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AUSTRIA

Argos3D-P230

Software User Manual

Version 2

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Argos3D-P230 – Software User Manual

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The information herein is given to describe certain components and shall not be considered as a guarantee of characteristics.

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Information

For further information on technology, delivery terms and conditions and prices please contact BECOM Systems www.becom-group.com

1 General Information

This guide applies to the Argos3D-P230 from BECOM Systems. Follow this guide chapter by chapter to set up and understand your product. If a section of this document only applies to certain camera parts, this is indicated at the beginning of the respective section.

The document applies to product V1.0.x

1.1 Symbols Used

This guide makes use of a few symbols and conventions:

Warning

Indicates a situation which, if not avoided, could result in minor or moderate injury and/or property damage or damage to the device.

Caution

Indicates a situation which, if not avoided, may result in minor damage to the device, in malfunction of the device or in data loss.

Note

Notes provide information on special issues related to the device or provide information that will make operation of the device easier.

Procedures

P

A procedure always starts with a headline

1. The number indicates the step number of a certain procedure you are expected to follow.
   Steps are numbered sequentially.

This sign ➤ indicates an expected result of your action.

References

This symbol indicates a cross reference to a different chapter of this manual or to an external document.

2 Overview

The document describes the necessary steps and settings to work with the Argos3D-P230 and describes the firmware dependent interfaces.

This document applies to firmware version 1.0.x.

For a hardware compatibility list please refer to our support site.

Software and documentation

https://support.bluetechnix.at/index.html

3 Interfacing

The Argos3D-P230 provides control and data interfaces via Gigabit-Ethernet.

The control interface is used to set and read the configuration of the Argos3D-P230 via a set of registers. Refer to chapter 6 for a detailed register description.

The data interface provides a continuous stream of ToF data depending on the configuration.

Note

BECOM Systems provides an abstraction of control and data interfaces by means of the *BltTofApi*. If you use this API, you need not be familiar with control and data interface in detail. Refer to chapter 7.1 for the *BltTofApi*.

3.1 Data Interface

A UDP stream delivers ToF data from the Argos3D-P230. BECOM Systems provides an abstraction the data interfaces by means of the *BltTofApi*. Refer to chapter 7.1 for the *BltTofApi*.

3.2 Camera Discovery

The Argos3D-P230 supports a discovery protocol via UDP/IP. It allows the discovery of the camera within the Ethernet network and the retrieval of camera properties.

The discovery service listens on UDP address 255.255.255.255 (broadcast) and port 11003.

Note

Discovery is supported by the BltTofApi and the BltTofSuite Chapter 7

3.3 Manual frame triggers

The default mode of the camera is video mode, where it streams continuously with configured frame rate. To use manual frame triggering, the video mode must be disabled in register ***Mode0***.

A frame can be triggered by Software trigger: See register ***Mode0***.

Software trigger will trigger the capturing of as many sequences on the ToF sensor, as is configured in register ***NofSequ***, as well as a transition to low on the trigger output.

3.4 External Illumination Interface

Please contact BECOM Systems support for information about the external illumination interface.

3.5 Secure Shell (SSH) Login

The Argos3D-P230 camera features an OpenSSH server listening to TCP port 22.

	Root account
Username	root
Default password	root

Table 3-1: Default login credentials

4 Camera Features

4.1 Basic Settings

The camera comes up according to the reset (default) values as described in the register description chapter (refer to chapter 6).

Each camera has been pre-configured with a factory-default register map.

4.2 ToF Image Processing Chain

The following flow diagram shows the image processing chain of the camera for the ToF sensor data. Filters can be applied individually to distance data. XYZ point cloud data is calculated from distance data on demand.

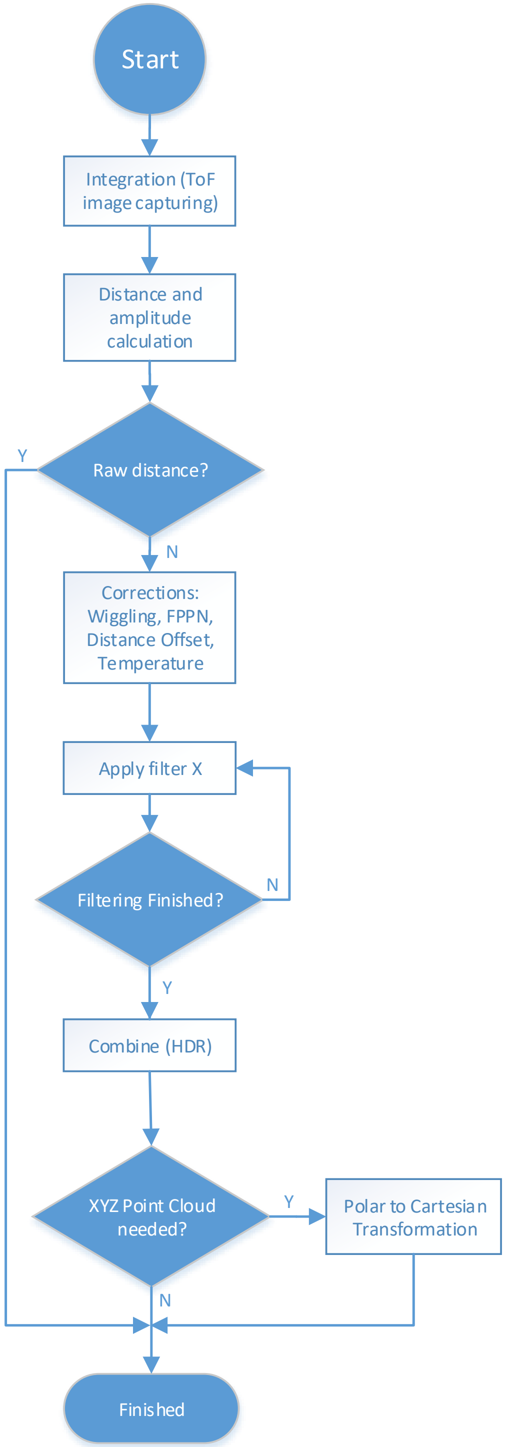

Figure 4-1: Image processing flow (note: Combine (HDR) is not available)

4.3 ToF Image Filters

After the distance and amplitude calculation, filters can be applied to the distance data. Each of the filters provides one or more configuration parameters. The iteration count for each filter can also be configured. The filters can be enabled or disabled by writing the ***ImgProcConfig*** (distance data) and ***ImgProcConfig2*** (amplitude data) registers.

Enabling more than one filter is possible but each added filter reduces the maximum achievable frame rate (as does the number of iterations).

