



FASTSERIES

ASCII CAMERA CONTROL PROGRAM

FVM-00405

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INTRODUCTION

This document contains information about how to operate the FC13 and FC40 ASCII camera control program. This program provides a filter for user input and camera output to control the camera manually through the camera link or USB interface.

INSTALLING THE PROGRAM

The installation program is provided in a subdirectory on the CD. The camera control program is installed by running **setup.exe**, or double clicking on the MSI file. You may install the program in any subdirectory. You may want to put your frame grabber's camera link DLL in this same directory as the camera control program, and if you have a JPEG camera, you may want to have JPEG.INI in this directory. In addition to the application executable, the DLL **libtiff.dll** is required. No special registry entries are needed to run the program, though the install does make several entries so you can un-install the program.

SERIAL INTERFACE FOR CAMERA LINK

This program connects to the serial interface of the camera through a camera link frame grabber DLL which is provided by the manufacture of the frame grabber you are using. According to the camera link specification the DLL should be named **CLSERXXX.DLL**, where XXX is replaced by a the frame grabber vendors choice of characters. If your frame grabber uses the host provided serial ports to communicate with the camera, the DLL **CLSERHST.DLL** is provided with the camera control program.

USB VERSION OF THE CAMERA

This program has marginal utility with the USB versions of the camera as all features and functions of the camera are controlled by the Fast Viewer program which came with the camera. If you wish to run the camera with the ASCII camera control program contact FastVision for a copy of the required DLL.

STARTING THE PROGRAM

After the installation is complete you may start the program with the provided desktop Icon, or via a command line. The program has two command line parameters, the name of the DLL you want to use, and the channel number to open on the DLL. Channels are numbered from zero. You will need to consult your frame grabber manual to determine which channel to use. If you are using the host serial interfaces via the CLSERHST DLL then channel 0 is serial port COM1, and so on. For example you might use

```
FCC4.exe CLSERHST.DLL 0
```

to start the program using COM1 on your host computer. When the program starts it will output a message that confirms the DLL loaded correctly and has the correct interfaces exported.

GETTING THE COMMAND LIST

The command prompt looks like:

Enter Command (? for menu)

The commands to the program are single letters which typically are not followed by the <Enter> key. For example when you press the 'H' key the program will output the current value of the frame counter. You can press 'H' over and over to watch it change.

When the command prompt is present you may type a question mark to get a listing of the commands supported by this version of the camera control program. In addition the date and time that the program was compiled is displayed. The listing looks like this:

```
Built May 26 2006 @ 14:56:25
A - Change assumed sensor clock rate
B - Select dll name
C - Completely erase the flash
D - Erase State Save area in flash (1 - 8)
F - Talk directly to the camera
E - Erase FPGA Area in Flash
G - Get Camera State
H - Ping Camera for Life
I - Restore Camera State from Flash
J - Initialize FPGA from Flash
K - Save Current Camera State to Flash
L - Write Flash
M - Read Flash
N - Set Camera State
O - Serial Trigger
P - Reset and Calibrate Sensor
Q - Directory listing
U - Setup JPEG tables
Y - Readout Image
Z - Reset Memory
X - Exit program
```

