

EVK LoRes Serial Communications Protocol

This Document describes the serial protocol used for the EVK LoRes. It contains intellectual property of Vision and should be treated as confidential.

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1 Protocol

1. All communications are via a RS-232 link.
2. All communications are initiated by the PC, ie, the PC is always the master and the camera always the slave.
3. All messages, both to and from the PC, are sent as packets starting with STX and terminating with ETX.
4. A command from the PC has the following format:

STX	Command	Data 1	Data 2	...	Data N	ETX
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- STX Standard ASCII character (0x02).
- Command A defined command byte.
- Data *n* Data for specific command. All commands have at least 1 byte of data (which is set zero if not used), some have more, the actually number is implicitly defined by the command byte.
- ETX Standard ASCII character (0x03).

5. On receipt of a command from the host PC, the camera will always return an acknowledgment. This will be either ACK (0x06) or NAK (0x15). An ACK is returned if the command was successfully received and recognized (it does not indicate whether it was executed successfully, that is done by a response packet). A NAK indicates the command was not received successfully or was unrecognized. If no ACK or NAK is received in response to a command, the comms are assumed to be faulty or the camera disconnected.
6. All commands cause the camera return a response packet to the PC. This is sent immediately after the ACK, subject to any delays in executing the command. A NAK will not be followed by a response packet. The response has the following format:

STX	Response	Data 1	Data 2	...	Data N	ETX
-----	----------	--------	--------	-----	--------	-----

- STX Standard ASCII character (0x02).
- Response A defined response byte.
- Data *n* Data for specific response. All responses have at least 1 byte of data (which is set zero if not used), some have more, the actually number is implicitly defined by the response byte.
- ETX Standard ASCII character (0x03).

7. Under normal conditions the response byte will be specific to the command sent, eg, a grab command byte would receive a grab response byte. However, when the camera is busy, all commands will receive a camera busy response packet. This has the following format.

STX	RB_CAMERA_BUSY (!)	<i>Busy Code</i>	ETX
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The *Busy Code* allows the camera to tell the host application what it is busy doing. The following codes are defined.

initiated	0x20	BUSY_TIMER	Camera is in "Wait" function (and hence Beep, etc)
	0x21	BUSY_EXPOSURE	Waiting for correct exposure after a grab has been
	0x22	BUSY_VIDEO	Camera is in continuous video mode (self-test only)
	0x23	BUSY_SHUTTER	Camera is waiting for the shutter (to come up)
	0x24	BUSY_COMMAND	RemoteCommand has been called when camera is busy
	0x25	BUSY_COUNTER	Counter is being reset (to non-zero value)

2 Command Summary

The following commands are defined (listed by numeric value of their ASCII code). The response indicated is under normal operating conditions. Each command will receive the “camera busy” response if the camera has not completed a previous command or is taking a picture.

COMMAND			RESPONSE		
Code	Symbol	Data Bytes	Code	Symbol	Data Bytes
A	CB_RESET_COUNTER	1 (image index)	a	RB_RESET_COUNTER	1 (error code)
B	CB_BEEP	2 (duration, numtimes)	b	RB_BEEP	1 (error code)
E	CB_ECHO	1 (test char)	e	RB_ECHO	1 (test char sent)
G	CB_GRAB_IMAGE	1 (delay & retry flags)	g	RB_GRAB_IMAGE	1 (error code)
I	CB_GET_IMAGE_INDEX	1 (ignored - set to zero)	i	RB_GET_IMAGE_INDEX	1 (image index)
J	CB_INC_COUNTER	2 (inc LSB, inc MSB)	j	RB_INC_COUNTER	2 (error code, value)
K	CB_WRITE_RAMBYTE	1 (value)	k	RB_WRITE_RAMBYTE	1 (error code)
L	CB_GO_IDLE	1 (ignored - set to zero)	l	RB_GO_IDLE	1 (error code)
M	CB_UPLOAD_THUMBNAIL	1 (ignored - set to zero)	m	RB_UPLOAD_THUMBNAIL	hdr + pixel data + info
P	CB_PORT0	1 (new port value)	p	RB_PORT0	1 (old port value)
Q	CB_VIDEO_MODE	1 (video mode)	q	RB_VIDEO_MODE	1 (error code)
R	CB_READ_CAMREG	1 (register index)	r	RB_READ_CAMREG	1 (register value)
T	CB_SET_EXPBAND	2 (grab min, grab max)	t	RB_SET_EXPBAND	1 (error code)
U	CB_UPLOAD_IMAGE	1 (ignored - set to zero)	u	RB_UPLOAD_IMAGE	hdr + pixel data + info
V	CB_GET_VERSION	1 (ignored - set to zero)	v	RB_GET_VERSION	version string
W	CB_WRITE_CAMREG	2 (reg index, value)	w	RB_WRITE_CAMREG	1 (error code)
X	CB_GET_EXPBAND	1 (ignored - set to zero)	x	RB_GET_EXPBAND	2 (grab min, grab max)
Y	CB_GRAB_RESULT	1 (ignored - set to zero)	y	RB_GRAB_RESULT	1 (grab result code)
Z	CB_QUIT_SELFTEST	1 (ignored - set to zero)	z	RB_QUIT_SELFTEST	1 (error code)
			!	RB_CAMERA_BUSY	1 (busy code)

