Operational Manager Software User's Guide
for the
ECS-320A
Embeddable Camera Electronics System

(Document Number 700-00000041-R10)

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1 Introduction

This guide has been written to help the user become acquainted with the Operational Manager Software (v2.12) and to some extent the Embeddable Camera Electronics System hardware.

An overview of the system configuration and communications is provided along with software installation instructions. This guide also provides detailed information on using the Operational Manager software to operate the ECS-320A hardware during system operation.

This document has been written with the assumption that the user is knowledgeable about Microsoft Windows OS based applications and the general characteristics of infrared cameras and systems.

2 System Requirements

Although the Operational Manager software will function on various Microsoft Windows platforms it has been designed and tested with Windows XP. The GUI screens and controls have also been tuned for a screen size of 1024 x 768 using the 'small fonts' selection.

Using this OS with the proper screen settings will provide the user with optimum performance and ease of use. Use of this software with Windows 95/98/Me will not be supported by Lumitron.

2.1 Frame Grabber Configuration

The Configuration Manager supports the use of National Instruments (NI) NI-1422 LVDS frame grabber.

Since Lumitron can not distribute the required application extensions, it will be necessary to install the NI software that is shipped with the frame grabber card. Follow the vendor's installation instructions. Once the NI software has been installed it will be necessary to perform some extra tasks to ready the Configuration Manager for use with the frame grabber.

Step 1: Locate the following files in the install directory of the Configuration Manager software.

LG2_240.icd (320x240 Camera Configuration File)

LG2_256.icd (320x256 Camera Configuration File)

LTron_240.iid (320x240 Camera Interface File)

LTron_256.iid (320x256 Camera Interface File)

Step 2: Copy or Move these files into the 'Data' directory of the NI software installation. The default install directory will be "C:\Program Files\National Instruments\NI-IMAQ\Data". This is where other manufacturer standard camera files are located.

Step 3: Next open (run) the NI Measurement and Automation Explorer application.

Step 4: In the Configuration window browse down to the "My System\Devices and Interfaces\IMAQ PCI-1422". Then on the file menu select the 'Open Interface'. Browse to the "LTron_240.iid" file and open it.

Step 5: Go to the file menu again and select 'Open Camera'. Browse to the "LG2_240.icd" and open it.

Step 6: Go to the 'Tools\IMAQ\Max number of buffers' menu and set that value to 300.

Step 7: Close the application.

The above steps can also be done with the 320x256 versions of the files as well. The NI will now be ready to use with the Configuration Manager Software.

3 Communications

Connection to the camera electronics is accomplished via a serial port connection. The desired port on the host side can be configured through the "Communications – COM Port…" menu command.

3.1 Setup

No setup is currently required on the computer side of the connection. All of the settings - baud rate, data size, parity, and stop bits are configured by the software automatically.

Once the physical connection is made and the Operational Manager software is started; the COM port is configured and then polled to determine connection type. If no connection is detected the software goes into terminal mode (paragraph 3.2), else if the camera is booted and operational (with no errors) the software is placed in PC Master Mode (paragraph 3.3).

3.2 Terminal Mode

This is the default communication mode when no connection with the camera is detected. In this mode the software goes into a 'listening' mode waiting for the camera to begin its boot process. During the boot process the camera will output strings to notify the user of current status. This data is viewed on the Bootloader Terminal Output window (paragraph 12.3) and also in the Camera Report Window (paragraph 7.9). Once the camera has completed the boot cycle and started normal operation the communication mode will automatically convert over to PC Master Mode.

Note: At any point during normal operation, if the camera is no longer detected, the software will revert back to Terminal Mode. To return to PC Master Mode, select the Debug Tab-View window and click on the 'Camera Re-Connect' button.

3.3 PC Master Mode

This mode will be used to control the camera during normal operation. While in PC Master Mode commands can be sent to control various camera functions, change settings, and update status. Peripheral and FPGA register values can also be inspected/modified using the Debug Tab-View controls. While in this mode, the embedded camera application is always polling the serial port for commands from the host. The camera can not initiate commands to the host.

PC Master is a packet driven protocol developed by Motorola to assist in the development and debugging of DSP based hardware by monitoring the embedded application in real time. It is included as part of the Software Developers Kit for the DSP56800 family of DSP's. Using this protocol gives the application developer the ability to send user commands, directly read and write to DSP data memory, and directly read and write to DSP peripheral registers. For more information about this protocol see Lumitron document 700-00000040.

4 Operational Manager Software Description

The Operational Manager software application is used to control various aspects of the camera during normal operation. It is assumed that the camera to be controlled has been configured (at factory or by OEM) for a specific focal plane array and calibrated appropriately.

The user will be able to select the configured operational mode, change gain/level control settings, select video and overlay palettes, control symbology overlay, monitor camera status, update embedded application, recalibrate a NUC table, and a host of other camera settings.

Several file paths can be stored to a file (using the Save or Save As command) in the Operational Manager Software. These are the paths to the embedded application file, Xilinx FPGA configuration files, video palette files, and overlay palette files. This allows the user an easier way to update several cameras to the same software revision and palettes.

Most of the data that is used to configure the host application controls are updated directly from the camera. Once the software is in PC Master Mode, the camera's operational settings are transferred to the application and stored locally. Any time there is a change detected in these settings, the host will update the applicable controls.

Along with various configuration settings several status values are also updated regularly. This includes the AGC brightness and contrast values, several internal temperatures, fan speed, and power voltage.

5 Menu Items

5.1 File Menu

5.1.1 New

Command opens a new Operational Manager file window with a default name and values.

5.1.2 Open…

Command opens an existing Operational Manager file, via the standard Windows file dialog, with stored file paths to embedded application and palettes.

5.1.3 Close

Command closes the currently active Operational Manager file. User will be asked to save changes to the file if any have been made.

5.1.4 Save

Command saves the currently active Operational Manager file.

5.1.5 Save As…

Command saves the currently active Operational Manager file to the user specified name/path via the standard Windows file dialog.

5.1.6 Print…

Command prints the current state of the camera to any connected printer. This feature has not been fully implemented.

5.1.7 Print Setup…

Command opens the Windows standard printer setup dialog to allow for printer and printer properties selection.

5.1.8 MRU Files

This area of the menu contains a list of the most recently used (MRU) Operational Manager files. The user can directly open one of these files by selecting it on the menu.

5.1.9 Exit

This command exits the application and closes any opened files. The user will have a chance to save any modified files before exiting.

5.2 View Menu

5.2.1 Toolbar

Shows or hides the icon based toolbar just below the menu items.

5.2.2 Status Bar

Shows or hides the status bar at the bottom of the main window frame.

5.3 Window Menu

Although the Operational Software was developed using a multiple documents interface (MDI), it is not recommended to operate the camera in this fashion. Difficulty connecting to the camera when switching between files can occur. The MDI was used to incorporate other features not available with a single document interface.

5.3.1 Cascade

Cascades all open windows (documents).

5.3.2 Tile

Tiles all open windows within the main frame.

5.3.3 Active Windows

Shows a list of all open windows (documents) and places a check by the active (top-most) file. Other windows can be selected using this menu.

5.4 Communications Menu

5.4.1 COM Port…

Displays a dialog for configuration of the Operational Manager to use either COM1 or COM2 for serial communications.

If the deserializer is enabled and present an additional control will be present that allows the user to select which camera to control via the COM port. This allows the user to monitor each of the attached cameras (up to 4) independently. The default is camera 1.

5.4.2 Enable Framegrabber

Enables the framegrabber check feature. If checked, the application will perform a check on boot to verify that a framegrabber is installed and configured for use. If not checked, then the application will not attempt any hardware check.

Note: When changing the state of the menu item, it will be necessary to restart the application.

5.4.3 Enable Embedded Deserializer

Enables the deserializer check feature. If checked, the application will perform a check on boot to verify that the embedded deserializer is installed and configured for use. If not checked, then the application will not attempt any hardware check. The deserializer is only used for a specific application and customer. Communications is performed through the parallel port. The majority of systems will not need this functionality.

Note: When changing the state of the menu item, it will be necessary to restart the application.

5.5 Help Menu

5.5.1 About OpMgr…

Menu item opens a dialog that displays the current version of the Operational Manager.

5.5.2 OpMgr Help…

Menu item opens a help window for the application.

6 Status Pane

The status pane is located at the bottom of the application frame and contains several items that give the user an indication to the camera's current status.

Messages are displayed in the leftmost portion of the bar. Typically it will display 'Ready'. If a communication error occurs a message will appear here with the corresponding error number. Download status of the Xilinx configuration files and palette files are also displayed in this location.

The status panes are located on the right portion of the bar and are similar to that shown in Figure 1.

Figure 1: Status Bar Panes

6.1 PC Master Baud Rate

The first pane (leftmost) contains the detected PC Master baud rate. The camera has a fixed baud rate that was configured by the OEM/factory. This rate is set shortly after execution has transferred from the bootloader to the embedded application.

6.2 Video Format

The next pane contains the configured video format of camera electronics. Typically this will be NTSC, PAL or NONE for digital only applications.

6.3 Camera Software Version

The third pane will show the current loaded embedded software version. Typically major changes (look/feel/functionality) to the embedded code will result in version increments.

6.4 Camera Software Build

The fourth pane will show the current loaded embedded software build. Increments in software builds can occur without the version changing. Typically minor changes to the embedded code will result in build increments.

6.5 Xilinx FPGA Configuration File Version

The fifth pane contains the Xilinx configuration file version stored in the serial flash.

6.6 Connection Type

The last pane indicates the serial communications mode as Terminal or PC Master.

7 Main Tab-View

The main tab view shown in Figure 2 contains controls that alter the general operation.

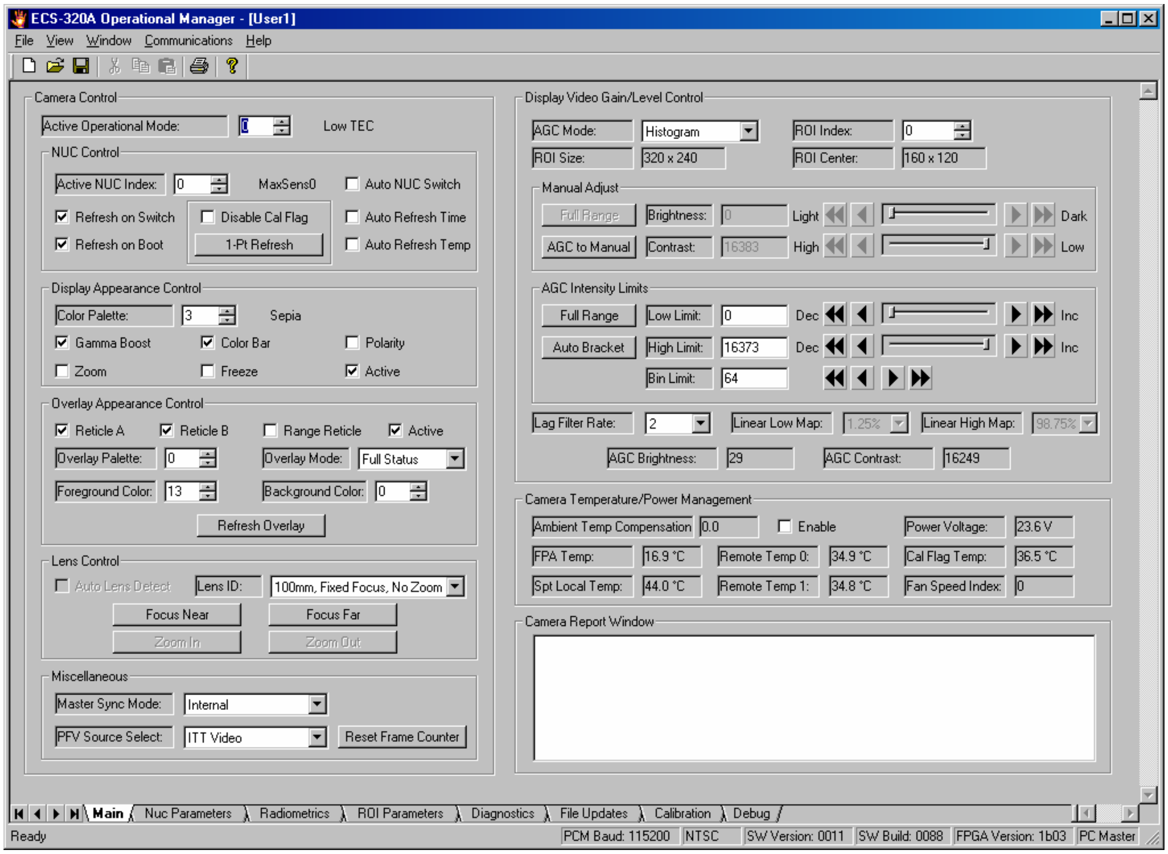

Figure 2: Main Tab-View Dialog

7.1 Operational Mode

The camera will be delivered with a predetermined number of operational modes. This control (Figure 3) gives the user the ability to select the active mode. The name of the mode which is stored in flash is displayed to the right of the index.

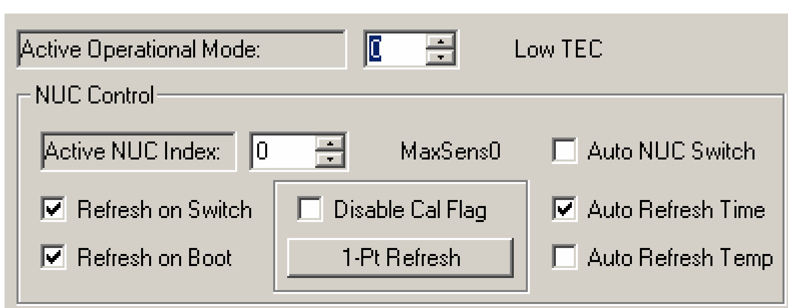

Figure 3: Operational Mode and NUC Controls

7.2 NUC Control

Within each operational mode will typically be a range of non-uniformity correction (NUC) tables stored in the camera. Using the spinner control the user can select the active NUC table. The base index is set to 0 for each available configured operational mode. The name of the NUC table which is stored in flash is displayed to the right of the index. Each of the settings in this group is stored in nonvolatile RAM and will be restored on boot.