The operation and function of the commands is explained below. One very useful command is the 'G' command which lists the current state of the camera. If you press 'G' in response to the command prompt you will see:

```
Initialized          = 69f05ac3
Binning              = 11
Camera Link Speed    = 66MHz
Camera Link Mode     = 1 Tap 8 Bits
Exposure Delay       = 0.000 msec = 0x00000000
Exposure             = 16.667 msec = 0x000cb735
Frame Burst Count    = 5 = 0x05
Frame Rate           = 2.980 Hz = 0x00ffffff
Line period          = 0.072 msec = 0x0e28
Output Shift         = 0
Serial Link          = 1458 9600.614439 baud
ROI Cols(0,2351) Lines(0,1727)
Vln2                 = e013 0.7992 volts
Vref1                 = d914 0.9990 volts
Vtest                = 0020 0.0000 volts
Vref2                 = e023 0.7992 volts
Vbias1                = 0030 0.0000 volts
Vref3                 = e832 0.5994 volts
Vbias2                = 0040 0.0000 volts
Vref4                 = 3641 0.2481 volts
Vbias3                = 0050 0.0000 volts
Vln1                  = e053 0.7992 volts
Vbias4                = 0060 0.0000 volts
Vlp                   = b269 1.9980 volts
Vunused1=            = 0070 0.0000 volts
Vclamp3              = 3e78 1.6983 volts
Vunused2=            = 0080 0.0000 volts
Vrstpix              = 8b8e 2.9971 volts
Trigger Mode         = Free-run = 0x0000
CC1 Trigger Enable   = Disabled
```

```

CC1 Trigger polarity      = Positive-edge
P4-TTL Trigger Enable    = Disabled
P4-TTL Trigger polarity  = Positive-edge
Trigger Timing           = Asynchronous-Trigger
CC2 Enable                = Disabled
CC2 Polarity              = Positive-edge
CC3 Enable                = Disabled
CC3 Polarity              = Positive-edge
CC4 Enable                = Disabled
CC4 Polarity              = Positive-edge
Clock Phase              = 1
Dark VREF3/VCLAMP enable= Enabled
Readout row increment     = 0
Burst Rate                = 50000000.000 Hz = 0x00000000
Post Trigger Image Cnt.  = 1
Debug Byte                = 03
Chunks per Y Command     = 214
Preview frame gap        = 512 lines
Noise control Amplitude  = 0 counts
Noise control FVAL reset= No
Noise control Sensor On  = Yes
Memory option DF Enable  = No
Memory option Pattern    = Enabled
Memory option Raw Image  = Enabled
Memory option Debug Jpeg= Disabled
Moving ROI CC1Reset      = Disabled
Moving ROI CC2Active     = ActiveHigh
Moving ROI Motion        = Disabled
Moving ROI FreeRun       = Triggered
Moving ROI HoldOnCC2     = Disabled
Moving ROI Reversing     = Disabled
Moving ROI TTLCC1       = Rising Edge
Moving ROI nFrames       = 0
Moving ROI DeltaX        = 0.000000
Moving ROI DeltaY        = 0.000000

```

The listing of the camera state contains the status of all the programmable features of the camera. This version program does not constrain the settings in any way. This means you can set the camera to configurations that will not work, or will not work with your frame grabber. Be certain that you understand what you are doing when you change settings.

Each of the commands is listed below with an explanation of its purpose and use.

Command A-Changes sensor clock

Changes assumed sensor clock rate between 50 MHz (FC40) and 66.66MHz (FC13).

Make sure you set the clock to the right setting. This is not automatic, you can attempt to operate the FC13 with the program set for 50MHz. The effect of this is none of the rate values you enter will produce the rate expected.

Command B-Select DLL name.

This command allows you to select a frame grabber's provided Standard Camera Link DLL. It defaults to using CLSERHST.DLL which uses the PC's serial ports. This command expects you to type the full path name AND the .dll. It does the normal Windows DLL search to find the DLL.

Command C-Completely erase the flash.

Do not do this unless you want to send your camera back the factory for repair, and possibly have to pay for reprogramming.

Command D-Erase state save area in flash (1 - 8).

You typically do not need to do this. Just write over the ones you want to change.

Command F-Talk directly to the camera.

This switches the input mode so that the commands you type are sent directly to the camera. The keys you press are buffered in the program, and sent after you press <Enter>. The response of the camera is copied to console out. You exit this mode by typing ^Z (control and Z together). No command prompt is given, you should wait for the camera response to stop before entering the next command. This command can be used to experiment with the camera command set directly should you be implementing some of the commands in your own application.

Command E-Erase FPGA area in flash

You typically do not need to do this. Just program the Data FPGA with the provided file. Note: Data FPGA files are NOT normally provided with the camera. Typically you will not use this.

Command G-Get camera state.

This displays the state of the camera see above for camera state. See below for details for each field.

Command H-Ping camera for life

Causes the camera to return its 32 bit frame counter. The counter increments on each frame sent, and is reset by power off.

Command I-Restore camera state from flash.

This command will load a camera state from flash. There are eight storage locations. Typically location 1 is loaded on power up. (This can be changed).

Command J-Initialize FPGA From flash.

This causes the DATA FPGA to be reloaded from Flash. This can be used to make a newly programmed FPGA active, without powering off, or can be used to reset the FPGA should it become confused. Note the signals being generated by the camera will do odd things while the FPGA is loading.

Command K-Save current camera state to flash.

This allows you to save the state of the camera to one of eight locations.

Command L-Write flash.

This command asks if you want to write the FPGA area or the Dark Field area of flash.

The FPGA file write to flash expects a Fast-Vision 'bin' file, which is correct for the size of FPGAs installed in the camera. You typically should not use this feature unless instructed to by the factory, or if you have purchased the FPGA development kit and are loading your own FPGA files.

