
Agricultural Camera User's Guide



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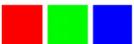
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About This Guide

The Agricultural Camera User's Guide contains general information about the ADC product, covering installation, operation, options and accessories, warranties, and technical support. The information is specific to firmware version 5.136 and later – users with earlier firmware should upgrade so that their units conform to the information herein.

The ADC is a single sensor digital camera designed and optimized for capture of visible light wavelengths longer than 520 nm and near-infrared wavelengths up to 920 nm. The primary use of this product is the recording of vegetation canopy reflectance. The resulting images are suitable for derivation of several vegetation indices.

The purpose of this document is:

1. To guide the user through the installation of the product and its supporting software on its target host system and microscope
2. To describe the basic camera operating procedures
3. To describe the interaction between the camera's interface software and the image editing and archiving software it may be used with.

This document assumes that the user is very familiar with the operation of an IBM personal computer running the Windows Vista, 7, or Windows XP operating system. The user should be familiar with USB serial ports and USB Disk devices, and in the use of near infrared images to evaluate the condition of plant life.

A PDF and HTML version of the manual is supplied on the installation CD, and can be read using a Web Browser..



Quick Start Instructions

Install the 8 AA alkaline batteries and compact flash memory card in the unit. Screw the C-Mount lens into the receptacle on the front of the unit, if it is not already installed. Activate the unit by pressing the On/Off button on the top edge of the housing (leftmost of the 4 small buttons). After approximately 5 seconds, the LCD display should activate. Take pictures by pushing the largest button on top of the camera housing.

STREAMING SOFTWARE MUST BE INSTALLED BEFORE CONNECTING THE CAMERA TO A USB PORT! Insert the CD and answer the installation questions. Have your Windows installation CD available in case your system does not have USB stream support installed. You will be asked for the Windows setup CD if this is the case. If you operate the camera as a USB Disk, no preliminary host software needs to be installed.

Install PixelWrench2 before connecting the camera to the computer. This program is needed to manage connections to the camera and to extract useful data from the NIR images the camera captures.

To review your pictures in the camera, press the button to the right of the On/Off button. A menu should appear. Select items in the menu using the two buttons to the right of the menu button. These buttons allow you to scroll through the selections. Pressing the menu button activates a selection. The "Review" selection gives you access to images in the camera for display on the LCD.

To view your pictures on a computer, you may remove the CF card and install it in a CF card reader, or plug the camera into the USB interface on your computer.

From PixelWrench2, you may open previews of the images on the CF card or in the camera, and extract them for viewing and analysis. Consult the online manual for PixelWrench2 and the camera for more detailed instructions.

If the camera is operated as a USB Disk, you can find the pictures with the File Explorer, and Open or Move them with Windows Mouse operations.

When you are done with the camera, turn it off by pressing the On/Off button.

The largest battery drain comes from the LCD display. Do not leave the camera on with the LCD display running for extended periods, if you want to have good battery life.

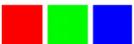
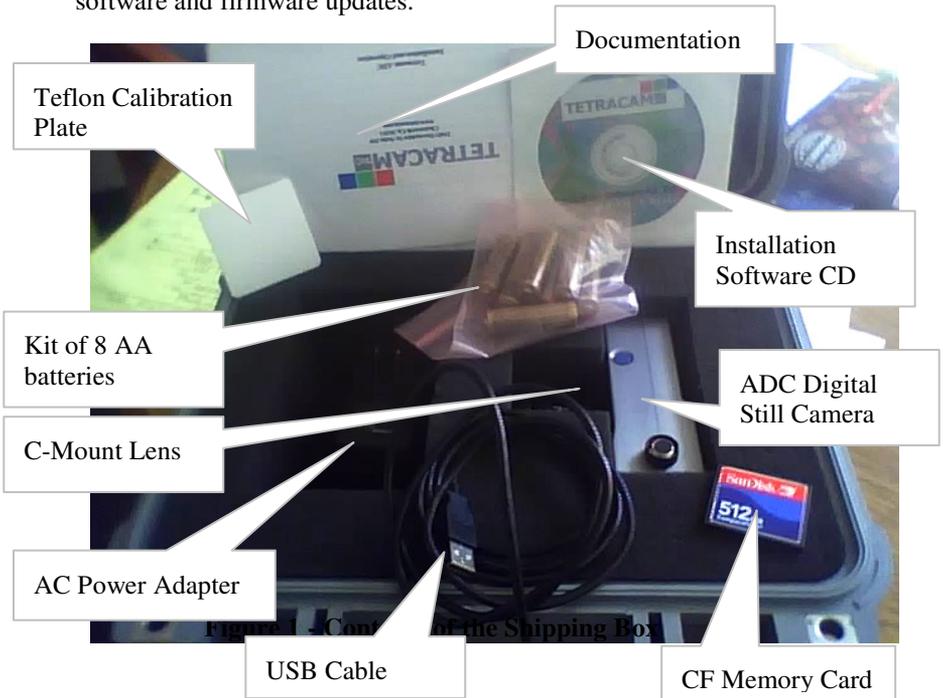


Unpacking The Box

This is what you should find in the box.

- A Hardened Plastic Camera Case
- An ADC Agricultural Digital Still Camera
- A C-Mount Objective Lens
- A CDROM with the installation software supporting the camera
- Product and Accessory Documentation
- A USB interconnection cable
- A Set of Eight Batteries
- A Compact Flash Memory Card
- An AC Power Adapter
- A White Teflon Calibration Plate

Your camera comes with a one-year warranty against defects. You should send in the warranty card to register the camera and qualify for additional software and firmware updates.



Getting Started

System Requirements

Any IBM compatible personal computer with a free USB serial port can be used to operate and configure the Camera. The unit produces RGB color images that are each approximately 9 million bytes in size when the images are rendered on a computer screen. You should select a computer with resources that can support manipulation of images that are this large. Our recommendations for a minimum configuration are:

- 1 GHz or better processor, Intel or AMD
- Windows Vista or Windows XP operating system
- 512 megabytes of SDRAM
- 24 bit color graphics adapter at 1280 by 1024 or better resolution
- 1280 X 1024 or higher display
- Large hard disk drive with 10 GBytes or more of free space

The camera can be made to operate on less capable systems, with penalties in speed and convenience.

Software Installation

The software installation CD is made up of two parts: The PixelWrench2 program, and an HTML version of the users manual. There is a button in the install screen for each component. Select each desired component in turn, and answer the questions posed by the installation process.

New registry entries are made when PixelWrench2 is installed. At the end of each installation you will be asked to restart your computer. It is not necessary to restart between installations. Wait until you are done selecting software, and then restart.

After restarting your computer, have your Windows installation CD handy when you plug the camera in for the first time. If you have not previously used a digital camera on your system, the Windows operating system may need to get some additional files to support the camera drivers.

If your computer does not have the Microsoft .NET 3.5 framework installed, the PixelWrench2 installer will try to open Microsoft.com and download the file “dotNetfx35.exe” to install .NET 3.5. This file is also on the CD in the root directory where you can run it directly prior to installing PixelWrench2.



Hardware Installation

The ADC runs on 8 AA batteries or 12VDC external power connected to the power connector on the camera's right side. To install batteries, open the battery door on the side of the camera. Insert fresh AA batteries, insure the direction and polarity agree with the symbols in the battery enclosure. The



camera will operate on Alkaline, NiCad or NiMH batteries. Replace the battery door to complete the battery installation.

