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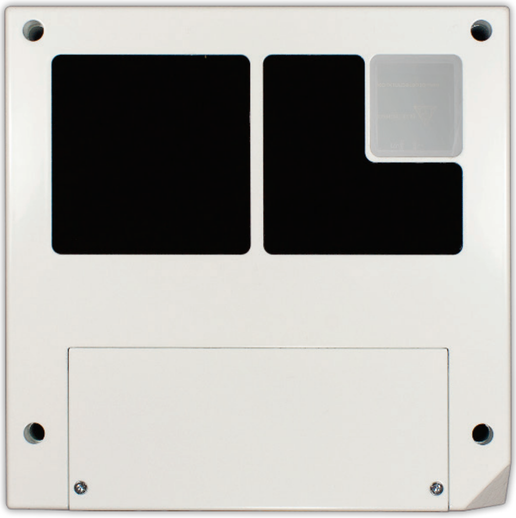
Embedding Ideas

Argos 3D - P310



Software User Manual

Version 1

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Argos 3D - P310 – Software User Manual

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Table of Contents

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Information

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Warning

Due to technical requirements components may contain dangerous substances.

1 General Information

This guide applies to the Argos 3D - P310 camera platform from Bluetechnix. 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.

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

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 Argos 3D - P310 and describes the firmware dependent interfaces.

This document applies to firmware version 1.0.0.

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

Software and documentation

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

3 Interfacing

The Argos 3D - P310 provides control and data interfaces via Fast Ethernet.

The control interface is used to set and read the configuration of the Argos via a set of registers. Refer to Chapter 6 for a detailed register description.

The data interface provides a continuous stream of the distance and amplitude values or the XYZ data depending on the configuration.

3.1 Control Interface

The Argos 3D - P310 can be configured using a TCP/IP connection. For the control interface the Argos is listening to the following factory default IP settings:

- **IP-Address**: 192.168.0.10
- **Subnet mask**: 255.255.255.0
- **Network protocol**: TCP
- **TCP port**: 10001

!

Note

The Ethernet IP settings can be configured using the ***Eth0_*** registers. The changes become active on a device reset.

Once a TCP connection has been established, the Argos can be configured using a dedicated set of command frames. The Argos answers to each command frame with a dedicated response frame. The following table shows the currently supported command frames:

Command frame	Description
Register Read	Used to read one or more consecutive registers
Register Write	Used to write one or more consecutive registers
Reset	Used to reset/reboot the Argos 3D - P310
Flash Update	Used to transfer files and updates
Keep Alive	Used to keep the TCP control connection alive. If no command is sent for 10 seconds, the Argos closes the control interface connection and waits for a new incoming connection request. Only 1 concurrent control connection is supported.

Table 3-1: Supported command frames

The following section describes each command frame and the expected answer in detail. To be able to communicate with the Argos 3D - P310, the frame must be composed exactly as described.

The following types are used:

- **Uint8**: 8 bit unsigned integer
- **Uint16**: 16 bit unsigned integer
- **Uint32**: 32 bit unsigned integer

Note
Values with ‘0x’ as prefix are hexadecimal values.

3.1.1 Register read

Command frame

Addr	Field	Type	Value	Description
0x00	Preamble	Uint16 (high byte first)	0xA1EC	Unique identifier, start of header
0x02	ProtocolVersion	Uint8	0x03	This description refers to protocol version V3.0
0x03	Command	Uint8	0x03	Command code for read registers
0x04	SubCommand	Uint8		Ignored
0x05	Status	Uint8		Ignored
0x06	Flags	Uint16	Refer to table	Optional flags
0x08	Length	Uint32 (high byte first)	<# of bytes to read>	Number of bytes to read. Must be a multiple of two. The length divided by two represents the # of registers to read.
0x0C	RegisterAddress	Uint16 (high byte first)	<Register Address>	Start register address for read command
0x0E	HeaderData2	Uint8		Ignored
0x0F	HeaderData3	Uint8		Ignored
0x10	Reserved (42 bytes)	Uint8[]		Ignored
0x3A	DataCrc32	Uint32 (high byte first)	0x0	No data present after header.
0x3E	HeaderCrc16	Uint16 (high byte first)	<CRC16 checksum>	Checksum over 60 bytes of Header: 0x02 – 0x3D 1)

Table 3-2: Register read command frame

Note 1): For the CRC16 calculation the CRC-CCITT is used (Polynom: 0x1021, start value: 0). Please ask the Bluetechnix support for an implementation example of the CRC-CCITT.

Response frame

Addr	Field	Type	Value	Description
0x00	Preamble	Uint16 (high byte first)	0xA1EC	Unique identifier, start of header
0x02	ProtocolVersion	Uint8	0x03	This document refers to protocol version V3.0
0x03	Command	Uint8	0x03	Command code for read registers
0x04	SubCommand	Uint8		Ignore
0x05	Status	Uint8	Refer to table	Result code
0x06	Flags	Uint16	Refer to table	Optional flags
0x08	Length	Uint32 (high byte first)	<# of bytes read>	The number of bytes read (length of <Data> in bytes). The length divided by two represents the # of registers read.

Addr	Field	Type	Value	Description
0x0C	RegisterAddress	Uint16 (high byte first)	<Register Address>	Start register address of read data
0x0E	HeaderData2	Uint8		Ignored
0x0F	HeaderData3	Uint8		Ignored
0x10	Reserved (42 bytes)	Uint8[]		Ignored
0x3A	DataCrc32	Uint32 (high byte first)	<CRC32 checksum>	Checksum over <Data> [2)]
0x3E	HeaderCrc16	Uint16 (high byte first)	<CRC16 checksum>	Checksum over 60 bytes of Header: 0x02 – 0x3D [1)]
0x40	Data	Uint16[] (high byte first)	<result data>	Result: One or more 16 bit values

Table 3-3: Register read response frame

Note 1): For the CRC16 calculation the CRC-CCITT is used (Polynom: 0x1021, start value: 0). Please ask the Bluetechnix support for an implementation example of the CRC-CCITT.

Note 2): For the CRC32 calculation the CRC-32 is used (Polynom: 0x04C11DB7, start value: 0xFFFFFFFF). Please ask the Bluetechnix support for an implementation example of the CRC-32.

Flags

Flags	Description
Bit 0	1: Ignore DataCrc32

Table 3-4: Register read flag description

Result codes

Status	Description
0x00	Ok
0x0D	Invalid handle (internal error)
0x0F	Illegal write: The Address is not valid or the register is not write-enabled
0x10	Illegal read: The Address is not valid (deprecated, replaced by 17)
0x11	Register end reached
0xFA	Length exceeds maximum file size (not enough memory for file download)
0xFB	HeaderCrc16 mismatch
0xFC	DataCrc32 mismatch
0xFD	Length invalid: Cannot be equal 0
0xFE	Length invalid: Cannot be grater 0
0xFF	Unknown command

Table 3-5: Result codes

3.1.2 Register write

Command frame

Addr	Field	Type	Value	Description
0x00	Preamble	Uint16 (high byte first)	0xA1EC	Unique identifier, start of header
0x02	ProtocolVersion	Uint8	0x03	This document refers to version V3.0
0x03	Command	Uint8	0x04	Command code for write registers
0x04	SubCommand	Uint8		Ignored

Addr	Field	Type	Value	Description
0x05	Status	Uint8		Ignored
0x06	Flags	Uint16	Refer to table	Optional flags
0x08	Length	Uint32 (high byte first)	<# of bytes to write>	The number of bytes to write. Must be a multiple of two and match length of <Data> in bytes. The length divided by two represents the # of registers to write.
0x0C	RegisterAddress	Uint16 (high byte first)	<Register Address>	Start register address for write command
0x0E	HeaderData2	Uint8		Ignored
0x0F	HeaderData3	Uint8		Ignored
0x10	Reserved (42 bytes)	Uint8[]		Ignored
0x3A	DataCrc32	Uint32 (high byte first)	<CRC32 checksum>	Checksum over <Data> [2)]
0x3E	HeaderCrc16	Uint16 (high byte first)	<CRC16 checksum>	Checksum over 60 bytes of Header: 0x02 – 0x3D [1)]
0x40	Data	Uint16[] (high byte first for each register value)	<data to write>	One or more 16 bit values in a stream that should be written

Table 3-6: Register write command frame

Note 1): For the CRC16 calculation the CRC-CCITT is used (Polynom: 0x1021, start value: 0). Please ask the Bluetechnix support for an implementation example of the CRC-CCITT.

Note 2): For the CRC32 calculation the CRC-32 is used (Polynom: 0x04C11DB7, start value: 0xFFFFFFFF). Please ask the Bluetechnix support for an implementation example of the CRC-32.

Response frame

Addr	Field	Type	Value	Description
0x00	Preamble	Uint16 (high byte first)	0xA1EC	Unique identifier, start of header
0x02	ProtocolVersion	Uint8	0x03	This document refers to version V3.0
0x03	Command	Uint8	0x04	Command code for write registers
0x04	SubCommand	Uint8		Ignored
0x05	Status	Uint8	Refer to table	Result code
0x06	Flags	Uint16	Refer to table	Optional flags
0x08	Length	Uint32 (high byte first)	0	No <Data> present
0x0C	RegisterAddress	Uint8 (high byte first)	<Register Address>	Same as in sent command
0x0E	HeaderData2	Uint8		Ignored
0x0F	HeaderData3	Uint8		Ignored
0x10	Reserved (42 bytes)	Uint8[]		Ignored
0x3A	DataCrc32	Uint32 (high byte first)	0x0	No data present after header.
0x3E	HeaderCrc16	Uint16 (high byte first)	<CRC16 checksum>	Checksum over 60 bytes of Header: 0x02 – 0x3D [1)]

Table 3-7: Register write response frame

Note 1): For the CRC16 calculation the CRC-CCITT is used (Polynom: 0x1021, start value: 0). Please ask the Bluetechnix support for an implementation example of the CRC-CCITT.

Flags

Flags	Description
Bit 0	1: Ignore DataCrc32

Table 3-8: Register write flag description

Result codes

Please refer to Table 3-5.