Selecting 'Auto NUC Switch' will inform the camera to automatically increment/decrement the NUC index based on current scene information. See paragraph 8.1 for information on how to set up the values used to determine the change. Clearing the check box disables this feature.

Selecting 'Refresh on Boot' will force the camera to do a 1-point refresh calibration during the boot process. Clearing the check box disables this feature.

Selecting 'Auto Refresh Temp' will inform the camera to perform a 1-point calibration when the internal temperature changes a specified amount from the temperature measured at the last refresh. This value is user defined and can be set in the NUC Parameters Tab-view (paragraph 8.2). Clearing the check box disables this feature.

Selecting 'Auto Refresh Time' will place the camera in a mode that 1-point refresh calibrations are performed at specified intervals. This value is user defined and can be set in the NUC Parameters Tab-view (paragraph 8.2). Clearing the check box disables this feature.

Selecting 'Refresh on Switch' will force the camera to perform a 1-point calibration upon detecting a NUC table switch. Clearing the check box disables this feature.

Clicking on the '1-Pt Refresh' button immediately performs the calibration. If the camera has not been configured with an internal calibration flag the camera will respond with a message and will wait until one is in place.

Any 1-point refresh calibration resets time counters and temperature readings.

7.3 Display Appearance Control

The controls shown in Figure 4 affect the appearance of the display video.

Figure 4: Display Appearance Controls

The camera has room to store up to 16 video palettes. The first two are reserved for monochrome palettes. The palettes are user defined and stored in a YCrCb format with an additional Y' component for gamma boost. Most of the settings in this group are stored in nonvolatile RAM and will be restored on boot. Those that are not are noted below.

Using the spinner control, the user can select the desired video palette. The palette mnemonic is displayed to the right of the index.

Selecting the 'Gamma Boost' check box enables the Y' component of the palette to be displayed. The Y' value is stored in flash along with the other palette components. No run time computations are performed. Clearing the check box disables this feature.

Selecting the 'Zoom' check box places the camera in a digital zoom mode. This mode takes the center 160 x 120(128) FPA pixels and duplicates them to create a 320 x 240(256) image for simulated zoom. Clearing the check box disables this feature. This setting is not saved in nonvolatile RAM.

Selecting the 'Color Bar' check box enables the on-screen display of a color bar that displays each color in the palette. The color bar is located near the top of the display screen. Clearing the check box disables this feature.

Selecting the 'Freeze' check box will freeze the current image on the display screen. The image will remain frozen until the check box is deselected. This setting is not saved in nonvolatile RAM.

Selecting the 'Polarity' check box will invert the mapping of the video palette. Under normal operation color number 0 is mapped to the low end count values and color 255 is mapped to the high end count values. Clearing the check box disables this feature.

Selecting the 'Active' check box enables the display video. This feature is automatically enabled if the camera video format is either NTSC or PAL. Clearing the check box will disable the display video output. This setting is not saved in nonvolatile RAM.

7.4 Overlay Appearance Control

The controls shown in control the appearance and functionality of the overlay symbology. Most of the settings in this group are stored in nonvolatile RAM and will be restored on boot. Those that are not are noted below.

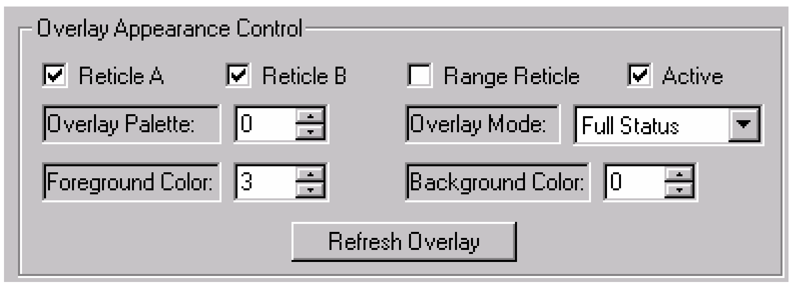

Figure 5: Overlay Appearance Controls

Selecting either 'Reticle A' or 'Reticle B' will enable the overlay reticle(s) on the screen. The reticle will be enabled in the location that is currently stored in nonvolatile memory. The location of the reticle can be modified with the controls on the Radiometrics Tab-View window. Clearing the check box disables the reticle.

Selecting the 'Range Reticle' checkbox will enable a ranging reticle on the overlay if the user lens setting matches a 100mm lens. The reticle has yet to be verified against requirements and is listed here only for information.

Selecting the 'Active' check box enables the overlay symbology. This feature is automatically enabled if the camera video format is either NTSC or PAL. Clearing the check box will disable the overlay symbology. This setting is not saved in nonvolatile RAM.

Using the 'Overlay Palette' spinner control, the user can select the desired overlay palette. There can be up to eight overlay palettes stored in the camera. These palettes are made up of 15 colors plus one for transparent (index zero). Color index 14 and 15 can be used for text colors but have been computed specifically for reticle overlay. The reticles are painted on the screen using the colors at these indexes.

Using the 'Foreground Color' and 'Background Color' spinner controls, the user can select the desired overlay color scheme for objects. Note that index 0 is reserved for transparent. Also if only blocks appear on the screen where text is expected - verify the foreground and background colors are not set to the same value.

7.5 Lens Control

Currently the Operational Manager can only control the focus of the Lumitron fixed focus lens cameras. These cameras have a motor internal to the camera housing which adjust the focal length.

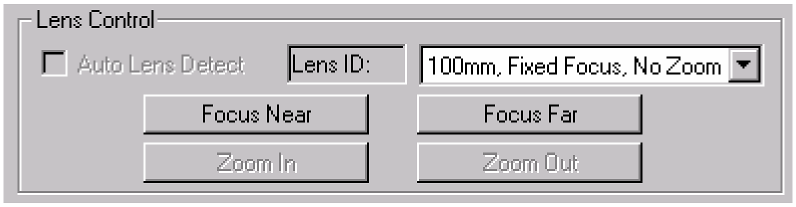

Figure 6: Lens Controls

The 'Lens ID' control provides the user with a means of telling the camera software which lens is installed. This setting may also enable/disable other controls for the OpMgr.

Clicking on the focus near button will send a command to the camera to pulse the motor for 200 ms duration in the near direction.

Clicking on the focus far button will send a command to the camera to pulse the motor for 200 ms duration in the far direction.

7.6 Display Video Gain/Level Control

The controls in this group are used to adjust the appearance of the real time analog display output.

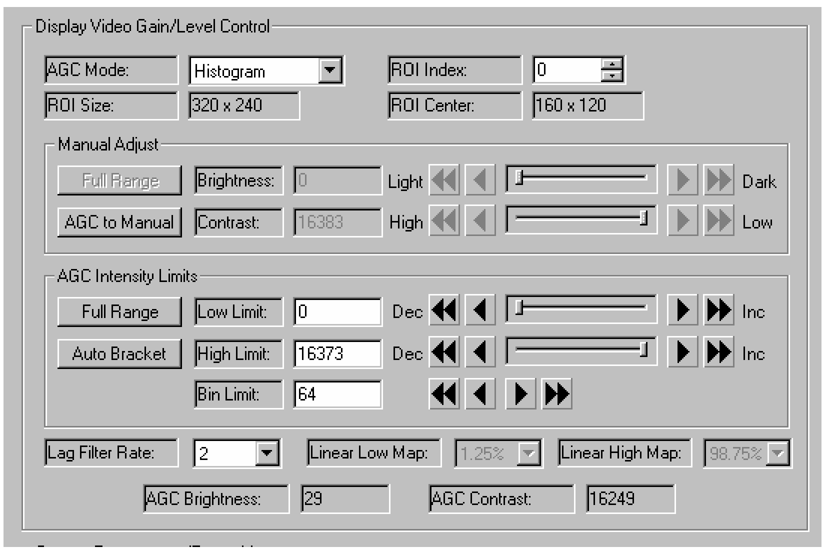

Figure 7: Display Video Gain and Level Controls

Located on the top left of Figure 7 is the current Automatic Gain Control (AGC) mode. There are four possible settings: Off, Manual Adjust, Linear, and Histogram. This setting determines how the camera will compute the intensity transform table (ITT). This table associates the pixel count value (0 – 16383) with a corresponding output color (0 – 255: actual color based on selected palette).

- Selecting mode "Off" bypasses the embedded applications AGC algorithm, and will not perform an update to the ITT.
- Selecting "Manual Adjust" mode enables the controls listed in paragraph 7.6.1. The ITT will be computed based on the user defined brightness and contrast values.
- Selecting "Linear" mode enables the controls listed in paragraph 7.6.2. The ITT will be computed using the embedded applications linear AGC/ALC algorithm with limits set by the user.
- Selecting "Histogram" mode enables the controls listed in paragraph 7.6.2. The ITT will be computed using the embedded applications histogram AGC/ALC algorithm with limits set by the user.

Just to the right of the AGC mode control is the Region of Interest (ROI) control. Each operational mode can have up to eight different ROI's preprogrammed during production. The ROI settings are used as the "window" for the AGC algorithms. Select the spinner control to increment or decrement the current ROI index. As the index is changed the active ROI size and center will be displayed on the lines just below the index. ROI index 0 is programmed for the full frame size.

At the bottom of the Display Video Gain and Level Controls window are the current AGC brightness and contrast values. These values represent the results of the AGC algorithms and the user supplied constraints.

7.6.1 Manual Adjust

The manual adjust controls are enabled when that mode is selected by the AGC mode control.

The brightness and contrast values are related in that the sum of the two values can not exceed 16383. The brightness value represents the low intensity in which all pixel values less than or equal to that value are mapped to the zero color (low end). The contrast value represents the delta between the low point and the high point, with a minimum setting of 255. This will be the range of intensities that the colors will be linearly 'spread' across.

There are several ways to adjust either the brightness or contrast settings:

- Directly type (enter) the desired value. Press the <TAB> key after entering data.
- Adjust the slider control to desired location.
- Click on one of the decrement buttons (x1 or x10).
- Click on one of the increment buttons (x1 or x10).

To reset the values to the full scale range (brightness = 0, contrast = 16383), click on the "Full Range" button.

To copy over the current brightness and contrast values for the active AGC algorithm, click on the "AGC to Manual". This will provide a starting point for fine adjustment applications in manual mode.

7.6.2 AGC Intensity Limits

The AGC Intensity Limits controls are enabled when either linear or histogram mode is selected.

The low and high limit values are related in that the delta between the high and low limits must be a minimum of 255. The low limit value represents the low intensity in which the algorithm will begin its computations. Typically this will force pixel intensities less than or equal to that value to color '0'. The high limit value represents the top end intensity. Typically this will force pixel intensities greater than or equal to that value to color '255'.

There are several ways to adjust either the AGC low or high limit settings:

- Directly type (enter) the desired value. Press the <TAB> key after entering data.
- Adjust the slider control to desired location.
- Click on one of the decrement buttons (x1 or x10).
- Click on one of the increment buttons (x1 or x10).

To reset the values to the full scale range (low limit = 0, high limit = 16383), click on the "Full Range" button.

The "Auto Bracket" button provides an efficient means of optimizing these limits by presetting the limits based on current scene information. When clicked the low limit is set to 95% of the current brightness, and the high limit is set to 105% of the sum of the current brightness plus the current contrast.

The bin limit value sets a maximum value for the number of pixel intensities that can be placed in each "bin" when computing histogram data. Thus adjusting the resulting color spread for the scene data.

7.6.3 AGC Characteristics

There are three additional combo box controls that can change the way the AGC routine operates.

The first is the 'Lag Filter Rate' index. There are 4 possible settings for this control. An increase in index value from 'Slow' to 'Fast' alters the rate of change in the AGC process. This setting is valid for both the linear and histogram algorithms.

The other two combo box controls are enabled only when the linear AGC mode is selected. These controls map the desired number of valid pixels that are to be included when computing the linear intensity transform table.

7.7 Camera Temperature/Power Management

The ECS-320A electronics monitors several temperatures/voltages during normal operation. These status indicators are the result of ADC inputs to the DSP. The Operational Manager Software polls the ADC results and converts those values to corresponding voltages and temperatures.

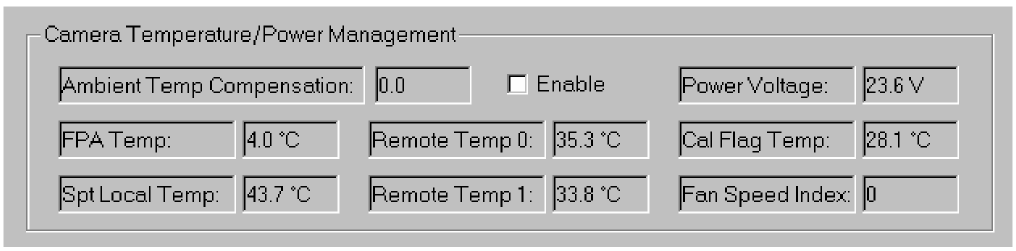

Figure 8: Camera Temperature & Power Management

These reported values are dependent upon FPA type and specific hardware configurations.

At the top of the group are the Ambient Temperature Compensation (ATC) and an associated enable check box. If enabled, the ATC value is added to each pixel value after the NUC coefficients have been applied. Typically this value is computed by the embedded application in an algorithm supplied by the OEM customer.

At the bottom of Figure 8 is the fan speed index. On the typical Lumitron assembly configuration there is a fan located near the rear of the assembly. The speed (power) of the fan is controlled via the DSP's pulse width modulator. The speed settings (duty cycle) are indexed from 0 (off) through 4 (full speed). Depending upon the internal temperature of the camera the fan speed is increased or decreased (to save power).

7.8 Miscellaneous Controls

Several additional controls are located in the miscellaneous controls group shown below in Figure 9.

Figure 9: Miscellaneous Camera Controls

The Master Sync Mode control allows the user to set the sync mode. Valid selections are internal and external (field toggle or field coherent).

