Interface Description for MityCAM-B1910 Camera Link Interface

(CT031 Revision: 1)

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1 Purpose

This document describes the communications interface to Critical Link's Altera Cyclone V SOC based camera using BAE sensors, MityCAM-B1910. The MityCAM-B1910 with Dual Camera Link option provides an input power jack and two standard Camera Link interface connectors. This document provides the details for both the power input and Camera Link interface.

1.1 Related Documents

Document #	Title	Description
60-000002	MityCAM-B1910 Datasheet	Complete specification for the MityCAM-B1910 product.
60-000007	MityCAM-B1910/B2521 User Manual	Details on basic and advanced Camera Link and MityViewer configuration and data acquisition. Also includes information regarding external triggering.
60-000008	MityCAM Camera Link Panel User's Guide	User's guide for generic MityCAM Camera Link panel application.

2 Camera Link Interface

Table below defines Camera Link signals:

Table 1 Camera Link Port 1 Connector

Cable Name	Camera Connector	Frame Grabber Connector	Channel Link Signal
Inner Shield	1	1	Inner Shield / GND
Inner shield	14	14	Inner shield / GND
PAIR1-	2	25	X0-
PAIR1+	15	12	X0+
PAIR2-	3	24	X1-
PAIR2+	16	11	X1+
PAIR3-	4	23	X2-
PAIR3+	17	10	X2+
PAIR4-	5	22	Xclk-
PAIR4+	18	9	Xclk+
PAIR5-	6	21	X3-
PAIR5+	19	9	X3+
PAIR6-	7	20	SerTC+
PAIR6+	20	7	SerTC-
PAIR7-	8	19	SerTFG-
PAIR7+	21	6	SerTFG+
PAIR8-	9	18	CC1-
PAIR8+	22	5	CC1+
PAIR9-	10	17	CC2+
PAIR9+	23	4	CC2-
PAIR10-	11	16	CC3-
PAIR10+	24	3	CC3+
PAIR11-	12	15	CC4+

Cable Name	Camera Connector	Frame Grabber Connector	Channel Link Signal
PAIR11+	25	2	CC4-
Inner Shield	13	13	Inner Shield / GND
Inner shield	26	26	Inner shield / GND

Table 2 Camera Link Port 2 Connector

Cable Name	Camera Connector	Frame Grabber Connector	Channel Link Signal
Inner Shield	1	1	Inner shield / GND
Inner shield	14	14	Inner shield / GND
PAIR1-	2	25	Y0-
PAIR1+	15	12	Y0+
PAIR2-	3	24	Y1-
PAIR2+	16	11	Y1+
PAIR3-	4	23	Y2-
PAIR3+	17	10	Y2+
PAIR4-	5	22	Yclk-
PAIR4+	18	9	Yclk+
PAIR5-	6	21	Y3-
PAIR5+	19	9	Y3+
PAIR6-	7	20	N/C
PAIR6+	20	7	N/C
PAIR7-	8	19	Z0-
PAIR7+	21	6	Z0+
PAIR8-	9	18	Z1-
PAIR8+	22	5	Z1+
PAIR9-	10	17	Z2-
PAIR9+	23	4	Z2+
PAIR10-	11	16	Zclk-
PAIR10+	24	3	Zclk+
PAIR11-	12	15	Z3-
PAIR11+	25	2	Z3+
Inner Shield	13	13	Inner Shield / GND
Inner shield	26	26	Inner shield / GND

3 Supported Camera Link Configurations

Several configurations of Camera Link are supported to allow for a larger range of evaluation options on different frame grabbers. By specifying an output mode and a BPP setting, the camera will be configured in the following manner:

Table 3 Available Camera Link Modes

Output Mode	BPP Setting	Camera Link Configuration	Full ROI Framerate (Rolling Shutter)
0 – Expanded	0 – 8 BPP	8 BPP, x10, 10-tap Camera Link	75 fps
0 – Expanded	1 – 16 BPP	16 BPP, x5, 10-tap Camera Link	75 fps
0 – Expanded	2 – 12 BPP	12 BPP, x6.66, 10-tap Camera Link	75 fps
1 – Base	0 – 8 BPP	8 BPP, x2, Base Camera Link	75 fps
1 – Base	1 – 16 BPP	16 BPP, x1, Base Camera Link	30 fps
1 – Base	2 – 12 BPP	12 BPP, x2, Base Camera Link	75 fps

