BLUETECHNIX
Embedding Ideas

# TIM-UP – 19k-S3-Spartan6

## Hardware User Manual

Version 2.8

Contact

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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 Introduction

## 1.1 Overview

The TIM$^{uP}$ – 19k-S3-Spartan6 is a smart sensor module, developed by Bluetechnix, operating on the Time-of-Flight (ToF) principle. The TIM$^{uP}$ – 19k-S3-Spartan6 is equipped with a PMD PhotonICs® 19k-S3 Time-of-Flight 3D chip and a FPGA for real time image processing. This smart sensor module delivers depth information and gray value image data for each pixel simultaneously. Therefore, it´s possible to analyze scenes based on 3D data only or in combination with 2D grayscale data. Using an external active IR illumination (like Bluetechnix' Light Modules, LIM), the sensor is able to capture 3D and 2D information at a resolution of 160x120 pixels with up to 160 frames per second independently of ambient light. The range of the sensor is dependent from the external light module. The field of view can be selected by the lens mounted on the TIM$^{uP}$ – 19k-S3-Spartan6 and on the external light module. The TIM$^{uP}$ – 19k-S3-Spartan6 provides multiple interfaces through a 100-pin connector. This sensor module can be used for next generation systems in various application fields like robotics, gesture recognition, HMI or people counting.

## 1.2 Key Features

- ToF-Module based on PMD PhotonICs® 19k-S3
- Size: 80 x 40mm
- USB interface
- ISM interface
- Support CS- and M12-lense holder
- Support for firmware updates
- 5V single supply

## 1.3 Applications

- Range measurements
- Object counting
- 3D safety areas
- Map building
- Robot navigation
- Obstacle detection
- Touch less control
- HMI for industrial Robots
- People counting
- Safety access control

# 2 General Description

## 2.1 Functional Description

The following image shows the block diagram of the TIM$^{uP}$ – 19k-S3-Spartan6.

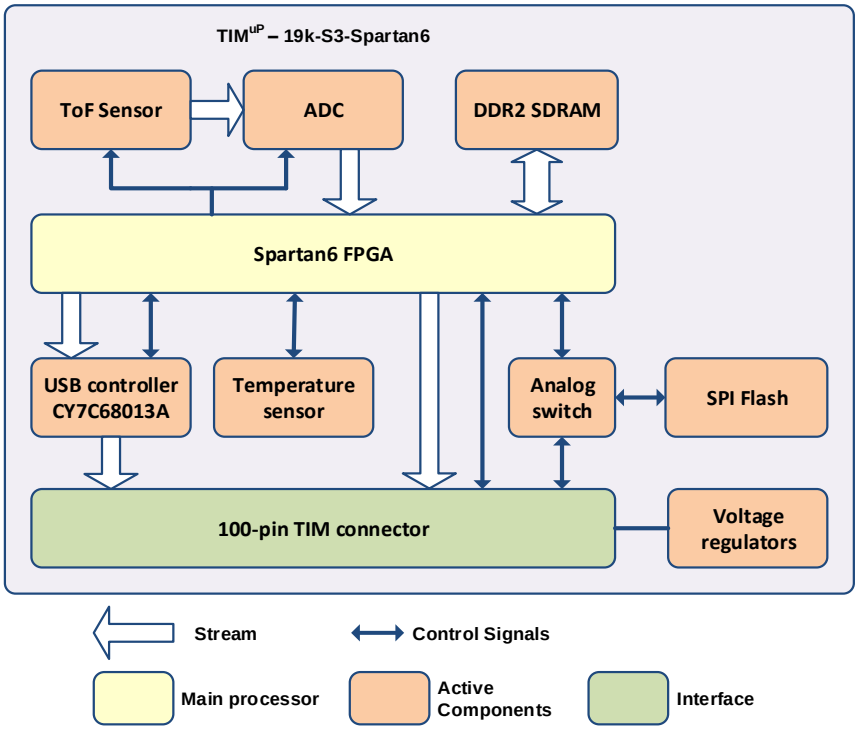


Figure 2-1 TIM$^{uP}$-19k-S3-Spartan6 block diagram

The following list shows the main components of the TIM$^{uP}$ – 19k-S3-Spartan6:

- Main processor (Xilinx Spartan6 **XC6SLX9-3**)
- ToF-Sensor (PMDtec **19k-S3**)
- USB2.0 Device Controller (Cyrrus Logic **CY7C68013A**)
- ADC (Analog Devices **AD9826KRSZ**)
- 128MByte DDR2 SDRAM
- SPI Flash (Winbond **W25Q64FVSSIG**)

## 2.2 Interfaces

The following chapters describes the interfaces on the 100-pin TIM connector.

