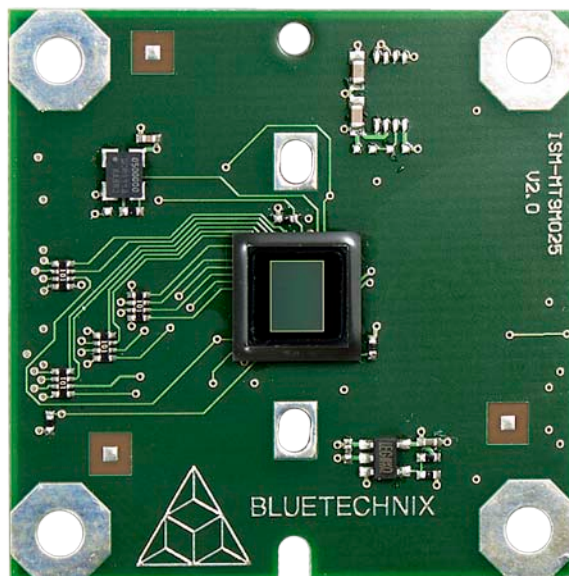
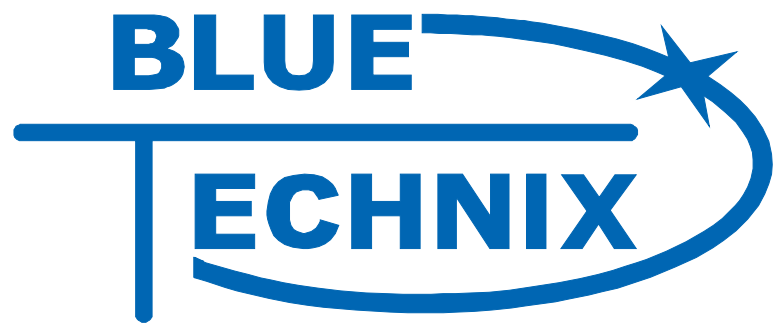




# Hardware User Manual

**ISM-MT9M025 V2.x**

*...maximum performance at minimum space*

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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 Introduction

The ISM-MT9M025 integrates Aptina's MT9M025 image SoC (System-on-a-Chip), oscillator, voltage control and a M12 or CS mount lens-holder to support numerous M12 or CS-mount lenses at a size of 30 x 40mm.

### 1.1 Overview

The MT9M025 CMOS digital image sensor from Aptina has an active-pixel-array of 1280H x 960V (1.2MP). This sensor can capture in either liner or high-dynamic-range (HDR) mode with rolling-shutter readout. The sensor can be programmed via an I<sup>2</sup>C-Interface and offers some sophisticated camera functions such as auto exposure control, windowing and both video and single frame modes. The sensor is able to capture in continuous mode for videos or single frame mode for clear sharp images for both low light and high dynamic range scenes.

The Sensor is available with three different color filter arrays: RGB Bayer, monochrome or RCCC.

### 1.2 Key Features

| Description                  | Value                                                                                                |
|------------------------------|------------------------------------------------------------------------------------------------------|
| <b>OPTICAL FORMAT</b>        | 1/3-inch (5:4)                                                                                       |
| <b>ACTIVE ARRAY</b>          | 1280H x 960V (1.2 MP)                                                                                |
| <b>IMAGING AREA</b>          | 4.6mm(H) x 3.7 mm(V)                                                                                 |
| <b>PIXEL SIZE</b>            | 3.75 x 3.75 µm                                                                                       |
| <b>RESPONSIVITY</b>          | 5.48V/lux-sec (550nm)                                                                                |
| <b>SNR</b>                   | Max 43.9 dB                                                                                          |
| <b>MAX DYNAMIC RANGE</b>     | >115 dB                                                                                              |
| <b>FRAME RATE</b>            | 45fps at 50MHz (SXGA 1280 x 960)<br>60fps at 50MHz (720p)                                            |
| <b>Data Output Format</b>    | Serial on request: HiSPi 12-, 14- or 20-bit<br>Parallel: 12-bit                                      |
| <b>Color Filter Array</b>    | RGB Bayer, monochrome, RCCC                                                                          |
| <b>SHUTTER TYPE</b>          | ERS - Electronic Rolling Shutter                                                                     |
| <b>MASTER CLOCK</b>          | 50MHz                                                                                                |
| <b>SINGLE SUPPLY VOLTAGE</b> | 2.5V to 3.1V                                                                                         |
| <b>POWER CONSUMPTION</b>     | 270mW @ 720p, 60 fps Parallel Output, Linear Mode<br>460mW @ 720p, 60 fps Parallel Output, HiDy Mode |
| <b>OPERATING TEMPERATURE</b> | -40°C to +105°C                                                                                      |
| <b>RoHS COMPLIANT</b>        | Yes                                                                                                  |
| <b>BLT-ISM-CONNECTOR</b>     | Yes                                                                                                  |
| <b>LENS HOLDER</b>           | M12 or CS-mount objective lens holder                                                                |
| <b>CS-MOUNT COMPATIBLE</b>   | Yes                                                                                                  |
| <b>M12-MOUNT COMPATIBLE</b>  | Yes                                                                                                  |
| <b>SIZE</b>                  | 30 x 40mm <sup>2</sup>                                                                               |

