

# Hardware User Manual

**ISM-MT9P031 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-MT9P031 integrates Aptina's MT9P031 image sensor, 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 MT9P031 CMOS digital image sensor from Aptina has an active-pixel-array of 2592H x 1944V (5MP). It offers a global reset which triggers the exposure of all rows simultaneously, has superior low-light performance, an automatic black level calibration and an on-chip phased-locked-loop (PLL). The sensor supports Aptina DigitalClarity® imaging technology and very high frame rates. The sensor can be programmed via a simple Two-Wire-Interface (TWI) and offers some sophisticated camera functions such as

- Bulb exposure mode, for arbitrary exposure times,
- Column and row binning modes to improve image quality when resizing,
- Column and row skip modes to reduce image size without reducing field-of-view (FOV),
- Snapshot mode to take frames on demand and
- Horizontal and vertical mirror image.

### 1.2 Key Features

| Description                  | Value  |
|------------------------------|--|
| <b>OPTICAL FORMAT</b>        | 1/2.5-inch (4:3)   |
| <b>ACTIVE ARRAY</b>          | 2592H x 1944V (5MP)  |
| <b>IMAGING AREA</b>          | 5.70mm(H) x 4.28mm(V)  |
| <b>PIXEL SIZE</b>            | 2.2µm x 2.2µm  |
| <b>RESPONSIVITY</b>          | 1.4 V/lux-sec (550nm)  |
| <b>SNR</b>                   | 38.1dB (full resolution)<br>44dB (2 x 2 binning)   |
| <b>MAX DYNAMIC RANGE</b>     | 70.1dB (full resolution)<br>76dB (2 x 2 binning)   |
| <b>FRAME RATE</b>            | 14 fps (2592 x 1944)<br>53fps (VGA with binning 640 x 480)<br>60fps (720p skipping mode) |
| <b>Data Output Format</b>    | 12-bit parallel  |
| <b>CHROMA</b>                | RGB Bayer pattern  |
| <b>SHUTTER TYPE</b>          | ERS - Electronic Rolling Shutter<br>GRR - Global reset release<br>Snapshot only          |
| <b>MASTER CLOCK</b>          | 50 MHz   |
| <b>SINGLE SUPPLY VOLTAGE</b> | 2.5V to 3.1 V  |
| <b>POWER CONSUMPTION</b>     | 381mW at 14 fps full resolution  |
| <b>OPERATING TEMPERATURE</b> | -30°C to +70°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 power supply (with different IO voltage support)

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

## 1.3 Applications

- High-resolution network cameras
- Wide field of view cameras
- High-definition surveillance cameras
- Dome cameras with electronic pan, tilt, and zoom
- Hybrid video cameras with high resolution stills
- Detailed feature extraction for smart cameras
- Small office monitoring
- Home monitoring

## 2 General Description

The ISM-MT9P031 image sensor module features Aptina's MT9P031 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, some handshake lines are connected to the MT9P031 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 MT9P031 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

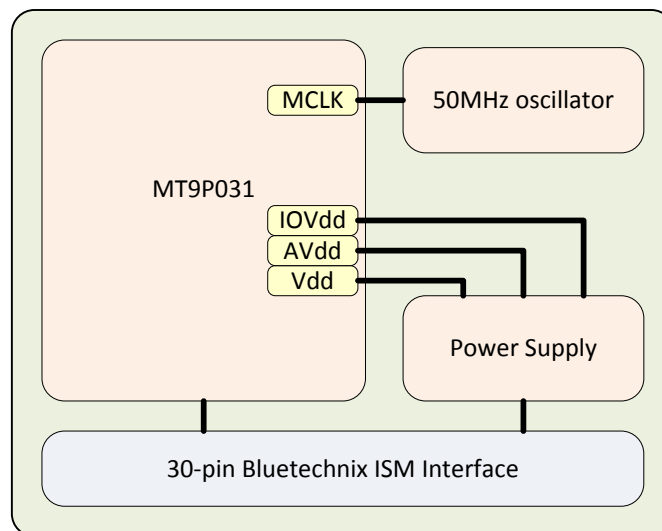


Figure 2-1: ISM-MT9P031 overview

#### 2.1.1 Powering

The ISM-MT9P031 can be powered with only a single supply between 2.6V 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 by 100Ω.



