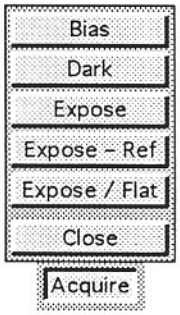
Acquiring and Viewing Images

Image200 is now ready for everyday use. This chapter provides a detailed explanation of the steps involved in image acquisition, and discusses how to use the Main screen to examine the current image.

All image acquisition is controlled by the Acquire menu on the Main screen.



The menu contains five image acquisition commands. Your settings and actions elsewhere in Image200 determine which commands are available.

Expose – Ref and **Expose / Flat** acquire images and perform image correction operations with a single command. **Expose – Ref** is available only if a reference image has been defined; **Expose / Flat** requires both a reference image and a flat field image. These commands are discussed in the chapter *Image Correction and Math*.

If a sequence is defined in the Setup dialog box, only the **Expose** command is available. Sequence definition and acquisition are discussed in the chapter *Defining and Acquiring Exposure Sequences*.

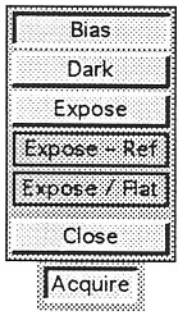
Types of Acquisition

When you choose one of the commands available on the Acquire menu, Image200 uses the parameters defined in the Setup dialog box and the Region Edit screen to acquire an image from the CCD.

There are three basic types of acquisition.

Bias The analog processor card in the CE200A Camera Electronics Unit can digitize only positive voltages. To ensure that only positive signals are obtained, Photometrics adds a DC offset, or bias component, to all CCD charge packets. A bias image provides a measurement of the bias component and any inherent structure in the unexposed CCD signal. Bias images are useful chiefly for diagnostic purposes.

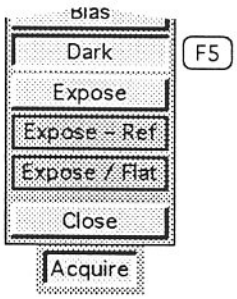
When you click the **Bias** button on the Acquire menu,



the AT200 Camera Controller simply reads out the CCD and digitizes the output. No time delay is counted and the shutter is not opened.

Dark A dark image measures the dark current (thermally generated charge) that accumulates on the CCD in the absence of light over a specified period of time. A dark image is usually timed to be the same length as an exposure, to represent the dark current accumulated over the exposure time. Subtracting a dark image from an exposure of the same length corrects for both the dark current and the DC bias.

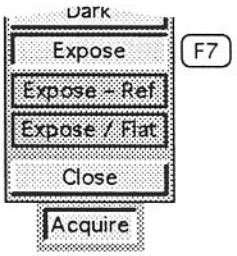
When you click the **Dark** button on the Acquire menu,



the AT200 allows the CCD to integrate for the specified time, then reads out the CCD and digitizes the output. The shutter is not opened.

Expose An exposed image or exposure is the usual method of image acquisition. It measures the charge that accumulates on the CCD in the presence of light over a specified period of time.

When you click the **Expose** button on the Acquire menu,



the AT200 opens the shutter, allows the CCD to integrate for the specified time, closes the shutter, reads out the CCD, and digitizes the output. (A shutter is typically not used with a frame transfer CCD.)

Acquisition Steps

During image acquisition, Image200, the AT200 Camera Controller, and the CE200A Camera Electronics Unit perform a precisely controlled sequence of tasks. If your imaging application does not call for precise timing or control, you may not need to know this level of detail.

The acquisition steps are discussed in three groups, according to whether the steps occur before, during, or after the time when charge accumulates in the potential wells on the CCD.

Before Integration

The hardware and software perform several steps to prepare for image acquisition.

1. The user chooses the **Bias**, **Dark**, or **Expose** command from the Acquire menu.
2. For dark images and exposures, an entry box appears if **Exposure time verification** is on in the Setup dialog box. By definition, a bias image has an exposure time of zero.

   The user accepts or changes the exposure time then presses ENTER, or presses ESC to abandon the acquisition and return to the Acquire menu.
3. Control of the acquisition process passes to the AT200 until the pixel data are ready to be read out. The AT200 prepares for acquisition by clearing onboard data buffers and accepting configuration and region settings from Image200.
4. If **Hardware handshaking** is on, the handshaking signal (on pin 5 of the AT200 User I/O connector) is driven low.
5. If the integration is longer than 10 seconds, the AT200 turns off the amplifier built into the CCD. This precaution is taken because some CCD amplifiers generate enough heat to produce a "glow" which is visible in the image. Not all CCDs and cameras have the ability to turn off the amplifier.
6. If the **Clear count** parameter in the Setup dialog box is non-zero, the CCD is being continually cleared between acquisitions, and is now explicitly cleared the number of times specified by the parameter. The time required depends on the CCD.