The camera will operate on external power with batteries in place or not. Connect a 12 VDC (+/- 2.5 volts) Center Positive supply to the connector provided. The camera is intended to be compatible with 12V vehicle power, A vehicle accessory adapter can be used to power the unit if desired.

The orientation of each battery is shown on the blue label on the back of the camera.

The ADC cameras come in three housing options.

The standard ADC is packaged in an aluminum case, has buttons for user input, and has a built in LCD display to show pictures and menus to an operator. The ADC AIR has a weatherproof case without buttons, and relies on a PAL or NTSC TV display being connected for the display of pictures and menus. The ADC Lite has a lightweight plastic case, making it suitable for use in small UAVs and also relies on PAL or NTSC TV displays for menu operation and managing pictures.

All the models share the same electronics. Illustrations that follow use views from all three versions.



ADC



ADC Air



ADC Lite



Camera Interconnections

Video Out – configurable by menu for NTSC or PAL

Trigger – Plug the optional external trigger unit into this connector.

Power – The camera requires a 12VDC, center positive polarity supply capable of delivering 0.5 Amps continuous. The supplied wall plug type supply connects to this jack.

USB – The main USB I/O connector.

Multi I/O – This 17 pin connector is allocated for use with certain Tetracam accessories. Call us to discuss your requirements if you need features such as a remote display, control buttons for triggering, menu operations, or power switching, or other remote control functions.



GPS In – A mini-stereo (3 pin) connector allocated for connection of a GPS unit. The camera serial port is configured 4800 – 8 – N – 1, the NMEA 0183 standard configuration. The camera firmware is designed to listen for the NMEA RMC sentence. If the sentence is found, it is written to the image status string (header) for extraction by application software. The serial port can also be used to control the camera from an external serial interface, using simple text commands described in the Programmers Reference section.

ADC Optics and Filters

The camera is typically supplied with one of two lenses:
8.5mm C-mount fixed focal length lens (standard);
or
4.5 to 12mm CS mount vari-focal lens (optional).

The vari-focus lens is adjustable from 4.5 (wide angle) to 12mm (slight telephoto) focal lengths. After making a focal length adjustment, the focus must be checked and adjusted. The lens aperture is also adjustable.

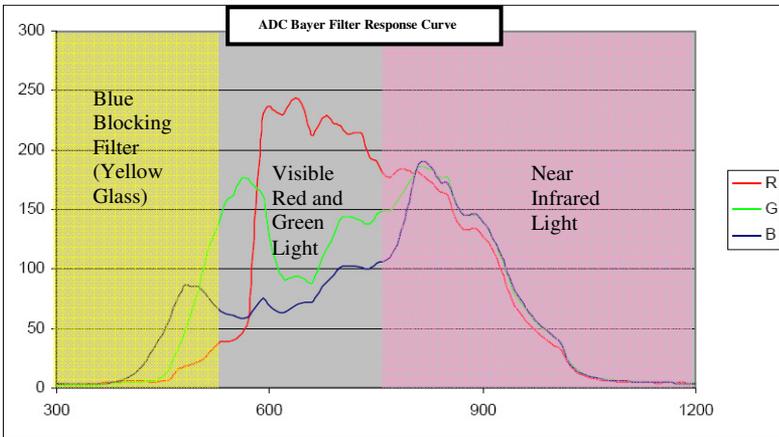


The standard camera is supplied with an 8.5mm fixed focal length C-mount lens with a C to CS mount adapter ring. An infinity focus mark is placed on the fixed focal length lenses for reference. Set the lens to this mark when shooting at distance, aerial images for example. ADC cameras are designed for use with either CS-mount or C-mount type lenses. C-mount lenses require a C to CS mount adapter ring (5 mm extension) to function properly. Any lens fitted to an ADC camera should be designed for use with 1/2" or larger optical format sensors.

Permanently mounted behind the lens is the yellow long-pass filter. Touching this filter should be avoided, clean using a soft clean cloth or lens tissue.

Spectral Response

The CMOS sensor in the camera is screened with a Bayer RGB filter array in a "checkerboard" pattern. The graph below shows the response of the sensor to different bands of light through the red, green and blue filters. A blue absorbing glass filter is used to eliminate the blue sensitivity, and the blue pixels in the sensor are used to measure NIR (Blue Curve). The image is then processed in Pixelwrench2 to subtract the measured NIR from the blue and red bands to produce the final Red/Green/NIR image.



Compact Flash Cards

The unit can handle compact flash cards up to 2 Gbytes. Since stored images are about 3 megabytes each, a 512 megabyte card is the minimum



recommended. A CF card is supplied with the unit.

Note: The ADC cannot take pictures without a compact flash card installed.

We recommend that the unit's power be turned off when the compact flash card is replaced. CF cards manufactured by SanDisk have proven most reliable in our testing of the unit.

The camera is usually operated away from the host computer. If a compact flash memory reader is present on the host computer, the software can extract images directly from the card, without having to connect the camera. This allows the camera to be left in the field, or attached to a vehicle. The CF card is exchanged to bring the pictures to a host computer.

Large CF Card Issues

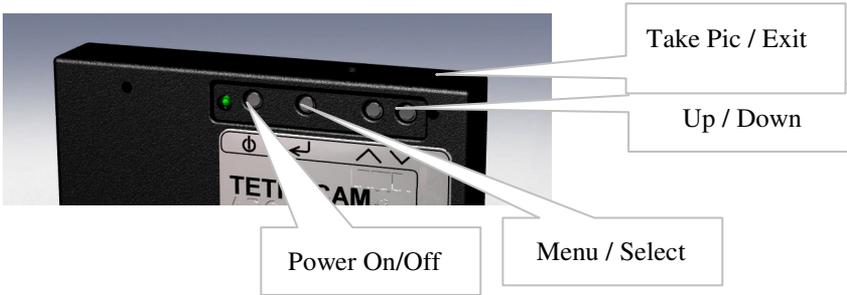
When CF card with capacities in excess of 2 Gigabytes are used they must be formatted as FAT32 cards on the PC. The camera is not capable of initializing CF cards to FAT32 format. Care must be taken to label the volume TTCDISK0 during formatting on the PC. The volume information is used by PixelWrench2 identify the device as a Tetracam camera when it appears as a USB Disk.

Camera Operations

Power Up

The camera's Power On/Off button is the leftmost button along the top edge of the camera. It is marked with the circle and bar symbol as shown in the next illustration. Press and release the button to power the camera on or off. At power up, the LCD will illuminate and begin displaying the live viewfinder image. Connect an optional video monitor to an ADC Air or ADC Lite to see the viewfinder. The update rate is controlled by the exposure time and will change if the camera is set to auto-exposure mode.





Button Functions

The Menu / Select button will invoke the camera's menu as well as select menu options. The Up / Down buttons are used to scroll through menu options and file lists. When in a menu prompt, press the Take Pic / Exit button to immediately exit the menu and go back to the viewfinder screen, ready to take pictures. From the viewfinder screen, press Take Pic to capture an image.

Initializing Internal Memory

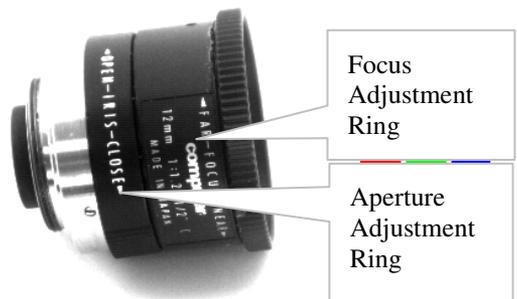
Sometimes the camera internal memory develops faults and must be reinitialized for the unit to power up correctly. Holding the shutter button and down arrow button while the power button is pushed will force the camera to initialize its internal memory.

