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**ADIC LINEAR ARRAY CONTROLLER R6
SOFTWARE USER'S MANUAL
REV. 0**

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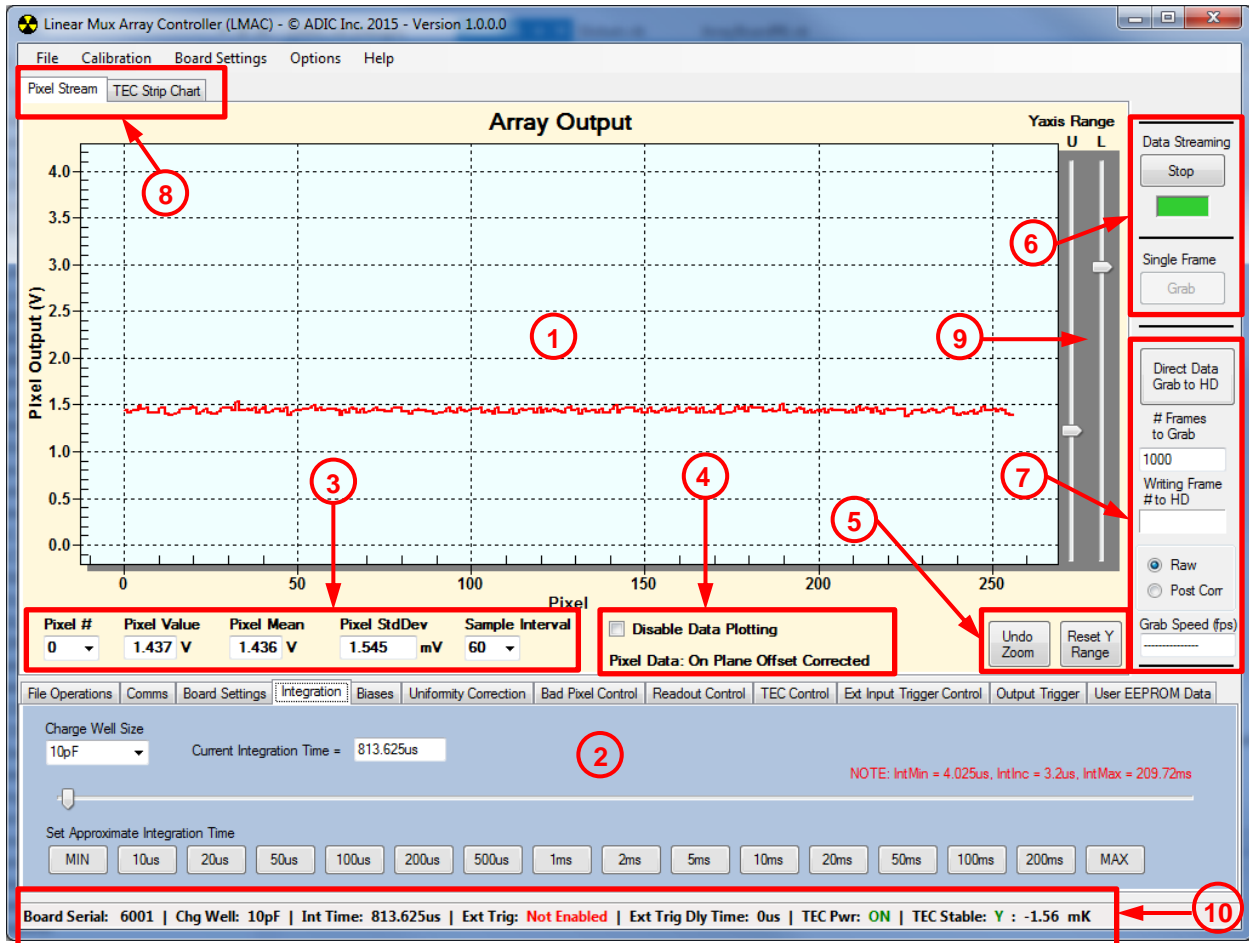


Figure 1: Linear Mux Array Controller (LMAC) Startup Screen

Figure 1 shows the screen that is presented when the Linear Mux Array Controller software, herein referred to as “LMAC”, is launched. The areas of the screen are described as follows:

Area (1) = this is the main pixel stream graph. In the figure a pixel stream is shown, but on initial software launch the graph will be blank until data streaming has been started.

Area (2) = on software launch, the default subpanel displayed is the integration subpanel where charge well size and integration time are set.

Area (3) = this area displays the selected pixel value and statistics. The pixel of interest is selected via the combo box on the far left. From left to right the values displayed are: the instantaneous pixel value, the mean value of the pixel using the # of samples selected in the sample interval combo on the far right, the pixel standard deviation, which is effectively the rms noise level, and the sample interval which is the number of sequential samples used to compute the mean and standard deviation. The choices of number of samples are 10, 30, 60, 90, 120, or 200 samples. When setting a large

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number of samples at extended integration times, if there is slow thermal drift of the array then the mean and standard deviation values will not be fully representative of the real numbers, so a smaller number of samples will give a more accurate mean and standard deviation.

Area (4) = plotting information / option. The disable data plotting checkbox when checked will turn off the plotting of the data to the pixel stream graph when continuous data streaming acquisition is enabled. This is useful when a frame rate boost is desired when streaming data to a data file on the computer and the frame rate is limited by the data acquisition loop turnaround time and not the integration time. All frames of data are plotted when the data acquisition continuous loop is running, and on the benchmark computer, the data plotting routine takes approximately 5ms to plot the data. This increases the minimum frame time by this ~ 5ms which reduces frame rate. Disabling the data plot function during streaming data to a data file will give a ~ 5ms reduction in the frame time. The text label below the disable data plotting check box will indicate what the correction state of the data being displayed is, raw, on plane offset corrected, post process offset corrected, or post process gain and offset corrected.

Area (5) = graph scale reset buttons. The graph can be zoomed in anywhere in the graph by holding the left mouse button and dragging to form a box. Releasing the left mouse button will then zoom in the graph to the bounded area of the zoom box. The “Undo Zoom” button resets the graph to the default zoom setting. The “Reset Y Range” button will reset the Y axis scale back to default if the Y axis has been changed using the U and L Y axis range sliders to the right of the graph (see Area (9) description).

Area (6) = this is where continuous data acquisition is selected. When the data streaming button says “Start” and is pressed the continuous data acquisition loop starts and pixel data is displayed on the graph if data plotting is not disabled. The box below the button will then turn green indicating data acquisition is running. The button text will change to “Stop”. When the “Stop” button is pressed, data acquisition is halted and the box below the button will turn red indicating the data acquisition loop is not running. Below the red/green indicator box is the single frame acquisition button. When the continuous data acquisition loop is not running, the “Grab” button is enabled and pressing the “grab” button will grab one frame of data. When the continuous data acquisition loop is running, the “Grab” button is disabled and cannot be operated.

Area (7) = block data acquisition control. This is an alternate method of grabbing N frames of data in one high speed block to a data file instead of the normal data acquisition method used in the continuous data acquisition loop via the file operations dialog box. This data collection method bypasses the normal data acquisition loop and does not display any data or pixel statistics in the pixel graph. Pressing the “Direct Data Grab to HD” button will prompt the user for a file name and once the “OK” button is

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pressed on the file save dialog, the number of frames specified in the “# Frames to Grab” entry field are grabbed in one block at high speed to a data file. The number of frames that can be grabbed in a block range from 1 to 65535. The block of data saved to a data file can be either data directly from the array (including on-plane offset corrected data) or post process corrected data corrected within the software. This option is selected by the Raw / Post Corr radio buttons. Once the block of data has been acquired in memory, it is then written to the data file, the frame being written is indicated in the “Writing Frame # to HD” text field. The grab speed of the block of data is indicated in frames per second in the “Grab Speed (fps)” text field. This speed is the time between the block grab function sending the request to the array board to the end of data read back from the array board, it does not include the time it takes to write the data to disk which will be a function of the number of frames grabbed in the block.

Area **(8)** = tab selections to choose which of the two graphs in the software is currently being displayed. The pixel stream graph is displayed by clicking the “Pixel Stream” tab and the TEC logging data is shown by clicking the “TEC Strip Chart” tab.

Area **(9)** = Y axis range sliders. The “U” and “L” y axis range sliders change the upper and lower bounds of the graph. Moving the “U” slider up slides the graph “up” making the upper bound of the graph a smaller value, conversely, moving the “L” slider down slides the graph “down” making the lower bound of the graph a larger value. Pressing the “Reset Y Range” button in area **(5)** will reset the graph Y axis range to default.

Area **(10)** = the status strip of the software. In this strip the following information is displayed real time: the board serial number, charge well size, integration time, external trigger status, external trigger delay time, TEC power status, TEC stability status, and the last reading of the TEC stability readout value. The TEC stability readout will stay fixed and not update when TEC polling is turned off, it merely retains the last value that was read. All other information in the status strip is updated real time when their settings are changed in the program.

