

# MLX90632 FIR sensor

Datasheet

## Features and Benefits

- Small size of 3x3mm
- Easy to integrate
- Factory calibrated
- External ambient and object temperature calculation
- Standard measurement resolution 0.02°C
- Medical measurement resolution 0.01°C
- Supply voltage of 3.3V, supply current 1mA (sleep current less than 2.5uA)
- I<sup>2</sup>C compatible digital interface
- Software definable I<sup>2</sup>C address with 1 LSB bit external address pin
- Field of View of 50°
- Default refresh rate 0.5s, configurable between 16ms and 2s
- Integrated post-calibration option

## Application Examples

- High precision non-contact temperature measurements
- Body temperature measurement
- Non-contact thermometer for mobile and IoT application
- Temperature sensing element for residential, commercial and industrial building air conditioning
- Industrial temperature control of moving parts
- Home appliances with temperature control
- Healthcare
- Livestock monitoring
- <https://github.com/melexis/mlx90632-library>



Figure 1: Image of MLX90632

# MLX90632 FIR sensor

## Datasheet

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### Description

The MLX90632 is a non-contact infrared temperature sensor in a small SMD SFN package. The device is factory calibrated with calibration constants stored in the EEPROM memory. The ambient and object temperature can be calculated externally based on these calibration constants and the measurement data.

A major strength of the MLX90632 is that these temperature differences around the sensor package will be reduced to a minimum. However, some extreme cases will influence the sensor.

The accuracy of the thermometer can be influenced by temperature differences in the package induced by causes like (among others): hot electronics behind the sensor, heaters/coolers behind or beside the sensor or by a hot/cold object very close to the sensor that not only heats the sensing element in the thermometer but also the thermometer package.

In the same way, localized thermal variations -like turbulence in the air- will not generate thermal noise in the output signal of the thermopile.

The MLX90632 is available in two different versions: standard and medical accuracy.

Both versions are calibrated in the ambient temperature range from -20 to 85°C.

The difference between both versions is visible in accuracy and the object temperature range.

The medical version is factory calibrated with an accuracy of  $\pm 0.2^\circ\text{C}$  within the narrow object temperature range from 35 to 42°C for medical applications. This version also allows Extended range operation. This measurement type option is implemented in order to give additional range to the medical devices. The object temperature range is limited from -20 to 100°C. For more information see Section 11.2.

On the other hand, the standard version covers an object temperature range from -20 to 200°C but offers an accuracy of  $\pm 1^\circ\text{C}$ .

It is very important for the application designer to understand that these accuracies are guaranteed and achievable when the sensor is in thermal equilibrium and under isothermal conditions (no temperature differences across the sensor package).

The typical supply voltage of the MLX90632 is 3.3V. For the I<sup>2</sup>C communication with the master microcontroller, two versions of the sensor are available, working either at 3.3V or 1.8V I<sup>2</sup>C reference voltage.

The communication to the chip is done by I<sup>2</sup>C in fast mode plus (FM+).

Through I<sup>2</sup>C the external microcontroller has access to the following blocks:

- RAM memory used for measurement data, in this document mainly referred to as 'storage memory'
- EEPROM used to store the trimming values, calibration constants and device/measurement settings

Based on this data, the external microcontroller can calculate the object temperature and if needed the sensor temperature.

An optical filter (long-wave pass) that cuts off the visible and near infra-red radiant flux is integrated in the sensor to provide ambient light immunity. The wavelength pass band of this optical filter is from 2 till 14µm.

