NOCTURN XS Monochrome Engineering User Guide

September 2014

Doc. No.: 200-LC-4020

Version B.01

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Document Revisions

Date	Version Number	Document Changes
Dec. 12, 2013	A-1	Initial Draft
Jan. 17, 2014	A-2	Initial Release
Sept. 13, 2014	B-1	Update for software version 610

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SAFETY SUMMARY

WARNING and CAUTION statements have been strategically placed throughout the text prior to operating or maintenance procedures, practices, or conditions considered essential to the protection of personnel (WARNING) or equipment and property (CAUTION). NOTES emphasize necessary and important data. CAUTIONS and NOTES appear in the text as applicable. Definitions for WARNINGS, CAUTIONS and NOTES are as follows:

WARNING

A warning indicates an operation, condition, or statement, etc., which, if not strictly observed, could result in injury to or death of personnel.

CAUTION

A caution indicates an operation, maintenance procedure, or condition, etc., which, if not strictly observed, could result in damage to, or destruction of, equipment or loss of hardware performance or function.

NOTE

A note indicates an essential operating or maintenance procedure, condition or statement or explanatory text.

1   Introduction

1.1   Scope and Purpose

The NOCTURN XS monochrome (see Figure 1) is a rugged low light camera module that features high-definition resolution, high sensitivity and high dynamic range with low power consumption. Powered by PHOTONIS' 1 inch optical format 1280×1024 pixel (SXGA) Lynx CMOS sensor, the NOCTURN provides real-time imaging capabilities (from daylight to one quarter moon scene illumination) in the visible and near infrared spectrum. Its small size, weight and power (SWaP) make this camera module ideal for integration into aerial, mobile and hand-held surveillance systems.

With its 9.7μm×9.7μm pixel pitch and 4e- median read noise, the NOCTURN provides unsurpassed signal to noise at low light with video rates up to 100 frames per second. Leveraging PHOTONIS expertise in night vision imaging, the NOCTURN electronics incorporates a multitude of functions to enhance the low light level performance. This camera features automatic gain control (AGC), automatic exposure control (AEC), high dynamic range (HDR), non-uniformity correction (NUC) and advanced image enhancement, allowing the NOCTURN to provide continuous situational awareness without compromising mobility and SWaP. The "XS" version of the NOCTURN specifically designed for integrator and original equipment manufacturer and offers a +3.3V parallel output.
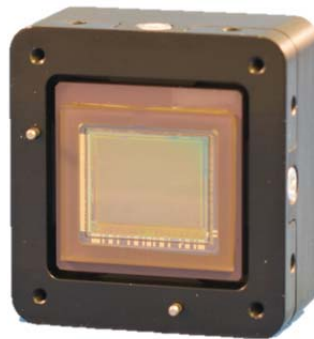
Figure 1 Front View of the NOCTURN XS Camera

This user guide provides a detailed overview of the functionality, operation and communication interface with the camera accessible by a user. The hardware interface for the camera are only briefly discussed in this guide, the user should referred to the NOCTURN XS Electro-Mechanical ICD for a detailed description. Please contact PHOTONIS USA technical support for details that are not covered in this guide.

1.2   Product Configuration

The "XS" model indicates that the NOCTURN camera has a single board to board connector for power input I/O and video output. The back panel of this NOCTURN configuration is shown in Figure 2.
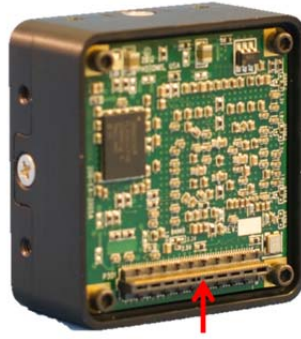
IO Interface:
P301

Figure 2 Back Side View of the NOCTURN XS Camera

For full pin-out of the NOCTURN XS camera please refer to the NOCTURN XS Electro-Mechanical ICD.

The NOCTURN XS input power specifications are provided in Table 1. Even though the camera can be operated down at 2.5V if specified, it is recommended to provide a regulated input between 4.3-4.7 for optimum performance.

Table 1 NOCTURN XS Input Power Specifications

Parameter	Description	Min	Typ	Max	Units
Vin	Input Voltage	2.5[1]	4.5	5.5	V
Icc	Input Current[2]	--	330[3]	--	mA

1.3   Product Specifications

Detailed specifications for the NOCTURN XS camera are given in Table 2.

Table 2 NOCTURN XS Specifications

Parameter	Specification
Sensor Resolution	1280 × 1024 Pixels
Sensor Pixel Pitch	9.7 μm × 9.7 μm

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[1] Voltage option must be specified when order is placed with factory
[2] Digital video output only without image processing enabled
[3] Measured with 5VDC input

Parameter	Specification
Sensor Well Capacity	> 25000 e-
Sensor Dynamic Range	> 60 dB
Sensor Read Noise	< 4 e- med. (60fps Mode)
Sensor Quantum Efficiency	> 60% at 600nm
Frame Rate[4]	50, 60 or 100Hz with full field resolution (user adjustable)
Sensor Image Lag	< 0.1 %
Sensor Shutter Mode	Rolling
Dimensions (W × H × D)	34.1 mm × 36.6 mm × 18 mm
Weight	< 45 grams
Digital Video Output	10bit 3.3V CMOS parallel output on 2 taps
Communication	Logic level serial interface
Image Correction	Bad pixel replacement and 2 points non uniformity correction
Contrast Enhancement	Contrast stretching, equalization and adaptive equalization
Gain Control	Automatic gain and exposure control or manual
Digital Zoom	8X (0.001 increment resolution)[5]
Synchronization	Frame start trigger (+3.3V) Analog output strobe reference (+3.3V)
Windowing[6]	Full field of view down to 2 lines vertical resolution
OSD	Full on screen display capability with text, standard geometrical shape and graphics

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[4] By default the camera is optimized only for 60 and 100fps mode. Please contact PHOTONIS if you need the camera optimized for 50fps.
[5] Digital zoom only available in the 60 and 50fps modes
[6] Feature only available on the digital video output interface with OSD disabled

Parameter	Specification
Snapshots	On board capture of *.JPG (8b) or *. PGM (8/10b)
Camera/Imaging Start Up Time	< 5 seconds
Operating Temperature	-40° to +60° C
Storage Temperature	-50° to +80° C
Input Voltage	+2.5 to +5.5 VDC or regulated +4.5[7] VDC (factory configurable)
Power (Typical)	60/50Hz mode < 1.6W (typ.)