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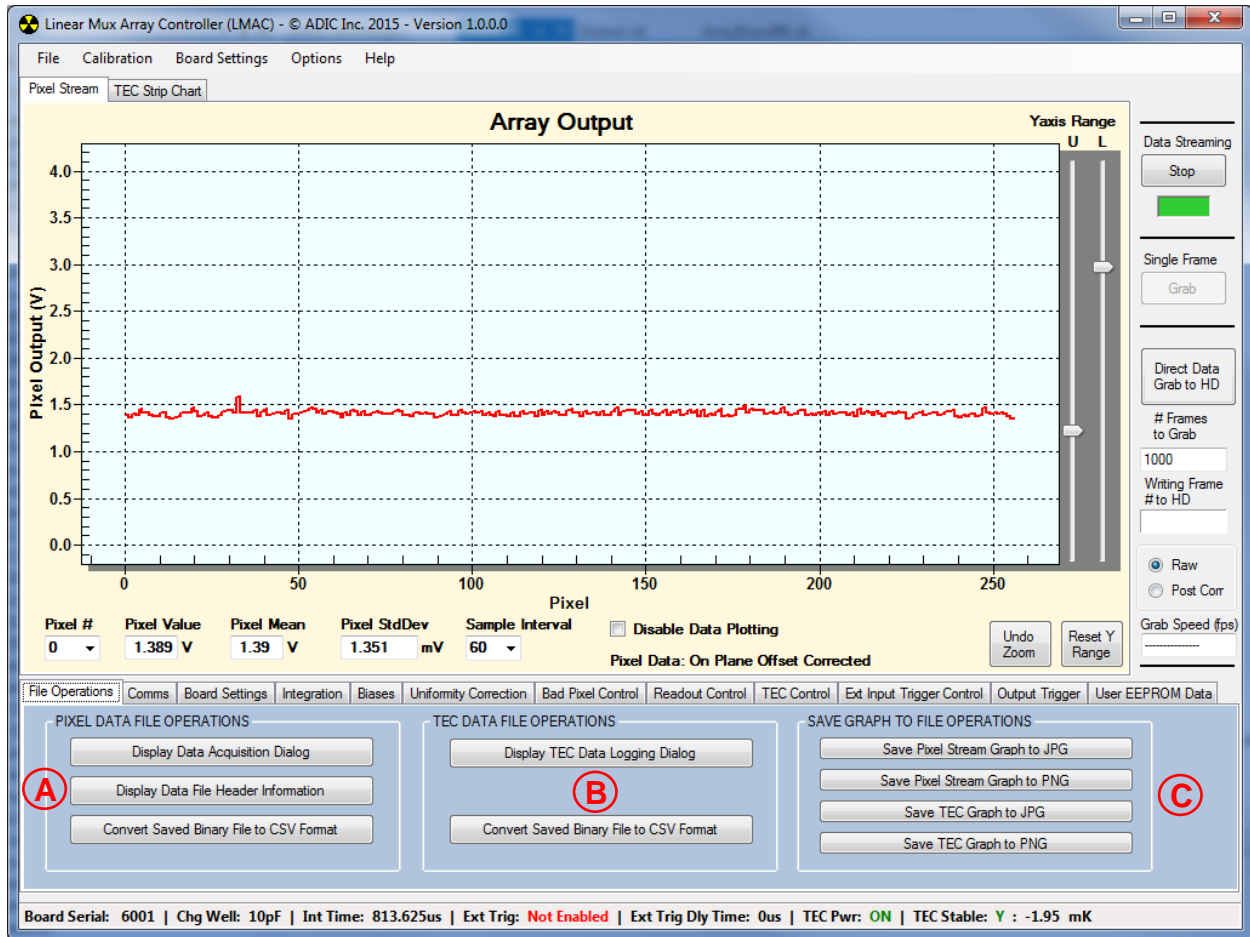


Figure 2: File Operations Subpanel

A = Pixel Data File Operations group box:

- “Display Data Acquisition Dialog” button = displays the pixel data file saving dialog box.
- “Display Data File Header Information” = displays the data file header information for a previously saved data file saved on the computer file system.
- “Convert Saved Binary File to CSV Format” = converts a previously saved pixel data file from the native binary format to a CSV formatted text file for reading into other programs such as Microsoft Excel.

B = TEC Data File Operations group box:

- “Display TEC Data Logging Dialog” button = displays the TEC data file saving dialog box.
- “Convert Saved Binary File to CSV Format” button = converts a previously saved TEC data file from the native binary format to a CSV formatted text file for reading into other programs such as Microsoft Excel.

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C = Save Graph to File Operations group box = Allows the user to save the displayed pixel data stream graph or the TEC data graph to either a JPG or PNG graphics file for importation in to other programs such as Microsoft Power Point.

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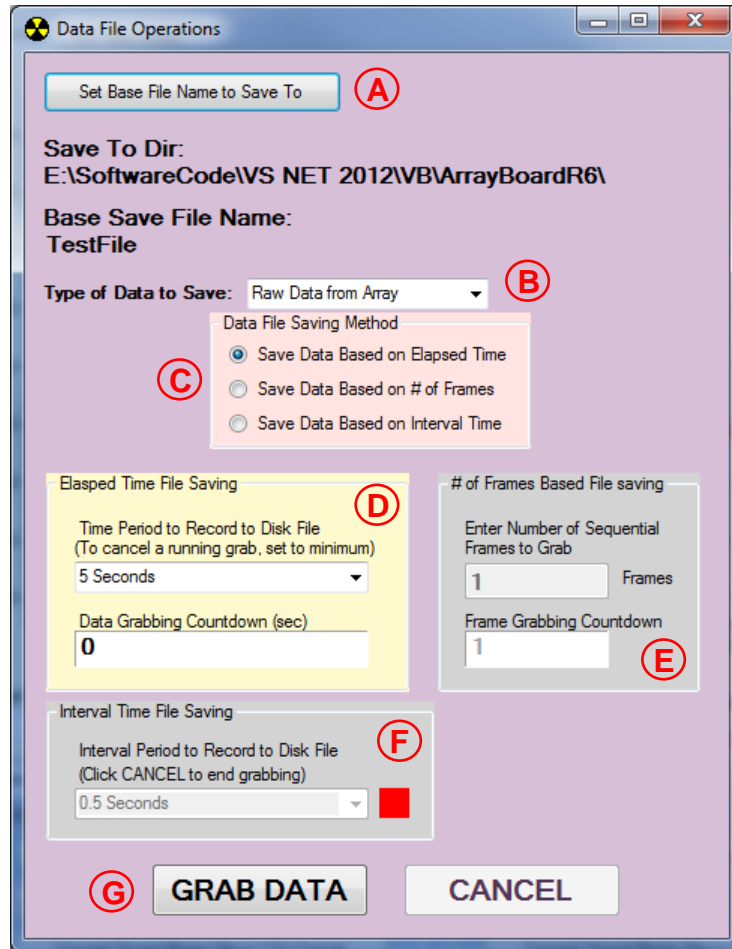


Figure 3: Pixel Data File Saving Dialog - with Elapsed Time Saving selected

The data file acquisition dialog panel allows the user to setup the base file name and data collection method for saving pixel data streams to a file on the computer file system. The (A) “Set Base File Name to Save To” button sets the base file name for the data file. Every time the (G) “Grab Data” button is pressed a new data file is started with the file name “basenameXXX” where XXX is a number sequence starting with 001. This allows the user to grab multiple standalone files without having to specify a new file name each time; the file name is automatically generated by the software. Individual data files can contain unlimited numbers of grabbed data stream frames, the Grab Data and Cancel buttons only stop and restart the data collection for starting new data files.

Two types of data can be saved, raw data coming directly off the array or post gain and/or offset corrected data, this option is selected via the combo box (B).

One of three types of data saving methods can be chosen from the “Data File Saving Method” group box (C). The data saving methods are:

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1. Save data based on an elapsed time (**D**): data is saved as fast as it can be read out from the array for a preset time. Once the preset time is reached data saving automatically stops.
2. Save data based on number of frames (**E**): data is saved as fast as it can be read out from the array for a preset number of frames. Once the number of frames is reached data saving automatically stops.
3. Save data at an interval time (**F**): data is saved at a preset interval amount of time until data saving is manually canceled.

The “Grab Data” and “Cancel” buttons (**G**) start and stop data saving to a data file. Clicking the “Grab Data” button again after a prior data file saving has been stopped will start a new data file with the data file name automatically generated with the base file name previously set with an incremented file name suffix number.