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# 1. Ordering Information

| Product  | Temperature Code | Package | Option Code | Packing Form |
|----------|------------------|---------|-------------|--------------|
| MLX90632 | S                | LD      | BCB-000     | RE           |
| MLX90632 | S                | LD      | DCB-000     | RE           |
| MLX90632 | S                | LD      | DCB-100     | RE           |

Table 1 : Ordering codes for MLX90632

## Legend:

|                   |   |
|-------------------|---|
| Temperature Code: | S: from -20°C to 85°C sensor temperature  |
| Package Code:     | “LD” for SFN 3x3 package  |
| Option Code:      | <p>XYZ-123</p> <p>X: Accuracy</p> <ul style="list-style-type: none"> <li>▪ B: Standard accuracy</li> <li>▪ D: Medical accuracy</li> </ul> <p>Y: Pixel type</p> <ul style="list-style-type: none"> <li>▪ C: High stability version</li> </ul> <p>Z: Field Of View</p> <ul style="list-style-type: none"> <li>▪ B: 50 degrees</li> </ul> <p>1: I<sup>2</sup>C level</p> <ul style="list-style-type: none"> <li>▪ 0: 3V3</li> <li>▪ 1: 1V8</li> </ul> <p>2-3:</p> <ul style="list-style-type: none"> <li>▪ 00: Standard configuration</li> <li>▪ xx: Reserved</li> </ul> |
| Packing Form:     | “RE” for Reel   |
| Ordering Example: | <p>“MLX90632SLD-DCB-000-RE”</p> <p>For a FIR Sensor type in SFN 3x3 package with medical accuracy, Field Of View of 50 degrees and 3V3 I<sup>2</sup>C level, delivered in Reel.</p>   |

Table 2: Coding legend

## 2. Glossary of Terms

|                  |   |
|------------------|---|
| POR              | <b>Power On Reset</b>   |
| IR               | <b>InfraRed</b>   |
| I <sup>2</sup> C | <b>Inter-Integrated Circuit</b>   |
| SDA              | <b>Serial DAta</b> – I <sup>2</sup> C compatible communication pins           |
| SCL              | <b>Serial CLock</b> – I <sup>2</sup> C compatible communication pins          |
| ACK / NACK       | <b>Acknowledge / Not Acknowledge</b>  |
| SOC              | <b>Start Of Conversion</b>  |
| EOC              | <b>End Of Conversion</b>  |
| FOV              | <b>Field Of View</b>  |
| Ta               | <b>Ambient Temperature</b> measured from the chip – (the package temperature) |
| To               | <b>Object Temperature</b> , ‘seen’ from IR sensor                             |
| SFN              | <b>Single Flat pack No-lead</b>   |
| TBD              | <b>To Be Defined</b>  |
| LSB              | <b>Least Significant Bit</b>  |
| MSB              | <b>Most Significant Bit</b>   |
| EMC              | <b>Electro-Magnetic Compatibility</b>   |
| ESD              | <b>Electro-Static Discharge</b>   |
| HBM              | <b>Human Body Model</b>   |
| CDM              | <b>Charged Device Model</b>   |

*Table 3: List of abbreviations*

### 3. Absolute Maximum ratings

| Parameter                               | Symbol     | Min. | Typ. | Max.           | Unit |
|---|------------|------|------|----------------|------|
| Supply Voltage, (over voltage)          | $V_{DD}$   |      |      | 5              | V    |
| Supply Voltage, (operating)             | $V_{DD}$   |      |      | 3.6            | V    |
| Reverse Voltage                         | $V_R$      |      |      | -1.5           | V    |
| Address-pin Voltage                     | $V_{ADDR}$ |      |      | $V_{DD} + 0.6$ | V    |
| Operating Temperature Range,            | $T_A$      | -20  |      | +85            | °C   |
| Storage Temperature Range,              | $T_S$      | -40  |      | +105           | °C   |
| ESD Sensitivity                         |            |      |      |                |      |
| - HBM (acc. AEC Q100 002)               |            |      |      | 2              | kV   |
| - CDM (acc. AEC Q100 011)               |            |      |      | 750            | V    |
| - Air discharge (acc. IEC61000-4-2)     |            |      |      | +4             | kV   |
| - Contact discharge (acc. IEC61000-4-2) |            |      |      | +2             | kV   |
| DC current into SCL                     |            |      |      | 10             | μA   |
| DC sink current, SDA pin                |            | 20   |      |                | mA   |
| DC clamp current, SDA pin               |            |      |      | 25             | mA   |
| DC clamp current, SCL pin               |            |      |      | 25             | mA   |
| EEPROM re-writes                        |            |      |      | 10             |      |

Table 4: Absolute maximum ratings

Exceeding the absolute maximum ratings may cause permanent damage. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability.