Toggling USB Mode

When the camera is connected to a Windows computer via the USB port, it will be seen by Windows as either a USB Mass Storage Device (USBDISK mode) or a SoundVision Camera (camera mode). While powering the camera on, press and hold the Menu / Select button for about 5 seconds to toggle the USB mode.

Taking Pictures

Taking a picture requires only aiming, adjusting focus if needed, and pressing the trigger button. As you view the live image on the LCD you will notice a general change in brightness, this is the camera auto adjusting the



exposure time. Allow a second or two for this process to complete before triggering. Depending on the lens fitted to the camera, you may have adjustable focus, zoom and lens opening (aperture). In general daylight photography of vegetation it is preferable to close the lens opening somewhat, called "stopping down". This generally increases image sharpness and contrast. It also increases depth of field.

Controlling the Viewfinder

In daylight conditions, a properly set aperture will produce a fairly dim viewfinder image on the LCD so that NIR data is not over-exposed. For certain pictures it may be useful to adjust the exposure using the UP and DOWN arrow keys while the viewfinder is running. UP makes the target image brighter, DOWN makes it darker. When in auto-expose mode, pressing the UP or DOWN buttons will increase or decrease the exposure by 1/3 fstop for each press. When in fixed expose mode, pressing the UP or DOWN buttons will increase or decrease the exposure time by 1/2 millisecond for each press.

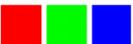
Once the viewfinder image is satisfactory, capture can be initiated with the shutter button or the external trigger box, and the Status LED will turn from green to red. After a capture, the camera completes the compression and storage of the image and the status LED returns to green indicating the camera is ready. At this time the image will be displayed momentarily. If the image format is set to RAW, the cycle is completed much more quickly.

The Camera Menu System

The camera can be configured from the host computer via the USB connection or by use of the menu selections accessible with the controller and video display.

Operation of the menu system uses the three rightmost buttons on the controller: the **SELECT**, **UP** and **DOWN** buttons. To enter the menu system, the **SELECT** button is pressed once. Sub menus appear, or menu items which have values to the right of them.

To select a submenu, use the **UP/DOWN** buttons to move the cursor up or down to the desired submenu entry. Press the **SELECT** key to display the next menu in the tree. If a submenu is not available, (**REVIEW** cannot be accessed unless pictures have been taken) it will be gray in the display



instead of white. The selected entry is hi-lighted in green.

To change a menu item value, press **SELECT** after an item has been selected with the **UP/DOWN** buttons. The value will change color. Use the **UP/DOWN** buttons to select the new value, and **SELECT** again to set the selection.

The menu system can be exited at any time by pressing the **TAKE PIC** button.

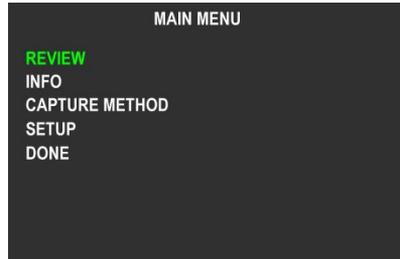
MAIN MENU

REVIEW – options for viewing or deleting stored images.

INFO – view battery status, firmware version and storage card space used / free.

CAPTURE METHOD – set file save mode, toggle fixed or auto exposure, toggle single or continuous capture settings, turn on events log.

SETUP – set timeout, display, date / time, and alarm settings, restore defaults, format memory card, select language, configure GPS setting.



REVIEW

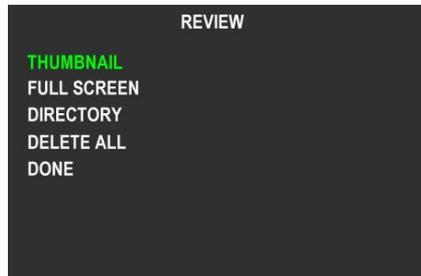
THUMBNAIL – displays four images at once on the screen to quickly scroll through images while viewing them.

FULL SCREEN – show full size images one at a time

DIRECTORY – show a list of saved images

DELETE ALL – erase all images on memory card at once

All images are listed in order from most recent to oldest. Images can be



erased one at a time when selected individually.

INFO

Shows the percentage of battery life left or DC input voltage if powered by DC input.

Shows the camera firmware version.

Shows used, free, and total space on the memory card.

CAPTURE METHOD

SAVE MODE – Select DCM 10 lossless image compression to store more images on the available memory card space or select RAW 10 or RAW 8 formats for faster, non-compressed but larger file sizes.

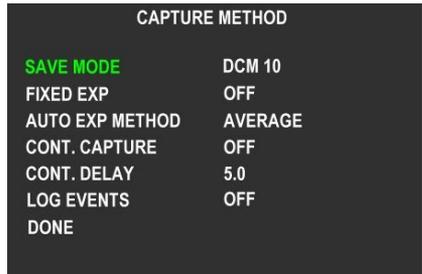
FIXED EXP – Select an exposure time in milliseconds or OFF for auto-exposure mode.

AUTO EXP METHOD – Select PEAK if the subject is the brightest part of the image, or AVERAGE for all others cases.

CONT CAPTURE – Turn ON to continuously capture images when the capture button is pressed. Turn OFF for normal operation.

CONT DELAY – Sets the amount of time the camera waits before taking another image when in Continuous Capture mode.

LOG EVENTS – Logs image number, time, and GPS position information to a text file.

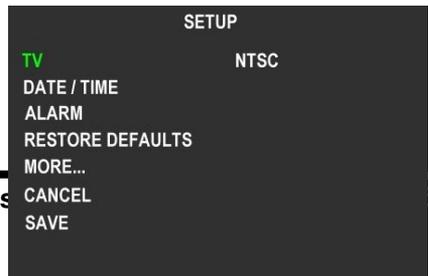


SETUP

TV – Sets the camera to output NTSC or various PAL standard display feeds.

DATE / TIME – Select this to set the time and date for image stamps.

ALARM – Sets the camera to



power itself on and take a picture.

RESTORE DEFAULTS – Select this to restore all factory default settings.

MORE... – More setup options.

MORE...

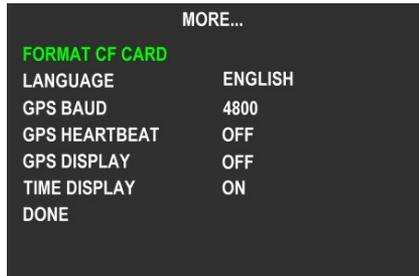
FORMAT CF CARD – Select this to format a new CF memory card.

GPS BAUD – Set the serial connection data rate between the camera and a GPS receiver.

GPS HEARTBEAT – Turn this feature ON to see the status light quickly flash red each time the camera gets an update from a GPS receiver.

GPS DISPLAY – Turn this feature ON to see the GPS coordinates in the camera’s viewfinder screen.

TIME DISPLAY – Toggles the date and time being shown on the viewfinder screen.



Continuous Capture

This mode of operation causes the camera to begin taking pictures when the shutter switch is pressed, and to continue taking pictures until the switch is pressed again. It is the simplest way to operate the camera on a remote aerial vehicle. The rate of capture is controlled by the file format selected, and the additional delay set between pictures. If delay longer than 60 seconds is desired, Alarm mode may be a better solution.

The highest rate of capture is for the 8 Bit RAW file format, at about 3 seconds per picture. The speed depends in part on the features of the CF card. For users who require more precision, the 10 bit RAW format is the next fastest, requiring about 6 seconds per picture.

