



# FrameLink Express User Training



J.Egri 4/09



## Features

- Camera Link interface
- Two independent Base Camera Link inputs using mini-CL connectors.
  - Fully Camera Link compliant.
  - 20 – 85 MHz clock.
  - Bi-directional serial interface ( 9600 to 115.2K BAUD rates ).
  - CC[1:4] discrete signals.
- Medium Camera Link input...can be supported in the future.
- Full Camera Link input...cannot be supported in the future.
- PoCL ( Power over Camera Link ) is not supported.
  
- ExpressCard Interface
- 54mm form factor.
- PCIe x1 interface providing 235 Mbytes/sec of throughput.
- Scatter/Gather DMA ( Direct Memory Access ) engine using 4K pages.
- Flow-thru pipelined architecture for low latency.



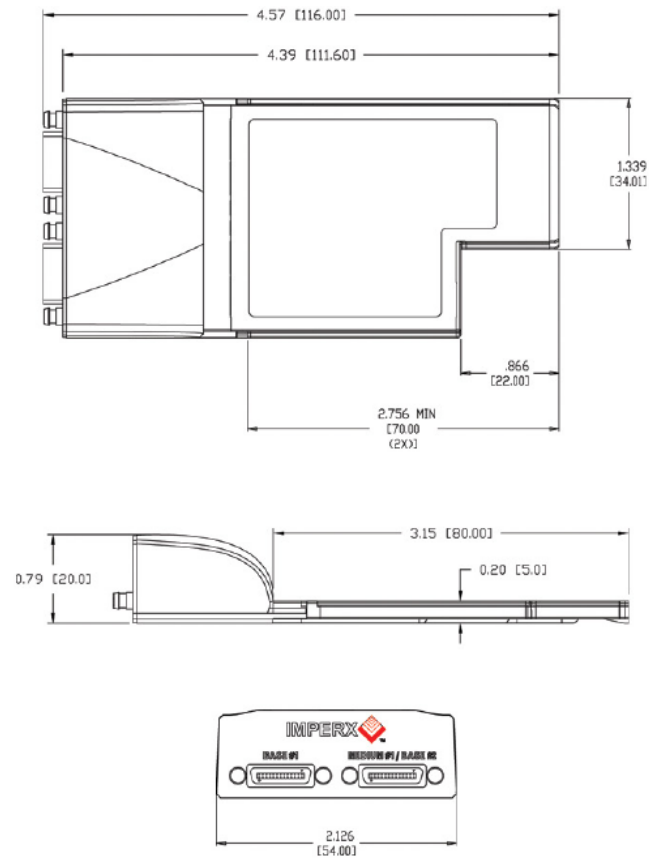
## Features (cont.)

- Features
- Master/Slave CC pulse generators with channel cross-coupling.
- Lookup table.
- Histograms.
- RGB gain/offset with auto-white balance.
- Hex pixel dump.
- Capture single frame, multiple frames or AVI clips.
- Save RAW, BMP, TIFF, JPEG or AVI files.
- Unique 'Auto-Learn' capability for easy CAM file creation.
- Firmware 'Remote Upgrade' capability.

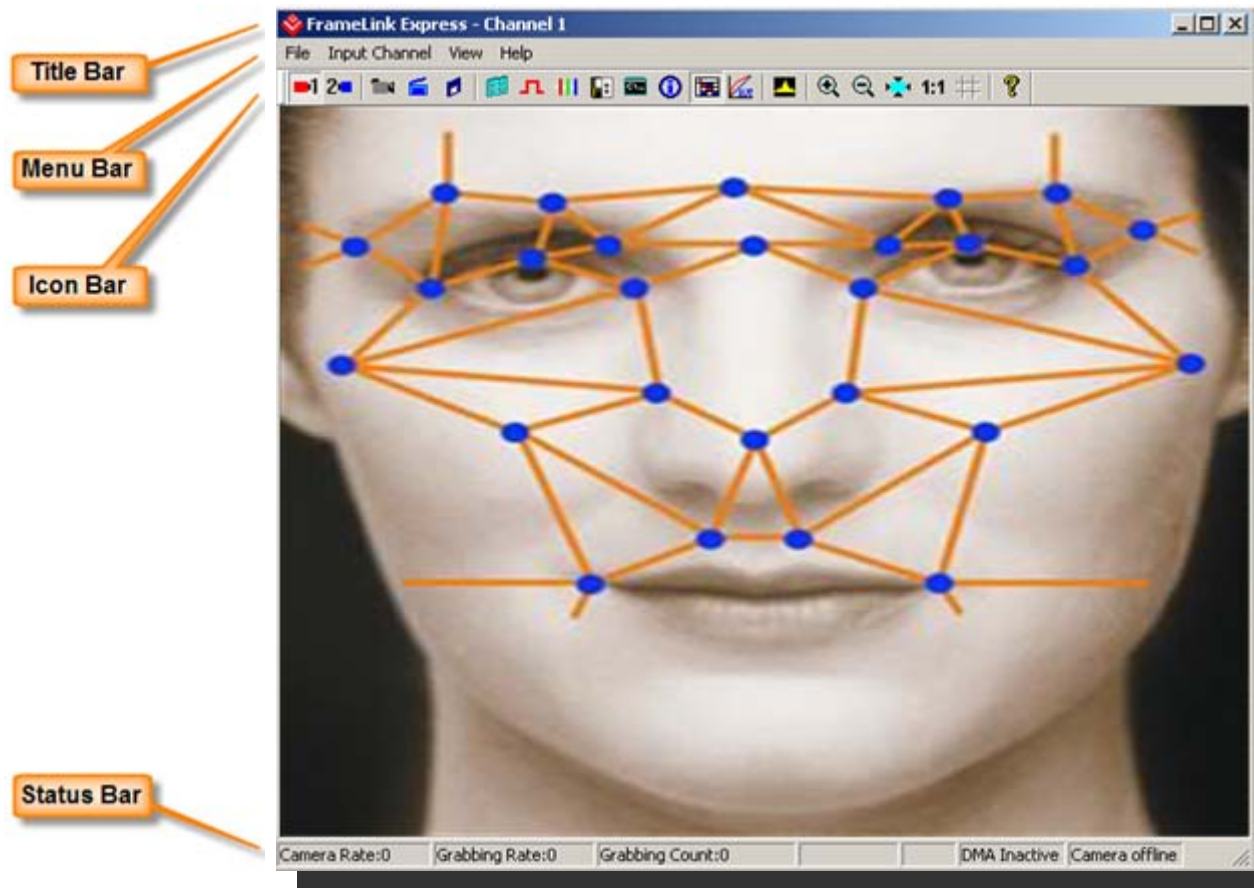


## Features (cont.)

- Mechanical
- ExpressCard 54mm form factor.
- 38 mm I/O extension.
- 4.6" x 2.1" x 0.8" overall size.
- 1.91 oz. ( 53.6 g ).
  
- Power
- 3.3 VDC +/- 5%.
- 500 mA steady current.
- 1.65 W constant power.



- Consists of a Title bar, a Menu bar, an Icon bar and a Status bar.

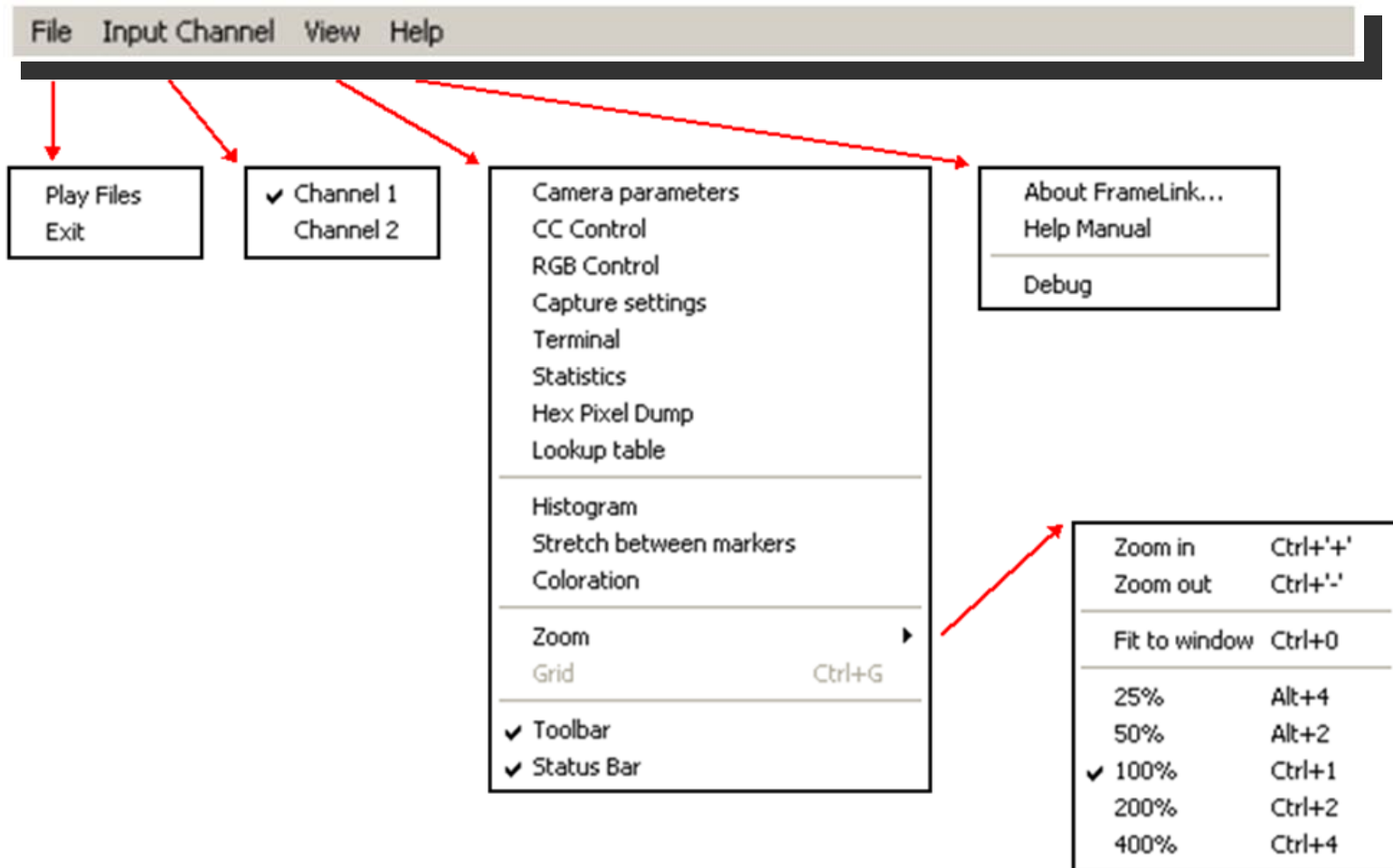
























## Title Bar



- Reflects the name assigned to the Camera Link port that is currently selected.
- A name of 'Channel 1' or 'Channel 2' is used as a default.
- The user can replace this default name by filling in the 'Alias' field in the 'Camera Parameters' dialog.