4 Communications

The command interface to the camera uses two sets of differential pair of signals for both communication to and from the camera. The underlying protocol is asynchronous serial communications:

- SerTFG: Differential pair from the camera to the frame grabber card.
- SerTC: Differential pair from the frame grabber card to the camera

A simple ASCII-based protocol is used to transmit and receive data between Critical Link's MityCAM Camera and frame grabber card. Commands are sent sequentially - one at a time - from a host PC through the serial data channel of a Camera Link interface. ASCII commands are processed by the onboard processor where each command is parsed and simple validation is performed. An ACK is returned if the command is validated and sent to the sensor, a NACK plus an error code is returned if the command was malformed, out of range or requested an invalid configuration.

If the camera is currently capturing when a configuration change is requested, the capture will stop, the value will be updated and configuration validation will occur again. A NACK may be generated if the change places the camera in an invalid state. Capturing can be resumed by correcting the configuration and re-sending the STRT command.

4.1 Serial Settings

The configuration settings for the asynchronous serial port are fixed to 115200-8-N-1.

- 115200 baud
- 8 data bits
- No parity
- 1 stop bit

4.2 Available Commands

The following commands are available for use from an FPGA / frame grabber card on a host PC.

Command (Page)	Section	Short Description
CAL (7)	4.4.1	Performs bias calibration using a dark image.
COOL (13)	4.4.32	Enable or Disable TEC cooling of sensor
FAN (14)	4.4.34	Enable or disable the cooling fan
GBPP (8)	4.4.8	Gets the current bits-per-pixel output of the camera.
GCLK (16)	4.4.44	Get the current SCLK frequency to the sensor
GETP (10)	4.4.19	Get the state of all GPIO pins as a bitmask (0x00 through 0x07)
GEXP (9)	4.4.12	Gets the currently set exposure time of the frame.
GFIT (9)	4.4.14	Gets the currently set frame interval time of the camera.
GFLX (14)	4.4.36	Get Flip X state.
GGAN (10)	4.4.16	Gets the currently set gain mode
GHBN (8)	4.4.6	Gets the currently set horizontal binning factor.
GMOD (12)	4.4.26	Gets the currently configured shutter mode.
GNRDC (15)	4.4.40	Get the status of the median filter noise reduction feature
GOMD (8)	4.4.9	Gets the Camera Link output mode of the camera.
GROI (12)	4.4.24	Gets the currently configured region of interest.
GSOMD (17)	4.4.46	Get the sensor's current readout order.
GSQRT (14)	4.4.38	Get square root compression state.
GVBN (8)	4.4.4	Gets the currently set vertical binning factor.
GVTX (16)	4.4.42	Return the current DAC setting for VTX2Neg.
PEEK (11)	4.4.20	A request for the 32-bit data value at one of the sensor's readable registers.
POKE (11)	4.4.21	Sets the 32-bit data value in one of the sensor's writeable registers.
RSET (11)	4.4.22	Reset command, causes the processor on the board to halt execution and reboot
SBPP (8)	4.4.7	A request to set the bits-per-pixel output of the camera.
SCLK (16)	4.4.43	Set current SCLK frequency to the sensor
SETD (10)	4.4.17	Sets up the directions of the GPIO pins to input or output.
SETP (10)	4.4.18	Set one GPIO pin to high (1) or low (0) if it is set to an output using SETD
SEXP (9)	4.4.11	A request to set the exposure time of the frame.
SFIT (9)	4.4.13	A request to set the frame interval time for frames.
SFLX (14)	4.4.35	Enable or disable flipping the image to be output on the X axis.
SGAN (10)	4.4.15	A request to set the gain mode
SHBN (8)	4.4.5	A request to set the horizontal binning factor of the camera
SMOD (12)	4.4.25	A request to set the shutter mode of the camera.
SNRDC (15)	4.4.39	Enable or disable median filter noise reduction feature
SOMD (9)	4.4.10	A request to set the Camera Link output mode of the camera.
SROI (11)	4.4.23	A request to set the region of interest.
SSOMD (17)	4.4.45	Set the sensor readout mode
SSQRT (14)	4.4.37	Enable or disable passing data through a square root compression feature.
STEC (14)	4.4.33	Set the TEC cooling setpoint in degrees Celsius
STOP (12)	4.4.28	Stops capturing if possible and applicable.

