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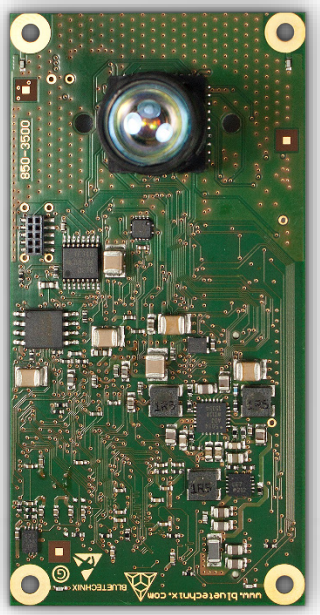
Embedding Ideas

# TIM-UP – 19k-S3-Spartan 6 V2.0.0



## Software User Manual

Version 5

Contact

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# Table of Contents

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Information

For further information on technology, delivery terms and conditions and prices please contact Bluetechnix (http://www.bluetechnix.com).

Warning

Due to technical requirements components may contain dangerous substances.

# 1 General Information

This guide applies to the TIM$^{uP}$ - 19k-S3-Spartan6 module from Bluetechnix GmbH. 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 TIM$^{uP}$ - 19k-S3-Spartan6 module and describes the firmware dependent interfaces.

**This document applies to firmware version v2.0.0 (0x19082014)**

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

**Software and documentation**

https://support.bluetechnix.at/wiki/TIM-UP-19k-S3-Spartan6

# 3 Interfacing

The TIM$^{uP}$ - 19k-S3-Spartan6 firmware provides a USB data and control interface, an ISM parallel sensor interface and I$^2$C control interface. All interfaces are exposed on the 100pin board to board connector.

The interfaces are split into a control and data interface. The control interface is used to set and read the configuration of the TIM$^{uP}$ - 19k-S3-Spartan6 module using a set of registers. For a complete register description refer to:

5 Register Description

## 3.1 General Data Format

The data output format on both, the USB and the ISM interface, is divided into four containers where each container has its own header. The content of the four containers can be configured using the calculation mode register.

For a complete register description refer to:

5 Register Description


Figure 3-1 Data Containers

Each header consists of 128 32bit double words of data stored in high byte first order, whereas the data container comes in low byte first order. For a complete description of the header data refer to our support site.

https://support.bluetechnix.at/wiki/PMDSDK_/_PMDMDK_User_Manual#Source_Data_Container_Header

The data containers hold the pixel information configured in the calculation mode register. By default, three data containers are configured.

- Data container 0: phase values [0..0xffff equal to a phase of 0..2π]
- Data container 1: amplitudes [0..0xffff]
- Data container 2: plausibility flags

**Note**

To calculate the distance you must multiply the phase value with ( c / ( 2 x f )) / 0xffff.
c…speed of light
f…modulation frequency

If the resulting value is greater than the ambiguity range subtract the ambiguity range. If the value is less than 0, add the ambiguity range.

## 3.2 USB Interface

For interfacing the TIM$^{uP}$ - 19k-S3-Spartan6 module over USB, a powerful Software Development Kit is provided. The SDK runs under Linux and Windows. Refer to our support site for downloading the SDK and for additional information and documentation.

**Software and documentation**

https://support.bluetechnix.at/wiki/TIM-UP-19k-S3-Spartan6

## 3.3 ISM / I²C Interface

### 3.3.1 I²C Configuration Interface

The TIM$^{uP}$ - 19k-S3-Spartan6 module can be configured using an I²C connection. The I²C control interface of the TIM$^{uP}$ - 19k-S3-Spartan6 module is listening on the following I²C slave address:

- **I²C Address:** 0x5D
- **SCL Frequency:** up to 400kHz

The TIM$^{uP}$ - 19k-S3-Spartan6 module has a set of 32bit registers and is addressed by a 16bit address pointer. Following two figures show the timing diagrams of the I2C read and write.