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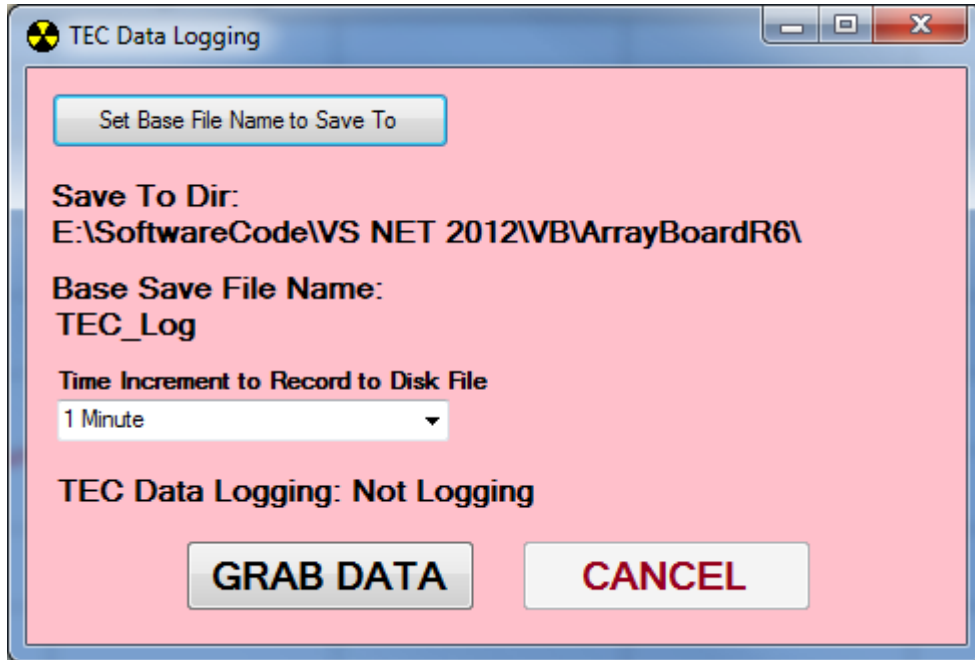


Figure 4: TEC Data Logging Dialog Box

The TEC Data Logging dialog box allows the user to log TEC status data to the computer file system after a base filename has been set when the “Grab Data” button is pressed while TEC polling is active. The data logging is saved in time increments selected by the drop down combo box “Time Increment to Record to Disk File”. To cancel logging of TEC data to a data file either pressing the “Cancel” button on the TEC Data Logging dialog box or turning off TEC Polling in TEC control subpanel in the software will stop TEC data logging to the computer file system. To start TEC logging to a data file TEC Polling must be active for the “Grab Data” button to be enabled for operation.

The data saved to the TEC log file is in the format shown below:

Data Interval:	10	Seconds					
Date	Time	DataPnt	TMON (mK)	ITEC (A)	VTEC (V)	VREF (V)	PWRDISS (W)
3/2/2015	3:35:51 PM	1	-783.152	0.996	4.186	2.459	4.171
3/2/2015	3:36:02 PM	2	-8.555	0.517	1.796	2.459	0.93
3/2/2015	3:36:12 PM	3	-6.222	0.522	1.796	2.459	0.938
End of Data							

The native binary format file is converted to CSV format via the “Convert Saved Binary File to CSV Format” in the TEC data file group box on the File Operations subpanel.

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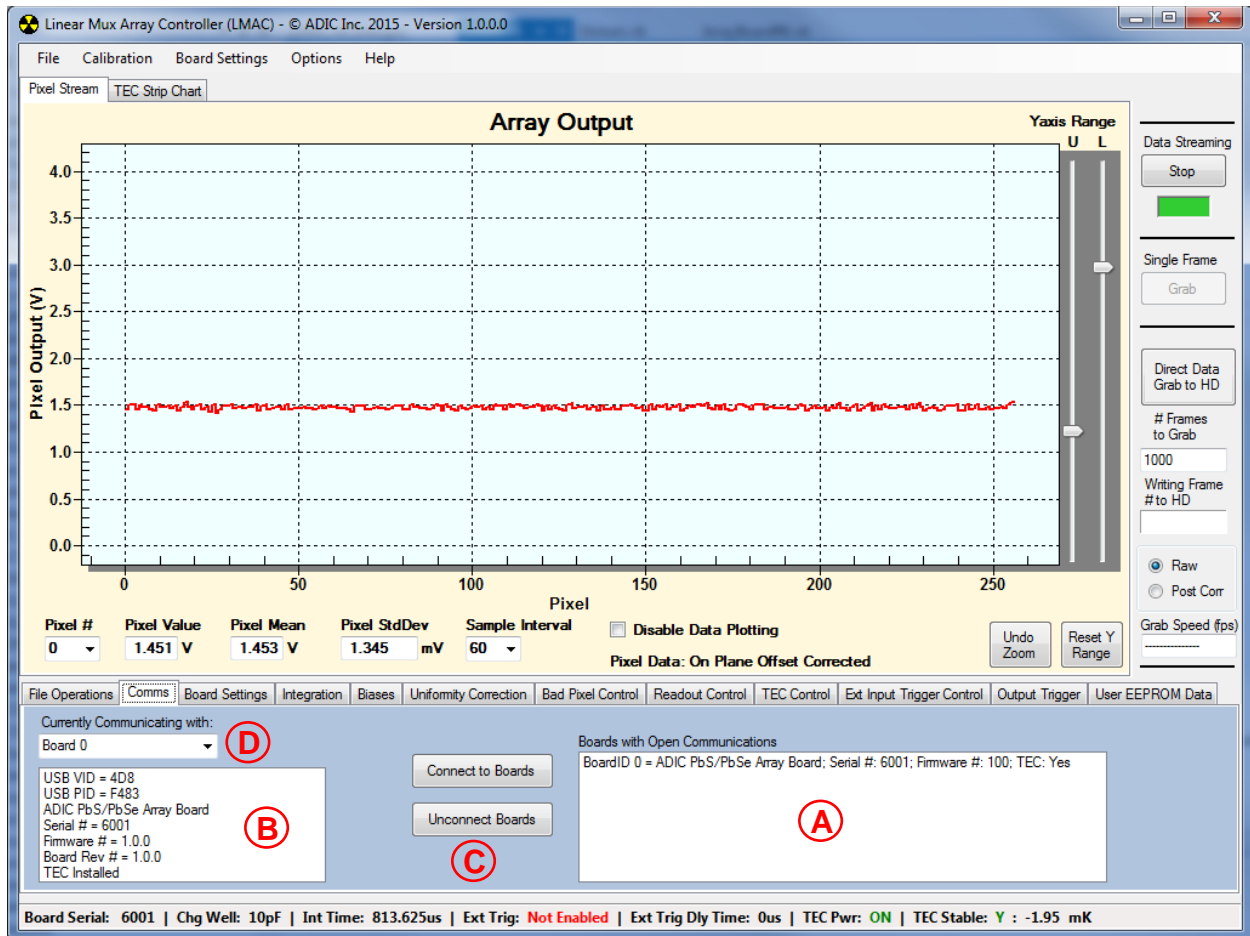


Figure 5: Comms Subpanel

A = This area list all detected boards on the USB bus, showing the board descriptors. Up to 8 boards are detected.

B = This area shows the information for the currently selected board controlled by the software.

C = The “Connect to Boards” button opens communications to the array boards detected in area “A”, and the “Unconnect Boards” button closes all board communications. Communications to boards are automatically opened when the software is launched and Board 0 is selected initially.

D = This drop down combo box selects which board is controlled by the software. All detected boards will show up in the list. If there is only one board connected to the computer via the USB bus, then only a Board 0 will be listed.

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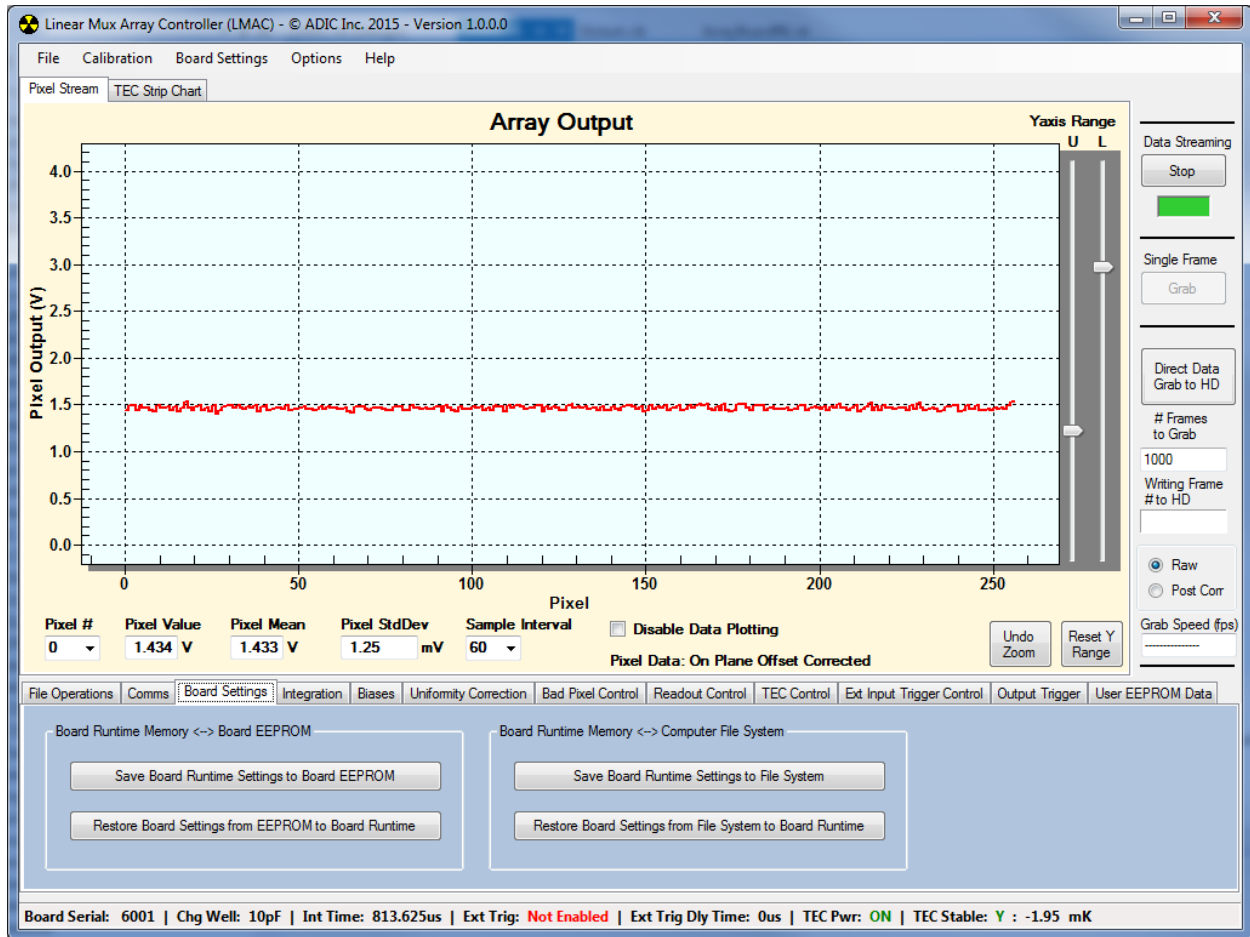


