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Version 6.0

Camera Guide:
Hamamatsu Digital Cameras

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Imaging Research Inc.

Hamamatsu Cameras

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Introduction

This chapter describes the installation, use and adjustment of the Hamamatsu C4880 and C4742 digital cameras. Most of the functions and features described here are exclusive to these cameras. The MCID™ Elite imaging system, however, provides many other features related to camera-based image acquisition in general (e.g., frame averaging for noise reduction, real-time image alignment). These are described in the online Reference Manual (Chapter 2: Acquiring Images).

Hamamatsu C4880

The Hamamatsu C4880 is a Fast Cooled Integrating (FCI) camera which is able to speed the transfer of image data from the camera to the computer. The shutter opening is adjustable from 20 msec (useful for freezing motion), to minutes for low light level applications.

The C4880 offers either 8 bit (256 gray level), 10 bit (1024 gray level) or 12 bit (4096 gray level) digitization. The higher bit densities will yield better densitometric sensitivity, but can slow down some of the imaging functions. For example, image subtraction will take longer with a 12-bit image than with an 8-bit image.

The C4880 also offers a number of display resolutions; full and binned. At full resolution, the image is 1024 x 1024 pixels. In each of the binned modes (2x2, 4x4, or 8x8), each group of pixels is summed to yield a single output pixel. This yields greater sensitivity for use with low light levels. Binning also yields a smaller image (2x2 binning will yield a 512 x 512 pixel image). The full and binned modes are user selectable from the Input Device Selection dialog box. Select the full resolution mode for work with higher light levels, or the various binned modes for low light conditions.

Connecting the Components

The Hamamatsu C4880 camera consists of a camera head, a power supply/control unit, a water pump/cooler, and a vacuum pump. Also included are water and vacuum hoses, a camera controller cable (camera head to control unit), a M5 Hamamatsu Input cable, a serial interface cable, and two AC power cords.

The camera controller cable is a thick, light gray cable with identical connectors at either end. It connects the camera head to the control unit. Plug one end into the back of the camera head and the other to the “Camera Head” terminal on the rear panel of the control unit.

The M5 Hamamatsu Input cable is a thick, light gray cable that connects the control unit to the digital imaging board. The cable has a 100-pin RS-422 connector at one end, and a smaller 68-pin mini-centronics connector at the other. Connect the 68-pin end to the DIGITAL OUT terminal at the rear of the control unit, and the 100-pin end to the RS-422 digital input board (see the MCID Elite Start-Up Guide for information regarding the RS-422 digital input board).

The serial interface cable has an 8 pin male mini-DIN connector at one end, and a female DB9 connector at the other. Connect the mini-DIN plug to the SERIAL I/F terminal at the back of the control unit and the DB9 plug to the serial port on the computer.

The coolant consists of a mixture of 25% Glycol to 75% water and is pumped to and from the camera head via two blue hoses. It is imperative that the coolant flows in the proper direction. When connecting the hoses, make sure the "OUT" on the cooling unit goes to the "IN" on the camera head, and vice versa.

The vacuum pump is used to prevent condensation from accumulating on the camera sensor during cooling. Make sure that the valve on the vacuum hose is in the "OFF" position. Then connect one end of the vacuum hose to the vacuum pump, and the other end to the "VAC" outlet on the camera head.

The two AC power cords plug into the camera control unit and the water pump/cooler unit.

Note: Make sure that the camera head is under a vacuum before switching on the camera cooling. Failure to observe this procedure will result in ice crystals forming on the sensor chip during cooling.

Installing in MCID Elite

The C4880 camera may be installed as an 8-bit input device (yielding 256 gray levels), 10 bit device (yielding 1024 gray levels), and/or a 12-bit device (yielding 4096 gray levels). To use these different capabilities, you must install the camera as though it were more than one device. For example, to use the camera in both 8 bits and 12 bits, it must be installed as two separate devices: an 8-bit camera and a 12-bit camera.

The MCID Elite imaging system's interface to cameras is controlled through the Settings > Input select menu command. The Input Device Selection dialog box (Figure 1) contains a list of available inputs. You can pick, add, or delete any input from the list. You can also edit the definition of a specific input.