The PFV Source Select control allows the user to select the format of the processed FPA video on the digital output port. Valid selections are: digital FPA video, NUC corrected video, pixel replaced video, and ITT video.

The user can click on the "Reset PFV Frame Counter" button to reset the frame count that is output in the instrumentation header data (via digital output port).

7.9 Camera Report Window

The camera report window is shown below in Figure 10. This area is used by the Operational Manager software to display camera software status as it steps through the boot process.

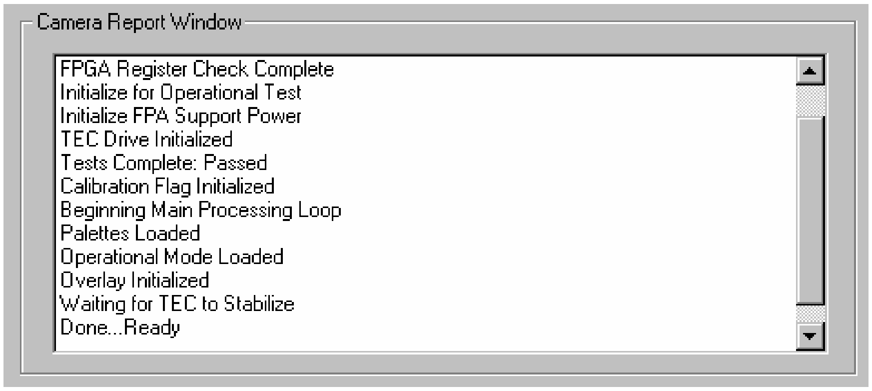

Figure 10: Camera Report Window

For information to be displayed about the boot process it is necessary for the Operational Manager to be running before power to the camera is supplied. As the camera boots, the Operational Manager polls the progress variables in the embedded application. As each of the steps is completed in the camera, the Operational Manager will output a string to the report window indicating its completion.

Note: The Operational Manager does not poll fast enough to provide real time status for this display. Therefore several of the steps may be output in a single pass.

8 NUC Parameters Tab-View

The NUC parameters tab view shown in Figure 11 has several controls that alter the automatic NUC table switching and automatic 1-point NUC refresh calibrations.

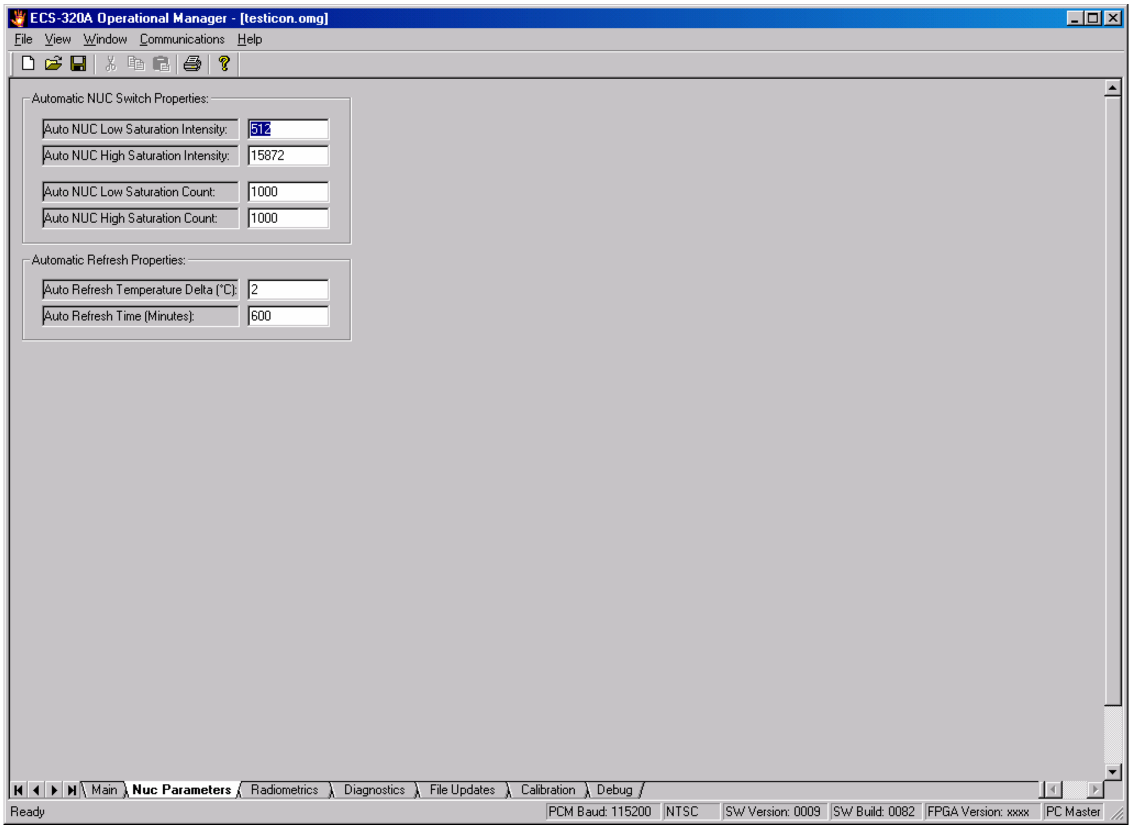

Figure 11: NUC Parameters Tab-View Dialog

8.1 Automatic NUC Switch Properties

The settings shown below in Figure 12 control the behavior of the automatic NUC switching feature.

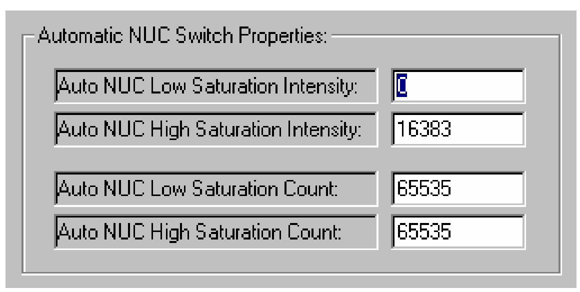

Figure 12: Automatic NUC Switch Settings

If the feature is enabled (see paragraph 7.2), and the proper condition is met, the NUC table may be incremented or decremented, for example to a NUC table with a smaller integration time.

The low saturation intensity values represents user defined low saturation point. All pixels less than or equal to this value would be counted.

The high saturation intensity values represents user defined high saturation point. All pixels greater than or equal to this value would be counted.

The low saturation count represents the user defined number of pixels required for the image to be considered in "low saturation".

The high saturation count represents the user defined number of pixels required for the image to be considered in "high saturation".

The NUC table index will decrement under the following conditions:

- Feature is enabled.
- Number of pixels at or below low saturation point is greater than or equal to low saturation count setting.
- Not currently at lowest NUC index.

The NUC table index will increment under the following conditions:

- Feature is enabled.
- Number of pixels at or above high saturation point is greater than or equal to high saturation count setting.
- Not currently at highest NUC index.

Note: Proper calibrations across the range of NUC tables, as well as optimized settings are required for this feature to operate as indicated. Increment/decrement of the current NUC table index to the next index should provide stable imagery to prevent "pinging" back and forth across tables.

8.2 Automatic Refresh Properties

The settings shown below in Figure 13 are used by the embedded application to determine when to perform automatic 1-point refresh calibrations.

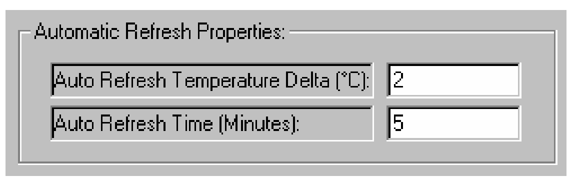

Figure 13: Automatic Refresh Settings

The user can set the desired temperature delta in the top box. If the feature is enabled (paragraph 7.2) and the camera embedded application detects a delta greater than or equal to the supplied value, a 1-point refresh flag is set. Then at the next available opportunity the refresh will be executed.

The user can also set the time interval between refreshes in the lower box. If the feature is enabled (paragraph 7.2) and the camera embedded application time interval expires, a 1-point refresh flag is set. Then at the next available opportunity the refresh will be executed.

Note: Any 1-point refresh calibration (manual or automatic) will reset/reinitialize the time interval count and the baseline temperature value.

9 Radiometrics Tab-View

The radiometric parameters tab view shown in Figure 14 has several controls that permit the user to locate each of the two reticles, modify the reticle size, and adjust various radiometric settings.

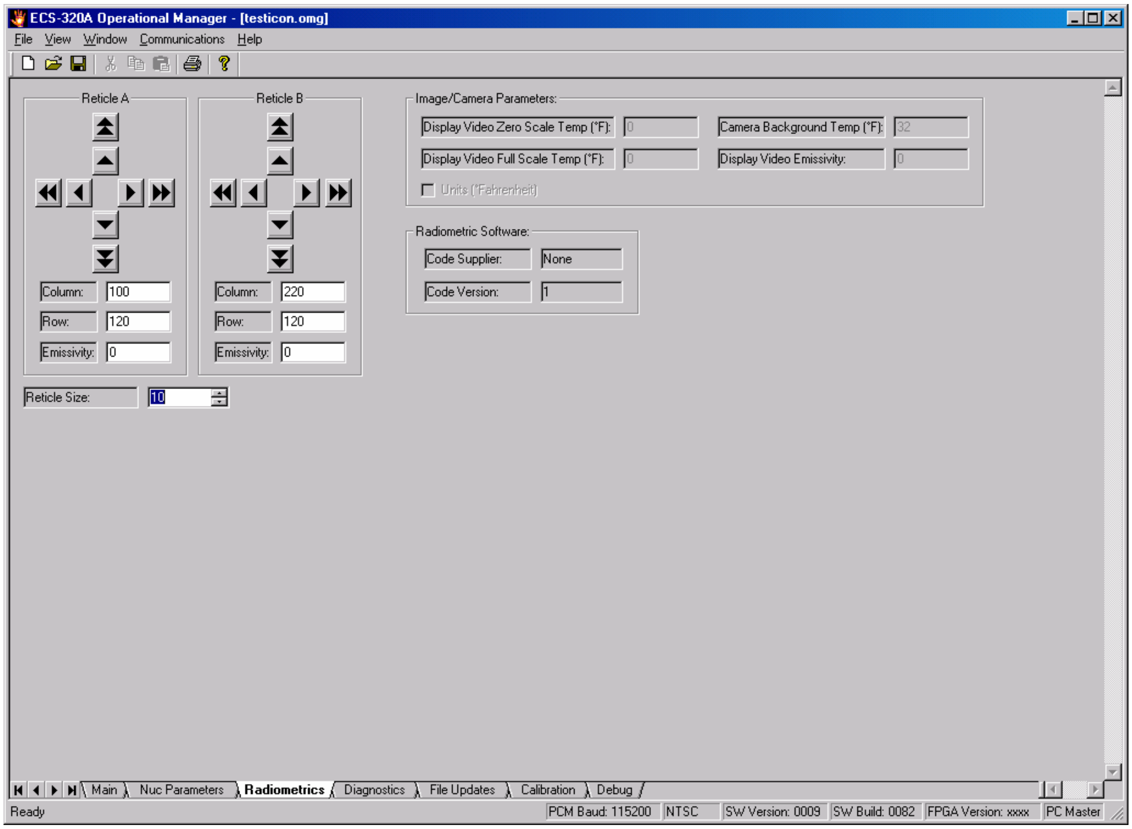

Figure 14: Radiometrics Tab-View Dialog

9.1 Reticle Control

There are two available reticles that can be placed on the video overlay. The controls to adjust the location of the reticle are shown in Figure 15.

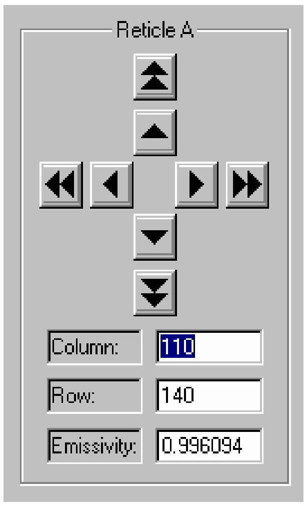

Figure 15: Reticle Controls

Each reticle has its own adjustment controls. The current row and column setting is listed in the associated text field. The current emissivity of the reticle is also displayed in its own text field.

Click one of the buttons to move the reticle in the desired direction. The single arrow buttons move the reticle one pixel position. The double arrow buttons move the reticle ten pixel positions.

To adjust the emissivity of the reticle, enter a desired value, and the will camera convert it to an actual value. The storage for this value is only byte wide so the values range from 0 to $1 - 2^{-8}$. The emissivity is only used if on board radiometric software is present.

Notes:

- There is a slight delay for the Operational Manager to output the command, embedded application to process the update, and then for the Operational Manager to acknowledge the change.
- Direct text entry of the reticle position is planned but not currently implemented.

9.2 Reticle Size

The reticle size (radius) control is shown below in Figure 16. It is common to both reticles and has a range of 1 – 15.

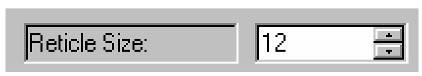

Figure 16: Reticle Size

Click on the spinner control to adjust the size up or down or type the value and hit the <TAB> key to set the value directly.

9.3 Image/Camera Parameters

The image and camera parameter controls shown below in Figure 17. These controls are only enabled if the embedded application contains the proper radiometric functionality.

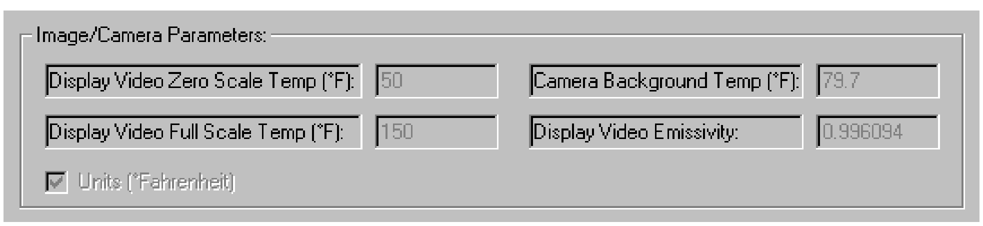

Figure 17: Image & Camera Parameter Settings

Each of the values that can be adjusted in this group only applies to certain embedded radiometric routines.