   If **Clear count** is zero, the CCD is not cleared and integration begins.

7. For an exposure, an open signal is sent to the shutter controller.

Integration

Parameters in the Setup and Hardware Options dialog boxes determine what happens as charge accumulates on the CCD.

8. The **MPP mode** button determines whether MPP inversion is used for the integration.
9. As charge accumulates, the integration is timed.

   For a bias image, the timer is set to zero and the system proceeds immediately to readout.

   For a dark image or an exposure, the timer counts down the specified exposure time.

   Timing provisions for shutter operation are added to the exposure time. These delay times allow the mechanical shutter to respond to the electronic open and close signals. The shutter open and close delays are based on the shutter selected in the Hardware Options dialog box.

   The shutter delays are counted for a dark image, even though the shutter is not opened. This allows the acquisition of a dark image of exactly the same duration as an exposure.
10. For an exposure, a close signal is sent to the shutter controller at the end of the exposure time.

After Integration

The tasks performed after integration consist mainly of processing CCD pixel data and arranging them into the regions defined on the Region Edit screen.

11. If the on-chip amplifier is off, an "on" signal is sent. A hardware-dependent delay is timed to allow the amplifier to respond and stabilize.
12. For a frame transfer CCD, the image array is shifted into the storage array. Only the storage array is read out on a frame transfer CCD.
13. Readout begins.

    CCD charge packets are shifted into the serial register and then to the output amplifier, as described in the *AT200 CCD Camera System Hardware Reference Manual*. If a packet does not fall into one of the defined regions, it is discarded. Packets within defined regions are combined according to the binning factors set for the region. The DC bias is added to the charge packets and they are sent to the CE200A.

    The analog processor card in the CE200A combines the base readout gain with the gain factor set in the Setup dialog box to determine how electronic charge is converted into digital values. Each charge packet is digitized, and the digitized pixel data are sent to the AT200 and on to the acquisition buffer in host computer memory.

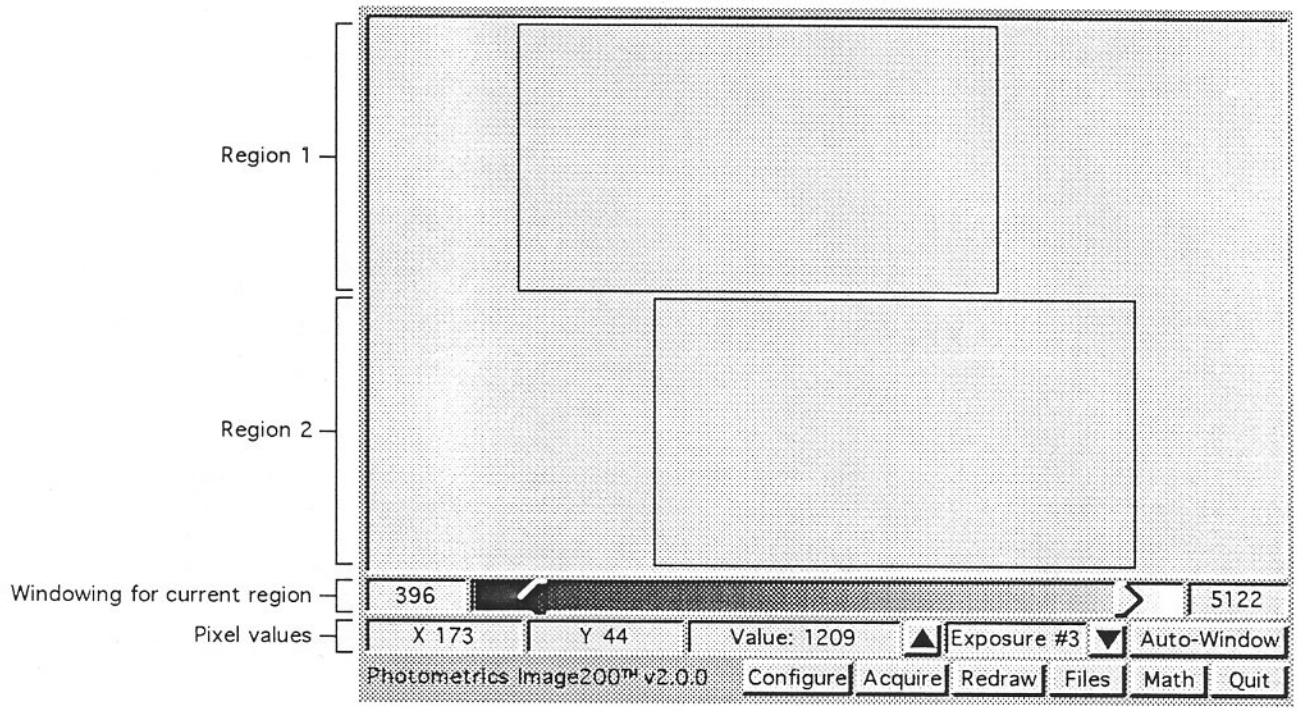
    Readout ends when all the pixels are in the acquisition buffer.