Figure 1: The Input Device Selection Dialog box lists all of the cameras installed in MCID Elite.

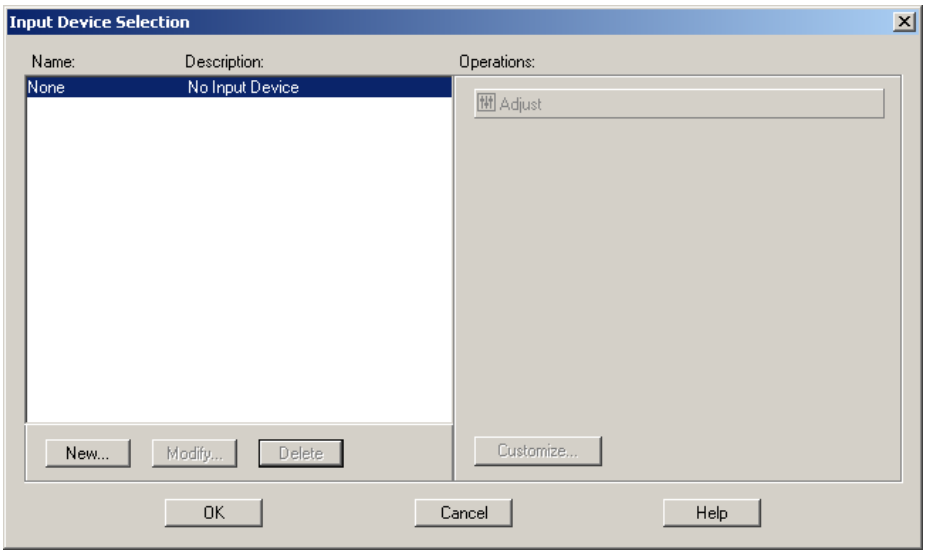
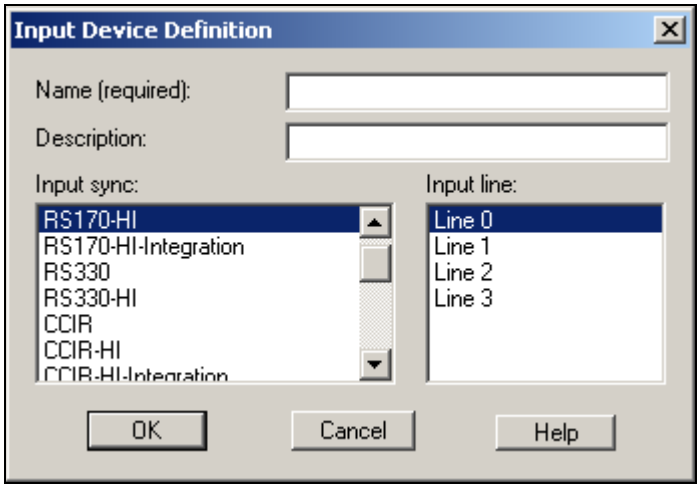


Figure 2: The Input Device Definition dialog box.



Procedure

To add the camera to the MCID Elite list of input devices:

1. Open the Settings menu and select Display format. Set the Image Type to the desired bit density (i.e., 8 bit mono, 10 bit mono or 12 bit mono).
2. Open the Settings menu again and select Input select. The Input Device Selection dialog box appears, which lists every camera that is currently installed in MCID Elite.
3. Click the [New] button. If another camera has been installed already, a Create Input Device dialog box will appear. Select the New input device option and

click [OK]. If no other cameras have been installed, the Input Device Definition dialog box appears (Figure 2).

4. Select the appropriate Input sync:
   - Hamamatsu - 12 to 8 -- 8 bit (compresses 12 bits of camera data to 8 bits)
   - Hamamatsu - 10 to 8 -- 8 bit (compresses 10 bits of camera data to 8 bits)
   - Hamamatsu – 10 -- 10 bit
   - Hamamatsu – 12 -- 12 bit
5. Enter a unique Name and Description in the entry fields (e.g., “Mono2”, “10 bit camera”). Click [OK] to exit the dialog box.
6. A Customize dialog box appears next (Figure 3), which allows you to assign various input device operations to this camera (e.g., frame averaging controls). You can select them now or assign them later (see Chapter 2: Acquiring Images in the online Reference Manual for details). Click [OK] to exit the dialog.