### 2.2.1 USB

An USB2.0 interface is available on the TIM connector. This interface allows to use the TIM$^{uP}$ – 19k-S3-Spartan6 as USB video stream device. For further information refer to Software User Manual or contact Bluetechnix support

### 2.2.2 ISM

The ISM interface provides an 8-bit parallel video stream interface and all necessary control signals as well as an I2C interface to configure the module. For further information refer to Software User Manual or contact Bluetechnix support

### 2.2.3 LIM

The LIM interface must be used in conjunction with an external LIM module. This interface consists of a 1-wire interface (LED.IO) or I2C (I2CM.SCL/I2CM.SDA) and the light modulation signal (differential: LED.MOD, single-ended: LED.SMOD).

**Note:**

Keep the connection between the TIM and LIM as short as possible.
If multiple LIMs are connected to one TIM then the modulation signals to each LIM must be length matched.

The LED.MOD signals must be routed with a differential impedance of 100 Ohm.
The LED.SMOD signal must be routed with an impedance of 50 Ohm.

### 2.2.4 EXTSPI

The EXTSPI interface provides a fast serial interface to the FPGA as well as an interface to the on-board SPI Flash for firmware updates.

The EXTSPI interface of the TIM connector can be routed by the on-board analog switch to the on-board SPI Flash using the ISM.nRESET signal. The ISM.nRESET signal is internally pulled up by a 10kΩ resistor. The EXTSPI.nCS signal is internally pulled up when connected to the SPI Flash.

| ISM.nRESET signal | Function |
|---|---|
| **LOW** | On-board SPI Flash connected to EXTSPI (Firmware update mode)<br>TIM module is in reset mode |
| **HIGH** | On-board SPI Flash connected to FPGA<br>SPI interface of TIM connector connected to FPGA |

Table 2-1 Function of ISM.nRESET signal

### 2.2.5 UART

Function is firmware dependent. For further information refer to Software User Manual or contact Bluetechnix support.

### 2.2.6 GPIOs

Function is firmware dependent. For further information refer to Software User Manual or contact Bluetechnix support.

### 2.2.7 I2CM

Function is firmware dependent. For further information refer to Software User Manual or contact Bluetechnix support.

### 2.2.8 PEN

The PEN signal (Power Enable signal) can be used to shut down the TIM module. The PEN signal is internally pulled up by a 10kΩ resistor.

| PEN signal | Function |
|---|---|
| **LOW** | TIM module power supply disabled |
| **HIGH** | TIM module power supply enabled. |

Table 2-2 Function of PEN signal

# 3 Hardware installation

## 3.1 Mounting

The TIM$^{uP}$-19k-S3-Spartan6 must be connected to a base board through a FX-10A-100P/10SV connector from Hirose (see chapter 7.4). The module provides 4 additional M2 mounting holes to fix it on the base board.

See chapter 7.4 for more information.

## 3.2 Processor cooling

In harsh environment or when the TIM$^{uP}$-19k-S3-Spartan6 is used within a case without appropriate cooling it may be necessary to provide a heat sink for the processor and DDR2 memory. In this case the base board must provide a cut-out area for cooling the ICs.

The module provides also the possibility to cool the 3D sensor by applying a heat sink on the bottom side of the board below the sensor. This might be useful to increase the accuracy of the sensor at high temperatures.

**Note:**

The cooling area for the 3D sensor is spread from solder mask and connected to GND. Take care if using non-isolated heat sinks!

See figure 7.2 for more information.

## 3.3 Lenses

The TIM$^{uP}$-19k-S3-Spartan6 provides a M12 lense holder as well as a CS-mount holder on request. The module will be equipped with a 90° objective. Other objectives can be provided by Bluetechnix on request.

## 3.4 Sensor sensitivity

Following diagrams shows the spectral sensitivity of the 19k-S3 sensor chip depending from the IR-cut filter mounted on the sensor chip.

