



AUTO FOCUS MODULE

CUSTOM CAMERAS FOR MASS PRODUCTION APPLICATIONS



USER GUIDE

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About this Document

This document is the User Guide for the Camelot Camera Auto Focus Program.

Target Audience

This document is meant for application programmers who wish to integrate Camelot series cameras with Auto-focus capabilities into 3rd party applications.

About this Application

The **Camelot AutoFocus Sample** Application was written to demonstrate to programmers how to control the Camelot Auto-focus modules.

Important Information

NOTE

Important information is shown as notes.

WARNING

Important Safety information is displayed in this format

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How to Contact Us

Website

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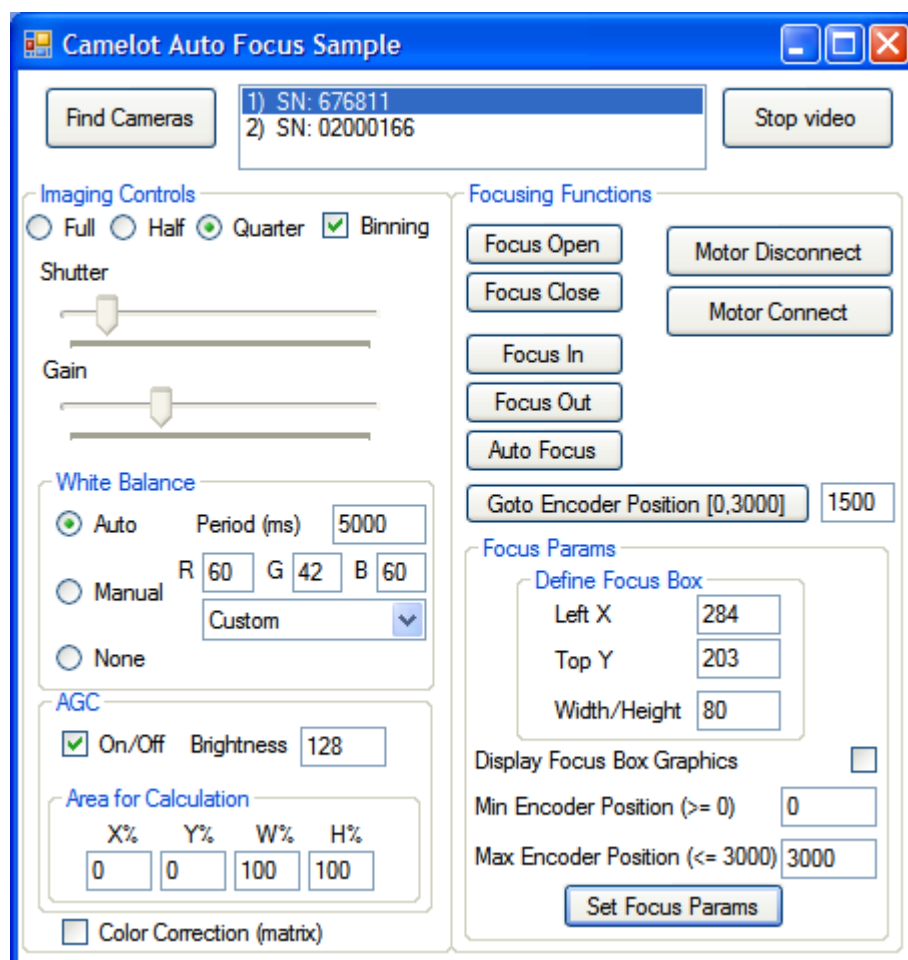
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USING THE AUTOFOCUS SAMPLE

Camelot AutoFocus Sample

The main screen is displayed when the application loads and contains the basic controls.

- ◆ **To start using the Imaging and Auto-focus features:**
 1. Click the **Find Cameras** button to find all USB and IP available cameras.
 2. Click the **Start Video** button to start streaming video from the selected camera to a separate window.



Imaging Controls Pane

This pane contains the capture parameters and advanced imaging controls.

For more information about these controls, please refer to the ***ID_Camelot_UserGuide.pdf***.