Figure 3: The Customize dialog box is used to link controls for various camera operations to the camera.

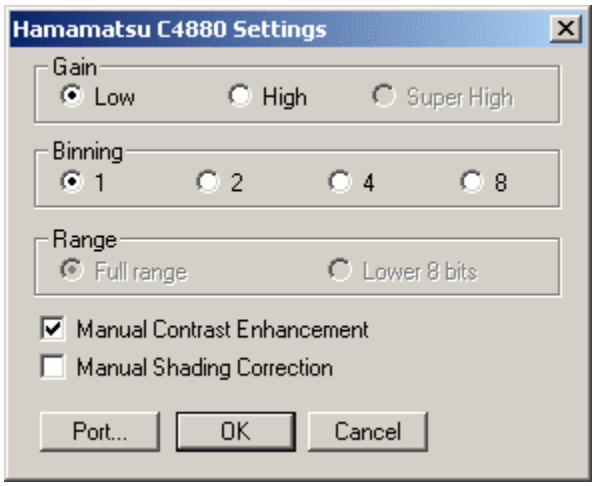


7. The camera is now listed in the Input Device Selection dialog box. Click on the Configure] button to enter the Hamamatsu C4880 Settings dialog box (Figure 4).
   a) Press the [Port] button and specify the serial port to which the camera control unit is connected (e.g., COM2).
   b) Press [OK] to exit the Settings and return to the Input Device Selection dialog box.
8. Click [OK] to exit the Input Device Selection dialog. The camera is now installed in the list of input devices. When you exit the Input Device Selection dialog box,

the camera (and all of the settings and operations associated with it) becomes the default input device. MCID Elite will automatically select this camera (and the corresponding display format; e.g., 8 bit mono) each time the program is started.

9. Repeat this procedure if you wish to install the camera under another bit density.

Figure 4: The Hamamatsu C4880 Settings dialog box.



Operating Instructions

Before you begin to use this camera please make sure that you have read the instruction manual supplied with the C4880 camera and in particular section 6 concerning the operation of the camera. It is important that the camera head contains a vacuum before the CCD cooler function is started. Otherwise ice crystals could form on the surface of the sensor chip and once formed they are very difficult to remove. By following the startup protocol outlined below you should not experience any problems with ice crystal formation.

PROCEDURE:

1. Make sure that the cables and the hoses are connected as shown in the connection diagrams (Fig. 5-1 and Fig. 5-2) found on pages 9 and 11 of the Hamamatsu C4880 instruction manual. The direction of the water flow into and out of the camera is important and must be connected correctly. Both of the cooling connectors on the camera head are labeled, one is labeled “IN” and the other is labeled “OUT”. Also make sure that the vacuum hose valve is in the “OFF” position before the connection is made to the camera head.
2. Once all the appropriate connections are made the vacuum pump may now be switched on. Once the pump has been switched on the valve should then be turned slowly to the “ON” position.
3. You are now ready to start the water circulation pump. Pay close attention to the direction of flow of the coolant and be sure that it coincides with the direction labels on the camera head.

4. Turn on the power switch of the C4880 camera control unit. Do not turn on the CCD cooler function on the camera control unit at this stage.
5. Allow at least 30 minutes for the vacuum pump to run before switching on the CCD cooler function. Once the pump has been running for 30 minutes turn the valve on the vacuum hose to the "OFF" position. You may now switch off the vacuum pump and disconnect the vacuum hose from the camera head. The camera vacuum hose connector is of the self sealing type and the camera head should be able to hold a vacuum for about two months before there is a need to recharge.
6. You are now ready to turn on the CCD cooler function on the C4880 camera control unit. Press the "MENU" button on the front of the control unit until the display shows the heading "COOLER SWITCH OFF". To turn the switch to "ON" press the "SELECT" button followed by the "RETURN" button. You should now see the temperature indicator slowly begin to drop. Once the camera unit has reached its operating temperature leave the system running for another 30 minutes to allow the temperature and camera head to equilibrate.