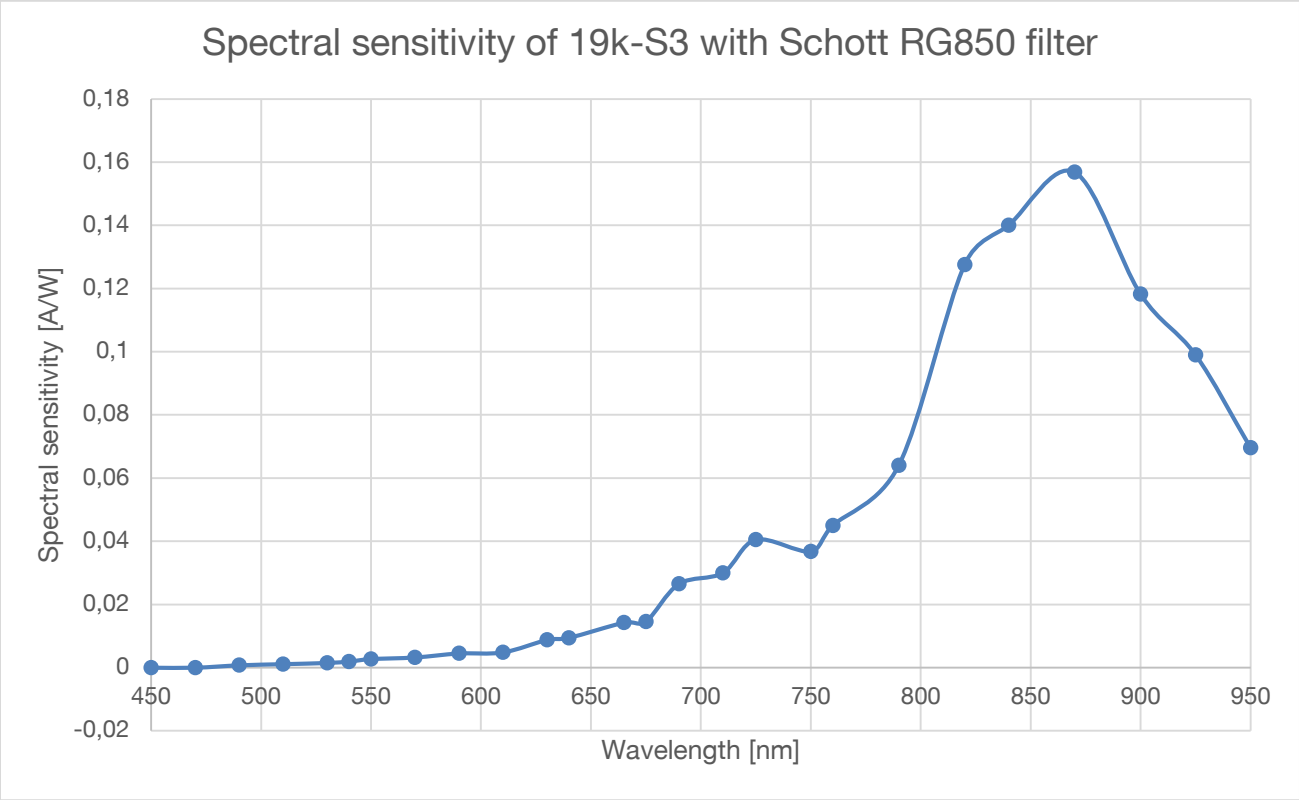


Figure 3-1 Spectral sensitivity of 19k-S3 with Schott RG850 filter

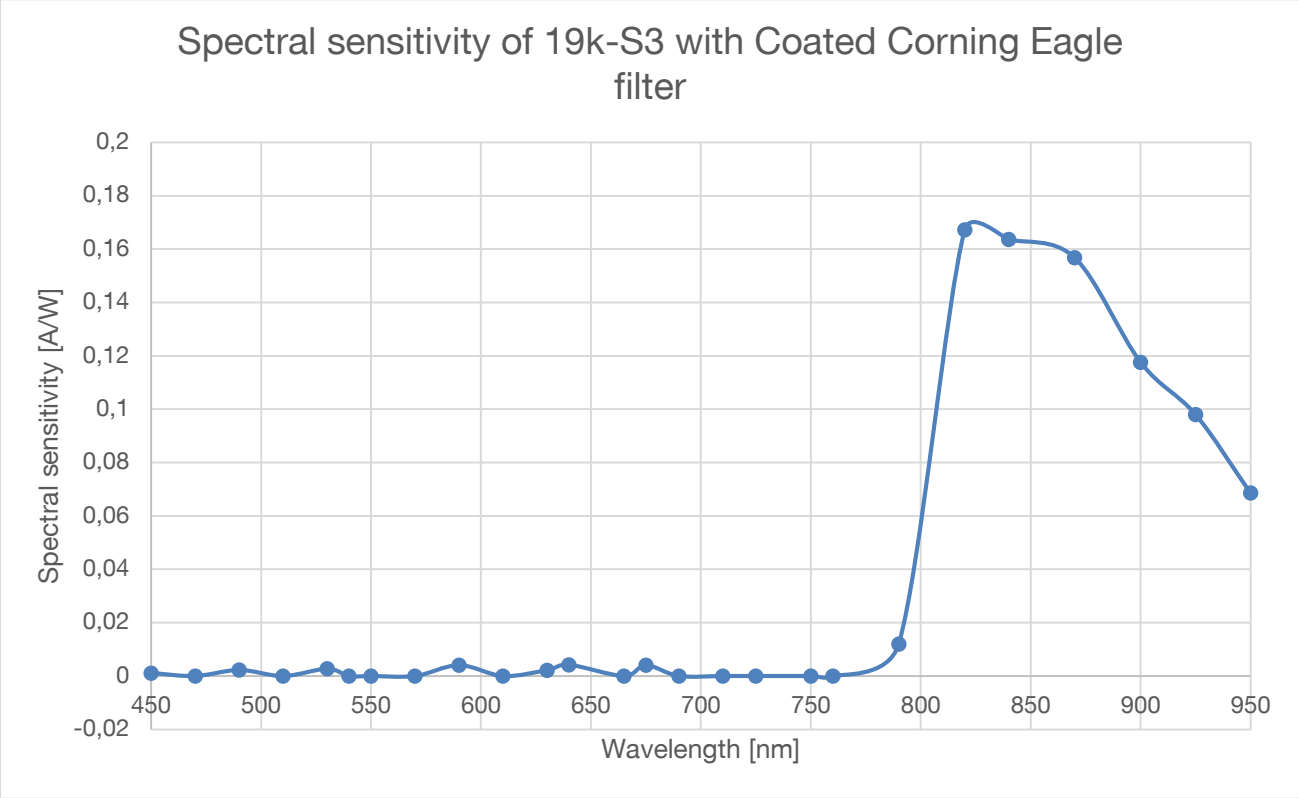


Figure 3-2 Spectral sensitivity of 19k-S3 with Coated Corning Eagle filter

## 3.5 Optical Isolation

To prevent direct irradiation from the Light Module into the camera lens, an optical barrier has to be applied. There is a component-free area on the PCB to support an optical barrier down to the PCB.

**Note:**

If an electrical conductive material (e.g. aluminum) is used for the optical barrier, please keep in mind that an isolation layer must be applied to prevent short-circuits on the TIM!

Take good care to the optical barrier design! Take in consideration, that even multiple reflections within a chassis