3.1.3 Reset

Command frame

Addr	Field	Type	Value	Description
0x00	Preamble	Uint16 (high byte first)	0xA1EC	Unique identifier, start of header
0x02	ProtocolVersion	Uint8	0x03	This document refers to version V3.0
0x03	Command	Uint8	0x07	Command code for reset
0x04	SubCommand	Uint8		Ignored
0x05	Status	Uint8		Ignored
0x06	Flags	Uint16	Refer to table	Optional flags
0x08	Length	Uint32 (high byte first)	0x0	No <Data> present
0x0C	HeaderData0	Uint8		Ignored
0x0D	HeaderData1	Uint8		Ignored
0x0E	HeaderData2	Uint8		Ignored
0x0F	HeaderData3	Uint8		Ignored
0x10	Reserved (42 bytes)	Uint8[]		Ignored
0x3A	DataCrc32	Uint32 (high byte first)	0x0	No data present after header.
0x3E	HeaderCrc16	Uint16 (high byte first)	<CRC16 checksum>	Checksum over 60 bytes of Header: 0x02 – 0x3D 1)

Table 3-9: Reset command frame

Note 1): For the CRC16 calculation the CRC-CCITT is used (Polynom: 0x1021, start value: 0). Please ask the Bluetechnix support for an implementation example of the CRC-CCITT.

Response frame

Addr	Field	Type	Value	Description
0x00	Preamble	Uint16 (high byte first)	0xA1EC	Unique identifier, start of header
0x02	ProtocolVersion	Uint8	0x03	This document refers to version V3.0
0x03	Command	Uint8	0x07	Command code for reset
0x04	SubCommand	Uint8		Ignored
0x05	Status	Uint8	Refer to table	Result code
0x06	Flags	Uint16	Refer to table	Optional flags
0x08	Length	Uint32 (high byte first)	0x0	No <Data> present

Addr	Field	Type	Value	Description
0x0C	HeaderData0	Uint8		Ignored
0x0C	HeaderData1	Uint8		Ignored
0x0E	HeaderData2	Uint8		Ignored
0x0F	HeaderData3	Uint8		Ignored
0x10	Reserved (42 bytes)	Uint8[]		Ignored
0x3A	DataCrc32	Uint32 (high byte first)	0x0	No data present after header.
0x3E	HeaderCrc16	Uint16 (high byte first)	<CRC16 checksum>	Checksum over 60 bytes of Header: 0x02 – 0x3D [1)]

Table 3-10: Reset response frame

Note 1): For the CRC16 calculation the CRC-CCITT is used (Polynom: 0x1021, start value: 0). Please ask the Bluetechnix support for an implementation example of the CRC-CCITT.

Flags

Flags	Description
	Currently no flags defined for this command

Table 3-11: Reset flag description

Result codes

Please refer to Table 3-5.

3.1.4 Flash Update

Command frame

Addr	Field	Type	Value	Description
0x00	Preamble	Uint16 (high byte first)	0xA1EC	Unique identifier, start of header
0x02	ProtocolVersion	Uint8	0x03	This document refers to protocol version V3.0
0x03	Command	Uint8	0x0B or 0x0C	0x0B: Flash boot loader 0x0C: Flash Application
0x04	SubCommand	Uint8	Refer to table	Indicates which flash to write to
0x05	Status	Uint8		Ignored
0x06	Flags	Uint16	Refer to table	Optional flags [3)]
0x08	Length	Uint32 (high byte first)	<# of bytes to write>	The size of the binary file to flash
0x0C	FlashAddress	Uint32 (high byte first)	<Flash Address>	Ignored
0x10	Reserved (42 bytes)	Uint8[]		Ignored
0x3A	DataCrc32	Uint32 (high byte first)	<CRC32 checksum>	Checksum over <Data> [2)]
0x3E	HeaderCrc16	Uint16 (high byte first)	<CRC16 checksum>	Checksum over 60 bytes of Header: 0x02 – 0x3D [1)]
0x40	Data	Uint8[]	<binary loader file>	The file to flash as a binary byte stream

Table 3-12: Flash update command frame

Note 1): For the CRC16 calculation the CRC-CCITT is used (Polynom: 0x1021, start value: 0). Please ask the Bluetechnix support for an implementation example of the CRC-CCITT.

Note 2): For the CRC32 calculation the CRC-32 is used (Polynom: 0x04C11DB7, start value: 0xFFFFFFFF). Please ask the Bluetechnix support for an implementation example of the CRC-32.

Note 3): The DataCrc32 is mandatory, the appropriate flag must be set to 0.

Response frame

Addr	Field	Type	Value	Description
0x00	Preamble	Uint16 (high byte first)	0xA1EC	Unique identifier, start of header
0x02	ProtocolVersion	Uint8	0x03	This document refers to protocol version V3.0
0x03	Command	Uint8	0x0B or 0x0C	0x0B: Flash boot loader 0x0C: Flash Application
0x04	SubCommand	Uint8	Refer to table	Indicates which flash to write to
0x05	Status	Uint8	Refer to table	Result code
0x06	Flags	Uint16	Refer to table	Optional flags
0x08	Length	Uint32 (high byte first)	0x0	No <Data> present
0x0C	HeaderData0	Uint8		Ignored
0x0D	HeaderData1	Uint8		Ignored
0x0E	HeaderData2	Uint8		Ignored
0x0F	HeaderData3	Uint8		Ignored
0x10	Reserved (42 bytes)	Uint8[]		Ignored
0x3A	DataCrc32	Uint32 (high byte first)	0x0	No data present after header.
0x3E	HeaderCrc16	Uint16 (high byte first)	<CRC16 checksum>	Checksum over 60 bytes of Header: 0x02 – 0x3D [1)]

Table 3-13: Flash update response frame

Note 1): For the CRC16 calculation the CRC-CCITT is used (Polynom: 0x1021, start value: 0). Please ask the Bluetechnix support for an implementation example of the CRC-CCITT.

Subcommand

SubCommand	Description
Ignored	For boot loader and application update

Table 3-14: Flash update subcommand description

Flags

Flags	Description
Bit 0	1: Ignore DataCrc32

Table 3-15: Flash update flag description

Result codes

Please refer to Table 3-5.

3.1.5 Keep Alive

Command frame

Addr	Field	Type	Value	Description
0x00	Preamble	Uint16 (high byte first)	0xA1EC	Unique identifier, start of header
0x02	ProtocolVersion	Uint8	0x03	This document refers to protocol version V3.0
0x03	Command	Uint8	0xFE	Command code for 'Keep Alive' message
0x04	SubCommand	Uint8		Ignored
0x05	Status	Uint8		Ignored
0x06	Flags	Uint16	Refer to table	Optional flags
0x08	Length	Uint32	0x0	No <Data> present
0x0C	HeaderData0	Uint8		Ignored
0x0D	HeaderData1	Uint8		Ignored
0x0E	HeaderData2	Uint8		Ignored
0x0F	HeaderData3	Uint8		Ignored
0x10	Reserved (42 bytes)	Uint8[]		Ignored
0x3A	DataCrc32	Uint32 (high byte first)	0x0	No data present after header.
0x3E	HeaderCrc16	Uint16 (high byte first)	<CRC16 checksum>	Checksum over 60 bytes of Header: 0x02 – 0x3D 1)

Table 3-16: Alive command frame

Note 1): For the CRC16 calculation the CRC-CCITT is used (Polynom: 0x1021, start value: 0). Please ask the Bluetechnix support for an implementation example of the CRC-CCITT.

Response frame

Addr	Field	Type	Value	Description
0x00	Preamble	Uint16 (high byte first)	0xA1EC	Unique identifier, start of header
0x02	ProtocolVersion	Uint8	0x03	This document refers to protocol version V3.0
0x03	Command	Uint8	0xFE	Command code for 'Keep Alive' message
0x04	SubCommand	Uint8		Indicates which flash to write to
0x05	Status	Uint8	Refer to table	Result code
0x06	Flags	Uint16	Refer to table	Optional flags
0x08	Length	Uint32 (high byte first)	0x0	No <Data> present
0x0C	HeaderData0	Uint8		Ignored
0x0D	HeaderData1	Uint8		Ignored
0x0E	HeaderData2	Uint8		Ignored
0x0F	HeaderData3	Uint8		Ignored
0x10	Reserved (42 bytes)	Uint8[]		Ignored
0x3A	DataCrc32	Uint32 (high byte first)	0x0	No data present after header.
0x3E	HeaderCrc16	Uint16 (high byte first)	<CRC16 checksum>	Checksum over 60 bytes of Header: 0x02 – 0x3D 1)

Table 3-17: Alive response frame

Note 1): For the CRC16 calculation the CRC-CCITT is used (Polynom: 0x1021, start value: 0). Please ask the Bluetechnix support for an implementation example of the CRC-CCITT.

Flags

Flags	Description
	Currently no flags defined for this command

Table 3-18: Alive flag description

Result codes:

Please refer to Table 3-5.

3.2 3D Data Interface

A UDP stream delivers depth and amplitude data from the Argos. Each UDP packet contains a header and up to 1400 bytes of data (Ethernet, IP, and UDP headers are not shown in Figure 3-1).

Error! No topic specified.

Figure 3-1: UDP streaming data format

The following types are used in the data streaming protocol:

- **Uint8**: 8 bit unsigned integer
- **Uint16**: 16 bit unsigned integer
- **Uint32**: 32 bit unsigned integer

! **Note**

Values with ‘0x’ as prefix are hexadecimal values.

The UDP streaming is enabled by factory default. The Argos streams to the following IP settings:

- **IP-Address**: Multicast address 224.0.0.1
- **UDP port**: 10002

! **Note**

The UDP stream settings can be configured using the ***Eth0_*** registers.

As multicast is used more than one host can receive the stream within the same subnet at the same time. The client has to join the appropriate multi cast group and open the port 10002 on his local network interface card (NIC) where the Argos is connected to. The receiver should receive the stream and interpret it as the following protocol description shows.

Note

! Be aware that a multicast stream may slow down your Ethernet network as the stream may be spread to all active links of switches/hubs and routers.

The current protocol version is **1**.

Each image transmitted on the UDP stream is split into packets of max. 1432 bytes length. Each packet consists of a 32 byte packet header and up to 1400 bytes of image data section (refer to Figure 3-1).