Command (Page)	Section	Short Description
STRT (12)	4.4.27	Starts capturing data if a valid configuration is present.
SVBN (8)	4.4.3	A request to set the vertical binning factor of the camera.
SVTX (15)	4.4.41	Set VTX2Neg voltage (enable/disable sensor anti-blooming feature)
TEMP (13)	4.4.31	Get the temperature of the sensor
TEST (13)	4.4.29	Turn on/off the test pattern and which test pattern is being used.
TRIG (13)	4.4.30	Set the trigger mode for the camera.
VERS (7)	4.4.2	A request for the hardware/software revision of the interface board

4.3 Error Codes

The camera will generate NACK response when it detects an invalid command or it's unable to execute the command. The response will consist of NACK followed by an error code. The camera will perform validation of configuration parameters when told to begin triggering or when a change in configuration occurs while capture is occurring. The current error codes are as follows:

Table 4 NACK Codes

Error Code Number	Description
1	Unrecognized Command
2	One or more arguments for the command was missing
3	One or more arguments for the command was out of range
4	Invalid configuration of camera
5	Capture in progress
6	Camera not responding
7	Operation not supported

4.4 Command Examples

4.4.1 CAL

Performs bias calibration using a dark image.
To initiate gain / offset calibration, the camera must be placed in a dark environment. To initiate the calibration, issue the following command. On successful calibrate, the new calibration coefficients are stored in non-volatile memory and applied immediately.

```
COMMAND-> <CAL>
RESPONSE-> <ACK>
```

4.4.2 VERS

A request for the hardware/software revision of the interface board
Request for version
Note: The format of the version command may change.

```
FORMAT -->   <COMMAND>
```

```
COMMAND -->  <VERS>
RESPONSE --> <ACK><1.0 1313>
```

4.4.3 SVBN

A request to set the vertical binning factor of the camera.
Set the vertical binning factor – Setting the vertical binning factor to 2.
Valid values for the vertical binning factor are 1 (no binning), 2, 4, or 8.

```
COMMAND-> <SVBN 2>
RESPONSE-> <ACK>
```

4.4.4 GVBN

Gets the currently set vertical binning factor.
Retrieve the currently set vertical binning factor.

```
COMMAND-> <GVBN>
RESPONSE-> <ACK><2>
```

4.4.5 SHBN

A request to set the horizontal binning factor of the camera
Set the horizontal binning factor – Setting the horizontal binning factor to 1.
Note: Horizontal binning is not currently supported.

```
COMMAND-> <SHBN 1>
RESPONSE-> <ACK>
```

4.4.6 GHBN

Gets the currently set horizontal binning factor.
Retrieve the currently set horizontal binning factor.

```
COMMAND-> <GHBN>
RESPONSE-> <ACK><1>
```

4.4.7 SBPP

A request to set the bits-per-pixel output of the camera.
Set the number of bits per pixel – Setting the mode to 8 BPP.

```
COMMAND-> <SBPP 0>
RESPONSE-> <ACK>
```

Table 5 Available Camera Link BPP Modes

Valid BPP Modes	Channel output mode
0	8 BPP
1	16 BPP
2	12 BPP

4.4.8 GBPP

Gets the current bits-per-pixel output of the camera.
Retrieve the currently selected bits per pixel mode.

```
COMMAND-> <GBPP>
RESPONSE-> <ACK><0>
```

4.4.9 GOMD

Gets the Camera Link output mode of the camera.

Get shutter mode – Get the shutter mode the camera is currently in according to the table in 5.4.14.

```
COMMAND-> <GOMD>
RESPONSE-> <ACK><0>
```

4.4.10 SOMD

A request to set the Camera Link output mode of the camera.

Set output mode – Set the Camera Link output mode. The camera supports 2 Camera Link output mode configurations. This command is used in concert with the Set bits per pixel command to define that Camera Link configuration.

```
COMMAND-> <SOMD 0>
RESPONSE-> <ACK>
```

Table 6 Available Camera Link Output Modes

Valid Output Modes	Shutter mode
0	Expanded / 10-tap mode
1	Base mode

4.4.11 SEXP

A request to set the exposure time of the frame.