Table 1-1: Key features

#### 1.2.1 BLT-ISM-Connector

The Bluetechnix Image-Sensor-Connector "BLT-ISM-Connector" is a Bluetechnix standardized interface with 30 pins, which allows easy connection of the Bluetechnix Image-Sensor-Modules to the development and extender boards from Bluetechnix.

Advantages of the BLT-ISM-Connector:

- One interface for all Image-Sensor-Modules
- Flexible, camera is not fixed on the baseboard
- Single\* or dual power supply

The BLT-ISM-Connector interface description can be read in chapter 4.

\*Depends on user hardware design.

### **1.3 Applications**

- Lane Departure Warning (LDW)
- Traffic Sign Recognition (TSR)
- Stereo Vision
- High Beam Control (HBC)
- Driver Monitoring
- Rear View
- Surround View
- Blind Spot Monitoring
- Machine Vision
- Video Surveillance
- Object Recognition

## 2 General Description

The ISM-MT9M025 image sensor module features Aptina's MT9M025 image SoC. The on-board oscillator and power regulators for core and analog voltages make it easy to use the module for any embedded system hardware.

The module needs a single voltage supply between 2.5V and 3.1V. The sensor IC can be configured by an I<sup>2</sup>C compatible configuration bus, the pixel data is available on a 12-bit parallel interface, or the 12-, 14-, or 20-bit serial SLDS compliant HiSPi interface.

Some handshake lines are connected to the MT9M025 for power saving or capture triggering.

A 50MHz oscillator connected to the master clock of the image sensor, supplies the internal PLL. An external clock input is not needed.

For detailed information about the image sensor please refer to the MT9M025 data sheet and reference manual available on the Aptina website (<http://www.aplina.com>).

To not constrain the developer in the various applications, the module is shipped without lens holder and optics. Bluetechnix though offers a M12 as well as a CS-Mount lens holder and some fitting optics. But also many 3<sup>rd</sup> party suppliers deliver matching accessories.