Setting the Display Format

The C4880 offers either 8 bit (256 gray level), 10 bit (1024 gray level) or 12 bit (4096 gray level) digitization. From the Settings - Display format selection, choose the bit density that is the most appropriate for your application. If the camera is not set up as the default device for the desired bit density, you must also select the camera from the list of input devices. Open the Settings menu and select Input select.

Digitizing

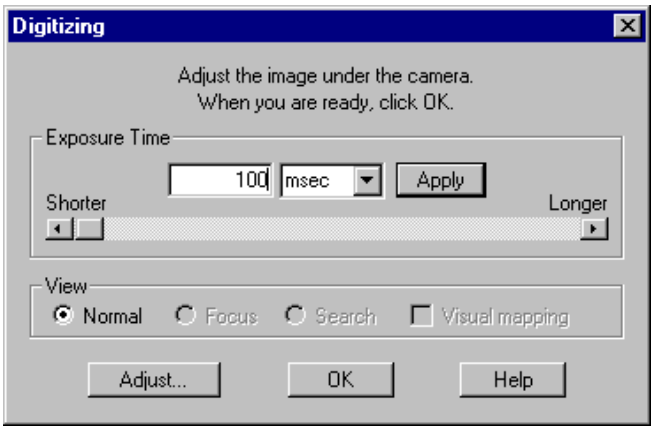


Click the Digitize icon to initiate digitization or press <Ctrl - D>. A dialog box appears to indicate that MCID Elite is digitizing continuously and a live image appears on the image monitor.

Light is accumulated as long as the shutter is open. Longer exposure yields higher sensitivity. Exposure is controlled by moving the integration time slider. For most purposes, an exposure of about 100 msec is fine. Faster shutter speeds tend to yield less stable density values. Adjust lighting to give proper illumination. In low light situations, the exposure time can be increased to a period of a few minutes. Because the camera is cooled there is no appreciable increase in background.

Press [OK] to terminate digitization. The image is now frozen, and any MCID Elite function may be applied to it.

Figure 5: Clicking the Digitize icon initiates the digitization procedure and displays a dialog box. Move the slider along the Exposure Time bar to control the exposure time.



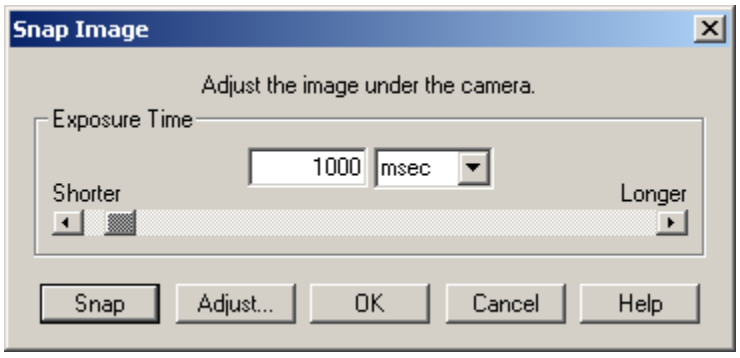
Snap Shots



Press the Snap Shot button to capture an image using a single exposure (i.e., without displaying a continuously 'live' image). The Snap Shot skips the display of the Digitizing dialog box (Figure 6) and simply snaps and captures a new image to the display monitor. This function can be very useful if you are working with dim specimens and you have already chosen the correct exposure time. Clicking the Snap Shot icon will automatically snap a fresh image.

To adjust the exposure time, Ctrl-click on the Snap Shot icon to display the Snap Image dialog box. Move the slider control to increase or decrease the exposure time. Press the [Snap] button to test the exposure.

Figure 6: The Snap Image dialog box.

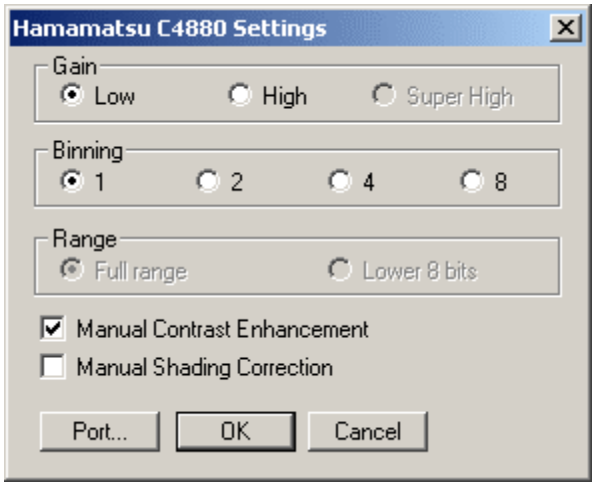


Adjusting the Camera Settings

MCID Elite allows digital control over a number C4880 settings. To access these controls, press the Adjust button while digitization is occurring. MCID Elite will display a dialog box for camera adjustment (Figure 7).