may cause incorrect measurements. Also the used material is essential for a good barrier. In most cases near infrared light is used for illumination, but some materials that seems “in-transparent” for visible wavelengths are transparent at wavelengths above 800nm.

The following drawings show an example for an optical barrier (dark blue), and the guaranteed component free area on every TIM version (light blue).

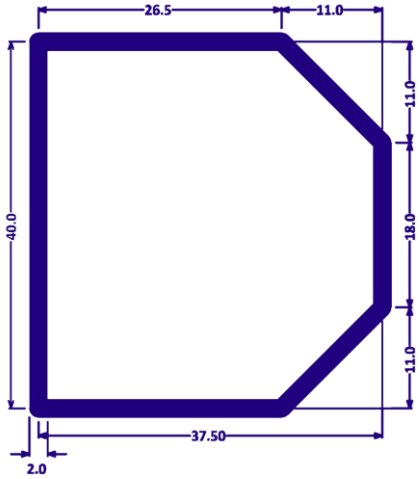


Figure 3-3: Example for an optical barrier

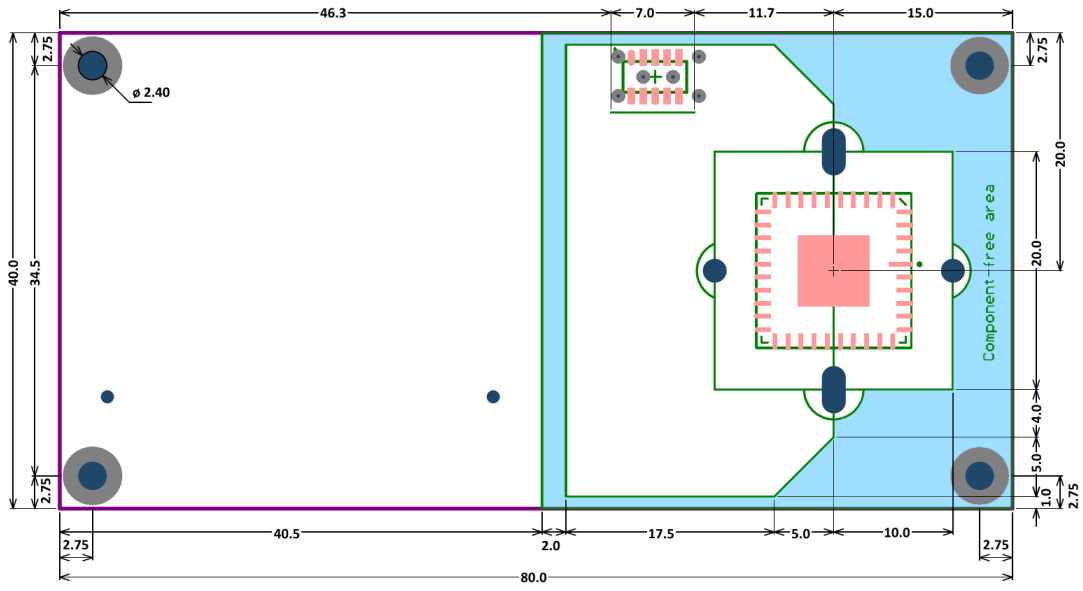


Figure 3-4: Component-free area for the optical barrier

## 3.6 Sensor Orientation

The 3D sensor is mounted in portrait mode as shown in Figure 3-5. For further information about the data format see Software User Manual.