The filters are applied in the following order:

1. Frame Average filter
2. Sliding Average filter
3. Average filter
4. Median filter
5. Bilateral filter

4.3.1 Median Filter

A 3x3 median filter can be applied.

Register: ***FilterMedianConfig***

The number of iterations is configurable.

4.3.2 Bilateral filter

Registers: ***FilterBilateralConfig, FilterBilateralConfig2***

Configuration options are σ_R (Width of range kernel), σ_S (Width of spatial kernel), number of iterations, and window size.

4.3.3 Average filter

Registers: **FilterAverageConfig**

Configuration option is the filter size.

4.3.4 Sliding Average Filter

Register: ***FilterSLAFconfig***

A sliding average filter over up to 255 frames can be applied. The number of frames is configurable. An increasing number of frames will not decrease the frame rate but may add blurring effects.

4.3.5 Frame Average Filter

Register: ***FilterFrameAverageConfig***

A frame average filter over up to 255 frames can be applied. The number of frames is configurable.

The frame rate of the data interface will be divided by the number of configured frames to be averaged, e.g., if the camera is configured to 40 frames per second, and the frame average filter with number 4 is used, the resulting output frame rate will be 10.

4.4 ToF Image Enhancements

4.4.1 Pixel invalidation

The Argos3D-P230 provides an on-board check for invalid pixels:

- Underexposed pixels: The amplitude is too low for the distance value to be trustworthy. The Argos3D-P230 sets the pixel distance to the maximum value. The threshold is set via register ***ConfidenceThresLow***.
- Overexposed pixels: The amplitude is too high for the distance value to be trustworthy. The Argos3D-P230 sets the pixel distance to the minimum value. The threshold is set via register ***ConfidenceThresHigh***.
- Invalid pixels: The Argos3D-P230 sets pixels to invalid when at least one measurement result is outside the sensor's linear range. The minimum/maximum thresholds are set via registers ***PhaseSaturationMin*** and ***PhaseSaturationMax***.

4.4.1.1 Distance values

If the amplitude of the reflected signal is below a threshold (underexposure) the distance value of the appropriate pixel will be set to 0xFFFF. If the amplitude is too high (overexposure) the distance value will be set to 0x0000.

For invalid pixels, the distance value is set to 0x0001.

4.4.1.2 XYZ values

If the amplitude of the reflected signal is below a threshold (underexposure) the X value of the appropriate pixel is set to 32767 (0x7FFF), i.e., the largest positive Int16 value. Y and Z values are set to 0.

If the amplitude of the reflected signal is above a threshold (overexposure) the X of the appropriate pixel is set to 0. Y and Z values are set to 0 as well.

4.4.2 Temperature compensation

The camera firmware continuously monitors temperatures of LIM, TIM, and base board, and corrects the measured distance with cubic polynomials.

4.5 Camera Coordinate System

The camera coordinate system is depicted in Figure 4-2.

Pixel numbering starts in the upper left corner of the pixel array, seen from the camera's point of view.

Distance data always contains the measured distance from the ToF sensor to the viewed scene.

Point cloud data contains X, Y and Z coordinates for each ToF pixel. Point cloud data is calculated via intrinsic lens parameters for the ToF sensor and optical system, and via extrinsic parameters. The reference point of the camera coordinate system, where X=Y=Z=0, is the front-top-right edge of the camera, seen from the camera's point of view.

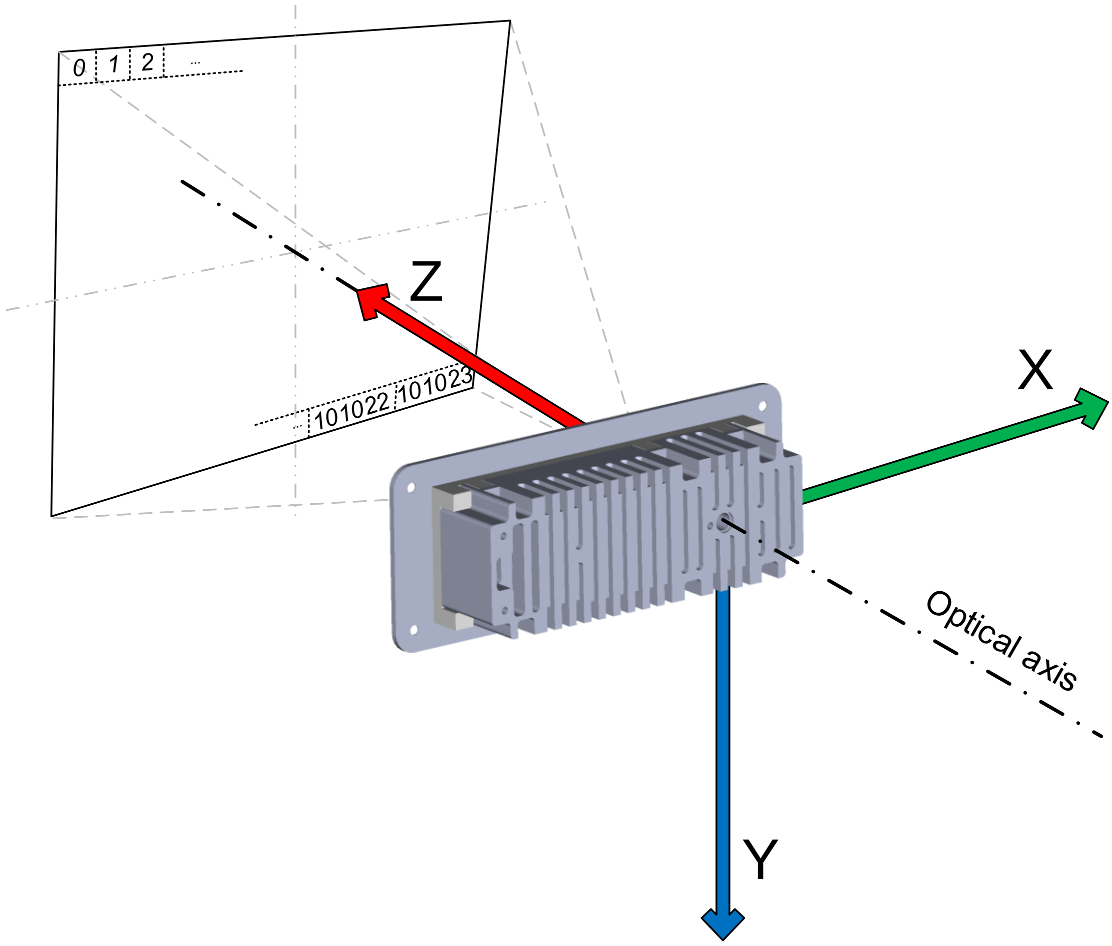

Figure 4-2: Argos3D-P230 Default Coordinate System (2)

Note

On protocol level the coordinate system may differ. Please contact BECOM Systems support for more information.