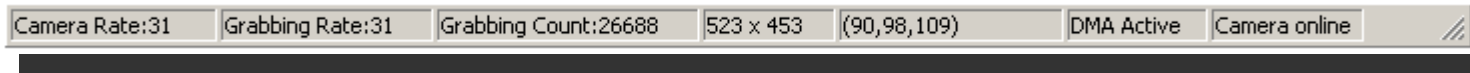


	Select <b>Channel #1</b>		Open <b>Statistics</b> dialog
	Select <b>Channel #2</b>		Open <b>Hex Pixel Dump</b> dialog
	Start/stop continuous <b>Grab</b>		Enable/disable <b>Lookup Table</b> processing
	<b>Snap</b> single frame		Open <b>Histogram</b> dialog
	Start/stop <b>Capture</b> to disk		<b>Zoom In</b>
	Open <b>Camera Parameters</b> dialog		<b>Zoom Out</b>
	Open <b>CC Control</b> dialog		<b>Fit to Window</b>
	Open <b>RGB Control</b> dialog		<b>Zoom 1:1</b>
	Open <b>Capture Settings</b> dialog		Turn <b>Grid</b> on/off
	Open <b>Terminal</b> dialog		<b>Help</b>



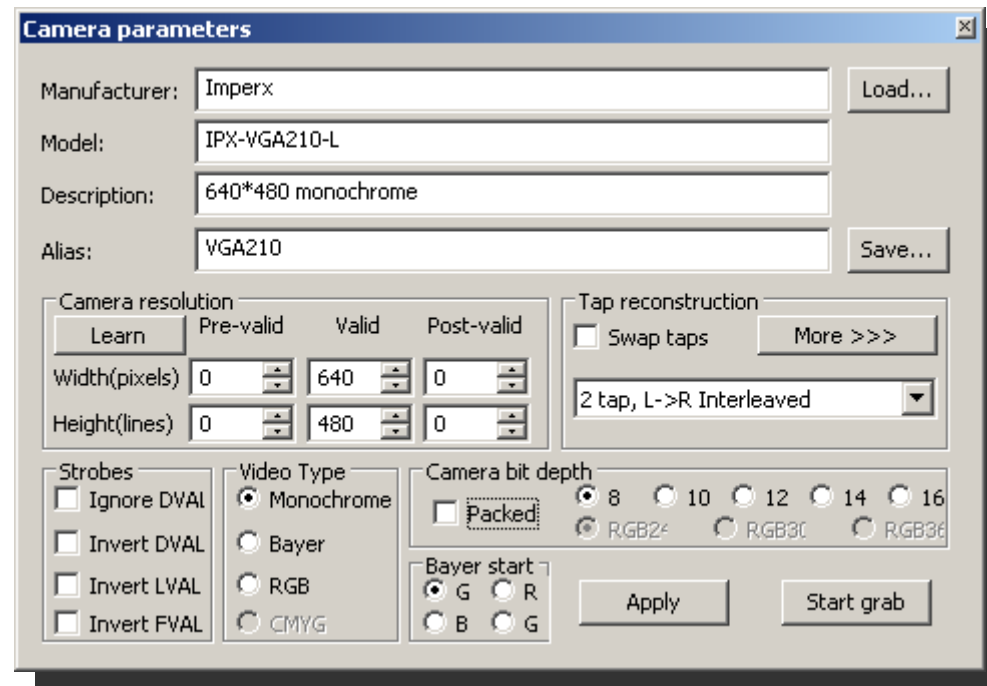


## Status Bar

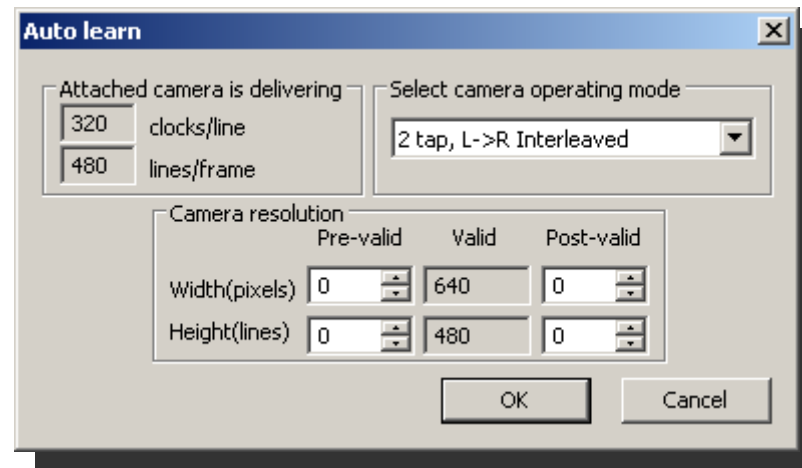


- Camera Rate**            Displays the real-time frame rate of the attached camera as measured at the input of the FrameLink Express card.
- Grabbing Rate**        Displays the real-time rate at which frames are being transferred from the card into host memory.
- Grabbing Count**      Displays a running count of the total number of frames transferred into system memory. This counter is reset when 'grabbing' is stopped.
- Pixel Coordinates**    Indicates the x,y coordinates of the pixel at the current cursor position.
- Pixel Value**            Indicates the value ( grayscale or RGB ) of the pixel at the current cursor position.
- DMA Status**            Displays the real-time status of the DMA process as being either : '**active**' or '**inactive**'.  
'**Active**' indicates that the user has commanded the FrameLink Express to acquire video data by clicking on the 'Start Grab' button and that the camera is providing valid framing.  
'**Inactive**' indicates that either the user has commanded the FrameLink Express to stop acquiring video data by clicking on the 'Stop Grab' button or that grabbing is enabled but the camera is not providing valid framing.
- Camera Status**        Displays the real-time status of the attached camera as being either : '**online**' or '**offline**'.  
'**Online**' indicates that the camera is powered on, attached and providing a video clock via the CameraLink interface.  
'**Offline**' indicates that the FrameLink Express card is not receiving a video clock from the camera either because the camera is powered off or the CameraLink cable is disconnected.

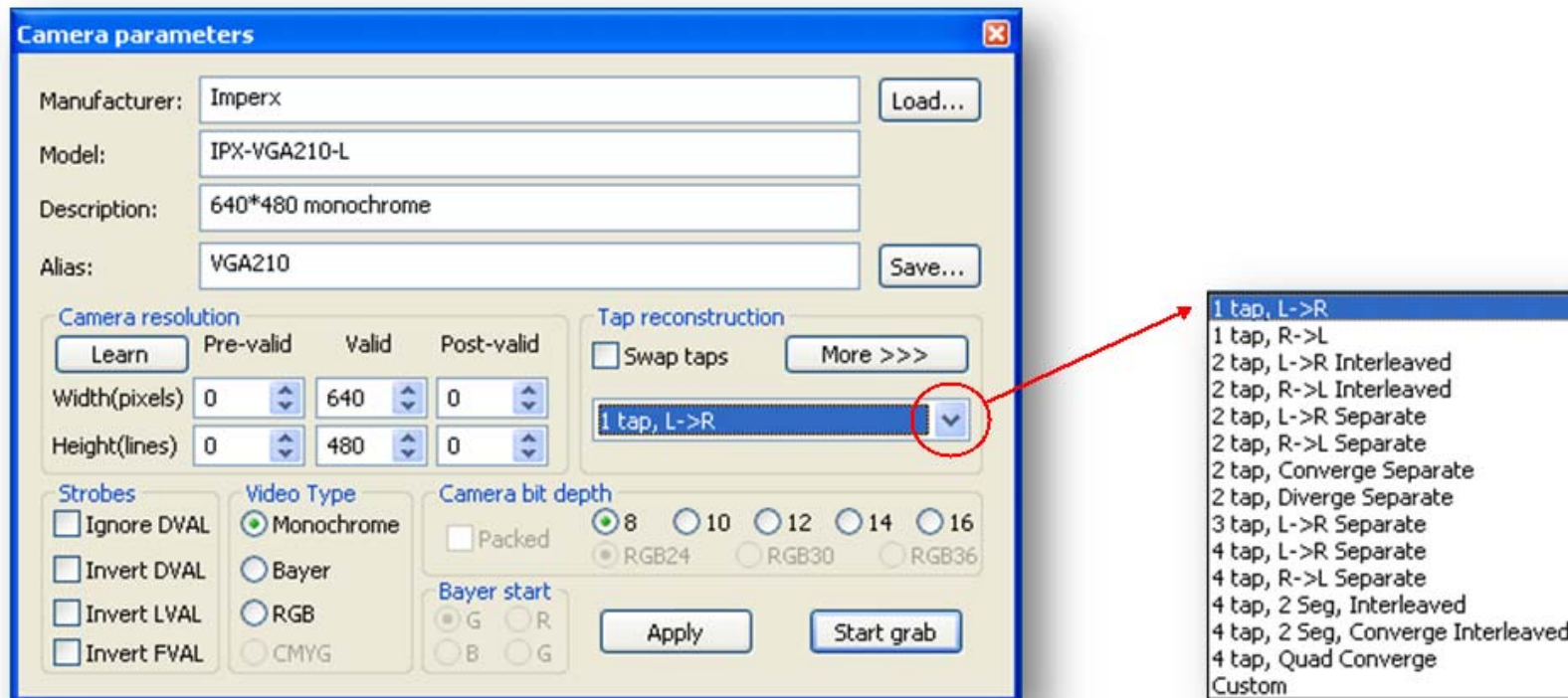
- Specifies all camera related parameters.
- Informs the FrameLink Express about how to reconstruct the image.
- Can 'save' and 'load' CAM files to/from disk.



