame Rate and Record Time, based on camera model
    b. Frame Rate and Exposure
    c. Lens Calculator
2. Case Studies to learn more about specific applications where Phantom high-speed cameras are in use.
3. Tutorials



11.6.2 Service, Support and Training Resources

PHANTOM SUPPORT COMMUNITIES

Vision Research offers a complete line of service programs, extended warranties and training classes to meet your specific operational needs. Our professional, factory trained service engineers and educators deliver this training and support through a network of service centers, and on-line / self-serve content that help you achieve the results you need.

- For answers to many questions please search the Phantom Community Knowledge Base including the FAQ Section.
- The Support by Model page on this site provides resources including mechanical drawings, spectral response charts, manuals, and links to the latest software and firmware for that product.
- For training, check out some of our video Tutorials or consider registering for one of our PCC Jump Start Courses.

Contacting Support

- For general product and / or technical support questions, please submit a request using General Support Request Form, or feel free to call us at the numbers below.

Phone Support Numbers and Times:

North / South America Region	Europe/Middle East Region	Asia/Pacific Region
Mon-Fri	Mon-Fri	Mon-Fri
9A-5P ET (UTC -5:00)	9AM-5PM (GMT +2:00)	9A-5P (GMT +8:00)
+1-973-692-4003	+40-021-210.8586	+88-21-5868-5111

PHANTOM ACADEMY

PHANTOM ACADEMY
HIGH-SPEED IMAGING

Vision Research offers a series of hands-on technical courses, and web-based application-specific courses, designed to prepare attendees for advanced high-speed imaging applications. Courses are led by Vision Research engineers and invited industry leaders. The content focuses on key technical concepts, notable examples from the field and training with cutting-edge equipment.

Depending on the application, courses will be taught by a variety of professional users, developers, partners, and high-speed imaging experts. Each instructor will work to deliver the information necessary for a participant to recreate successful experiments in the future.

Visit the Phantom Academy website to review the latest course topics for webinars and hands-on courses, and follow instructions for more information.

www.phantomhighspeed.com

Vision Research Corporate Headquarters
100 Dey Road
Wayne, New Jersey 07470
USA
Ph: +1.973.696.4500
Fax: +1.973.696.0560