### 2.1 Functional Description

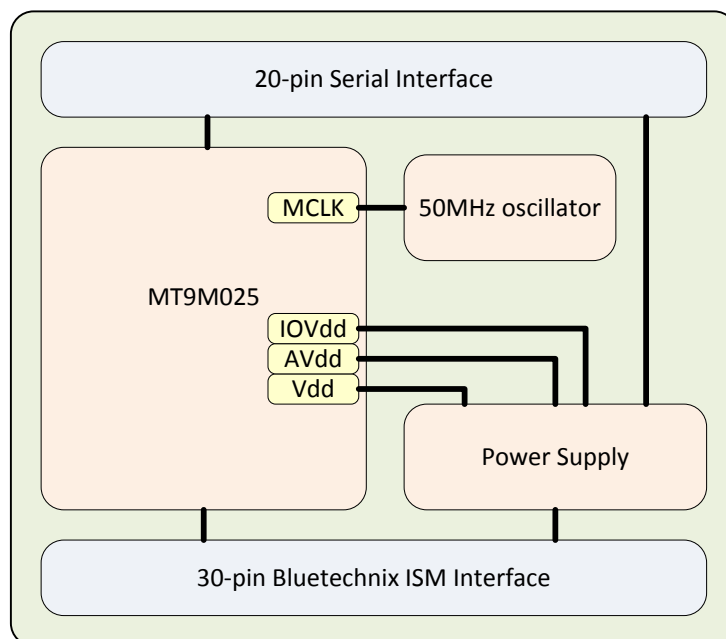


Figure 2-1: ISM-MT9M025 overview

#### 2.1.1 Powering

The ISM-MT9M025 can be powered with only a single supply between 2.5V and 3.1V. If the MCU needs lower I/O voltage levels, a separate I/O voltage supply of min. 1.7V can be applied to the VDDIO pin.

## 2.1.2 Signal Termination

All data and sync signals are serial terminated with 100Ω serial resistors.

## 2.2 Mechanical Outline

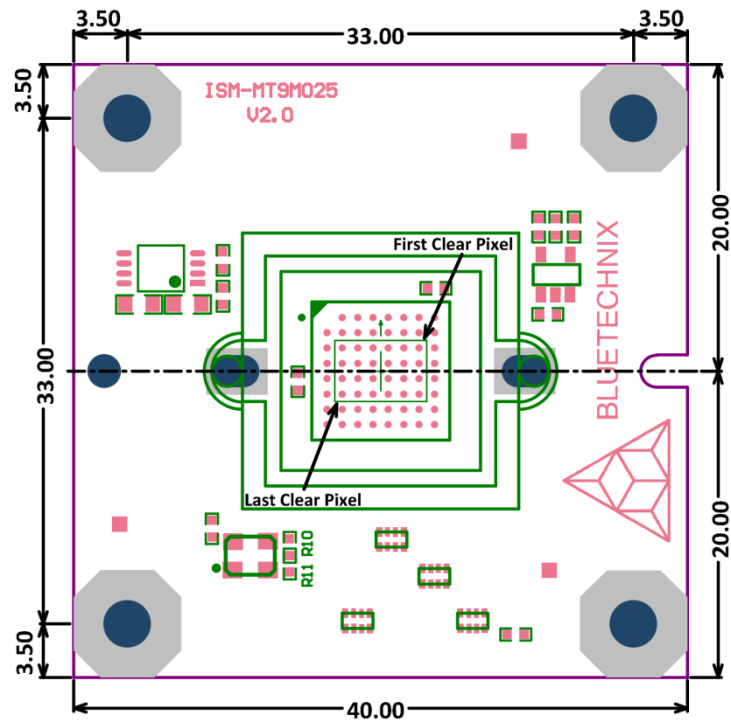


Figure 2-2: Top dimensions (mounting hole position and sensor orientation)

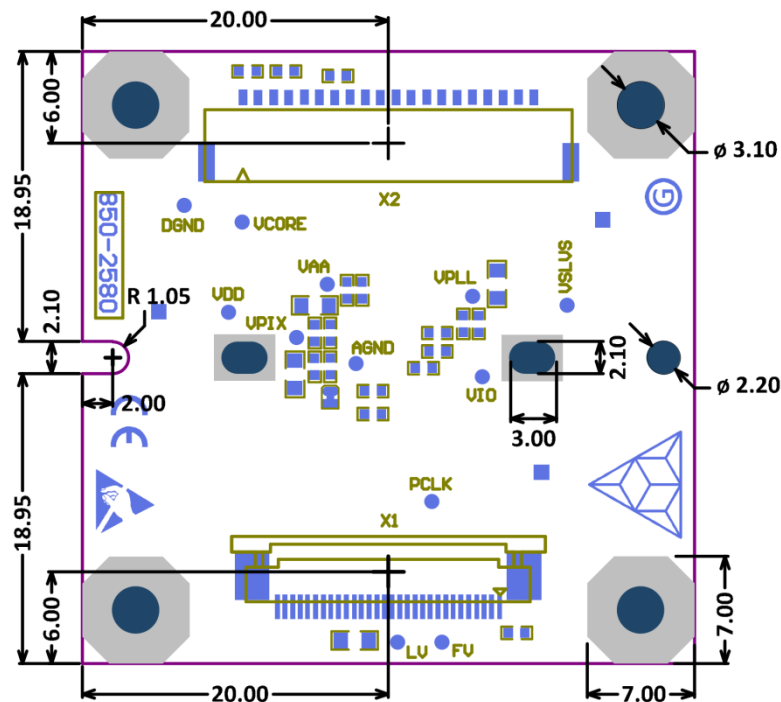


Figure 2-3: Bottom dimensions (mounting holes dimension)