The RAW files are quite large – 6 megabytes for the 10 bit format and 3 megabytes for the 8 bit format. Compression (DCM format) cuts the size of the files in half, but takes up to 10 seconds per picture. We therefore think of DCM compressed continuous mode as “low speed”. Besides the smaller file size, another advantage of the DCM format is that the files contain previews which speed up the image access speed using Pixelwrench2.



File Format	-----Advantages-----	-----Disadvantages-----
RAW 8 bit	Fastest cycle time	Less dynamic range, no embedded previews or image management info
RAW 10 bit	Fastest cycle time with full dynamic range	Big files, no embedded previews or image management info
DCM 10	Smallest file size with full dynamic range	Longest time between pictures (up to 8 seconds)

The table above shows the relative advantages and disadvantages of camera file formats. These apply to all modes of operation.

Configure the camera for SAVE MODE RAW 8 and LOG EVENTS OFF for fastest possible operation. To slow the rate of capture, a delay value, in seconds, can be selected in the CONT DELAY setting. The settings selected in the CAPTURE METHOD menu will only be saved by selecting the SAVE menu item in the SETUP screen.

Alarm Mode

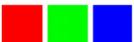
This mode of operation causes the camera to power itself up from a power off state and take a defined number of pictures at set intervals as frequent as one minute apart. The camera powers itself off between each picture take. Alarm mode is a better alternative to Continuous Capture mode when the camera is mounted stationary and / or picture intervals of a minute or more are desired. In order for alarm mode to operate as intended, it is best to make sure the camera's time is set accurately. The camera's time can be set to the nearest second if you select "DONE" from the DATE / TIME menu right when seconds = 00.

DAY, HOUR, and MINUTE

To program the camera to wake up and take a picture at a specific time and day, set the DAY, HOUR and MINUTE. To program the camera to take a picture at a specific time *every day*, leave DAY set to OFF and only set HOUR and MINUTE.

To program the camera to take a picture at a specific minute every hour, set DAY and HOUR to OFF, and just set MINUTE. You could also set the camera to take a picture on a specific

ALARM	
DAY	OFF
HOUR	10
MINUTE	OFF
INTERVAL	60
PIC. COUNT	5
DONE	



minute of every hour but only on one certain day, by setting DAY and MINUTE but leaving HOUR set to OFF.

INTERVAL and PIC. COUNT

To program the camera to take timed interval pictures, starting from a certain time, set the desired DAY, HOUR, MINUTE and INTERVAL (from 1 to 60, in minutes), and PIC. COUNT (1 – 16, number of pictures to take). With INTERVAL set to greater than 1, the camera will count INTERVAL number



of minutes and wake up again and take another picture, and it will repeat this process until PIC. COUNT number of pictures has been taken.

Example:

In the above image, the alarm is set to turn on the camera every day at 10 am and take one picture. It will then turn off and wait 60 minutes before it will wake up and take another picture and then turn off. The process is repeated three more times, for a total of five pictures taken every hour from 10am to 2pm. This would happen every day with the camera being powered on for only about two minutes total time per day.

GPS Option Installation and Use

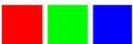
Your ADC will capture and append the most recent GPS data string to each image as it is taken. The following requirements apply; Your GPS receiver must be configured to output the standard NMEA "GGA" sentence. The default output protocol for NMEA sentences is 4800 baud, 8 data bits, 1 stop bit, no parity. Your receiver should allow you to configure it for GGA at 4800:8:1:N. If your GPS receiver can be configured for a higher baud setting you should take advantage of the feature, since it will make the GPS data more accurate as less time is lost transferring the messages. The menu in the camera has an entry for the GPS baud. There is also an advanced setup screen, accessible via Pixelwrench2 that can save a higher baud rate.

The GGA sentence is emitted once per second and contains the following fields:

1. Time UTC
2. Latitude and Longitude
3. Fix quality
4. Number of satellites tracked
5. Horizontal dilution of position
6. Altitude in meters MS
7. Height above MSL

Attach the supplied serial cable to the small serial connector (see the illustration in the Hardware Installation section of this manual). Attach the other end to the serial port of the receiver.

The most recent GGA sentence sent to the camera will be appended to the image data file. You can print (or hide) the GGA sentence on the image



using Pixelwrench2. On the Pixelwrench2 Camera menu select Enable GPS Tagging to have the GPS data placed along the upper edge of the image. Using the. The camera firmware also supports an event or position logging system that will exactly place the GPS locations versus the time pictures are taken with a resolution of 10 milliseconds.

Event Log File

When LOG EVENTS is set to on in the CAPTURE METHOD screen, the camera will maintain a file with a record of key events that can be used to accurately position the location at which the picture was taken. Generally, a GPS receiver is connected to the camera serial port that sends \$GGA... and \$RMC...position strings to the camera.

This feature is used most often with aerial photography, when the GPS point is directly below the camera, so that both the camera and the image are at the same coordinate.

When the option is enabled, the camera creates the file CURRENT.LOG on the CF memory card in root folder. If there is a pre-existing CURRENT.LOG file, the file is moved to the image folder (TTCADC in the case of the standard ADC) and renamed according to the image numbers that were captured while the camera was last in operation.

Example:

If images 31, 32, 33, and 34 were captured, there will be event log records for each of those captures in the file. The file is scanned image capture records, and the smallest and largest image numbers found are used to compose a file name. In this case, the file would be renamed to 00310034.LOG. The first four characters of the new file name are the lowest image capture record in the file, the second four letters are the highest image capture record in the file.

A typical Event Log file is shown on the next page. Each line shown is one record in the file, terminated by a newline character, and NULL. The NULL characters and hidden, and additional line feeds added for clarity in the illustration.

Log files can accumulate on the camera's CF memory card. If they are not erased from time to time, the resources to capture large numbers of images may not be available. The files can be deleted from the CF card using the conventions of the desktop PC.

Log files are much easier to manage if the camera is set up to operate in the USB Disk mode described earlier. The Log files are not directly accessible



from the Pixelwrench2 using the stream interface. When the camera shows up as a folder window on the desktop, as it does in USB Disk mode, the moving and deleting files is trivial.



The CLK record is added when the camera powers up. It shows the camera date and time.

Every Record has a "Ticks" Field that shows the cameras internal clock count of 10 millisecond ticks. The count 104 means that the CLK record was written 1.040 seconds after power on.

CLK 000000104 Date/Time: 10/22/2009 15:15:01

GPS 000002006 00217 \$GPRMC,192254.00,A,2942.79012,N,08223.30667,W,0.0,0.0,0.0,221009,03.3,W,A*0B

GPS 000002064 00217 \$GPRMC,192254.00,A,2942.79012,N,08223.30667,W,0.0,0.0,0.0,221009,03.3,W,A*0B
\$GPGGA,192255.00,2942.79047,N,08223.30663,W,1,04,2.58,00040,M,-031,M,,*5D

IMG 000003049 00218

GPS 000003102 00218 \$GPRMC,192302.00,A,2942.79461,N,08223.30899,W,0.0,0.0,0.0,221009,03.3,W,A*0B

EXT 000003217 External Event Bit

GPS 000003280 00219 \$GPRMC,192302.00,A,2942.79461,N,08223.30899,W,0.0,0.0,0.0,221009,03.3,W,A*0B
\$GPGGA,192303.00,2942.79461,N,08223.30899,W,1,06,2.58,00040,M,-031,M,,*55

If a GPS is connected, an entry is made each time a GPS update string is received. Different GPS messages are concatenated as they come in

The ADC AIR system does not have a power button. In these systems, a 3.3V external event signal can be connected to the external signal contact for the remote PWR SW. When the line pulses, an EXT record will be written to the log file. Since the time in a GPS record is offset by the transmission time, an accurate external tick pulse from the GPS can be recorded here to improve accuracy.