For point cloud calculation, the camera requires proper calibration files (Lens calibration, Geometric Model Parameters). These calibrations are identified by the ***HardwareConfiguration*** identifier (register). To check for proper calibration, registers ***CalibStatus*** and ***CalibStatus2*** may be read.

4.6 Camera Data Format

The camera provides up to four data channels via its data interface. The meaning of each data channel depends on the selected data format. The factory default setting provides an array of distance data and an array of amplitude data.

Alternatively, a 3D XYZ point cloud can be provided. Refer to chapter 4.4 for a description of the coordinate system of the camera.

Note

Data formats with XYZ point clouds cannot be enabled if there is no proper lens calibration data stored on the camera. Please use register ***HardwareConfig*** to configure the ToF lens calibration hardware identifier and register ***CalibStatus*** to read the status of lens calibration availability.

A channel can carry one of the following data types:

- Distance data from the ToF sensor, in millimeters, as 16-bit unsigned (Uint16) values. Resolution is always 352x287 pixels.
- Amplitude data from the ToF sensor, as 16-bit unsigned (Uint16) values. Resolution is always 352x287 pixels.
- Z coordinate values, in millimeters, as 16-bit signed (Int16) values. No negative values allowed. Resolution is always 352x287.
- X coordinate values, in millimeters, as 16-bit signed (Int16) values. Resolution is always 352x287.
- Y coordinate values: Same as X.
- Raw depth data (without scaling, corrections and filters), as 16-bit unsigned (Uint16) values. Resolution is always 352x287 pixels.
- Raw phase data (0°, 90°, 180°, 270°), as 16-bit unsigned (Uint16) values. Resolution is always 352x287 pixels.

Which image format will be transferred can be selected by the register ***ImageDataFormat***. The following sections describe each of the supported formats in detail. Only the data section which contains the image data of the transferred frame will be described. For information about the packet format and meta-data please refer to chapter 3.2.

4.6.1 Distances and Amplitudes

In this mode the distances and amplitudes will be transferred in progressive mode, first the distance array (channel 0), then the amplitude array (channel 1). The stream starts always with pixel #0.

The **distances** are coded in **millimeters** as **Uint16**, the **amplitudes** also as **Uint16**.

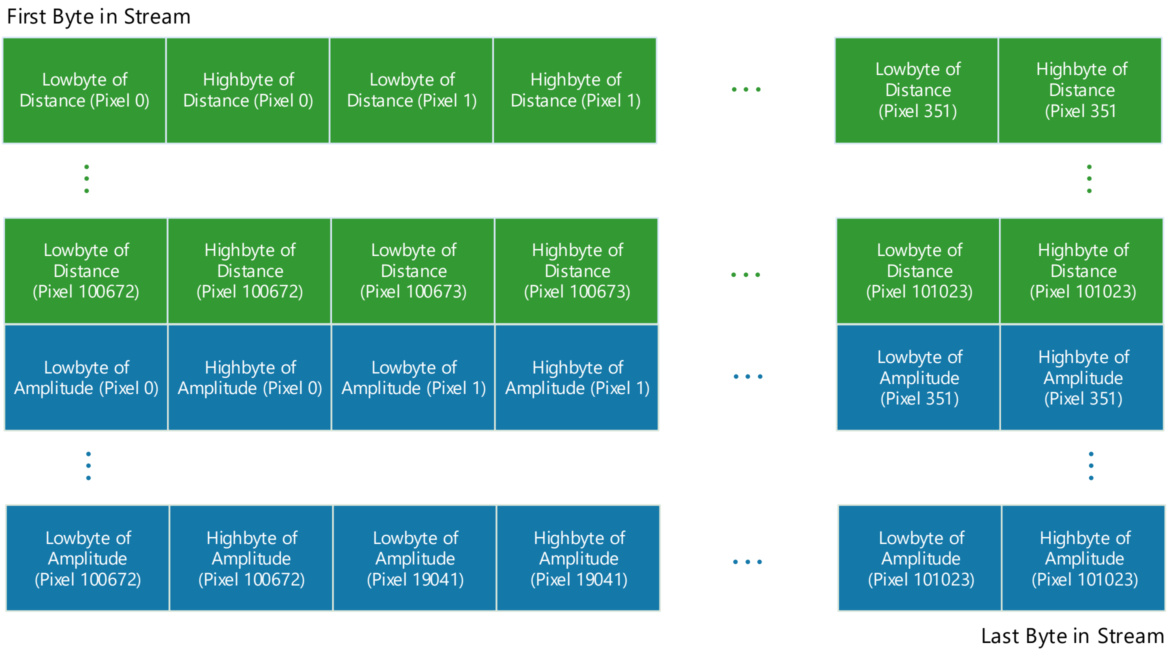

Figure 4-3: Data stream of Distance and Amplitude data

4.6.2 XYZ Point Cloud

In this mode the XYZ point cloud will be transferred in progressive mode, first the X coordinate array (channel 0) then the Y (channel 1) and Z (channel 2) coordinate array. The stream starts always with pixel #0.