Figure 6: Board Settings Subpanel

The Board Settings subpanel allows the user to save and restore all board settings, including on-plane offset correction coefficients to either the array board EEPROM or a file on the computer system. This allows saving and restoration of all settings, except TEC setpoint temperature which is saved and restored under the TEC control subpanel, to a known state even after a board power cycle. Only a single state of board settings is saved or restored from the array board's EEPROM, but an infinite number of run states can be saved and restored to the computer file system as separate files. This allows instantly swapping array board states by loading different preset settings files from either EEPROM or a disk file or just loading a known state after a power cycle of the array board.

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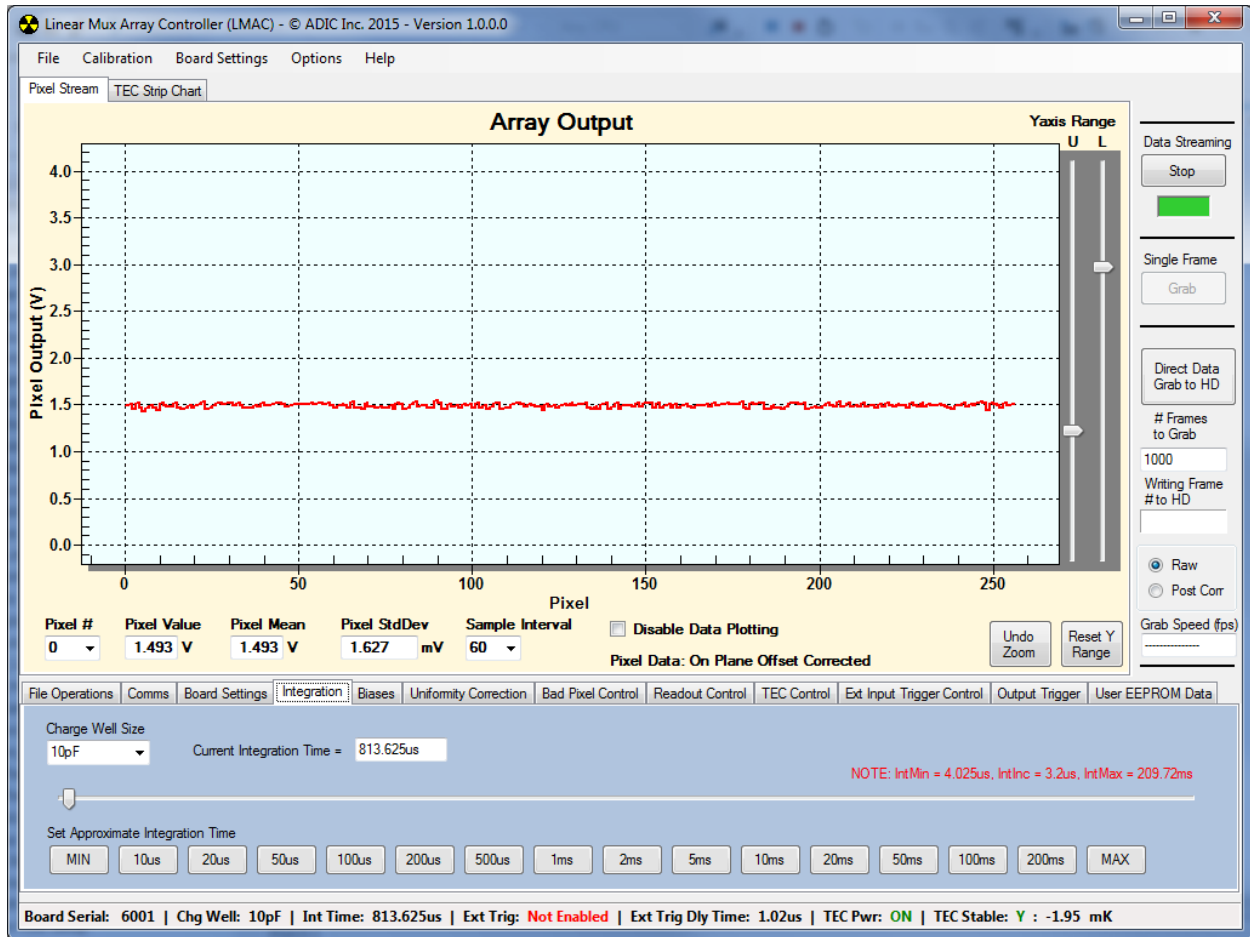


Figure 7: Integration Subpanel

The integration subpanel allows the user to set the ROIC's charge well size and the integration time. The charge well size and integration time are globally set for all 256 channels of the ROIC.

The charge well can be set to the following sizes: 1pF, 4pF, 7pF, 10pF, 11pF, 14pF, 17pF, and 20pF.

The integration time can be set by either the slider control or to fixed times via the button selections below the slider. The minimum settable integration time is 4.025us and the maximum settable integration time is ~ 209.72ms. Integration time is set in increments of 3.2us. One increase or decrease of the slider position is +/- 3.2us. The slider can be moved by using the mouse or by giving the slider focus and using the left and right arrow keys on the keyboard. For precision setting of the integration time use the arrow keys on the keyboard since using a mouse scroll wheel generally increments the slider in steps of 3 instead of steps of 1 that the keyboard will do.

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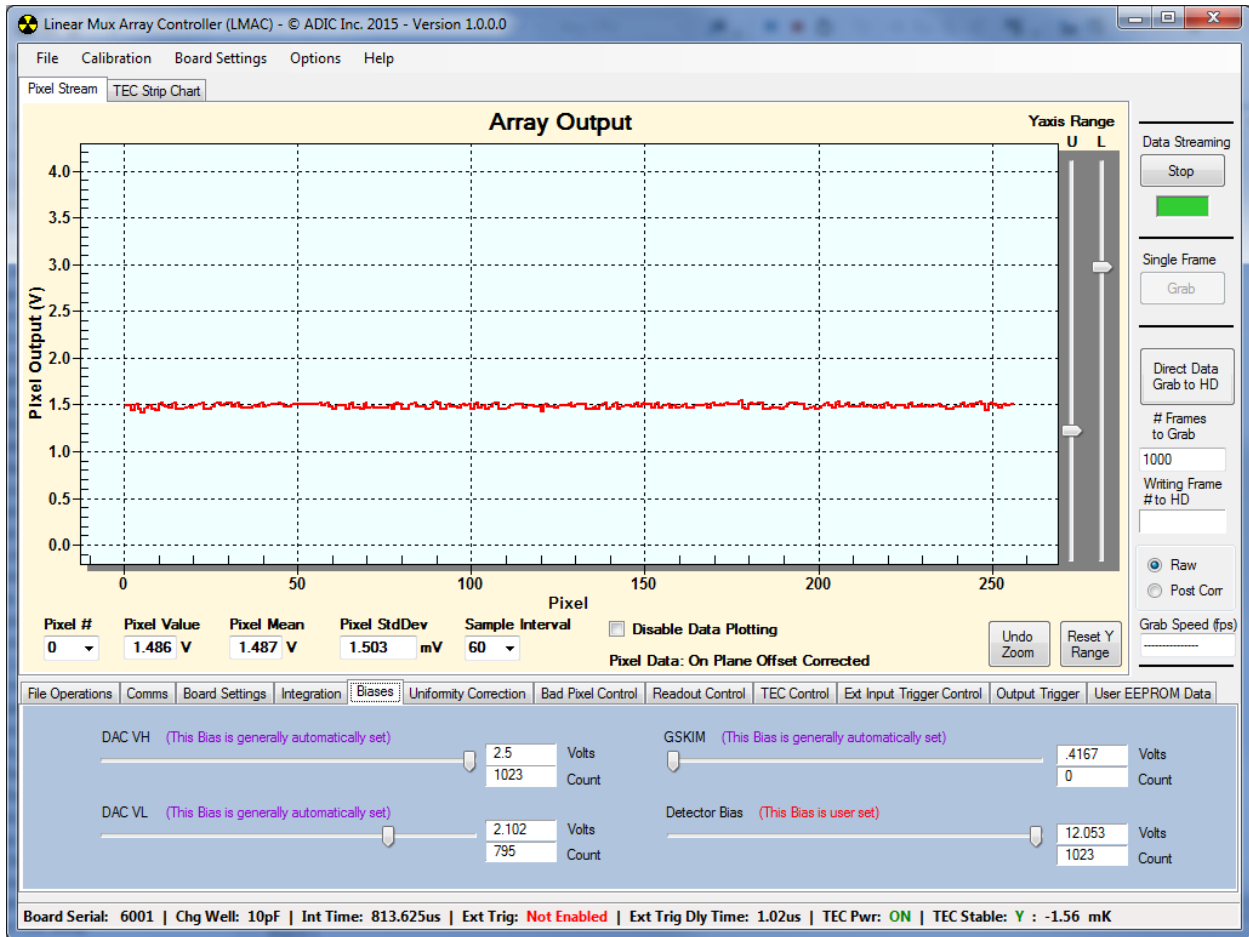