1.4　Quantum Efficiency

The typical quantum efficiency as a function of wavelength for the LYNX CMOS for versions with and without micro-lenses is shown in *Figure 3*.
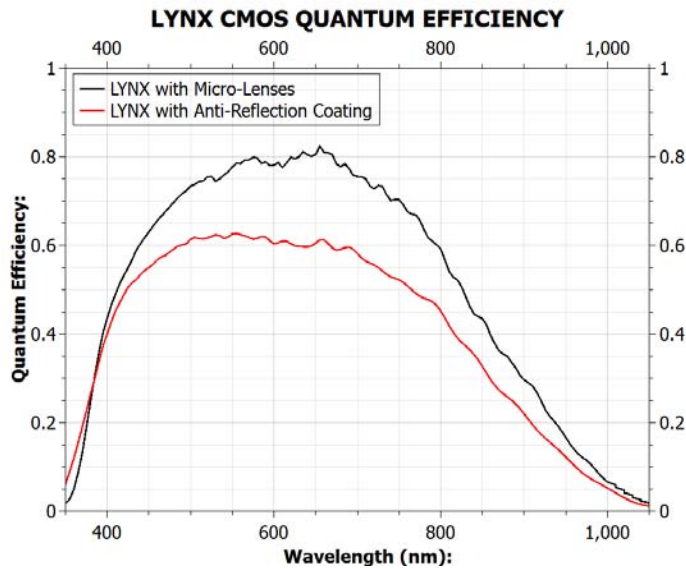
Figure 3 LYNX CMOS Quantum Efficiency Curve

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[7] Improves noise performance

2   Getting Started with the Camera

This section provides some key information on how to unpack the camera.

<div style="border:1px solid black; text-align:center;">

WARNING

</div>
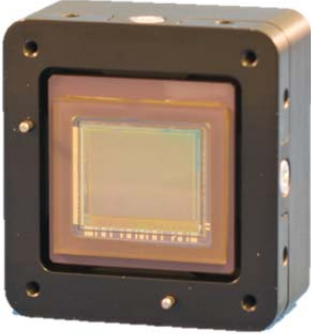
The NOCTURN XS cameras contain electrostatic sensitive parts and assemblies and should be handled within protected areas and in accordance with industry standard electrostatic discharge (ESD) protective handling procedures. Under no circumstances, should the camera be disassembled unless directed to do so by PHOTONIS personnel. Disassembly of the camera and damage to the anti-tamper sticker on the side of the camera will void the warranty.

2.1   Unpacking Instructions

Table 3 Unpacking Instructions for the NOCTURN XS Camera

Description	Image
Inspect shipping container and notify PHOTONIS personnel of any damage that may have occurred during shipping.	
Record the camera serial number located on the side of the shipping container for your records. This number is also engraved on the bottom of the camera. You will need that number to be able to receive technical support with your product.	

Description	Image
Open shipping container by breaking the PHOTONIS seal and lifting the cardboard lid.	
Remove the antistatic bag containing the camera module from the suspended clear plastic clamshell.	
Unseal antistatic bag and remove camera module using proper ESD procedures.	

Description	Image
Inspect camera module for proper configuration and potential shipping damage. Immediately report any problem to PHOTONIS personnel.	

3 Camera Controls

The NOCTURN XS is controlled by a serial communication protocol. This section of the user guide provides an overview of the command and associated syntax to control the camera as well as the serial port settings needed.

3.1.1 Basic Communication Settings

The serial communication should be set with the following configuration for both the main and the aux serial interface:

- **Number of bits:** 8
- **Baud rate:** 115200 bps
- **Parity:** none
- **Number of stop bits:** 1 bit
- **Flow control:** none.

<u>**NOTE**</u>

The NOCTURN XS cameras are shipped with a default baudrate of 115200bps. The latter can be changed by the user by using the "baudrate" command described in this section.

3.1.2 Communication Protocol

The protocol to communicate with the NOCTURN XS is based on ASCII printable messages. A carriage return and line feed must be sent following a command. After power is initially applied to the camera will send "{BOOT_DONE}" indicating that the camera is ready to receive commands. Once an initial message has been sent to the camera, a ">" will appear at the console when the camera is ready to accept new messages. The camera will answer

">OK" to all user command that are accepted and ">Error <error message>" when an error occur.

A standard message to the camera should have the following architecture:

 <Command><Optional Payload><CR>[8]<LF>[9].

NOTE

> *With this current firmware/software release, the camera no longer echos command by default. The echo can be re-enabled by using the "echo" command. To enable the echo on the USB port, type "echo usb 1<CR><LF>" at the serial interface. This can be saved as power on default state for the camera by saving the flash configuration (type "save flash<CR><LF>").*

The following examples demonstrate the communication protocol (please refer to the following sections for camera syntax details) and assumes that:

- **Example 1:** displaying the help menu after initial boot up

{BOOT_DONE}<CR><LF>   *//camera boot complete*

?<CR><LF>   *//serial message sent by user to display help menu*

                //response from the camera

===<CR><LF>

?/help   Display this console help menu<CR><LF>

baudrate   Set serial port baudrate<CR><LF>

log   Print system boot log<CR><LF>

status   Reprint signon information<CR><LF>

update [user|factory|help]   Print flash update menu (default=user) <CR><LF>

PIC   Print Picture menu<CR><LF>

CL   Print CameraLink menu<CR><LF>

TEMP   Print the temperature sensor menu<CR><LF>

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[8] Carriage return
[9] Line feed