The **coordinates** are coded in **millimeters** as **Int16.**

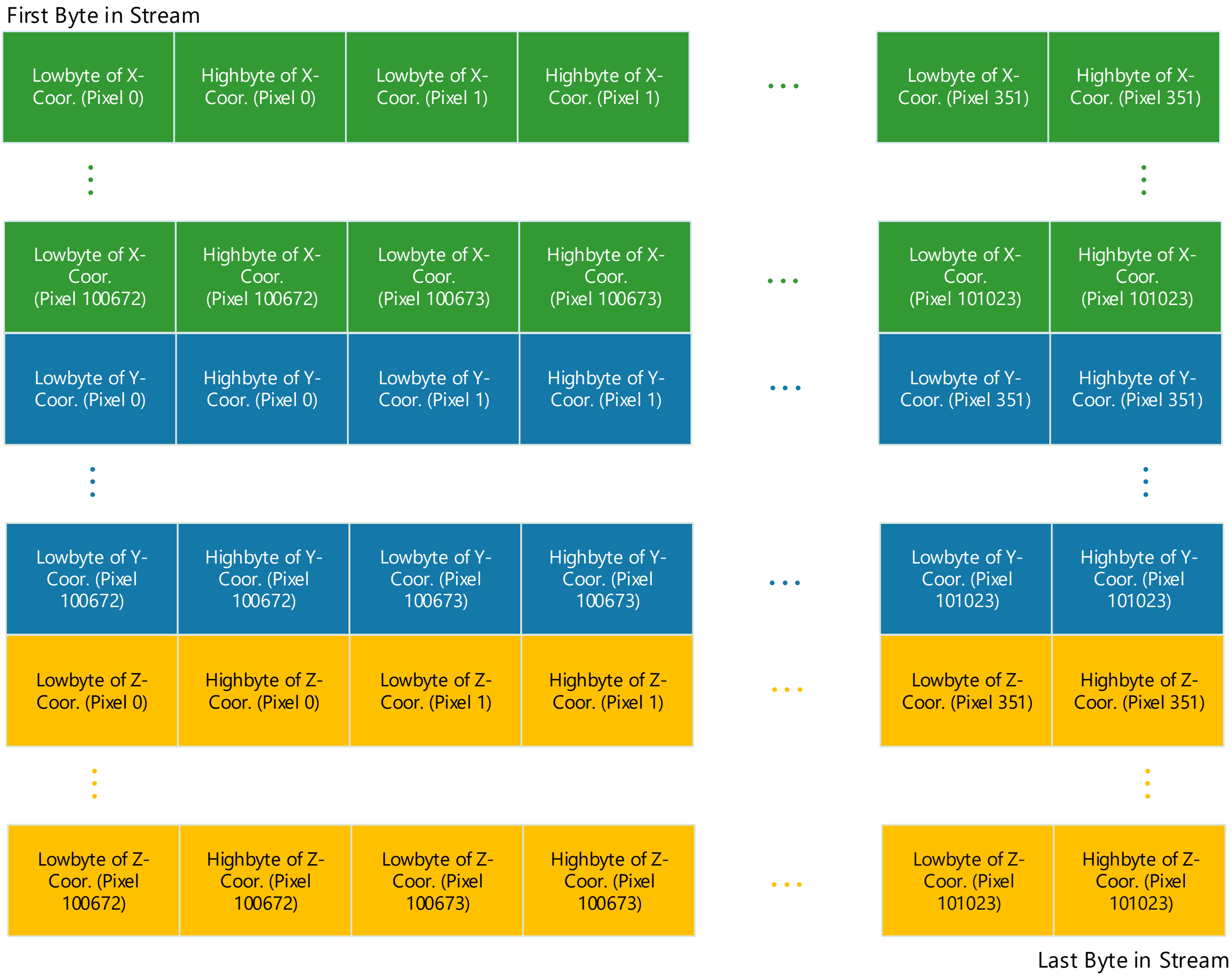

Figure 4-4: Data stream of XYZ Point Cloud

4.6.3 XYZ Point Cloud and Amplitudes

In this mode the XYZ point cloud and the amplitude will be transferred in progressive mode, first the X coordinate array (channel 0), then the Y (channel 1) and Z (channel 2) coordinate array, then the amplitude array (channel 3). The stream starts always with pixel #0.

The **coordinates** are coded in **millimeters** as **Int16** the **amplitudes** as **Uint16.**

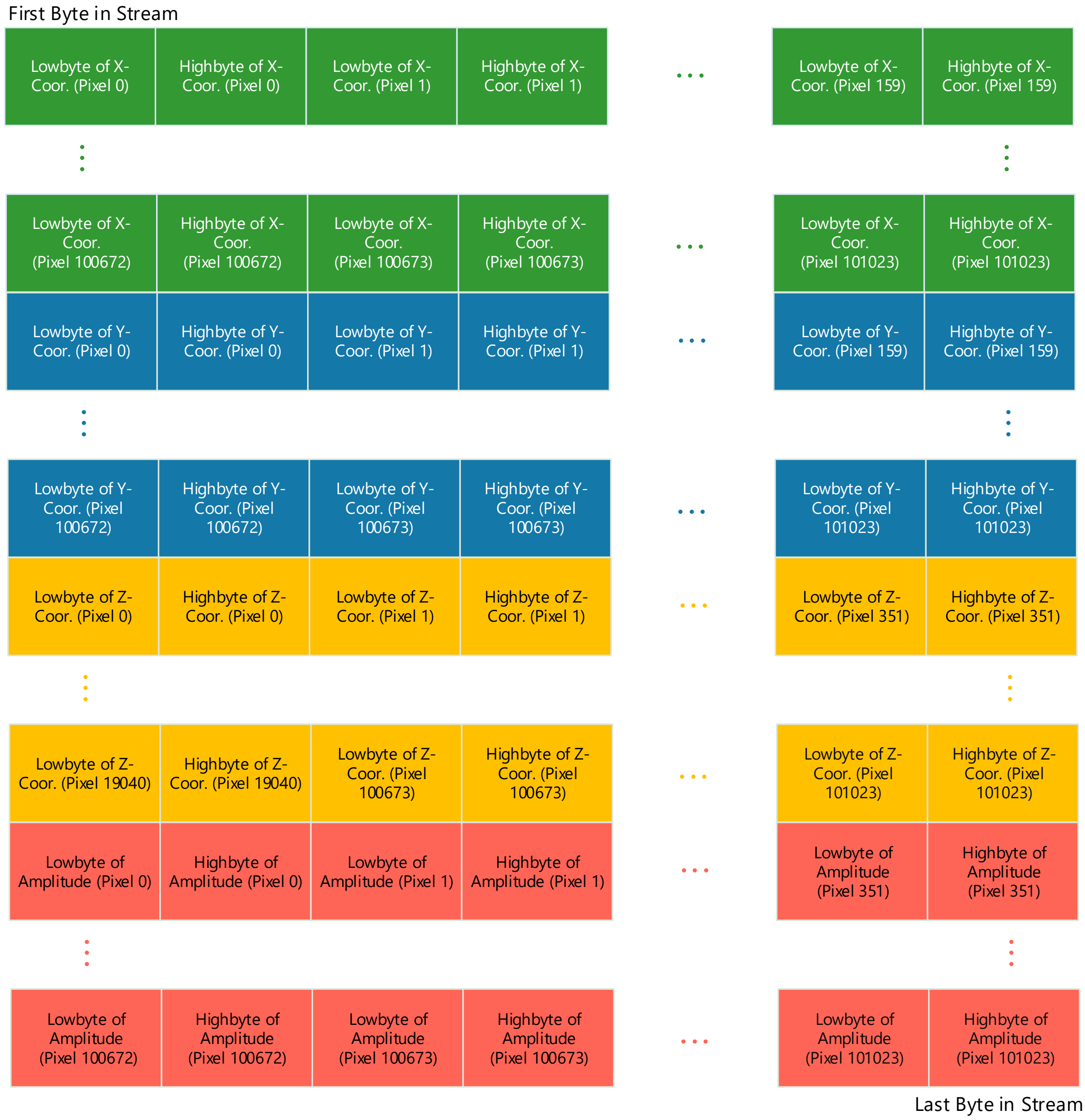

Figure 4-5: Data stream of XYZ Point Cloud and Amplitude

4.6.4 Distances and XYZ Point Cloud

In this mode the distances and the XYZ point cloud will be transferred in progressive mode, first the distances array (channel 0), then X (channel 1), Y (channel 2), and Z (channel 3) coordinate arrays. The stream starts always with pixel #0.