Addr	Field	Type	Value	Description
0x00	Version	Uint16 (high byte first)	0x0001	Protocol version
0x02	FrameCounter	Uint16 (high byte first)		Continuous frame counter. On an overrun it restarts at 0.
0x04	PacketCounter	Uint16 (high byte first)		Actual packet #. The frame data must be recomposed in order of the packet #.
0x06	DataLength	Uint16 (high byte first)		Length of the image data section of the current packet.
0x08	FrameSize	Uint32 (high byte first)		Size of the image data. It may be used to calculate the expected # of packets for a frame.
0x0C	PacketCRC32	Uint16 (high byte first)		CRC32 checksum over the entire packet (pos 0 to pos n) [1)]
0x10	Flags	Uint32	Refer to Table 3-20	Optional flags
0x14	Reserved			Reserved for future use
0x20	ImageData			Image data section

Table 3-19: UDP packet header

Note 1): For the CRC32 calculation the CRC-32 is used (Polynom: 0x04C11DB7, start value: 0xFFFFFFFF). Please ask the Bluetechnix support for an implementation example of the CRC-32.

Flags

Flags	Description
Bit 0	1: Ignore DataCrc32

Table 3-20: UDP packet header flag description

Image data

The image data assembled out of multiple packets again consists of 64 byte image header and the image data section. The format of the image data depends on the selected image format and is described in chapter 4.3. Below you can find the format of the 64 byte image header.

Addr	Field	Type	Value	Description
0x00	Reserved	Uint16	0xFFFF	
0x02	HeaderVersion	Uint16 (high byte first)	0x0003	Current header version
0x04	ImageWidth	Uint16 (high byte first)		Width of the image in pixels.
0x06	ImageHeight	Uint16 (high byte first)		Height of the image in pixels.

Addr	Field	Type	Value	Description
0x08	NofChannels	Uint8		Nof data channels. Depends on the image format
0x09	BytesPerPixel	Uint8		Bytes per pixel of the 3D image data.
0x0A	ImageFormat	Uint16 (high byte first)		The content is the same as in the register *ImageDataFormat*).
0x0C	Timestamp	Uint32 (high byte first)		Timestamp of the actual image in µs
0x10	FrameCounter	Uint16 (high byte first)		Continuous frame counter. On an overrun it restarts at 0.
0x12	Reserved			
0x1A	MainTemp	Uint8		Typically, ToF sensor temperature in °C + 50. Decrement this field by 50 to get the current temperature of the ToF sensor.
0x1B	LedTemp	Uint8		LED temperature in °C + 50. Decrement this field by 50 to get the current temperature of the illumination LEDs.
0x1C	FirmwareVersion	Uint16 (high byte first)		Content of the register *FirmwareInfo.*
0x1E	MagicV31	Uint16 (high byte first)	0x3331	These magic bytes indicate that header version is 3.1 *Valid since version 3.1*
0x20	IntegrationTime	Uint16 (high byte first)		Integration time in us. *Valid since version 3.1*
0x22	ModFreq	Uint16 (high byte first)		Modulation frequency with resolution 10 kHz (e.g., a value of 0x1234 means frequency 46.6 MHz) *Valid since version 3.1*
0x24	Temp3	Uint8		Temperature sensor #3 (Baseboard Sensor) in °C + 50. Decrement this field by 50 to get the current temperature. *Valid since version 3.1*
0x25	Reserved			
0x26	Reserved			
0x28	Reserved			
0x2A	Reserved			
0x3E	CRC16	Uint16 (high byte first)		CRC16 checksum over the header without the first two bytes and the CRC16 checksum itself (addr 0x02 to addr 0x3D) [1)]
0x40	Data	Bytestream		Various channels described by the header with ToF data

Table 3-21: Image data header

Note 1): For the CRC16 calculation the CRC-CCITT is used (Polynom: 0x1021, start value: 0). Please ask the Bluetechnix support for an implementation example of the CRC-CCITT.

3.3 Manual frame triggers

The default mode of the Argos is video mode, where the camera streams continuously with configured frame rate. To use manual frame triggering, you have to disable the video mode in register ***Mode0***.

You can either trigger a frame via

- Hardware trigger: The signal is sensitive to a falling edge.
- Software trigger: See register ***Mode0***.

Both will trigger a frame capture on the ToF sensor, as well as a transition to low on the trigger output.

3.4 External Illumination Interface

An external illumination unit (ToF-Flash) is supported. It features

- The differential modulation signal according to the selected modulation frequency

Please refer to the Hardware User Manual for detailed information on the interface.

3.5 GPIOs

The camera features 2 general-purpose input and 4 general-purpose output. Please see the register description in chapter 4.11 for more information.

3.6 Status LED

The Status LED is used to give some basic information about the status of the Argos. The following table shows the meaning depending on the mode.

Mode	LED signaling
Bootloader mode	Toggles every second
Video mode	Toggling with each frame (signals the frame-rate)
Manual mode	Toggles with each frame (signals frame capturing)

Table 3-22: Status LED meaning

The Status LED can be disabled using the register *Mode1*.

4 Camera Features

4.1 Basic Settings

The Argos comes up according to the factory default values as described in the register description section (refer to chapter 6).

4.2 Image Processing Chain

The following flow diagram shows the image processing chain of the Argos for the depth data. For the amplitude data there will currently no post processing be performed.

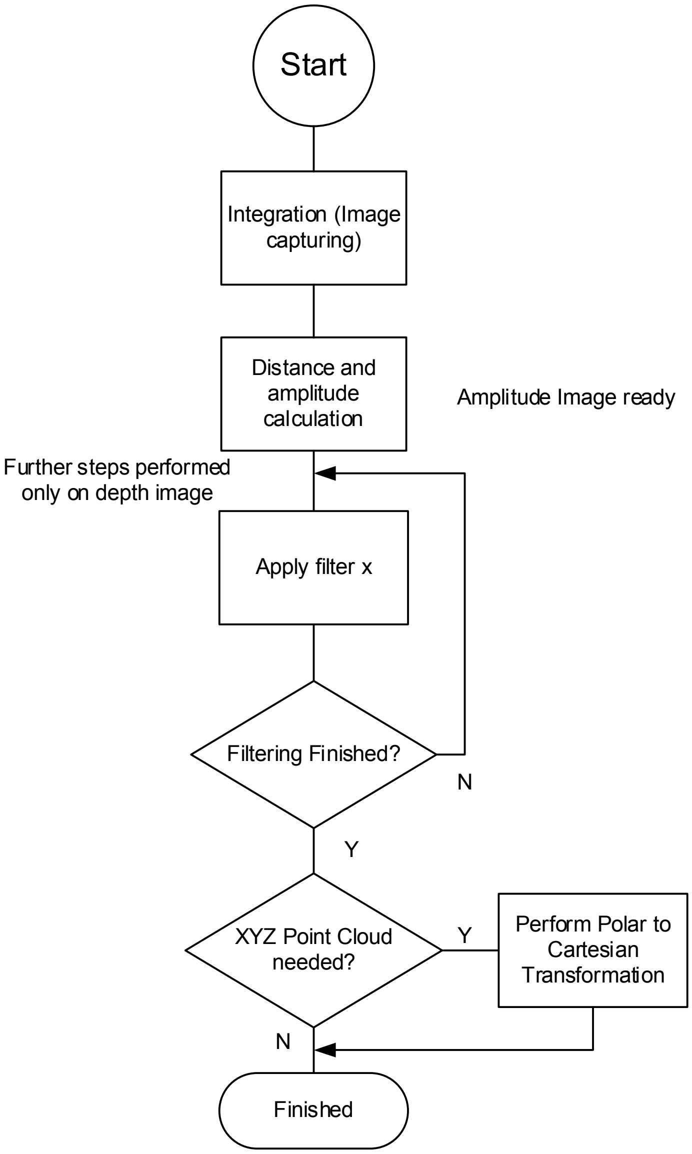

Start
Integration (Image capturing)
Distance and amplitude calculation
Amplitude Image ready
Further steps performed only on depth image
Apply filter x
Filtering Finished?
N
Y
XYZ Point Cloud needed?
Y
Perform Polar to Cartesian Transformation
N
Finished

Figure 4-1: Image processing flow

4.2.1 Image filtering

After the distance and amplitude calculation, the filters are applied to the depth data. The amplitude data will be left unfiltered. Each of the filter 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*** register. Enabling more than one filter is possible but each added filter reduces the maximum achievable frame rate (as does the number of iterations).

4.2.1.1 Median Filter

A 3x3 median filter can be applied.

Register: ***FilterMedianConfig***

The number of iterations is configurable.

4.2.1.2 Bilateral filter

Registers: ***FilterBilateralConfig***

Configuration options are σ_R (weight for radius), σ_D (weight for data) and number of iterations.

4.2.1.3 Sliding Average Filter

Register: ***FilterSLAFconfig***

A sliding average filter over up to 20 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.

4.2.2 Pixel invalidation

The Argos 3D - P310 provides an on-board check for invalid pixels.

If the amplitude of the reflected signal is below a threshold (underexposure), the distance value of the corresponding pixel will be set to 0xFFFF. If the amplitude is too high (overexposure) the distance value will be set to 0x0000. The lower and upper amplitude limit for invalidating pixels can be set by using the registers ***ConfidenceThresLow*** and ***ConfidenceThresHigh***.

For inconsistent pixels (due to unreliable data), the distance value is set to 0x0001.

4.3 Camera Coordinate System

The default coordinate system starts pixel numbering in the upper left corner of the pixel array, seen from the camera’s point of view. Also note the directions of X, Y, and Z coordinates (In XYZ image modes).