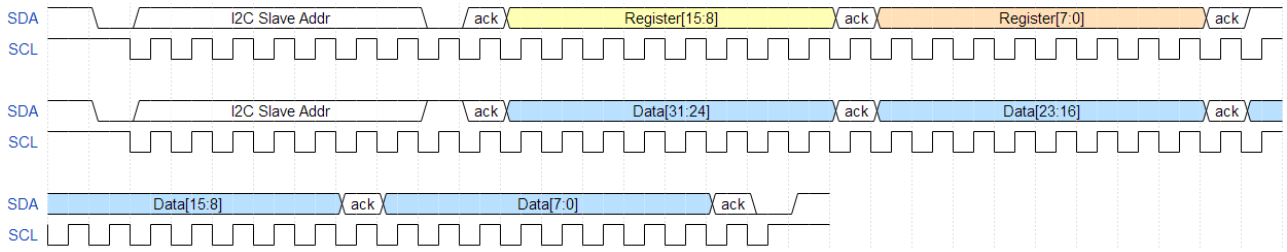


Figure 3-2 I²C register read timing diagram

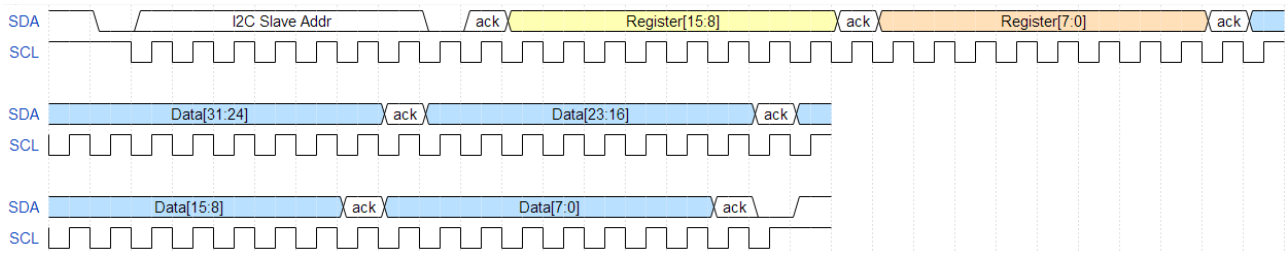


Figure 3-3 I²C register write timing diagram

For a complete register description refer to:

### 3.3.2 ISM Data Interface

When configured to stream data over ISM in free run mode, the TIM$^{uP}$ - 19k-S3-Spartan6 module starts transferring frames automatically and can only be interrupted by switching to manual trigger mode.

Each frame starts with a rising edge on the VSYNC signal followed by a rising edge of the HSYNC signal. With the first HSYNC signal, the first data block is transmitted as shown in Figure 3-4 Timing diagram of the ISM data interface. Every data block contains 512bytes and starts with a HSYNC.

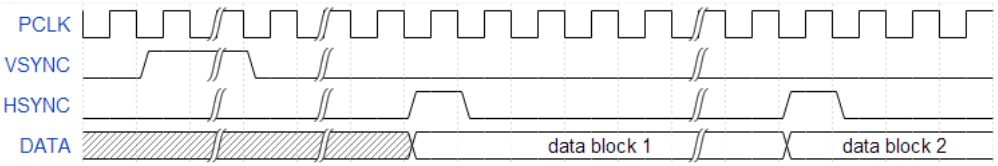


Figure 3-4 Timing diagram of the ISM data interface

Data comes low byte first and has to be captured on every rising edge starting with the rising edge of the HSYNC signal.

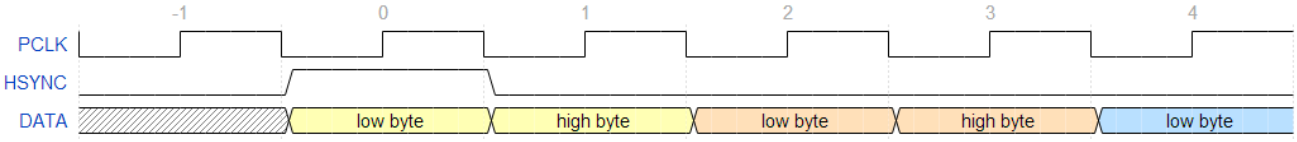


Figure 3-5 Byte order of the ISM data interface

The data stream during one frame is continuous, there is no horizontal blanking before the next HSYNC. The vertical blanking period varies depending on frame rate. Once ISM.nDE is low, the pixel clock never stops. ISM.PCLK stays constant at 48MHz.