## 3 Specifications

### 3.1 Operating Conditions

| Symbol     | Parameter                                 | Min                   | Typical | Max                   | Unit    |
|------------|-------------------------------------------|-----------------------|---------|-----------------------|---------|
| $V_{DD}$   | Input supply voltage                      | 2.5                   | 2.8     | 3.1                   | V       |
| $V_{DDIO}$ | IO Voltage                                | 1.7                   | 1.8/2.8 | 3.1                   | V       |
| $V_{OH}$   | High level output voltage                 | $V_{DDIO}-0.3$        |         | $V_{DDIO}$            | V       |
| $V_{OL}$   | Low level output voltage                  | 0                     |         | 0.4                   | V       |
| $I_{OH}$   | High level output current                 | -22                   |         | 26.5                  | mA      |
| $I_{OL}$   | Low level output current                  |                       |         | 22                    | mA      |
| $V_{IH}$   | High level input voltage                  | $V_{DDIO} \times 0.7$ |         |                       | V       |
| $V_{IL}$   | Low level input voltage                   |                       |         | $V_{DDIO} \times 0.3$ | V       |
| $I_{IN}$   | Input leakage current                     | 20                    |         |                       | $\mu$ A |
| $P_{Lin}$  | 720p, 60 fps Parallel Output, Linear Mode |                       | 270     |                       | mW      |
| $P_{HDR}$  | 720p, 60 fps Parallel Output, HiDy Mode   |                       | 460     |                       | mW      |
| $f_{MCLK}$ | Master clock frequency                    |                       | 50      |                       | MHz     |

Table 3-1: Electrical characteristics

### 3.2 Operatin Current Consumption

| Resolution | Framerate | Interface | Dynamic | Typ <sup>1)</sup> | Max <sup>1)</sup> | Unit |
|------------|-----------|-----------|---------|-------------------|-------------------|------|
| 1280x960   | 45fps     | Parallel  | Linear  | 145               | 205               | mA   |
| 720p       | 60fps     | Parallel  | Linear  | 145               | 205               | mA   |
| 1280x960   | 45fps     | Parallel  | HiDy    | 217               | 265               | mA   |
| 720p       | 60fps     | Parallel  | HiDy    | 263               | 265               | mA   |
| 1280x960   | 45fps     | HiSPi     | Linear  | 135               | 186               | mA   |
| 720p       | 60fps     | HiSPi     | Linear  | 135               | 186               | mA   |
| 1280x960   | 45fps     | HiSPi     | HiDy    | 210               | 256               | mA   |
| 720p       | 60fps     | HiSPi     | HiDy    | 210               | 256               | mA   |

Table 3-2: Operating Currents for Video Streaming

<sup>1)</sup> Measured with single supply:  $V_{DD} = V_{DDIO} = 2.8V$ .

### 3.3 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 |
|--------------|---------------------------|------|------------------|------|
| $V_{DD}$     | Supply voltage            | -0.3 | 4.5              | V    |
| $V_{IO}$     | Input or output voltage   | -0.3 | $V_{DDIO} + 0.3$ | V    |
| $I_{MAX}$    | Total Current             | 0    | 265              | mA   |
| $T_{OP}$     | Operating temperature     | -40  | 85               | °C   |
| $T_{STO}$    | Storage temperature       | -40  | 150              | °C   |
| $\phi_{AMB}$ | Relative ambient humidity |      | 90               | %    |

Table 3-3: Absolute maximum ratings

### 3.3.1 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.

## 4 Connector Description

### 4.1 BLT-ISM-Connector

The image sensor connector is a standard 0.5mm bottom contact ZIF connector and mates with any 30 pole 0.5mm pitch and 0.4mm thick flat flex cable. To prevent EMI problems we recommend keeping the cable as short as possible.