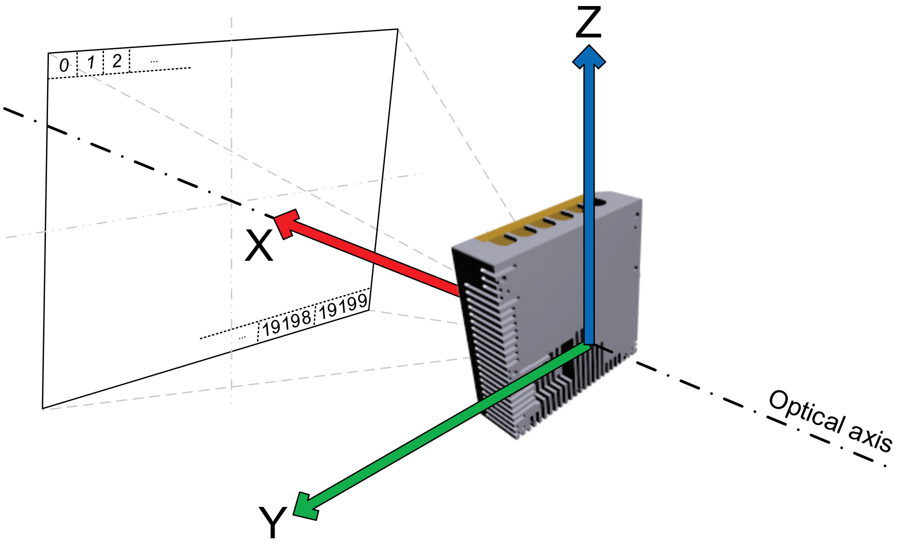


Figure 4-2: Argos 3D - P310 Default Coordinate System

4.4 Camera Data Format

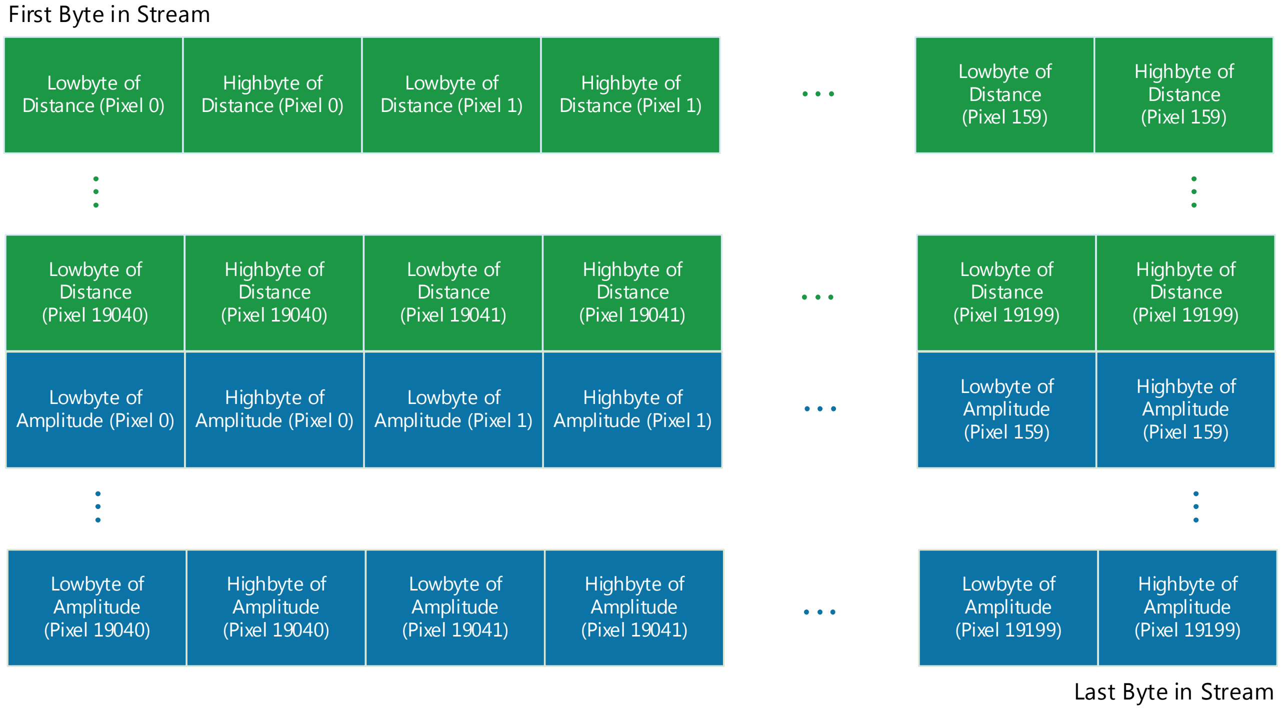
The camera provides up to four data channels. The meaning of each data channel depends on the selected data format. The factory default setting provides an array of depth data in millimeters as 16 bit unsigned (Uint16) and an array of grayscale values (Amplitudes) also as 16bit unsigned for each pixel. When changing the image data format properly, a 3D XYZ coordinate set per pixel is provided. Refer to chapter 4.3 for a description of the coordinate systems of the camera.

The image format can be selected in 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.

4.4.1 Distances and Amplitudes

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

[ImageDataFormat = 0] The **distances** are coded in **millimeters** as **Uint16**. The **amplitudes** are also **Uint16**.



First Byte in Stream

Lowbyte of Distance (Pixel 0)	Highbyte of Distance (Pixel 0)	Lowbyte of Distance (Pixel 1)	Highbyte of Distance (Pixel 1)	…	Lowbyte of Distance (Pixel 159)	Highbyte of Distance (Pixel 159)
⋮						⋮
Lowbyte of Distance (Pixel 19040)	Highbyte of Distance (Pixel 19040)	Lowbyte of Distance (Pixel 19041)	Highbyte of Distance (Pixel 19041)	…	Lowbyte of Distance (Pixel 19199)	Highbyte of Distance (Pixel 19199)
Lowbyte of Amplitude (Pixel 0)	Highbyte of Amplitude (Pixel 0)	Lowbyte of Amplitude (Pixel 1)	Highbyte of Amplitude (Pixel 1)	…	Lowbyte of Amplitude (Pixel 159)	Highbyte of Amplitude (Pixel 159)
⋮						⋮
Lowbyte of Amplitude (Pixel 19040)	Highbyte of Amplitude (Pixel 19040)	Lowbyte of Amplitude (Pixel 19041)	Highbyte of Amplitude (Pixel 19041)	…	Lowbyte of Amplitude (Pixel 19199)	Highbyte of Amplitude (Pixel 19199)

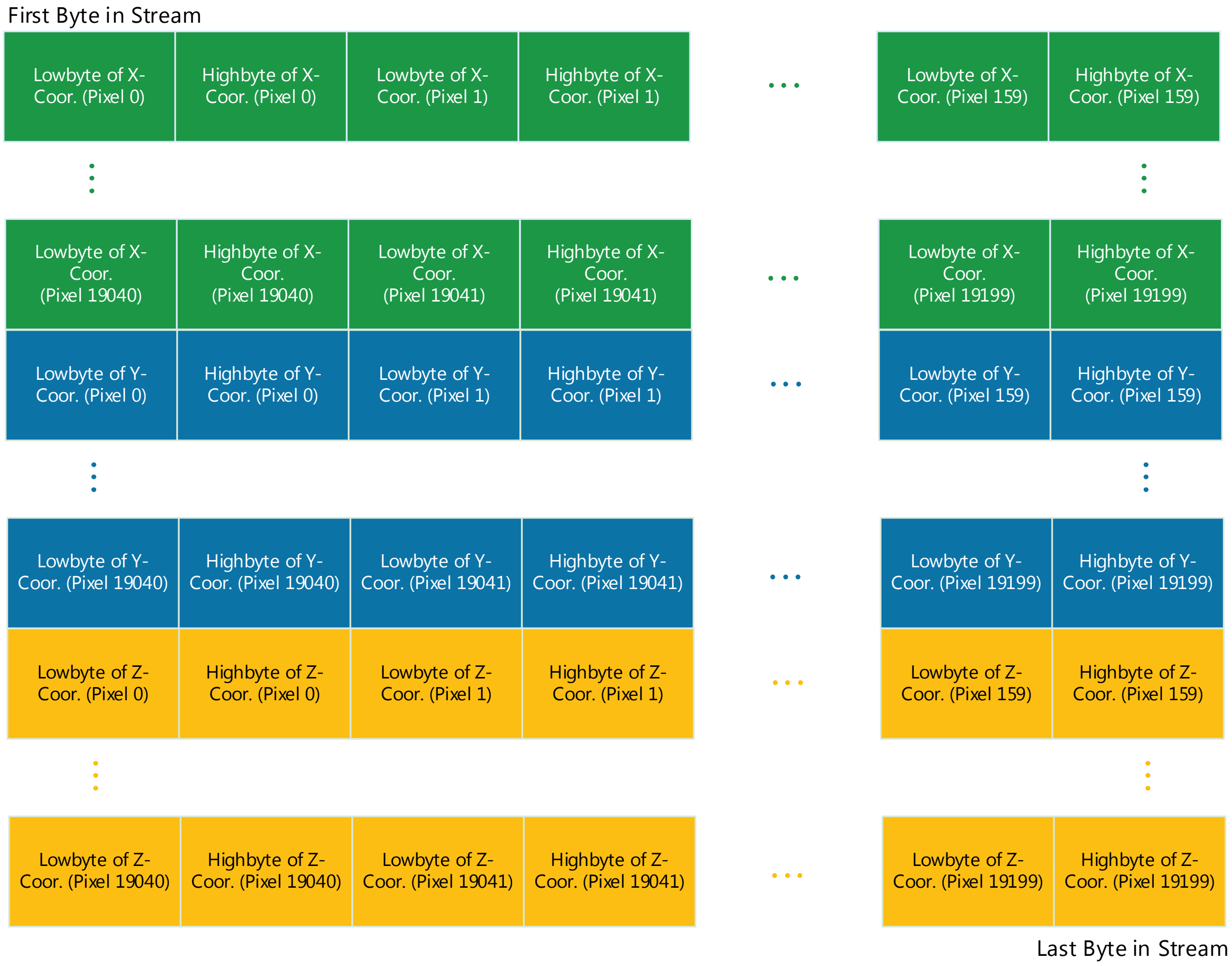
Last Byte in Stream

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

4.4.2 XYZ Point Cloud

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

[ImageDataFormat = 24] The **coordinates** are coded in **millimeters** as **Int16.**



First Byte in Stream

Lowbyte of X-Coor. (Pixel 0)	Highbyte of X-Coor. (Pixel 0)	Lowbyte of X-Coor. (Pixel 1)	Highbyte of X-Coor. (Pixel 1)	…	Lowbyte of X-Coor. (Pixel 159)	Highbyte of X-Coor. (Pixel 159)
⋮						⋮
Lowbyte of X-Coor. (Pixel 19040)	Highbyte of X-Coor. (Pixel 19040)	Lowbyte of X-Coor. (Pixel 19041)	Highbyte of X-Coor. (Pixel 19041)	…	Lowbyte of X-Coor. (Pixel 19199)	Highbyte of X-Coor. (Pixel 19199)
Lowbyte of Y-Coor. (Pixel 0)	Highbyte of Y-Coor. (Pixel 0)	Lowbyte of Y-Coor. (Pixel 1)	Highbyte of Y-Coor. (Pixel 1)	…	Lowbyte of Y-Coor. (Pixel 159)	Highbyte of Y-Coor. (Pixel 159)
⋮						⋮
Lowbyte of Y-Coor. (Pixel 19040)	Highbyte of Y-Coor. (Pixel 19040)	Lowbyte of Y-Coor. (Pixel 19041)	Highbyte of Y-Coor. (Pixel 19041)	…	Lowbyte of Y-Coor. (Pixel 19199)	Highbyte of Y-Coor. (Pixel 19199)
Lowbyte of Z-Coor. (Pixel 0)	Highbyte of Z-Coor. (Pixel 0)	Lowbyte of Z-Coor. (Pixel 1)	Highbyte of Z-Coor. (Pixel 1)	…	Lowbyte of Z-Coor. (Pixel 159)	Highbyte of Z-Coor. (Pixel 159)
⋮						⋮
Lowbyte of Z-Coor. (Pixel 19040)	Highbyte of Z-Coor. (Pixel 19040)	Lowbyte of Z-Coor. (Pixel 19041)	Highbyte of Z-Coor. (Pixel 19041)	…	Lowbyte of Z-Coor. (Pixel 19199)	Highbyte of Z-Coor. (Pixel 19199)