Table 1: Imaging Controls Pane

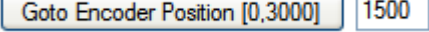
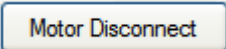
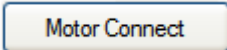
Parameter	Description	
Full	The camera transmits a full sized image.	
Half	The camera transmits a 1/4 sized image. (1/2 width x 1/2 height).	
Quarter	The camera transmits a 1/16 sized image. (1/4 width x 1/4 height)	
Binning	Binning is when skipped rows and columns are averaged into pixel value (in HALF and QUARTER resolutions).	
White Balance		
Auto	Should AWB (Automatic White Balance) be applied to all captured frames automatically?	
	Period (ms)	AWB will be performed in this period of milliseconds.
Manual	Sets the R:G:B ratio for subsequent gain adjustments. The gain trackbar controls the R component gain – and the G & B gains will be set according to this ratio. The R:G:B proportion values can be initialized by allowing <i>Auto</i> mode to run and then switching to <i>Manual</i> .	
	R	Red gain proportion value (0..1024)
	G	Green gain proportion value (0..1024)
	B	Blue gain proportion value (0..1024)
	Custom	Combo-box with a list of set RGB proportions for different types of lighting
None	No White <i>Auto</i> or <i>Manual</i> Balance is performed – the R:G:B ratio for gain control is set to 1:1:1.	
AGC (Automatic Gain Control)		
On/Off	Should AGC (Automatic Gain Control) be used when processing the captured frames?	
	Brightness	Average brightness of pixels in frame (0..255)
	Area for Calculation	
	X%	Percentage of X offset from upper left corner (0..100)
	Y%	Percentage of Y offset from upper left corner (0..100)
	W%	Percentage of Width of frame (0..100)
	H%	Percentage of Height of frame (0..100)
Color Correction	ColorMatrix operations are performed in the RGB colorspace (red, green, blue). A ColorMatrix consists of a 3x4 matrix.	

Focusing Functions Pane - M3 only

This pane controls the focusing capabilities of the AutoFocus module.

The M3 motor has a range of 1.5mm. Use the steps listed below to setup the camera before using the Auto Focus module:

◆ **To set up the camera before using the Auto Focus module:**

1. Set the encoder position to the middle 
2. Disconnect the auto focus motor by pressing 
3. Adjust the lens manually (screw in/out) to the middle range of the focus. This will allow the maximal margin.
4. Connect the auto focus motor 

NOTE

When adjusting the lens manually, make sure that the auto focus motor is disconnected in order not to damage the module.

Table 2: Focusing Functions Pane

Parameter	Description
Focus Open	Opens Focus completely – focuses in, towards the object (narrower view).
Focus Close	Closes Focus completely – focuses away from object (wider view).
Focus In	Focuses in a step from the current position. For M3 modules the step is 100 (default – can be changed programmatically) and the final position is limited to 3000.
Focus Out	Focuses out a step from the current position. For M3 modules the step is 100 (default – can be changed programmatically) and the final position is limited to 0.
Auto Focus	Starts the auto focus macro. This opens focus to the limit and starts closing focus until the peak in focus value has been passed, and then backtracks to the focus peak. In M3 modules this process is repeated at reduced amplitude and speed to provide fine tuning.
Goto Encoder Position	M3 modules only. Moves focus to an exact position. The values are in range of [0..3000].
Motor Disconnect	M3 modules only. Disconnects the auto focus motor, which subsequently cannot be controlled by camera.
Motor Connect	M3 modules only. Connects auto focus motor so that it can be controlled by camera.
Focus Params	
Define Focus Box	Defines position and width/height of square area used for focusing.
	Left X X position of upper left corner
	Top Y Y position of upper left corner
	Width/Height Width and Height of box
Display Focus Box Graphics	Should focus box be displayed?
Min Encoder Position	For M3 module. When using Auto focus, define minimum position. Auto focus focusing will range between Min and Max Encoder positions.