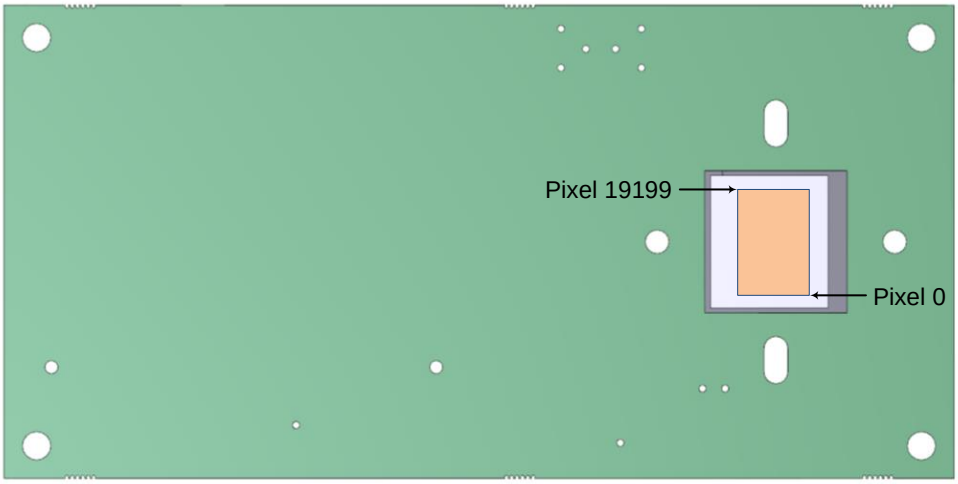


Figure 3-5 Sensor orientation

# 4 Specifications

## 4.1 Electrical Specifications

### 4.1.1 Operating Conditions

| Symbol | Parameter | Min | Typical | Max | Unit |
|---|---|---|---|---|---|
| $V_{IN}$ | Input supply voltage | 4.9 | 5.0 | 5.1 | V |
| $I_{IN}$ | Input current | - | 500 | 650 | mA |
| $V_{OH}$ | High level output voltage | 3.0 | 3.3 | 3.45 | V |
| $V_{OL}$ | Low level output voltage | 0.0 | | 0.4 | V |
| $T_{OP}$ | Operating Temperature | -20 | - | 60 | °C |
| $T_{STG}$ | Storage Temperature | -65 | - | 150 | °C |
| **FITP** | Frame-rate Integration Time Product | - | TBD | - | |

Table 4-1: Electrical characteristics

### 4.1.2 Maximum Ratings

Stressing the device above the rating listed in the absolute maximum ratings table may cause permanent damage to the device. These are stress ratings only. Operation of the device at these or any other conditions greater than those indicated in the operating sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

| Symbol | Parameter | Min | Max | Unit |
|---|---|---|---|---|
| $V_{IO}$ | Input or output voltage | -0.6 | 3.95 | V |
| $V_{IN}$ | Input supply voltage | 4.5 | 5.5 | - |
| $I_{OH}$ /$I_{OL}$ | Current per pin | 0 | 12 | mA |
| $T_{AMB}$ | Ambient temperature | -20 | 60 | °C |
| $T_{STO}$ | Storage temperature | -65 | 150 | °C |
| $\varphi_{AMB}$ | Relative ambient humidity | - | 90 | % |

Table 4-2: Absolute maximum ratings

### 4.1.3 ESD Sensitivity

**ESD (electrostatic discharge) sensitive device**. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

# 5 Connector Description

## 5.1 TIM 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 |
| 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 |
| 18 | I | ISM.TRIGGER | ISM Trigger signal |
| 19 | O | ISM.HSYNC | ISM Frame valid (HSYNC) |
| 20 | O | ISM.VSYNC | ISM Line valid (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 | ISM.nRESET | ISM Reset signal |
| 27 | NC | | |
| 28 | I | ISM.SADDR | ISM Slave address |
| 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 | | |

| Pin # | Type | Signal name | Description |
|---|---|---|---|
| 44 | NC | | |
| 45 | NC | | |
| 46 | I | UART.RX[1)] | UART Receive |
| 47 | O | UART.TX[1)] | UART Transmit |
| 48 | NC | | |
| 49 | NC | | |
| 50 | NC | | |
| 51 | O | LED.SMOD | LIM Single ended mod signal |
| 52 | I/O | LED.IO[1)] | LIM one-wire communication bus |
| 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 | I/O | GPIO.3[1)] | GPIO 3 |
| 58 | I/O | GPIO.2[1)] | GPIO 2 |
| 59 | I/O | GPIO.1[1)] | GPIO 1 |
| 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[2)] | SPI Clock signal |
| 77 | I/O | SPI.SIO0[2)] | SPI Data 0 |
| 78 | I/O | SPI.SIO1[2)] | SPI Data 1 |
| 79 | O | SPI.nCS[2)] | SPI Chip select |
| 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 Data differential pair – negative |
| 90 | I/O | USB.D_P | USB Data differential pair – positive |
| 91 | NC | | |
| 92 | NC | | |

| Pin # | Type | Signal name | Description |
|---|---|---|---|
| **93** | O | I2CM.SCL[1)] | I2C Master Clock signal |
| **94** | O | I2CM.SDA[1)] | I2C Master Data signal |
| **95** | PWR | GND | Power ground |
| **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 5-1 Pin-out of the TIM$^{uP}$ – 19k-S3-Spartan6 connector

[1)] Function is firmware dependent. For further information refer to Software User Manual or contact Bluetechnix support.