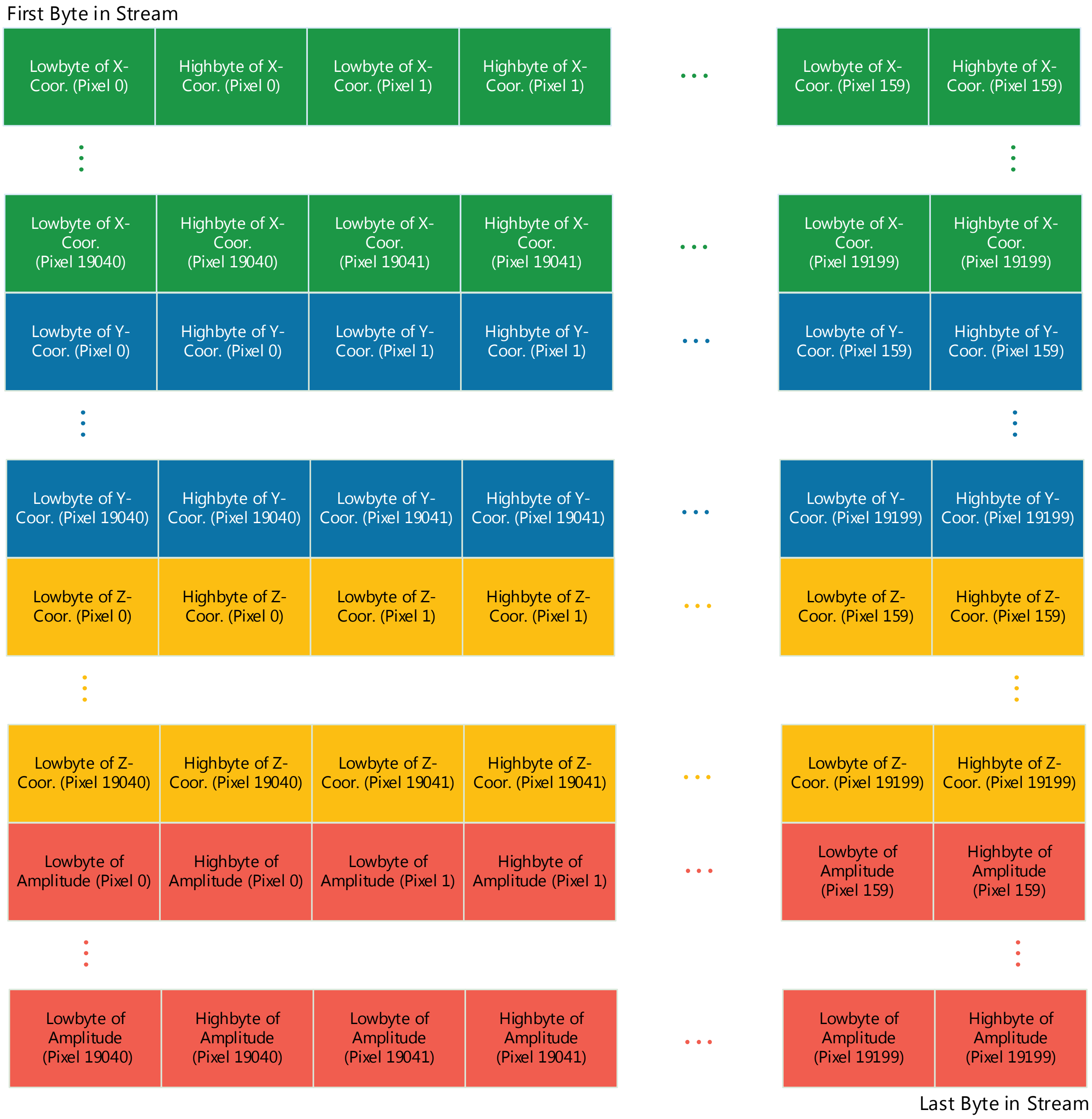
Last Byte in Stream

Figure 4-4: Data stream of XYZ Point Cloud

4.4.3 XYZ Point Cloud and Amplitude

In this mode the XYZ point cloud and the amplitude will be transferred in progressive mode. The stream starts always with pixel #0.

[ImageDataFormat = 32] The **coordinates** are coded in **millimeters** as **Int16** the **amplitudes** as **Uint16.**



First Byte in Stream

Lowbyte of X-Coor. (Pixel 0)	Highbyte of X-Coor. (Pixel 0)	Lowbyte of X-Coor. (Pixel 1)	Highbyte of X-Coor. (Pixel 1)	...	Lowbyte of X-Coor. (Pixel 159)	Highbyte of X-Coor. (Pixel 159)
⋮					⋮	
Lowbyte of X-Coor. (Pixel 19040)	Highbyte of X-Coor. (Pixel 19040)	Lowbyte of X-Coor. (Pixel 19041)	Highbyte of X-Coor. (Pixel 19041)	...	Lowbyte of X-Coor. (Pixel 19199)	Highbyte of X-Coor. (Pixel 19199)
Lowbyte of Y-Coor. (Pixel 0)	Highbyte of Y-Coor. (Pixel 0)	Lowbyte of Y-Coor. (Pixel 1)	Highbyte of Y-Coor. (Pixel 1)	...	Lowbyte of Y-Coor. (Pixel 159)	Highbyte of Y-Coor. (Pixel 159)
⋮					⋮	
Lowbyte of Y-Coor. (Pixel 19040)	Highbyte of Y-Coor. (Pixel 19040)	Lowbyte of Y-Coor. (Pixel 19041)	Highbyte of Y-Coor. (Pixel 19041)	...	Lowbyte of Y-Coor. (Pixel 19199)	Highbyte of Y-Coor. (Pixel 19199)
Lowbyte of Z-Coor. (Pixel 0)	Highbyte of Z-Coor. (Pixel 0)	Lowbyte of Z-Coor. (Pixel 1)	Highbyte of Z-Coor. (Pixel 1)	...	Lowbyte of Z-Coor. (Pixel 159)	Highbyte of Z-Coor. (Pixel 159)
⋮					⋮	
Lowbyte of Z-Coor. (Pixel 19040)	Highbyte of Z-Coor. (Pixel 19040)	Lowbyte of Z-Coor. (Pixel 19041)	Highbyte of Z-Coor. (Pixel 19041)	...	Lowbyte of Z-Coor. (Pixel 19199)	Highbyte of Z-Coor. (Pixel 19199)
Lowbyte of Amplitude (Pixel 0)	Highbyte of Amplitude (Pixel 0)	Lowbyte of Amplitude (Pixel 1)	Highbyte of Amplitude (Pixel 1)	...	Lowbyte of Amplitude (Pixel 159)	Highbyte of Amplitude (Pixel 159)
⋮					⋮	
Lowbyte of Amplitude (Pixel 19040)	Highbyte of Amplitude (Pixel 19040)	Lowbyte of Amplitude (Pixel 19041)	Highbyte of Amplitude (Pixel 19041)	...	Lowbyte of Amplitude (Pixel 19199)	Highbyte of Amplitude (Pixel 19199)

Last Byte in Stream

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

4.4.4 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, then X, Y, and Z coordinate arrays (in this order). The stream starts always with pixel #0.

[ImageDataFormat = 72] The **distances** are coded in millimeters as Uint16. The **coordinates** are coded in **millimeters** as **Int16**.

4.4.5 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, as well as the amplitudes.

[ImageDataFormat = 80] **Coordinate** values are coded in **millimeters** as **Int16**. The **amplitudes** are coded as **Uint16**.

4.4.6 Distances

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

[ImageDataFormat = 96] The **distances** are coded in **millimeters** as **Uint16**.

4.5 Modulation Frequency

The modulation frequency is set to 20 MHz per default. Other modulation frequencies can be set using the register ***ModulationFrequency***. Be aware that this also changes the ambiguity range of the camera.

The following modulation frequencies can be selected:

Index	Frequency
0	5 MHz
1	7.5 MHz
2	10 MHz
3	15 MHz
4	20 MHz
5	25 MHz
6	30 MHz

Table 4-1: Pre-defined modulation frequencies

In the register you can either write the frequency in 10-kHz-steps (frequency/10000) or the index. On a read of the register you get the currently selected modulation frequency (again, in 10-kHz-steps).

Other frequencies between 5 MHz and 30 MHz can be set as well, but as there is no calibration data available for other frequencies than the indexed ones it may result in unpredictable distance values.

4.6 Frame rate and Integration Time

The frame rate and the integration time can be set by using the registers ***Framerate*** and ***IntegrationTime***. The camera integration time is limited by hardware to 24ms.

The maximum frame rate is ~50 fps but may be limited by the integration time. 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.

Note

If the Auto Exposure Control is enabled the integration time will be set automatically and the register *IntegrationTime* should not be written!

4.7 Automatic Exposure Control (AEC)

The Argos 3D - P310 provides an automatic exposure control feature which controls the integration time according to the currently observed amplitude data. The AEC is disabled by default and must be enabled in the register ***Mode1***.

The AEC is controlled through dedicated registers, which are listed in chapter 6.5.

The AEC algorithm also supports weighting. One may assign specific weights to each of 25 areas into which the sensor area is divided. These weights are inputs to calculate the current overall amplitude. Please see Figure 4-6: AEC weighing areas for an illustration. Each area's weight is a Uint8 value and can range from 0% (0x0) to 100% (0xf).