The Dark field area of flash holds an 8 bit per pixel image which is subtracted from the 10 bit pixels from the sensor (with clipping at zero), to correct for Fixed Pattern Noise (FPN). It expects a 2352x1729x8 bit tiff file for the FC40, or a 1280x1024x8 bit tiff file for the FC13. Programming the FPN can take up to 10 minutes on the FC40. If you enable Dark Field subtraction (Offset 63 in the state table), be sure VREF2 is set to zero AND do not use the P command. The program will execute a U command to determine the format of Bank 1 and to load the JPEG table values if needed.

Command M-Read flash.

This allows you to examine the Flash contents. Page zero is probably the only page with interesting information, which is the header for the Data FPGA that is programmed into the camera.

Command N-Set camera state

The camera contains nine areas where camera states are stored. The first through the eighth are stored in the FLASH and reflect states of the camera saved by the user. The ninth state is the active state of the camera. This state is not persistent, if you turn off the camera it will load one of the saved states when you turn it back on, typically state one is loaded at power up, but this can be changed.

The **N** command allows you to manipulate the settings of the camera. It will ask you for the offset of the field you want to change. When you provide that you can change its value. See below for details on the fields. This is typically output when you press the **N** command:

```
[ 0]=Initialize
[ 4]=Vln2
[ 6]=Vref1
[ 8]=Vtest
[10]=Vref2
[12]=Vbias1
[14]=Vref3
[16]=Vbias2
[18]=Vref4
[20]=Vbias3
[22]=Vln1
[24]=Vbias4
[26]=Vlp
[28]=Vunused1
[30]=Vclamp3
[32]=Vunused2
[34]=Vrstpix
[36]=ROI Start Pixel
[38]=ROI End Pixel
[40]=ROI Start Line
[42]=ROI End Line
[44]=Line Period in Pixel Clocks
[46]=Exposure Time in Pixel Clocks
[50]=Frame Period in Pixel Clocks
[54]=Exposure Delay in Pixel Clocks
[58]=Serial Link Bit Period in Pixel Clocks
[60]=Camera Link Readout Mode
[61]=Camera Link Clock Frequency
[62]=Binning
[63]=Memory Options Debug[3]:Raw[2]:Pattern[1]:DFSub[0]
[64]=Output down shift
[65]=Trigger Mode
[67]=Frame count for Multi-Trigger mode
[68]=CC2-4 controls
[69]=DarkVoltageEnable,clock phase
[70]=Row Increment
[71]=Burst Period
```

```

[ 75]=Moving ROI Mode
[ 76]=Number of frames in ROI Move
[ 78]=Delta X [16.16]
[ 82]=Delta Y [16.16]
[ 86]=Control FPGA Extension
[128]=Image Count after Trigger
[130]=Debug Byte
[131]=Blocks sent for each Y command
[132]=USB:12 bit vertical blank time
[134]=Noise Control DisableSensor[11]:FrameReset[10]:Amplitude[9:0]
[136]=Data FPGA Extension

```

Command O-Serial trigger.

Sending an O to the camera will trigger the camera similarly to a trigger generated by the CC1 line or the TTL input trigger.

Command P-Reset and calibrate sensor.

This command triggers the calibration process provided by the sensor. It attempts to null the input offset voltage of the analog to digital converters in the sensor. If you see grey vertical lines this may help you.

Command Q-Directory listing.

Gives a directory listing of the current directory. Typically used to find the camera link DLL.

Command U-Setup JPEG tables.

This command should only be used with the JPEG camera. This command allows you to set the JPEG tables that control the encoding performed by the camera. The camera performs single pass compression on the incoming image data, this means that the tables you upload will have to be complete, that is support all possible DC values and AC values. This means you will need to provide a DC coefficient table for changes of 0 to 8 bits and AC tables for all the run/value pairs for 00 to ff, and 00 for the EOB code. Codes 01 to 0f are not used but must be provided. The tables can come from two sources, the default setting in this program, which match the JPEG standard for monochrome image compression.

If you wish to change the tables, then you will need to provide a file in INI format with the section [JPEG] which contains the keys "Quantization", "DCLength", "DCValue", "ACLength", and "ACValue". The values that follow these key are hex values that do not have the 0x prefix that is two hex digits, separated by white space, the first value should not have white space in front of it. The quantization table is presented in row major order (column values first 8 for each row), and there must be 64 of values. The quantization table should be in none zigzag order. The DCLength and the ACLength must have 16 entries, for code sizes of to 16 bits. The sum of all the DCLength values is the number of entries in the DCValue key. The sum of the ACLength values is the number of codes in the ACValue table. Please see the JPEG standard for the meaning / function of these tables.