The **distances** are coded in millimeters as Uint16. The **coordinates** are coded in **millimeters** as **Int16**.

4.6.5 X Coordinate and Amplitudes

In this mode a single coordinate array, more specifically, the one belonging to the optical axis of the camera (X), is transferred in channel 0, as well as the amplitudes (channel 1).

Coordinate values are coded in **millimeters** as **Int16**. The **amplitudes** are coded as **Uint16**.

4.6.6 Distances

In this mode a single array with distances is transferred in channel 0. The stream starts always with pixel #0.

The **distances** are coded in **millimeters** as **Uint16**.

4.6.7 4 phases without image processing

In this mode the 4 phases (0°, 90°, 180° and 270°) will be transferred in progressive mode, as 16-bit unsigned (Uint16) values

4.6.8 Test mode

In this mode four arrays with test data are transferred in progressive order.

- Channel 0: Uint16 value = Pixel Index
- Channel 1: Uint16 value always constant '0xbeef'
- Channel 2: Uint16 value = $(\text{Pixel Index})^2$
- Channel 3: Uint16 value always constant '0x0000'

4.6.9 Raw Distances and Amplitudes

In this mode, raw distance values are transferred in channel 0, and amplitude values are transferred in channel 1.

Raw distance values are forwarded as retrieved from the TIM. No conversion to millimeters and no corrections are performed on the values. Filter settings for raw distance values are ignored as well.

4.7 ToF Modulation Frequency

The modulation frequency of the illumination is set to 20 MHz per default. Other modulation frequencies can be set using registers ***ModulationFrequency***, ***ModFreqSeq1***, ***ModFreqSeq2***, ***ModFreqSeq3***. Be aware that this also changes the ambiguity range of the camera. On writing these registers, if inexact values are supplied, the camera searches for the next possible modulation frequency automatically.

The following modulation frequencies can be selected:

Frequency	Unambiguity Range
2.29 MHz	~65m
5.004 MHz	~30m
7.5 MHz	~20m
10.007 MHz	~15m
15 MHz	~10m
20.013 MHz	~7.5m
25.016 MHz	~6m
30 MHz	~5m
40.026 MHz	~3.75m
50.032 MHz	~3m
60 MHz	~2.5m
70 MHz	~2.1m
78.06 MHz	~1.9m
80.051 MHz	~1.8m

Table 4-1: Pre-defined modulation frequencies

The register content is the frequency in 10-kHz-steps (frequency in Hz/10000). On a register read, the currently selected modulation frequency (again, in 10-kHz-steps), is returned.

Note

The BltTofSuite demo application displays and takes modulation frequencies in MHz and calculates the register content transparently!

4.8 Frame Rate and Integration Time

The frame rate and the integration time of the ToF sensor can be set by using the registers ***Framerate*** and ***IntegrationTime/IntTimeSeq1/IntTimeSeq2/IntTimeSeq3*** (for sequence 0/1/2/3). The ToF sensor's integration time is limited to 24ms.

The combination of frame rate and integration time influences the input current as well as the dissipated heat and will be characterized by the *"Frame rate Integration Time Product"* (FITP) which has been defined as follows:

$$FITP = t_{INT}\,[ms] \cdot fps\,\left[\frac{1}{s}\right] \cdot 4$$

Caution

Be careful in setting different integration times and frame rate combinations. Not all combinations are possible! Without appropriate cooling the device may be damaged! Refer to the Hardware User Manual for more information.

4.9 Sequencing

The Argos3D-P230 allows the configuration of up to 4 sequences on the TIM. These sequences are captured immediately after each other by the TIM. Each sequence can be configured with individual integration time and modulation frequency.

If the camera's video mode is disabled (see register ***Mode0***), and the camera is manually triggered, each trigger will generate as many sequences as currently configured.

The number of sequences can be configured in register ***NofSequ***.
For sequence 0, use registers ***IntegrationTime*** and ***ModulationFrequency*** to set integration time and modulation frequency, respectively.
For sequence 1, use registers ***IntTimeSeq1*** and ***ModFreqSeq1***.
For sequence 2, use registers ***IntTimeSeq2*** and ***ModFreqSeq2***.
For sequence 3, use registers ***IntTimeSeq3*** and ***ModFreqSeq3***.

Each sequence is processed and streamed by the camera as one individual frame. Each frame header contains the sequence number in field *SequenceNumber*.

4.10 Distance Offset Calibration

Each Argos3D-P230 is offset-calibrated out of factory.

For each pre-defined modulation frequency, there is an absolute offset in millimeters that all distance values are corrected with. The absolute offsets are stored in registers ***DistOffset0*** (for 2.29 MHz modulation frequency) to ***DistOffset13*** (for 80 MHz). Offsets can be modified by direct register writes.

Distance Offset correction is enabled or disabled in register ***ImgProcConfig***.

4.11 Manual Frame Trigger

There are two types of manual trigger. To enable the manual trigger, the video mode must be disabled in register ***Mode0***, Bit[0].

A manual trigger will start capturing of as many sequences as currently configured in register ***NofSequ***.

4.11.1 Software Trigger

A software trigger is available. To start a frame capturing by software, set the appropriate bit (Bit[4]) in register ***Mode0***.

4.12 Temperature Sensors

4.12.1 Over Temperature Protection

The Argos3D-P230 firmware has a built-in monitoring for over-temperature condition of the LIM. If the LIM temperature exceeds 70°C, the camera will automatically stop illumination and streaming, until temperature is below 68°C.

During over-temperature condition, bit 9 of the ***Status*** register is set.

The maximum allowed temperature for the LEDs can be changed in register ***MaxLedTemp***. However, we do not recommend to set values larger than 70°C, because it drastically reduces the lifetime of the LEDs.