These adjustments are also accessible from the Input Device Selection dialog box, by pressing the [Configure] button, and/or by Ctrl-clicking on the Digitize icon.

Figure 7: Settings for the Hamamatsu C4880 camera.



Gain

The gain sets the amplification signal within the camera control unit. Three options are available; Low, High and Super High. The last setting of Super High is only accessible when the camera is used in the 12-bit mode.

Binning

The camera may be directed to combine pixels during readout. This combining increases sensitivity and speed, while decreasing resolution. For example, a binning factor of 2 causes the camera to sum each array of 2 x 2 pixels into a single value. This decreases resolution, as our minimum spatial element is now four pixels in size. However, sensitivity is increased, as we are reading out photons from a larger area of the sensor. A factor of 4 means each spatial element is sixteen pixels and a factor of 8 means each spatial element is sixty four pixels.

Range

This selection is only available when the camera is used in 8-bit mode. Two choices are available in the Range selection, Full range or Lower 8 Bits. With Full range selected the full 12 bits (4096 gray levels) or 10 bits (1024 gray levels) of the camera are mapped to the 256 display gray levels. Each MCID Elite gray level now represents either 16 or 4 camera gray levels. With Lower 8 bits selected the lowest or darkest 8 bits of the camera range are mapped to the 256 display levels. Each MCID Elite gray level now represents one camera gray level.

Manual Contrast Enhancement

Enabling this item allows you to manually adjust the gain and offset controls on the camera control unit. This selection is only available when the camera is used in 8- or 10-bit mode.

Manual Shading Correction

Enabling this option allows you to manually adjust the shading pattern of the camera from the camera control unit. This selection is only available when the camera is used in 8- or 10- bit mode.

Port

Pressing the [Port] button gives access to the Serial Port Characteristics dialog box. This allows the various communication parameters between the camera and computer to be configured.

Turning Off the System

To turn the C4880 camera system off you first have to turn off the CCD cooler function by selecting the switch to “OFF”. The water coolant pump must be allowed to operate until the temperature indicator on the camera control unit has reached room temperature and stabilized. Only then can the water coolant pump be turned off, followed by the camera control unit.

Hamamatsu C4742

The Hamamatsu C4742 is a 10-bit chilled, high-resolution digital integrating camera (later models are 12-bits). Its output can also be “binned” to provide higher sensitivity for low light applications. Its cooling unit chills the CCD to about 5° C, allowing longer exposures with less noise.

Connecting the Components

The Hamamatsu C4742 camera consists of a camera head and a power supply/control unit. Also included are a camera controller cable (camera head to control unit), a custom M5 Hamamatsu Input cable (control unit to MCID Elite), a serial interface cable (control unit to MCID Elite), and an AC power cord.

The camera controller cable is a thick, black cable with identical 50-pin connectors at either end. It connects the camera head to the control unit. Plug one end into the back of the camera head and the other to the “CAMERA HEAD” socket on the rear panel of the control unit.

The M5 Hamamatsu Input cable is a thick, light gray cable that connects the control unit to the digital imaging board. The cable has a 100-pin RS-422 connector at one end, and a smaller 68-pin mini-centronics connector at the other. Connect the 68-pin end to the DIGITAL OUT terminal at the rear of the control unit, and the 100-pin end to the RS-422

digital input board (see the MCID Elite Start-Up Guide for information regarding the RS-422 digital input board).

The serial interface cable connects the control unit to a vacant serial port on the computer (COM1 or COM2). The serial cable has female DB9 connectors at each end other. Plug one end into the SERIAL I/F socket on the rear of the control unit and the other into the serial port on the computer.