For example you file might contain:

```

[JPEG]
Quantization=10 10 10 <and so on>
DCLength=00 01 01 01 01 01 01 01 01 01 00 00 00 00 00 00
DCValue=00 01 02 03 04 05 06 07 08
ACValue= 00 01 <and so on for a total 256 values>

```

When you press **U** the program will ask if this camera is a JPEG camera. Be sure to answer correctly as the JPEG camera has a different format for bank 1, if you make an error here, your saved Dark Field, will be corrupted.

Next the program will ask if you want to load the JPEG values from a file. If you say no, the program will use the JPEG standard default values. Then the program checks the current directory to determine if there is a file named JPEG.INI and it will ask if you want to use it. If you say yes it will load the file. If it finds an error in the file an open file dialog box will pop up so you can select a correct file. If you elect not to use the file in the current directory, there is none, or there is an error in the file in the current directory, an open file dialog box will pop up requesting that you select a file from another location. If you provide a correct file, then it will load it and save the results to flash, where the camera expects it to be. (Bank 1 Page 0).

Command Y-Readout image.

This command is used the USB camera to read out data from RAM. It is not used by the camera link versions of the camera (as of 26 May 2006).

Command Z-Reset memory.

This command is used by the USB camera to clear the contents of memory and begin collecting images into memory again.

Command X-Exit program.

N COMMAND FIELDS

Below are all the settable parameters in the camera.

[0]=Initialize

Do not modify this field. See command C above for the warning.

Camera Reference Voltages

Do not modify these values unless you know what you are doing. If you are going to adjust them, then **SAVE THE CORRECT SETTINGS AS YOU WILL NEED THEM**. It is very easy to make the image look really bad, and hard to improve it. See the warning in command C above.

- a) [4]=V_{LN2}
- b) [6]=V_{REF1}
- c) [8]=V_{TEST}
- d) [10]=V_{REF2}
- e) [12]=V_{BIAS1}
- f) [14]=V_{REF3}
- g) [16]=V_{BIAS2}
- h) [18]=V_{REF4}
- i) [20]=V_{BIAS3}
- j) [22]=V_{LN1}
- k) [24]=V_{BIAS4}
- l) [26]=V_{L_P}
- m) [28]=V_{UNUSED1}
- n) [30]=V_{CLAMP3}
- o) [32]=V_{UNUSED2}
- p) [34]=V_{RSTPIX}

Camera Region of Interest

q) [36]=ROI START PIXEL

r) [38]=ROI END PIXEL

s) [40]=ROI START LINE

t) [42]=ROI END LINE

These four values select the region of interest extracted from the sensor. The values are zero based. Full frame settings are 0,2351,0,1727 for the FC40 and 0,1279,0,1023 for the FC13. Only the pixels in the ROI are delivered to the user.

[44]=Line Period in Pixel Clocks

This is the number of SENSOR CLOCKS used to read out a line from the sensor. It can not be less than 132 and have the sensor operate correctly. It is clamped to 132 or above by the camera logic. This field is used to stretch the line timing, to slow down the camera for slower frame grabbers. The FC40, for line lengths larger than 2048, you need to add one to this value for every 16 samples added to the line length, a full line (2352) requires 153 clocks.

READ THE SECTION BELOW ABOUT CAMERA RATE CONTROL.

[46]=Exposure Time in Pixel Clocks

This is the exposure time used by the camera in pixel clocks (50 MHz for the FC40, 66.66MHz for the FC13). This values must always be less than or equal to the value in offset 50 for correct operation. You may enter this value in microseconds, or equivalent rate, see data entry below.

[50]=Frame Period in Pixel Clocks

This is the time between frames captured by the camera, in pixel clocks (50 MHz for the FC40, 66.66MHz for the FC13). This determines the frame rate delivered by the camera in free running mode.

[54]=Exposure Delay in Pixel Clocks

This value provides some dead time from when the exposure should occur to when the exposure is done. This can be used to synchronize the exposure to a triggered event. This value should be set to zero for most applications.

[58]=Serial Link Bit Period in Pixel Clocks

The value controls the baud rate of the serial interface in the camera link version, and is not used by the USB version of the camera.