XFER   Print file transfer I/O menu<CR><LF>

DR   Print OSD menu<CR><LF>

===<CR><LF>

>   *//camera ready for next command*

- **Example 2:** requesting contrast function help

>   *//camera ready for command*

video contrast ?<CR><LF>   *//serial message sent by user to get contrast help*

                                      //response from camera

VIDEO contrast Selects contrast enhancement: <CR><LF>

                    0 - No enhancement<CR><LF>

                    1 - histogram stretching<CR><LF>

                    2 - histogram equalization<CR><LF>

                    3 - limited equalization<CR><LF>

                    4 - histogram unrounded equalization<CR><LF>

                     99 - auto contrast (table driven) <CR><LF>

>   *//camera ready for next command*

- **Example 3:** changing the contrast

>   *//camera ready for command*

video contrast 1<CR><LF>   *//serial message sent by user to enable hist. stretching*

OK<CR><LF>   *//reply from camera that command was accepted*

>   *//camera ready for next command*

- **Example 4:** query contrast setting

>   *//camera ready for command*

video contrast <CR><LF>   *//serial message sent by user to get contrast status*

CONTRAST = 1<CR><LF>   *//reply that contrast is set to hist. stretching*

OK<CR><LF>   *//reply from camera that command was accepted*

>   *//camera ready for next command*

- **Example 5:** invalid parameter resulting in an error

>   *//camera ready for command*

video contrast 500<CR><LF>   *//message sent by user with invalid contrast setting*

      //error response from the camera

Error 6012, Video Pipeline: Invalid contrast parameter<CR><LF>

<CR><LF>   *//blank line sent by camera*

>   *//camera ready for next command*

3.1.3 Camera Serial Commands

The following section contains all of the serial command available on the NOCTURN XS.

3.1.3.1 Top Level Commands

Table 4 Top Level Commands

Command	Optional Payload	Description
help		Display console help menu
?		Display console help menu
baudrate	(see 3.1.3.2)	Set serial port baudrate
echo	(see 3.1.3.3)	Set the serial port echo state
log		Print system boot log, used for debugging user/camera problems
save	?/help	Display help for command
	flash	Save current flash settings (baudrate etc)
	user	Save changes to user settings.ini file
	factory keyword	Save changes to factory settings.ini file

Command	Optional Payload	Description
status		Reprint sign on information
update	?/help	Flash update menu help
	user	Update user flash
	factory	Update factory flash
CS	? (see 3.1.3.4)	(For factory use only) Camera sensor command menu. Type "?" to get embedded help menu
VIDEO	(see 3.1.3.4)	Video pipeline command menu
PIC	(see 3.1.3.6)	Picture command menu
CL	(see 3.1.3.7)	Digital video output command menu
NUC	(see 3.1.3.9)	Non uniformity correction command menu
TEMP	(see 3.1.3.10)	Print the temperature sensor menu
XFER	(see 3.1.3.11)	Print file transfer I/O menu Type "?" to get embedded help menu
DR	(see 3.1.3.12)	Draw OSD menu
AGC STATUS	(see 3.1.3.13)	Prints AGC settings and available commands

3.1.3.2   Baudrate Commands

By default the NOCTURN XS camera is shipped with a preset baud rate of 115200bps (main COM interface is called USB in the command menu to maintain compatibility with the NOCTURN XL firmware). The baud rate command allows you to both query the current baud rate setting but also change it.

All valid serial command shown in Table 5 should be sent as:

baudrate <Command> <Optional Payload><CR><LF>

Table 5 Baud rate Commands

Command	Optional Payload	Description

Command	Optional Payload	Description
USB	?	Display baudrate help and current setting for the USB port (main external serial port)
USB	921600	Set the USB baud rate to 921600bps
	460800	Set the USB baud rate to 460800bps
	230400	Set the USB baud rate to 230400bps
	115200	Set the USB baud rate to 115200bps
	57600	Set the USB baud rate to 57600bps
	38400	Set the USB baud rate to 38400bps
	28800	Set the USB baud rate to 28800bp
	19200	Set the USB baud rate to 19200bps
	9600	Set the USB baud rate to 9600bps
AUX	?	Display baudrate help and current setting for the AUX port
AUX	921600	Set the AUX baud rate to 921600bps
	460800	Set the AUX baud rate to 460800bps
	230400	Set the AUX baud rate to 230400bps
	115200	Set the AUX baud rate to 115200bps
	57600	Set the AUX baud rate to 57600bps
	38400	Set the AUX baud rate to 38400bps
	28800	Set the AUX baud rate to 28800bp
	19200	Set the AUX baud rate to 19200bps
	9600	Set the AUX baud rate to 9600bps

3.1.3.3   Echo Commands

By default the NOCTURN camera is shipped with the echo turned off on all serial interface port. The echo command can be used to turned the echo on or off on any serial of the communication ports

All valid serial command shown in Table 6 should be sent as:

echo <Port> <Optional Payload><CR><LF>

Table 6 Echo commands

Command	Optional Payload	Description
?		Echo help menu
USB	0	USB port echo off
	1	USB port echo on
AUX	0	AUX port echo off
	1	AUX port echo on

3.1.3.4   CS Commands

<div style="border:1px solid black; text-align:center;">**CAUTION**</div>

Adjusting the default CMOS settings could affect the low light level performance of the camera and the default non-uniformity correction tables

All valid serial command shown in Table 7 should be sent as:

CS <Command> <Optional Payload><CR><LF>

Table 7 CS Commands

Command	Optional Payload	Description
?		CS command help menu
cs lnf	0	Disables the line noise filter
	2	Set the line noise filter to use 2 columns
	4	Set the line noise filter to use 4 columns
	8	Set the line noise filter to use 8 columns