| Pin | Name                | Type | Description                                                |
|-----|---------------------|------|------------------------------------------------------------|
| 1   | Vdd                 | PWR  | Voltage Supply                                             |
| 2   | GND                 | PWR  | Power Ground                                               |
| 3   | SADDR <sup>1)</sup> | IpU  | Serial Address (internally pulled up with 10kΩ)            |
| 4   | NC (MCLK)           | -    | Not connected (Camera Master Clock) <sup>2)</sup>          |
| 5   | nRESET              | I    | Reset (Active Low)                                         |
| 6   | SCL                 | I    | Configuration Bus Clock Line (external pull-up needed)     |
| 7   | SDA                 | I/O  | Configuration Bus Data Line (external pull-up needed)      |
| 8   | NC                  | -    | Not connected                                              |
| 9   | GND                 | PWR  | Power Ground                                               |
| 10  | PCLK                | O    | Pixel Clock                                                |
| 11  | FV                  | O    | Line valid (VSYNC)                                         |
| 12  | LV                  | O    | Frame valid (HSYNC)                                        |
| 13  | TRIGGER             | I    | Trigger Signal                                             |
| 14  | STROBE              | O    | Strobe Signal                                              |
| 15  | NC                  | -    | Not connected                                              |
| 16  | NC                  | -    | Not connected                                              |
| 17  | D0                  | O    | Pixel Data (LSB)                                           |
| 18  | D1                  | O    | Pixel Data                                                 |
| 19  | VddIO               | PWR  | I/O Voltage Supply                                         |
| 20  | GND                 | PWR  | Power Ground                                               |
| 21  | D2                  | O    | Pixel Data                                                 |
| 22  | D3                  | O    | Pixel Data                                                 |
| 23  | D4                  | O    | Pixel Data                                                 |
| 24  | D5                  | O    | Pixel Data                                                 |
| 25  | GND                 | PWR  | Power Ground                                               |
| 26  | D6                  | O    | Pixel Data                                                 |
| 27  | D7                  | O    | Pixel Data                                                 |
| 28  | D8                  | O    | Pixel Data                                                 |
| 29  | D9                  | O    | Pixel Data (MSB)                                           |
| 30  | nOE                 | IpU  | Output Enable (Active Low; internally pulled up with 10kΩ) |

Table 4-1: BLT-ISM-Connector interface description (X1)

- <sup>1)</sup> The address of the sensors serial interface is 0x20 for write, and 0x21 for read access. The address the addresses may be changed to 0x30 and 0x31 by connecting the SADDR pin to ground.
- <sup>2)</sup> The Master Clock is generated by the on board oscillator. If a different clock frequency is needed, there is a possibility to apply an external clock signal to a modified Module. For modification details please contact Bluetechnix.

## 4.2 ISM- HiSpi-Connector

The HiSpi Interface is available on a 20 pin Hirose DF19 connector.

Note that this connector is not mounted in default configuration. If you need to use the HiSpi Interface, please contact Bluetechnix for specially prepared modules.

| Pin | Name    | Type | Description                                            |
|-----|---------|------|--------------------------------------------------------|
| 1   | GND     | PWR  | Power Ground                                           |
| 2   | VddIO   | PWR  | I/O Voltage Supply                                     |
| 3   | Vdd     | PWR  | Voltage Supply                                         |
| 4   | GND     | PWR  | Power Ground                                           |
| 5   | nRESET  | I    | Reset (Active Low)                                     |
| 6   | STROBE  | O    | Strobe Signal                                          |
| 7   | TRIGGER | I    | Trigger Signal                                         |
| 8   | SDA     | I/O  | Configuration Bus Data Line (external pull-up needed)  |
| 9   | SCL     | I    | Configuration Bus Clock Line (external pull-up needed) |
| 10  | SLVS3+  | O    | HiSpi serial data lane 3, differential positive        |
| 11  | SLVS3-  | O    | HiSpi serial data lane 3, differential negative        |
| 12  | SLVS2+  | O    | HiSpi serial data lane 2, differential positive        |
| 13  | SLVS2-  | O    | HiSpi serial data lane 2, differential negative        |
| 14  | SLVS1+  | O    | HiSpi serial data lane 1, differential positive        |
| 15  | SLVS1-  | O    | HiSpi serial data lane 1, differential negative        |
| 16  | SLVS0+  | O    | HiSpi serial data lane 0, differential positive        |
| 17  | SLVS0-  | O    | HiSpi serial data lane 0, differential negative        |
| 18  | SLVSC+  | O    | HiSpi serial clock lane, differential positive         |
| 19  | SLVSC-  | O    | HiSpi serial clock lane, differential negative         |