[2)] Function is firmware dependent when ISM.nRESET=1. If ISM.nRESET=0 then EXTSPI can be used for firmware updates. See chapter 2.2.4 for further information.

# 6 Application Information

See Application manual.

# 7 Mechanical Outline

## 7.1 Top View

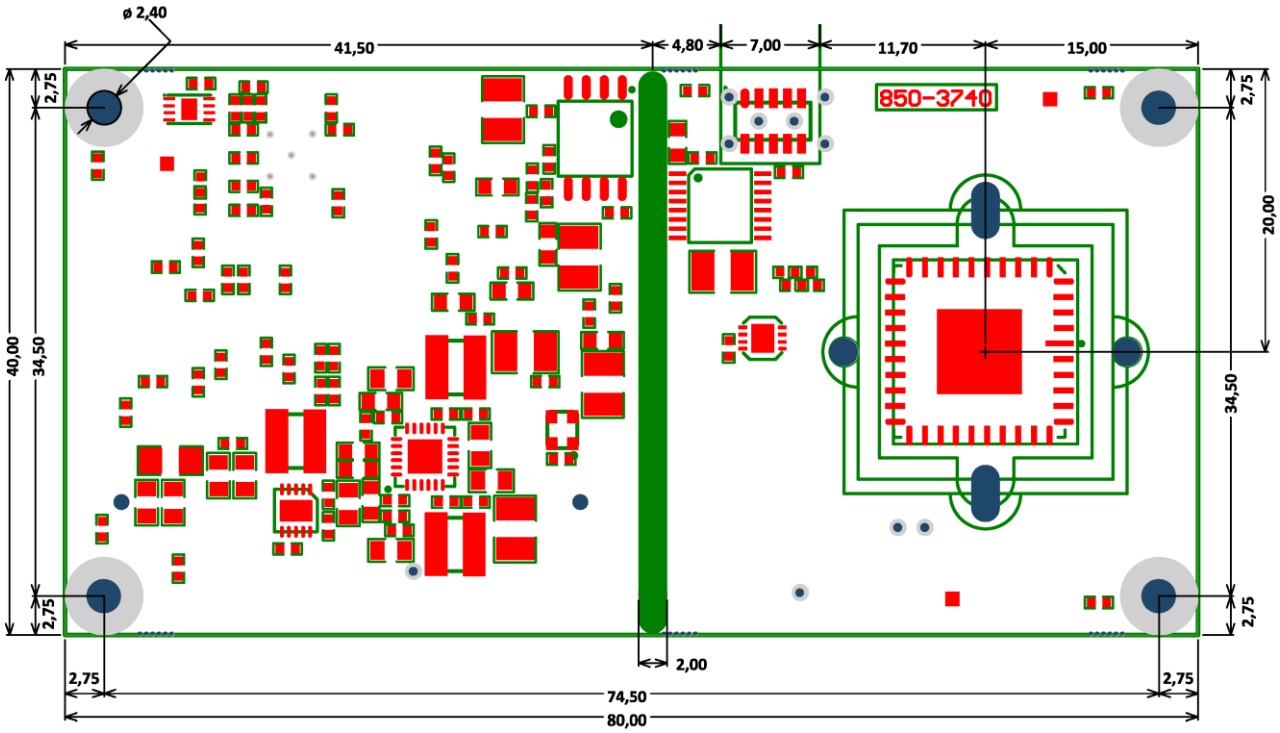


Figure 7-1 Top View of the TIM$^{uP}$ – 19k-S3-Spartan6

## 7.2 Bottom View

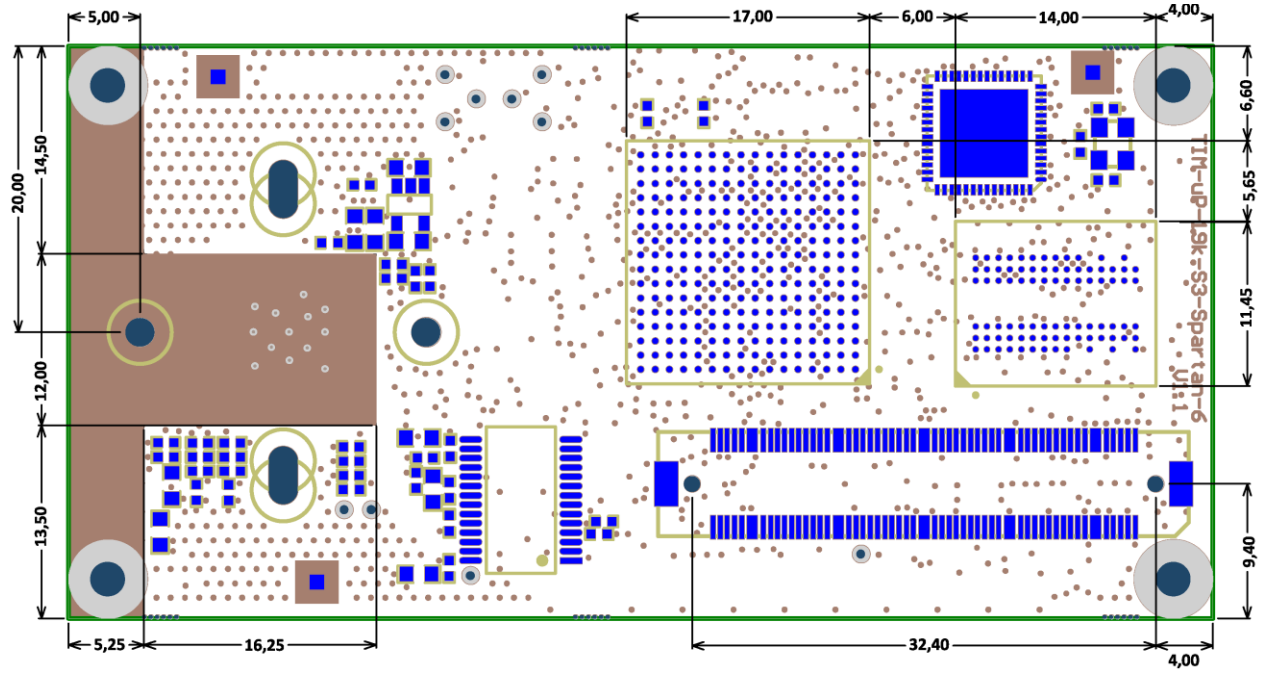


Figure 7-2 Bottom View of the TIM$^{uP}$ – 19k-S3-Spartan6

## 7.3 Side View


Figure 7-3 Side view of the TIM$^{uP}$ – 19k-S3-Spartan6

A 3D-STEP file is available on request.