To adjust either of the video scale temperatures, type in the desired value and then press the <TAB> key. Storage for these values is at this time a 16-bit integer value. Therefore the current range is limited to -32786 – 32767. It is planned for this value to have some decimal precision but it has not yet been decided to what extent and thus has not been implemented.

To adjust the camera background temperature, type in the desired value and then press the <TAB> key. Storage of this value is currently an 8-bit value stored as degrees Celsius. The most significant bit contains the sign and the least significant bit contains the fractional part (0.5). Once the desired value is entered an update to the field will be made that corresponds to the closest actual value.

To adjust the display video emissivity setting, type in the desired value and then press the <TAB> key. Storage for this value is 8 bits all of which are used to create a fractional value less than 1. Therefore the possible values range from 0 to $1 - 2^{-8}$.

The “units” check box will be used by the embedded application to determine the reticle display units of the overlay symbology.

9.4 Radiometric Software

The status controls shown below in Figure 18, provide the user with information about enabled radiometric software in the embedded camera application.

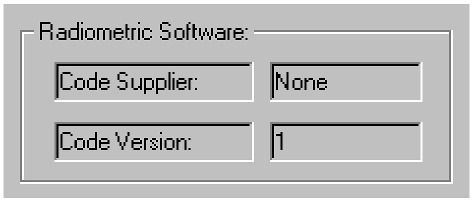

Figure 18: Radiometric Software Status

The code supplier block contains the name of the company that provided the radiometric algorithms. The value is “none” if no radiometric software is detected.

The code version is the internal code version for the supplier.

10 ROI Parameters Tab-View

The ROI (region of interest) parameters tab view shown in Figure 19 provides controls to permit the user to configure the ROI settings for the active operational mode.

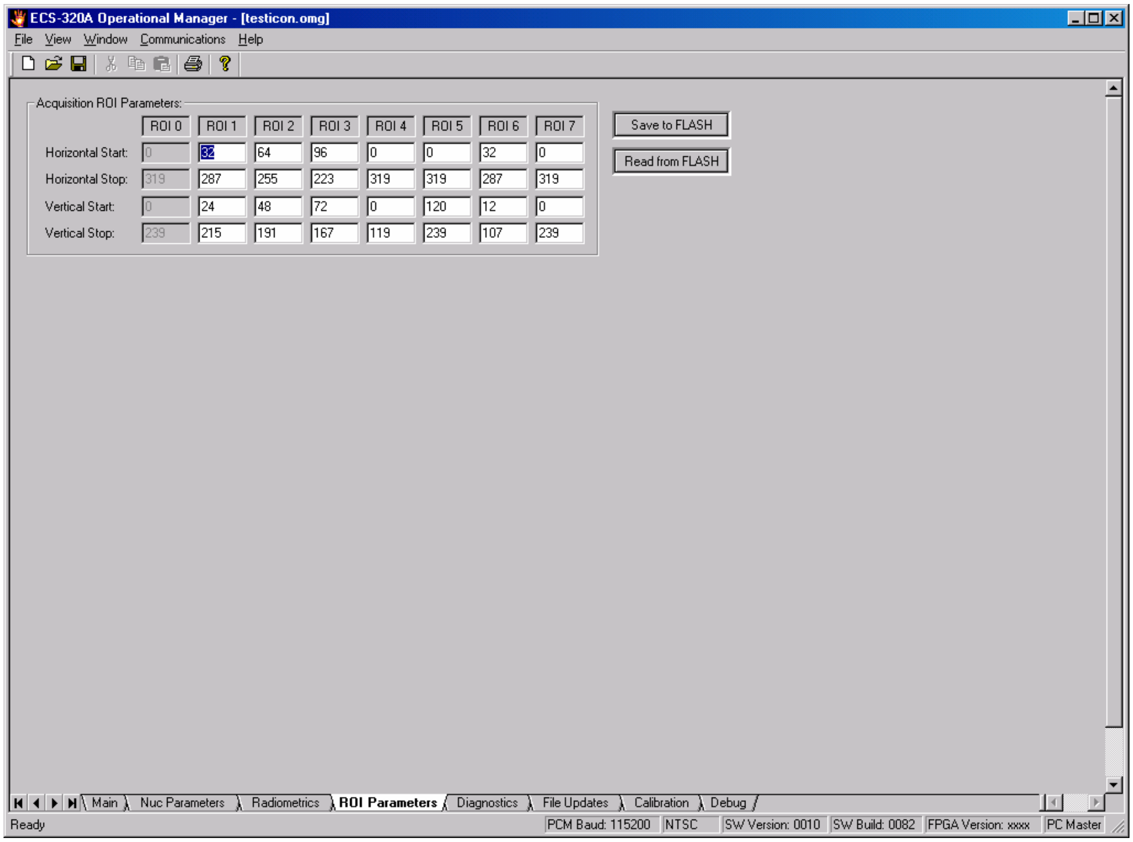

Figure 19: ROI Parameters Tab-View Dialog

10.1 Acquisition ROI Parameter Configuration

The edit fields below in Figure 20 are used to configure multiple regions of interest zones for an operational mode. Each mode can have up to eight different regions of interest with the only exception being that ROI 0 is reserved for full frame only.

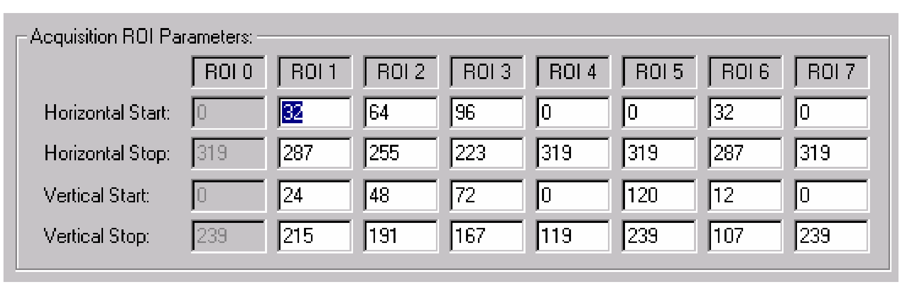

Figure 20: ROI Parameter Entry Controls

The 'Horizontal Start' value controls the horizontal starting position of the image/histo-grab memory ROI.

The 'Horizontal Stop' value controls the horizontal stop (end) position of the image/histo-grab memory ROI.

The 'Vertical Start' value controls the vertical starting position of the image/histo-grab memory ROI.

The 'Vertical Stop' value controls the vertical stop (end) position of the image/histo-grab memory ROI.

10.2 Flash Controls

The buttons shown below in Figure 21 are used to save and retrieve the operational mode ROI data.

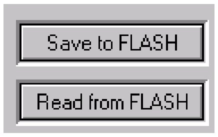

Figure 21: ROI Update Controls

Clicking on the 'Read from FLASH' button reads the settings from the camera and stores them in the local copy.

Once the user has updated the fields to the desired value, it can be saved to the camera by clicking on the 'Save to FLASH' button. This will save the GUI values to the active mode table.

11 Diagnostics Tab-View

The diagnostics tab view dialog shown in Figure 22 below contains several status controls and test controls to establish the overall operational status of the camera embedded electronics.

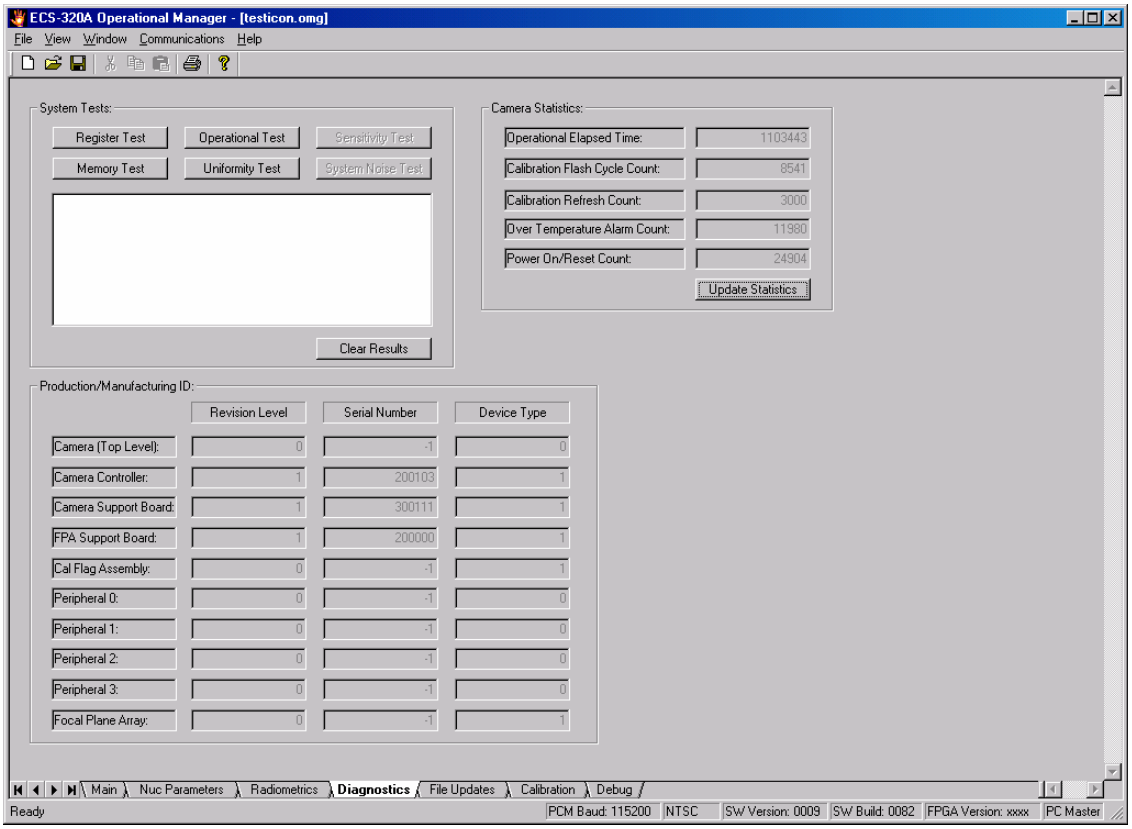

Figure 22: Diagnostics Tab-View Dialog

11.1 System Tests

The embedded application has several built-in tests (BIT) that provide the user with an indication of the operational status of the camera. These controls are shown in Figure 23: System Tests Controls below.

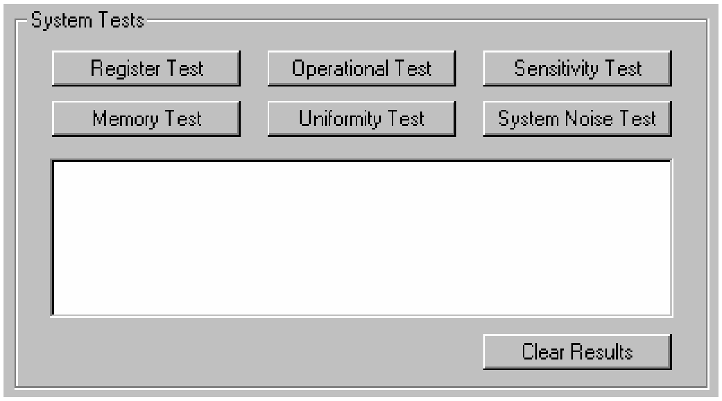

Figure 23: System Tests Controls

The system tests group provides a means to initiate particular tests remotely and monitor the results in the status window. If a failure is detected, the current test will break out of its loop and the additional tests will continue if present.

Click on the "Register Test" button to begin a test of the Xilinx FPGA registers. These tests consist of walking 0/1 and crosstalk checks.

Click on the "Memory Test" button to start a test of FPGA and utility memory. The test of each block will be accomplished by writing a ramp count to the entire block and then verifying the contents by reading each location and comparing it to its expected value.

Click on the "Operational Test" button to commence with an overall test of the system components. The data flow from the FPA through the NUC processor is verified. The tests include: force 1, force 0, force count, force count coadd, histogram count, and NUC gain and offset.

The uniformity test is still undergoing revision.

The sensitivity and system noise tests have yet to be implemented.

Click on the "Clear Results" button to clear existing text from the results window.

11.2 Camera Statistics

The embedded application records various system level statistics during normal operation. These values are displayed in the camera statistics controls shown below in Figure 24.

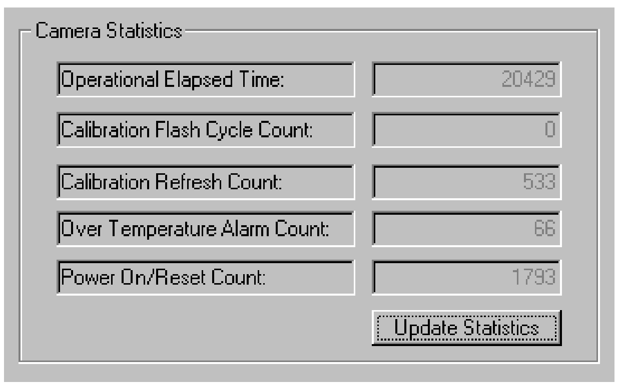

Figure 24: Camera Statistics

These values are read once by the Operational Manager on PC Master connect. To update to the current values click on the "Update Statistics" button.

The operational elapsed time shows the amount of time, in minutes, the camera has been in operational mode.

The calibration flash cycle count contains the number of times the flash has been cycled (erased and subsequently written). The number increments on 2-point and 1-point calibrations and execution of pixel defect detection.

The calibration refresh count indicates the number of times a 1-point refresh calibration has been performed.

The over-temperature alarm count specifies the count of over-temp conditions that have been detected by the embedded application.

The power on/reset count displays the number of times the camera electronics have had a power cycle or reset.

11.3 Production/Manufacturing ID

Production and manufacturing information is fixed into the embedded electronics flash during the manufacturing phase. This information is read once the connected is established and displayed in the status boxes shown below in Figure 25.