Command	Optional Payload	Description
	16	Set the line noise filter to use 16 columns
cs vbo	[0-255]	Sets the video black offset when the line noise filter is enabled
cs active	0	Clears the sensor active signal to the CMOS image sensor
	1	Set the sensor active signal to the CMOS image sensor
cs dumptbl		Displays camera sensor register default table data to console (store in camera)
cs dump		Displays current sensor register settings read from sensor on the console
cs rd	xx	Reads camera sensor register address xx and display value on the console
cs wr	xx dd	Write camera sensor register address xx with value dd
cs save	user	Save current sensor register settings as power on default (the gain and exposure settings will be ignored and the value entered in under the agc setup will be used)

A list of all possible registers for the "cs wr" and "cs rd" is given in Table 8. It is recommended to refer to the LYNX CMOS datasheet for further explanation of the sensor register settings. Typical usage of the "cs wr" and "cs rd" command should be as follows:

Writing register:

CS wr <Address> <Value><CR><LF>

Reading register

 CS rd <Address><CR><LF>

Table 8 CMOS Sensor Registers

Name	Address	Size	Description

Name	Address	Size	Description
SENSOR_ACTIVE	0	1	Disable/Enable continuous grabbing of images; external SENSOR_ACTIVE pulses are ignored
60FPS	1	1	Use 2 or 4 output channels, resulting in 60fps or 100 fps operation
ADDR_Y	2-3	11	The start address of the readout window. Valid range for this register is 0 to 1044-SIZE_Y.
SIZE_Y	4-5	11	The number of rows in the readout window. Valid range for this register is 1 to 1044
NROF_SLOPES	6	2	The number of slopes is 1, 2 or 3. '0' is an invalid setting for this register.
INTE_FIRST	7-9	24	The number of slots light integrates on the pixels for the 1st first slope of the response curve. The default value yields the maximum integration time available while maintaining the desired maximum frame rates of 60fps and 100fps. A longer integration time will decrease the frame rate. '0' is an invalid setting for this register.
INTE_SECOND	10-12	24	The number of slots light integrates on the pixels for the 2nd slope of the response curve. By default, the second slope is not used, so the default value is 0.
INTE_THIRD	13-15	24	The number of slots light integrates on the pixels

Name	Address	Size	Description
			for the 3rd slope of the response curve. By default, the third slope is not used, so the default value is 0.
ADC_CALIB_MODE	16	2	Set the ADC calibration mode: 0 → No calibration 1 → Calibration during overhead row 2 → Calibration at start of each (conversion) row (60 fps mode only!) 3 → Calibration during overhead row and at start of each (conversion) row (60 fps mode only!)
COL_CALIB_MODE	16	1	Set the column amplifier calibration mode: 0 → No calibration 1 → Calibration at start of each row
CLOCK_SELECTION	17	2	Select the (input) high speed clock: 0 → LVDS input clock 1 → Analog PLL 2 & 3 → Digital PLL
SELECT_PULSED	18	1	Change the behavior of the row select: 0 → Select constant high during sampling 1 → Select is low during transfer
CLK_ADC_CONT	18	1	Set the behavior of the ADC clock 0 → ADC clock stops between reset and signal conversion 1 → ADC clock continues to toggle between reset and signal conversion

Name	Address	Size	Description
COL_EB	18	1	Controls behavior of electrical black columns 0 → All columns normal 1 → First 20 columns (in non-flipped readout) are black, rest are normal
DB_TEST_IMAGE	18	1	Disable/Enable digital test image output
DB_OVF_DISABLE	18	1	Change the handling of large conversion results 0 → Output is clipped at '1111111111' 1 → Output overflows and outputs lowest 10 bits
DB_LOAD_FALLING	18	1	Change the clock edge that is used to sample the digital data when going from parallel to serial data
FLIP	19	2	0 → Read out left bottom to right top 1 → Read out right bottom to left top 2 → Read out left top to right bottom 3 → Read out right top to left bottom
OFFSET_60FPS	20-21	10	Offset in 60 fps mode.
OFFSET_100FPS	22-23	10	Offset in 100 fps mode.
TRAINING_WORD	24-25	10	Set the training word that is sent on the data channels when the sensor is idle
TMUX1	26	4	Select output signal on digital multiplexer 1: 0 → clk_pix 1 → slot_adc 2 → fval 3 → dval 4 → sync_x_even

Name	Address	Size	Description
			5 → sync_x_odd
			6 → line_0_sample
			7 → line_0_adc
			8 → line_0_read
			9 → adc_ramp_r
			10 → adc_ramp_s
			11 → adc_vtzero
			12 → col_init
			13 → col_init_off
			14 → pix_select
			15 → pix_transfer
TMUX2	27	4	Select output signal on digital multiplexer 2:
			0 → clk_adc_gated
			1 → slot_pix
			2 → lval
			3 → bypass_even
			4 → sensor_idle
			5 → reset_first
			6 → reset_second
			7 → reset_third
			8 → row_clk_y
			9 → row_sync_y_read
			10 → row_sync_y_inte0
			11 → row_sync_y_inte1

Name	Address	Size	Description
			12 → row_sync_y_inte2
			13 → write
			14 → read
			15 → col_vtzero
DPLL_MULT	30	8	Digital PLL multiplication factor (252 = x10)
DPLL_EN	31	1	Disable/Enable digital PLL
DPLL_DIVMODE	31	1	Internal selection of feedback mechanism in digital PLL
DPLL_F_RANGE	31	2	Select output frequency range of digital PLL
APLL_MULT	32	5	Analog PLL multiplication factor = APLL_MULT + 1
TMUXA	33	4	Select output signal on analog multiplexer:
			0 → ground
			1 → CMDN_LVDS_REC
			2 → CMDN_2X
			3 → REF144
			4 → REF270
			5 → VDCPC_ADC
			6 → VCLAMP_ADC
			7 → VBGAP_BIAS
			8 → VTSIG
			9 → VTREF
			10 → VREF
			11 → VRAMP