Parameter	Description
Max Encoder position	For M3 module. When using Auto focus, define maximum position. Auto focus focusing will range between Min and Max Encoder positions.
Set Focus Params	Uploads the focus parameters to the camera.

PROGRAMMING USING AUTO FOCUS API

Sending UserMessages to the AutoFocus Module

The Auto Focus feature is an enhancement to the Camelot API (see [ID_Camelot_EVK_API_functions.pdf](#)).

These specific focusing functions are implemented through *Camelot.dll*'s **SendMessage** function:

SendMessage(unsigned char *Data, int cbData) or

CamSendMessage(int CamID, unsigned char *Data, int cbData)

- **Data[0]** holds the command ID – see [Appendix A](#) and [Appendix B](#) for commands specific to the different auto focusing modules.
- **Data[1...]** holds the parameters
- **cbData** is the length in bytes of the command parameters + 1 (for the command ID)

Please refer to the Camelot_CSharp_AutoFocus sample source code for examples that use these messages to control the Auto Focus module.

Understanding the FrameInfo Structure

Each frame captured includes a tFrameInfo structure that describes the current state of the frame. Below is a short explanation of the fields in the structure, which can be accessed in a PC Callback function (see [Camelot_EVK_API_functions.pdf](#) for more details).

```
typedef struct {
    int         FocusValue;           // at peak, focus is optimal
    short      EncoderPosition;      // current encode position
                                           // (for M3 module in range 0 - 3000)
    short      AlgStatus;            // status of auto focus algorithm -
                                           // 0: inactive
                                           // 4: calculating focus value only
                                           // otherwise: auto focus active
                                           // - one of the AutoFocus modes
    short      AlgRetCode;           // Return code of last auto focus mode
                                           // A non-zero value indicates an
                                           // error/warning
    short      reserved;
} tAutoFocusInfo;

typedef struct {
    unsigned char  AGCStatus;        // 0: steady state,
                                           // 1: brightness decreasing,
                                           // 2: brightness increasing
    unsigned char  Brightness;      // current avg brightness 0 - 255
    char           reserved;
    char           reserved2;
    int            AWBValue;        // indicates convergence of AWB algorithm
}
```

```
                                                                    // convergence threshold is 50
} tAGC_AWBInfo;

// characteristics of the frame
// PC - struct member align 8-byte boundary
typedef struct {
    unsigned short   FrameType;      // BAYER_RAW, BAYER_8_BIT or FILLER
    unsigned short   PixelWidth;     // Frame Width
    unsigned short   PixelHeight;    // Frame Height
    unsigned short   PixelBits;      // Bits per pixel
    unsigned int     SizeBytes;       // u32 - Size of frame in bytes
    unsigned char    RawNoLUT;       // is data RAW, without being translated
                                                // with LUT?
    unsigned char    WithFlash;      // was picture taken with flash
    unsigned char    WithTrigger;    // frame was captured due to GPIO trigger
    unsigned char    reserved;       // for alignment
    unsigned short   reserved1;      // for alignment
    unsigned short   PixelBytes;     // calculate once - assume no packing
    unsigned int     FrameNumber;    //
    unsigned long long TimeMs;       // u64 - constant timer
    tAutoFocusInfo   AFInfo;
    tAGC_AWBInfo     AGC_AWBInfo;
} tFrameInfo;
```

The commands described below make up the M3-F Auto Focus User Project Interface.

*Commands in blue are currently not available.