When a picture is taken, a record is written showing the system ticks at the end of integration. The camera can only do one thing at a time, so there will always be a system ticks offset between capturing a picture and the GPS messages. The actual position of the camera when the picture is captured can be approximated by interpolating between the two GPS messages using the system ticks.

The Calibration Image

An important part of the entire camera and software system is the need to calibrate the software supplied with the camera. Calibration consists of taking an image of the Teflon calibration tag under the same lighting conditions as the images under study. This image is used to teach the application software what the spectral balance of that day's sunlight is. The ratio of red/NIR or green/NIR is then applied as an offset to the calculation of the various vegetation indexes.

If a calibration image is not taken within an hour or two of pictures in the field, the vegetation index calculations will be less accurate, and the pictures may not be as useful.

Place the calibration target on the ground or hold it level to the ground and photograph it. It should nearly fill the entire frame and it must not be overexposed. Make sure to avoid a direct reflection of the sun. The sample image on the right is of a properly exposed calibration target.

Later, when the pictures are imported to the host computer, the calibration picture on the CF card will be used to refine the vegetation index calculations using the supplied software applications.



Calibration Target Image

Host Software

The software supplied on the installation CD is made of several major components:

1. An image acquisition and manipulation application, named Pixelwrench2
2. An optional GPS guided camera trigger application named SensorLink
3. A camera interface DLL for extracting images from the camera or CF card, and converting them to Windows DIB format for display.

The goal of this software is to allow the user to extract the NIR / Green / Red images from the camera, and convert the proprietary format into a Windows DIB according to rules specified by the user. (The NIR band can be mapped to Green, Red or Blue in the final image, as can the two visible colors).

PixelWrench2

PixelWrench2 is a powerful image editing program with several tools specific to multi-spectral images and working with Tetracam ADC and MCA cameras. Open the PW2 folder and run Setup.Exe. This will install PixelWrench2. See the PixelWrench2 online help for more information.

PW2 can open ADC proprietary DCM10, RAW10 and RAW8 image files along with several standard image file types (BMP, JPEG, TIF, PNG etc.)

SensorLink

If you purchased the optional SensorLink application you will find a folder by that name on the CDROM included with the camera.

SensorLink is a GPS waypoint triggering application enabling camera triggering at pre-defined waypoints. It uses the same .NET 3.5 framework. Simply run Setup.exe in the SensorLink folder to install it. See the SensorLink online help for more information.

Connecting the camera for Driver Installation

Connect the USB cable from a working USB port on the computer to the connector labeled USB on the camera interconnect panel. Apply 12VDC with **Center Positive** polarity to the power connector. The small wall plug type power supply shipped with the camera is provided for this or you may install 8 AA size batteries following the polarity diagram on the camera.

On Windows XP systems, the first time the camera is connected to a USB port, Windows will fire the *New Hardware Found* wizard. This will guide you through installation of the camera driver called SvStream.sys. If you plan to operate the camera as a USB Disk, skip to the next section.

Do not let Windows search for the driver. In every case select the option where you specify the name and location of the driver. The driver SvStream.sys and its information file SvStream.inf will be copied to your Windows/System32/Drivers folder when you install either PixelWrench2 or SensorLink. When the driver installation wizard asks for a location browse to Windows/System32/Drivers.

In both PixelWrench2 and SensorLink, you are required to specify the camera type prior to accessing the camera. In PixelWrench2, on the Camera Toolbar, click the small down arrow on the top button (Status). Select ADC as your camera type. This loads the correct DLL for use with the ADC. See the PixelWrench2 online help file for further specifics on camera communications.

USB Disk Configuration:

With the introduction of firmware version **5.097** the ADC can be configured to appear as a USB disk drive to the operating system. For Windows Vista, or operating systems other than Microsoft, the camera must be operated as a USB Disk device. To switch to USB Disk mode, the MENU button must be held while the camera is powered on with the CF card inserted. This will cause critical files to be created on the CF card, and the unit will subsequently power up in USB Disk mode by default. The files are:

USBDISK.INI
VIEWDATA.BIN
SETTINGS.TXT

Care should be taken when managing the CF Card to preserve these files. They should not be deleted or moved. Once USB Disk mode operation has been selected, it is retained by the camera until the key files are erased from the CF memory card, or the MENU button is held again during power up to return to the stream interface.

However the camera is configured, it will be recognized when the Pixelwrench2 application is started. In the original stream mode of operation, Pixelwrench2 is the only way to exchange data with the camera over a USB link. When the unit is configured as a USB Disk, files can be dragged and dropped to and from the camera from any personal computer that has USB Disk drivers.



Managing and Processing ADC Images in PixelWrench2

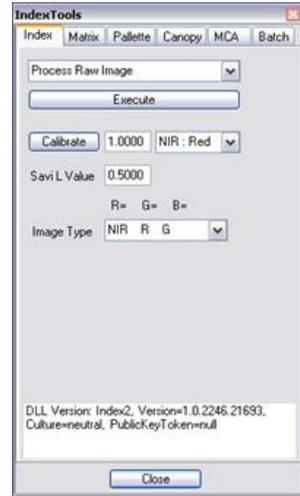
The ADC system writes losslessly compressed image files or RAW files to the CF card for every image. These images carry the extension *.DCM or *.RAW. PixelWrench2 offers all the tools needed for management of ADC images located on the pages of the IndexTools form.

There are four ways to retrieve images from the ADC;

1. Remove the CF card from the camera and copy it's contents to a folder on your computer. The *.DCM and *.RAW files can then be opened directly in PixelWrench2.
2. In PixelWrench2, open the camera toolbar then click *Open Camera*. The camera inventory screen will appear with thumbnails of all the images. Select an image (or images) then click *Load*. The image(s) will be extracted from the camera, color processed using the matrix values entered and stored by the DLL and displayed on screen as an RGB dib.
3. In PixelWrench2, click *Save DCA* on the CameraToolbar. A filesave dialog will appear allowing designation of a filename and target location. A single archive file will be created containing all the DCM files on the CF card. The resulting DCA file can then be opened and individual images can be extracted from it using PixelWrench2.
4. Power up the camera in USB disk mode and open *.DCM or *.RAW files directly using PW2.

Important!

DCM and RAW files are grayscale images displaying “raw” pixel values. The DCM or RAW file must be color-processed prior to further use. When opening an image directly from the camera (or a DCA file) you can choose to let the camera library (DLL) do the color processing by clicking *Load* on the camera inventory dialog or you can import the image un-processed by clicking *Load Raw*. The raw image can then be color processed using the tools in PixelWrench2. Color process files (*.cpf) named *32_standard.cpf*, and *50_standard.cpf* are included on the installation CD. You will find them in the Support folder under the PixelWrench2 application folder. See the PixelWrench2 help files for detailed information.



Configuring the Camera with Pixelwrench2

Many camera configuration settings can be modified using the Edit Camera Settings dialog accessed from the PW2 Camera Toolbar. To open the Edit Camera Settings dialog, make sure the camera is powered up and connected to USB. Click *Status:ADC* to enable the other toolbar buttons. Click *Setup*. The Setup Camera Attributes dialog will appear. Click *Advanced* and the Edit Camera Settings dialog will appear.