Set exposure time – Requests to set an exposure time. The exposure time must be less than or equal to the rate of update. Exposure times greater than the update period will push the period of update to be equal to the exposure time. If the exposure time cannot be matched, the camera will set the parameters to the closest possible valid exposure time.

Example: Set rate of exposure to 5ms.

```
COMMAND->  <SEXP 5000>
RESPONSE-> <ACK>
```

4.4.12 GEXP

Gets the currently set exposure time of the frame.

Get exposure time – Get the last set exposure time which was not out of range.

```
COMMAND->  <GEXP>
RESPONSE-> <ACK><5000>
```

4.4.13 SFIT

A request to set the frame interval time for frames.

Set frame interval time – Requests that a new frame be transmitted at the period specified. The resolution of the command is in microseconds. If the rate cannot be matched, the camera will set parameters to the closest possible valid rate of update.

If a rate is faster than the region of interest supports, the shortest frame interval time for the ROI will be used.

Example: Set interval time to 10ms (100 FPS).

```
COMMAND->  <SFIT 10000>
RESPONSE-> <ACK>
```

4.4.14 GFIT

Gets the currently set frame interval time of the camera.
Get the frame interval time – Get the last set frame interval time which was not out of range.

```
COMMAND->  <GFIT>
RESPONSE-> <ACK><10000>
```

4.4.15 SGAN

A request to set the gain mode
Configure the gain mode for the camera.

```
COMMAND-> <SGAN 0>
RESPONSE-> <ACK>
```

Table 7 Available Sensor Gain Modes

Value to write	Gain mode
0	Corrected combined gain mode
1	Corrected high gain mode
2	Corrected low gain mode
3	Non-corrected high gain mode
4	Non-corrected low gain mode
5	Non-corrected combined gain mode

4.4.16 GGAN

Gets the currently set gain mode
Return the currently configured gain mode of the camera according to the table in 5.4.14.

```
COMMAND-> <GGAN>
RESPONSE-> <ACK><0>
```

4.4.17 SETD

Sets up the directions of the GPIO pins to input or output.
Set Pin Direction – Set the pin direction via index and value. Set pin 3 to be an output. 1 is for output, 0 is for input.

```
COMMAND->  <SETD 3 1>
RESPONSE-> <ACK>
```

4.4.18 SETP

Set one GPIO pin to high (1) or low (0) if it is set to an output using SETD
Set Pin – Setting pin 1 to low (0). Other valid values are high (1) and “expose strobe” (2).

NOTE: Exposure strobe is only available for pin CamIO 1.

```
COMMAND->  <SETP 1 0>
RESPONSE-> <ACK>
```

4.4.19 GETP

Get the state of all GPIO pins as a bitmask (0x00 through 0x07)
Get Pins – Response is a bit-mask corresponding to the value of pins 1 through 3

```
COMMAND->  <GETP>
RESPONSE-> <ACK><8>
```

The above shows pin 3 is high, 0-2 are low.

4.4.20 PEEK

A request for the 32-bit data value at one of the sensor's readable registers.
Read register address 0x22:

```
COMMAND -->  <PEEK 22>
RESPONSE --> <ACK><1234>
```

4.4.21 POKE

Sets the 32-bit data value in one of the sensor's writeable registers.
Write hex value 0x1234 to register address 0x22:

```
COMMAND -->  <POKE 22 1234>
RESPONSE --> <ACK>
```

4.4.22 RSET

Reset command, causes the processor on the board to halt execution and reboot
Command to reset camera
Note: subsequent commands will no longer be accepted until reboot completes

```
COMMAND->  <RSET>
RESPONSE-> <ACK>
```

4.4.23 SROI

A request to set the region of interest.
Set the region of interest as seen by the sensor. Specified are the start column, start row, width of region and height of the region. The origin (0, 0) will be specified as the upper left-most pixel in the entire field of view of the sensor.

Note: These values are with respect to the sensor; binning will reduce the number of pixels output by the camera.

Certain sensors may have on restrictions to the region of interest. The MityCAM-B1910 requires the following:

- The ROI height (number of rows) must be evenly divisible by the vertical binning factor.
- The ROI width (number of columns) must be evenly divisible by the horizontal binning factor.
- The ROI width divided by the horizontal binning factor must be evenly divisible by 16 for Base modes and 80 for Expanded modes.
- The ROI horizontal offset must start on an even pixel.