Use the AC power cord to plug the camera control unit into an AC power source.

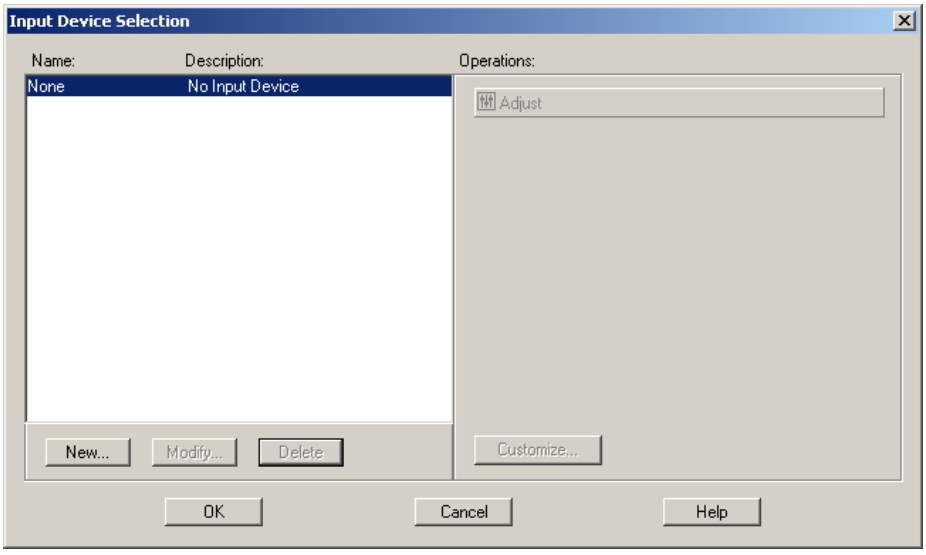
Installing in MCID Elite

The C4742 offers two display resolutions, full and binned. At full resolution, the image is 1280 x 1024 pixels. In binned mode, each 2x2 group of pixels is summed to yield a single output pixel. This yields greater sensitivity for use with low light levels. Binning also yields a smaller image (640 x 512 pixels).

To use these different capabilities, you must install the camera as though it were more than one device. For example, to use the camera in both full and binned display resolutions, it must be installed as two separate devices: a high resolution camera and a binned camera. The full and binned modes then become software-selectable.

The MCID Elite imaging system's interface to cameras is controlled through the Settings > Input select menu command. The Input Device Selection dialog box (Figure 8) contains a list of every camera that you have already installed. You can select, add, or delete any camera input from the list. You can also edit the definition of a specific input, and assign specific operations and settings to it. See Chapter 2: Acquiring Camera Images in the online Reference Manual for details.

Figure 8: The Input Device Selection list.



TO INSTALL THE C4742 AT FULL RESOLUTION:

1. Open the Settings menu and select Display format. Set the Image Type to 10 bit mono.
2. Open the Settings menu again and select Input select. The Input Device Selection dialog box appears, which lists every camera that is currently installed in MCID Elite.
3. Click the [New] button. If another camera has been installed already, a Create Input Device dialog box will appear. Select the New input device option and click [OK]. If no other cameras have been installed, the Input Device Definition dialog box appears (Figure 9).
4. Select "Hamamatsu C4742" as the Input sync, and enter a unique Name and Description in the entry fields (e.g., "Mono1", "C4742 Full"). Press [OK] to exit the dialog box.
5. A Customize dialog box appears next (Figure 10), which allows you to assign various input device operations to this camera (e.g., frame averaging controls). You can select them now or assign them later (see Chapter 2: Acquiring Images for details). Click [OK] to exit the dialog.
6. The camera is now listed in the Input Device Selection dialog box. Click on the [Configure] button to display the Hamamatsu C4742 Settings dialog box (Figure 11).
7. Press the [Port] button and specify the serial port to which the camera control unit is connected (e.g., COM2).
8. Press [OK] to exit the Settings and return to the Input Device Selection dialog box.
9. Click [OK] to exit the dialog. The camera is now installed in the list of input devices. When you exit the Input Device Selection dialog box, the camera (and all of the settings and operations associated with it) becomes the default input device. MCID Elite will automatically select this camera (and the corresponding display format; e.g., 10 bit mono) each time the program is started.