- Feature unique to Imperx FrameLink Express frame grabber.
- Simplifies CAM file creation.
- Automatically 'learns' camera parameters by measuring Camera Link signals.



- Specifies the order in which pixels are delivered by the camera.
- Specifies the number of taps utilized to deliver the image.

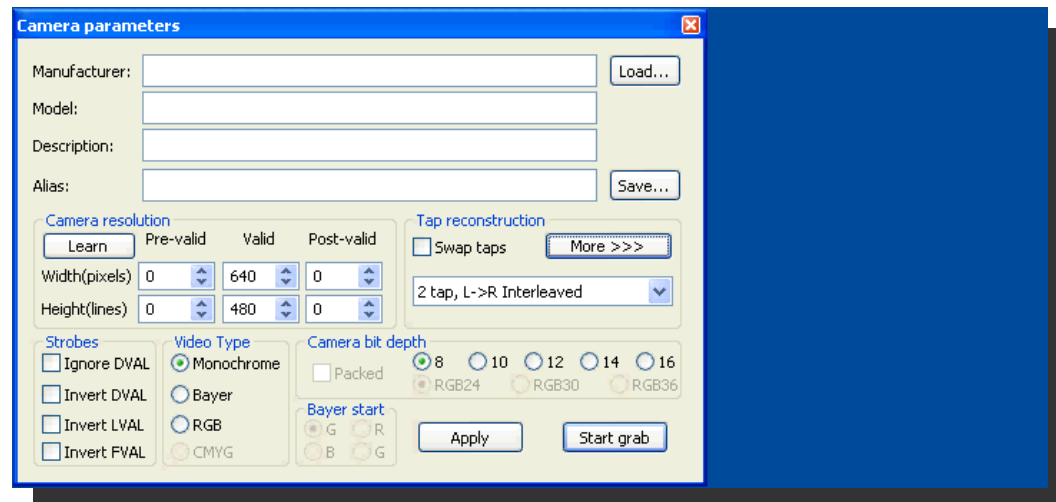
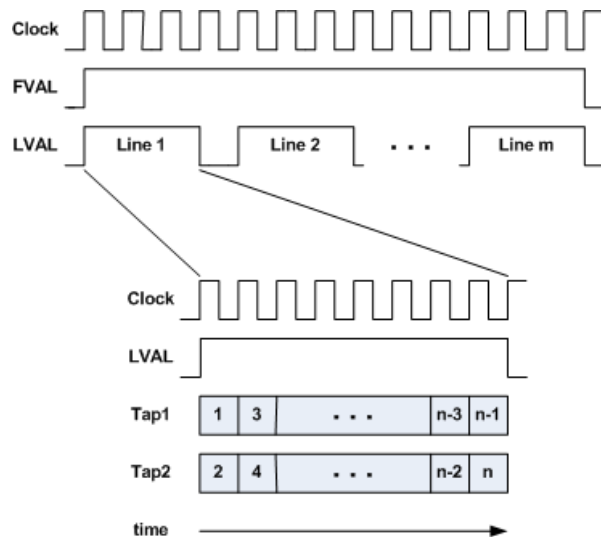


The screenshot shows the 'Camera parameters' dialog box. The 'Tap reconstruction' section is highlighted, showing a dropdown menu with the following options:

- 1 tap, L->R
- 1 tap, R->L
- 2 tap, L->R Interleaved
- 2 tap, R->L Interleaved
- 2 tap, L->R Separate
- 2 tap, R->L Separate
- 2 tap, Converge Separate
- 2 tap, Diverge Separate
- 3 tap, L->R Separate
- 4 tap, L->R Separate
- 4 tap, R->L Separate
- 4 tap, 2 Seg, Interleaved
- 4 tap, 2 Seg, Converge Interleaved
- 4 tap, Quad Converge
- Custom

# Tap Reconstruction Example #1

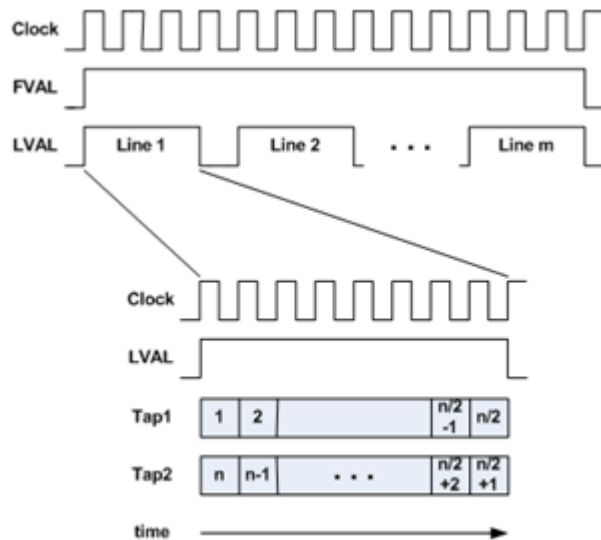
- 2 tap, L->R Interleaved
  - Odd pixels (red) are delivered on Tap1 from Left-to-Right.
  - Even pixels (green) are delivered on Tap2 from Left-to-Right.



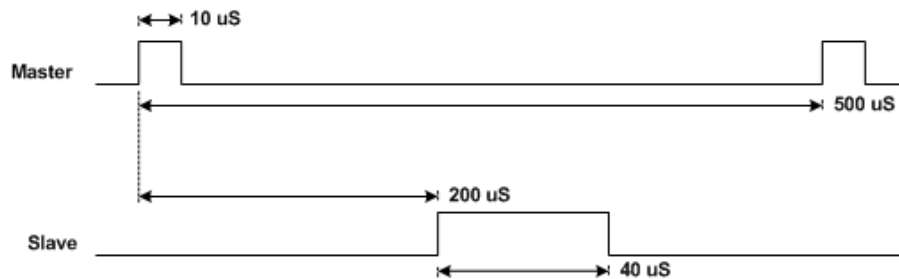
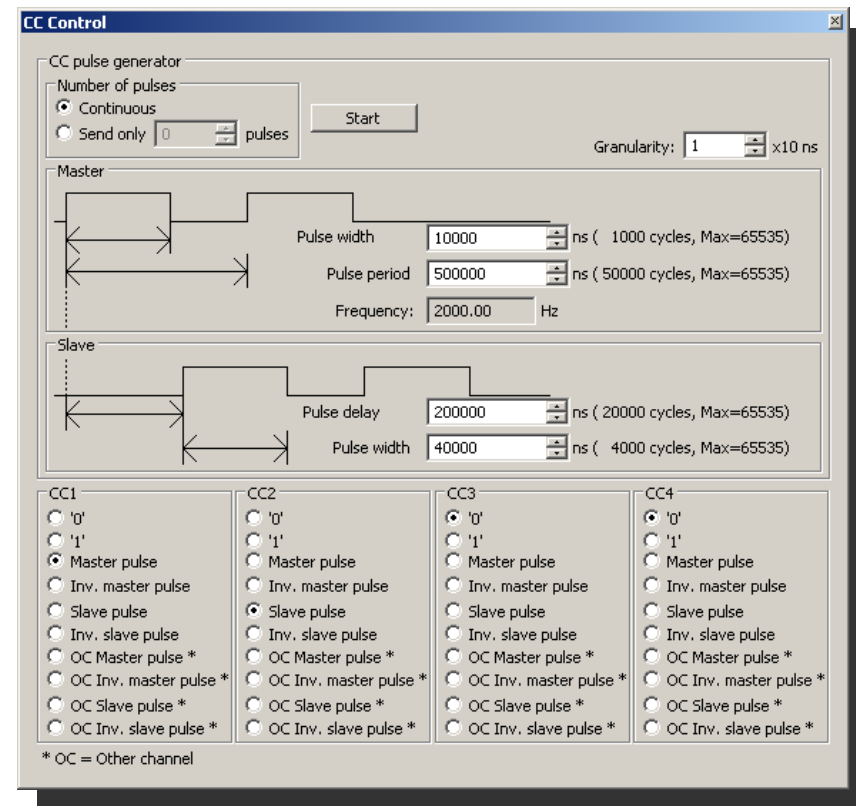


# Tap Reconstruction Example #2

- 2 tap, Converge Separate
  - Left half pixels (red) are delivered on Tap1 from Left-to-Center.
  - Right half pixels (green) are delivered on Tap2 from Right-to-Center.

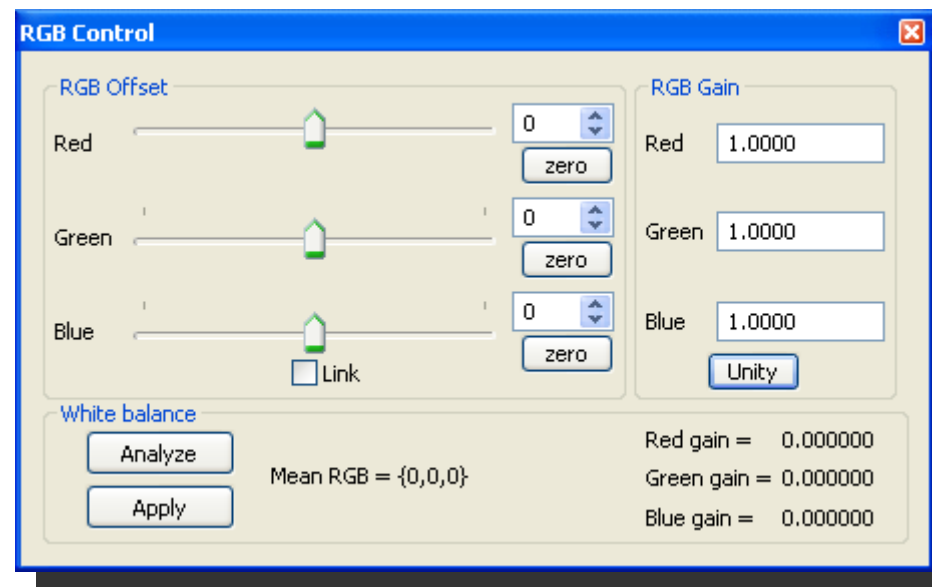


- Dual master-slave pulse generators per channel.
- Continuous or programmable number of pulses.
- Cross coupling between Camera Link channels.