If changing the ROI would produce an invalid exposure or interval (ie: interval time is too short [too high of a frame-rate] for the larger ROI), the time will be adjusted to the closest value.
Setting a valid interval or exposure time for the new ROI before changing the ROI will not cause these values to change.

```
FORMAT-> <SROI StartRow StartColumn Width Height>
```

Example: Setting full resolution

```
COMMAND-> <SROI 0 0 1920 1080>
RESPONSE-> <ACK>
```

4.4.24 GROI

Gets the currently configured region of interest.
Returns the current configuration for the region of interest.

```
COMMAND-> <GROI>
RESPONSE-> <ACK><StartRow><StartColumn><Width><Height>
```

4.4.25 SMOD

A request to set the shutter mode of the camera.
Set shutter mode – Set the camera shutter mode to rolling shutter.

```
COMMAND-> <SMOD 0>
RESPONSE-> <ACK>
```

Table 8 Available Shutter Modes

Valid Shutter Modes	Shutter mode
0	Rolling Shutter
1	Global Shutter

4.4.26 GMOD

Gets the currently configured shutter mode.
Get shutter mode – Get the shutter mode the camera is currently in according to the table in 5.4.12.

```
COMMAND-> <GMOD>
RESPONSE-> <ACK><0>
```

4.4.27 STRT

Starts capturing data if a valid configuration is present.
Validates configuration of the camera and begins capturing frame data. This command may be expanded in the future to designate an external trigger to capture on.

```
COMMAND-> <STRT>
RESPONSE-> <ACK>
```

4.4.28 STOP

Stops capturing if possible and applicable.
If the camera is capturing, requests to stop capturing. Otherwise, this does nothing.

```
COMMAND-> <STOP>
RESPONSE-> <ACK>
```

4.4.29 TEST

Turn on/off the test pattern and which test pattern is being used.
Turn on or off the test pattern and which test pattern is being used.

```
COMMAND-> <TEST 0>
RESPONSE-> <ACK>
```

Table 9 Available Test Patterns

Value to write	Result
0	Test pattern turned off
1	Gradient from sensor
2	Digital pattern from FPGA

4.4.30 TRIG

Set the trigger mode for the camera.
Turn on external triggering/internal free-run.

```
COMMAND-> <TRIG 0>
RESPONSE-> <ACK>
```

Table 10 Available Trigger Modes

Value to write	Result
0	Internally triggered free-run
1	External trigger on CamIO 0

4.4.31 TEMP

Get the temperature of the sensor
The camera supports reading the ADC voltage and temperature sensor values from the sensor chip. For the CIS1910 sensor, the table indicates the allowed arguments.

```
COMMAND-> <TEMP 3>
RESPONSE-> <ACK><33.5>
```

Table 11 Available Temperature Sensors

Valid TEMP Arguments	Description
0	Reports voltage and converted temperature of all sensors.
1	Reports VPAT of CIS1910.
3	Reports thermocouple bonded to CIS1910 package.
4	Reports temperature Sensor on processor board.

4.4.32 COOL

Enable or Disable TEC cooling of sensor
To enable or disable the TEC cooling circuit, issue the following command. Valid arguments are “ON” or “OFF”.

```
COMMAND-> <COOL ON>
RESPONSE-> <ACK>
```

4.4.33 STEC

Set the TEC cooling setpoint in degrees Celsius
When TEC cooling is enabled, the camera will attempt to drive the case of the chip sensor (as reported by <TEMP 2>) to the defined setpoint (in degrees Celsius).

```
COMMAND-> <STEC 25.1>
RESPONSE-> <ACK>
```

4.4.34 FAN

Enable or disable the cooling fan
NOTE: Disabling the cooling fan may cause damage if the camera overheats.

```
COMMAND-> <FAN [1 | 0]>
RESPONSE-> <ACK>
```

4.4.35 SFLX

Enable or disable flipping the image to be output on the X axis.

Example: Disable Flip X functionality.

```
COMMAND->  <GFLX 0>
RESPONSE-> <ACK>
```

4.4.36 GFLX

Get Flip X state.

Example: Get flip x; it is enabled.

```
COMMAND->  <GFLX>
RESPONSE-> <ACK><1>
```

4.4.37 SSQRT

Enable or disable passing data through a square root compression feature.

Example: Disable square root compression

```
COMMAND->  <SSQRT 0>
RESPONSE-> <ACK>
```

4.4.38 GSQRT

Get square root compression state.