## 4. Pin definitions and descriptions

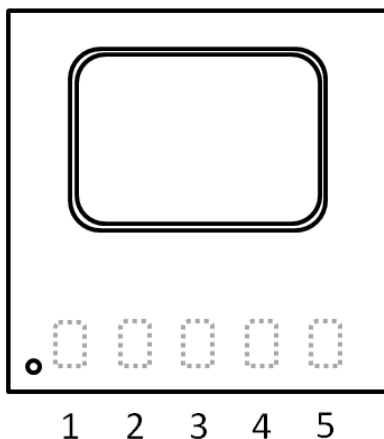


Figure 2: MLX90632 TOP view

| Pin # | Name | Direction | Description                     |
|-------|------|-----------|---------------------------------|
| 1     | SDA  | In/Out    | I <sup>2</sup> C Data line      |
| 2     | VDD  | POWER     | Supply                          |
| 3     | GND  | GND       | Ground                          |
| 4     | SCL  | In        | I <sup>2</sup> C Clock line     |
| 5     | ADDR | In        | LSB of I <sup>2</sup> C address |

Table 5: Pin definition



## 5. Electrical characteristics

All parameters are valid for  $T_A = 25\text{ }^\circ\text{C}$ ,  $V_{DD} = 3.3\text{V}$  (unless otherwise specified)

| Parameter   | Symbol           | Test Conditions   | Min                 | Typ      | Max                 | Units |
|---|------------------|---|---------------------|----------|---------------------|-------|
| <b>Supplies</b>   |                  |   |                     |          |                     |       |
| External supply   | $V_{DD}$         |   | 3                   | 3.3      | 3.6                 | V     |
| Supply current  | $I_{DD}$         | No load   | 0.5                 | 1        | 1.4                 | mA    |
| Sleep current   | $I_{DDpr}$       | No load, erase/write EEPROM operations                      |                     | 1.5      | 2.5                 | uA    |
| <b>Power On Reset</b>                                       |                  |   |                     |          |                     |       |
| POR level   | $V_{POR\ up}$    | Power-up (full temp range)                                  | 1.3                 |          | 2.4                 | V     |
| POR level   | $V_{POR\ down}$  | Power-down (full temp range)                                | 1.1                 |          | 2.1                 | V     |
| POR hysteresis  | $V_{POR\ hys}$   | Full temp range   | 200                 |          | 500                 | mV    |
| $V_{DD}$ rise time (10% to 90% of specified supply voltage) | $T_{POR}$        | Ensure POR signal   |                     |          | 20                  | ms    |
| Output valid (result in RAM)                                | $T_{valid}$      | After POR   | 64                  |          |                     | ms    |
| <b>I<sup>2</sup>C compatible 2-wire interface</b>           |                  |   |                     |          |                     |       |
| I <sup>2</sup> C Voltage                                    | $V_{I2C}$        | I <sup>2</sup> C version = 1.8V                             | 1.65                | 1.8      | 1.95                | V     |
|   |                  | I <sup>2</sup> C version = 3.3V                             | 3                   | $V_{DD}$ | 3.6                 | V     |
| Input high voltage  | $V_{IH}$         | Over temperature and supply                                 | $0.7 \cdot V_{I2C}$ |          | $V_{I2C} + 0.5$     | V     |
| Input low voltage   | $V_{IL}$         | Over temperature and supply                                 | -0.5                |          | $0.3 \cdot V_{I2C}$ | V     |
| Output low voltage  | $V_{OL}$         | Over temperature and supply                                 | 0                   |          | 0.4                 | V     |
| Address pin voltage ("1")                                   | $V_{ADDR,HI}$    |   | 2                   | $V_{DD}$ | $V_{DD} + 0.5$      | V     |
| Address pin voltage ("0")                                   | $V_{ADDR,LO}$    |   | 0                   |          | 0.5                 | V     |
| ADDR leakage  | $I_{ADDR, leak}$ |   |                     |          | 1                   | μA    |
| SCL leakage   | $I_{SCL, leak}$  | $V_{SCL} = 3.6\text{V}$ , $T_a = +85\text{ }^\circ\text{C}$ |                     |          | 1                   | μA    |
| SDA leakage   | $I_{SDA, leak}$  | $V_{SDA} = 3.6\text{V}$ , $T_a = +85\text{ }^\circ\text{C}$ |                     |          | 1                   | μA    |
| SCL capacitance   | $C_{SCL}$        |   |                     |          | 10                  | pF    |
| SDA capacitance   | $C_{SDA}$        |   |                     |          | 10                  | pF    |
| Slave address   | SA               | Factory default, ADDR-pin grounded                          |                     | 3A       |                     | hex   |