### 3 Specifications

#### 3.1 Operating Conditions

| Symbol      | Parameter   | Min  | Typical | Max      | Unit    |
|-------------|---|------|---------|----------|---------|
| $V_{DD}$    | Input supply voltage                                      | 2.6  | 2.8     | 3.1      | V       |
| $V_{DDIO}$  | IO Voltage  | 1.7  | 1.8/2.8 | 3.1      | V       |
| $V_{OH28}$  | High level output voltage ( $V_{DDIO} = 2.8V$ )           | 1.9  |         | $V_{DD}$ | V       |
| $V_{OL28}$  | Low level output voltage ( $V_{DDIO} = 2.8V$ )            | 0    |         | 0.6      | V       |
| $V_{OH18}$  | High level output voltage ( $V_{DDIO} = 1.8V$ )           | 1.3  |         | 1.82     | V       |
| $V_{OL18}$  | Low level output voltage ( $V_{DDIO} = 1.8V$ )            | 0.16 |         | 0.35     | V       |
| $I_{OH}$    | High level output current                                 |      |         | 22.3     | mA      |
| $I_{OL}$    | Low level output current                                  |      |         | 5.1      | mA      |
| $V_{IH28}$  | High level input voltage ( $V_{DDIO} = 2.8V$ )            | 2.0  |         | 3.3      | V       |
| $V_{IL28}$  | Low level input voltage ( $V_{DDIO} = 2.8V$ )             | -0.3 |         | 0.8      | V       |
| $V_{IH18}$  | High level input voltage ( $V_{DDIO} = 1.8V$ )            | 1.3  |         | 2.3      | V       |
| $V_{IL18}$  | Low level input voltage ( $V_{DDIO} = 1.8V$ )             | -0.3 |         | 0.5      | V       |
| $I_{INLK}$  | Input leakage current                                     |      | <10     |          | $\mu A$ |
| $P_{FULL}$  | Power consumption at 15fps streaming with full resolution |      | 381     |          | mW      |
| $P_{4xBIN}$ | Power consumption at 15pfs streaming with 4x Binning      |      | 363     |          | mW      |
| $f_{MCLK}$  | Master clock frequency                                    |      | 50      |          | MHz     |

Table 3-1: Electrical characteristics

#### 3.2 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        |
|--------------|---------------------------|------|-----|-------------|
| $V_{DD}$     | Supply voltage            | -0.3 | 3.1 | V           |
| $V_{IO}$     | I/O voltage supply        | -0.3 | 3.1 | V           |
| $V_{IN}$     | voltage level on I/O pin  | -0.3 | 3.4 | V           |
| $I_{MAX}$    | Total Current             | 0    | 242 | mA          |
| $T_{OP}$     | Operating temperature     | -30  | 70  | $^{\circ}C$ |
| $T_{STO}$    | Storage temperature       | -40  | 125 | $^{\circ}C$ |
| $\Phi_{AMB}$ | Relative ambient humidity |      | 90  | %           |

Table 3-2: Absolute maximum ratings

##### 3.2.1 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 Selection (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  | D0                  | O    | Pixel Data   |
| 16  | D1                  | O    | Pixel Data   |
| 17  | D2                  | O    | Pixel Data   |
| 18  | D3                  | O    | Pixel Data   |
| 19  | VddIO               | PWR  | I/O Voltage Supply   |
| 20  | GND                 | PWR  | Power Ground   |
| 21  | D4                  | O    | Pixel Data   |
| 22  | D5                  | O    | Pixel Data   |
| 23  | D6                  | O    | Pixel Data   |
| 24  | D7                  | O    | Pixel Data   |
| 25  | GND                 | PWR  | Power Ground   |
| 26  | D8                  | O    | Pixel Data   |
| 27  | D9                  | O    | Pixel Data   |
| 28  | D10                 | O    | Pixel Data   |
| 29  | D11                 | O    | Pixel Data   |
| 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 0xBA for write, and 0xBB for read access. The address the addresses may be changed to 0x90 and 0x91 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.

## 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>100-3204-2</b> | ISM-MT9P031 -Color | Image Sensor Module based on Aptina's MT9P031 imager. |
| <b>100-3210-2</b> | ISM-MT9P031 -Mono  | Image Sensor Module based on Aptina's MT9P031 imager. |

Table 6-1: Ordering information ISM

Note that the ISM-MT9P031 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 Optics

| 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     | 2011 11 30 | New Mechanical Outlines (40x40mm <sup>2</sup> ). |
| 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     | 2011 11 30 | No anomalies reported yet. |
| 1.0     | 2011 07 11 | No anomalies reported yet. |

Table 8-2: Overview product anomalies

## 9 Document Revision History

| Version | Date       | Document Revision                    |
|---------|------------|--------------------------------------|
| 2       | 2011 11 30 | Update for new hardware release V2.0 |
| 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>GRR</b>            | Global reset release                              |
| <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>LSB</b>            | Least Significant Bit                             |
| <b>MSB</b>            | Most Significant Bit                              |
| <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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