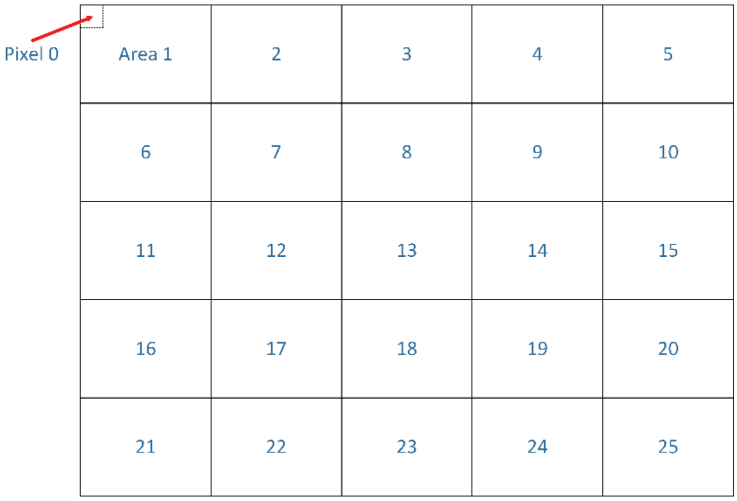


Figure 4-6: AEC weighing areas

4.8 Manual Frame Trigger

There are two types of manual trigger. To enable the manual trigger you have to disable the video mode in register ***Mode0**,* Bit[0].

4.8.1 Hardware Trigger

The camera provides an extension connector where a hardware trigger can be applied. Please refer to Chapter 3.3 for more information.

4.8.2 Software Trigger

In addition to the hardware trigger a software trigger is available. To start a frame capturing by software, set the appropriate bit (bit 4) in register ***Mode0***.

4.8.3 Trigger Output

Every image capturing process will trigger a transition to low on the trigger output. An additional delay for this signal can be set in register ***TriggerOutDelay.***

4.9 Over Temperature Protection

The Argos 3D - P310 firmware has a built-in monitoring for over-temperature condition of the LIMs. If the LIM temperature exceeds 70°C, the camera will automatically stop illumination and streaming, until temperature is below 70°C. This limit can be adjusted in register ***MaxLedTemp***.

4.10 Communication Keep Alive (CKA)

The communication keep alive feature should improve a stable operation in environments where a high availability of the camera services will be needed.

If the CKA feature has been enabled by writing a value >0 to the register ***CommKeepAliveTimeout*** (0x004E), the host computer must periodically write the reset value 0xCA82 to the register ***CommKeepAliveReset*** (0x004F). If the reset value will not be written within the programmed timeout the device reboots.

The timeout can be set by the register ***CommKeepAliveTimeout*** by writing the timeout value in seconds. This value will also be saved, if the register map will be saved in flash. But after a reboot the timeout check starts only after the first write of the reset value in register ***CommKeepAliveReset***.

4.11 GPIOs

The Argos3D-P310 provides 2 general-purpose input connectors (IN1-2) and 4 general-purpose output connectors (OUT1-4). The GPIO state is mapped to register ***IOstate0*** (see chapter 6.4 for details).

Please refer to the Hardware User Manual for detailed information on the GPIOs.

4.12 Save Registers

The entire register map can be saved into the 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.

4.13 Ethernet/IP Settings

4.13.1 MAC Address

A dedicated Ethernet MAC address from Bluetechnix MAC address pool is assigned to each Argos by factory default. This MAC address is saved in the OTP and cannot be changed by the user.

The user is allowed to assign a different MAC address using the registers ***Eth0Mac0*** to ***Eth0Mac2***. Be sure to make the changes persistent by saving the register map to flash using registers ***CmdEnablePasswd*** and ***CmdExec.*** Then reboot or power cycle the sensor.

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

4.13.2 IP/TCP/UDP Settings

The IP Settings of the Argos can be changes via the ***Eth0_**** registers. A change of the IP settings (IP address, port, subnet mask, default gateway) will take effect after a reboot. Please see the register description for details. Be sure to make the changes persistent by saving the register map to flash using registers ***CmdEnablePasswd*** and ***CmdExec.*** Then reboot or power cycle the sensor.

4.14 Reset to Factory Default

The Argos 3D - P310 can be reset to the factory default register settings by deleting the saved register map. This can be done by writing a dedicated value to the register ***CmdEnablePasswd*** and ***CmdExec***.

Alternatively, a factory reset is executed via the extension connector's Reset signal. (Please consult the Hardware User Manual for details.) It must be active for 5 seconds during boot-up.

4.15 Bootloader and Firmware Update

The Argos will be delivered with a bootloader which is capable to update the onboard firmware. The communication with the bootloader will be done using dedicated TCP/IP command frames over the control interface connection.

Bluetechnix provides tools for updating the Argos firmware over Ethernet. Please refer to our support site.

Bluetechnix ToF-Suite

↳ https://support.bluetechnix.at/wiki/Argos_3D_-_P310

4.15.1 Boot Sequence

After a power on or reboot the bootloader will be started. The bootloader checks if a valid firmware is installed and tries to start the firmware. If no application can be found or the bootstrap pin is high at startup the bootloader stays in bootloader mode waiting for incoming TCP connection requests.

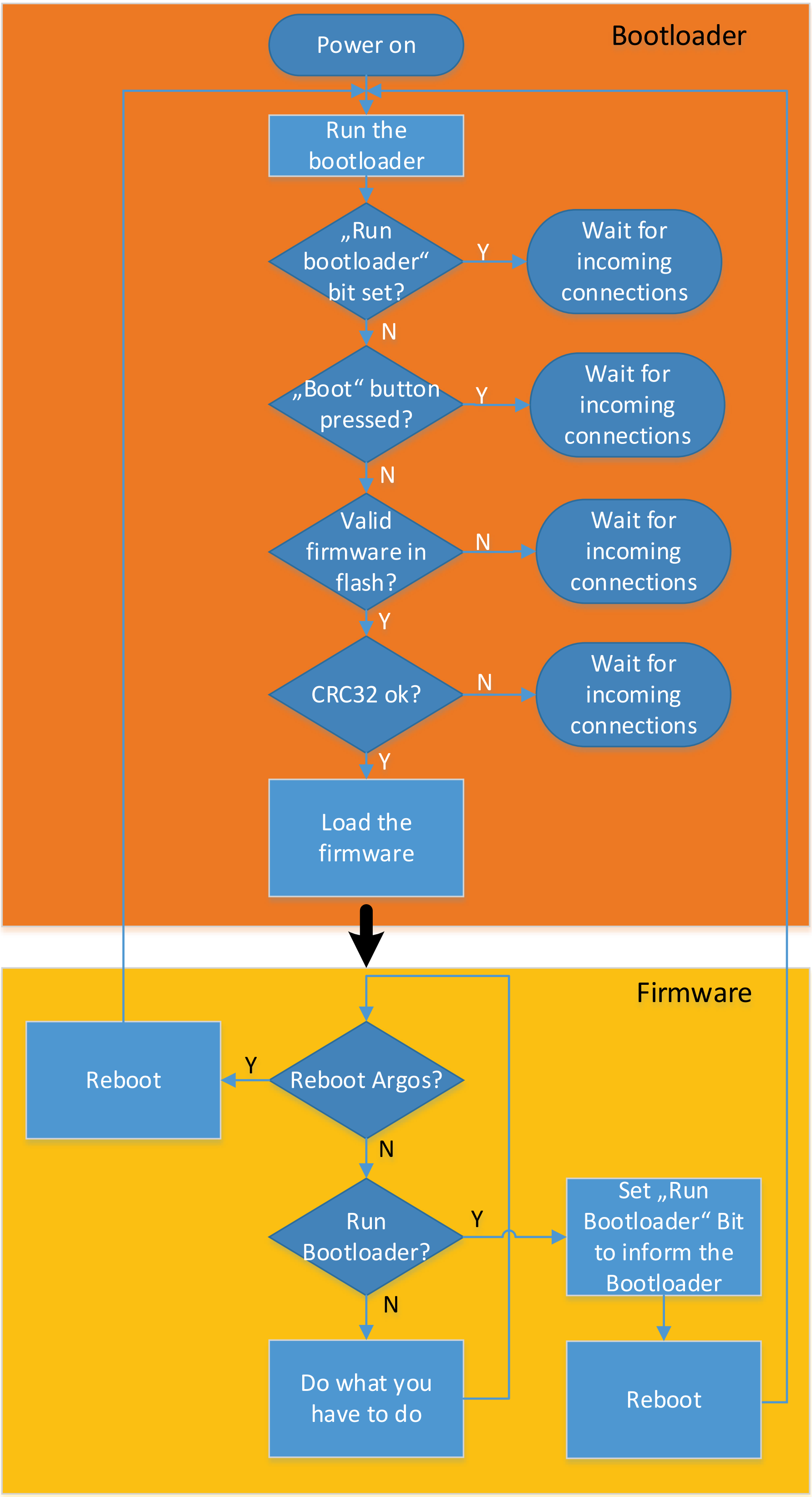

Bootloader
Power on
Run the bootloader
„Run bootloader“ bit set?
Y
Wait for incoming connections
N
„Boot“ button pressed?
Y
Wait for incoming connections
N
Valid firmware in flash?
N
Wait for incoming connections
Y
CRC32 ok?
N
Wait for incoming connections
Y
Load the firmware
Firmware
Reboot
Y
Reboot Argos?
N
Run Bootloader?
Y
Set „Run Bootloader“ Bit to inform the Bootloader
N
Do what you have to do
Reboot

Figure 4-7: Boot sequence

4.15.2 Bootloader Bootstrap Button

To force the module to stay in bootloader mode without starting the firmware the bootstrap button can be used. To stay in bootloader mode push the button labled "BOOT" while applying the supply voltage to the Argos or while resetting the Argos. The bootloader samples this button immediately after startup and if it is pressed the bootloader doesn't start the firmware but remains in bootloader mode waiting for incoming commands or TCP connections on the control interface port.

4.15.3 Bootloader default settings

- **IP-Address:** 192.168.0.10
- **TCP port for the control interface:** 10001
- **MAC Address:** Factory default MAC address

!

Note

The bootloader doesn't use any saved register map but always factory default register settings. That means that any changes in the IP-Settings made for the firmware are not valid for the bootloader!

5 Software

5.1 Demo Application

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

Software and documentation

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

6 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.