Table 6: Electrical characteristics

## 6. Detailed General Description

### 6.1. Block diagram

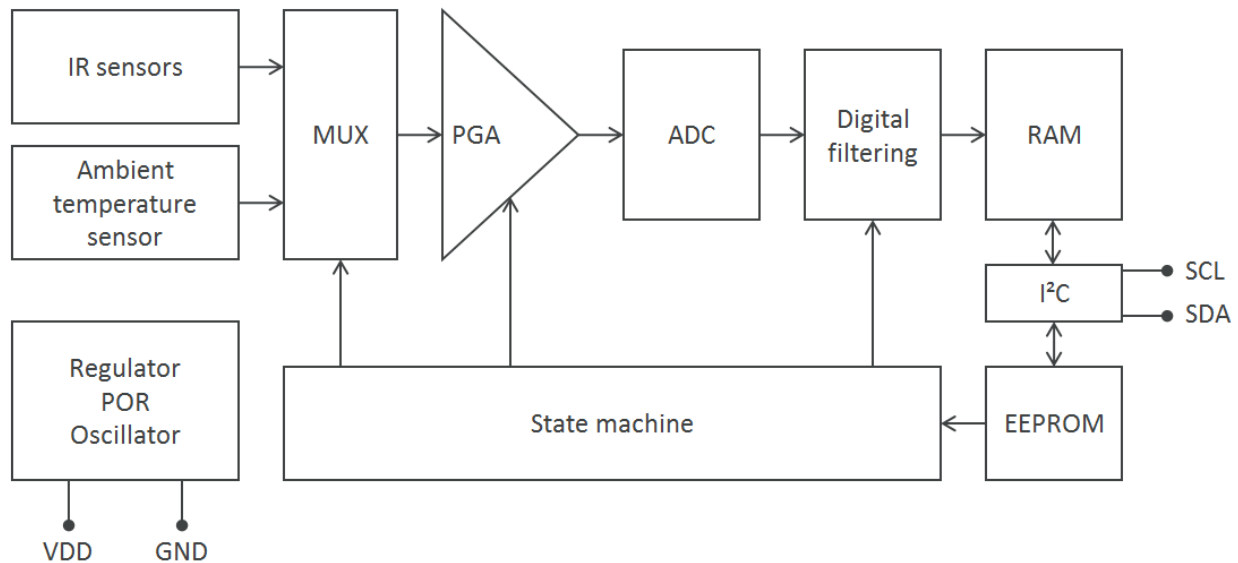


Figure 3: Block diagram

### 6.2. Description

The MLX90632 is a far infrared, non-contact temperature sensor which is factory calibrated to a high accuracy. Internally, electrical and thermal precautions are taken to compensate for thermally harsh external conditions. The thermopile sensing element voltage signal is amplified and digitized. After digital filtering, the raw measurement result is stored in the RAM memory. Furthermore, the MLX90632 contains a sensor element to measure the temperature of the sensor itself. The raw information of this sensor is also stored in RAM after processing. All above functions are controlled by a state machine. The result of each measurement conversion is accessible via I<sup>2</sup>C.