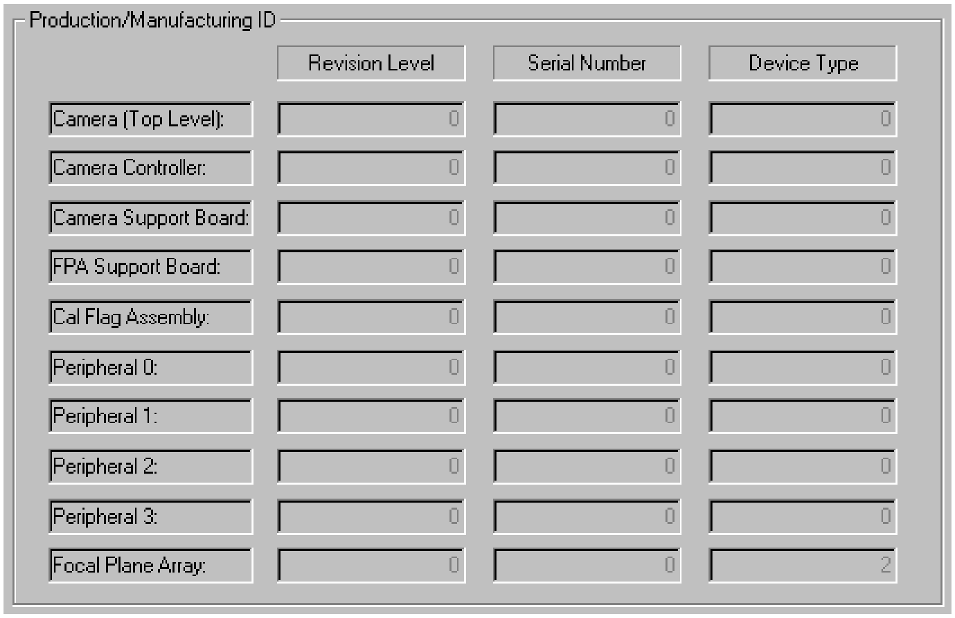

Figure 25: Production & Manufacturing ID Codes

Hardware component revisions, serial numbers, and types are listed in these text fields and can be used when communicating issues back to the OEM or supplier.

12 File Updates Tab-View

The file updates tab view shown in Figure 26 below, provides the user the capability of updating the embedded application, FPGA configuration file, and video palettes.

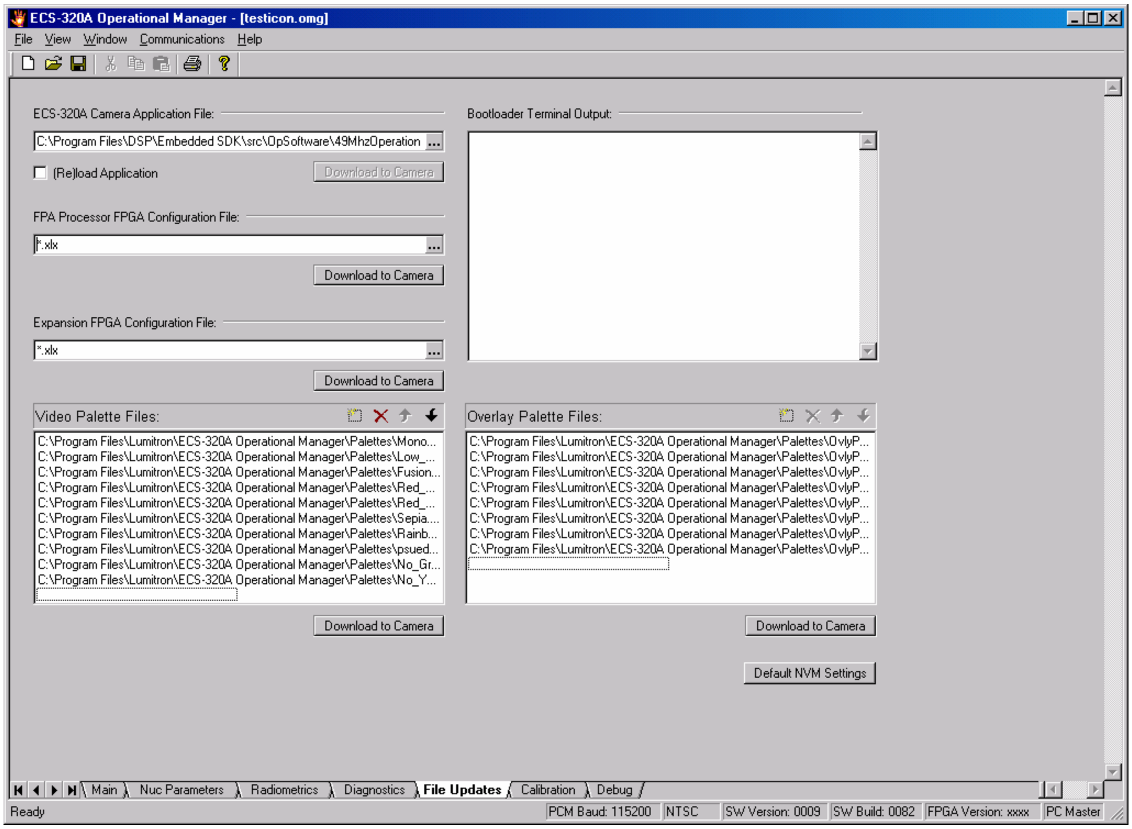

Figure 26: File Updates Tab-View Dialog

12.1 Camera Application File

The Operational Manager software provides a method for updating the embedded application. The first step would be to select the file (*.elf.S) to be downloaded. This control is shown in Figure 27.

This file, obtained from Lumitron, is an output file from the Metrowerks CodeWarrior for Motorola DSP56800 development application. Once the desired file has been selected the user can check the "(Re)Load Application" check-box. This tells the Operational Manager to load the file locally and then wait for the download trigger. The download is initiated with a power cycle of the camera electronics (make sure the communication mode changes to 'Terminal').

Once the Operational Manager recognizes the bootloader is awaiting an download, the transfer will begin. Status of the transfer process is displayed in the bootloader output window (Figure 28).

The automatic "Download to Camera" button is disabled and has not been implemented.

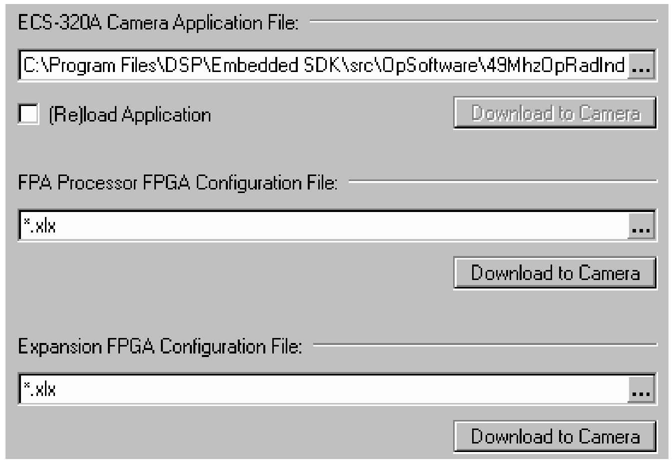

Figure 27: Application and FPGA File Controls

12.2 Xilinx Configuration File(s)

The FPA Processor Xilinx FPGA configuration file can be upgraded using the Operational Manager Software. Using the file browser control (Figure 27), locate the desired file. Then click the "Download to Camera" button. Since this download uses the embedded application instead of the bootloader, the download status is displayed on the far left of the status pane.

Currently the expansion FPGA configuration file is not used, although the upgrade capability is functional.

12.3 Bootloader Terminal Output

When the embedded application resets (power cycle) the code execution begins with a small application in the DSP boot flash. This executable outputs some start up status information as well as serves for the download of the main executable. This output is shown in the bootloader terminal output window shown below (Figure 28).

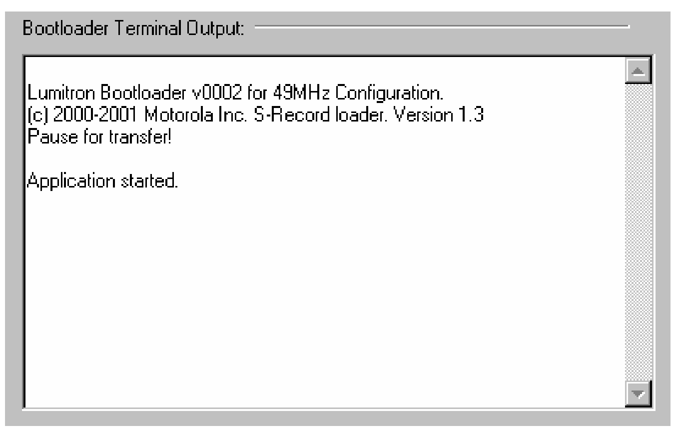

Figure 28: Bootloader Terminal Output Window

If no output is displayed in this window during reset confirm that the proper COM port has been selected for the Operational Manager (paragraph 5.4).

12.4 Video Palette Files

The embedded application has storage for up to 16 video palettes. The palettes can be loaded via the controls shown below in Figure 29.

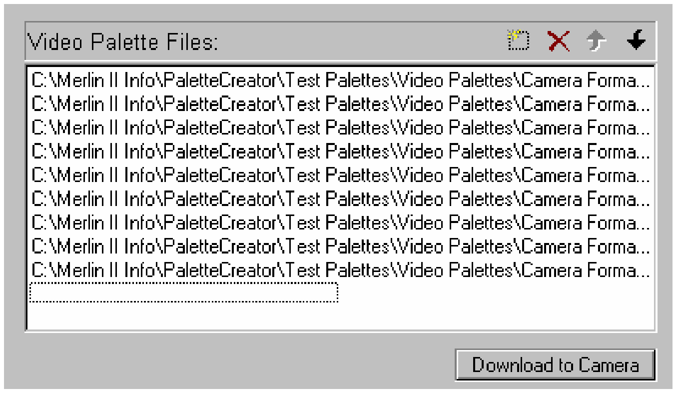

Figure 29: Video Palette Update Controls

To select a file locally click on the icon or double click on the next open line. A control will appear to the right of the open line. Click on that icon to open a standard file dialog and browse to the desired file. Select "Open" and the filename (full path) will be placed in the window.

As the desired files are loaded locally into the video palette file window, the user can adjust the index or position of the files. Using the move up () or move down () controls, the palette file's position can be modified. This position will directly correlate to the video palette selection on the main tab-view dialog (paragraph 7.3). A file can also be deleted from the list using the control.

Click on the "Download to Camera" button once all the files have been loaded into the palette control window. This will download all of the palettes to serial flash. The status of the download will be displayed in the far left portion of the status pane.

Note: All palettes are loaded in a single pass; therefore it is not possible to append a single palette to camera storage.

12.5 Overlay Palette Files

The embedded application has storage for up to 8 overlay palettes. The palettes can be loaded via the controls shown below in Figure 30.

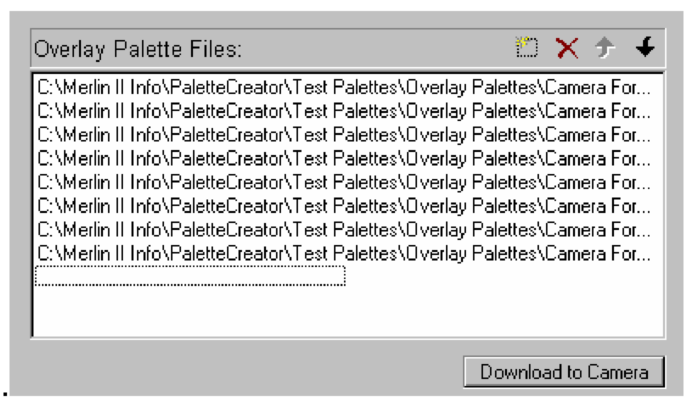

Figure 30: Overlay Palette Update Controls

The loading process is identical to that listed for video palettes; refer to paragraph 12.4 for information on loading palettes.

13 Calibration Tab-View

The controls in the calibration tab view (shown in Figure 31) provide a means of adjusting FPA settings to desired levels before performing calibrations. If the host computer has either an Arvoo Picasso LVDS or National Instruments NI-1422 LVDS framegrabber installed, then digital data can also be monitored to assist with the FPA setup.

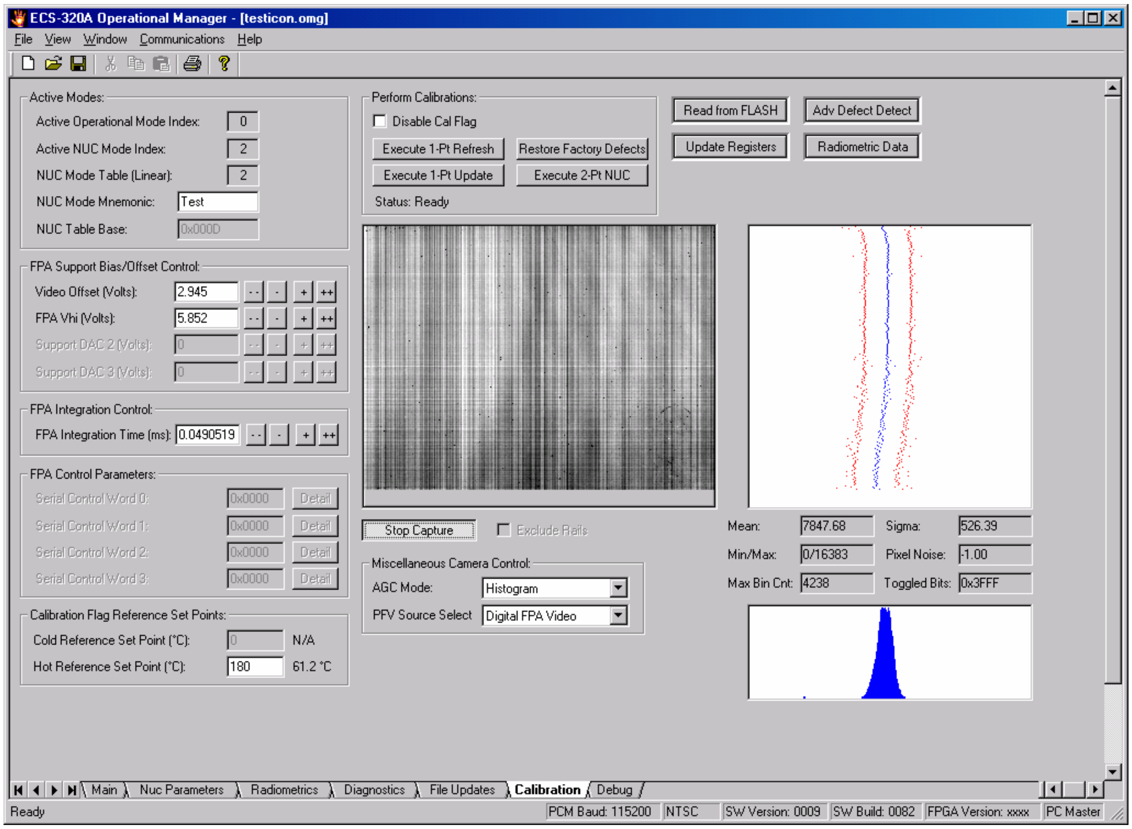

Figure 31: Calibration Tab-View Dialog

13.1 NUC Index

The NUC index field shown in Figure 32 displays the corresponding linear or flat index that corresponds to the active camera's NUC mode shown in the main tab-view.