The screenshot shows the 'CC Control' software interface. It features a 'CC pulse generator' section with a 'Number of pulses' dropdown set to 'Continuous' and a 'Start' button. The 'Granularity' is set to 1 x10 ns. Below this are sections for 'Master' and 'Slave' pulse parameters. The 'Master' section includes 'Pulse width' (10000 ns), 'Pulse period' (500000 ns), and 'Frequency' (2000.00 Hz). The 'Slave' section includes 'Pulse delay' (200000 ns) and 'Pulse width' (40000 ns). At the bottom, there are four columns (CC1, CC2, CC3, CC4) for selecting pulse types (e.g., '0', '1', Master pulse, Slave pulse, etc.) and their coupling to other channels (OC).

- Programmable RGB Gain and Offset.
- Automatic white balance feature computes RGB gains.

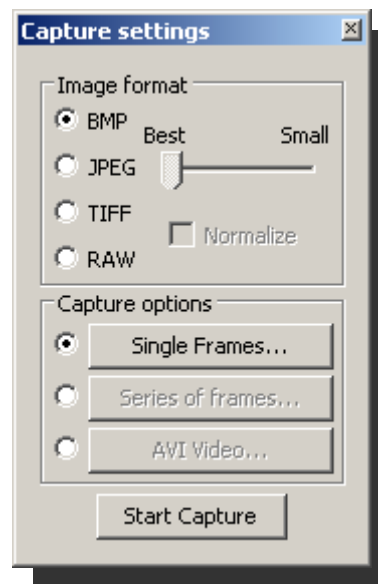




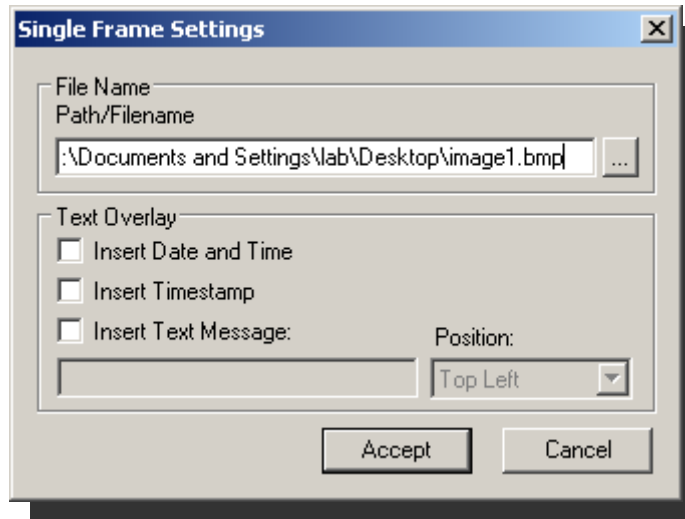


## Capture Settings

- Specifies file format for images saved to disk.
- Specifies capture mode.

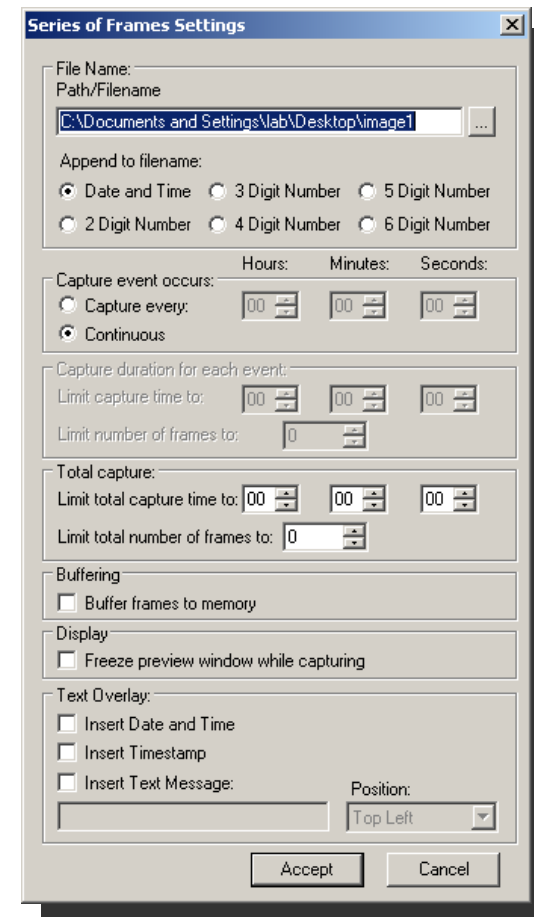


- Used to record one frame only.
- Specify the path and filename for the recorded file.
- Insert optional date/time/timestamp/text to be overlaid on image saved.
- The overlay text is destructive ( i.e. persistent ) to the image saved.



## Series of Frames

- Used to record multiple frames.
- Specify the path and filename for the recorded file.
- Insert optional date/time/timestamp/text to be overlaid on images saved.
- The overlay text is destructive ( i.e. persistent ) to the image saved.
- Specify capture event frequency.
- Specify capture duration for each event.
- Specify capture limits.





# Series of Frames Examples

- **Example #1:** To capture 5 frames, every 1.5 hours, over a 12 hour period.

Capture event occurs: Capture every: 01 Hr 30 Min 00 Sec  
Capture duration for each event: Limit number of frames to: 5  
Total capture: Limit total capture time to: 12 Hr 00 Min 00 Sec

- **Example #2:** To capture 5 minutes worth of images, every 15 minutes and not to exceed a total of 250 images.

Capture event occurs: Capture every: 00 Hr 15 Min 00 Sec  
Capture duration for each event: Limit capture time to: 00 Hr 05 Min 00 Sec  
Total capture: Limit total number of frames to: 250

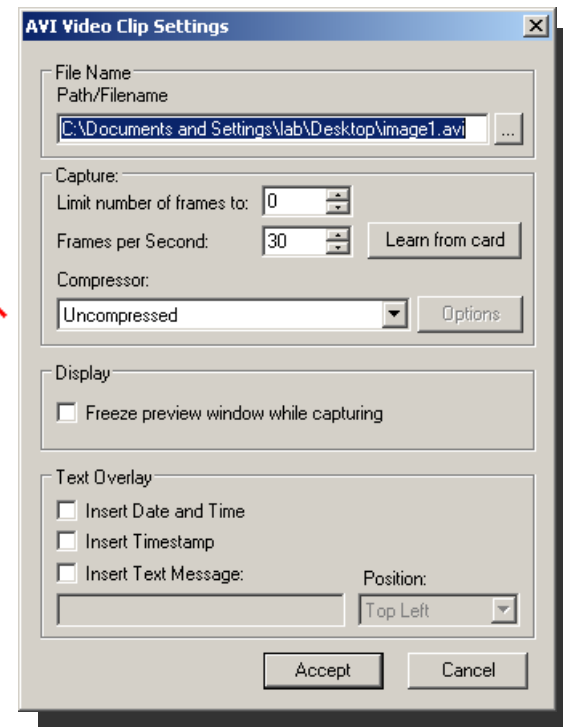
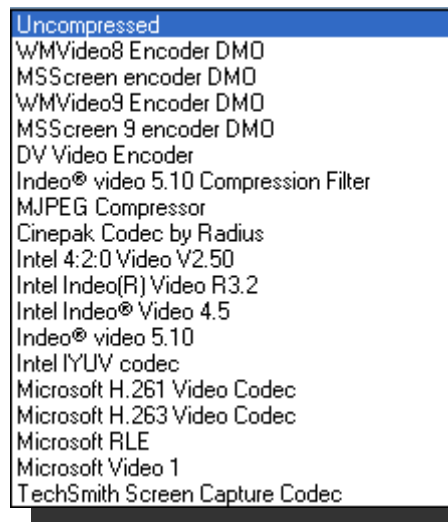
- **Example #3:** To capture 10 frames, every 1 hour, over a 6 hour period and not to exceed a total of 300 images.

Capture event occurs: Capture every: 01 Hr 00 Min 00 Sec  
Capture duration for each event: Limit number of frames to: 10  
Total capture: Limit total capture time to: 06 Hr 00 Min 00 Sec  
Limit total number of frames to: 300

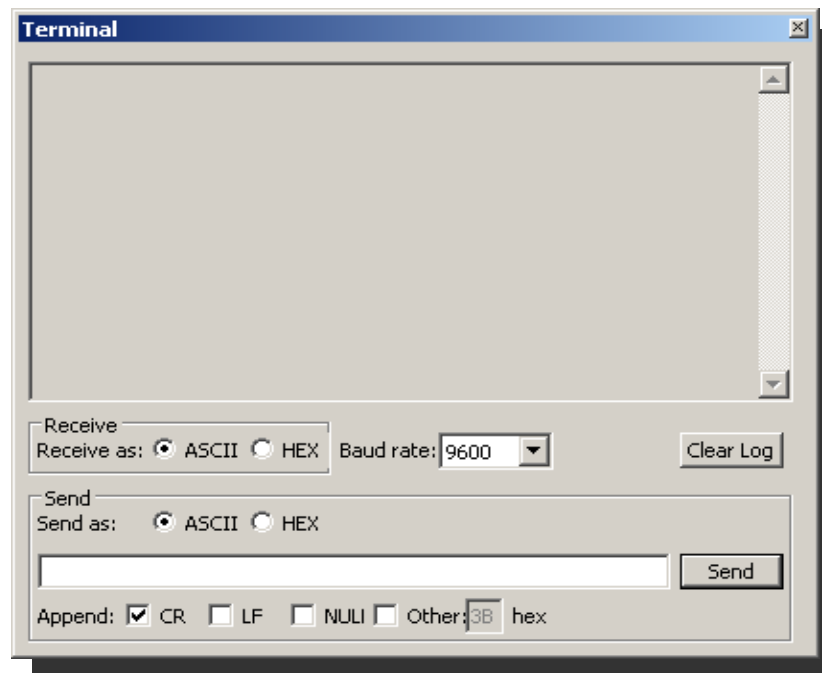
- **Example #4:** To capture continuously for a period of 2 hours and not to exceed a total of 100 images.