6.1 General registers

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
0001	Mode0	0001	R/W	Bit[0]: 0..Manual Mode, 1.. Video Mode Bit[2]: 0..Full On, 1..Sleep Mode Bit[4]: 1..Manual Trigger Bit[6]: 1..Clear status register Bit[8]: 1..Start Bootloader (Start Bootloader requires writing 0x5e6b into register CmdEnablePasswd (0x0022))
0003	Status	0040	R	Bit[0]: 0..Application Mode, 1..Bootloader Mode Bit[2]: 1..Ongoing Calibration Bit[3]: 1..LED-Board temperature sensor error Bit[4]: 1..Main-Board temperature sensor error Bit[5]: 1..Calibration data missing Bit[6]: 1..Factory Regmap was loaded Bit[9]: 1..LED board over-temperature Bit[14]: 1..Base-Board temperature sensor error
0004	ImageDataFormat	0000	R/W	Bit[3:10]: 0… 2 bytes depth-data / 2 bytes amp-data 3… X/Y/Z coordinates (2 bytes in signed format for each coordinate) 4… X/Y/Z coordinates and amp-data (2 bytes in signed format for each coordinate,2 bytes unsigned for the amp value) 9… depth-data and X/Y/Z coordinates (2 byte unsigned for the depth value , 2 byte in signed format for each coordinate) 10… X coordinate and amp-data (2 bytes in signed format, 2 bytes unsigned for amp-data) 11… 4 channels Test mode: arithmetic functions with coordinates as input (2 bytes ascending index; 2 bytes constant 0xbeef; 2 bytes ascending squared index; 2 bytes constant 0x0000) 12… 2 bytes depth-data
0005	IntegrationTime	05DC	R/W	Integration Time [µs] (max: 25000)
0006	DeviceType	9BA6	R	Hardware specific identification
0007	DeviceInfo		R	Bit[0-3]: Hardware Revision

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
0008	FirmwareInfo		R	Bit[0-5]: Non Functional Revision Bit[6-10]: Minor Revision Bit[11-15]: Major Revision
0009	ModulationFrequency	07D0	R/W	Modulation frequency index: 0.. 5 MHz 1.. 7,5 MHz 2.. 10 MHz 3.. 15 MHz 4.. 20 MHz 5.. 25 MHz 6.. 30 Mhz or a modulation frequency in multiples of 10kHz (may take a while to apply and no calibration data will be available)
000A	Framerate	0028	R/W	Framerate [Hz]
000B	HardwareConfiguration	005A	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 19.. Calibrate DistOffset of the current frequency
0010	ConfidenceThresLow	012C	R/W	Amplitude threshold for valid distance data
0011	ConfidenceThresHigh	3A98	R/W	Amplitude threshold for valid distance data
0019	Mode1	0800	R/W	Bit[3]: 0..AEC Off, 1..AEC On Bit[7]: 1..MinMax calculation On Bit[8]: 1..Disable status LED Bit[11]: 1..Enable Sliding Median for Min Registers
001A	CalculationTime		R	Calculation time for the last frame in 10[µs]. The inverse of this value shows the maximum achievable frame rate based on the CPU load.
001B	LedboardTemp		R	Temperature of LED-Board in 0,01[°C] (FFFF: Sensor not available).
001C	MainboardTemp		R	Temperature of Main-Board in 0,01[°C] (FFFF: Sensor not available).
001D	LinearizationAmplitude		R/W	Amplitude for Linearization Function [float value x 10000]
001E	LinearizationPhaseShift		R/W	Amplitude for Linearization Function [float value x 10000]
001F	FrameTime		R	Time between the last two frames. In 0,1[ms]
0020	RealWorldXcoordinate	0000	R/W	Distance to the calibration target [mm].
0021	CalibrationExtended	0000	R	Bit[0-7]: Status/error 0.. Idle 20.. Erasing flash 161.. Operation done 255.. Generic error 254.. NVM error 252.. Out of memory 249.. Led board failure

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
				248.. Invalid modulation frequency 246.. Wrong image mode (Need depth) Bit[10]: 1..Error occurred Bit[11]: 1..No FPN Calibration data in NVM Bit[12]: 1..No FPPN Calibration data in NVM Bit[13]: 1..No Dist Calibration data in NVM Bit[14]: 1..No Lens Calibration data in NVM Bit[15]: 1..Temperature compensation error
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 LED-Board temperature 0,01[°C]
0026	HorizontalFov	1)	R	Horizontal field of view in 0,01[°]
0027	VerticalFov	1)	R	Vertical field of view in 0,01[°]
002B	TriggerDelay	0000	R/W	Delay between trigger assertion (either software or hardware) and image capturing [ms]
002C	BootloaderStatus	4000	R	Bit[14-15]: Firmware Load Counter. This counter is reset by the firmware. It counts the boot attempts. In Bootloader mode it is used to detect a firmware load problem
002D	TempCompGradientLim		R/W	Factor ‘c’ of the illumination temperature compensation function: y [mm] = a/10000 * x^3 + b/10000 * x^2 + c/1000 * x + u
002E	ApplicationVersion		R	See “FirmwareInfo (0x0008)” for bit description, in Bootloader mode this register contains the firmware info of the flashed application
002F	DistCalibGradient	4000	R/W	Gradient of dist value, interpreted as fixed comma shifted by 14 binary digits
0030	TempCompGradient2Lim		R/W	Factor ‘b’ of the illumination temperature compensation function: y [mm] = a/10000 * x^3 + b/10000 * x^2 + c/1000 * x + u
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 0.. In progress or idle 1.. Success Other.. Error This register clears itself after reading it
0035	FactoryMacAddr2		R	Highest and second highest byte of the MAC address stored in OTP flash

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
0036	FactoryMacAddr1		R	Byte 3 and 2 of the MAC address stored in OTP flash
0037	FactoryMacAddr0		R	Byte 1 and lowbyte 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 timezone (stored in OTP flash)
003C	TempCompGradient3Lim		R/W	Factor ‘a’ of the illumination temperature compensation function: y [mm] = a/10000 * x^3 + b/10000 * x^2 + c/1000 * x + u
003D	BuildYearMonth		R	Build date/time Bit[14-4]: Year Bit[3-0]: Month
003E	BuildDayHour		R	Build date/time Bit[9-5]: Day Bit[4-0]: Hour
003F	BuildMinuteSecond		R	Build date/time Bit[11-6]: Minute Bit[5-0]: Second
0040	UpTimeLow		R	Lower 16 bit of uptime in [s]
0041	UpTimeHigh		R	Higher 16 bit of uptime in [s]
0042	AkfPlausibilityCheckAmpLimit	0032	R/W	Limit for the akf plausibility check
0043	TimSerialLow		R	Serial Number of the TIM module, low word
0044	TimSerialHigh		R	Serial Number of the TIM module, high word
004A	TempCompGradientTim		R/W	Factor ‘c’ of the ToF sensor temperature compensation function: y [mm] = a/10000 * x^3 + b/10000 * x^2 + c/1000 * x + u
004B	TempCompGradient2Tim		R/W	Factor ‘b’ of the ToF sensor temperature compensation function: y [mm] = a/10000 * x^3 + b/10000 * x^2 + c/1000 * x + u
004C	TempCompGradient3Tim		R/W	Factor ‘a’ of the ToF sensor temperature compensation function: y [mm] = a/10000 * x^3 + b/10000 * x^2 + c/1000 * x + u
004D	TriggerOutDelay		R/W	Delay between completed sensor data readout and trigger output [ms]
004E	CommKeepAliveTimeot		R/W	Communication keepalive timeout [s] After this timeout, a watchdog reset occurs if the timeout is not reset by writing the reset value to the CommKeepAliveReset register
004F	CommKeepAliveReset		R/W	Communication keepalive write register Resets the CommKeepAlive timeout when the value 0xCA82 is written

Table 6-1: General register

Note 1): The content depends on the mounted lens and the calibration data and represents the real viewing angles.

6.2 Registers for Segmentation

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
0050	SegmentCount	0020	R/W	Nr. Of Segments/Macrocells
0051	TopOpeningAngle	1)	R/W	Top Opening Angle in 0,01[°] [4]
0052	TopRow	1)	R/W	Bit[0-7]: Top Row (0-119)
0053	BottomOpeningAngle	1)	R/W	Top Opening Angle in 0,01[°] [4]
0054	BottomRow	1)	R/W	Bit[0-7]: Bottom Row (0-119)
0055	SegmentMinCountThreshold	1388	R/W	Bit[0-15] Percentage of pixel per segment where the distance has to be 0 to set the minimum distance to 0, [Percent * 100] [4]
0056	SegmentMaxCountThreshold	1388	R/W	Bit[0-15] Percentage of pixel per segment where the distance has to be 0xFFFF to set the maximum distance to 0xFFFF, [Percent * 100]
0057	SegMinSlidingMedianWindowSize	0005	R/W	Windows size for the Sliding Median Filter, has to be odd
005F	SegMinMaxError		R	Error for the min max calculation (cleared on read): 0..No error (currently no error available)
0060	SegMinDistance0		R	Minimum Distance of Segment 0, 0.. Amplitude to high [3], 0xFFFF..Amplitude to low [2].
0061	SegMinDistance1		R	Minimum Distance of Segment 1, 0.. Amplitude to high [3], 0xFFFF..Amplitude to low [2]
	…		…	…
007E	SegMinDistance30		R	Minimum Distance of Segment 30, 0.. Amplitude to high [3], 0xFFFF..Amplitude to low [2]
007F	SegMinDistance31		R	Minimum Distance of Segment 31, 0.. Amplitude to high [3], 0xFFFF..Amplitude to low [2]
0080	SegMaxDistance0		R	Maximum Distance of Segment 0, 0.. Amplitude to high [3], 0xFFFF..Amplitude to low [2]
0081	SegMaxDistance1		R	Maximum Distance of Segment 1, 0.. Amplitude to high [3], 0xFFFF..Amplitude to low [2]
	…		…	…
009E	SegMaxDistance30		R	Maximum Distance of Segment 30, 0.. Amplitude to high [3], 0xFFFF..Amplitude to low [2]
009F	SegMaxDistance31		R	Maximum Distance of Segment 31, 0.. Amplitude to high [3], 0xFFFF..Amplitude to low [2]

Table 6-2: Register for segmentation

Note 1): The content depends on the lens and the calibration data and will be set per default to the field of view. Dedicated registers will be provided for each segment. This causes a bit more overhead if all segments must be read. But it is also possible to read only the segment of interest

Note 2): This means that the amplitude is too low for correct distance measurement. The object might be underexposed.

Note 3): This means the amplitude is too high for correct measurement. The object might be overexposed.