This dialog on the next page contains two columns of edit boxes. Place your cursor over an edit box to view a tooltip describing the setting parameters for that box. In the figure the cursor was placed over the SAVE MODE box. The tooltip shows the possible settings for file save mode. This camera is configured to save in DPCM lossless. Many of the settings boxes do not apply to how the ADC should be configured and there is no reason to change the existing settings.

The list below outlines the settings of interest;

GPS Baud – Sets the baud rate for capture of GPS data. NMEA default is 4800 but some receivers support higher rates.

NTSC PAL State – 0 for NTSC, 1 through 4 for several PAL configurations, 5 to disable and use the LCD (default power up condition).

The Edit Camera Setting dialog

VERSION	5096	ZOOM (archaic)	1
SERIAL_NUMBER	0	DONVFORMAT	0
AUTO_OFF	0	EXCITER CONTROL	0
GPS BAUD	4800	VIEW CONTROL	0
NTSC_PAL_STATE	5	POWER_HZ	
SLIDE_SHOW	5	SEE RAW FILES	0
UNIT ID	0	SATURATION	0
EXPOSURE_ADJUST	0	MAX EXPOSURE	1800000
FLASH_MODE	2	MAX DIGITAL GAIN	4
GAMMA	0	MAX EXP CHANGE	30
JPEG	70	AEC CENTER POINT	35
IMAGE NUMBER INDEX	21	COLFIX METHOD	1
LANGUAGE	0	MOSAIC ADJUST 1	2
ACQUISITION MODE	0	MOSAIC ADJUST 2	2
RES_FACTOR	1	SAVE MODE	1
BURST MODE	10	FIXED EXPOSURE	0
LIGHTING (archaic)		COLOR/GRAYSCALE	2
WHITE_BAL	5	POWER SAVINGS	0
SAVERAW	0	BAD PIXEL	3
LOCKED_GAIN		VIDEO EXPOSURE CAP	100

0 = Color JPEG, 1 = DPCM Lossless, 2 = 10 Bit Raw, 3 = 8 Bit Raw.

Save Cancel Check Error Log

Image Number Index – Sets the number that will be applied to the next image taken, then auto increments as images accumulate. Can be set to any positive value or 0.

Burst Mode – 10 to disable, 11 to set continuous capture, 1 through 5 to set an additional delay between images.

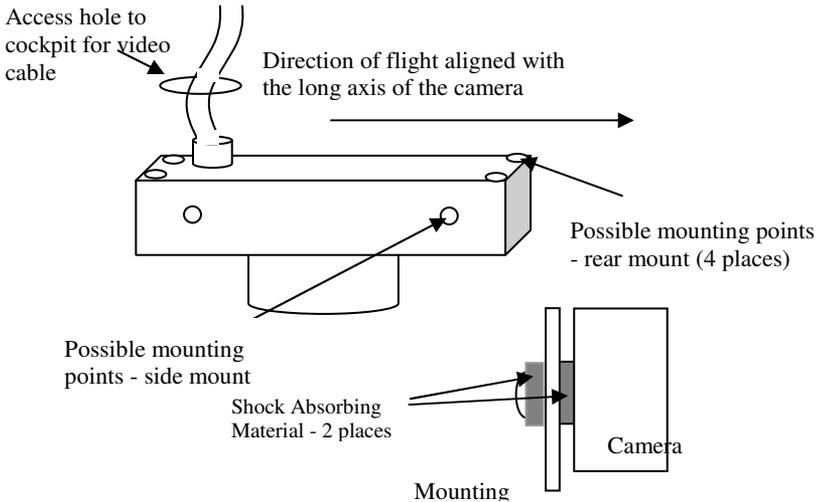
Save Mode – Sets the file format that images are saved in. The ADC should save in DCM, RAW 10 or RAW 8.

Fixed Exposure – Allows presetting a fixed exposure. The value is entered in microseconds. Enter 0 to set the camera to Auto Exposure mode.

Typical Utilization Plan for an ADC AIR camera system

Mounting the unit

The camera should be mounted with its' long Axis along the direction of flight. We recommend a shock absorbing material be used between the mounting bracket and the aircraft, and also from the bracket to the 1/4" mounting threads. All connections to the camera, including power, are available through the cable to the optional video display. If there is no video display, the camera may be operated from internal batteries without any connection to the aircraft.

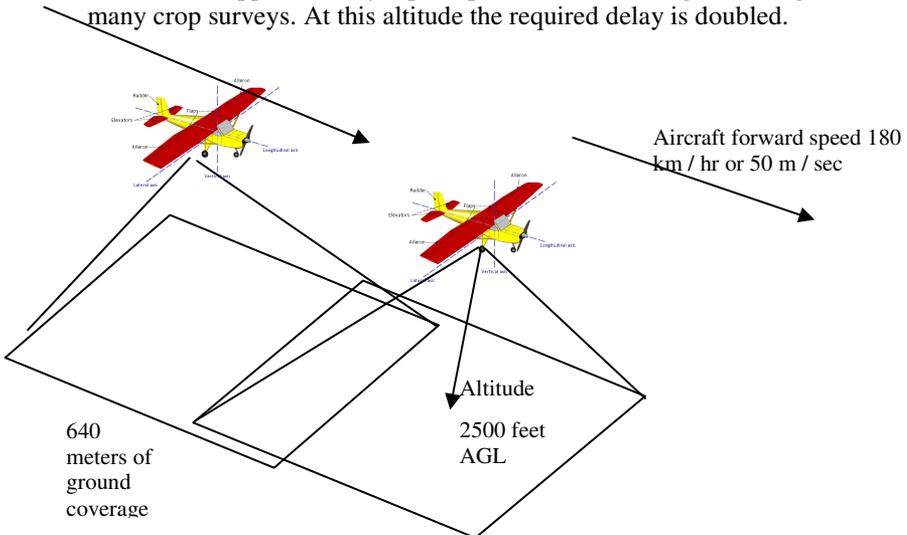


Capture Delays for Aerial Photography

The simplest way to map large areas is to place the camera in TOGGLED mode (see burst settings), with a BURST DELAY that will insure adequate overlap of the images. Since picture storage is cheap, 30 to 50% overlap is recommended. In order to calculate the delay, the cruise speed of the aircraft and altitude above the ground must be known. For example:

Using the standard 8.5mm focal length lens, at 2500 feet AGL the camera captures 1/2 meter per pixel, or 1.28 kilometers along the long axis. If approximately 30% overlap is desired, we would take pictures every 450 meters. If the aircraft is traveling at 180 Km/hour or 50 m/sec, the time to cover 450 meters is 9 seconds. We would, therefore, set the burst delay in the camera to 9 seconds. In practice, the delay will need to be smaller than this because it takes the camera 2 to 5 seconds to save the picture, depending on the file format. The operator should time the intervals between pictures as displayed on the viewer to verify he has the right picture capture rate.

Increasing the altitude above the ground increases the delay needed while reducing the ground resolution of the images. At 5000 feet AGL, the camera resolution is approximately 1 pixel per meter, which is good enough for many crop surveys. At this altitude the required delay is doubled.



The captured images can be easily assembled into a mosaic by stitching software. Autopano Pro does a fast and accurate job of building a mosaic from separate images. We recommend that the images be processed first into the color space needed for analysis - palletized NDVI, or false color NIR, for example. Pixelwrench can do this quickly, using its built in batch functions.



Bytes 8-9

Pixel Rows – 16 bit values



Bytes 10-(data size + 10) DATA – 8 bit values
Bytes (data size+10)-EOF JPEG Preview image.