Table 4-2: BLT-ISM-Connector interface description (X1)

## 5 Support

### 5.1 General Support

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

### 5.2 Board Support Packages

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

### 5.3 Blackfin® Software Support

#### 5.3.1 BLACKSheep® OS

BLACKSheep® OS stands for a powerfully and multithreaded real-time operating system (RTOS) originally designed for digital signal processing application development on Analog Devices Blackfin® embedded processors. This high-performance OS is based on the reliable and stable real-time VDK kernel from Analog Devices that comes with VDSP++ IDE. Of course BLACKSheep® OS is fully supported by all Bluetechnix Core-Modules and development hardware.

#### 5.3.2 LabVIEW

You can get LabVIEW embedded support for Bluetechnix Core Modules by Schmid-Engineering AG <http://www.schmid-engineering.ch>.

#### 5.3.3 uClinux

You can get uClinux support (boot loader and uClinux) for Bluetechnix Core Modules at <http://blackfin.uClinux.org>.

### 5.4 i.MX Software Support

#### 5.4.1 Linux

Linux BSP and images of derivatives can be found at Bluetechnix' support site <https://support.bluetechnix.at/wiki> at the software section of the related product.

### 5.5 Blackfin® and i.MX Design Services

Based on more than seven years of experience with Blackfin and i.MX, Bluetechnix offers development assistance as well as custom design services and software development.

#### 5.5.1 Upcoming Products and Software Releases

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

## 6 Ordering Information

### 6.1 Image Sensor Module

| Article Number    | Name              | Description                                              |
|-------------------|-------------------|----------------------------------------------------------|
| <b>100-3206-2</b> | ISM-MT9M025-Color | Image Sensor Module based on Aptina's MT9M025C image SoC |
| <b>100-3200-2</b> | ISM-MT9M025-Mono  | Image Sensor Module based on Aptina's MT9M025M image SoC |
| <b>100-3208-2</b> | ISM-MT9M025-RCCC  | Image Sensor Module based on Aptina's MT9M025R image SoC |

Table 6-1: Ordering information ISM

Note that the ISM-MT9M025 is shipped without lens holder and optics. For available accessories see the tables below and take a look on our website for new products.

### 6.2 Related Products

| Article Number    | Name                | Description                                      |
|-------------------|---------------------|--------------------------------------------------|
| <b>100-2342-2</b> | eDEV-BF5xx          | Extended Blackfin Core Modules Development Board |
| <b>100-2524-1</b> | EXT-SBC-i.MX51-COMM | Communication Extension Board for the SBC-i.MX51 |
| <b>100-2523-1</b> | EXT-SBC-i.MX51-DISP | Display Extension Board for the SBC-i.MX51       |
| <b>100-1420</b>   | DEV-i.MX53 Dev. Kit | Development Kit for the CM-i.MX53                |

Table 6-2: Ordering information of related products

### 6.3 Lens Holders and Cables

| Article Number  | Name                             | Description              |
|-----------------|----------------------------------|--------------------------|
| <b>100-9043</b> | Lens holder M12 x 0,5 18mm       | M12 Lens holder for ISM. |
| <b>100-9103</b> | ZIF cable 30 pins, 50mm for ISM  | 50mm ZIF cable for ISM.  |
| <b>100-9104</b> | ZIF cable 30 pins, 150mm for ISM | 150mm ZIF cable for ISM. |

Table 6-3: Ordering information accessories

CS-Mount equipment can be bought from [www.vd-shop.de](http://www.vd-shop.de)

| Article Number | Name                            | Shop                                               |
|----------------|---------------------------------|----------------------------------------------------|
| <b>301461</b>  | Lense-Holder CS-Mount Boardlens | <a href="http://www.vd-shop.de">www.vd-shop.de</a> |
| <b>10208</b>   | C-CS-Mount-Adapter              | <a href="http://www.vd-shop.de">www.vd-shop.de</a> |

Table 6-4 - CS/C Mount equipment

**NOTE:** Custom hard and software developments are available on request! Please contact Bluetechnix ([office@bluetechnix.com](mailto:office@bluetechnix.com)) if you are interested in custom hard- and software developments.