4.13 Save Registers

The entire register map can be saved into non-volatile flash using the register ***CmdExec***. It will be restored from flash after a reboot or power cycle. Use this feature to save a user specific configuration.

After camera boot, one may query a ready bit which indicates that all the settings have been applied within the camera: Bit 1 of register ***Ready***.

4.14 Ethernet/IP Settings

4.14.1 MAC Address

A dedicated Ethernet MAC address from BECOM Systems MAC address pool is assigned to each Argos3D-P230 by factory default. This MAC address is saved in the OTP and cannot be changed by the user.

The user is allowed to assign the camera another MAC address using the registers ***Eth0Mac0*** to ***Eth0Mac2***. Be aware that in order to make the changes persistent, the register map must be saved to flash using register ***CmdExec,*** otherwise the changes will be lost on a reboot or power cycle.

If the register map in the flash will be cleared the factory default MAC address from OTP will be loaded.

4.14.2 IP/TCP/UDP Settings

The IP Settings of the Argos3D-P230 can be changes via the ***Eth0_**** registers. A change of the IP settings (IP address, subnet mask, default gateway) will take effect on writing the latter one. Port settings will take effect immediately. UDP destination IP addresses will take effect immediately. Please see the register description for details.

To make the changes persistent the register map must be saved to flash by writing a dedicated value to the ***CmdExec*** register.

4.15 Reset to Factory Default

The Argos3D-P230 can be reset to factory default settings by deleting the saved register map. This can be done by writing a dedicated value to the register ***CmdExec***.

Alternatively, a factory reset is executed via the camera's reset signal. (Please consult the Hardware User Manual for details.) It must be active until the firmware is completely booted and the data stream is present.

4.16 Logging

The camera automatically saves log messages to a dedicated partition in the internal flash.

Log data may be retrieved using the Secure Shell login (see chapter 3.5) and can be found at `/var/logs/messages*` files. Newest log data is contained in file `messages`.

4.17 Error Indication

The Argos3D-P230 indicates detected errors mainly in the ***Status*** register:

- Bit 3: Indicates a temperature measurement error on at least one LIM. The bit is automatically cleared if the error disappears.
- Bit 5: Indicates that calibration data are missing, refer to ***CalibStatus*** and ***CalibStatus2***.
- Bit 9: Indicates the LIM temperature has exceeded the maximum tolerable value
- Bit 14: Indicates a temperature measurement error on the base board. The bit is automatically cleared if the error disappears.
- Bit 15: Indicates a communication error with the TIM, or an error with triggering the TIM. This bit is automatically cleared if the error disappears.

5 Register Description

Note

Some critical registers are password protected. To enable the functionality a specific value must be written to the ***CmdEnablePasswd*** register in advance to enable the functionality. This should prevent from accidentally executing certain functions.

5.1 General

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
0001	Mode0	0001	R/W	Bit[0]: 0...Manual Mode, 1...Video Mode Bit[4]: 1...Manual Trigger (self-clearing bit) Bit[6]: 1...Clear status register (self-clearing bit)
0003	Status	0040	R	Bit[2]: 1...Ongoing Calibration Bit[3]: 1...LIM temperature sensor error (Temperature sensors not found, or temporary temperature reading error) Bit[5]: 1...Calibration data missing Bit[6]: 1...Factory Regmap was loaded Bit[9]: 1...LIM over-temperature Bit[14]: 1...Base board temperature sensor error Bit[15]: 1...TIM error
0004	ImageDataFormat	0000	R/W	Bit[3:10]: 0 ... Distances and Amplitudes 3 ... XYZ Point Cloud 4 ... XYZ Point Cloud and Amplitudes 7 ... 4 phases without image processing 4 times 2 bytes for 0°, 90°, 180° and 270° 9 ... Distances and XYZ Point Cloud 10 ... Z Coordinate and Amplitudes 11 ... Test mode 12 ... Distances 13 ... Raw Distances and Amplitudes
0005	IntegrationTime	05DC	R/W	Integration Time [µs]
0006	DeviceType	03FC	R	Hardware specific identification
0008	FirmwareInfo		R	Bit[0-5]: Non Functional Revision Bit[6-10]: Minor Revision Bit[11-15]: Major Revision

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
0009	ModulationFrequency	07D0	R/W	Modulation frequency in multiples of 10kHz
000A	Framerate	0028	R/W	ToF frame rate [Hz]
000B	HardwareConfiguration		R/W	Lens opening angle identifier
000C	SerialNumberLowWord		R	Lower 16bit of the 32bit Serial Number
000D	SerialNumberHighWord		R	Higher 16bit of the 32bit Serial Number
000E	FrameCounter		R	Frame Counter (increments on every captured frame)
000F	CalibrationCommand	0000	R/W	Bit[0:7]: Cmd code 13...FPPN calibration for the current modulation frequency. Exactly one sequence must be configured in register ***NofSequ***. 16...Clear FPPN calibration data for the current modulation frequency. Always takes modulation frequency of first sequence!
0010	ConfidenceThresLow	03E8	R/W	Amplitude threshold for valid distance data
0011	ConfidenceThresHigh	EA60	R/W	Amplitude threshold for valid distance data
001B	LedboardTemp		R	Temperature of LIM in 0.01[°C] (FFFF: Sensor not available).
0021	CalibrationExtended	0000	R	Bit[0-7]: Status/error 0...Idle 19...FPPN calibration 20...Erasing flash 21...DistOffset calibration 161...Operation done 246...Wrong image mode (Need distance) or Mode0 setting (Need video mode) 248.. Invalid modulation frequency 255...Generic error Bit[10]: 1...Error occurred Bit[12]: 1...No FPPN Calibration data in NVM Bit[14]: 1...No Lens Calibration data in NVM
0022	CmdEnablePasswd	0000	R/W	Set a password for critical operations: 0x4877: Register map flash operations (register CmdExec 0x0033) 0x5E6B: Test commands (register TestConfig 0x01C0)
0024	MaxLedTemp	1B58	R/W	Maximum tolerable LIM temperature 0.01[°C]
0026	HorizontalFov	2)	R	Horizontal field of view in 0,01[°]
0027	VerticalFov	2)	R	Vertical field of view in 0,01[°]