## 7.4 Footprint

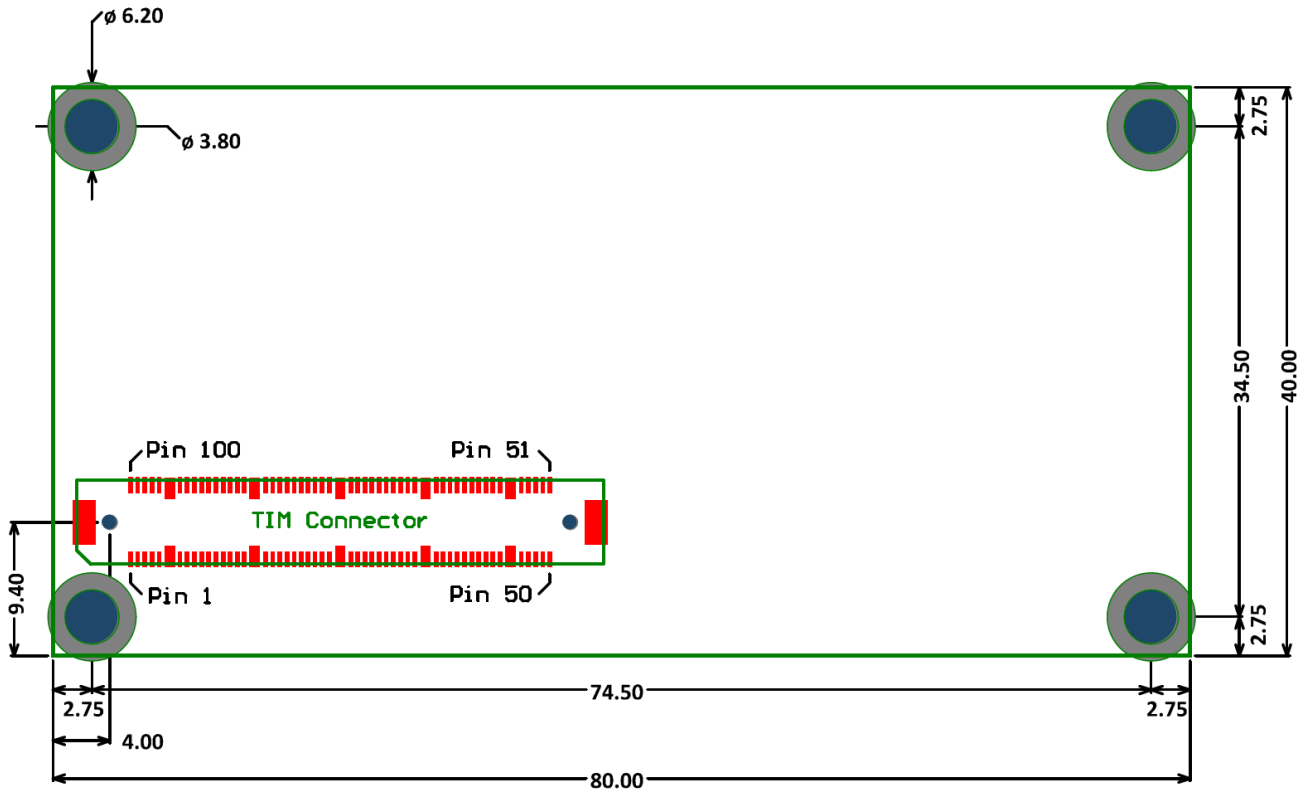


Figure 7-4 Footprint of the TIM$^{uP}$ – 19k-S3-Spartan6

The footprint for Altium Designer is available on request. The used connector is FX-10A-100P/10SV from Hirose. For detailed dimensions of the connectors please see the datasheet from the manufacturer's web site.

The mounting holes are designed for reflow solderable spacers SMTSO-M2-4 from PEM. For further details regarding dimensions and paste expansion please refer the manufacturer's website. If simple holes are desired on the base board, identical ones as on the TIM$^{uP}$ – 19k-S3-Spartan6 are recommended.

## 7.5 Connectors

| Connector | Manufacturer | Manufacturer Part No. |
|---|---|---|
| **Module connector** | Hirose | FX-10A-100S/10SV |
| **Matching connector** | Hirose | FX-10A-100P/10SV |

Table 7-1: Connector types

# 8 Support

## 8.1 General Support

General support for products can be found at Bluetechnix' support site https://support.bluetechnix.at/wiki

## 8.2 Board Support Packages

Board support packages and software downloads are for registered customers only
https://support.bluetechnix.at/software/

### 8.2.1 Upcoming Products and Software Releases

Keep up to date with all product changes, releases and software updates of Bluetechnix at http://support.bluetechnix.com.

# 9 Ordering Information

| Article Number | Name | Temperature Range |
|---|---|---|
| **150-2201-2** | TIM-UP-19k-S3-Spartan-6 | -20 to +60°C |

Table 9-1: Ordering information

**NOTE:** Custom specifications are available on request! Please contact Bluetechnix (office@bluetechnix.com) if you are interested in custom Core Modules.

# 10 Product History

## 10.1 Version Information

### 10.1.1 TIM$^{uP}$ – 19k-S3-Spartan6-M12-ISM-90-160 (TIM$^{uP}$ – 19k-S3-Spartan6)

| Version | Component | Type |