## **7 Dependability**

### **7.1 MTBF**

Please keep in mind that a part stress analysis would be the only way to obtain significant failure rate results, because MTBF numbers just represent a statistical approximation of how long a set of devices should last before failure. Nevertheless, we can calculate an MTBF of the development board using the bill of material. We take all the components into account. The PCB and solder connections are excluded from this estimation. For test conditions we assume an ambient temperature of 30°C of all development board components. We use the MTBF Calculator from ALD (<http://www.aldservice.com/>) and use the reliability prediction MIL-217F2 Part Stress standard. Please get in touch with Bluetechnix ([office@bluetechnix.com](mailto:office@bluetechnix.com)) if you are interested in the MTBF result.

## 8 Product History

### 8.1 Version Information

| Version | Date       | Changes                                                                                                                                                             |
|---------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2.0     | 2012-01-03 | New 40x40mm <sup>2</sup> ISM design applied.<br>Serial master clock termination changed to 27R (previously 100R).<br>New 50MHz oscillator for full IO supply range. |
| 1.1     | 2011-07-05 | Power Supply added on Module.<br>50MHz Oscillator added on Module.                                                                                                  |
| 1.0     | 2011-05-24 | First release V1.0 of the Hardware.                                                                                                                                 |

Table 8-1: Overview product changes

### 8.2 Anomalies

| Version | Date       | Description                                                                        |
|---------|------------|------------------------------------------------------------------------------------|
| 2.0     | 2012-01-03 | No anomalies reported yet.                                                         |
| 1.1     | 2011-07-05 | Master Clock not compatible with full VDD-IO range (1.8V IO supply not available). |
| 1.0     | 2011 05 24 | No anomalies reported yet.                                                         |

Table 8-2: Overview product anomalies

## 9 Document Revision History

| Version | Date       | Document Revision                            |
|---------|------------|----------------------------------------------|
| 2       | 2012 01 03 | Changes for HW-Revision V2.0. Updated photo. |
| 1       | 2011 07 11 | First release V1.0 of the Document           |

Table 9-1: Revision history

## 10 List of Abbreviations

| Abbreviation          | Description                                       |
|-----------------------|---------------------------------------------------|
| <b>ABR</b>            | Auto Black Reference                              |
| <b>AWB</b>            | Auto White Balance                                |
| <b>CM</b>             | Core Module                                       |
| <b>ERS</b>            | Electronic Rolling Shutter                        |
| <b>ESD</b>            | Electrostatic Discharge                           |
| <b>FPS</b>            | Frames per Second                                 |
| <b>HDR</b>            | High Dynamic Range                                |
| <b>HiDy</b>           | High Dynamic                                      |
| <b>HiSPi</b>          | High-Speed Serial Pixel Interface                 |
| <b>I</b>              | Input                                             |
| <b>IpU</b>            | Input with internal pull-up resistor              |
| <b>I<sup>2</sup>C</b> | Inter-Integrated Circuit                          |
| <b>I/O</b>            | Input/Output                                      |
| <b>ISM</b>            | Image Sensor Module                               |
| <b>LVDS</b>           | Low Voltage Differential Signaling                |
| <b>MTBF</b>           | Mean Time Between Failure                         |
| <b>NC</b>             | Not Connected                                     |
| <b>O</b>              | Output                                            |
| <b>PLL</b>            | Phase-locked Loop                                 |
| <b>PWR</b>            | Power                                             |
| <b>QSXGA</b>          | Quarter Super Extended Graphics Array (640 x 512) |
| <b>QVGA</b>           | Quarter Video Graphics Array (320 x 240)          |
| <b>RTOS</b>           | Real-Time Operating System                        |
| <b>SLVS</b>           | Scalable Low-Voltage Signaling                    |
| <b>SoC</b>            | System on Chip                                    |
| <b>SXGA</b>           | Super Extended Graphics Array (1280 x 960)        |
| <b>TISM</b>           | Tiny Image Sensor Module                          |
| <b>ZIF</b>            | Zero Insertion Force                              |

Table 10-1: List of abbreviations

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