Example: Get square root compression; it is enabled.

```
COMMAND->  <GSQRT>
RESPONSE-> <ACK><1>
```

4.4.39 SNRDC

Enable or disable median filter noise reduction feature

Enable or disable noise reduction with a median filter. The command requires an enable and a threshold for top side clipping (hot pixel correction) and bottom side clipping (dark pixel correction).
Note: Only top side clipping is supported; the command still requires the additional parameters.

The algorithm replaces a pixel with the median of the surrounding pixels (5 pixels on either side within a row) if the selected pixel exceeds the configured threshold value.

Example: Enable top side pixel correction with a threshold of 10 counts with low side correction disabled.

```
COMMAND->  <SNRDC 1 10 0 0>
RESPONSE-> <ACK>
```

4.4.40 GNRDC

Get the status of the median filter noise reduction feature

Example: Get noise reduction state. (High side is enabled for pixels >10 counts from neighbors)

```
COMMAND->  <GNRDC>
RESPONSE-> <ACK><1><10><0><0>
```

4.4.41 SVTX

Set $VTX2_{Neg}$ voltage (enable/disable sensor anti-blooming feature)

Set the voltage for $VTX2_{Neg}$ DAC. $VTX2_{Neg}$ DAC voltage affects the $VTX2_{Neg}$ voltage in the following manner:

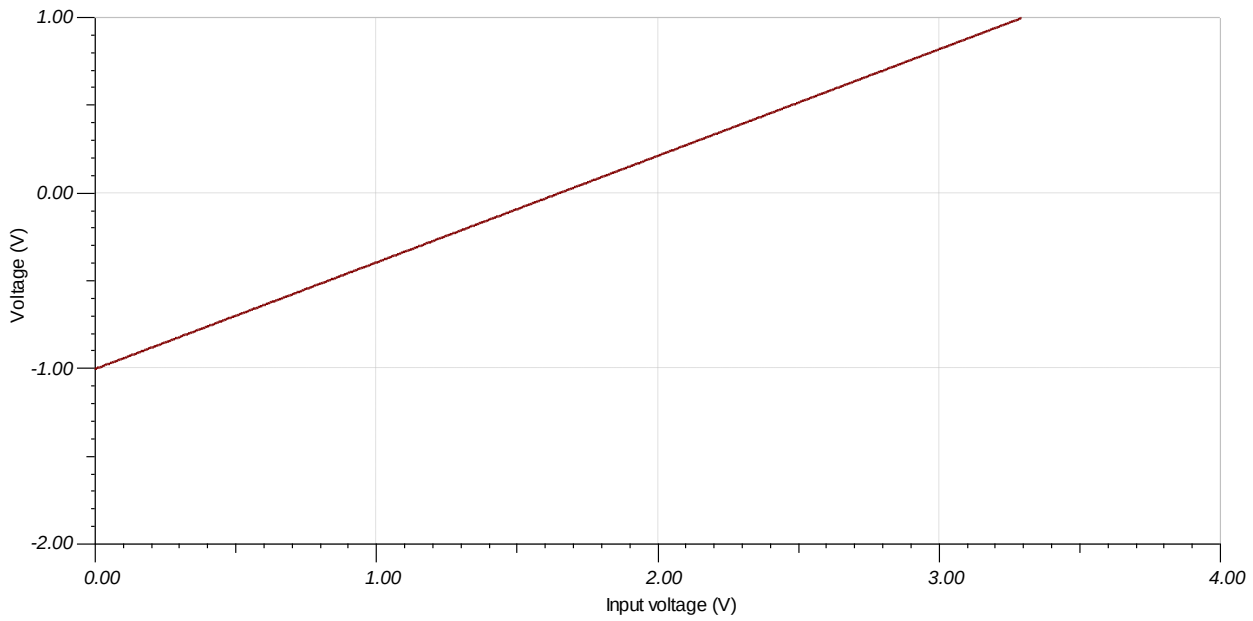

Figure 1. DAC Voltage to VTX_{Neg} VTC Curve

The $VTX2_{Neg}$ adjustment allows for enabling/disabling an anti-blooming feature of the sensor at the expense of dynamic range. For best dynamic range, set $VTX2_{Neg}$ DAC to 1.0. For best anti-blooming performance, set $VTX2_{Neg}$ to 3.0V.