[60]=Camera Link Readout Mode

The Fast Vision cameras support all the modes in the camera link specification, and more modes outside of the specification. The programmability of these modes allows the user to decide which mode best suits their application. The Modes are:

Mode[0] = 1 Tap 8 Bits

Mode[1] = 1 Tap 10 Bits

Mode[2] = 1 Tap 12 Bits

Mode[3] = 1 Tap 16 Bits

Mode[4] = 2 Taps 8 Bits

Mode[5] = 2 Taps 10 Bits

Mode[6] = 2 Taps 12 Bits

Mode[7] = 3 Taps 8 bits

Mode[8] = 3 Taps 10 bits

Mode[9] = 3 Taps 12 bits

Mode[10] = 4 Taps 8 bits

Mode[11] = 4 Taps 10 bits

Mode[12] = 4 Taps 12 bits

Mode[13] = 4 Taps 16 bits

Mode[14] = 2 Taps 16 bits

Mode[18] = 8 taps 8 bits

Mode[19] = 8 taps 10 bits

Not part of the Camera Link Standard.

Mode[20] = 10 taps 8 bits

Not part of the Camera Link Standard.

Mode[21] = 10 taps 10 bits

Not part of the Camera Link Standard, more than full camera link.

Mode[22] = 16 taps 8 bits

Not part of the Camera Link Standard, more than full camera link.

Mode[23] = 8 taps 16 bits

Not part of the Camera Link Standard, more than full camera link.

The FC13 and FC40 can be operated with 5 channel links with the proper frame grabber hardware. Modes 21,22 and 23 require special frame grabber hardware.

[61]=Camera Link Clock Frequency

This field can take the values 0,1,2, and 3. Which gives: 0 = 33 MHz, 1=42.5MHz, 2=66.66MHz and 3 = 85MHz. This field only effects the camera link clock speed; it does NOT change the sensor clock speed which is fixed at 50 MHz for the FC40 and 66.66MHz for the FC13. If you find that your frame grabber is not working, you may want to check the specification on the camera link clock speed, and lower the clock speed to match the specification. Note: The camera is in general much faster than most frame grabbers, (especially the FC40), which means there are settings where the camera is working, but the frame grabber can not keep up. Please see the technical issues below for more information about clock domains in the camera.

[62]=Binning

The binning field allows the camera to 'sum' pixels digitally, horizontally and/or vertically to improve sensitivity. Note: This is NOT an analog function like it is in CCD cameras, but is performed on the digital pixel values. This means there is no real reason to do this if you are digitally processing the images in your computer.

The hex value 0xXY where X is the horizontal binning factor, and Y is the vertical binning factor. X and Y can be 1,2,4, or 8 and can be set independently. For example 42 means each block 4 pixels wide and two pixels high is totaled, and the image is reduced by a factor of four in width and two in height.

The Binning field is some time used for other functions in custom version of the camera.

[63]=Memory Options Debug[3]:Raw[2]:Pattern[1]:DFSub[0]

This byte was named Memory Options, even though it has nothing to do with memory. Bit 3 is a debug bit in the JTAG version of the camera. Bit 2 is the input image enable on the JPEG camera, bit 1 turns on a ramp pattern, and bit zero enables dark field subtraction.

[64]=Output down shift

This field controls the number of times to shift the pixel value to the right before it is output on the tap data lines. The values are typically saturated, so that any one bit to the left outside of the tap bits will force the pixel to all bits on. The native mode of the sensor is 10 bits per pixel, and these 10 bits are processed to produce the bits that are sent out the tap lines. If this value is set to 2 for example and binning is set to 11, you will get the upper 8 bits of the 10 bit pixel.

[65]=Trigger Mode

This is a bit field which controls the various trigger modes:

Bits	Name	Function
1-0	Mode	0=Free Run 1=Multi-edge 2=signal-edge 3=ext-Exposure (See below)
2	CC1Enable	1=enabled 0=disabled
3	CC1Invert	1=falling edge 0=rising edge
4	SyncExpose	1=Readout-Sync_Exposure 0=do not (Use 0)
5	P2Trigger	1=enabled 0=disabled
6	P2Invert	1=falling edge 0=rising edge
7-15	not used	

The basic trigger modes are listed above. **Free run** mode is the state where the camera generates images without a trigger input based on the frame period value (offset 50). **Multi-edge trigger** mode is a single trigger will acquire multiple images (up to 255, this is set by offset 67). **Single-edge** mode is normal edge triggered triggering. **Ext-exposure mode** is positive or negative edge triggering (as set by bit 3 or 6) where the width of the trigger signal controls the exposure.