# 4 Hardware Connector

The following table shows the pin-out of the 100-pin TIM connector:

| Pin # | Type | Signal name | Description |
|---|---|---|---|
| 1 | I | ISM.nDE | ISM Output enable: 0: ISM bus enabled, 1: ISM bus high Z |
| 2 | NC | | |
| 3 | NC | | |
| 4 | NC | | |
| 5 | NC | | |
| 6 | PWR | GND | Power ground |
| 7 | O | ISM.D7 | ISM Data Bit 7 (MSB) |
| 8 | O | ISM.D6 | ISM Data Bit 6 |
| 9 | O | ISM.D5 | ISM Data Bit 5 |
| 10 | O | ISM.D4 | ISM Data Bit 4 |
| 11 | PWR | GND | Power ground |
| 12 | NC | | |
| 13 | O | ISM.D3 | ISM Data Bit 3 |
| 14 | O | ISM.D2 | ISM Data Bit 2 |
| 15 | O | ISM.D1 | ISM Data Bit 1 |
| 16 | O | ISM.D0 | ISM Data Bit 0 (LSB) |
| 17 | O | ISM.STROBE | ISM Strobe signal: high during LED modulation |
| 18 | I | ISM.TRIGGER | ISM Trigger signal: trigger on rising edge |
| 19 | O | ISM.HSYNC | ISM Line Sync (HSYNC) |
| 20 | O | ISM.VSYNC | ISM Frame Sync (VSYNC) |
| 21 | O | ISM.PCLK | ISM Pixel clock |
| 22 | PWR | GND | Power ground |
| 23 | NC | | |
| 24 | I/O | ISM.SDA | ISM Configuration bus data signal |
| 25 | I | ISM.SCL | ISM Configuration bus clock signal |
| 26 | I | nRESET | Reset signal: hardware reset on low |
| 27 | NC | | |
| 28 | I | ISM.SADDR | ISM Slave address (currently not supported) |
| 29 | PWR | GND | Power ground |
| 30 | NC | | |
| 31 | NC | | |
| 32 | PWR | GND | Power ground |
| 33 | NC | | |
| 34 | NC | | |
| 35 | PWR | GND | Power ground |
| 36 | NC | | |
| 37 | NC | | |
| 38 | PWR | GND | Power ground |
| 39 | NC | | |
| 40 | NC | | |
| 41 | PWR | GND | Power ground |
| 42 | NC | | |
| 43 | NC | | |
| 44 | NC | | |
| 45 | NC | | |
| 46 | I | UART.RX | UART Receive |

| Pin # | Type | Signal name | Description |
|---|---|---|---|
| 47 | O | UART.TX | UART Transmit |
| 48 | NC | | |
| 49 | NC | | |
| 50 | NC | | |
| 51 | O | LED.SMOD | LIM Single ended mod signal |
| 52 | I/O | LED.IO | LIM one-wire communication bus (currently not supported) |
| 53 | PWR | GND | Power ground |
| 54 | O | LED.MOD_N | LIM Differential pair mod signal – negative |
| 55 | O | LED.MOD_P | LIM Differential pair mod signal – positive |
| 56 | PWR | GND | Power ground |
| 57 | O | GPIO.3 | GPIO 3: status signal (toggle on every frame capture) |
| 58 | I | GPIO.2 | Factory Default Reset: 4sec on low while reboot to delete register map from flash and boot default configuration |
| 59 | I | GPIO.1 | GPIO 1: not used – internal pull up |
| 60 | NC | | |
| 61 | NC | | |
| 62 | NC | | |
| 63 | PWR | GND | Power ground |
| 64 | NC | | |
| 65 | NC | | |
| 66 | NC | | |
| 67 | NC | | |
| 68 | PWR | GND | Power ground |
| 69 | NC | | |
| 70 | NC | | |
| 71 | PWR | GND | Power ground |
| 72 | NC | | |
| 73 | NC | | |
| 74 | I | PEN | Module power enable |
| 75 | NC | | |
| 76 | O | SPI.SCLK | Not used – high Z |
| 77 | I/O | SPI.SIO0 | Not used – high Z |
| 78 | I/O | SPI.SIO1 | Not used – high Z |
| 79 | O | SPI.nCS | Not used – high Z |
| 80 | NC | | |
| 81 | NC | | |
| 82 | NC | | |
| 83 | PWR | GND | Power ground |
| 84 | NC | | |
| 85 | NC | | |
| 86 | NC | | |
| 87 | NC | | |
| 88 | PWR | GND | Power ground |
| 89 | I/O | USB.D_N | USB D- Signal: high Z on reset |
| 90 | I/O | USB.D_P | USB D+ Signal: high Z on reset |
| 91 | NC | | |
| 92 | NC | | |
| 93 | O | I2CM.SCL | I2C Master Clock signal: connect I2C bus from LIM |
| 94 | O | I2CM.SDA | I2C Master Data signal: connect I2C bus from LIM |
| 95 | PWR | GND | Power ground |