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
002D	TempCompGradientLim		R/W	Factor 'c' of the illumination temperature compensation function: y [mm] = a/100000 * x^3 + b/10000 * x^2 + c/1000 * x
0030	TempCompGradient2Lim		R/W	Factor 'b' of the illumination temperature compensation function: y [mm] = a/100000 * x^3 + b/10000 * x^2 + c/1000 * x
0032	CPLDVersion		R	FPGA firmware version
0033	CmdExec	0000	R/W	Initiate an operation: 0xC2AE...Clear RegMap in flash 0x9E20...Read RegMap from flash 0x909A...Read factory RegMap 0xDD9E...Save RegMap in flash Writing this register must be preceded by writing 0x4877 into register CmdEnablePasswd (0x0022).
0034	CmdExecResult	0000	R	Result code of the operation initiated using CmdExec 1...Success Other...Error
0035	FactoryMacAddr2		R	High byte and byte 4 of the MAC address stored in OTP flash
0036	FactoryMacAddr1		R	Byte 3 and 2 of the MAC address stored in OTP flash
0037	FactoryMacAddr0		R	Byte 1 and low byte of the MAC address stored in OTP flash
0038	FactoryYear		R	Production year (stored in OTP flash)
0039	FactoryMonthDay		R	Bit[0-7]: Production day (stored in OTP flash) Bit[8-15]: Production month (stored in OTP flash)
003A	FactoryHourMinute		R	Bit[0-7]: Production hour (stored in OTP flash) Bit[8-15]: Production minute (stored in OTP flash)
003B	FactoryTimezone		R	Production time zone (stored in OTP flash)
003C	TempCompGradient3Lim		R/W	Factor 'a' of the temperature compensation function: y [mm] = a/100000 * x^3 + b/10000 * x^2 + c/1000 * x
003D	BuildYearMonth		R	Firmware Build date/time Bit[14-4]: Year Bit[3-0]: Month
003E	BuildDayHour		R	Firmware Build day/hour Bit[9-5]: Day Bit[4-0]: Hour
003F	BuildMinuteSecond		R	Firmware Build date/time Bit[11-6]: Minute

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
				Bit[5-0]: Second
0040	UpTimeLow		R	Lower 16 bit of uptime in [s]
0041	UpTimeHigh		R	Higher 16 bit of uptime in [s]
0043	TimSerialLow		R	TIM Serial number low part
0044	TimSerialHigh		R	TIM Serial number high part
0046	ProcessorStatus		R	Bit[0:7]…Temperature of the processor in °C (0xFF: Sensor not available)

Table 5-1: General registers

Note 2): The content depends on the mounted lens and the calibration data and represents the real viewing angles.

5.2 Distance Offset

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
00C1	DistOffset0		R/W	An offset for distance values when operating at modulation frequency 2.29 MHz
00C2	DistOffset1		R/W	An offset for distance values when operating at modulation frequency 5 MHz
00C3	DistOffset2		R/W	An offset for distance values when operating at modulation frequency 7.5 MHz
00C4	DistOffset3		R/W	An offset for distance values when operating at modulation frequency 10 MHz
00C5	DistOffset4		R/W	An offset for distance values when operating at modulation frequency 15 MHz
00C6	DistOffset5		R/W	An offset for distance values when operating at modulation frequency 20 MHz
00C7	DistOffset6		R/W	An offset for distance values when operating at modulation frequency 25 MHz
00C8	DistOffset7		R/W	An offset for distance values when operating at modulation frequency 30 MHz
00C9	DistOffset8		R/W	An offset for distance values when operating at modulation frequency 40 MHz
00CA	DistOffset9		R/W	An offset for distance values when operating at modulation frequency 50 MHz
00CB	DistOffset10		R/W	An offset for distance values when operating at modulation frequency 60 MHz

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
00CC	DistOffset11		R/W	An offset for distance values when operating at modulation frequency 70 MHz
00CD	DistOffset12		R/W	An offset for distance values when operating at modulation frequency 78 MHz
00CE	DistOffset13		R/W	An offset for distance values when operating at modulation frequency 80 MHz

Table 5-2: Distance Offset registers

5.3 User Defined

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
0100	UserDefined0	0	R/W	For any purpose
0101	UserDefined1	0	R/W	For any purpose
0102	UserDefined2	0	R/W	For any purpose
0103	UserDefined3	0	R/W	For any purpose
0104	UserDefined4	0	R/W	For any purpose
0105	UserDefined5	0	R/W	For any purpose
0106	UserDefined6	0	R/W	For any purpose
0107	UserDefined7	0	R/W	For any purpose
0108	UserDefined8	0	R/W	For any purpose
0109	UserDefined9	0	R/W	For any purpose

Table 5-3: User Defined registers

5.4 General

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
010A	TempCompGradientBaseboard		R/W	Factor 'c' of the ToF base board temperature compensation function: y [mm] = a/100000 * x^3 + b/10000 * x^2 + c/1000 * x + u
010B	TempCompGradient2Baseboard		R/W	Factor 'b' of the ToF base board temperature compensation function: y [mm] = a/100000 * x^3 + b/10000 * x^2 + c/1000 * x + u
010C	TempCompGradient3Baseboard		R/W	Factor 'a' of the ToF base board temperature compensation function: y [mm] = a/100000 * x^3 + b/10000 * x^2 + c/1000 * x + u

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
010D	BaseboardTemp		R	Temperature of baseboard in 0,01[°C] (FFFF: Sensor not available).
0118	CalibStatus2		R	Bit[0]: … No wiggling calibration data in NVM
011A	LimTempsInconsistentCounter	0000	R	Counts number of inconsistent temperature measurements on LIMs (difference between 2 LIM temperature sensors exceeds certain limit, e.g., 10°C).

Table 5-4: General registers

5.5 Sequencing

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
0120	NofSequ	1	R/W	Number of sequences recorded by the ToF sensor without wait time in between, 1…4
0121	IntTimeSeq1	05DC	R/W	Integration time to be used for capturing sequence 1 NOTE: Sequence 0 integration time is set via register ***IntegrationTime***
0122	IntTimeSeq2	05DC	R/W	Integration time to be used for capturing sequence 2
0123	IntTimeSeq3	05DC	R/W	Integration time to be used for capturing sequence 3
0128	ModFreqSeq1	07D0	R/W	Modulation frequency to be used for capturing sequence 1 Register description: See ***ModulationFrequency***
0129	ModFreqSeq2	07D0	R/W	Modulation frequency to be used for capturing sequence 2 Register description: See ***ModulationFrequency***
012A	ModFreqSeq3	07D0	R/W	Modulation frequency to be used for capturing sequence 3 Register description: See ***ModulationFrequency***