Name	Address	Size	Description
			12 → DPLL_LOCKED
			13 → DPLL_UNDERFLOW
			14 → DPLL_OVERFLOW
			15 → VRAMP
CLKMATCH	34	8	Set compensation for channel-to-channel skew:
			0 → no compensation
			254 → maximum compensation
			Note: '255' is an invalid setting
PGA_GAIN	35	3	Set the analog gain in the column amplifier:
			0 → 0.8
			1 → 1.2
			2 → 1.6
			3 → 2.0
			4 → 2.4
			5 → 3.6
			6 → 4.8
			7 → 6.0
ADC_GAIN	36	6	Set the gain in the ADC
CHANNEL_EN	37	7	Disable/Enable output, clock and control channels:
			Bit[0]-Bit[3] ⬜ Data channels
			Bit[4] ⬜ Clock channel
			Bit[5] ⬜ Control channel
			Bit[6] ⬜ LVDS clock receiver
I_COLPC	38	4	Column load precharge current

Name	Address	Size	Description
I_COL	38	4	Column load current
I_COLAMP	39	4	Column amplifier current
I_ADC	39	4	ADC comparator current
I_COMPINV	40	4	ADC output invertor current limit
I_ADCPC	40	4	ADC precharge voltage buffer current
I_LVDS_REC	41	4	LVDS receiver current
I_LVDS_DRIV	41	4	LVDS driver current
V_ADCPC	42	7	ADC precharge voltage
V_ADCCLAMP	43	7	ADC clamp voltage
RST_LOW	44	7	Pixel reset low voltage
VTX_LOW0	45	7	Set the saturation/anti-blooming level for the integration after slope 3.
VTX_LOW1	46	7	Set the reset level for the third slope. Change this register to control the position of the knee point between slope 2 and slope 3. Set the saturation/anti-blooming level in case of dual slope operation.
VTX_LOW2	47	7	Set the reset level for the second slope. Change this register to control the position of the knee point between slope 1 and slope 2. Set the saturation/anti-blooming level in case of single slope operation.
V_VRAMP2	48	7	Starting voltage of 2nd ramp in AD conversion
V_VRAMP1	49	7	Starting voltage of 1st ramp in AD conversion
V_VREF	50	7	Reference voltage for the column amplifier

Name	Address	Size	Description
V_TREF	51	7	Reference voltage for the reset conversion in test_mode
V_TSIG	52	7	Reference voltage for the signal conversion in test_mode
V_TEST_HIGH	53	6	Highest voltage adjustment of V_TREF and V_TSIG
V_TEST_LOW	54	6	Lowest voltage adjustment for V_TREF and V_TSIG
V_BLSUN	55	7	Voltage setting for clipping of reset in black sun protection
TEMP	62-63	16	Temperature sensor (readout only!)

3.1.3.5   Video Commands

All valid serial command shown in Table 9 should be sent as:

VIDEO <Command> <Optional Payload><CR><LF>

Table 9 Video commands

Command	Optional Payload	Description
?		Video help menu
AGC	0	AGC disabled
	1	AGC enabled
bpp	0	Digital video output at 10 bits per pixel
	1	Digital video output at 8 bits per pixel
contrast	0	No contrast enhancement

Command	Optional Payload	Description
	1	Stretching contrast
	2	Equalization contrast
	3	Limited/adaptive equalization contrast
	4	Unrounded equalization contrast
	99	Automatic based on AGC settings
hconalways	0	Do not service contrast enhancement every histogram update
	1	Service contrast enhancement every histogram update
imgfmt	0	Selects PGM snapshot image format
	1	Selects JPG snapshot image format
mf	0	Median filter turned off
	1	Median filter turned on
	2	Median filter turns automatically with AGC
sf	0	Disable the convolution filter
	1	Enables the convolution filter
	2	Convolution filter turns automatically with AGC
vflip	0	Image output in default vertical orientation
	1	Image output vertically inverted from default orientation
zmode	0	Output fit for zoom set to full screen
	1	Output fit 1:1 output for zoom
	2	Output fit output width for zoom
	3	Output fit output height for zoom
	4	Output fit for zoom set to center screen

Command	Optional Payload	Description
	5	Output fit for zoom set to window screen
	6	Output fit for zoom set to sensor resolution
zoom	[x.xxxxx]	Set the digital video zoom to x.xxxxx (1.0 to 8.0)
framerate[10]	0	Sets the video frame rate to 60Hz mode
	1	Sets the video frame rate to 100Hz mode
	2	Sets the video frame rate to 50Hz mode[11]
	3	Sets the video frame rate to 30Hz mode[12]
	4	Sets the video frame rate to 25Hz mode[13]
hist enable	0	Disables histogram hardware
	1	Enables histogram hardware
hist limits	[height] [width]	Set histogram image limits
hist print		Print histogram information on the console
hist roi	[left][right][top][bot]	Sets the region of interest for the histogram
hist roi_bottom	[xxx]	Sets bottom offset for region of interest
hist roi_left	[xxx]	Sets left offset for region of interest
hist roi_right	[xxx]	Sets right offset for region of interest
hist roi_top	[xxx]	Sets top offset for region of interest
Hist roi_auto_scale	0	Auto- scale ROI with digital zoom off
	1	Auto-scale ROI with digital zoom on

[10] A power cycle of the camera is recommended after changing frame rate mode

[11] Unless requested at the time of purchase, this mode is available but not optimized for performance and image quality

[12] Unless requested at the time of purchase, this mode is available but not optimized for performance and image quality

[13] Unless requested at the time of purchase, this mode is available but not optimized for performance and image quality

Command	Optional Payload	Description
hist status		Displays on the console the histogram settings and current metrics
pan	[+/-xxx] [+/-yyy]	Pan the center image while in zoom to the XY coordinate (positive coordinate is down/right of center with standard imaging lens)
panx	[+/-xxx]	Coordinate for new PAN X location
pany	[+/-xxx]	Coordinate for new PAN Y location
pani	[+/-xxx] [+/-yyy]	Pan the center image while in zoom to the increment XY coordinate (positive coordinate is down/right of center with standard imaging lens)
panix	[+/-xxx]	Increment in X Coordinate for new PAN location
paniy	[+/-xxx]	Increment in Y Coordinate for new PAN location
vid_roi	[left][top][width][height]	Sets video ROI left, top offset, width, height[14]
vid_shift	[mode][left][top]	Sets the video left, top shift using [mode] where M is for absolute offset and r for relative offset
shname	[filename]	Loads convolution filter with the flash name [filename]. Convolution filter is then enabled/disabled using the "video sf" command
tp	0	Video test pattern generator set to OFF
	1	Video test pattern generator set to ON
show		Show CVI and frame buffer registers. Used to help customer debug imaging problems