There are three sources of triggers, one is via the camera link input, on the CC1 line, another is via a TTL input on the P2 connector (the power connector), and finally the camera can be trigger via software over the serial interface. The two trigger signals can be both enabled in which case the resulting trigger event can come from either source. In the case of a USB camera the software trigger is sent over USB to the camera.

[67]=Frame count for Multi-Trigger mode

This single byte field determines the number of frames to generate in multi edge trigger mode (Trigger Mode = 1). Zero is one frame, 1 is two frames, and 255 is 256 frames.

[68]=CC2-4 controls

This byte controls the enables and the polarities of CC2 through CC4. CC2 can be used to cause a frame to be sent over the USB, (this performs a Y command). CC3 is used to reset memory (this performs a Z command), and CC4 is used to cause the sensor to perform a calibration cycle (this performs a P command).

Bit	Name	Function
0	CC2Enable	0=CC2 is disabled 1=CC2 does a Y command
1	CC2Invert	0=active high/positive edge 0=active low negative edge
2	CC3Enable	0=CC3 is disabled 1=CC3 does a Z command
3	CC3Invert	0=active high/positive edge 0=active low negative edge
4	CC4Enable	0=CC3 is disabled 1=CC3 does a P command
5	CC4Invert	0=active high/positive edge 0=active low negative edge
6-7	not used	

[69]=DarkVoltageEnable,clock phase

This field should be set to 128 (0x80).

Bit	Name	Function
0-5	ClockPhase	0 to 31, controls the clock duty cycle, used to overcome problems in MV40 sensor.
6	Not used	
7	DarkEnable	1=Enable VCLAMP3 on MV13 sensor 0=disable

[70]=Row Increment

This should normally be set to zero. A value of one will read out every other line, 2 every third line etc.

[71]=Burst Period

This word (32 bits) controls the number of frame bursts per second when bursting in free run mode. The Frame period controls the time between frames in a burst.

[75]=Moving ROI Mode

A special version of the camera supports moving the ROI from frame to frame. This byte is not used on the normal camera.

[76]=Number of frames in ROI Move

Total number of frames in the ROI motion. This is a 16 bit field.

[78]=Delta X [16.16]

The amount the frame moves in the X direction after each frame. Can be fractional.

[82]=Delta Y [16.16]

The amount the frame moves in the Y direction after each frame. Can be fractional.

[86]=Control FPGA Extension

These bytes are reserved (total of 42).

[128]=Image Count after Trigger

In the USB camera this controls the number of frames to capture after the trigger, after which writing to memory stops.

[130]=Debug Byte

This field is used by the FPGA designers for testing.

[131]=Blocks sent for each Y command

Determines the number of blocks of memory to send with each Y command from memory in the camera. Blocks being 640x480 bytes.

[132]=USB:12 bit vertical blank time

Number of line times to wait before sending the next block of data over USB.

[134]=Noise Control NU[15:12]:DisableSensor[11]:FrameReset[10]:Amplitude[9:0]

Noise control field. The camera contains a pseudo-random noise generator which can be used to dither the pixel values, so that averaging will improve bit depth in a more reliable way, and beyond the bit depth provided by the A to D converters.

[136]=Data FPGA Extension

These bytes are reserved.

DATA ENTRY

Values entered into the control program can be expressed in several different ways depending on which field you are changing. The way the value is interpreted is control by the prefix applied to the number entered. No prefix and the number is interpreted as a decimal number which is loaded into the offset selected.

An 'x' before a number means the digits that follow are hex digits (conversion stops at the first non-hex digit.) A't' before the number, cause the number to be converted to pixel clocks from microseconds, for example t5000 is 5000 microseconds or 25000 pixel clocks in the FC40. Typically't' is used for exposure settings.

An 'f' before the number, causes the number to be converted from Hertz (Hz) to pixel clocks. For example f500 means 500 Hz, or 100,000 pixel clocks in the FC40. This is typical used to set the frame period, as frame rate is a more normal way to think of this. Note you can use the 'f' prefix for setting the exposure as well, which is some times useful for setting the exposure and frame period to the same value.

A 'v' is used to set the reference voltages.

Do not set the reference voltages without reading 'Camera Reference Voltages' section above.

A 'p' is used for setting the fixed point X delta and Y delta registers, which do not exist on the standard camera, so this will probably not be to useful to you.

Supported Prefix Entry modes are:

###=decimal

x####, or 0x####=hex

t####=usec

f####=Hz

v##.##=voltage

p##.##=Fixed Point 16.16

Enter value:

CAMERA RATE CONTROL. (IMPORTANT-READ!!!)

Several values determine the actual timing of frames you get when the camera is operating.