14. Image200 separates the pixel data into distinct regions, adds region definition information, and sends the data to the current image buffer.

    The current image buffer may be in memory or on disk. Image200 assumes there will be enough space to store the acquired image.

Viewing Images

After acquisition, the current image is shown on the Main screen.



As on the Focus screen, each region is shown at the largest possible size while maintaining aspect ratio and relative horizontal positioning.

Current Region

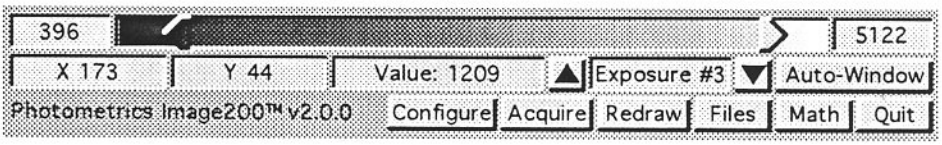
One of the displayed regions is highlighted with a red border, identifying it as the current region. Some commands available from the Main screen apply only to the current region.

To change which region is the current region, click anywhere within the display area of another region. You can scroll through all the regions in the image by pressing the left-arrow and right-arrow keys on the keyboard.

Windowing

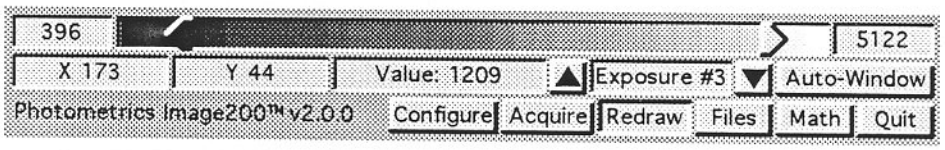
Each region has independent gray-scale windowing settings. To adjust the windowing for a region, click it to make it the current region.

The Windowing bar is the same as the ones on the Focus and Region Edit screens, except that its settings apply only to the current region.



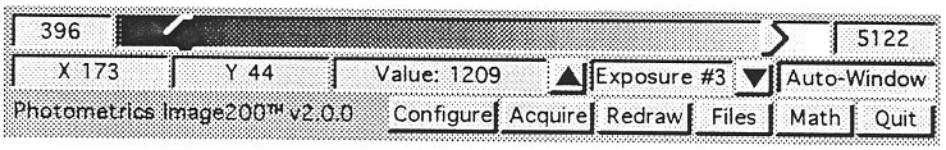
As usual, you can drag the windowing markers with the mouse, or click in the display boxes to edit the marker values.

When the Windowing bar shows the desired settings, click **Redraw** to apply the settings to the current region.



Windowing settings are retained when you make another region the current region. When you return to a region, the Windowing bar shows the windowing values you set for that region.

To reset the gray-scale windowing of *all* regions to the sampled maximum and minimum for each region, click **Auto-Window**.

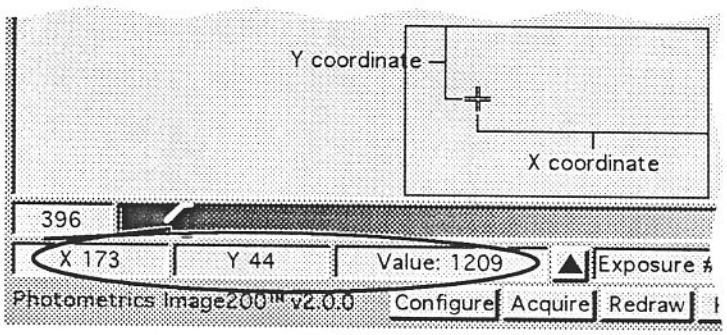


Auto-Window resets all regions, no matter which region is current.