[14] This options should not be adjusted if using the default non-uniformity correction tables

Command	Optional Payload	Description
trigi delay	[x]	Sets delay in micro seconds between start of new frame and the trigger input. Valid value range from 0 to 16000000.
trigi enable	0	Disables the external trigger input
	1	Enables the external trigger input
trigi polarity	0	External trigger input polarity set to active high
	1	External trigger input polarity set to active low
trigi width	[x]	Sets trigger input pulse width. Valid value range from 0 to 16000000
trigo delay	[x]	Sets delay in micro seconds between start of new frame to the strobe output. Valid value range from 0 to 16000000.
trigo enable	0	Disables the external strobe output
	1	Enables the external strobe output
trigo polarity	0	External strobe trigger polarity set to active high
	1	External strobe trigger polarity set to active low
trigo width	[x]	Sets strobe output pulse width. Valid value range from 0 to 16000000

3.1.3.6 Picture Commands

All valid serial command shown in Table 10 should be sent as:

PIC <Command> <Optional Payload><CR><LF>

Table 10 Picture commands

Command	Optional Payload	Description

Command	Optional Payload	Description
?		Picture help menu
snap	bpp	Takes a snapshot of the frame buffer with bpp bits per pixel
list		List currently stored snapshots
erase	n	Erase snapshot n
	all	Erase snapshot all

By default, when using a NOCTURN camera, the snapshots will be store under "/a/snapshots/". To download a snapshot to a PC, use YMODEM protocol:

SEND -Y /a/snapshots/<NAME OF IMAGE><CR><LF>

3.1.3.7   CameraLink Commands

All valid serial command shown in Table 11 should be sent as:

CL <Command> <Optional Payload><CR><LF>

Table 11 CameraLink commands

Command	Optional Payload	Description
?		CameraLink help menu
gamma	[x.xxxxx]	Sets the gamma value for the digital video output channel
power	0	Turns off the digital video output channel
	1	Turns on the digital video output channel

3.1.3.8   Analog Video Commands

All valid serial command shown in Table 12 should be sent as:

AV <Command> <Optional Payload><CR><LF>

Table 12 Analog Video commands

Command	Optional Payload	Description
?		Analog Video help menu
gamma	[x.xxxxx]	Sets the gamma value for the analog video output channel
power	0	Turns off the analog video output channel
	1	Turns on the analog video output channel
set	NTSC	Sets the analog video output to NTSC format
	PAL	Sets the analog video output to PAL format
tp	0	Turns off the analog video test pattern
	1	Turns on the analog video channel test pattern
	2	Turns on the internal analog video chip test pattern

3.1.3.9   NUC Commands

All valid serial command shown in Table 13 should be sent as:

NUC <Command> <Optional Payload><CR><LF>

Table 13 NUC commands

Command	Optional Payload	Description
?		NUC help menu
gain	on	Enables the non-uniformity gain correction
	off	Disables the non-uniformity gain correction
offset	on	Enables the non-uniformity offset

Command	Optional Payload	Description
	off	correction Disables the non-uniformity offset correction
global gain		Displays the global gain for the non-uniformity correction on the console
global gain	xxx	Sets global gain for the non-uniformity correction to xxx
global offset		Displays the global offset for the non-uniformity correction on the console
global offset	xxx	Sets global offset for the non-uniformity correction to xxx
load gain	[filename]	Loads gain file [filename] into bufferset
load offset	[filename]	Loads offset file [filename] into bufferset
status		Displays current status of the non-uniformity correction on the console
use bufferset		Displays the current buffer set in use
use bufferset	xx	Sets bufferset number to xx to use for gain and offset tables

3.1.3.10 Temperature Commands

All valid serial command shown in Table 14 should be sent as:

TEMP <Command> <Optional Payload><CR><LF>

Table 14 Temperature commands

Command	Optional Payload	Description
?		Temperature help menu
rd	[xx]	Reads temperature sensor register xx (0 is currently the default on the NOCTURN camera)

Command	Optional Payload	Description
wr	[xx] [dd]	Writes the temperature register [xx] with value [dd]

The NOCTURN only has one temperature sensor available. It can be read by sending the following command:

TEMP RD 0<CR><LF>

3.1.3.11 Transfer Commands

All valid serial command shown in Table 15 should be sent as:

XFER <Command> <Optional Payload><CR><LF>

Table 15 Transfer commands

Command	Optional Payload	Description
?		Transfer help menu
receive	[filename]	Xmodem/Ymodem receive file from PC. [filename] is the flash filename to write.
send	-x [filename] -y [filename]	Sends [filename] using Xmodem1k Sends [filename] using Ymodem1k [filename] is the flash filename to send

3.1.3.12 Draw Commands

All valid serial command shown in Table 16 should be sent as:

DR <Command> <Optional Payload><CR><LF>

Table 16 Draw commands

Command	Optional Payload	Description
?		Draw help menu

Command	Optional Payload	Description
ac	x y w h p	Cleans an area with top x, left y coordinate, w width, h height and effect p (should be set to 0 by default)
cf	n x y r p	Draws a filled circle n (should be > or = 1) at coordinate x y, radius r, and effect p
c	n x y r p	Draws a circle n (should be > or = 1) at coordinate x y, radius r, thickness t and effect p
dly	n	Introduces an n milliseconds delay between time draw commands are entered and the time they are drawn on the screen
enable	0	On screen display disabled
	1	On screen display enabled
effects	0	Disables effects in bitmap images (0 pixel value is transparent)
	1	Enables effects in bitmap images
ef	n x y xd yd a p	Draws a filled ellipse n (should be > or = 1) at coordinate x y, xd and yd diameter, angle of rotation a and effect p
e	n x y xd yd a t p	Draws a filled ellipse n (should be > or = 1) at coordinate x y, xd and yd diameter, angle of rotationa, thickness t and effect p
fliph	0	Display overlay output in default horizontal orientation
	1	Display overlay output horizontally inverted from default orientation
flipv	0	Display overlay output in default vertical orientation
	1	Display overlay output vertically inverted from default orientation
ic	n x y s	Clears icon n at x y coordinate with size s