| Pin # | Type | Signal name | Description |
|---|---|---|---|
| 96 | PWR | GND | Power ground |
| 97 | PWR | VIN | 5V Power supply |
| 98 | PWR | VIN | 5V Power supply |
| 99 | PWR | VIN | 5V Power supply |
| 100 | PWR | VIN | 5V Power supply |
| 101 | PWR | GND | Power ground |
| 102 | PWR | GND | Power ground |
| 103 | PWR | GND | Power ground |
| 104 | PWR | GND | Power ground |
| 105 | PWR | GND | Power ground |
| 106 | PWR | GND | Power ground |
| 107 | PWR | GND | Power ground |
| 108 | PWR | GND | Power ground |
| 109 | PWR | GND | Power ground |
| 110 | PWR | GND | Power ground |

Table 4-1 Pin-out of the TIM$^{uP}$ – 19k-S3-Spartan6 connector

# 5 Register Description

**Note**

Some critical registers are password protected. To enable the functionality, a specific value must be written to the FlashMagic register (0x0014) prior to enabling the functionality. This should prevent from unattended enabling of certain functions.

## 5.1 General Registers

| Addr (hex) | Register Name | Default Value (hex) | R/W | Description |
|---|---|---|---|---|
| 01 | SerialNumber[1)] | - | R | Bit[0:19]: Serial Number<br>Bit[20:31]: Device Type |
| 02 | ReleaseDate | - | R | Release date, hex value interpreted as date |
| 03 | FrameSize | 1C800 | R | Frame size in bytes |
| 04 | NumRows | 78 | R | Number of vertical pixels |
| 05 | NumColumns | A0 | R | Number of horizontal pixels |
| 0B | SequenceLength | 1 | R/W | Number of sequences to be calculated |
| 0F | CalculationMode[3)] | 22E9F7DF | R/W | Bit[21:22]: Content of container 0<br>0.. Intensities<br>1.. corr phase<br>2.. Amplitudes<br>3.. Raw phase 0<br>Bit[23:24]: Content of container 1<br>0.. Distances<br>1.. Distances plaus<br>2.. Plausibility flags<br>3.. Raw phase 1<br>Bit[25:26]: Content of container 2<br>0.. Amplitudes<br>1.. Amplitudes plaus<br>2.. Phase Frequency 1<br>3.. Raw phase 2<br>Bit[27:28]: Content of container 3<br>0.. Plausibility flags<br>1.. Distances<br>2.. Phase Frequency 2<br>3.. Raw phase 3 |
| 10 | TempMainboard | - | R | Temperature of Mainboard in fixedpoint 9.4 [°C] |
| 11 | TempIllumination | - | R | Temperature of Illumination in fixedpoint 9.4 [°C] |
| 16 | ChipsizeColumns | A0 | R | Horizontal count of pixels |
| 17 | ChipsizeRows | 78 | R | Vertical count of pixels |
| 19 | TriggerMode | 0 | R/W | Bit[0]: 0.. free run mode<br>1.. hardware trigger mode<br>2.. software trigger mode |
| 1B | TempIlluminationGain1 | 0 | R/W | Coefficient c3 for cubic temperature compensation of the illumination module temperature<br>x/10000 |
| 1C | TempIlluminationGain2 | 0 | R/W | Coefficient c2 for cubic temperature compensation of the illumination module temperature<br>x/10000 |