Table 5-5: Registers for Sequencing

5.6 Filter Configuration

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
01E0	ImgProcConfig	28C0	R/W	Bit[0]: 1...enable Median Filter for Distance Image Bit[1]: 1... enable Average Filter Bit[3]: 1...enable Bilateral Filter for Distance Image Bit[4]: 1...enable Sliding Average for Distance Image Bit[5]: 1...enable distance calculation using LUT Bit[6]: 1...enable wiggling compensation for Distance Image Bit[7]: 1...enable FPPN compensation for Distance Image Bit[10]: 1...enable FrameAverage Filter for Distance Image Bit[11]: 1...enable temperature compensation for Distance Image Bit[13]: 1...enable offsets via registers ***DistOffsetX*** (0x00C1 onwards) for Distance Image Bit[14]: 1... enable ACF plausibility check (affected pixels have a distance of 1)
01E1	FilterMedianConfig	0001	R/W	Bit[0-7]: Nr. Of Median Iterations
01E2	FilterAverageConfig	0100	R/W	Bit[0-7]: 0... 3x3 Pixel 1... 5x5 Pixel 2... 2x2 Pixel Bit[8-15]: Nr of iterations
01E4	FilterBilateralConfig	13DE	R/W	Bit[0-5]: Sigma R (Width of range kernel) Bit[6-11]: Sigma S (Width of spatial kernel) Bit[12-15]: Nr. Of iterations
01E5	FilterSlafConfig	0005	R/W	Bit[0-7]: Window size
01E6	FilterBilateralConfig2	0003	R/W	Bit[0-5]: Square size (=> Window size = square size x square size)
01E7	FilterFrameAverageConfig	0002	R/W	Bit[0-7]: Number of Frames
01E9	ImgProcConfig2		R/W	Bit[0]: 1... enable Median Filter for Amplitude Image

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
				Bit[1]: 1… enable Bilateral Filter for Amplitude Image Bit[2]: 1… enable Sliding Average Filter for Amplitude Image Bit[3]: 1… enable FrameAverage Filter for Amplitude Image

Table 5-6: Register for filter configuration

5.7 Registers for Advanced Image Processing

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
0197	PhaseSaturationMin	0	R/W	Lower saturation limit of the phase values. Pixel with a phase value lower this value get masked as invalid.
0198	PhaseSatruationMax	0	R/W	Higher saturation limit of the phase values. Pixel with a phase value higher this value get masked as invalid.

5.8 Ethernet configuration

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
0240	Eth0Config	0006	R/W	Bit[0]: 1.. Enable DHCP Bit[1]: 1.. Enable UDP streaming Bit[2]: 1.. Ignore CRC for UDP streaming
0241	Eth0Mac2		R/W	Byte 5 (=High byte) and byte 4 of MAC address Writing this register has no immediate effect.
0242	Eth0Mac1		R/W	Byte 3 and byte 2 of MAC address Writing this register has no immediate effect.
0243	Eth0Mac0		R/W	Byte 1 and byte 0 (=Low byte) of MAC address **Writing this register will update the network configuration with the new MAC address.**
0244	Eth0Ip0	000A	R/W	Low word of IP address Writing this register has no immediate effect (see register 0x0249).
0245	Eth0Ip1	C0A8	R/W	High word of IP address

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
				Writing this register has no immediate effect (see register 0x0249).
0246	Eth0Snm0	FF00	R/W	Low word of subnet mask Writing this register has no immediate effect (see register 0x0249).
0247	Eth0Snm1	FFFF	R/W	High word of subnet mask Writing this register has no immediate effect (see register 0x0249).
0248	Eth0Gateway0	0001	R/W	Low word of gateway Writing this register has no immediate effect (see register 0x0249).
0249	Eth0Gateway1	C0A8	R/W	High word of gateway **Writing this register will update the network configuration with new IP address, subnet mask and gateway.**
024B	Eth0TcpCtrlPort	2711	R/W	Port for TCP control interface
024C	Eth0UdpStreamIp0	0001	R/W	Low word of IP address for UDP stream Writing this register has no immediate effect.
024D	Eth0UdpStreamIp1	E000	R/W	High word of IP address for UDP stream **Writing this register will update the network configuration with the new UDP stream address.**
024E	Eth0UdpStreamPort	2712	R/W	Port for UDP streaming
0259	Eth0UdpPacketSize	0578	R/W	Packet size for UDP data interface

Table 5-7: Registers for Ethernet configuration

6 Firmware History

6.1 Version Information

Firmware Version	Status	Release date	Changes
1.0.0	Initial Release	Jan 2019	• First official release

Table 6-1: Overview Argos3D-P230 firmware changes

Note

Please refer to our support site for additional information about product changes.

6.2 Anomalies

Applies to	Date	Description
1.0.0	Jan 2019	Network may not recognize 100Mbit links.
1.0.0	Jan 2019	Modulation frequency embedded in image frames contain rounded values

Table 6-2: Firmware anomalies

7 Software

7.1 BltTofApi

SDK for ToF products: Blt 'Time of Flight' API

In order to create a common interface for our products we define the interfaces between a ToF device and an application. The main part of this model is the *BltTofApi* which is written in C for platform independency.

The library which provides this API for Ethernet-based devices as the Argos3D-P230 is the *BtaEthLib* (*BltTofApi* Ethernet Library).

Please visit our support Wiki to get information and to download the SDK.

Blt 'Time of Flight' API

https://support.bluetechnix.at/wiki/ (Section Software)

7.2 MATLAB SDK

MATLAB SDK for ToF products: BltTofApi Matlab SDK

The MATLAB SDK is able to access the *BltTofApi* interface and will therefore be compatible with any device with an existing library implementing the *BltTofApi*.

Blt 'Time of Flight' API Matlab SDK

https://support.bluetechnix.at/wiki/ (Section Software)

7.3 BltTofSuite

For the first evaluation of the camera and to evaluate different settings and configurations a .NET demo application for Microsoft Windows is provided: *BltTofSuite*. The demo application can be downloaded from our support web site.

Software and documentation

https://support.bluetechnix.at/index.html

8 Support

8.1 General Support

General support for products can be found at BECOM Systems' support site

Support Link

https://support.bluetechnix.at/index.html

8.2 Software Downloads

Camera support packages are available for registered customers only. Please contact BECOM Systems support if you do not yet have an account.

Software Download Portal

https://support.bluetechnix.at/software/

8.3 Camera Development Package

The camera offers the possibility to bring your own application onto the Argos3D-P230.

The Argos3D-P230 is based on an embedded ARM Linux system based on the Zynq-7010 SoC from Xilinx Inc.

Please contact BECOM Systems support for more information.

9 Document Revision History

Version	Date	Document Revision
1	15.01.2019	First preliminary draft of the document
2	30.01.2019	Layout changed and typos corrected

Table 9-1: Revision history

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