Figure 9: The Input Device Definition dialog box.

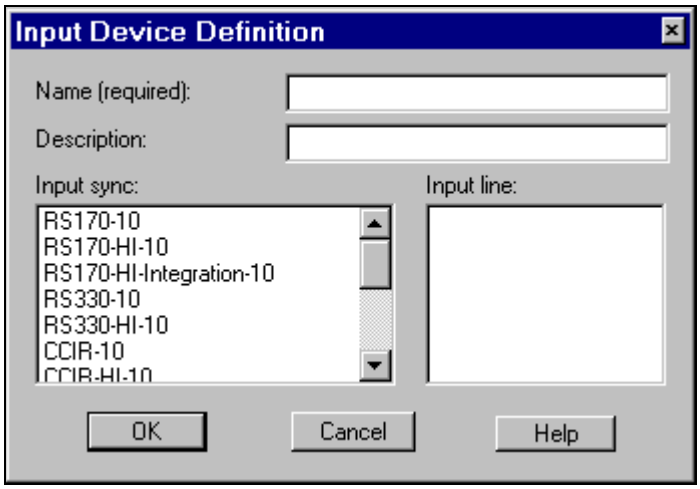
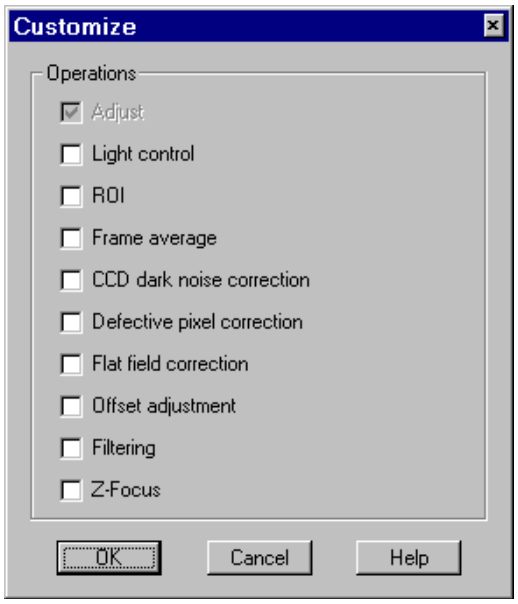


Figure 10: The Customize Input Selection dialog box is used to link controls for various camera operations to the camera.

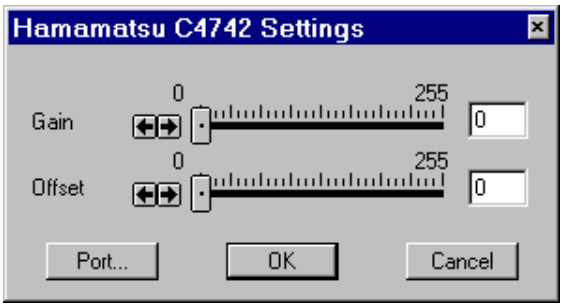


TO INSTALL THE CAMERA AS A BINNED DEVICE:

1. Repeat steps 1 – 4 above.
2. Select "Hamamatsu C4742 2x2" as the Input sync, and enter a different Name and Description in the entry fields (e.g., "Mono2", "C4742 Binned").
3. Repeat steps 6 – 9 above.

The camera is now installed as two separate devices. Select the full resolution camera for work with higher light levels, or the binned camera for low light conditions. Whichever camera is selected when MCID Elite is shut down becomes the default input device.

Figure 11: The Hamamatsu C4742 Settings dialog box.



Acquiring Images

If you have installed the camera as both a full resolution and a binned device, you will have to select the camera that best suits your application. If it is not the default camera, open the Settings menu and select Input select. Select the appropriate camera from the list of input devices. Be certain that the current Settings > Display format is set to 10 bit mono.