Figure 8: Biases Subpanel

The biases subpanel allows the user to set the four biases of the array board. Generally the only bias the user needs to set is the detector bias, all other biases are automatically set by the on-plane correction algorithms and should not be adjusted.

The detector bias slider can set the detector bias from a range of ~ 6V to ~ 12V. Best performance is attained with as high a bias as can be set on the detectors for the given operating parameters.

The DAC VH and DACVL biases are used as references for per pixel on-plane offset correction functions and the GSKIM bias sets the global dark current subtraction current. The DAC VH & DAC VL sliders are provided mainly for visual feedback of their settings after correction.

The GSKIM slider will usually always be at the 0 count setting indicating GSKIM is turned off, global skim is generally not used, and the recommendation for the best noise performance of the system is to not calibrate with global skim. The GKIM bias will only be in the non-zero position when global skim is used for on-plane correction. The only

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time global skim should be used is when the detectors are extremely high dark current detectors, i.e. very low impedance detectors or at high operating temperature. Generally the per pixel on-plane correction current subtraction has enough range to subtract dark current in most all scenarios.

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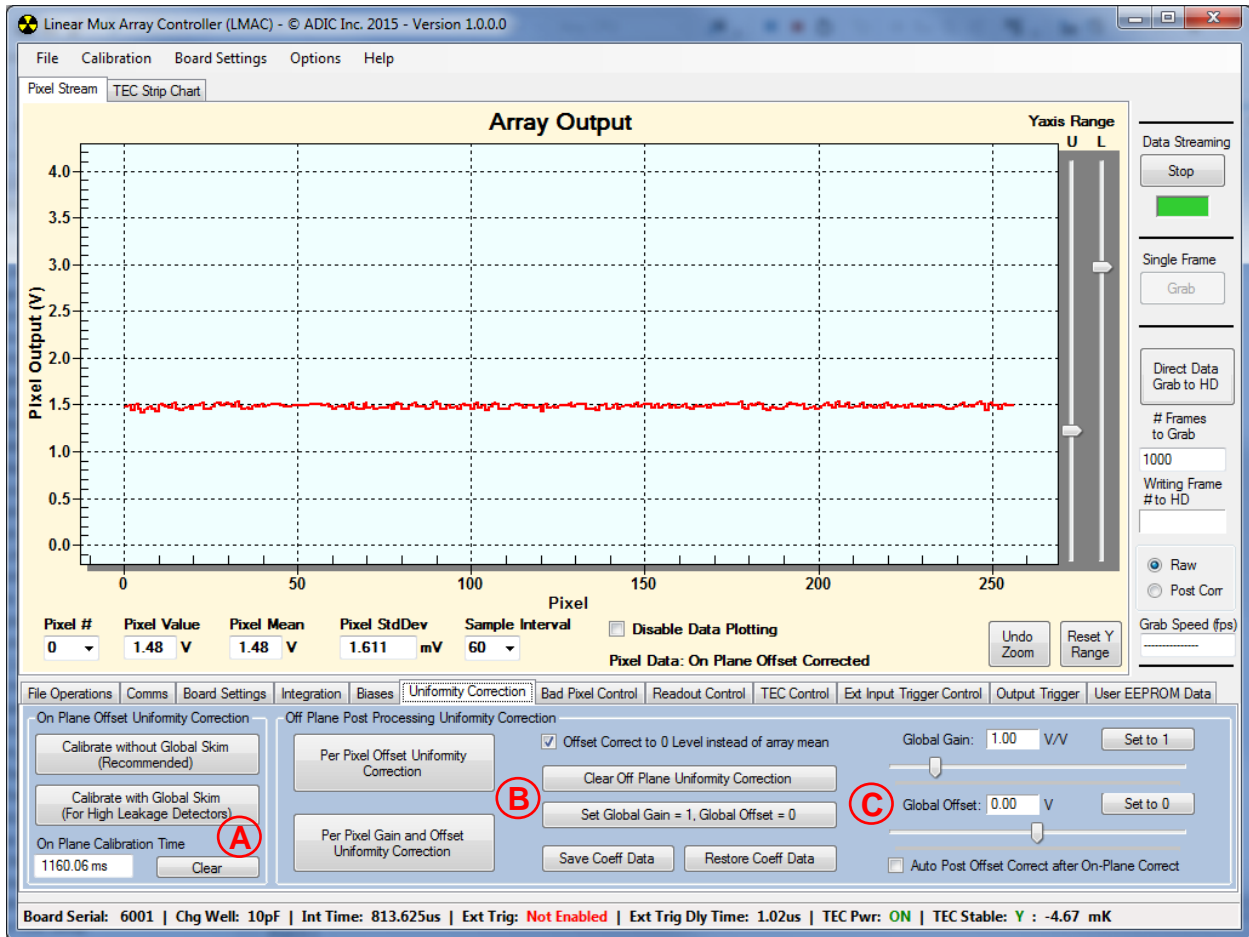


Figure 9: Uniformity Correction Subpanel

The uniformity correction subpanel allows the user to perform various combinations of pixel offset and gain correction.

Area (A) performs on-plane offset correction, with or without using global dark current subtraction (skim) via the two calibration button choices. Generally calibration without using global skim is recommended for the best noise performance as the global skim circuit, when on, will add a small amount of noise to the overall pixel noise. Calibration with global skim is provided for the cases where the per pixel correction circuits within the ROIC cannot converge properly due to too high of detector dark current which is rarely encountered. Only with extremely low impedance detectors or very high operating temperatures with extended integration times will the case where global skim is required present itself. In the lower left of the on-plane offset correction group box the length of time it took to calibrate with on-plane correction will be displayed after correction completes. Generally the time to calibrate is in the 0.8 to 1.2 seconds time for correction without global skim, but can be between 10 to 15 seconds for the case with global skim. The time to calibrate with global skim is longer as the global skim bias on the array board is heavily filtered and wait states are programmed into the array

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board to allow the global skim bias to settle due to the long filter time constant. To clear the on-plane correction coefficients and set them all to zero state, press the “Clear” button.

Area (B) performs post correction within the computer software application for further correction of the pixel data beyond the results of the on-plane correction. Either per pixel offset or per pixel gain and offset correction can be performed. To the right of the post correction offset or gain & offset calibration buttons are options that can be used for the post correction. The checkbox “Offset correct to 0 level instead of array mean” when checked will perform post correction and remove any pedestal in the data so that when the array is un-illuminated the pixel levels will be at the 0 level in the pixel graph. Below the checkbox is the button “Clear Off Plane Uniformity Correction” which will clear the post correction by setting the per pixel post correction offset coefficients to all 0’s and the per pixel post correction gain coefficients to all 1’s.

The “Set global gain = 1, Global offset = 0” button will set the global gain and offset values set in area (C) back to their default values of 1 and 0 respectively.

The “Save Coeff Data” and “Restore Coeff Data” buttons will save and restore the post correction coefficients to a file on the computer system in case the post correction coefficients want to be reapplied at a later time without re-computation.

In area (C), a global gain and/or offset can be applied to the data by moving their respective sliders. The adjustment range for global gain is from 0.5V/V to 4V/V, and the adjustment range for global offset is -2V to +2V.