Command	Optional Payload	Description
i	n x y p s	Draws icon n[15] at x y coordinates using effects value p and size s
l	n ax ay bx by t p	Draws a line n between screen coordinate (ax, ay) and (bx, by) with thickness t and effect p
ovlintensity	xxx	Set the overlay intensity (0-255)
p	n x y r p	Draws a point n at coordinate x y, with radius r and effect p
qf	n ax ay bx by cx cy dx dy p	Draws a filled quadrangle between points (ax, ay), (bx, by), (cx, cy), and (dx, dy) with effects p
q	n ax ay bx by cx cy dx dy t p	Draws a filled quadrangle between points (ax, ay), (bx, by), (cx, cy), and (dx, dy) with thickness t and effects p
ret_c	s	Clear and turn off the reticle in slots s (0- all, 1- slot 1 and 2- slot 2)
ret_o	0	Disables the reticles at system boot up
	1	Enables the reticles at system boot up
ret_r	s	Redraws/Turn-on the reticles in slot s (0- all, 1- slot 1 and 2- slot 2)
ret	r n x y p s	Displays reticle r in slot r centered x y coordinate using p effects and size s
rf	n ax ay w h p	Draws a filled rectangle n with top left coordinate (x, y), width w, height h and effects p
rposg	s	Gets information for reticle in slots s
rwc		Clears the reticle window on the screen
rwg		Gets reticle window coordinates

---

[15] Icons should be loaded in the "/a/system/icons/preload/" directory and named "<name of icon>_n.pgm" where n a unique identifier for each icon.

Command	Optional Payload	Description
rws	ax ay bx by	Sets the reticles window with top left corner at (ax, axy) and bottom right corner at (bx, by)
r	n ax ay w h t p	Draws a rectangle with top left corner at (ax, ay), width w, height h, thickness t and effects p
sc		Clears the overlay screeen
tf	n ax ay bx by cx cy p	Draws a filled triangle n with vertices at screen coordinate (ax, ay), (bx, by) and (cx, cy) and effects p
t	n ax ay bx by cx cy t p	Draws a triangle n with vertices at screen coordinate (ax, ay), (bx, by) and (cx, cy), thickness t and effects p
tp		Sets test pattern mode- function used for troubleshooting display operation
txt	x y f b s ttt	Displays text ttt at the x y coordinate (top left corner) with foreground color f, background color b and size s
vidintensity	xxx	Sets the overlay draw intensity to xxx (0-255)
vidinvert	0 1	Sets the video polarity on the screen to non-inverted Sets the video polarity on the screen to inverted

The overlay effects that can be setup in the on screen display by adjusting the variable p found in several of the commands in Table 16. The variable p is an 8bit [7:0] value where:

- Bit [7:4]: overlay intensity bits (0xF0 will be changed to 0xFFF in hardware when overlay is enabled)
- Bit [3:0]: effects bits
    - [1:0]: transparency multiplier
        - ➢ Value 0- overlay 75% transparent
        - ➢ Value 1- overlay 50% transparent

- ➢ Value 2- overlay 25% transparent
- ➢ Value 3- overlay is opaque
  - o [2]: XOR enable- XOR's MSB of video data with 1 to provide 50% contrast between the overlay and the video data
  - o [3]: blink enable

3.1.3.13 AGC Commands

A list of valid AGC functions and current value can be queried from the camera by sending the following command:

AGC status <CR><LF>

All valid serial command shown in Table 17 should be sent as:

AGC <Command> <Optional Payload><CR><LF>

Table 17 AGC Commands

Command	Optional Payload	Description
status		Display the AGC commands and settings
agcupdinterva	XX	Number of histogram to collect before doing an AGC update
saturationlev	XXX	Sets the digital value at which a pixel is considered saturated
bdeltalim	XXX	Sets the minimum brightness delta between the high and low limit of the cumulative histogram in conjunction with the "saturationlev" to determine if the sensor output is saturated under normal operation
bhidnlim	XXX	Increase exposure value if "bhipcagc" is lower than this digital output value
bhipcagc	XX	Mean brightness high percentage of the cumulative histogram to remap that AGC algorithm tries to maintain to "bhitgt" digital value
blopcagc	XX	Mean brightness low percentage of the cumulative histogram to remap that AGC algorithm tries to maintain to 0 digital

Command	Optional Payload	Description
		value
bhipccontrast	XX	Percentage of the cumulative histogram at which the histogram stretching maps to 1023 digital value output
blopccontrast	XX	Percentage of the cumulative histogram at which the histogram stretching maps to 0 digital value output
bhitgt	XXX	Target brightness that AGC tries to maintain "bhipcagc"
bhiuplim	XXX	Decrease exposure value if "bhipcagc" is lower than this digital output value
count	XX	Number of histogram to obtain running average to calculate AGC statistics
evlim	XX	Maximum percentage change in exposure value allowed between AGC updates
int_g	XX	Maximum reduction in exposure value if the scene is saturated
integtime	XXXX	Sets camera integration time (in lines) to x if the AGC is disabled
integr8b4agc	0	Update averaging statistics during AGC
	1	Update averaging statistics before AGC
intg_max	XXXX	Sets the maximum integration time allowed (in lines) by the AGC. By default the NOCTURN are shipped with an AGC lookup table that only allows increase of the integration time to 2120 lines. In order to use this function for values greater than 2120, the AGC table must be adjusted.
mingain	X	Minimum gain allowed by the AGC
maxgain	X	Maximum gain allowed by the AGC

Command	Optional Payload	Description
gain	X	Sets camera gain to x if the AGC is disabled
minbins	XX	Minimum number of bins used to stretched the image is contrast stretching is enabled
table	X	Selects the default AGC look-up table to use with the camera. By default, the NOCTURN camera is shipped with only one AGC table (0).