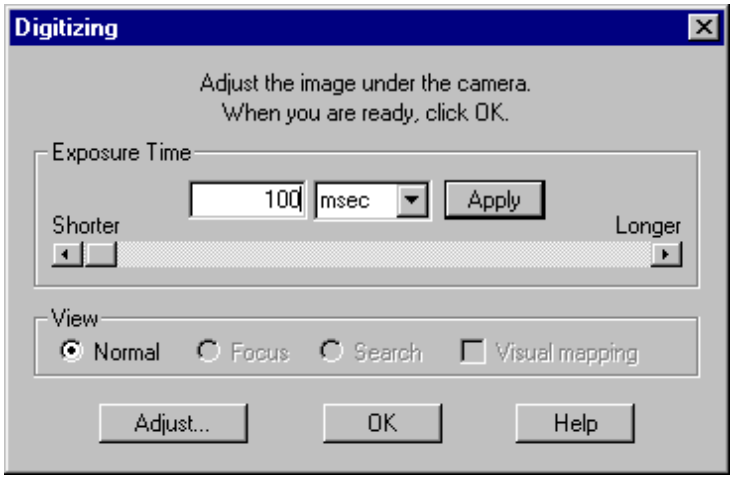
Digitizing



Click the Digitize icon to initiate digitization or press <Ctrl - D>. A dialog box appears to indicate that MCID Elite is digitizing continuously and a live image appears on the image monitor.

Adjust the integration time using the Exposure Time control on the camera control unit and focus the microscope by reference to the image monitor. Do not integrate if the image is bright. Just use a single frame. If the image is less bright, you will have to adjust the integration time. Once everything looks OK, click on [OK] (or press the <Enter> key) to terminate the digitization process.

Figure 12: Clicking the Digitize icon initiates the digitization procedure and displays a dialog box. Move the slider along the Exposure Time bar to control the exposure time.



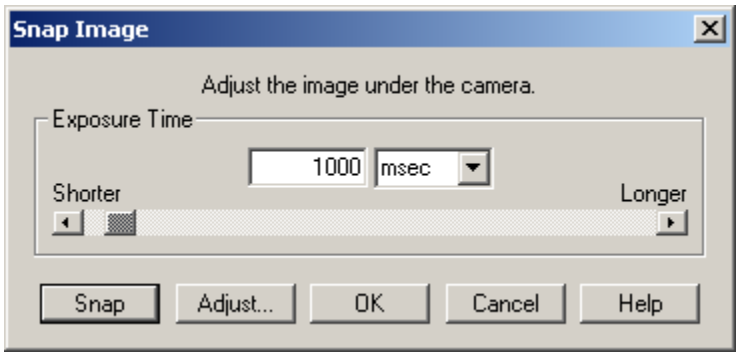
Snap Shots



Press the Snap Shot button to capture an image using a single exposure (i.e., without displaying a continuously 'live' image). The Snap Shot skips the display of the Digitizing dialog box (Figure 13) and simply snaps and captures a new image to the display monitor. This function can be very useful if you are working with dim specimens and you have already chosen the correct exposure time. Clicking the Snap Shot icon will automatically snap a fresh image.

To adjust the exposure time, Ctrl-click on the Snap Shot icon to display the Snap Image dialog box. Move the slider control to increase or decrease the exposure time. Press the [Snap] button to test the exposure.

Figure 13: The Snap Image dialog box.

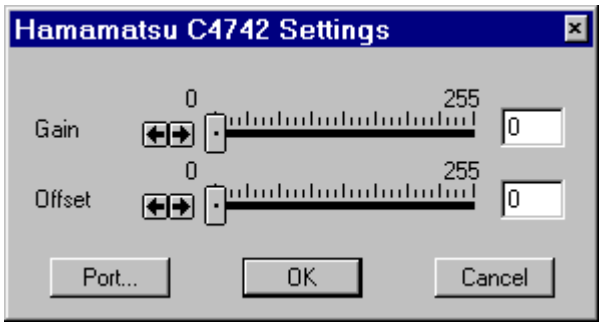


Adjusting the Camera Response

MCID Elite allows digital control over camera gain (the amount of light amplification) and offset (the size of the no-light signal). To access these controls, press the [Adjust] button while digitization is occurring. MCID Elite will display a dialog box for camera adjustment (Figure 14).

Gain and offset should be adjusted to yield optimal camera response with your specimens (i.e., the best image contrast), which is typically arrived at by experimentation. By default, MCID Elite sets both at 0.

Figure 14: The C4742 Settings dialog box.



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