Note 4): The top angle must be greater than or equal to the bottom angle. The top angle cannot be higher than the Field of View angle and the bottom angle cannot be below the Field of View angle.

6.3 More General Registers

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
00C1	DistOffset0	1)	R/W	An offset for distance values when operating at modulation frequency with index 0
00C2	DistOffset1	1)	R/W	An offset for distance values when operating at modulation frequency with index 1
00C3	DistOffset2	1)	R/W	An offset for distance values when operating at modulation frequency with index 2
00C4	DistOffset3	1)	R/W	An offset for distance values when operating at modulation frequency with index 3
00C5	DistOffset4	1)	R/W	An offset for distance values when operating at modulation frequency with index 4
00C6	DistOffset5	1)	R/W	An offset for distance values when operating at modulation frequency with index 5
00C7	DistOffset6	1)	R/W	An offset for distance values when operating at modulation frequency with index 6
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
010A	TempCompGradient Baseboard		R/W	Factor ‘c’ of the ToF baseboard temperature compensation function: y [mm] = a/10000 * x^3 + b/10000 * x^2 + c/1000 * x + u
010B	TempCompGradient 2Baseboard		R/W	Factor ‘b’ of the ToF baseboard temperature compensation function: y [mm] = a/10000 * x^3 + b/10000 * x^2 + c/1000 * x + u
010C	TempCompGradient 3Baseboard		R/W	Factor ‘a’ of the ToF baseboard temperature compensation function: y [mm] = a/10000 * x^3 + b/10000 * x^2 + c/1000 * x + u
010D	BaseboardTemp		R	Temperature of baseboard in 0,01[°C] (FFFF: Sensor not available).

Table 6-3: General registers

Note 1): This value varies from unit to unit.

6.4 Registers for GPIOs

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
00d0	IOstate0	0000	R/W	Bit[0]: … state of IN_1 (read only) Bit[1]: … state of IN_2 (read only) Bit[8]: … state of OUT_1 Bit[9]: … state of OUT_2 Bit[10]: … state of OUT_3 Bit[11]: … state of OUT_4

Table 6-4: Registers for GPIOs

6.5 Registers for Automatic Exposure Control

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
01A9	AecAvgWeight0	4444	R/W	Bit[15-12]: Weight for average, area 1 Bit[11-8]: Weight for average, area 2 Bit[7-4]: Weight for average, area 3 Bit[3-0]: Weight for average, area 4
01AA	AecAvgWeight1	44CC	R/W	Bit[15-12]: Weight for average, area 5 Bit[11-8]: Weight for average, area 6 Bit[7-4]: Weight for average, area 7 Bit[3-0]: Weight for average, area 8
01AB	AecAvgWeight2	C44C	R/W	Bit[15-12]: Weight for average, area 9 Bit[11-8]: Weight for average, area 10 Bit[7-4]: Weight for average, area 11 Bit[3-0]: Weight for average, area 12
01AC	AecAvgWeight3	FC44	R/W	Bit[15-12]: Weight for average, area 13 Bit[11-8]: Weight for average, area 14 Bit[7-4]: Weight for average, area 15 Bit[3-0]: Weight for average, area 16
01AD	AecAvgWeight4	CCC4	R/W	Bit[15-12]: Weight for average, area 17 Bit[11-8]: Weight for average, area 18 Bit[7-4]: Weight for average, area 19 Bit[3-0]: Weight for average, area 20
01AE	AecAvgWeight5	4444	R/W	Bit[15-12]: Weight for average, area 21 Bit[11-8]: Weight for average, area 22 Bit[7-4]: Weight for average, area 23 Bit[3-0]: Weight for average, area 24
01AF	AecAvgWeight6	4000	R/W	Bit[15-12]: Weight for average, area 25
01B0	AecAmpTarget	02BC	R/W	Auto exposure target amplitude value to which the controller is controlling to
01B1	AecTintStepMax	0021	R/W	Auto exposure maximum change of integration time percentage. The relative change of the integration time will be lower than this percentage
01B2	AecTintMax	2710	R/W	Auto exposure maximum integration time the controller calculates
01B3	AecKp	0028	R/W	Proportional part of the auto exposure controller in percent
01B4	AecKi	000F	R/W	Integral part of the auto exposure controller in percent
01B5	AecKd	0000	R/W	Differential part of the auto exposure controller in percent

Table 6-5: Registers for automatic exposure control

6.6 Registers for Test Commands

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
01C0	TestConfig	0000	R/W	Bit[1]: 1… Watchdog Test Writing this register must be preceded by writing 0x5E6B into register CmdEnablePasswd (0x0022)

Table 6-6: Registers for Test Commands

6.7 Registers for Device Update

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
01D1	FileUpdateStatus	0000	R	0.. idle 1.. ok 2.. max_filesize_exceeded 3.. out_of_memory 4.. buffer_overrun 5.. packet crc error 6.. file crc error 7.. file ok 8.. erasing flash 9.. flashing 10.. verifying 11.. erasing failed 12.. flashing failed 13.. verifying failed 14.. update success 15.. wrong packet nr 16.. header version conflict 17.. missing fw identifier 18.. wrong fw identifier 19.. flash boundary exceeded 20.. data inconsistent 21.. in progress 255.. protocol violation
01D2	FileSizeLow	0000	R/W	Size of the file to be transmitted
01D3	FileSizeHigh	0000	R/W	Size of the file to be transmitted
01D4	FlashStartAddLow	0000	R/W	Position in flash to write to
01D5	FlashStartAddrHigh	0000	R/W	Position in flash to write to
01D6	FileCrcLow	0000	R/W	Crc sum of the file to be transmitted
01D7	FileCrcHigh	0000	R/W	Crc sum of the file to be transmitted

Table 6-7: Registers for device update

6.8 Registers for Filter Configuration

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
01E0	ImgProcConfig	7BC1	R/W	Bit[0]: 1… enable Median Filter Bit[1]: 1… enable Average Filter Bit[2]: 1… enable Gauss Filter Bit[3]: 1… enable Bilateral Filter Bit[4]: 1… enable Sliding Average Bit[6]: 1… enable wiggling compensation Bit[7]: 1… enable FPPN compensation Bit[8]: 1… enable ModFreq scaling Bit[9]: 1… enable scaling to [mm] Bit[11]: 1… enable temperature compensation Bit[12]: 1… enable scaling via register DistCalibGradient (0x002F) Bit[13]: 1… enable offsets via registers DistCalibOffsetX (0x00C1 onwards) Bit[14]: 1… enable akf plausibility check (affected pixel 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 Bit[8-15]: Nr of iterations
01E3	FilterGaussConfig	0100	R/W	Bit[0-7]: 0… 3x3 Pixel 1… 5x5 Pixel Bit[8-15]: Nr of iterations
01E4	FilterBilateralConfig	2082	R/W	Bit[0-5]: Sigma R (factor for weighing for radius, max: 6) Bit[6-11]: Sigma D (factor for weighting for data, max: 6) Bit[12-15]: Nr of iterations
01E5	FilterSlafConfig	0005	R/W	Bit[0-7]: …Window size

Table 6-8: Register for filter configuration

6.9 Registers for 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	Low byte and byte 1 of MAC address (default value differs in factory config)
0242	Eth0Mac1		R/W	Byte 2 and byte 3 of MAC address (default value differs in factory config)
0243	Eth0Mac0		R/W	Byte 4 and high byte of MAC address (default value differs in factory config)
0244	Eth0Ip0	000A	R/W	Low word of IP address
0245	Eth0Ip1	C0A8	R/W	High word of IP address
0246	Eth0Snm0	FF00	R/W	Low word of subnet mask

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
0247	Eth0Snm1	FFFF	R/W	High word of subnet mask
0248	Eth0Gateway0	0000	R/W	Low word of gateway
0249	Eth0Gateway1	0000	R/W	High word of gateway
024A	Eth0TcpStreamPort	2710	R/W	Port for TCP streaming
024B	Eth0TcpConfigPort	2711	R/W	Port for TCP control interface
024C	Eth0UdpStreamIp0	0001	R/W	Low word of IP address for UDP stream
024D	Eth0UdpStreamIp1	E000	R/W	High word of IP address for UDP stream
024E	Eth0UdpStreamPort	2712	R/W	Port for UDP streaming
024F	Eth0UdpStreamStride	1	R/W	Stride for UDP stream 0: Don't stream any frame 1: Stream every frame x: Stream every xth frame

Table 6-9: Registers for Ethernet configuration

6.10 Registers for Temperature Management

Addr (hex)	Register Name	Default Value (hex)	R/W	Description
0293	TempDevStatus0	0000	R/W	Status of Baseboard sensor Bit[12]: … Temperature differs strongly from average Bit[13]: … Temperature Plausibility Error Bit[14]: … Sensor IO Error Bit[15]: … Initialization error
0297	TempDevStatus1	0000	R/W	Status of TIM sensor See register TempDevStatus0
029B	TempDevStatus2	0000	R/W	Status of LIM1 sensor See register TempDevStatus0
029F	TempDevStatus3	0000	R/W	Status of LIM2 sensor See register TempDevStatus0
02D0	TempDevTemperature0	0000	R	Temperature of Baseboard in 0,01[°C] (FFFF: Sensor not available).
02D1	TempDevTemperature1	0000	R	Temperature of TIM in 0,01[°C] (FFFF: Sensor not available).
02D2	TempDevTemperature2	0000	R	Temperature of LIM1 in 0,01[°C] (FFFF: Sensor not available).
02D3	TempDevTemperature3	0000	R	Temperature of LIM2 in 0,01[°C] (FFFF: Sensor not available).

Table 6-10: Registers for Temperature Management

7 Support

7.1 General Support

General support for products can be found at Bluetechnix’ support site

Support Link

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

7.2 Software Packages

Software packages and software downloads are for registered customers only

Software Package

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

7.3 Related Products

- TIM^{UP}-19k-S3 USB 2.0 PVI
- LIM-U –LED-850 6

8 Firmware History

8.1 Version Information

Firmware Version	Status	Release date	Changes
0.9.0	(X-Grade)	Aug 2014	
1.0.0	First Release	Oct 2014	

Table 8-1: Overview Argos 3D - P310 firmware changes

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Note

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

8.2 Anomalies

Applies to	Date	Description

Table 8-2 – Firmware anomalies

8.3 Document Revision History

Version	Date	Document Revision
1	2014 07 29	Initial version of the document

Table 8-3: Revision history

9 Index