Looking backwards into the data encompassed by the size value in the header there are several fixed length fields, given below with their sizes.

GPS data – 1024 Bytes
Tags for temperature and clock ticks – 16 bytes

We do not recommend trying to process the DCM files with your own code. Contact Tetracam for assistance with sample ‘C’ source files if reading the DCM file data is absolutely necessary.

Programmer’s Reference – C and Visual Basic Support

The interface to the camera is in the library SXGAADC.DLL This library provides a number of useful camera interface functions. Developers, to incorporate the camera interface into their own programs and plug-ins, can use the interface functions embedded here. The file sxgaadc.lib is provided in the installation directory to allow static linking to the DLL.

The “include” file loadext.h is available in the installation directory to be made part of any C or C++ program making use of the DLL. It is reprinted in part below. All requests are made by filling the a PixRequest structure before the function is called. Sample source files are available from Tetracam to help with the creation of a custom application.

```
typedef struct _PXR
{
    int requestType;           // ACTION type
    int workSilently;         // do not pop up status or hourglass the cursor
    int imageNumber;         // 0 = last image in camera or file
    char far *fileName;      // 0000:0000 = use camera - Otherwise the file to open
                             // "" = ask userask user for file name
                             // "xxxx" = use file xxxx.DCA for reading
    int imageBlue;           // Used for various arguments
    int imageGreen;         // Used for various arguments
    char far *statusString;  // copy camera/image status string to here
                             // if not 0000:0000
} PixRequest;
```



In Visual Basic a wrapper function is provided which accepts the values passed in as individual variables. It then creates the required structure before calling ProgrammerPlug(). A sample calling sequence from Visual Basic is shown below the interface function definition:

```
TTCAM_API HANDLE VBProgrammerPlug
(
    int FAR *requestType,
    int FAR *workSilently,
    int FAR *imageNumber,
    char FAR *fileName,
    int FAR *imageBlue,
    int FAR *imageGreen,
    char FAR *statusString
);
```

/* Here is what a call looks like made from Visual Basic into the DLL:
 Declare Function VBProgrammerPlug% Lib "SXGAADC"

```
(
    requestType%,
    workSilently%,
    imageNumber%,
    fileName as Any,
    imageBlue%,
    imageGreen%,
    statusString as Any
)
```

For integers, According to the VB manual for version 1.0 or thereabouts, VB passes, by default, all arguments by reference, (or far pointers, if your a 'C' programmer. ByVal overrides this by placing the contents of the variable on the stack, rather than the pointer to the variable.

For strings, It appears the ByVal is the way to point to a string that is to be modified by the DLL. The examples in the book for calling Windows APIs that modify strings show a declaration as ByVal. See the chapter headed "Calling DLL Routines with Specific Data Types" for details.

To pass a NULL pointer to VBProgrammerPlug, use ByVal 0& as the parameter for fileName or statusString. To pass a pointer to a fixed length string, use the syntax ByVal StringName\$ in the argument list.

*/

The Visual Basic call ends up here after translation of the calling parameters into a PixRequest Structure

```
TTCAM_API HANDLE PASCAL ProgrammerPlug(PixRequest FAR *);
```

```
/****** Multifunction DLL interface *****/
```

IMPORTANT

The caller must always use the HOOKUP request before any other requests are made!!!!

Passed a pointer to a request block this function will perform the requested action, (see enumerated list, below) and return either the state of the current hookup, a handle to a DIB image, or the camera or file status string. After processing any image controlled by the DIB handle returned, you are responsible for freeing the memory controlled by the DIB's handle BEFORE calling ProgrammerPlug for another image.





```

enum {HOOKUP = 0, // Hook up to the camera/file and prepare DLL to
// load images in following calls.
// if fileName = 0000:0000, use the camera
// if fileName = "xxxxx" or "xxxx.xxx", use file
// if fileName = "" or "", prompt user for file name
// RETURNED PixRequest values:
//     requestType = COLOR or GRAYSCALE
//     depending on camera or file type
//     imageNumber set to # of images available
//
//     requestType and imageNumber are both set
//     to 0 if a file or camera I/O error occurred

// If a non-NULL pointer is found in statusString,
// the camera or file status string is copied. a ""
// is returned if there was an error.

STAMP = 1, // return a handle to the STAMP DIB
// RETURNED PixRequest values:
// HANDLE to a Device Independent Bitmap, (DIB)
// requestType = COLOR or GRAYSCALE depending on
// what picture type the stamp represents
// Returns a 0 on error

GETIMAGE = 2, // standard gray scale image
// RETURNED PixRequest values:
// HANDLE to a DIB
// Returns a 0 on error

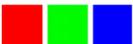
CAPTUREBUFFER = 7, // Returns the camera's image capture buffer
// as a DIB. Stretch, sharpen and scale
// are also done.
// CALL WITH:
// imageNumber = image type to return
// RETURNED PixRequest values:
// HANDLE to a DIB
// returns NULL on error

CAMERASTATUS = 8, // Send the camera status string
// RETURNS:
// Camera status string copied to statusString.
// Returns "" on error

IMAGESTATUS = 9, // Send the imageNumber status string to
// RETURNS:
// Image #imageNumber status copied to statuString
// Returns "" on error

SETEXPOSURE = 10, // Send the value in Blue (LSW) and Green (MSW)
// to camera as exposure time. 0=automatic,

```



```

MULTISELECT = 16, // Allow Operator to Selecting Multiple Images
// CALL WITH:
// imageNumber = Number of images pre-selected
// statusString= pointer to NULL terminated byte
//     array containing the ID numbers of
//     images to pre-select, in the order
//     desired.
//     ARRAY SPACE MUST BE AT LEAST
//     57 BYTES!!
// imageGreen = Maximum number of images allowed
//     to be selected. If 0, the max
//     is the number of images in the
//     file/camera.
// imageBlue = TRUE=Show selection order number
//     in stamp upper left corner.
//     FALSE= No selection Number.
// RETURNED PixRequest values:
// imageNumber = Number of images selected, or
//     zero if none or error
// statusString= pointer to NULL terminated byte
//     array containing the ID numbers of
//     operator selected images in the
//     order selected. The array is
//     left untouched by errors.

```

```

SNAPSHOT = 17, // Take a picture
// CALL WITH:
// Nothing
// RETURNED PixRequest values:
// imageNumber = TRUE if connection made
//     FALSE if comm I/O error

```

```

FASTSHOT = 18, // Take a fast snapshot, and return the DIB
// CALL WITH:
// imageGreen = Non-zero uses an on-screen Viewfinder

```

```

GETCOMPRESSEDDATA = 19, // Return DIB HANDLE points to the
//compressed JPEG or DPCM
// Data from the file in the camera.

```

```

ERASEIMAGES = 22, // Erases all images in the camera
// without prompting the user for confirmation.

```

```

CLOSECAMERAPORT = 25, // Shuts down communications thru any currently
// active port

```

```
};
```



Tetracam RS232 Serial Control Commands

Camera serial port command strings consist of a lead-in character, (ESC) a command character (A-Za-z) and a number of numeric arguments. The numeric arguments are strings of Hex ASCII digits either 4 or 8 characters long depending on the magnitude of the value (16 bit or 32 bit). Separators are not required between the argument values, or between the command character and an argument. Spaces can be used as separators if desired.

Below is a table of the command characters currently implemented, and a description of the responses to be expected from the camera. Arguments are shown as <ARG16> or <ARG32> depending on their magnitude (16 or 32 bits).