The Line Period (44) sets the timing of the line readout from the sensor. This value times the number of lines $((42) - (40) + 1)$ divided by the sensor clock rate is the frame readout time. It is not possible to readout frames faster than the inverse of this time, in frames per second. If the Frame period (50) divided by the sensor clock rate is set to lower than the frame readout time, the camera will be limited by the frame readout time and will deliver that frame rate.

ALWAYS VERIFY THAT YOU ARE GETTING THE FRAME RATE YOU NEED BEFORE YOU RUN YOUR EXPERIMENT. One way to do this is to take a movie of a clock, or a counter that is going fast enough. An additional issue is long exposures. If you set the exposure to longer than the frame rate, it does not slow down the frame rate, but instead it becomes asynchronous to the frame readout, which means you get a flashing effect in the images, essentially the exposure system quits working in a useful way. Hence always be sure that the exposure time is less than or equal to the frame readout time or frame period whichever is larger

The same observations apply to triggered operation. If the trigger rate is faster than the exposure time the same problem occurs. See below about triggering.

TRIGGERING THE CAMERA

The camera can be triggered several different ways as explained in the section (65) above. The way the triggering system works, a trigger event is latched by what ever input comes first. When the timing cycle permits the next frame readout to occur, a frame is read out and the trigger inputs are re-armed. This means if you generate triggers faster than the frame readout time or frame period, whichever is larger; the 'extra' triggers will be ignored. In fact you can get a sub-sampling effect and get 1/2 the expected number of frames.

For example, suppose the frame readout time is 10,000 microseconds, and the frame rate is set to 80 Hz. The frame period in this case is 12,500 microseconds, which is larger than the frame readout time, so the frame rate will actually be 80 fps. Now if you generate 160 triggers per second. You will get 80 frames per second because every other trigger will be ignored (actually it's a bit more complex because of phase relationships but go with it). Now suppose you start lowering the trigger rate. As you lower it you will still get 80 frames per second, with the occasional missed frame ever once in a while, as the phase drifts. When you reach 80 frames per second the frame rate will begin to track the trigger rate as it slows down.

If you set the exposure to 16,667 microseconds. This is longer than the frame period and the frame readout time, so the exposure system will not be working as expected. When you hit 60 frames per second as the frame rate is lowered, the exposure will phase lock and you will begin getting the exposure you set in the register.

CLOCK DOMAINS AND DATA RATES

Another consideration is the data rate as it flows through the various parts of the system. Suppose for example you have the following setup, an 85 MHz full camera link frame grabber which can accept data at 680 MB/sec, and DMA it into host memory over PCIe. Furthermore suppose you are using the FC40 and would like to obtain 195 full frames per second.

Start at the sensor. The sensor is operating at 50 MHz, and provides 16 taps of 10 bits on each clock. The data from the sensor is provided in interleaved mode which means tap 1 has the first pixel, tap 2 the second pixel and so on, or the first clock, then tap 1 has pixel 17 on the next clock and so on. Now for the sensor to read out 2352 pixels, it takes it 133 clocks to get the first 2048 pixels, and an additional 20 clocks to get the remaining pixels or 153 clocks per line. You set the line period (44) to 153.

The data is passed from the sensor to the Data FPGA in the camera where it changes from the sensor clock domain to the camera link clock domain. The data FPGA contains a full line depth FIFO in it, which is operating at the camera link clock speed. If the camera link clock speed is set to 33 MHz or 42.5MHz the interface will be too slow to keep up with the sensor data (because camera link does not have a 16 tap 10 bit mode). We set the camera link clock rate to 85 MHz because we know we are attempting to maximize our throughput

The camera link spec defines the widest data path supported is 8 tap 8 bit mode. This means the highest data rate that can be transferred on camera link (in the spec at least) is 680 MB/sec. The sensor is providing 16 taps of 10 bits at 50 MHz or 8000 megabits per second. Using 8 bit data we will be receiving 800 MB/sec peak. This is too fast.

Thus we have 180 clocks per line. There is 1728+1 lines (1 for FVAL false time) so $50,000,000 / (1729 * 180)$ is 160 frames per second. So **85 MHz full camera link** supports at most 160 frames per second.

USB OPERATION

The FC40 and FC13 can be purchased with a USB option. This version of the camera has up to one gigabyte of internal memory which allows frames to be captured at full speed until the memory is full. For the FC13 that is 508 frames of 10 bit data, and for the FC40 that is 250 frames of 8 bit data. So the FC40 can operate at its rated 195 fps into memory for about 1.5 seconds. The 1GB of data can then be read out over USB which from this camera runs at about 8.5 MB/sec so it takes about 120 seconds to read out memory.