This setting will persist between power cycles of the camera.

Example: Set the DAC to 3V

```
COMMAND->  <SVTX 3.0>
RESPONSE-> <ACK>
```

4.4.42 GVTX

Return the current DAC setting for $VTX2_{Neg}$.

Example: Get the DAC setting.

```
COMMAND->  <GVTX>
RESPONSE-> <ACK><3.0>
```

4.4.43 SCLK

Set current SCLK frequency to the sensor

Set the current SCLK for the sensor to use. Parameter is the desired clock in MHz. The table below shows the supported values.

Table 12 Available SCLKs

SCLK (MHz)	MityCAM-B1910 Row Time (us)
30	82.13
40	61.6
80	30.8
200	12.32

Example: Set SCLK to 30MHz.

```
COMMAND->  <SCLK 30>
RESPONSE-> <ACK>
```

4.4.44 GCLK

Get the current SCLK frequency to the sensor

Get the currently configured SCLK.

Example: Get the current SCLK; it is 30MHz.

```
COMMAND->  <GCLK>
RESPONSE-> <ACK><30>
```

4.4.45 SSOMD

Set the sensor readout mode
Set the readout order of the sensor. See the illustrations below:

Table 13 Available Sensor Readout Modes

SSOMD Setting	Readout Order
0	
1	

Example: Set readout to be from center out.

```
COMMAND->  <SSOMD 0>
RESPONSE-> <ACK>
```

4.4.46 GSOMD

Get the sensor's current readout order.
Example: Get the current readout order.

```
COMMAND->  <GSOMD>
RESPONSE-> <ACK><0>
```

4.4.47 Invalid commands

Issuing an invalid command will result in a NACK sequence as illustrated below.
Bad command (trying to set an input pin, assuming pin 2 was set to input):

```
COMMAND-> <SETP 2 1>
RESPONSE-> <NACK 3>
```

Bad command (missing required data value):

```
COMMAND-> <POKE 37>
RESPONSE-> <NACK 2>
```

Bad command (address out of range):

```
COMMAND-> <PEEK 8888>
RESPONSE-> <NACK 3>
```

Bad command (unrecognized due to misspelled command):

```
COMMAND-> <POEK 24 1234>
RESPONSE-> <NACK 1>
```

Bad command (ROI out of range):

```
COMMAND-> <SROI 0 0 2800 2160>
RESPONSE-> <NACK 3>
```

Bad command (Invalid configuration detected):

```
COMMAND-> <TRIG>
RESPONSE-> <NACK 4>
```

Bad command (Configuring while capture is in progress):

```
COMMAND-> <SROI 0 0 2560 2160>
RESPONSE-> <NACK 5>
```

5 Miscellaneous Details

5.1 Commands While Capturing

Some commands are available while the camera is capturing. Certain ones are restricted to use when the camera is not capturing to prevent invalid configurations from being used and placing the hardware in an ambiguous state.

Table 14 Table of Commands and Support While Capturing

Command	While Capturing?		Command	While Capturing?
SFIT	No		PEEK	Yes
SEXP	No		VERS	Yes
SMOD	No		GROU	Yes
SBPP	No		GEXP	Yes
SVBN	No		GMOD	Yes
SHBN	No		GBPP	Yes
SROI	No		GVBN	Yes
SGAN	No		GHBN	Yes
POKE	No		GROI	Yes
			GGAN	Yes
RSET	Yes			
TEST	No		SSQRT	Yes
TRIG	No		GSQRT	Yes
STRT	N/A		SNRDC	Yes
STOP	N/A		GNRDC	Yes
SETD	Yes		CAL	No
SETP	Yes		WCAL	No
GETP	Yes			
			SSOMD	No
STEC	Yes		GSOMD	Yes
COOL	Yes			
FAN	Yes			

6 Revision History

Revision	Date	Author	Description
1A	8/1/2013	Mike Williamson	Initial Release
1B	5/2/2015	Mike Williamson / Jeff Myers	Formal release - Added calibration and additional output modes. - Clarified output modes and Camera Link configuration. - Added TEC commands - Assignment of document number with new revision scheme. - Apply MityCAM Styleguide template, coverpage, etc.
1C	11/6/2015	Jeff Myers	ROI width restriction is 16 for Base mode and 80 for Expanded