<ESC>E

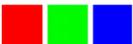
Erase all Image files stored in the camera's file system.

<ESC>T

Take a picture and save the image to CF card memory.

<ESC>X<ARG16>

This command controls the camera exposure for the next image with the value in the argument. If the value is 0, the camera performs a light measurement operation, and calculates a reasonable exposure itself. Otherwise, the exposure is set to the number of milliseconds given in the argument.



Specifications

Basic

3.2 megapixel CMOS sensor, 2048 x 1536

Sensor Image Array 6.59x4.9 mm

Sensor pixel pitch 3.18 um.

Permanently mounted long pass filter behind lens

Image storage to Compact Flash in Tetracam RAW or DCM lossless format.

CS or C mount lens system (C mount lenses require CS to C adapter)

Standard lens supplied - 8.5mm C mount with CS to C adapter

USB interface

Multi-pin I/O connector for use with Tetracam designed accessories

CNC machined aluminum enclosure

Image Capture

Capacity: (DCM10) Approx. 2.3MB per image

(RAW10) 6.15MB per image

(RAW8) 3.07MB per image

Rate: (DCM10) Capture to end of cycle: 7 sec.

(RAW10) Capture to ready : 4 sec.

(RAW 8) Capture to ready : 3 sec.

Burst Mode – 1 frame every second until buffer full. (5 to 8 pictures max)

Inputs

6 – 12 VDC

Rs-232 dedicated to capture of NMEA GPS sentences

External Trigger

USB 1.1 Data Connection

Outputs

LCD viewfinder for image review and menu operations.

Real time NTSC or PAL Video for both viewfinder and menu operations

USB 1.1 Data Connection

ADC Dimensions

4.8 x 3.0 x 1.6 in. (122 x 78 x 45mm) without lens

12 oz. (460 gr.) without internal batteries

18 oz. (640 gr.) with alkaline AA batteries.



ADC Lite Dimensions

4.5 x 3.0 x 0.9 in. (114 mm x 77 mm x 22 mm) no lens

4.5 x 3.0 x 2.4 in. (114 mm x 77 mm x 60.5 mm) w/8.5 mm lens

7.0 oz. (200 gr.)

ADC Air Dimensions

5.4 x 3.5 x 3.2 in. (137 mm x 90 mm x 80 mm) with lens hood

22 oz. (630 gr.)

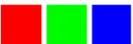
FCC Emissions Standards Information

This equipment has been tested and found to comply with the limits for a class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

1. Reorient or relocate the receiving antenna.
2. Increase the separation between the equipment and receiver.
3. Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
4. Disconnect the external DC power completely, and run the unit on its internal batteries.
5. Consult the dealer or an experienced radio/TV technician for help.

This equipment has been certified to comply with the limits for a class A computing device, pursuant to FCC rules. In order to maintain compliance with FCC regulations, shielded cables must be used with this equipment. Operation with non-approved equipment or unshielded cables is likely to result in interference to radio and TV reception. The user is cautioned that changes and modifications made to the equipment without the approval of Tetracam could void the user's authority to operate the equipment.



Support Info

Your camera comes with a one year warranty against defects or hardware failures.

Technical Support:

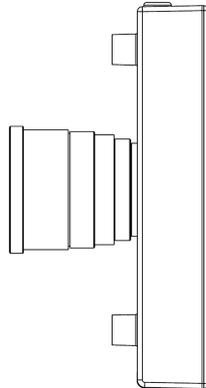
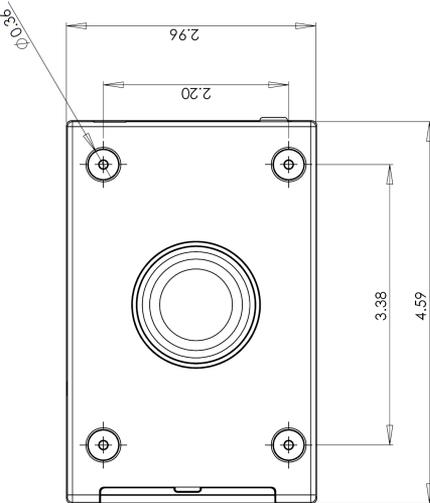
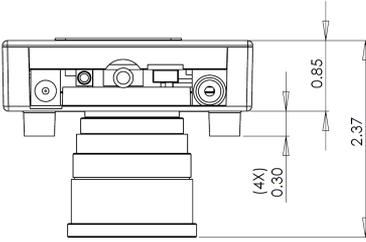
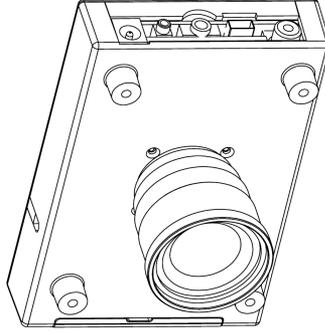
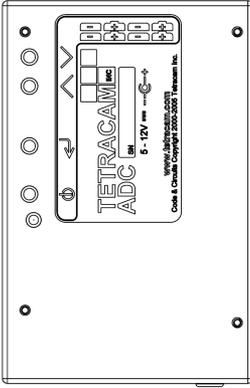
Tel: 818-667-1731 (8 A.M. to 4 P.M. Pacific Standard Time)

Email: steve@tetracam.com

Web: www.tetracam.com

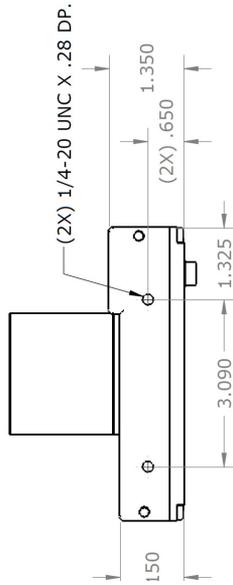
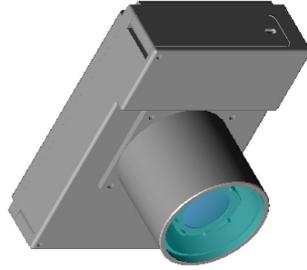
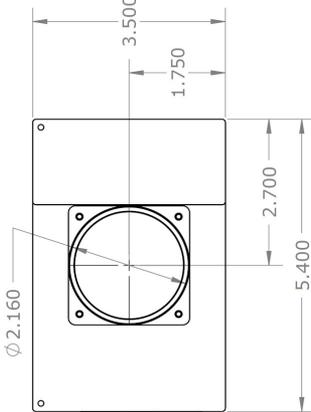
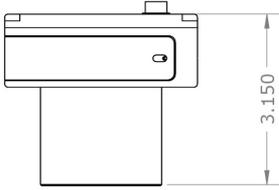
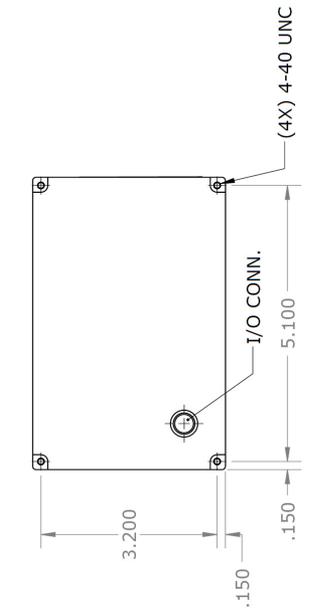


Camera Envelope Drawings



DIMENSIONS IN INCHES





ACCESS TO BOTH ENDS OF CAMERA FOR CF CARD AND STANDARD I/O PANEL.



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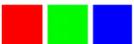
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