Capture event occurs: Continuous  
Total capture: Limit total capture time to: 02 Hr 00 Min 00 Sec  
Limit total number of frames to: 100

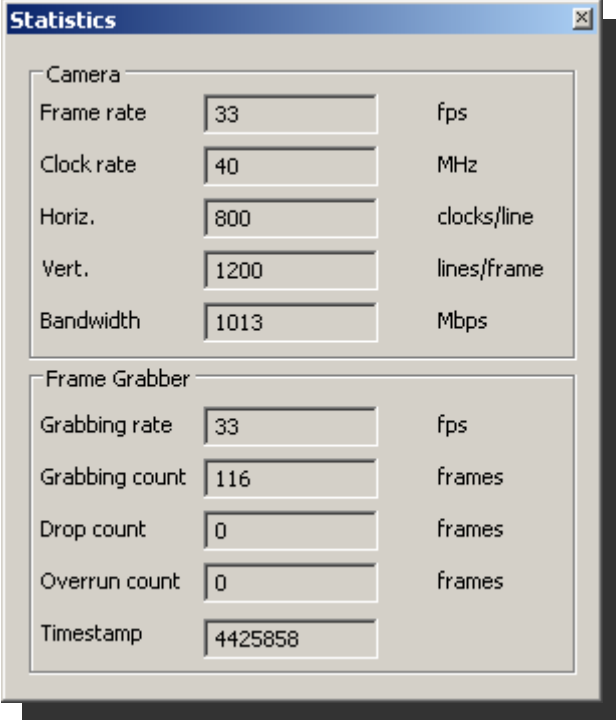
- Used to record AVI movies.
- Specify the path and filename for the recorded file.
- Insert optional date/time/timestamp/text to be overlayed on images saved.
- The overlay text is destructive ( i.e. persistent ) to the image saved.
- Specify capture limits.
- Specify codec compressor.
- Searches hard drive for all installed compressors.



- Terminal emulator for Camera Link serial interface.
- Allows user to send commands and receive responses to/from camera.
- Supports both ASCII and hexadecimal strings with programmable terminators.
- Configures BAUD rate from 9600 to 115.2K bps.



- Displays real time camera performance attributes.
- Displays real time frame grabber performance attributes.
- Useful in determining if frame grabber can keep up with the camera.



The screenshot shows a window titled "Statistics" with two sections: "Camera" and "Frame Grabber". Each section contains several performance metrics with their values and units.

Camera		
Frame rate	33	fps
Clock rate	40	MHz
Horiz.	800	clocks/line
Vert.	1200	lines/frame
Bandwidth	1013	Mbps

Frame Grabber		
Grabbing rate	33	fps
Grabbing count	116	frames
Drop count	0	frames
Overrun count	0	frames
Timestamp	4425858	



# Hex Pixel Dump

- Displays a two-dimensional table of real-time pixel values, plotting row ( Y ) vs. column ( X ), for a bounded region of pixels.
- The background color of each cell is grayscale or color coded.
- Hovering the mouse over a given pixel reveals both the pixel's hexadecimal and integer values.

Hex dump	099	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140			
232	092	090	092	09A	0A2	0AF	0A9	0AC	0AD	0BD	0AD	0AE	0B0	0AF	0AE	0AD	0AD	0B2	0AC	0AA	0B0	0B2	0B2	0B2	0B2	0AC	0B								
233	063	063	063	07D	09A	0A2	0A7	0A8	0AE	0AA	0AB	0B2	0AE	0AF	0B2	0AB	0AF	0AC	0AF	0AE	0B0	0AC	0B2	0B4	0B3	0AF	0AE	0B							
234	035	02C	034	064	095	09E	0A4	0A8	0A9	0AA	0AB	0AC	0B1	0A9	0A8	0AE	0AD	0AB	0AD	0AD	0AF	0B4	0AF	0B4	0AF	0AE	0AB	0B							
235	026	01F	020	05D	091	09F	0A3	0A9	0A9	0A9	0AD	0AF	0AD	0AE	0AC	0AF	0AA	0AD	0AC	0AF	0A9	0AB	0AE	0B2	0AD	0B2	0AD	0AE	0A						
236	022	01C	025	058	08A	09A	0A1	0A7	0AA	0A9	0A7	0A6	0A9	0AB	0AD	0AB	0A9	0A9	0A6	0AD	0AA	0AC	0AE	0B0	0A4	0AE	0AF	0A							
237	021	01C	024	056	086	095	0A0	0A7	0A5	0A9	0A5	0A9	0A7	0A7	0A7	0A5	0A6	0A0	0A5	0AC	0A9	0A7	0AD	0AB	0A5	0A5	0A5	0A							
238	022	01B	023	054	096	09D	0A1	0A4	0A4	0A5	0A9	0A9	0A0	09F	0A2	09C	09E	0A2	0A0	0A9	0A7	0AD	0AC	0A7	0A7	0AD	0A4	0A							
239	022	01B	023	054	091	09D	0A3	0A3	0A4	09F	09E	09E	09E	09F	09E	09E	09A	09E	0A2	0A5	0A4	0A5	0A3	09F	09E	09E	09								
240	024	01C	022	054	086	094	09C	0A2	0A5	09D	09D	09C	066	05B	05F	064	072	071	06E	09B	0A0	0A3	09A	091	081	07C	07F	09							
241	026	01C	021	04F	088	096	09A	098	09F	092	09B	038	040	030	02A	02C	031	030	049	064	096	09D	09C	092	070	031	03E	046	04						
242	027	01C	021	04F	088	096	09A	098	09F	092	09B	038	040	030	02A	02C	031	030	049	064	096	09D	09C	092	070	031	03E	046	04						
243	02A	01D	021	04E	077	08F	094	095	08A	05F	054	01F	01F	02B	030	03B	018	020	01D	024	03B	076	091	08A	06B	033	020	01F	03						
244	02A	01D	01F	04D	07D	08B	094	091	07F	0A8	011	01B	023	0B3	06D	05D	036	021	01B	02B	05A	09F	08A	0A9	0A9	02E	01D	01E	02						
245	027	01B	023	04E	07F	08F	092	08A	05C	02E	01B	020	01C	023	0B6	078	07E	04B	021	01B	022	046	07F	08E	073	041	01B	01E	02						
246	02B	01B	025	051	0A2	0A7	0A8	0A3	0A8	020	01A	029	065	078	0A6	0A7	07C	05B	02B	019	01B	033	0A0	063	078	046	015	01E	02						
247	027	01B	026	050	0A0	0A8	0A8	0A0	03C	01B	01A	032	0A0	082	08E	08E	080	08C	030	01A	01A	02D	067	085	080	0A0	030	01B	01						
248	02B	01C	025	04F	08B	097	086	061	034	019	01A	03B	06F	07C	08E	082	07A	064	027	01A	01A	027	060	082	089	068	03B	01A	01						
249	02B	01C	025	04F	08B	097	086	061	034	019	01A	03B	06F	07C	08E	082	07A	064	027	01A	01A	027	060	082	089	068	03B	01A	01						
250	02B	01C	025	04F	08B	097	086	061	034	019	01A	03B	06F	07C	08E	082	07A	064	027	01A	01A	027	060	082	089	068	03B	01A	01						
251	024	019	01B	043	07C	08F	080	05B	027	017	01B	01B	01F	021	023	022	020	020	01D	01C	020	02B	05E	08B	091	087	030	01							
252	021	016	01A	044	07B	08A	07F	05C	026	01B	01B	024	037	039	03F	049	045	042	03F	042	046	048	06D	091	092	080	071	03F	01						
253	020	017	01B	042	07F	08F	07E	05F	028	016	01B	033	04F	06A	071	079	077	070	06F	074	077	079	089	091	095	08B	07B	048	02						
254	025	016	01C	042	082	08B	084	05F	028	016	01B	03B	073	080	084	08A	08A	080	07F	071	081	08E	091	099	092	087	05E	02							
255	020	019	01B	038	07A	08B	084	05F	028	017	01A	03C	070	080	08D	093	090	089	07B	066	05F	065	075	095	096	093	08A	065	03						
256	022	016	017	03F	07A	08B	085	055	035	01A	01B	035	074	08D	093	094	08E	084	05E	038	02C	035	06D	08D	09B	09E	091	074	03						
257	01F	017	01B	041	07E	08D	088	072	041	01D	01B	02F	0A8	08E	08F	093	08B	080	0A8	027	01A	02C	065	08D	097	09A	092	074	03						
258	01F	01B	01B	042	07D	08A	097	07D	049	021	01A	027	05E	092	09D	099	091	046	022	01C	02B	070	092	09C	09B	09B	09A	04							
259	01F	017	01B	045	08D	08F	087	08D	05A	02B	01A	01B	03E	070	084	082	07A	05C	033	01C	01B	03D	07C	090	0A4	090	08E	07							
260	019	017	01D	045	08B	097	097	08C	06A	03F	01F	01B	026	04B	061	062	054	034	01F	01D	026	04C	086	09A	09C	0A2	09B	08							
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262	01F	01E	026	04A	08B	09B	09B	09B	08F	07A	05B	05A	026	021	023	022	01F	017	02A	043	043	043	08C	09C	0A2	0A7	0A5	0A8	09						
263	04C	04D	042	06A	091	09B	0A1	09B	09F	08F	07F	06C	027	043	01D	03A	03B	042	04B	07B	08A	09B	0A0	0A5	0A6	0A5	0A9	0A1	09						
264	071	08D	08D	08E	09E	0A0	0A5	0A2	09D	09B	095	09F	09E	07C	07F	071	074	07D	09B	09D	0A0	0A5	0A6	0A4	0A7	0A6	0A2	09							
265	09F	09F	09F	09E	0A4	0A2	0A5	0A7	0A4	0A4	0A1	09A	09E	09F	09F	09E	09F	09F	09F	0A4	0A4	0A5	0A3	0A3	0A6	0A4	0A6	0A							
266	0A1	0A0	0A0	0A1	0A7	0A8	0A4	0A9	0A8	0A7	0A6	0A4	0A3	09E	09E	09F	0A1	0A1	0A3	0A4	0A7	0A8	0A2	0A8	0A2	0A8	0A8	0A7	0A						

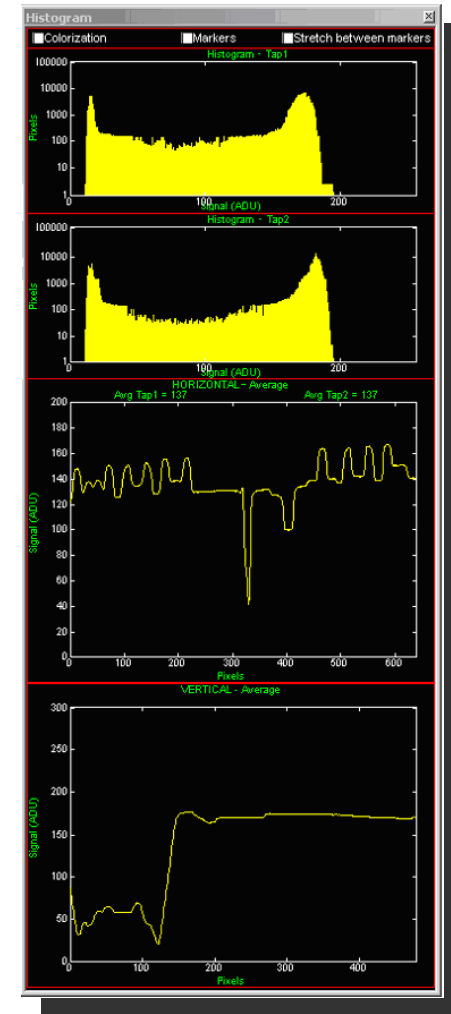
Hex dump	1264	1265	1266	1267	1268	1269	1270	1271	1272	1273	1274	1275	1276	1277	1278	1279	1280
93	R 76	R 71	R 6E	R 6C	R 6C	R 5E	R 52	R 3A	R 22	R 2B	R 33	R 3D	R 49	R 4A	R 4B	R 4B	R 4B
	G CC	G D0	G C8	G C6	G BB	G AD	G 7A	G 39	G 2A	G 25	G 36	G 45	G 46	G 49	G 4B	G 4E	G 4C
	B 79	B 79	B 77	B 77	B 77	B 77	B 51	B 45	B 45	B 47	B 79	B AB	B B8	B C6	B D8	B CA	B CA
94	R 73	R 71	R 6F	R 6E	R 6C	R 5E	R 52	R 3A	R 22	R 2B	R 33	R 3D	R 49	R 4A	R 4B	R 4B	R 4B
	G CB	G CB	G C5	G C5	G BE	G A7	G 84	G 47	G 28	G 2B	G 37	G 42	G 49	G 4A	G 4C	G 4C	G 4B
	B 79	B 79	B 77	B 75	B 75	B 77	B 5E	B 45	B 47	B 49	B 7B	B AD	B B8	B C6	B C6	B C8	B CA
95	R 70	R 70	R 71	R 6F	R 6E	R 60	R 52	R 3A	R 22	R 2B	R 33	R 3C	R 46	R 4B	R 4A	R 4A	R 4B
	G CC	G CE	G C8	G C5	G BE	G D0	G 7B	G 38	G 2C	G 29	G 37	G 45	G 4A	G 4D	G 4B	G 4B	G 4C
	B 7B	B 79	B 77	B 75	B 77	B 77	B 5E	B 43	B 45	B 49	B 79	B A9	B B6	B C6	B C6	B C8	B CA
96	R 73	R 71	R 71	R 6F	R 6C	R 5E	R 52	R 3A	R 23	R 2B	R 32	R 3C	R 46	R 49	R 4B	R 4B	R 4B
	G C8	G CA	G C5	G C6	G C2	G A9	G B3	G 48	G 28	G 2B	G 39	G 44	G 4D	G 4C	G 4A	G 4C	G 4F
	B 7B	B 79	B 77	B 77	B 77	B 79	B 5E	B 43	B 45	B 49	B 77	B A5	B B4	B C6	B C6	B C8	B CC
97	R 75	R 71	R 71	R 6F	R 6C	R 5E	R 52	R 3B	R 24	R 2B	R 32	R 3C	R 46	R 4A	R 4D	R 4D	R 4D
	G CC	G CE	G CA	G CA	G BF	G C6	G 7D	G 3D	G 2C	G 25	G 36	G 47	G 4C	G 4C	G 4C	G 4F	G 4D
	B 7D	B 7B	B 79	B 79	B 77	B 77	B 60	B 4E	B 47	B 47	B 77	B A7	B B6	B C6	B C6	B C8	B CA
98	R 71	R 71	R 71	R 6F	R 6C	R 60	R 53	R 3B	R 24	R 29	R 30						



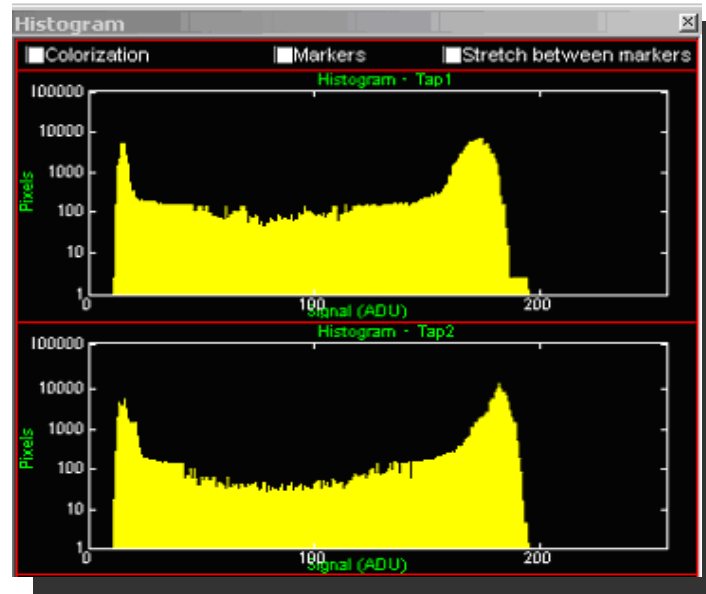


## Histogram Dialog

- Displays three graphs of the live image:
  - Histogram plot.
  - Horizontal Average plot.
  - Vertical Average plot.
- Provides advanced features including:
  - Colorization.
  - Markers.
  - Stretching.

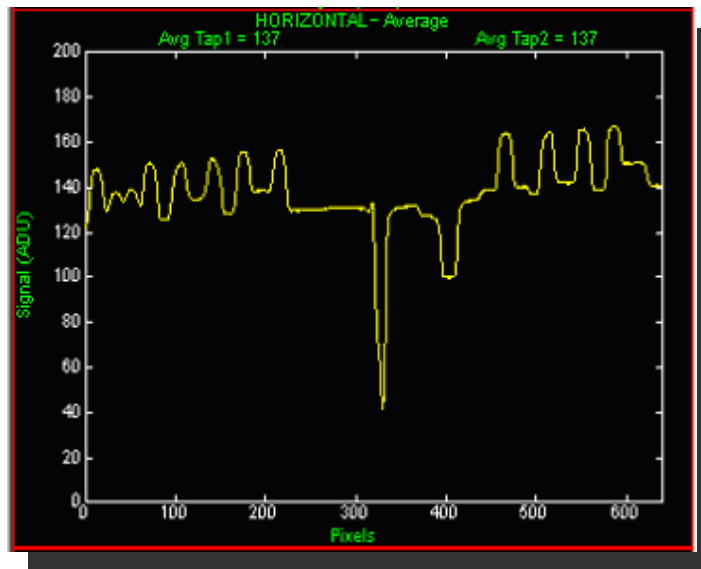


- Plots the histogram as a function of pixel frequency ( Y-axis ) vs. pixel value ( X-axis ).
- The range of the pixel value, in the X-axis, depends on the bit depth of the camera.
- Plots both taps separately.



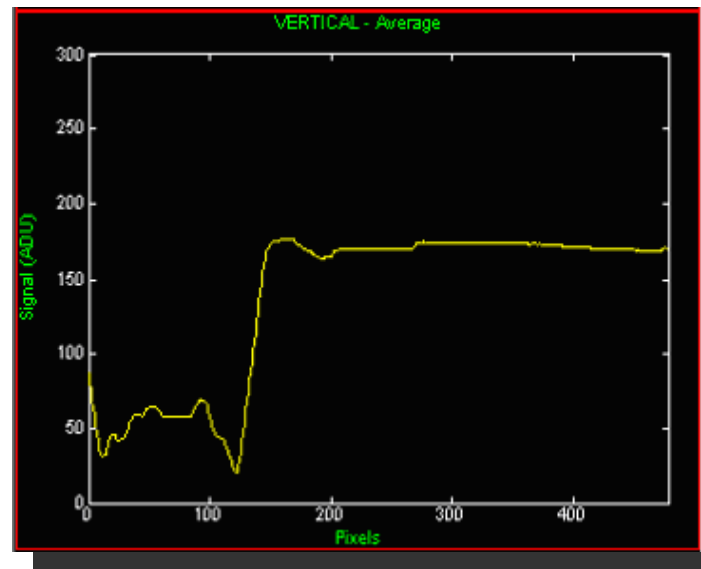
## Histogram Horizontal Average

- Plots the average value as a function of average pixel value ( Y-axis ) vs. horizontal position ( X-axis ).
- The average value for all pixels in a given column of the image is plotted on the Y-axis.
- The range of the horizontal positions, in the X-axis, depends on the number of columns in the frame.



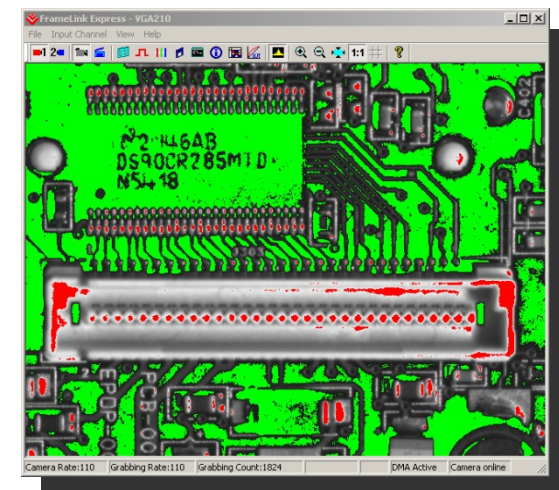
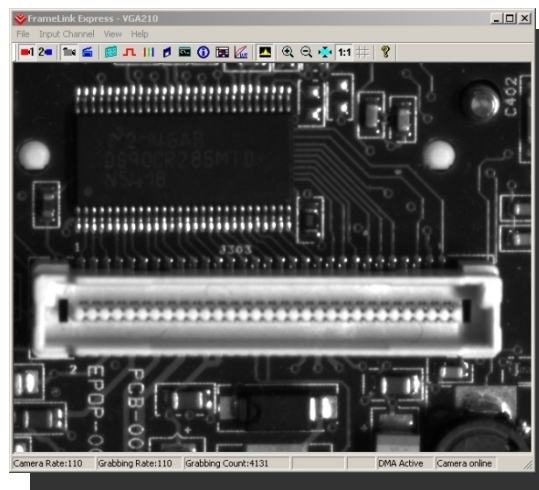
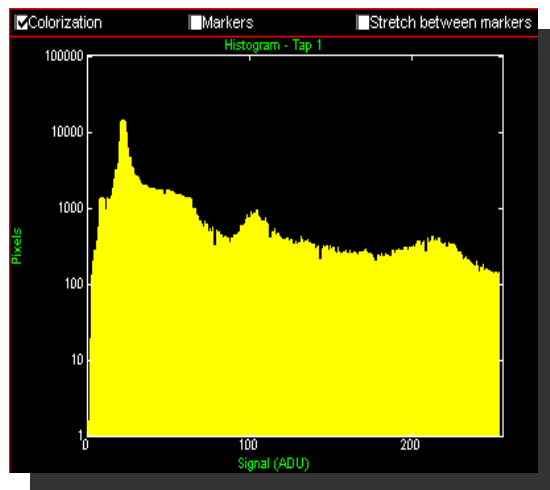
## Histogram Vertical Average

- Plots the average value as a function of average pixel value ( Y-axis ) vs. vertical position ( X-axis ).
- The average value for all pixels in a given row of the image is plotted on the Y-axis.
- The range of the vertical positions, in the X-axis, depends on the number of rows in the frame.



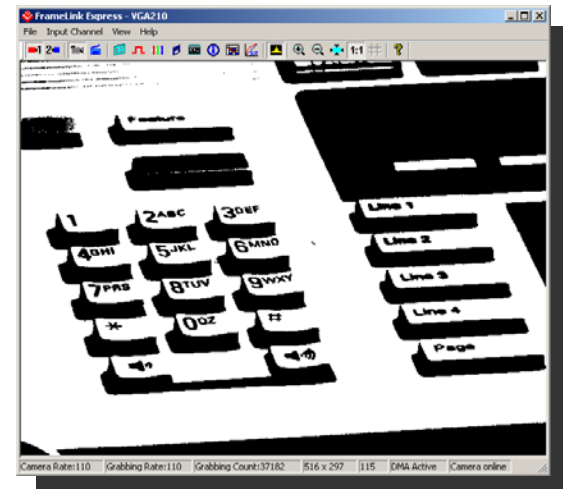
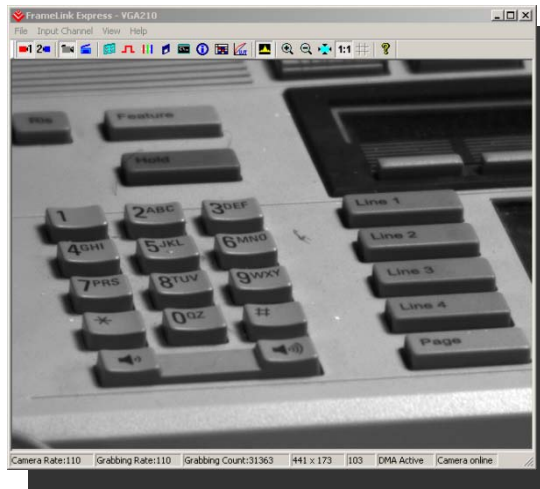
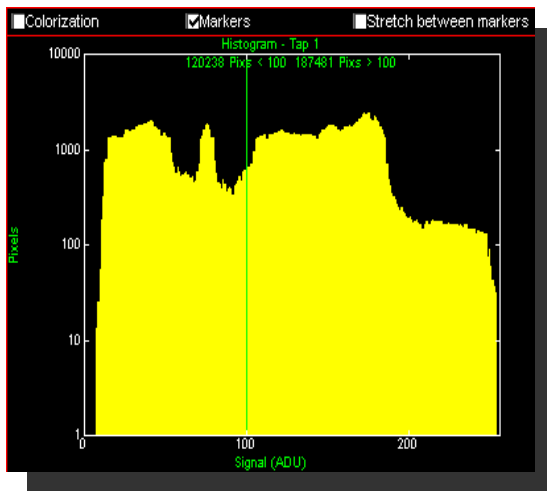
## Histogram Example #1

- **Colorization.**
- Replaces dark pixels (a value of 0x00), with green color.
- Replaces saturated pixels (a value of 0xFF), with red color.



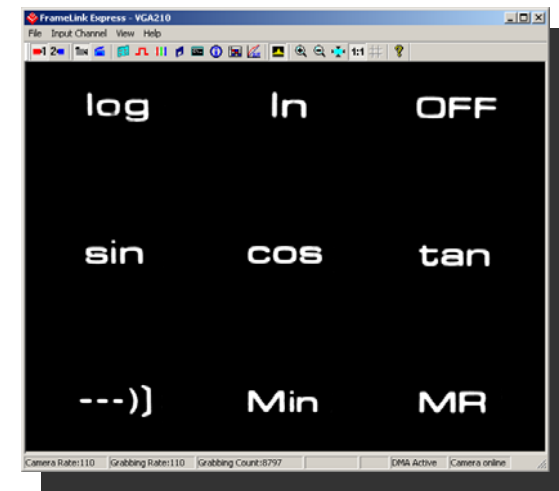
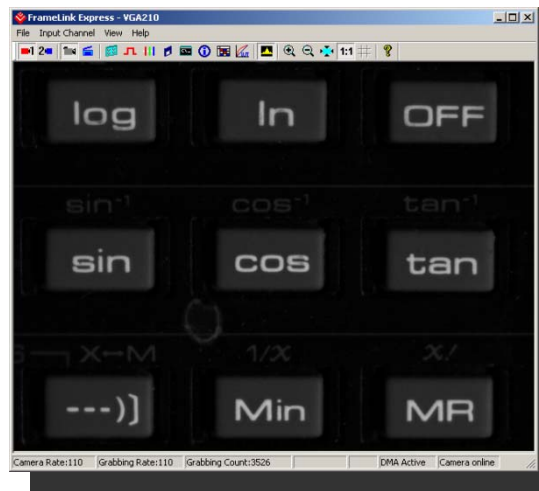
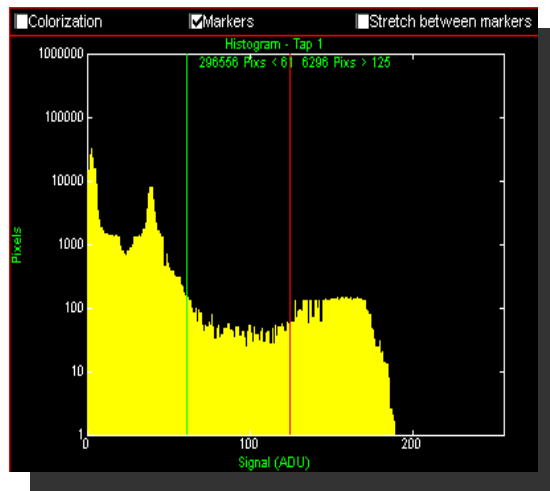
## Histogram Example #2

- **Markers – single threshold.**
- Creates an image with only two pixel values: dark (0x00) and saturated (0xFF).
- Replaces all pixel values below the marker with 0x00.
- Replaces all pixel values above the marker with 0xFF.



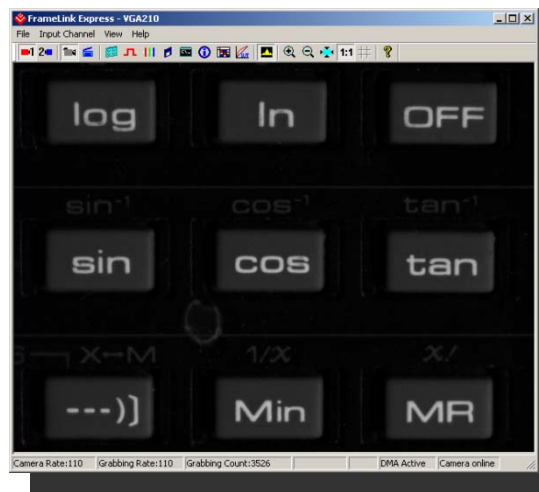
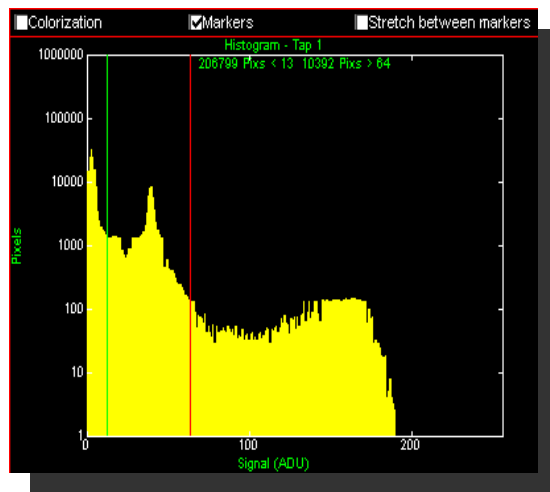
## Histogram Example #3

- **Markers – double threshold.**
- Replaces all pixel values below the green marker with 0x00.
- Replaces all pixel values above the red marker with 0xFF.
- All pixel values between the markers are unmodified.



## Histogram Example #4

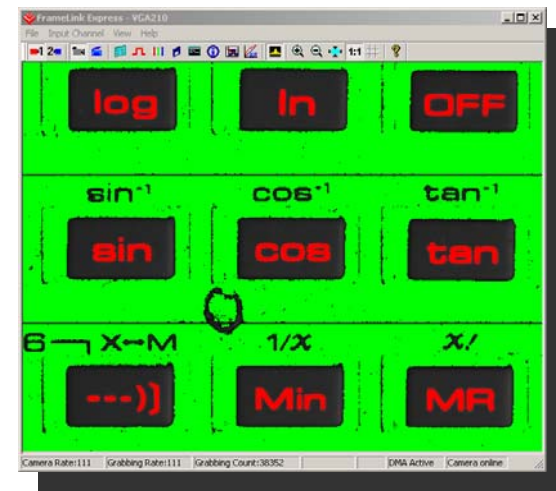
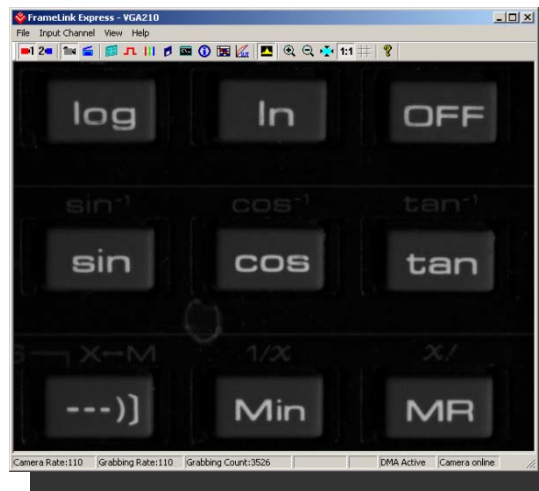
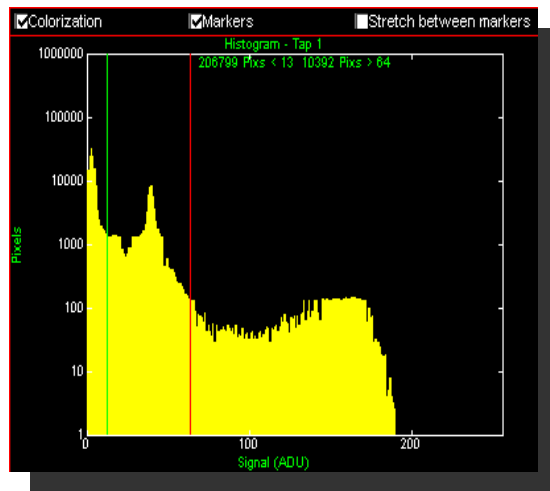
- **Markers – double threshold.**
- Same as Example #3 except that markers are moved lower.





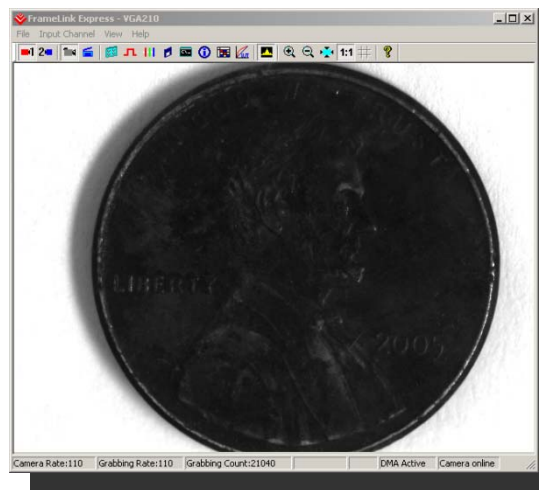
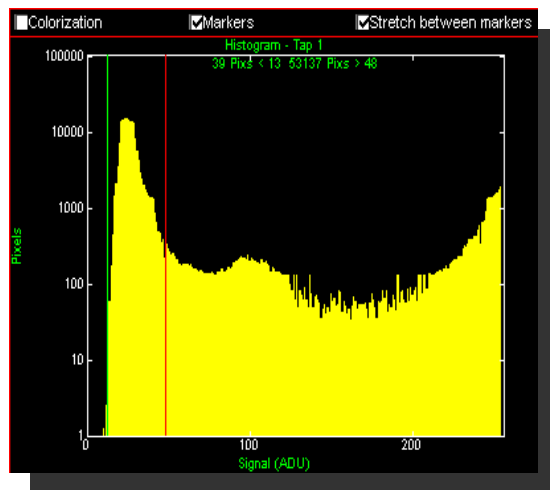
## Histogram Example #5

- **Markers – double threshold w/colorization.**
- Same as Example #4 except that colorization is enabled.

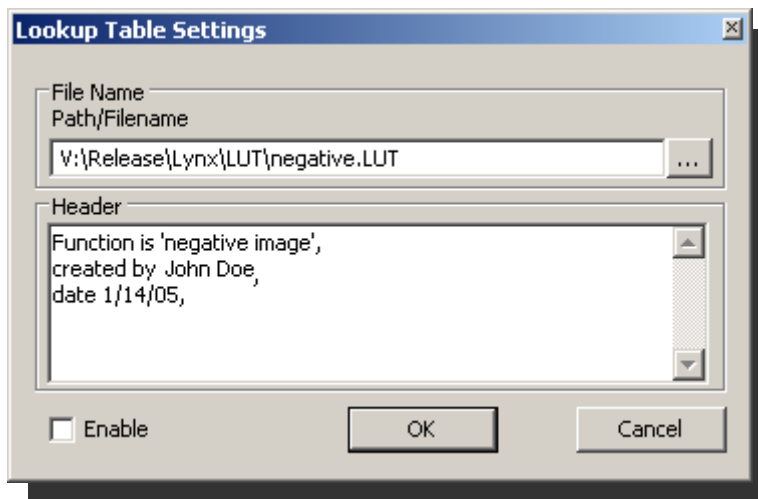
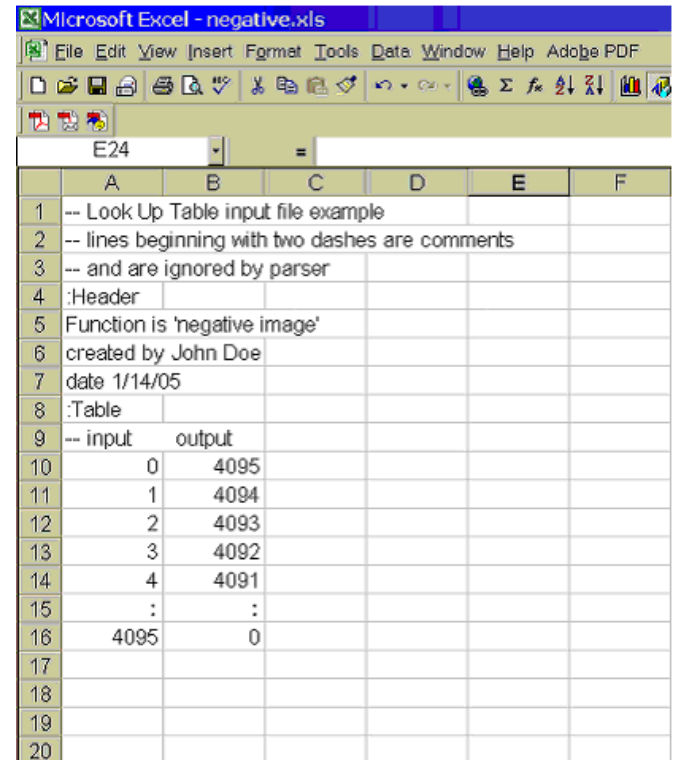


## Histogram Example #6

- **Stretch between Markers – contrast enhancement.**
- Replaces all pixel values below the green marker with 0x00.
- Replaces all pixel values above the red marker with 0xFF.
- All pixel values between the markers are ‘stretched’, so that they occupy the entire range from 0x01 to 0xFE, in effect causing contrast enhancement.



- Allows the user to select and enable a lookup table transfer function.
- Allows the user to modify and transform the original video data into any arbitrary value.
- Useful for Gamma correction, digital gain/offset, thresh-holding, etc.
- Displays header information from the LUT file.
- LUT files can be created with Excel or any ASCII editor.

	A	B	C	D	E	F
1	-- Look Up Table input file example					
2	-- lines beginning with two dashes are comments					
3	-- and are ignored by parser					
4	:Header					
5	Function is 'negative image'					
6	created by John Doe					
7	date 1/14/05					
8	:Table					
9	-- input	output				
10	0	4095				
11	1	4094				
12	2	4093				
13	3	4092				
14	4	4091				
15	:	:				
16	4095	0				
17						
18						
19						
20						

- Allows the user to zoom or scale the displayed image.
- Menu can be invoked via the View item on the Menu bar, icons on Icon bar or by right clicking the mouse over the image window.

Zoom in	Ctrl+'+'
Zoom out	Ctrl+'-'
Fit to window	Ctrl+0
25%	Alt+4
50%	Alt+2
✓ 100%	Ctrl+1
200%	Ctrl+2
400%	Ctrl+4

	<b>Zoom In</b>
	<b>Zoom Out</b>
	<b>Fit to Window</b>
	<b>Zoom 1:1</b>
	<b>Turn Grid on/off</b>

## Remote Upgrade

- Card contains two non-volatile firmware images: 'Factory' and 'Application'.
- Both images are programmed into the card during manufacturing.
- Card loads the 'factory' image on power-on, which then runs and loads the 'application' image ( if a valid 'application' image is present ).
- A 'Remote Upgrade' utility allows the user to upgrade the card's 'application' firmware image in the field.
- User is supplied with a self-executable remote upgrade utility with the 'application' firmware image embedded in it.