The communication to the chip is done by I<sup>2</sup>C in fast mode plus (FM+). The requirement of the standard is to run at frequencies up to 1MHz. Through I<sup>2</sup>C the external unit can have access to the following blocks:

- Control registers of internal state machines
- RAM (96cells x 16bit) for pixel and auxiliary measurement data, in this document mainly referred to as 'storage memory'.
- EEPROM (256cells x 16bit) used to store the trimming values, calibration constants and various device/measurement settings.

From the measurement data and the calibration data the external unit can calculate both the sensor temperature and the object temperature. The calculation allows the customer to adjust the calibration for his own application in case an optical window or obstructions are present.

## 7. Memory map

Some bits in the registers below are Melexis reserved. Those bits need to be read and masked, prior to writing operation.

| Access        | Address | Name             | Description   |
|---------------|---------|------------------|---|
| <b>EEPROM</b> |         |                  |   |
| Read-only     | 0x2405  | ID0[15:0]        | Chip version  |
| Read-only     | 0x2406  | ID1[15:0]        | Chip version  |
| Read-only     | 0x2407  | ID2[15:0]        | Chip version  |
| Read-only     | 0x2408  | ID_CRC16         | CRC   |
| Read-only     | 0x2409  | EE_PRODUCT_CODE  | Sensor information  |
| -             | -       | Melexis reserved |   |
| Read-only     | 0x240B  | EE_VERSION       | EEPROM version  |
| Read-only     | 0x240C  | EE_P_R [15:0]    | P_R calibration constant (16-bit, Least Significant Word) |
| Read-only     | 0x240D  | EE_P_R [31:16]   | P_R calibration constant (16-bit, Most Significant Word)  |
| Read-only     | 0x240E  | EE_P_G [15:0]    | P_G calibration constant (16-bit, Least Significant Word) |
| Read-only     | 0x240F  | EE_P_G [31:16]   | P_G calibration constant (16-bit, Most Significant Word)  |
| Read-only     | 0x2410  | EE_P_T [15:0]    | P_T calibration constant (16-bit, Least Significant Word) |
| Read-only     | 0x2411  | EE_P_T [31:16]   | P_T calibration constant (16-bit, Most Significant Word)  |
| Read-only     | 0x2412  | EE_P_O [15:0]    | P_O calibration constant (16-bit, Least Significant Word) |
| Read-only     | 0x2413  | EE_P_O [31:16]   | P_O calibration constant (16-bit, Most Significant Word)  |
| Read-only     | 0x2414  | EE_Aa [15:0]     | Aa calibration constant (16-bit, Least Significant Word)  |
| Read-only     | 0x2415  | EE_Aa [31:16]    | Aa calibration constant (16-bit, Most Significant Word)   |
| Read-only     | 0x2416  | EE_Ab [15:0]     | Ab calibration constant (16-bit, Least Significant Word)  |
| Read-only     | 0x2417  | EE_Ab [31:16]    | Ab calibration constant (16-bit, Most Significant Word)   |
| Read-only     | 0x2418  | EE_Ba [15:0]     | Ba calibration constant (16-bit, Least Significant Word)  |
| Read-only     | 0x2419  | EE_Ba [31:16]    | Ba calibration constant (16-bit, Most Significant Word)   |
| Read-only     | 0x241A  | EE_Bb [15:0]     | Bb calibration constant (16-bit, Least Significant Word)  |
| Read-only     | 0x241B  | EE_Bb [31:16]    | Bb calibration constant (16-bit, Most Significant Word)   |
| Read-only     | 0x241C  | EE_Ca [15:0]     | Ca calibration constant (16-bit, Least Significant Word)  |
| Read-only     | 0x241D  | EE_Ca [31:16]    | Ca calibration constant (16-bit, Most Significant Word)   |
| Read-only     | 0x241E  | EE_Cb [15:0]     | Cb calibration constant (16-bit, Least Significant Word)  |
| Read-only     | 0x241F  | EE_Cb [31:16]    | Cb calibration constant (16-bit, Most Significant Word)   |
| Read-only     | 0x2420  | EE_Da [15:0]     | Da calibration constant (16-bit, Least Significant Word)  |
| Read-only     | 0x2421  | EE_Da [31:16]    | Da calibration constant (16-bit, Most Significant Word)   |
| