Operation Manual

CV-Cam®

Control Vision Inc.

PRELIMINARY

ADVISORIES

Three types of advisories are used throughout this manual to stress important points or warn of potential hazards to the user or the system. They are the **Note**, the **Caution**, and the **WARNING**. The following are examples of each advisory:

Note: The note is used to present special instructions, or to provide extra information which may help to simplify the use of the product.

A **Caution** is used to alert you to a situation which if ignored **can** cause injury or damage to the equipment.

A **WARNING** is used to alert you of a situation which if ignored **will** cause serious injury to personnel or damage to the equipment. High voltage and risk of electric shock are also implied.

Cautions and **WARNINGS** are accented with ISO3864 triangular symbols. The exclamation symbol in all Cautions alerts you to the important instructions. The lightning flash symbol on the left side a warning notifies you that the advisory relates to risk of shock, high voltage, serious operator injury, or severe damage to the equipment.

You must refer to the documentation of this manual before operation or installation of this system to ensure all precautions and procedures are followed.

Please read all of the materials provided prior to operating CV-Cam.

1. Introduction

High-luminosity processes such as electric arc welding and others, are normally quite difficult to monitor with the human eye or conventional picture taking equipment. The process detail is submerged within the luminous envelope of the plasma or flame. When one attempts to use video or photographic equipment, the field of interest is further degraded by the excess sensitivity of the medium causing over or under exposed areas; delimiting the contrast of the subject. With arc welding in particular, one can expect to see a bright fireball in the center of the welding pool, but most of the detail at the edge of the welding pool and in the area of the welding seam and groove, will be lost in shadowy darkness.

The goal of using CV-Cam is to capture a video image of the high-luminosity process; using reflected or silhouette lighting, provided by a synchronized light source, rather than using the light from the process itself. Through the use of special optical filtering, the image is enhanced; giving the user a detailed, high contrast picture, of the desired process, for research, quality control, or process control.

This manual describes the CV-Cam system and it's use in incorporating the use of one or two xenon strobe units, to obtain these detailed pictures.

Thank you for your interest in CV-Cam. We at Control Vision Inc. are always eager to assist you in optimizing your CV-Cam's performance for your particular application. We encourage you to contact us when contemplating a new application or when encountering a problem. Our goal is to provide innovative vision solutions for science and industry. To this end, if you have any questions or comments regarding CV-Cam or this manual, please contact Control Vision Inc. via the following methods:

- phone: 208.523.5506
- fax: 208.523.5520
- E-mail: vision@controlvisioninc.com
- mail: PO BOX 51505, Idaho Falls, ID 83405-1505

2. General Description

CV-Cam is a self contained system incorporating a light weight tethered imager, a camera interface unit, a controller unit, and one or two strobed light sources. CV-Cam uses the optical energy from the pulsed light sources to overwhelm the process light energy. CV-Cam systems typically incorporate pulsed Xenon Strobe light sources. The optical energy from each strobe unit is transported to the viewing area with an fiber-optic cable. The strobe light at the site of interest is, for an instant, much brighter than either the direct or reflected light from the process. The CV-Cam system exploits this very temporary situation by capturing this image with a special-purpose CCD imager. The CCD imager is configured to produce a very high speed electronic shutter. The electronic shutter is electronically synchronized with the triggering and production of the strobe light pulse. The shutter and strobe pulse are in turn synchronized with the video framing of the CV-Cam Unit and they are pulsed once for each captured video frame.

A conventional video camera has a normal framing rate of 30 frames per second, the effective shutter time (exposure time) is therefore 33.3 milliseconds (or usually 16.7 milliseconds if a solid-state image sensor is used). For CV-Cam system, the minimum shutter time is approximately 5 micro-seconds and it follows that the camera exposure time is reduced by the factor of 6,660:1; the brightness of the welding arc or plasma in the video image is likewise reduced by the same factor, but the optical contribution to the image by the strobe light is not affected because the strobe and shutter are synchronized.

To further enhance the quality and contrast of the video image the CV-Cam CCD Imager is equipped with an special optical filter to notch the CCD Imager's wavelength, this further suppresses the process lighting. The net combination of both temporal, shutter to lighting synchronization, and spectral filtering will typically result in a video image that is free of all of the adverse process lighting effects except, perhaps, for some minor remaining evidence of the brightest core of an arc or plasma.

3. System Components

The CV-Cam system consist of four parts: The CV-Cam Controller, CV-Cam Unit, the tethered CCD Imager and the X20 Xenon Strobe Unit. The CV-Cam Controller Unit is an analogue operational interface to operate the CV-Cam system. The CV-Cam Unit is the interface for the CCD Imager and provides the video output of the CV-Cam system. The X20 Xenon Strobe Unit is the light source for the CV-cam system.

The two CV-Cam system enclosures may be mounted together in a central location, or separate, to allow remote operation of the camera system, away from hot or harsh environments. Additionally, Control Vision Inc. has optional software, allowing the CV-Cam system to be operated digitally with a standard PC computer through a common RS232 COM port. This convenient Graphic Users Interface (GUI) mimics the CV-Cam Controller's interface to operate the system in very harsh environments like an electron beam welding chamber.

3.1 The CV-Cam Controller

The CV-Cam Controller provides the user interface to operate the CV-Cam system. This unit communicates with the CV-Cam Unit, providing critical electrical and timing information for the system to maintain electronic synchronization between the Xenon Strobe Unit and the CCD Imager.

3.1.1 CV-Cam Controller Front Panel Controls

The front panel of the CV-Cam Controller has the necessary analogue switches and indications to fully operate the CV-Cam system.

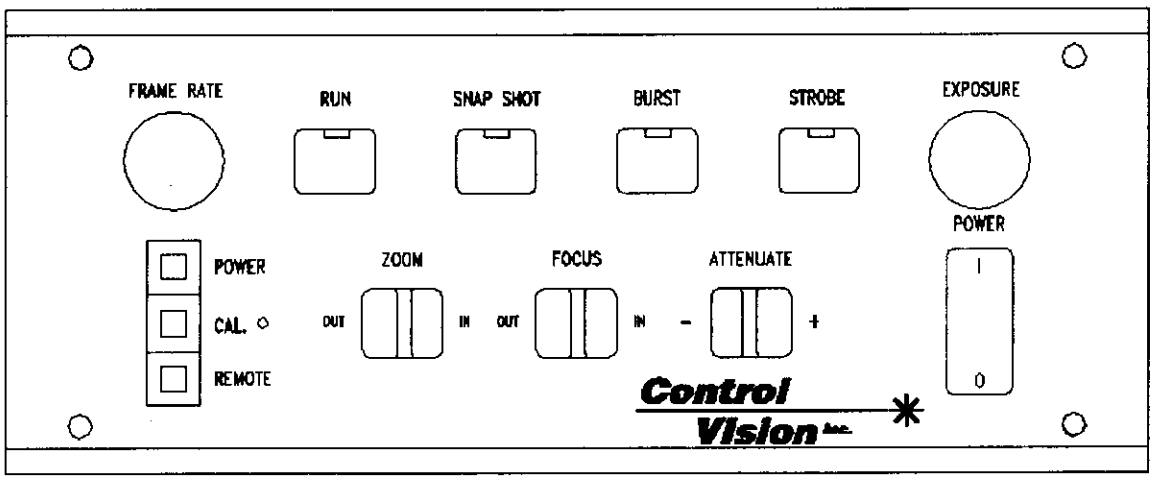


Figure 1 CV-Cam front panel controls

The POWER switch controls the AC input power to the CV-Cam system. Depressing this switch to the (I) position energizes the CV-Cam Controller, the CV-Cam Unit, and the X20 Xenon Strobe. The lighting of Green POWER LED indicates that the power is ON. When the CV-Cam Controller is turned on, the internal computer initializes, then recalls the previous settings used when CV-Cam system was turned off.

The RUN button initiates the taking pictures. When pressed the buttons LED will light, showing that the system is actively taking pictures. Also note the SNAP SHOT LED will flash when the system is actively taking pictures at the frame rate selected by the FRAME RATE adjustment knob. When the RUN push button is pressed again, the system will stop taking pictures. This is indicated by the RUN LED turning OFF and the video monitor going blank.

The SNAP SHOT push button allows the taking of one picture, which is saved to memory, as seen on the video display. When SNAP SHOT is pressed, the system will take one picture of the object in view of the CCD Imager. As stated above, the SNAP SHOT button's LED will flash, when the system is actively taking pictures, at the same repetition rate as set by the FRAME RATE adjustment knob.

The FRAME RATE adjustment knob controls the frame rate at which CV-Cam takes pictures. Manipulating the knob counter-clockwise reduces the number of pictures taken per second, down to one frame per second; while turning the FRAME RATE knob clockwise, increases the rate the system takes pictures, to a maximum rate of 30 frames per second.

The BURST push button enables the burst mode picture taking function. This function utilizes the BNC connector on the rear panel of the CV-Cam Controller labeled BURST. Pressing this button enables the CV-Cam Controller's BURST mode as indicated by the button's LED being lit. This mode allows an operator to use a TTL signal to initiate the taking of a series of pictures at a predetermined, factory set, frame rate. When the signal is removed, the system will utilize the last used FRAME RATE determined by the FRAME RATE adjustment knob. Please contact Control Vision Inc. for guidance in utilizing this function.

The STROBE push button enables or disables the X20 Xenon Strobe trigger circuitry. When the button is pressed its LED will toggle. If the LED is ON, the Xenon strobe is enabled, allowing it to be triggered while pictures are being taken. If the LED is OFF, the Xenon strobe's trigger circuitry is disabled, so the Xenon strobe will not flash as pictures are being taken. This function can be utilize while the system is actively taking pictures.

Note: To obtain pictures using the X20 Xenon Strobe, the Strobe must be enabled, STROBE LED ON, to allow the Strobe to fire in sync with the CCD Imager's shutter.

The EXPOSURE control knob adjust the sensitivity of the CCD Imager. This function gives the operator control of how bright or dark the picture is on the video monitor and may be adjusted to suit ones needs. It adjusts the contrast and brightness of the object of interest and how much process light the operator wants in the picture for study.

3.1.2 Remote Lens Controls (Optional)

The CV-Cam system has an optional remote lens control feature. This feature allows remote ZOOM, FOCUS, and ATTENUATE controls for motorized lenses. All of these controls are operated by momentarily toggling, left or right as desired, the paddle switches. For example: to ZOOM IN one simply toggles the ZOOM paddle switch to the right, while watching the video monitor, to obtain a closer field of view of the object of interest. Once the desired field of view is obtained release the paddle switch and the lens will maintain this new setting until the lens is manually adjusted or the appropriate paddle switch is operated again.

Note: If a paddle switch is toggled and it appears nothing is happening on the video monitor, it is most likely that the lenses motor has turned all the way to its mechanical stop. Continued toggling of the switch will result in no further adjustment. It is advised that the switch be released. If held in for a very long period of time, an electronic protective device will open, to protect the lenses motor windings from damage. This protective device requires approximately 20 seconds to reset allowing continued operation of all remote lens features.

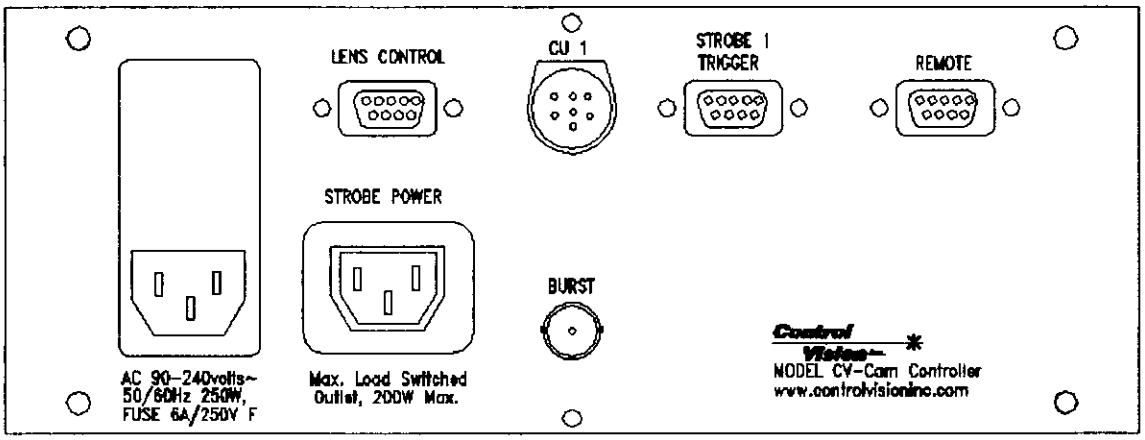


Figure 2 CV-Cam Rear Panel Connections

3.1.3 CV-Cam Controller Rear Panel Connections

WARNING: The power to the CV-Cam system must be OFF prior to connecting or disconnecting any cables to or from the CV-Cam system. Damage to the CV-Cam system will occur.

Looking at the rear panel (Figure 2) of the CV-Cam Controller one will find all of the necessary connections to make the CV-Cam system operate.

The AC input module accepts an internationally standard IEC-320 AC power input plug. This allows the use of various world wide AC power cordage. The AC input voltage rating is 90-240 volts AC at 50/60 Hz, allowing the CV-Cam system to operate worldwide. Behind the hinged panel of the power entry module are user replaceable fuses which protect the system from electrical

overload in the unlikely event of a system failure. The fuse size is 5X20mm, rated at 6 Amps at 250 volts AC, and are of the "F" or quick acting low-breaking capacity.

The STROBE POWER connection is used to provide AC power to the X20 Xenon Strobe Unit(s) allowing remote ON/OFF control of the Strobe Unit(s). This power plug is rated at 200 watts and should only be utilized for the AC input power of the X20 Xenon Strobe Units. A convenient combination power/trigger cable is provided with the CV-Cam system; the IEC male connector of this cord is plugged into STROBE POWER to provide AC power to your X20 Xenon Strobe. In the case of a two Strobe system, an approved twin end cord set is proved along with the two power/trigger cables for each X20 Xenon strobe unit.

The LENS CONTROL, 9 pin D-Sub connector is for the optional remote controlled optical lens. This connector provides the necessary motor drive control signals to operate remotely the ZOOM, FOCUS, and ATTENUATE functions of the lens. The connection is made by simply pressing the connector on after ensuring that the wide shape of the connector is at the twelve o'clock position, then tightening the thumb screws.

The connector(s) labeled CU 1 (CU 2) connects the CV-Cam Controller to the CV-Cam Unit(s) via the supplied cable. This connection supplies the CV-Cam Unit(s) the necessary timing and voltage signals to allow local and remote camera triggering of the CV-Cam system. To engage this connector line up the key-way at the twelve o'clock position and push on until an audible click is heard. To release the connection simply press the finger tab on top of the connector and withdraw the connector from its receptacle.

The STROBE 1 (STROBE 2) TRIGGER, 9 pin D-Sub connector(s) is used to trigger the X20 Xenon Strobe(s). It passes timing and triggering information to the Strobe units in sync with the shuttering of the CCD Imager. The connection is made by simply pressing the connector on after ensuring that the wide shape of the connector is at the twelve o'clock position, then tightening the thumb screws.

Caution: Ensure that all connectors are properly tightened to prevent incidental disconnection of the connections during operation. Damage to the CV-Cam System can occur if the connections are not tight.

The REMOTE, 9 pin D-Sub connector is the interface connection for use of the optional Graphic User Interface (GUI) software allowing remote, PC computer, operation of the CV-Cam system using a computer's RS232 COM port.

3.2 The CV-Cam Unit

The CV-Cam Unit is the tethered CCD Imager's interface. To allow for a light weight Imager design, most of the necessary electronics to support the CCD Imager are embedded in the CV-Cam Unit. The Imager sends electronic image information to the CV-Cam Unit which is then converted into usable RS170 video or optional SVGA video.

3.2.1 The CV-Cam Unit Rear Panel Connectors

WARNING: The power to the CV-Cam system must be OFF prior to connecting or disconnecting any cables to or from the CV-Cam system. Damage to the CV-Cam system will occur.

Looking at the rear panel (Figure 3) of the CV-Cam Unit one finds all the necessary connectors to connect the CV-Cam Unit to the CV-Cam Controller.

The CU connector utilizes the matte-silver multi-pin circular connector on the supplied cable. This connection provides the CV-Cam Unit the timing and triggering information to synchronize the CCD Imager to the X20 Xenon Strobe Unit, as will as the necessary DC voltage to power the CV-Cam Unit and CCD Imager. To engage this connector simply line up the key-ways of the connector with the largest being at the twelve o'clock position and push on until an audible click is heard. To release this connector, simply pull back on the knurled section of the connector and pull away for the panel.

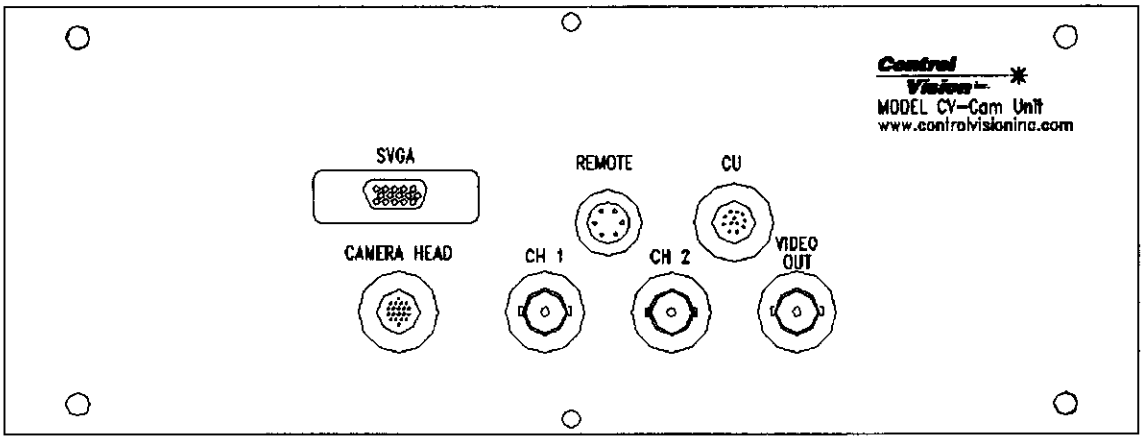


Figure 3 CV-Cam Unit Real Panel Connections

The tethered CCD Imager's silver multi-pin circular connector is connected to the CAMERA HEAD connector on the CV-Cam Unit. This connector is of the push-on and screw tight variety and is keyed at the twelve o'clock position. To mate this connector simply line up the key-way at the twelve o'clock position, push the connector on until it is fully seated, then turn the knurled section of the connector to tighten the outside sleeve, which locks it in place.

Caution: Ensure that all connectors are properly tightened to prevent incidental disconnection of the connections during operation. Damage to the CV-Cam System can occur if the connections are not tight.

The VIDEO OUT BNC style connector provides RS170 video to a video monitor. A standard video cable is supplied with the CV-Cam system. This video cable is installed between the VIDEO OUT of the CV-Cam, to the VIDEO IN of an appropriate video monitor or recorder device.

The SVGA connector provides an optional SVGA video signal. Please contact Control Vision Inc. for more information and configuration. This is an optional video output and if the system is not factory configured correctly the video output will be garbled and unusable.

CH1, CH2, and REMOTE are for factory use only and provide no user functionality.

3.3 The CV-Cam CCD Imager

The tethered CCD Imager has a 3 meter tethered cable. This cable connects to the CAMERA HEAD connector on the CV-Cam Unit. The front of the Imager has the necessary mechanical fittings to accept special optics, c-mount lens, or the optional remote controlled lens. Most of the optics used for the CV-Cam are application specific. Please contact Control Vision Inc. regarding your specific optical application needs or follow the instructions provided by the lens manufacturer.

3.4 X20 Xenon Strobe Unit

The X20 Xenon Strobe Unit is the light source that allows CV-Cam to obtain high contrast pictures. The strobe power/trigger cable is connected to the X20 Strobe and to the CV-Cam Controller unit. This provides the trigger signals and electrical voltages to the X20 strobe unit. The X20 strobe unit utilizes the female 9 pin D-sub connector end of the strobe power/trigger cable. There is a power switch at the rear of the X20 strobe unit. Pressing the switch into the (I) position turns the AC power ON to the unit. This switch may be left in the ON position if the CV-Cam systems STROBE POWER connection is utilized with the strobe power/trigger cable. This allows the CV-Cam Controller's POWER switch to remotely apply AC power to the strobe unit.

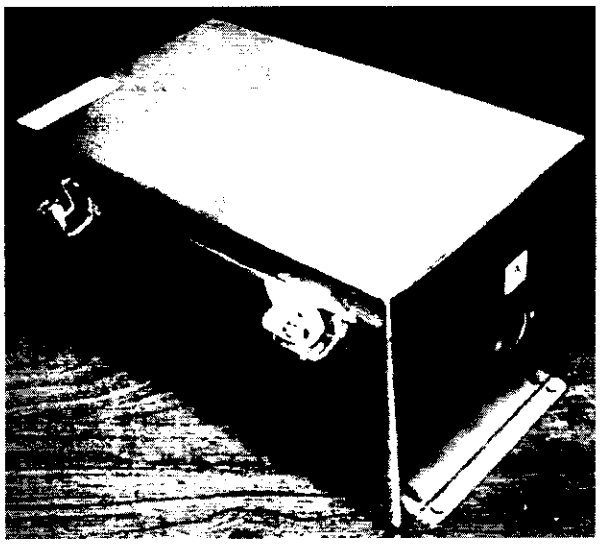


Figure 4 Xenon Strobe Unit

3.4.1 Optical Fiber Bundle

An optical fiber bundle may be optionally supplied with the CV-Cam system. The fiber bundle incorporates a randomized optical fiber bundle, placed within a strip-wound stainless steel sheath. This sheathing provides both flexibility and protection for the optical fibers. Each end on the cable is polished and sealed with a high-temperature epoxy, capable of with-standing temperatures of up to 500 degrees centigrade. The optical fiber bundle is partially encased in a semi-rigid plastic tube for positioning the end towards the area to be illuminated. One end of the optical fiber bundle is protected from spatter and fumes by a small copper colored cap, holding a clear mica disk. Spare mica disks are supplied. When the mica disk becomes contaminated, remove the small copper cap and replace the clear mica disk with a new one. Additional mica disks can be ordered by contacting Control Vision Inc..

Caution: The optical fiber bundle should not be exposed to very high temperatures (exceeding 500 degrees C), or be used without a protective clear mica window.

To install to fiber bundle on to the strobe simply insert the free end into the input module flange, on the front of the strobe unit, and tighten the thumb screws on the flange.

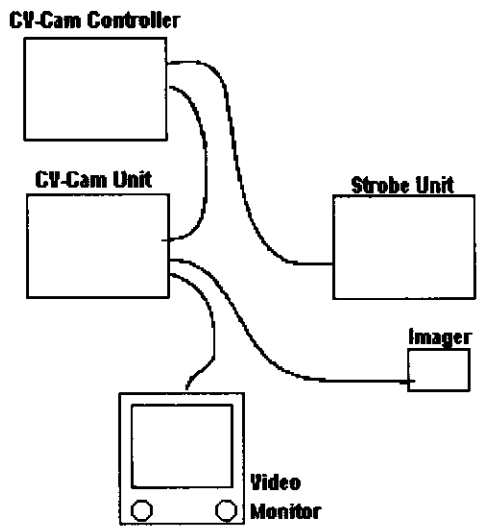
3.4.2 Fresnal Lens Assembly

Some applications require use of a fresnel lens with X20 strobe illumination. These applications typically incorporate larger fields of view and greater stand off distances. The Fresnal lens projects the strobe light pulse long distances while enabling the focus of the light pulse to be adjustable to properly illuminate the field of interest.

4. System Setup and Operation

4.1 Cabling

4.1.1 Single CV-Cam system



Connecting the CV-Cam system is relatively straight forward as most connector used have only one mating partner. The CV-Cam Controller to CV-Cam Unit cable has one black circular connector and one silver circular connector. The Strobe Unit power/trigger cable has two 9 pin D-Sub connectors and two IEC 320 power plugs. The female ends connect to the strobe unit and the male ends connect to the CV-Cam Controller. The tethered CCD imager has one small circular connector which is connected to the CV-Cam Unit. The video cable is of the standard BNC connector type. Please observe each connector and identify which connector goes to which rear panel connection then follow the diagram at the left to connect your CV-Cam.

WARNING: The power to the CV-Cam system must be OFF prior to connecting or disconnecting any cables to or from the CV-Cam system. Damage to the CV-Cam system will occur.

Caution: Ensure that all connectors are properly tightened to prevent incidental disconnection of the connections during operation. Damage to the CV-Cam System can occur if the connections are not tight.

4.2 Power Up Sequence

After setting-up CV-Cam and making sure that all cables are securely attached, the system can now be turned on. Several steps are required to properly power up the system. Failure to follow these steps could result in damage to the equipment and potential electrical shock.
Power-up the system with the following procedure. One should always use extra caution during initial start-up of a newly delivered CV-Cam system or during restart of one that has been relocated or reconfigured to an installation in some way. In these cases the following procedure applies:

1. Check that all connections are securely seated and tight.
2. Verify that the fiber bundle is securely installed in the input module on the Xenon strobe.
3. Turn the Xenon strobe ON by switching its AC power switch to the (I) position.
4. Turn ON the Video monitor and recorder if connected
5. Turn ON the CV-Cam Controller by switching its POWER switch to the (I) position
6. Ensure the strobe is ENABLED by ensuring the STROBE LED is lit, if not depress it to light the LED.
7. Depress the RUN push button to start the system taking pictures.
8. Adjust FRAME RATE and EXPOSURE as necessary to obtain best picture with most information.
9. Focus camera as necessary to obtain best picture.
10. Adjust the STROBE unit fiber-optic to illuminate the field of interest efficiently.