In the bottom right of area (C) is the checkbox “Auto post offset correct after on-plane correct”. When this checkbox is checked, a post offset correction will be performed on the pixel data in one shot after the on-plane offset correction button is pressed without the need to manually perform the post correction after the on-plane correction completes. This removes the need to show the array the cold reference a second time for the post offset correction as on-plane and off-plane offset corrections are done in a single step.

Anytime on-plane offset correction is performed the post correction off-plane gain and offset per pixel coefficients are automatically cleared and set back to gain = 1 and offset = 0 for each pixel unless the “Auto post offset correct after on-plane correct” checkbox is checked. In this case the post gain coefficients are all set back to gain = 1 but the post correction per pixel offset coefficients are recomputed and applied immediately after the on-plane offset correction is completed, all in one step.

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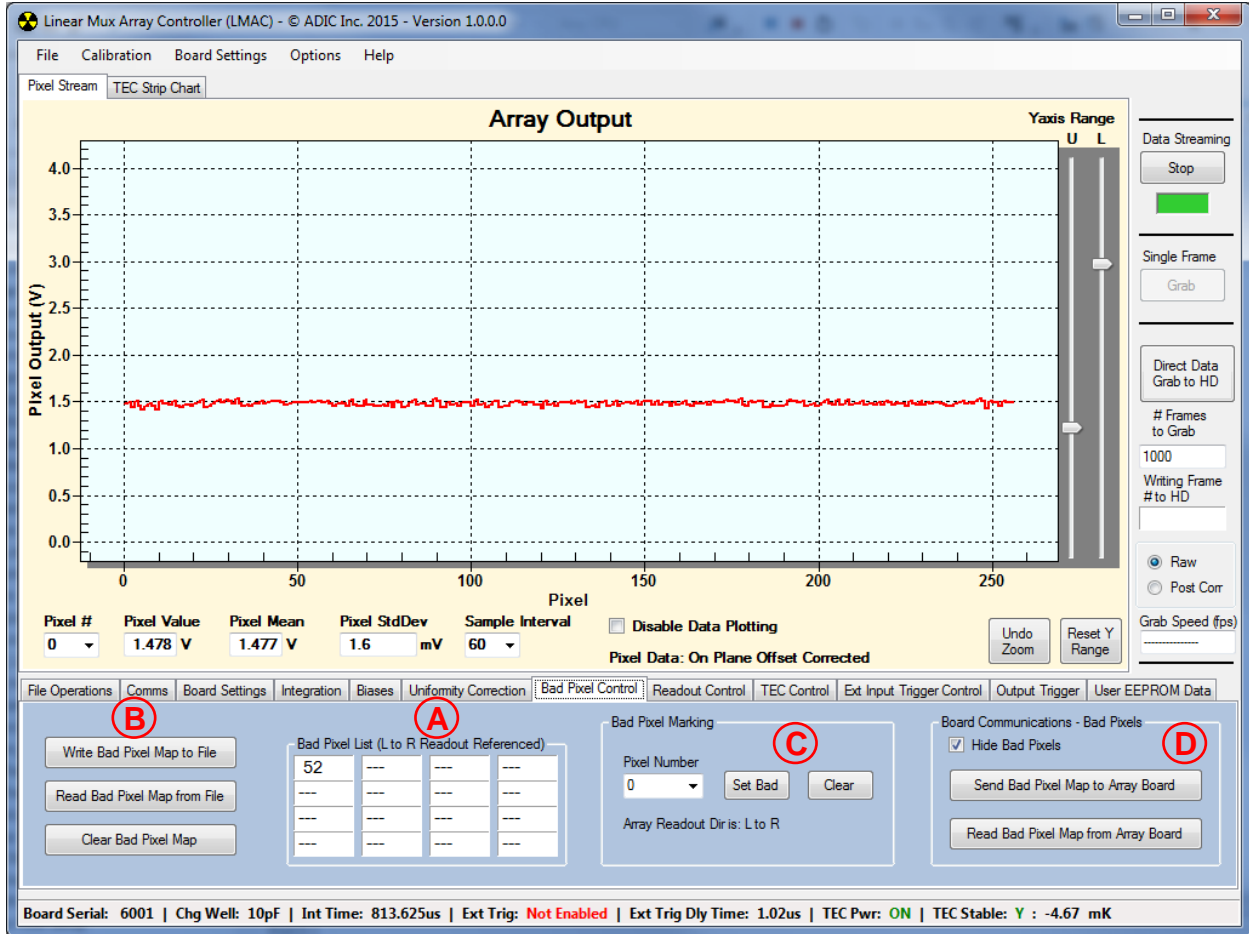


Figure 10: Bad Pixel Control Subpanel

The bad pixel control subpanel allows the user to replace bad pixels in the detector array. Up to 16 bad pixels are allowed. Bad pixels are replaced by the average of their two adjacent neighbors on either side of the pixel in question except for the ends of the array window being read out where the end pixels, if being replaced, are just a copy of its adjacent pixel interior to the array.

Area (A) in the figure above is the current bad pixel list memory resident in the software. Pixels are marked or cleared as being bad in area (C) by selecting the pixel to mark with the drop down combo box and then either pressing the “Set Bad” or “Clear” button.

The bad pixel list is only sent to the array board and takes effect when the button “Send Bad Pixel Map to Array Board” in area (D) is pressed. Once sent to the array board, bad pixel replacement can be toggled on and off by checking or unchecking the “Hide Bad Pixels” checkbox in area (D). The “Read Bad Pixel Map from Array Board” button will read back the bad pixel list in the array board’s runtime memory and populate the list in area (A). The bad pixel list in the board’s runtime memory is stored along with the

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board settings either to EEPROM on the array board or to disk files in the board settings subpanel.

In area (B), the bad pixel list shown in area (A) can be written to a disk file, a disk file can be read and populate the bad pixel list, or the bad pixel list can be cleared.

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Figure 11: Readout Control Subpanel

The readout control subpanel allows the user to reverse the read out order of the pixels or to read out only a portion of the array.

In area (A) of the figure above, the “Readout in Reverse Order” checkbox will readout the array in reverse order if checked, and the left address and right address sliders will set the left and right pixel read out limits.

The ROIC readout architecture is such that the readout window size is set relative to the center of the array. So when in left to right readout order, the left address spans 0 to 127, and the right address spans 128 to 255. Full array readout is when the left address is 0 and the right address is 255 when readout order is left to right. Area (B) in the figure shows the current readout window start and stop pixels along with the window size.

The button “Set Left to Right Full Frame” in are (C) in the figure is a quick way to return to full array left to right readout order.

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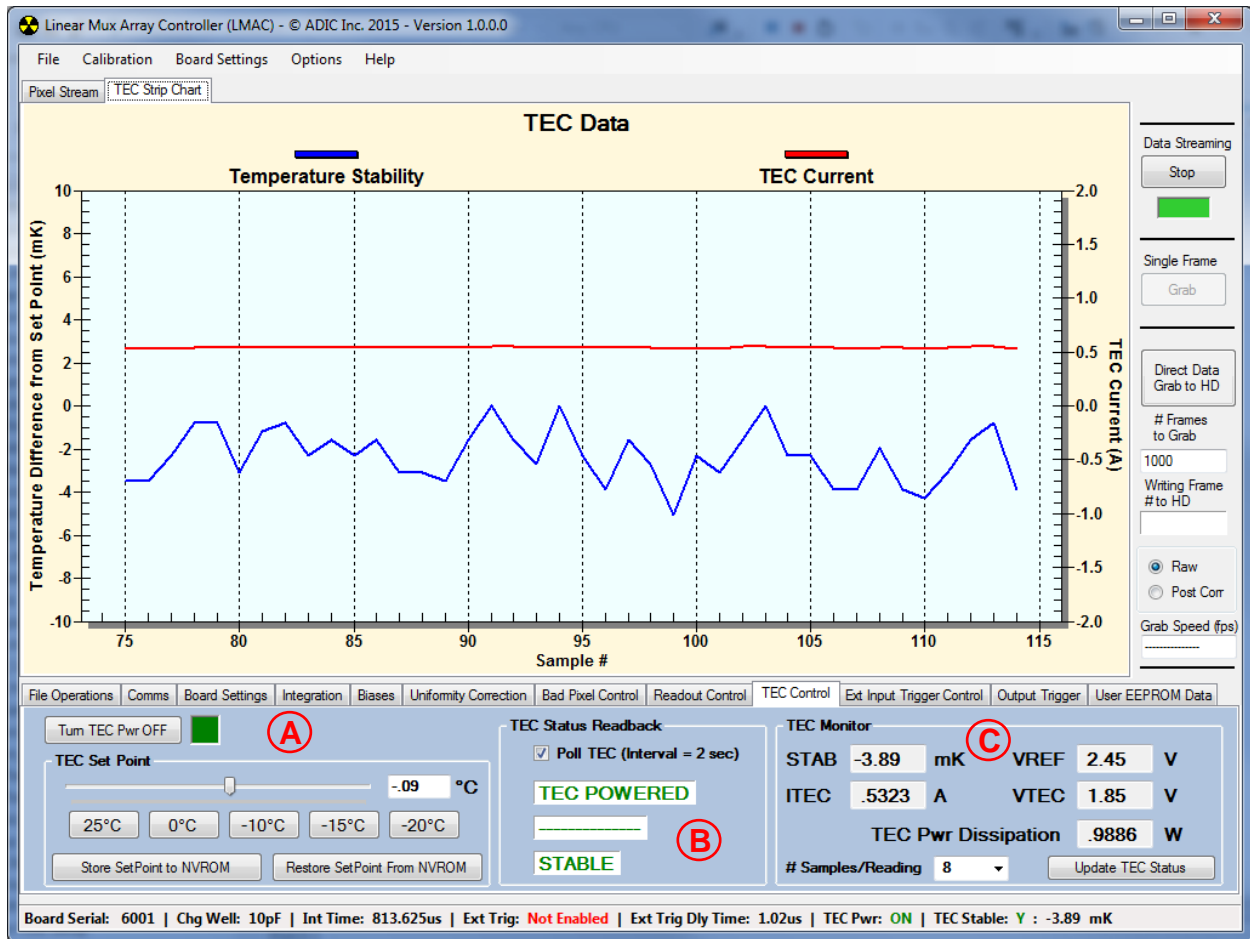


Figure 12: TEC Control Subpanel – TEC Strip Chart Graph Shown

The TEC (thermal electric cooler) control subpanel allows control and monitoring of the thermal electric cooler installed in the array package if the TEC controller board is installed underneath the main array board. The controls on this subpanel are disabled and hidden from the user if no TEC controller board is detected when communications to the main array board are opened.

Area (A) in the figure is where TEC power on/off and the TEC set point temperature is set. The button “Turn TEC Pwr xx” controls the TEC power. When the box to the right of the button is green the TEC power is on, and when the box is red the TEC power is off. The button label changes state whether the TEC power is on or off, it will either say “Turn TEC Pwr OFF” or “Turn TEC Pwr ON”.

The TEC temperature set point is set by either the slider or the preset temperature buttons in the TEC Set Point group box. The buttons in the bottom of the group box will store or recall the current runtime temperature set point value in the TEC controller board to/from an EEPROM memory on the TEC controller board. Keep in mind that even though the temperature control range will go down to ~ -21 degrees C, that doesn't

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mean you can actually attain that cold of temperature. The limit to how cold of temperature the TEC will stabilize at depends on many factors, primary of which is what is the heat load from the array and how well the TEC is heat sunked. The array board should easily be able to stabilize the TEC temperature down to temperatures in the range of -10 to -15 degrees C, but is unlikely to stabilize with a set point of -20 degrees C with the array and TEC in a standard 28 pin tub package with moderate heat sinking. If the TEC cannot stabilize at the set point temperature that is set, then after a certain amount of time attempting to stabilize without stabilizing, the TEC will automatically shut itself off to avoid being damaged. In this case set the set point temperature to a higher temperature that will stabilize.

Area (B) in the figure, when the checkbox “Poll TEC” is checked, will display the current power state, whether the TEC is cooling or heating, and whether the TEC temperature is stable or not. When TEC polling is turned on and the TEC is not stable, the polling rate is once every 0.5 seconds. Once the TEC is stable, the polling rate backs off to once every 2 seconds. During TEC polling, every time the TEC controller is polled the data in area (C) and the TEC strip chart area are updated with new values. The strip chart shows the TEC current and the temperature delta from the set point. When stable, the temperature delta will read less than +/- 10mK, generally in the +/- 5mK or less. Whether it is positive or negative depends on the operating conditions and the ambient temperature. The actual stability of the TEC temperature will be the delta between the upper and lower peaks of the blue curve on the graph.

Area (C) in the figure shows the instantaneous read out values of the TEC status information for the last time the TEC was polled. The STAB number is the representation in kelvin of the output of the error amplifier of the TEC controller which is the difference between the actual current temperature and the set point temperature. VREF is a reference voltage on the TEC controller board and should always read ~ 2.45V to ~ 2.50V. ITEC and VTEC are the current through the TEC and the voltage across the TEC respectively. The TEC power dissipation is computed from the ITEC and VTEC numbers. The “# Samples/Reading” combo option sets the number of readings averaged inside the TEC controller processor before being sent to the PC. The button “Update TEC Status” allows the user to manually request a onetime status update of the TEC if polling is turned off.

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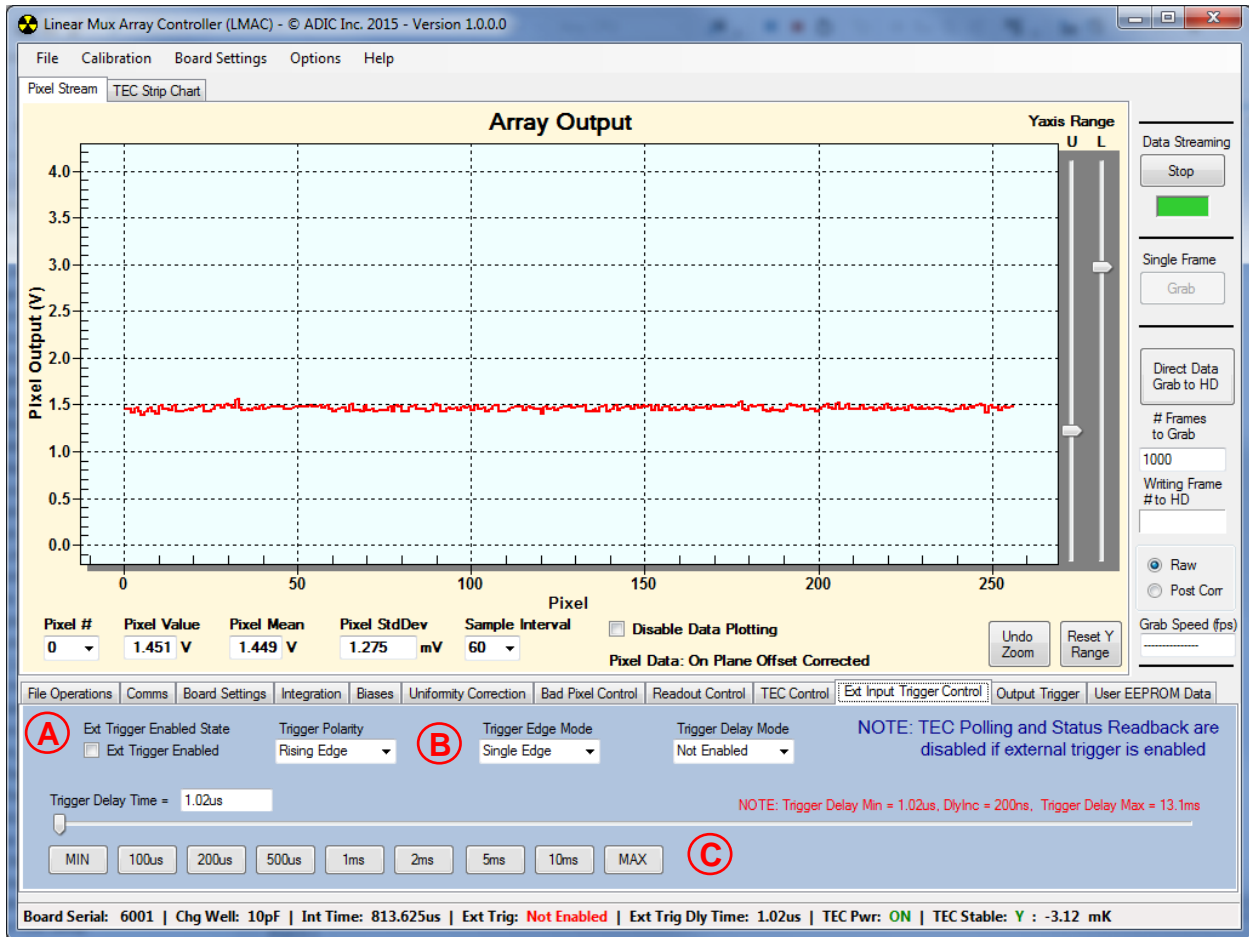


Figure 13: External Input Trigger Control Subpanel

The external trigger control subpanel turns the external trigger function on/off and configures how the array board is externally triggered for the start of integration.

The array integration time and array readout is initiated by a software request for data when the external trigger is disabled, and initiated by an external trigger TTL pulse when external trigger mode is enabled.

The external trigger input is enabled or disabled by the “Ext Trigger Enabled” checkbox (A). When the external trigger input is disabled, the trigger polarity, trigger edge mode, trigger delay mode, and trigger delay time have no effect on the operation of the array board.

The polarity of the input pulse that triggers data collection when external triggering is enabled and the trigger edge mode is set to single is set by the “Trigger Polarity” combo box in area (B) of the figure. The “Trigger Edge Mode” combo box selects either single or dual edge triggering. In dual edge triggering data collection is initiated on both the rising and falling edge of the input trigger.

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The “Trigger Delay Mode” combo box allows enabling or disabling a delay time between the external input trigger edge and when data collection (integration time) begins. The trigger delay time is set in area (C) of the figure either by the slider or the preset delay time buttons. The minimum settable delay is ~ 1.02us and the maximum delay is ~ 13.1ms. The delay is set in increments of 200ns.

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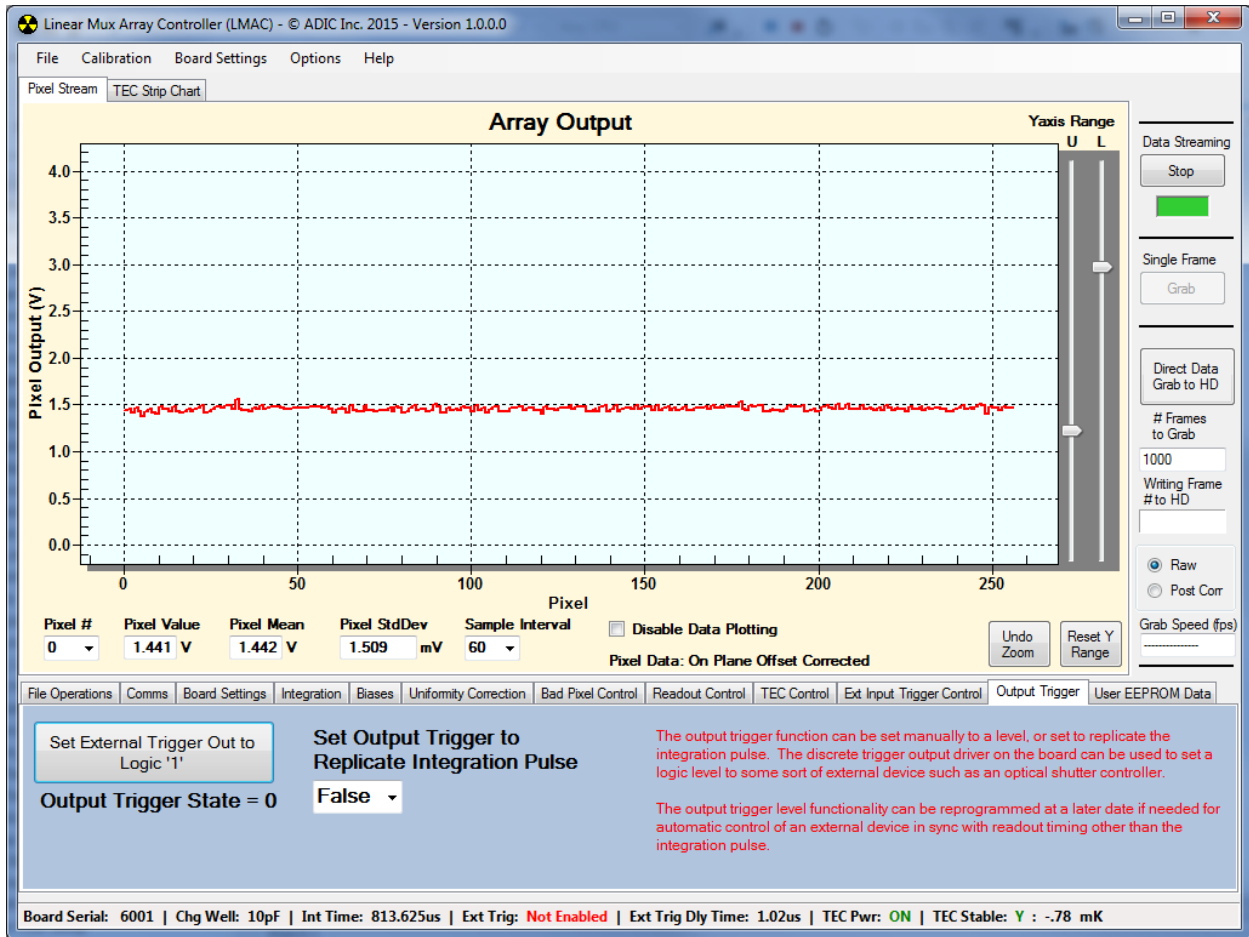


Figure 14: Output Trigger Subpanel

The output trigger subpanel controls an output logic signal from the array board. In this current software, it can be used in two different ways, a logic level state controlled by the “Set External Trigger Out to Logic “x””, or to replicate the integration control pulse to the array. The output trigger logic pulse can be used to control some external device such as a shutter control module. If it is desired to be in sync with the array timing other than the integration control pulse, a custom version of array board firmware could be created by ADIC.

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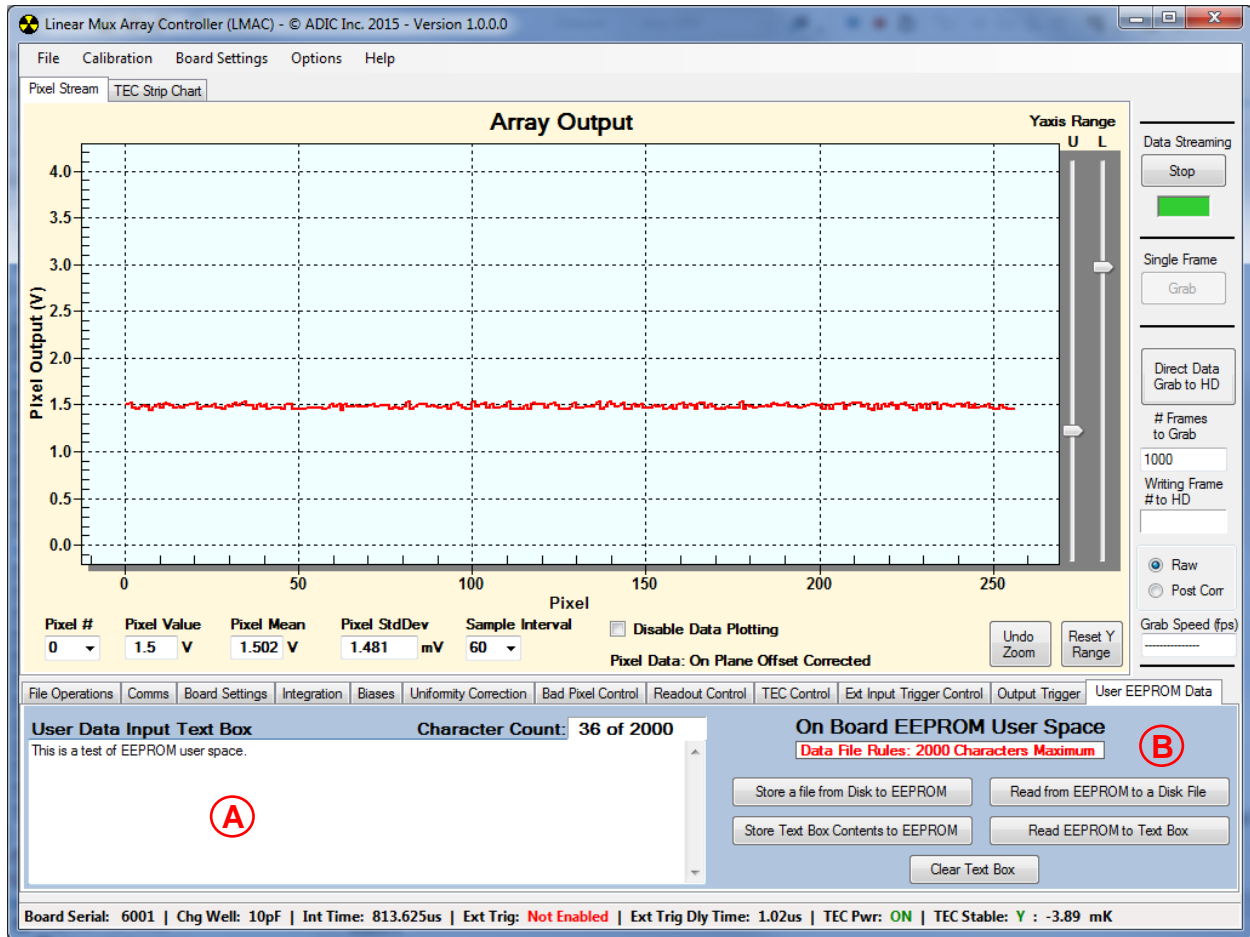


Figure 15: User EEPROM Data Subpanel

The array board has 2000 bytes available in the on board EEPROM for user data. Since a character is a byte, 2000 characters of text data can be stored/retrieved to/from the array board. This is useful if test setup information for a particular configuration or other data is desired to be stored and linked to a specific array board.

In area (A) of the figure, the user can type anything desired into the text input box to be stored to the array board memory. In the upper right of the text box is a character counter that keeps track of how many of the 2000 characters are currently in use. Once 2000 characters are reached the text box will accept no more characters.

In area (B) of the figure are the control buttons for saving or restoring data to / from the EEPROM on the array board. Data can be stored from either the text input box in the subpanel or from a text file on disk. Data can also be read from the array board back to the text input box or to a file on the computer.

The "Clear Text Box" button will clear the contents of the text box for new entry, but doesn't alter the board's EEPROM data in any way.

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