The USB versions of the camera provide 640x480 previews of what is being recorded to memory over USB (or base camera link if you connect to it). Please see the USB Fast Motion Manual for more details about the USB camera.

TROUBLESHOOTING

There are several things you can try before you call FastVision Technical Support for help.

- _____ Make sure the computer is plugged in. Make sure the power source is on.
- _____ Go back over the hardware installation to make sure that the system is properly installed.
- _____ Go back over the software installation to make sure you have installed all necessary software.
- _____ Run the Installation User Test to verify correct installation of both hardware and software.
- _____ Run the user-diagnostics test for your main board to make sure it's working properly.
- _____ Insert the FastVision CD-ROM and check the various Release Notes to see if there is any information relevant to the problem you are experiencing.

FASTVISION TECHNICAL SUPPORT

FastVision offers technical support to any licensed user during the normal business hours of 9 a.m. to 5 p.m. EST. We offer assistance on all aspects of processor board and PMC installation and operation.

CONTACTING TECHNICAL SUPPORT

To speak with a Technical Support Representative on the telephone, call the number below and ask for Technical Support:

Telephone: **603-891-4317**

If you would rather FAX a written description of the problem, make sure you address the FAX to Technical Support and send it to:

Fax: **603-891-1881**

You can email a description of the problem to support@FastVision.com

Before you contact technical support have the following information ready:

- _____ Serial numbers and hardware revision numbers of all of your cameras. This information is written on the invoice that was shipped with your products.
- _____ Also, each camera has its serial number on a serial number label on the back of the camera.
- _____ The version of the software that was provided with the camera.
- _____ The type and version of the host operating system, i.e., Windows 98.
- _____ Returning Products for Repair or Replacements

Our first concern is that you be pleased with your FastVision products.

If, after trying everything you can do yourself, and after contacting FastVision Technical Support, you feel your hardware or software is not functioning properly, you can return the product to FastVision for service or replacement. Service or replacement may be covered by your warranty, depending upon your warranty. The first step is to call FastVision and request a "Return Materials Authorization" (RMA) number. This is the number assigned both to your returning product and to all records of your communications with Technical Support. When a FastVision technician receives your returned hardware or software he will match its RMA number to the on-file information you have given us, so he can solve the problem you've cited.

When calling for an RMA number, please have the following information ready:

- _____ Serial numbers and descriptions of product(s) being shipped back
- _____ A listing including revision numbers for all software, libraries, applications etc.
- _____ A clear and detailed description of the problem and when it occurs
- _____ Exact code that will cause the failure
- _____ A description of any environmental condition that can cause the problem

All of this information will be logged into the RMA report so it's there for the technician when your product arrives at FastVision. Put camera inside their anti-static protective bags. Then pack the product(s) securely in the original shipping materials, if possible, and ship to:

**FastVision LLC.
71 Spit Brook Road, Suite 200
Nashua, NH 03060
USA**

Clearly mark **the outside of your package:**

Attention **RMA #90XXX**

Remember to include your return address and the name and number of the person who should be contacted if we have questions.

REPORTING BUGS

We at FastVision are continually improving our products to ensure the success of your projects. In addition to ongoing improvements, every FastVision product is put through extensive and varied testing. Even so, occasionally situations can come up in the fields that were not encountered during our testing at FastVision.

If you encounter a software or hardware problem or anomaly, please contact us immediately for assistance. If a fix is not available right away, often we can devise a work-around that allows you to move forward with your project while we continue to work on the problem you've encountered.

It is important that we are able to reproduce your error in an isolated test case. You can help if you create a stand-alone code module that is isolated from your application and yet clearly demonstrates the anomaly or flaw.

Describe the error that occurs with the particular code module and email the file to us at:

support@FastVision.com

We will compile and run the module to track down the anomaly you've found.

If you do not have Internet access, or if it is inconvenient for you to get to access, copy the code to a disk, describe the error, and mail the disk to Technical Support at the FastVision address below.

If the code is small enough, you can also:

FAX the code module to us at 603-891-2745.

If you are faxing the code, write everything large and legibly and remember to include your description of the error.

When you are describing a software problem, include revision numbers of all associated software.

For documentation errors, photocopy the passages in question, mark on the page the number and title of the manual, and either FAX or mail the photocopy to FastVision.

Remember to include the name and telephone number of the person we should contact if we have questions.

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