Details of the commands and associated responses are given in the following sections. Remember that all commands may receive the RB_CAMERA_BUSY response as well as the specific response described. When a command receives the RB_CAMERA_BUSY response, the command will not have been executed.

3 Reset Image Counter

Sets the image counter within the camera to point to the specified image. This will cause the next image to be acquired to that location. An index of zero resets the address counter to zero whilst non-zero values advance the counter by *index* x NIMGBYTES bytes. Note that 6 (the maximum number of images) is a legal argument and will set the address counter to point to the location immediately after the last image – this will cause the EVK LoRes unit to behave as though it has captured the maximum number of images.

Command

STX	CB_RESET_COUNTER (A)	<i>Index</i>	ETX
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The required image index. Must be in range 0 to MAX_IMAGES or expect erratic results.

Response

STX	RB_RESET_COUNTER (a)	<i>Error Code</i>	ETX
-----	----------------------	-------------------	-----

Error Code is always zero. If the camera is busy the RB_CAMERA_BUSY response is returned with the appropriate busy code.

4 Beep

Sounds the camera's buzzer.

Command

STX	CB_BEEP (B)	<i>Duration</i>	<i>Num Times</i>	ETX
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The *Duration* argument specifies how long the buzzer will sound for in EVK LoRes clock ticks (these are approximately 50 mS).

The *Num Times* argument specifies how many times the buzzer will be sounded. If *Num Times* is greater than 1, each beep will be separated by a silence of *Duration* ticks.

Response

STX	RB_BEEP (b)	<i>Error Code</i>	ETX
-----	-------------	-------------------	-----

Error Code is always zero.

5 Echo Byte

An arbitrary test byte is sent to the camera. If the command is executed successfully, the test byte is echoed in the response. No other action is taken. This command is intended to test the communications link and may also be used to wake up the camera.

Command

STX	CB_ECHO (E)	<i>Test Byte</i>	ETX
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The *Test Byte* may be any value, but it would probably be prudent to avoid control characters such as ACK, NAK, STX and ETX.

Response

STX	RB_ECHO (e)	<i>Test Byte</i>	ETX
-----	-------------	------------------	-----

If the returned *Test Byte* is not the same as that sent in the command then an error has occurred.

6 Grab Image

Causes the camera to grab an image to the next location in its image memory. After the grab, the image counter will point to the next image location. Note that this command only initiates the grab and a response is returned immediately. There may be some considerable delay before the grab is completed due to the use of the self-timer or because the correct exposure can not be attained. Use the grab result command to find out when the grab is completed and whether it was successful or not.

Command

STX	CB_GRAB_IMAGE (G)	<i>Control</i>	ETX
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The lower nibble of *Control* specifies the self-timer delay (0-15). A delay of zero means the grab is to be executed immediately. The upper nibble controls the response to bad lighting conditions. Bits 4-6 specify the number of retries if the exposure is bad, ie, 0, 16, 32 ...112. Bit 7 is reserved with the intention of implementing a "grab anyway" option if needed.

Response

STX	RB_GRAB_IMAGE (g)	<i>Error Code</i>	ETX
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Error Code will always be set to zero. Use the grab result command to find out the status of the grab.

7 Get Image Index

Requests the camera to report the current setting of its image counter. If this has been modified by the reset counter command, this may not reflect the number of images that have actually been taken. The value will also be invalidated by test commands CB_INCREMENT_COUNTER and CB_WRITE_RAMBYTE and also by switching the camera into video mode. To restore the counter to a known state use CB_RESET_COUNTER (and ensure that video mode is off).

Command

STX	CB_QUERY_NUM_IMAGES (I)	0	ETX
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The argument is always zero

Response

STX	RB_QUERY_NUM_IMAGES (i)	<i>Image Index</i>	ETX
-----	-------------------------	--------------------	-----

Image Index will be in the range 0 to 6 (note 6 is a legal value but means that the memory is full). Any other value should be treated as an error condition.