Command	ID	Data		Description
		Parameter	Bytes	
USER_CMD_DO_AWB*	1	-	-	Performs a single AWB pass and sets the gains appropriately.
USER_CMD_MSG_SEGMENTS*	2	Buffer Num	1	Requests transmission of message buffer 0 or 1. Only ~400 bytes can be sent along with a frame during streaming. This starts sending the requested buffer segment by segment along with the following frames. Sending buffer # 1 also resets both the buffers.
USER_CMD_SET_GAIN*	3	RGB Gains	3	Sets RGB Gain – values from 0-255. Data[1] – Red gain Data[2] – Green gain Data[3] – Blue gain
USER_CMD_FOCUS_OPEN	5			Opens Focus, the encoder position is set to 3000.
USER_CMD_FOCUS_CLOSE	6			Closes Focus, the encoder position is set to 0.
USER_CMD_AUTO_FOCUS	7	MUST be 4	1	Switches on the algorithm that calculates a focus value for each frame. Returns this value to the client application as a string.
USER_CMD_M3_CONNECT	8			Establishes computer control of M3-F device, initializes control in closed loop mode, and connects the M3-F's motor.
USER_CMD_M3_DISCONNECT	9			Disconnects the M3-F Device.
USER_CMD_FOCUS_PLUS	10	Extent	2	Open focus from the current position according to extent. The final position is limited to 3000.
USER_CMD_FOCUS_MINUS	11	Extent	2	Close focus from the current position according to extent. The final position is limited to 0.
USER_CMD_M3_SPEED_PCT	13	% of Maximum		Adjusts M3-F motor speed as a percentage of the maximum. This is done to reduce M3-F's power consumption (470mW at max speed). Default setting upon establishing control is 30%. Using a higher percentage may cause the camera to reset. <i>This setting is currently overridden each time the auto focus macro is invoked...</i>
USER_CMD_AUTO_FOCUS_MACRO	14			Starts the auto focus macro. This opens focus to the limit and starts closing focus until the peak in focus value has been passed, and then backtracks to the focus peak.

Command	ID	Data		Description
		Parameter	Bytes	
USER_CMD_SET_FOCUS_WINDOW	15	X,Y coordinates Width Display GFX Min, Max	24	Data[1..4] – x coordinate (int) Data[5..8] – y coordinate (int) Must be greater or equal to 0 Data[9..12] - Width of focus window. $20 \leq W \leq 160$ Data[13..16] - Display focusing GFX 0 - no, 1 - yes. Data[17..20] – min encoder position [0] Data[21..24] – max encoder position [3000] $0 \leq \text{min} < \text{max} \leq 3000$ Limit auto focus search to [min,max]
USER_CMD_FOCUS_GOTO	16	Position	2	Move focus to exact position at next frame. values [0..3000]
USER_CMD_FOCUS_GOTO_IMMED	17	Position	2	Move focus to exact position immediately (even if not in streaming video). values [0..3000]
USER_CMD_AWB_STARTUP*	'W'			Optimize image macro performs AGC and several AWB passes.
USER_SET_TRIGGER*	'X'			Enables PWM and triggers capture of a snapshot.

The commands described below make up the Canon Digital SLR Auto Focus User Project Interface.

Command	ID	Data		Description
		Parameter	Bytes	
USER_CMD_IRIS_OPEN	3			Open the iris completely.
USER_CMD_IRIS_CLOSE	4			Close the iris one step.
USER_CMD_FOCUS_OPEN	5	0 or 1	1	0: Opens focus to the maximum. 1: Starts the auto focus macro. This opens focus to the limit, and starts closing focus until the peak in focus value has been passed, and then backtracks to the focus peak.
USER_CMD_FOCUS_CLOSE	6			Closes focus to the minimum.
USER_CMD_AUTO_FOCUS	7	Must be 4	1	Switches on the algorithm that calculates a focus value for each frame and returns this to the client application as a string.
USER_CMD_FOCUS_PLUS_MACRO	9	Step Size, Inter-step delay ms, Max number of steps	3	<i>Step Size, Inter-step delay ms, Max number of steps</i> This provides parameters used in the backtrack macro.
USER_CMD_FOCUS_PLUS	10	Extent	2	Open focus from current position by extent.
USER_CMD_FOCUS_MINUS	11	Extent	2	Close focus from current position by extent.
USER_CMD_AUTO_FOCUS_MACRO	14			Starts the auto focus macro, which opens focus to the limit, starts closing focus until the peak in focus value has been passed – and then backtracks to the focus peak.
USER_CMD_SET_FOCUS_WINDOW	15	X,Y coordinates	8	Data[1..4] – x coordinate; Data[5..8] – y coordinate

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We appreciate any feedback about the Camelot EVK Auto Focus User Project API.

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