4 Maintenance

This section covers basic maintenance that should be performed periodically by the end user. Please note that all servicing of the NOCTURN XS camera should be referred to Photonis USA.

Recommended periodic inspection and cleaning – recommend camera be inspected and cleaned every time a lens change is performed.

1. Visually inspect the external surfaces of the camera and connectors for damage, bent pins and ensure they are clean and free of debris.

<div style="text-align:center">

CAUTION

</div>

The NOCTURN XS must be handled carefully at all times to prevent damage.

2. Clean the external body of the camera, including connectors, with a dry, lint free cloth and soft brush if necessary to remove dirt, dust and debris. For caked on dirt, the cleaning cloth may be moistened with a small amount of water or Methanol.

<div style="text-align:center">

CAUTION

</div>

A To avoid damage to the camera hardware, do not immerse the camera in any type of liquid, and do not pour any liquid on, or in the camera.

3. Visually inspect the sensor for dust, debris, and residue (e.g., fingerprints, smears, etc.)
4. Clean the sensor and board with low pressure, dry, compressed air or nitrogen if necessary.
5. If there are fingerprints, smears, or other oily residue, the sensor glass may be cleaned with a lint free cotton-tipped applicator moistened with a small amount of isopropyl alcohol. Allow the sensor to air dry.
6. After the sensor is dry, visually verify no residue remains.

5 Storage

In preparation for storage, it is recommended that all cables and connectors be removed from the camera.

1. If operating, shut down and power off the camera.
2. Disconnect all cables
3. Visually inspect the external surfaces of the camera and connectors for damage, bent pins and ensure they are clean and free of debris.
4. Clean the external body of the camera, including connectors, with a dry, lint free cloth and soft brush if necessary to remove dirt, dust and debris. For caked on dirt, the cleaning cloth may be moistened with a small amount of water or Methanol. Do not immerse the camera in any type of liquid.

<div style="border:1px solid black; text-align:center;">

CAUTION

</div>

To avoid damage to the camera hardware, do not immerse the camera in any type of liquid, and do not pour any liquid on, or in the camera.

5. If necessary, clean the sensor and board with low pressure, dry, compressed air or nitrogen. If there are fingerprints or other oily residue evident on the sensor glass, the sensor glass may be cleaned with a lint free cotton-tipped applicator and Methanol.
6. If the sensor is cleaned using isopropyl alcohol, allow the sensor to air dry.
7. Once the sensor is fully dry, install a protective blue lens saver dot.
8. Place the camera in a protective ESD bag and package.
9. For long term storage, a humidity and temperature controlled environment is recommended, however, the ambient temperature in the storage area should not exceed the range of -50°C to +80°C.

6 Quality

6.1 Acceptance Test Protocol

Prior to shipment to customers, all NOCTURN XS cameras are tested according to Photonis Acceptance Test Protocol (ATP). The ATP verifies that the camera units meet the operating, functionality and imaging characteristics specified by Photonis. Every unit is shipped with a test sheet displaying these characteristics against the NOCTURN XS specifications.

6.2 Warranty

Unless otherwise agreed, the Seller shall at its option repair or replace or refund the price paid for, those NOCTURN XS Cameras which are proved to the Seller's reasonable satisfaction not to conform to the published specifications at the time of receipt by the Buyer or to have failed for any reason of faulty design, material or workmanship for a period of twelve (12) months following the date of delivery.

Such warranty does not apply: (i) if the product has been modified or altered in any way by parties other than Photonis, (ii) iif the product has been exposed to unusual or excessive environmental, mechanical, electrical, or thermal stress during the course of installation or use, or (iii) if the absolute maximum ratings are exceeded for any reason including, but not limited to, equipment design and improper device installation or application, or (iv) if product malfunction is the result of misuse, abuse, improper installation or application, alteration, accident, or negligence in use, storage, transportation or handling, or if the original identification markings on the product have been removed, defaced or altered.

In order to permit Photonis to properly administer this warranty, Buyer shall (i) notify Photonis promptly in writing of any claims, and (ii) provide Photonis with the opportunity to inspect and test the product claimed to be defective. Such inspection may be on Buyer's premises and/or Photonis may request the return of the product at Buyer's expense. However, Photonis shall not be responsible for packing, inspection, or labor costs in connection with the return of product. In order to avoid administrative difficulties that result from unauthorized returns, Buyer shall request a formal Return Authorization from Photonis before returning product for any reason.

Any product replaced shall belong to Photonis and any repaired or replacement products shall be guaranteed for the unexpired portion of the 12 month warranty period.

The liability of Photonis hereunder or otherwise is solely and exclusively limited to replacement, repair or credit of the purchase price, as Photonis may elect, for any product which is returned by Buyer during the applicable warranty period, or services for which timely notice of defect has been given by Buyer, and which are found by PUPI to be subject to adjustment under this warranty. IN NO EVENT SHALL PHOTONIS BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSS OF ANTICIPATED PROFIT OR OTHER ECONOMIC LOSS OR FOR ANY DAMAGES ARISING IN TORT WHETHER BY REASON OF STRICT LIABILITY, NEGLIGENCE OR OTHERWISE.

Photonis' warranty as herein set forth shall not be enlarged, diminished or affected by, and no obligation or liability shall arise or grow out of, Photonis' rendering of technical advice, facilities or services in connection with Buyer's order or the products furnished hereunder.

The foregoing warranty extends to Buyer of Photonis and not to purchasers or users of such Buyer's products, except that if Buyer is an authorized distributor of Photonis, the foregoing warranty (and no other), subject to the terms and conditions thereof, may be extended to purchasers from such distributor of the products covered hereby. Photonis MAKES NO

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