8 Increment Image Counter

Increments the address counter from its current position by the specified number of steps. Note that this command will invalidate the camera's internal image index that is returned by CB_GET_IMAGE_INDEX. To re-align the address counter with the image index, call reset counter with the image index as the argument.

Command

STX	CB_INC_COUNTER (J)	<i>Increment LSB</i>	<i>Increment MSB</i>	ETX
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The number of increments to be applied to the counter. The number is interpreted as a 16-bit word and is sent with the least significant byte first. The range can not span the whole memory (128kB) so it is recommended to keep the increment in the range 0 – 32,767 so as to avoid possible signed/unsigned problems. This is large enough to step over a single image at a time. A value of zero leaves the counter unchanged but allows the contents of the current RAM location to be read.

Response

STX	RB_INC_COUNTER (j)	<i>Error Code</i>	<i>RAM Value</i>	ETX
-----	--------------------	-------------------	------------------	-----

Error Code is always zero. *RAM Value* will contain the contents of the RAM location pointed to be the counter after the increment has been applied.

9 Write RAM Byte

Writes a byte to the current RAM location. This will automatically increment the address counter by one after the byte has been written. Note that this command will invalidate the camera's internal image index that is returned by the CB_GET_IMAGE_INDEX command. To re-align the address counter with the image index, call reset counter with the image index as the argument.

Command

STX	CB_WRITE_RAMBYTE (K)	<i>Value</i>	ETX
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Value is written to the current address location.

Response

STX	RB_WRITE_RAMBYTE (k)	Error Code	ETX
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Error Code will always be set to zero.

10 Go Idle

Switches the camera into its idle mode. It will remain in idle mode until another command is sent over the serial link or one of the shutter buttons is pressed.

Command

STX	CB_GO_IDLE (L)	0x00	ETX
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The command data should be set to zero.

Response

STX	RB_WRITE_RAMBYTE (k)	Error Code	ETX
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Error Code will always be set to zero. Note, the response is returned before the camera goes to sleep!

11 Upload Thumbnail Image

Causes the camera to upload a thumbnail image from the current location in its image memory. After the upload, the image counter will point to the start of the next image and the image index will be incremented by 1. If required, the counter reset command can be called before the upload to select the desired image.

Command

STX	CB_UPLOAD_THUMBNAIL (M)	0	ETX
-----	-------------------------	---	-----

The argument is always zero.

Response

STX	RB_UPLOAD_THUMBNAIL (m)	N_1	N_2	N_3	N_4	D_1	D_2	...	D_n	ETX
-----	-------------------------	-------	-------	-------	-------	-------	-------	-----	-------	-----

The thumbnail image is returned as a stream of data bytes. This includes visible lines and status bytes. The total number of data bytes may be determined from the leading 4 bytes, $N_1 - N_4$, as follows:

$$N_{tot} = N_1 \times (N_2 + N_3) + N_4 \quad \text{where} \quad \begin{array}{l} N_1 \text{ is the number of columns in the image (40)} \\ N_2 \text{ is the number of black lines (0)} \\ N_3 \text{ is the number of visible lines (31)} \\ N_4 \text{ is the number of status bytes (16)} \end{array}$$

Note that N_{tot} is the number of data bytes $D_1 - D_n$ only, it does not include the 6 leading header bytes or the final ETX.

There is no explicit error reporting within the response message but the image status bytes may contain useful information.

12 Set Video Mode

Switches the camera in and out of video mode. In video mode, the camera free runs (FST/QCK continuously enabled) and full images are generated. This function is for testing only and will invalidate all memory contents and the image index. A capture card must be used to acquire the image data.

Command

STX	CB_VIDEO_MODE (Q)	<i>Mode</i>	ETX
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If *Mode* is non-zero, the camera is put into video mode. If zero, normal grab mode. After restoring normal operation, the image counter is reset to zero.

Response

STX	RB_WRITE_RAMBYTE (k)	<i>Error Code</i>	ETX
-----	----------------------	-------------------	-----

Error Code will always be set to zero.

13 Read Camera Register

Reads the contents of a specified camera register. See the VVL300 data sheet for more details on camera registers.

Command

STX	CB_READ_CAMREG (R)	<i>Reg Addr</i>	ETX
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Reg Addr is the address of the camera register to read.

Response

STX	RB_READ_CAMREG (r)	<i>Reg Val</i>	ETX
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In the event of an error *Reg Val* will be set to 0xFF, note, however, that this does not uniquely identify an error as 0xFF may be a legitimate register value. The host software must do any additional range checks on the returned value.