Calibrations performed while in this dialog are saved to the location that corresponds to the camera's active mode.

13.2 Miscellaneous NUC Configuration

The miscellaneous NUC table controls are shown in Figure 32.

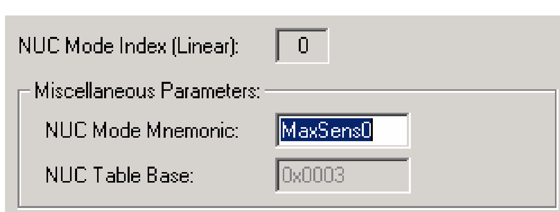

Figure 32: NUC Index and Miscellaneous Controls

Each configured NUC mode should have a name associated with the table. The mnemonic will be stored along with the mode data and can be retrieved by the host or embedded application during normal operation.

The 'NUC Table Base' field displays the register value that represents the most significant bits of an address in NUC flash memory. This address is a pointer (to the base of the first block within the flash device) for the desired NUC coefficient set.

13.3 FPA DAC Bias Configuration

FPA DAC bias setting controls are shown in Figure 33 below.

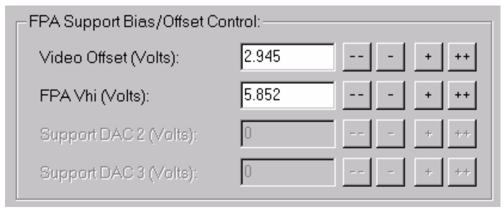

Figure 33: FPA DAC Bias Setting Controls

The Configuration Manager software will identify the camera FPA type and then enable and name the available bias controls. Each bias is controlled through a register value that has a resolution of 0 – 255. These values are converted to a voltage for the user interface.

Clicking on the single increment '+' or decrement '-' button adjusts the register value by 1. The updated voltage value will be displayed in the edit field.

Clicking on the double increment '++' or decrement '--' button adjusts the register value by 10. The updated voltage value will be displayed in the edit field.

13.4 FPA Integration Configuration

The integration setting control is shown in Figure 34.

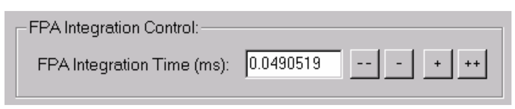

Figure 34: FPA Integration Time Setting Controls

The Configuration Manager software will identify the camera FPA type and then select the proper conversion for the integration time. The integration time is displayed in milliseconds and is limited by the conversion equation for the specific FPA.

Clicking on the single increment '+' or decrement '-' button adjusts the register value by 1. The updated time value will be displayed in the edit field.

Clicking on the double increment '++' or decrement '--' button adjusts the register value by 10. The updated time value will be displayed in the edit field.

13.5 FPA Serial Control Word Configuration

FPA serial control parameters can be modified using the controls shown in Figure 35.

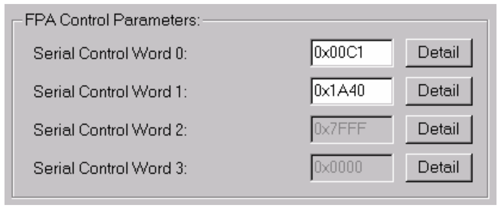

Figure 35: FPA Serial Control Word Setting Controls

The control words are made up of bit fields that represent various internal FPA settings. These values are serially loaded to the FPA during normal operation.

Depending upon the FPA type these controls may not be enabled, indicating either a fixed setting or an absent setting. If the control is enabled then it can be modified to adjust camera FPA behavior.

The value can be entered directly into the edit field or by using the 'Detail' button to bring up a dialog with detailed settings such as the one shown in Figure 36.

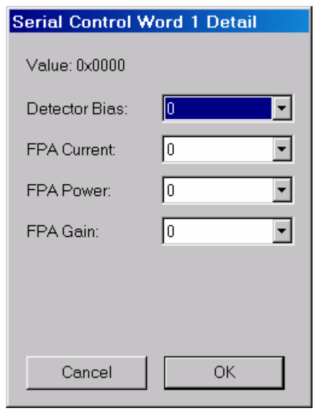

Figure 36: Serial Control Word Detail Dialog

13.6 Calibration Flag Reference Configuration

The controls for setting the calibration flag reference are shown in Figure 37.

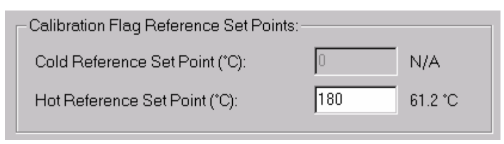

Figure 37: Calibration Flag Reference Setting Controls

If a calibration flag is installed in a camera it will be one of three types: ambient only, heated only, and dual temperature.

If the type is ambient only, both edit fields will be disabled. If the type is heated only, just the hot reference field will be enabled.

The value that goes into the edit field represents a register value applied to the corresponding DAC; which has a range of 0 – 255.

In the case when the calibration flag type contains a TEC, a resulting temperature will be shown next to the entered value. Otherwise a "N/A" will be displayed.

13.7 Calibration Controls

Controls for performing calibrations are shown in Figure 38. The defective pixel detection, 1-point, and 2-point calibrations are performed using a series of commands/messages between the host and the connected camera. These buttons are not enabled if no connection exists.

The calibration buttons are also not enabled if the current GUI settings do not match the camera register settings. This prevents a calibration being performed with invalid settings, which would be saved to the camera prior to the execution of the calibration.

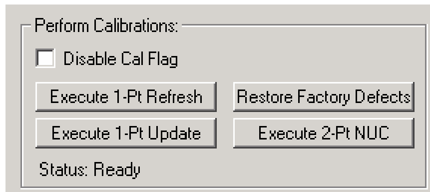

Figure 38: Calibration Controls

The 'Disable Cal Flag' check box, when selected, informs the embedded application to execute the calibration with an external flag. The user will be responsible for placing the reference in the camera field of view at the proper time.

Click on the 'Execute 1-Pt Refresh' to initiate a one point refresh calibration. The resulting coefficients are stored in volatile memory and are dependent upon the active NUC table.

Click on the 'Execute 1-Pt Update' to initiate a one point update calibration. This calibration assumes a two point data set is already in flash and will update the offset coefficients only.

Click on the 'Restore Factory Detects' button to initiate a NUC table reset. The routine will completely erase the NUC flash area and then write '0x0000' into the gain terms to identify bad pixels as defined by the camera's factory defect table for the active NUC. This '0x0000' term will be ignored during the two point calibration but will be used as a trigger for the bad pixel replacement algorithm. Subsequent two point calibrations will not reset any previously detected bad pixels, it can only add to them.

Click on the 'Execute 2-Pt NUC' to initiate a two point calibration process. These coefficients will be stored in the NUC flash memory at the desired index. Defective pixels from the existing NUC (if any) will be saved before the flash area is erased and then re-inserted to the new coefficient set.

The 'Status:' text line provides a GUI interface of the current process state.

13.8 Miscellaneous Camera Controls

Two miscellaneous camera controls are shown in Figure 39.

Figure 39: Miscellaneous Camera Controls

These two controls are provided to assist with framegrabber data acquisition. The 'AGC Mode' selection control is used to set the automatic gain algorithm that the embedded application uses to process analog display video.

The 'PFV Source Select' control sets the format of the output of the digital port. Typically the user would select digital FPA video prior to performing a calibration and pixel replaced video afterwards.

13.9 Digital Port Grab Display Controls

Controls for initiating and viewing frame grab data is shown in Figure 40.

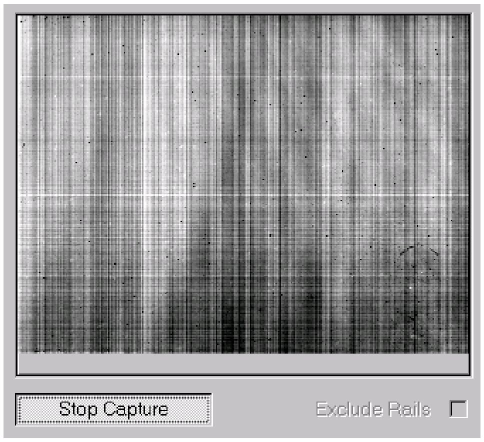

Figure 40: Framegrabber Controls

The data display window is sized for a 320 x 256 array. If the actual FPA size is 320 x 240, there will be a blank area at the bottom of the window as shown above. The video data that gets displayed goes through a simple linear AGC routine for the purposes of efficiency.

Click on the 'Start Capture' button to begin a capture and click it again to stop the process.

Note: The controls will not be enabled if a framegrabber is not present or if there was an error detecting/initializing the hardware.

13.10 Digital Port Statistics Controls

The area used for displaying information about the digital data stream is shown in Figure 41.

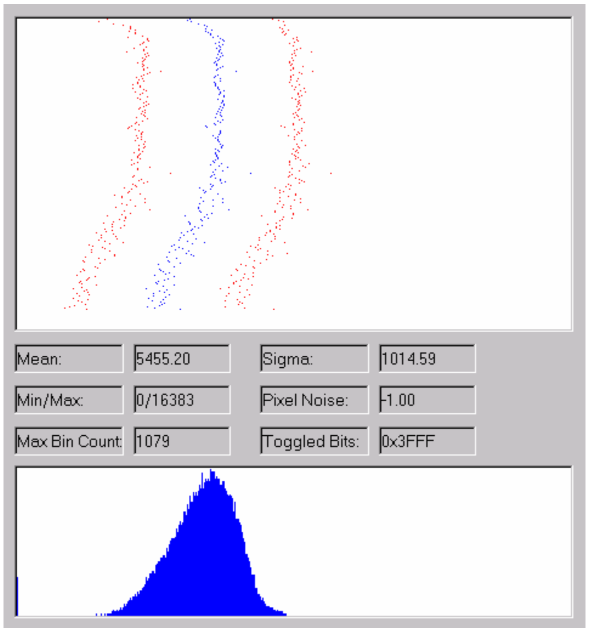

Figure 41: Digital Data Statistics

Digital port data while being captured is also processed for statistical analysis. This data can assist in the characterization of the camera FPA and for setting up calibrations.

The top window displays a row by row average of the pixel data with noise. The blue dot represents the row average pixel value from 0 – 16383. The red dots on either side represent the (±) three sigma point of that row's pixel values.

The edit fields, between the two display windows, are statistics based on the entire frame. The pixel noise is computed on a 32 frame summation (frames are not in sequence). A value of '-1' for pixel noise indicates that not enough frames have been processed to display the results.

The bottom window displays a histogram of a frame of pixel values. The horizontal axes of the window represent bins from 0 to 16383. The height of the window is scaled to the maximum bin value which is reported in the 'Max Bin Count' field.

13.11 Flash and File Controls

The buttons shown below in Figure 42 are used update and retrieve active NUC mode data.

Figure 42: Flash and File Controls

Clicking on the 'Read from FLASH' button reads the current settings from the camera and stores them to the local copy (represented by the GUI).

The 'Update Registers' button updates all the registers in the camera that are associated with this dialog. This ensures that the GUI settings, that the user sees, are the same as what the camera is currently operating. Only during a calibration are the GUI settings stored to serial data flash for permanent storage.

13.12 Advanced Configuration

Additional dialogs for more advanced camera configuration can be accessed via the buttons shown in Figure 43.

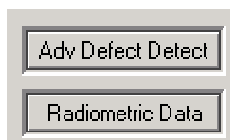

Figure 43: Advanced Controls

Clicking on the 'Adv Defect Detect' button initiates a dialog for a more advanced method of detecting defective pixels and calibration (see paragraph 0).

Clicking on the 'Radiometric Data' button initiates a dialog for entering OEM radiometric parameters (see paragraph 16).

14 Debug Tab-View

The debug tab view shown in Figure 44 below, gives the user access to various settings, registers, and memory for the purpose of debugging. Peripheral and FPGA registers may be read and/or modified to verify operation. It is recommended that no changes be made if the user is unsure of the result or device being affected.