|---|---|---|
| 1.0.0 | Sensor | PMDTech 19k-S3 with RG850 filter |
| | FPGA | Xilinx XC6SLX25-3FTG256I |
| | DDR2 | Micron MT47H64M16HR-3IT |
| 2.0.0 | Sensor | PMDTech 19k-S3 with RG850 filter |
| | FPGA | Xilinx XC6SLX25-3FTG256I |
| | DDR2 | Micron MT47H64M16HR-3IT |

Table 10-1: Overview TIM$^{uP}$ – 19k-S3-Spartan6 product changes

## 10.2 Anomalies

| Version | Date | Description |
|---|---|---|
| V2.0 | 2014 05 27 | The LIM.SMOD signal is tied HIGH by a pull-up resistor when the TIM-Module boots. Use a 560R to 1k pull-down resistor connected to LIM.SMOD to tie the signal LOW. |
| V2.0 | 2014 07 04 | The module will not shutdown when PEN is set to LOW.<br>Use instead a power switch to gate VIN to the module. |

Table 10-2 – Product anomalies

# 11 Document Revision History

| Version | Date | Document Revision |
|---|---|---|
| **1** | 2014 04 29 | First release V2.0 of the document<br>The optical axis of the 3D sensor was moved accordingly to the TIM standard |
| **2** | 2014 05 27 | Anomaly regarding LIM.SMOD added to chapter 10.2. |
| **3** | 2014 06 02 | Electrical specifications updated. |
| **4** | 2014 07 04 | Anomaly regarding PEN function added to chapter 10.2. |
| **5** | 2014 07 08 | Connector pin numbering corrected |
| **6** | 2014 08 22 | Note added to chapter 3.5 |
| **7** | 2015 07 30 | Reference to SUM in USB/ISM chapter added |
| **8** | 2015 10 29 | New chapter: optical isolation |

Table 11-1: Revision history

# A List of Figures and Tables

### Figures



### Tables