Pixel Values

The Main screen can show pixel values for individual pixels in the current image.

To examine pixel values, move the crosshair into a region display area and hold down any mouse button.



The display boxes below the Windowing bar report the coordinates and intensity value of the pixel in the center of the crosshair. Coordinates are measured as offsets from the region origin. The values will update as long as you hold down the mouse button.

When you click in a region display area to examine pixel values, that region becomes the current region.

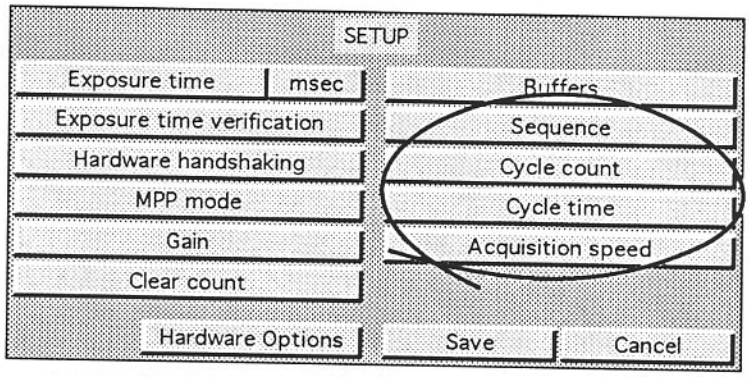
Defining and Acquiring Exposure Sequences

Image200 lets you acquire multiple exposures with a single command. In many ways, exposure sequences simply extend what you already know about single exposures. Definition, acquisition, and viewing are all implemented with familiar elements of the Image200 interface.

Defining Sequences

A sequence is made up of individual exposures which are acquired according to the integration parameters in the Setup dialog box. The exposure sequence parameters are also set in this dialog box. (Sequence commands apply only to exposures; you can't acquire a sequence of bias or dark images.)

From the Main screen, click **Setup** on the Configure menu. The four sequence buttons are on the right side of the dialog box.



These buttons control all aspects of exposure sequences.

Sequence Type

The **Sequence** button controls overall sequence behavior and determines which of the other sequence buttons are available. When you click the button, it cycles through three settings:

- Sequence off
- Sequence on event
- Sequence on time interval

Sequence off

Image200 acquires single exposures. The **Cycle count**, **Cycle time**, and **Fast/Slow acquire** buttons are unavailable.

Sequence on event

Image200 acquires exposures on a trigger signal. The signal must be supplied to the User I/O connector on the AT200, as described in the *AT200 CCD Camera System Hardware Reference Manual*. The number of exposures in the sequence is determined by the **Cycle count** button; the **Cycle time** button is unavailable. The **Fast/Slow acquire** button determines what processing is performed on raw pixel data during acquisition.

Sequence on time interval

Image200 acquires a sequence of exposures with a regular timed delay between exposures. The **Cycle count** button determines the number of exposures; the **Cycle time** button determines the interval between exposures. The **Fast/Slow acquire** button determines what processing is performed on raw pixel data during acquisition.

Count

The cycle count is the number of exposures in a triggered or timed sequence. When the **Cycle count** button is available, you can click it and get an entry box.

Type a number and press ENTER to change the cycle count, or press ESC to leave the current value unchanged.

Time Interval

The cycle time determines the interval between exposures in a timed sequence. It is the time from the beginning of one exposure to the beginning of the next, and thus includes exposure and processing time. When the **Cycle time** button is available, you can click it and get an entry box.

Type a new time interval (in seconds) and press ENTER to change the cycle time, or press ESC to leave the current value unchanged.

Acquisition Speed

The **Fast/Slow acquire** button determines what processing is performed on raw pixel data during a sequence acquisition. When the button is available, clicking it toggles the setting between "Fast acquire" and "Slow acquire".

There are many tradeoffs between acquisition speed, sequence size, disk use, and memory use. The best combination for a particular sequence acquisition depends on the details of your host computer configuration.

Fast acquire

Image200 buffers the entire incoming pixel data stream directly into memory (in the acquisition buffer), for the maximum exposure repetition rate. At the end of the sequence, the pixel data are reorganized into the individual expo-

sures and regions which make up the current image. Because the acquisition buffer must hold the entire sequence, the fast acquisition method requires a lot of memory.

The number of images in the sequence is limited by the number of EMS handles available to your EMS Memory Manager. For more information on EMS handles, see the chapter *Installing Image200*.