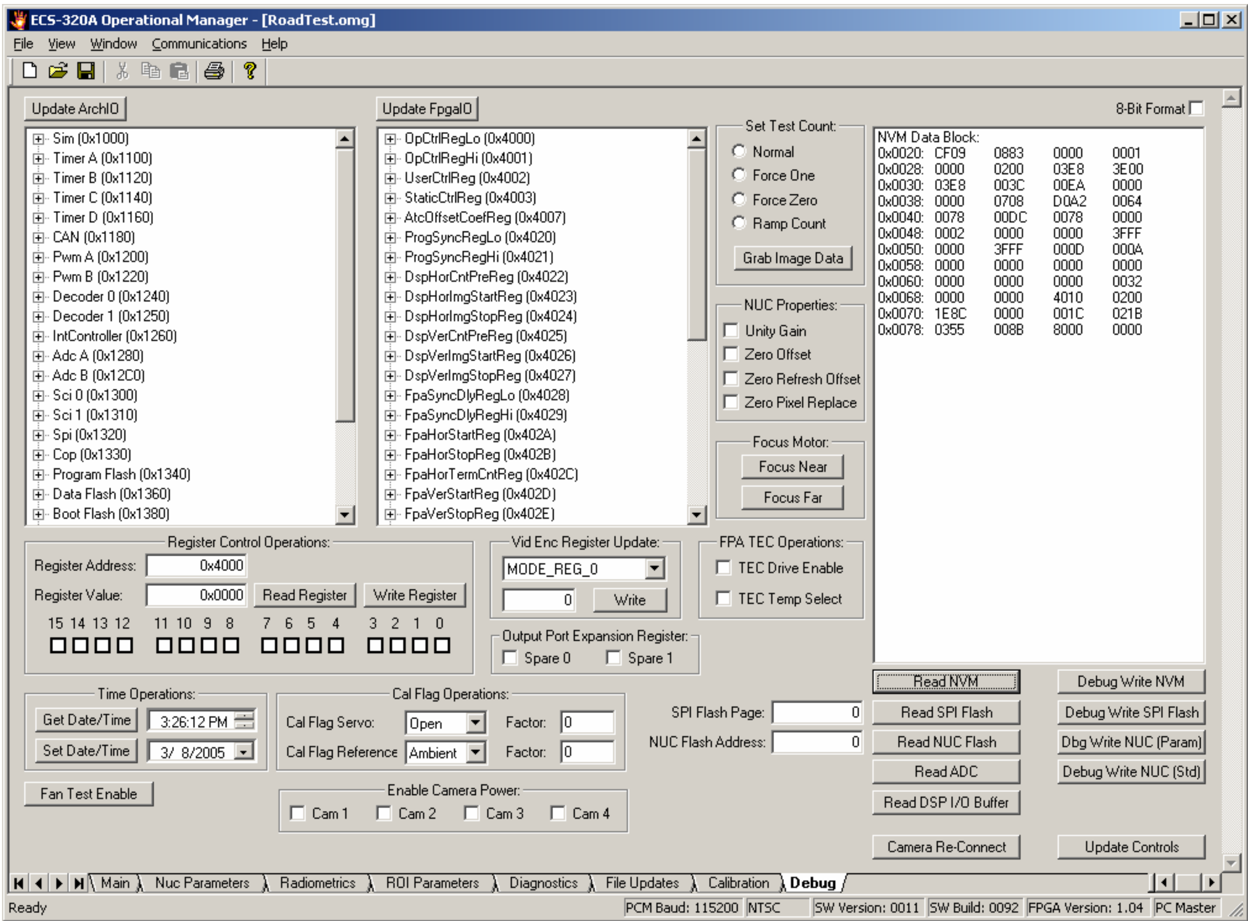

Figure 44: Debug Tab-View Dialog

14.1 DSP Peripheral I/O Registers

The DSP peripheral register control window is shown below in Figure 45. This window gives the user access to the value of each of the peripherals built into the DSP architecture.

By clicking on the "Update ArchIO" button, a read of the entire memory mapped region is performed and the results can be viewed with the tree list control. The tree list shows each peripheral base register address. Typically a peripheral has multiple registers that are used to define its operation. Click on the "+" next to the peripheral to expand the tree list and view sub-registers.

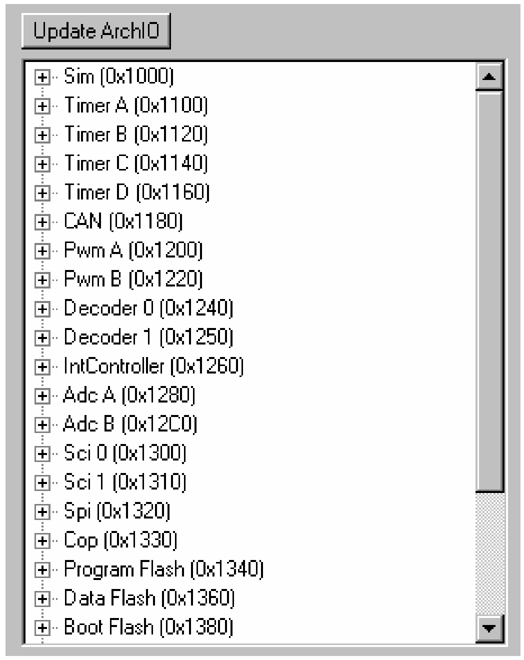

Figure 45: DSP Peripheral I/O Register Control

Specific information about register contents can be found in the Motorola DSP56F80X User's Manual (DSP56F801-7UM/D).

14.2 Xilinx FPGA I/O Registers

The Xilinx FPGA register control window is shown below in Figure 46. This window gives the user access to read each of the registers in the FPGA map.

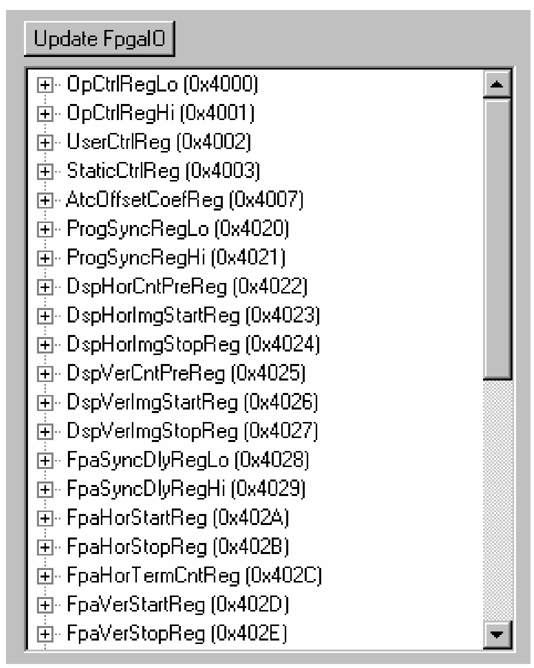

Figure 46: Xilinx FPGA I/O Register Control

Click on the "Update FpgaIO" button to refresh the state of each of the registers in the map. The tree list control displays each of the register mnemonic and memory mapped address. Click on the "+" to expand the list tree and reveal the current register value. Double clicking on the register mnemonic will place the address in the single register control window (paragraph 14.3) along with the current value.

Specific register information may be obtained from Lumitron.

14.3 Register Control

The register control group provides the user with read/write access to both the DSP peripheral and Xilinx FPGA registers. Actually even valid memory locations in DSP data memory space can be accessed as well.

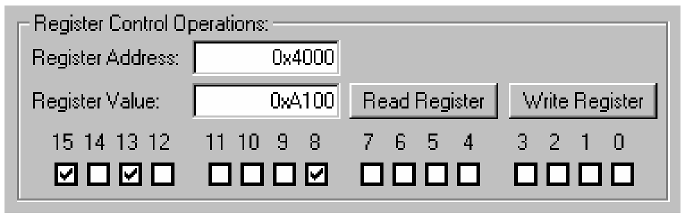

Figure 47: Register Control

To read data at a specific location: (a) enter the address in hexadecimal form (0xXXXX) (b) and then click the "Read Register" button. The updated value will be shown in hexadecimal form in the value edit field, and the appropriate bits will be set in the check boxes below.

To write a value to a specific location: (a) enter the address in hexadecimal form (0xXXXX), (b) enter the desired output value (directly or with bit check boxes), (c) then click the "Write Register" button.

Note: Care should be taken to update known addresses only, since DSP data memory is also accessible, stack and variable values are not protected.

14.4 Memory View Window/Controls

The memory view control group shown below in Figure 48, provides a mechanism to read various memory locations on the electronics. These memory locations are all peripheral to the actual DSP.

Data read back is displayed in the widow in 16-bit form. A check box is provided to display the data in 8-bit form if required.

Each of the buttons on the left hand column read a different peripheral memory. The first is the "Read NVM" button. When pressed this control will read the 96 bytes of RAM located on the serial data real time clock/non-volatile memory chip.

When the "Read SPI Flash" button is pressed an entire serial flash page (264 bytes) is displayed. The desired serial flash page can be entered in the edit box to the left of the read button. Valid values are 0 – 4095.

The reading of the flash associated with the NUC coefficients is done by pressing the "Read NUC Flash" button. This will read 160 words of data from the user supplied address at the left of the button. The base address will appear at the top of the display window with the offset listed in the left-hand column. Since the flash part is a 16-bit device the 8-bit checkbox will be ignored.

The next button at the bottom left of the group will read the ADC results registers when pressed. The ADC results registers contain the current count value. These values are scaled by shifting the values down 3 bits. The resulting voltage can be computed by using the equation:

$$Volts = V_{\mathrm{Ref}} \times \frac{ADC_{Value}}{4095}; V_{\mathrm{Ref}} = 2.8V$$

The last button will read and display the current contents (160 words) of the "scratch pad" buffer on the camera. This buffer is used as a temporary transfer location for the host and camera during communications as well as extra memory space for the camera software.

The buttons located in the right hand column call routines that write values to specific locations in the associated memory. Use of these buttons will over-write existing settings or values currently being used by the camera.

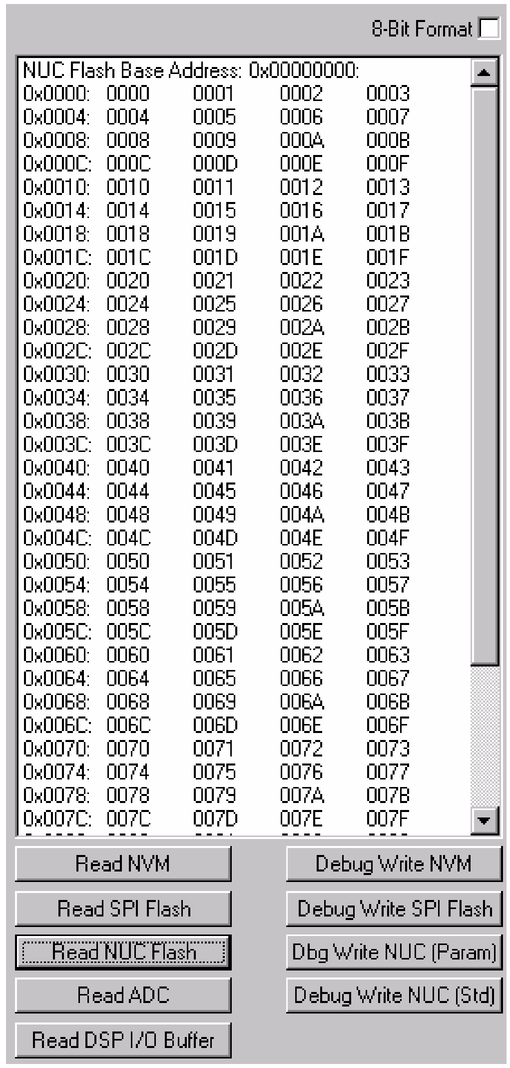

Figure 48: Miscellaneous Memory View Controls

Press on the "Debug Write NVM" button to output a ramp test pattern to the non-volatile RAM.

A click of the "Debug Write SPI Flash" button outputs a ramp test pattern to serial flash at page 1536.

Press on the "Dbg Write NUC (Param)" button to initiate a command that outputs a ramp test pattern in the NUC flash parameter blocks (0 – 7).

Press on the "Debug Write NUC (Std)" button to initiate a command that outputs a ramp test pattern in the NUC flash standard blocks (10 – 14).

14.5 Test Count

The test count controls shown in Figure 49, are used to manipulate the hardware test pattern generator.

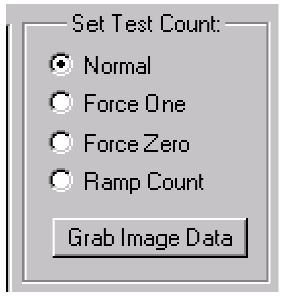

Figure 49: Test Count Control

Select 'Normal' for standard operation (no pattern); 'Ramp Count' to generate a repeating 0 – 0x3FFF ramp pattern; 'Force Zero' to have every pixel set to 0; and 'Force One' to have every pixel set to 0x2000.

Press on the "Grab Image Data" to grab and display the first three rows of pixel data in the memory view control window.

14.6 Time Set

The time operations controls shown in Figure 50 below, can be used to set and retrieve the camera time.

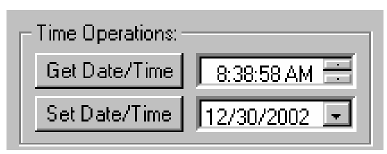

Figure 50: Time & Date Controls

Press on the "Get Date/Time" button to perform a read of the camera time.

To set the camera time:

- Click on the hour, minute, second, or AM/PM portion of the edit control.
- Click the up/down spinner to set to desired value.
- Click on the date control to show calendar dialog.
- Click on the desired day/date.
- Click on the "Set Date/Time" button.

14.7 Focus Motor Control

The focus motor operations buttons shown in Figure 51, initiate a command to focus either near or far.

Figure 51: Focus Motor Controls

14.8 FPA TEC Control

The FPA TEC control group is shown below in Figure 52. These controls operate the TEC control.

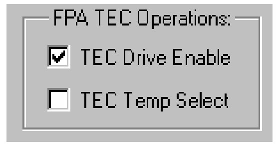

Figure 52: FPA TEC Drive Controls

Select the TEC Drive Enable to "turn on" the control circuitry.

Select the TEC Temp Select to set to the "high" temperature otherwise it will operate at the "low" temperature point.

14.9 NUC Table Properties

The NUC table coefficient property controls are shown below in Figure 53. These settings are use to apply or disable different portions of the NUC coefficients.