14 Set Exposure Thresholds

Sets the minimum and maximum frame average values necessary before executing a grab. This is not actually a 300 register but should be treated as such from a development/product point of view, ie, it is initialized in firmware and any later modifications by the host will be lost once the camera is powered down

Command

STX	CB_SET_EXPBAND (T)	<i>Min</i>	<i>Max</i>	ETX
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Min and *Max* are the new threshold values. *Min* should be less than *Max* but no checks are made.

Response

STX	RB_SET_EXPBAND (t)	<i>Error Code</i>	ETX
-----	--------------------	-------------------	-----

The error code is always zero.

15 Upload Image

Causes the camera to upload the image from the current location in its image memory. After the upload, the image counter will point to the start of the next image. If required, the counter reset command can be called before the upload to select the desired image.

Note: this call makes no checks on the value of the image index and will happily upload data from an arbitrary location (for example if INC_COUNTER has been called) or if the index is already at 6 and above. It will always increment the image index afterwards and thus it is possible to end up with illegal values (eg, of 7) which can be confusing.

Command

STX	CB_UPLOAD_IMAGE (U)	0	ETX
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The argument is always zero.

Response

STX	RB_UPLOAD_IMAGE (u)	N_1	N_2	N_3	N_4	D_1	D_2	...	D_n	ETX
-----	---------------------	-------	-------	-------	-------	-------	-------	-----	-------	-----

The complete image is returned as a stream of data bytes. This includes black lines, visible lines and status bytes. The total number of data bytes may be determined from the leading 4 bytes, $N_1 - N_4$, as follows:

$$N_{tot} = N_1 \times (N_2 + N_3) + N_4$$

where N_1 is the number of columns in the image (164)
 N_2 is the number of black lines (2)
 N_3 is the number of visible lines (124)
 N_4 is the number of status bytes (16)

Note that N_{tot} is the number of data bytes $D_1 - D_n$ only, it does not include the 6 leading header bytes or the final ETX.

There is no explicit error reporting within the response message but the image status bytes may contain useful information.

16 Get Firmware Version

Request the camera to report the version of its firmware. This is a null terminate ASCII string.

Command

STX	CB_GET_VERSION (V)	0	ETX
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The argument is always zero

Response

STX	RB_GET_VERSION (v)	<i>String Size</i>	C_1	C_2	...	C_N	<i>Null</i>	ETX
-----	--------------------	--------------------	-------	-------	-----	-------	-------------	-----

Note that the size of the string reported includes the null character. If any error occurs during the execution of the command *String Size* will be set to zero and will immediately be followed by ETX.

17 Write Camera Register

Writes a given value to a specified camera register.

Command

STX	CB_WRITE_CAMREG (W)	<i>Reg Addr</i>	<i>Reg Val</i>	ETX
-----	---------------------	-----------------	----------------	-----

Reg Addr is the address of the camera register and *Reg Val* is the value to be written.

Response

STX	RB_WRITE_CAMREG (w)	Error Code	ETX
-----	---------------------	------------	-----

If the write was successful, *Error Code* will be set to 0x00, otherwise it will be set to 0xFF.

18 Get Exposure Thresholds

Request the camera to report its exposure thresholds. These values are stored within the microcontroller memory and are not 300 registers.

Command

STX	CB_GET_EXPBAND (X)	0	ETX
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The argument is always zero

Response

STX	RB_GET_EXPBAND (x)	<i>GrabMin</i>	<i>GrabMax</i>	ETX
-----	--------------------	----------------	----------------	-----

GrabMin and *GrabMax* are the current exposure threshold values.

19 Grab Result

Reports the success or otherwise of the last grab. Note that whilst the grab is in progress (either because a self-timer delay or large number of retries have been requested) the RB_CAMERA_BUSY response will be generated. The grab result is not valid until the RB_GRAB_RESULT response is received.

Command

STX	CB_GRAB_RESULT (Y)	0	ETX
-----	--------------------	---	-----

The argument is always zero

Response

STX	RB_GRAB_RESULT (y)	Error Code	ETX
-----	--------------------	------------	-----

Error Code will be set to one of the following values:

- 0x00 Grab was successful.
- 0x80 Image not grabbed because memory was already full.
- 0x81 Image not grabbed because good exposure could not be attained.

Note that the result returned corresponds to the last grab executed by the camera and this could have been initiated by pressing one of the trigger buttons not just the grab command.

20 Quit Self Test

Causes the camera to leave the self-test routine.

Command

STX	CB_QUIT_SELFTEST (Q)	0	ETX
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The argument is always zero

Response

STX	RB_QUIT_SELFTEST (q)	0	ETX
-----	----------------------	---	-----

Error Code will be set to zero.