| Addr (hex) | Register Name | Default Value (hex) | R/W | Description |
|---|---|---|---|---|
| 1D | TempIlluminationGain3 | 0 | R/W | Coefficient c1 for cubic temperature compensation of the illumination module temperature<br>x/1000 |
| 1E | TempMainboardGain1 | 0 | R/W | Coefficient c3 for cubic temperature compensation of the mainboard temperature<br>x/10000 |
| 1F | TempMainboardGain2 | 0 | R/W | Coefficient c2 for cubic temperature compensation of the mainboard temperature<br>x/10000 |
| 20 | TempMainboardGain3 | 0 | R/W | Coefficient c1 for cubic temperature compensation of the mainboard temperature<br>x/1000 |
| 21 | TempLimit | 46 | R/W | Temperature limit for over temperature protection of the illumination module |
| 22 | SoftwareTrigger | 0 | R/W | Set 1 to trigger a frame capture when in software trigger mode (Register 0x19) |
| 30 | ModLedEnable[2)] | 1B | R/W | Bit[0]: reserved - high<br>Bit[1]: enable differential LED mod signal<br>Bit[2]: enable single ended LED mod signal<br>Bit[3]: reserved - low<br>Bit[4]: enable ISM.STROBE signal during modulation |
| 31 | StatusLedEnable[2)] | 0 | R/W | Bit[0]: 0.. Status LED disabled<br>1.. Status LED enabled |
| 37 | DataInterfaceType | 0 | R/W | Bit[0]: 0.. USB interface<br>1.. ISM interface |
| 38 | FirmwareInfo | - | R | Bit[6:10]: Firmware minor version<br>Bit[11:15]: Firmware major version |
| 76 | ModulationFrequency0 | 1312D00 | R/W | First possible modulation frequency [Hz] |
| 77 | ModulationFrequency1 | 989680 | R/W | Second possible modulation frequency [Hz] |
| 78 | 5MHz_Offset | 0 | R/W | Offset for 5MHz modulation frequency [mm] |
| 79 | 7.5MHz_Offset | 0 | R/W | Offset for 7.5MHz modulation frequency [mm] |
| 7A | 10MHz_Offset | 0 | R/W | Offset for 10MHz modulation frequency [mm] |
| 7B | 15MHz_Offset | 0 | R/W | Offset for 15MHz modulation frequency [mm] |
| 7C | 20MHz_Offset | 0 | R/W | Offset for 20MHz modulation frequency [mm] |
| 7D | 25MHz_Offset | 0 | R/W | Offset for 25MHz modulation frequency [mm] |
| 7E | 30MHz_Offset | 0 | R/W | Offset for 30MHz modulation frequency [mm] |
| 7F | FramesPerSecond | 5 | R/W | FPS considering the configured sequence length and the corresponding integration times |

Table 5-1 General registers description of the TIM[uP] – 19k-S3-Spartan6

[1)] The Serial Number field contains the device type code and the serial number. For a list of all device type codes refer to:

https://support.bluetechnix.at/wiki/PMDSDK_/_PMDMDK_User_Manual#No._Serial.2FCustomer

[2)] For detailed information on hardware pins refer to:

4 Hardware Connector_Hardware_Connectors

[3)] For a detailed description of the calculation mode register refer to:

https://support.bluetechnix.at/wiki/PMDSDK_/_PMDMDK_User_Manual#Camera_Registers

## 5.2 Sequence Registers

| Addr (hex) | Register Name | Default Value (hex) | R/W | Description |
|---|---|---|---|---|
| 80 | Seq0PLLSelect | 0 | R/W | PLL config of the correct modulation frequency<br>Modulation frequency 0 and 1 are configured in register 76 and 77 |
| 81 | Seq0IntegrationTime | 1F4 | R/W | Integration time of sequence 0 in µs |
| 82 | Seq0ModFreq | 1312D00 | R/W | Modulation frequency to use for this sequence<br>Only modulation frequencies set in register 76 and 77 are valid for this register |
| 87 | Seq0AmpMin | 12C | R/W | Sets the minimal amplitude for valid pixels. Pixels with an amplitude below this value will be tagged by the amplitude low flag |
| 8A | Seq1PLLSelect | 1 | R/W | PLL config of the correct modulation frequency<br>Modulation frequency 0 and 1 are configured in register 76 and 77 |
| 8B | Seq1IntegrationTime | 1F4 | R/W | Integration time of sequence 1 in µs |
| 8C | Seq1ModFreq | 989680 | R/W | Modulation frequency to use for this sequence<br>Only modulation frequencies set in register 76 and 77 are valid for this register |
| 91 | Seq1AmpMin | 12C | R/W | Sets the minimal amplitude for valid pixels. Pixels with an amplitude below this value will be tagged by the amplitude low flag |

Table 5-2 Sequence registers description of the TIM$^{uP}$ – 19k-S3-Spartan6

# 6 Support

## 6.1 General Support

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

**Support Link**

https://support.bluetechnix.at/wiki/TIM-UP-19k-S3-Spartan6

## 6.2 Software Packages

Software packages and software downloads are for registered customers only

**Support Link**

https://support.bluetechnix.at/wiki/TIM-UP-19k-S3-Spartan6

### 6.2.1 Related Products

- LIM-U-LED-850

# 7 Product History

## 7.1 Version Information

### 7.1.1 TIM$^{uP}$ – 19k-S3-Spartan6-USB

| Version | Release date | Changes |
|---|---|---|
| 0x28042014 | April 2014 | First preliminary version |

Table 7-1: Overview TIM$^{uP}$ – 19k-S3-Spartan6-USB firmware changes

### 7.1.2 TIM$^{uP}$ – 19k-S3-Spartan6

| Version | Release date | Changes |
|---|---|---|
| 2.0.0 (0x19082014) | 2014 08 19 | See release notes of v2.0.0 |

Table 7-2: Overview TIM$^{uP}$ – 19k-S3-Spartan6-ISM firmware changes

## 7.2 Anomalies

| Version | Date | Description |
|---|---|---|
| V1.0 | 2014 04 28 | No anomalies reported yet. |
| V2.0.0 | 2014 08 19 | Compatibility to PMDSDK v0.3.0:<br>To get correct distance values when setting a new modulation frequency a disconnect and reconnect has to be performed! |

Table 7-3 – Product anomalies

## 7.3 Document Revision History

| Version | Date | Document Revision |
|---|---|---|
| 1 | 2014 04 28 | First release V1.0 of the Document |
| 2 | 2014 05 16 | Unused Pins changed from pulldown to high-Z |
| 3 | 2014 08 01 | Description of phase values added |
| 4 | 2014 08 07 | USB and ISM interfaces merged, register description updated |
| 5 | 2014 08 19 | Added new Modulation Frequency description and finalized SUM for v2.0.0 update |

Table 7-4: Revision history

# 8 List of Abbreviations

| Abbreviation | Description |
|---|---|
| **DC** | Direct Current |
| **EBI** | External Bus Interface |
| **ESD** | Electrostatic Discharge |
| **FPN** | Fixed Pattern Noise |
| **FPPN** | Fixed Phase Pattern Noise |
| **GPIO** | General Purpose Input Output |
| **I** | Input |
| **I²C** | Inter-Integrated Circuit |
| **I/O** | Input/Output |
| **ISM** | Image Sensor Module |
| **NC** | Not Connected |
| **O** | Output |
| **OS** | Operating System |
| **PPI** | Parallel Peripheral Interface |
| **PWR** | Power |
| **ROI** | Region Of Interest |
| **SPI** | Serial Peripheral Interface |
| **SPORT** | Serial Port |
| **UART** | Universal Asynchronous Receiver Transmitter |
| **USB** | Universal Serial Bus |

Table 8-1: List of abbreviations

# A List of Figures and Tables

## Figures



## Tables