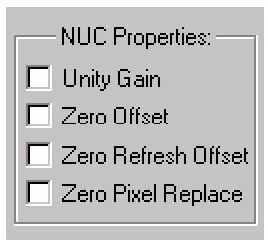

Figure 53: NUC Processor Controls

Enabling the 'Unity Gain' checkbox will set the gain coefficient for each pixel to a value of 1.

Enabling the 'Zero Offset' checkbox will set each pixel's offset coefficient to 0.

Enabling the 'Zero Refresh Offset' checkbox will set each pixel's refresh offset coefficient to 0.

Enabling the 'Zero Pixel Replace' checkbox will bypass the pixel replacement algorithm and allow the bad pixels to be viewed.

14.10 Calibration Flag Control

The servo control group is shown below in Figure 54. These controls are valid for the single temperature calibration flag.

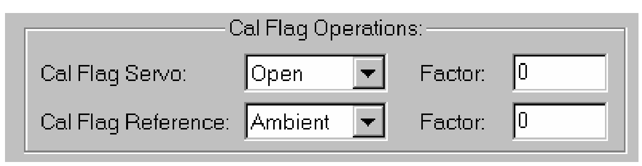

Figure 54: Calibration Flag Controls

The top combo-box control can be used to open and close the servo, assuming that it is present and configured properly.

To bottom combo-box control sets the temperature of the calibration flag to ambient or the programmed "hot" temperature.

14.11 Video Encoder Register Control

The video encoder register control group is shown below in Figure 55. These controls give the user the ability to modify the video encoder registers for debug purposes.

Please refer to documentation about the Analog Devices ADV7170/7171 digital video encoder for information about register mnemonics and modes of operation.

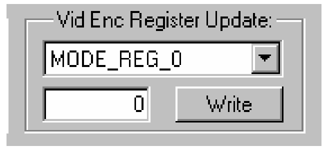

Figure 55: Video Encoder Register Controls

Using the combo-box control select the desired register to modify. Then enter the value to be written to that register. Finally press on the "Write" button to execute the command.

14.12 Output Expansion Port Register Control

The Output Expansion port register controls are shown below in Figure 56. These settings are use to set or clear the two spare output signal lines.

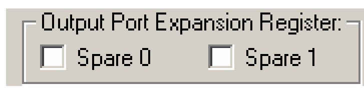

Figure 56: Expansion Port Register Controls

Enabling the 'Spare 0' or 'Spare 1' checkbox will set the corresponding register bit to high and thus enable the output signal.

14.13 Camera Power Control

The Camera power controls are shown below in Figure 57. These settings are use to turn power on or off to a camera connected via the deserializer board.

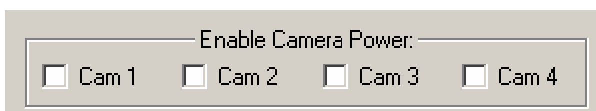

Figure 57: Camera Power Controls

Enabling any of the 'Cam X' checkboxes will apply power (if not already powered up) to the desired camera port on the deserializer. Clear the checkbox to power down an attached camera.

Note: the current power state of any camera is undetermined and the corresponding command will be sent regardless of status.

15 Advanced Pixel Defect Replacement

The advanced pixel defect replacement dialog in Figure 58; can be used to identify defective pixels automatically, during a calibration, or by manual selection. An installed framegrabber is required for this process.

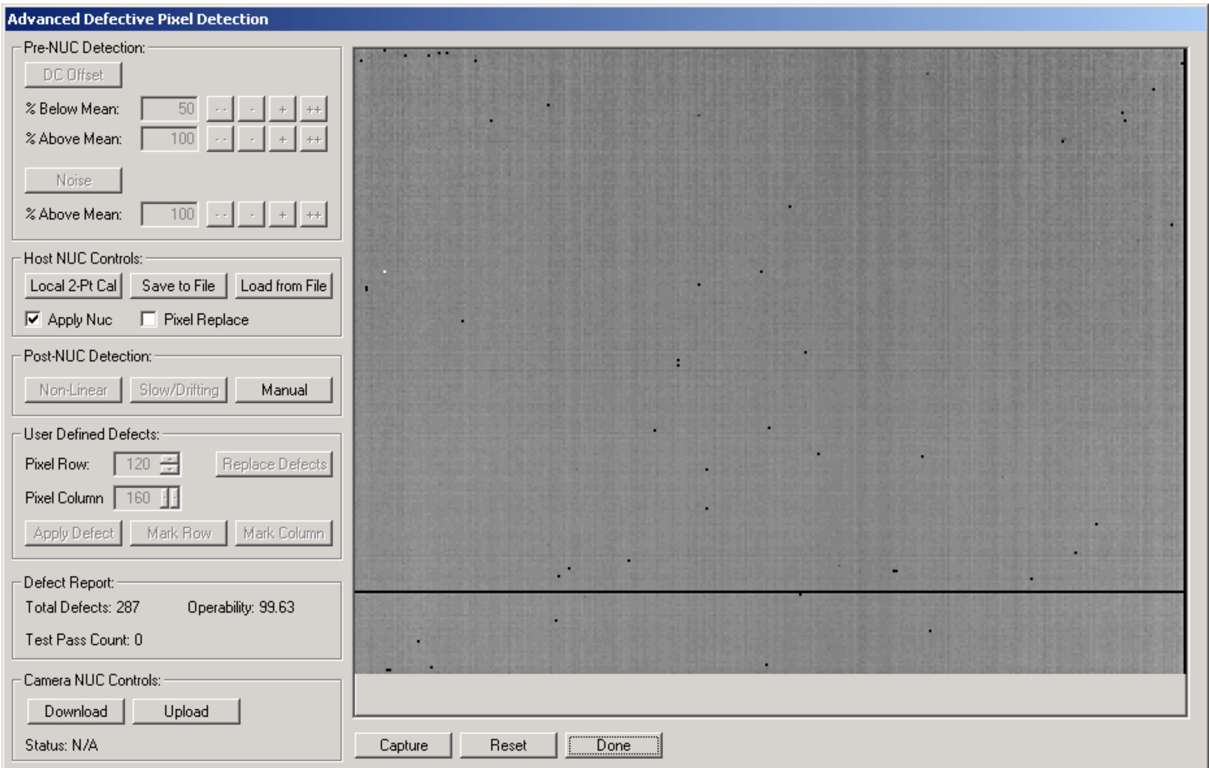

Figure 58: Advanced Defective Pixel Replacement Dialog

The 'Capture' button begins a digital video grab where the data is used for defect identification, display video, and/or manual defective pixel removal.

Clicking on the 'Reset' button resets all buffers (detected defects) and local calibration coefficients.

Clicking on the 'Done' button closes the dialog without further action.

15.1 Pre-NUC Detection Controls

The controls used to detect bad pixels before performing a two point calibration are shown below in Figure 59.

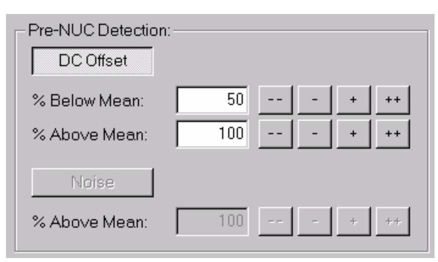

Figure 59: Pre-NUC Defect Detection Controls

The pre-NUC detection controls work in conjunction with the capture process to acquire, compare, and identify defective pixels based on DC offset and/or noise.

To detect pixels outside of desired DC offset range click on the 'DC Offset' button. Next, adjust the percent above and below mean levels to determine limits. The single increment '+' or decrement '-' buttons adjust the setting by 1 percent. The double increment '++' or decrement '--' buttons adjust the setting by 10 percent. Changes to the settings will reset defects previously identified by this test and start over. The defective pixel will be displayed in the capture window in a black/white format.

The equation used to compute the threshold for below the mean:

$$Threshold_{Low} = FrameMean \times (1 - GUIValue/100)$$

The equation used to compute the threshold for above the mean:

$$Threshold_{High} = FrameMean \times (1 + GUIValue/100)$$

Click on the 'Noise' button to detect pixels above a desired noise threshold. Noise data is collected over a 32 frame summation and will take longer to compute results. The increment controls operate the same as those listed above for the DC offset test.

15.2 Host NUC Controls

The host NUC controls shown below in Figure 60, are used for creating/saving/loading non-uniformity coefficients.

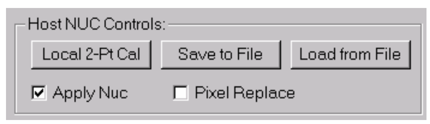

Figure 60: Host NUC Controls

To begin the process of performing a two point calibration click on the 'Local 2-Pt Cal' button. The calibration will use external references only and will incorporate any defects computed in the pre-NUC detection process. As part of the calibration process defective pixels will go through the pixel replace algorithm to compute a replacement pixel.

Note: If the application is being used in conjunction with a National Instruments 1422 framegrabber an additional dialog will appear. This dialog will permit the user to change the number of frames used in the calibration acquisition process. Initially the default will be 32 with additional choices of 64, 128, and 256 frames.

Once completed, the user can click on the 'Capture' button to preview the results. The 'Apply Nuc' checkbox is automatically set and the coefficients will be applied to the incoming digital data. Initially the preview data will show defective pixels as off or black. Enable the 'Pixel Replace' checkbox to have the defective pixels replaced.

The two point calibration data can be saved to a file on the host computer in a simple binary file format. To save the file click on the 'Save to File' button and provide a filename in the Windows File Dialog. The data is saved as raw floating point values - a gain term followed by an offset term for each pixel (4 byte floats).

Clicking on the 'Load from File' button will open a Windows File Dialog that can be used to load an existing NUC data file.

With this file capability, accompanied by the camera NUC upload/download functions (paragraph 15.6), it is possible to manipulate NUC coefficient sets for just about any application.

15.3 Post-NUC Detection Controls

Post-NUC defective pixel detection controls are shown in Figure 61.

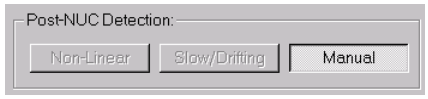

Figure 61: Post-NUC Defect Detection Controls

Currently the only implemented post NUC defective pixel removal tool is manual mode.

Clicking on the 'Manual' button will change the cursor to a cross hair and allow the user to begin selection of pixels to be added as defects. See paragraph 15.4 for more detailed information about the user defined defect selection process.

15.4 User Defined Defect Controls

Controls used in the selection of user defined defects are shown in Figure 62.

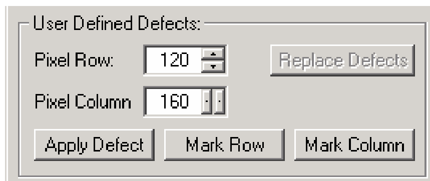

Figure 62: User Defined Defective Pixel Controls

Once the manual defect mode has been enabled (paragraph 15.3); the cursor will change to a cross hair. Also a flashing pixel (identifying the currently selected pixel) will appear on the preview window. Since the flashing pixel control is embedded in the preview process it is recommended to enable capture mode during manual pixel removal.

Position the cross hair over the desired pixel to be removed and left click the mouse. This will set the flashing cursor to that pixel and update the row and column values. To zoom to a larger image, making the selection process easier, right click on the mouse to toggle the zoom state. The zoom will attempt to center the window around the location of the cursor when it was right clicked. The user can also move the pixel cursor via the 'Pixel Row' and 'Pixel Column' edit controls.

Once the desired pixel has been identified click on the 'Apply Defect'. This will mark the pixel as bad for later replacement. Also the button name will change to 'Undo Defect' giving the user an opportunity to undo the last pixel. If the 'Apply Defect' button is not enabled, it means that the current pixel location has already been identified as defective.

The user can also define an entire row or column as 'bad' by clicking on the corresponding button. Note: there is no way to undo this change in the defect list.

Once the user has made the necessary changes then the 'Manual' button can be deselected ending the process. At this point the 'Replace Defect(s)' button will enable. Clicking on this button will execute a routine to recomputed replacement pixel values for all defective pixels. This is done to ensure that replacement index values that previously were pointing to valid pixels before manual replacement are updated along with the newly added defects.

Finally the NUC data can be saved locally or uploaded to the camera as desired.

15.5 Defect Report Window

The defect report window is shown in Figure 63.

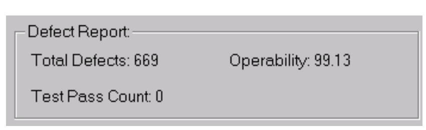

Figure 63: Defective Pixel Report

During the defective pixel detection process the number of bad pixels and operability is displayed in the 'Defect Report' area. If defects are being detected using the pre-NUC tests, the number of passes/checks is also displayed.

The operability represents the percent of valid pixels to the entire array.

15.6 Camera NUC Controls

Camera NUC transfer controls are shown in Figure 64.

Figure 64: Camera NUC Up/Download Controls

The camera NUC controls are made up of three parts; download, upload and status of current operation.

The user can click the 'Download' button to initiate a transfer of NUC coefficients for the NUC table that corresponds to the index set in the NUC Configuration tab-view. This process takes a minute or so to complete so the status text line indicates the progress. The data that is requested is actually stored in NUC flash which is not accessible to the host. So the data is first copied to utility memory and then read in small chunks until complete. The area in utility memory for temporary storage is not large enough for both the gain and offset terms; therefore, the gain terms are downloaded separately from the offset terms. Also the data is being received in formatted for the camera hardware (16 bit). As the data is being downloaded it is converted to 4-byte floats for use by the host software. When the download is complete it can be manipulated just as a locally computed calibration table. The downloaded coefficients can not be merged with pre-NUC defects, but manual defects may be added to the data.

After creating, loading, or modifying a downloaded NUC table it can be save to camera flash. It is a good idea to save the table to a local file before beginning an upload. Click on the 'Upload' button to initiate an upload of the current NUC coefficients. Again this is a two part process that will upload the gain terms first followed by the offset terms. The local data will be converted form floating point to 16-bit values. The flash will also be erased before the actual upload occurs so make sure the NUC index is properly set.

16 Radiometric Parameter Data

Radiometric parameter data entry is OEM specific and beyond the scope of this document