Slow acquire

The incoming pixel data are reorganized into regions and added to the current image at the end of each exposure in the sequence. This frees the acquisition buffer for the next exposure in the sequence.

When used with disk buffers, slow acquisition requires minimal memory during acquisition, allowing the acquisition of more data with limited memory. However, slow acquisition greatly lowers the repetition rate possible for the sequence exposures.

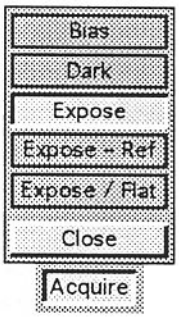
Save the Configuration

When you have set all of the exposure and sequence parameters in the Setup dialog box, click the **Save** button to save the changes in your configuration file and return to the Main screen.

To leave the Setup dialog without saving, click **Cancel.** If you have made any changes since you opened the dialog box, Image200 asks whether you want to save the setup.

Acquiring Sequences

Now you are ready to acquire an exposure sequence. The **Expose** command on the Acquire menu begins the sequence acquisition.



When **Sequence** is on, only the **Expose** command is available on the Acquire menu on the Main screen. Reference subtraction and flat field correction are not available.

As the sequence is acquired, Image200 displays messages to keep you informed of progress. You can stop the sequence during the current exposure by pressing ESC.

Storage Space

Image200 assumes there is enough space to store the entire sequence in the current image buffer. If a problem develops during readout, Image200 tries to save the exposures which have already been acquired.

A sequence can require large amounts of memory and hard disk space. Space requirements can depend on:

- Sequence size
- Buffer setting
- Acquisition speed
- Number and size of regions
- Binning

If you have any doubts, check the space available before you begin an important sequence acquisition.

Acquisition Steps

The exposures in a sequence are acquired much like single exposures. The additional processing performed between exposures depends on the acquisition speed set in the Setup dialog box.

For a sequence acquisition using a frame transfer CCD (as determined by the setting of the **Frame transfer** button in the Hardware Options dialog box), the shutter is opened once at the beginning of the sequence and remains open until the end of the sequence. After each exposure is integrated, the image array is shifted to the storage array and the storage array is read out.

Triggered sequence

For a triggered sequence, the exposure begins when the trigger line is driven low. The trigger line is pin 6 of the AT200 User I/O connector, as described in the *AT200 CCD Camera System Hardware Reference Manual.*

If **Hardware handshaking** is on (in the Setup dialog box), the handshaking signal on pin 5 of the User I/O connector is driven low when the AT200 is ready and waiting for a trigger signal.

If the **Clear count** parameter in the Setup dialog box is non-zero, the AT200 clears the CCD continually while waiting for each trigger, and abandons clearing as soon as a trigger is received. Thus, the actual number of times the CCD is cleared depends on how long the AT200 waits for the trigger signal.

If **Clear count** is zero, the AT200 does not clear the CCD between exposures. On a frame transfer CCD, the shutter is open and charge accumulates continuously. When a trigger signal is received, the image array is shifted to the storage array and read out, and charge immediately begins accumulating on the image array.

To acquire a single triggered exposure, set up a triggered sequence with a cycle count of 1.

Timed sequence

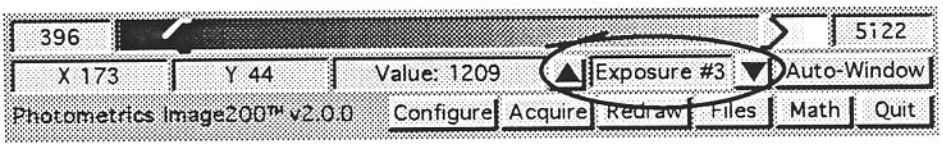
For a timed sequence, the AT200 counts the specified time interval between exposures. The interval is counted from the beginning of one exposure to the beginning of the next.

During the delay, Image200 may need to complete buffering operations on the host computer. The actual length of those operations thus determines a minimum possible delay.

Viewing Sequences

When the sequence acquisition is complete, the first exposure in the sequence is shown on the Main screen.

The display box next to the **Auto-Window** button shows the current exposure number.



To go to a specific exposure, click the box. An entry box appears.

As usual, type an exposure number and press ENTER to go to that exposure, or press ESC to stay with the current exposure.

The arrow buttons on either side of the exposure display box let you scroll through the exposures in the sequence. The keyboard equivalents are the up-arrow and down-arrow keys.

The settings shown on the Windowing bar for each region are applied to that region in all exposures in the sequence. Thus, the Windowing bar does not change when you change the exposure.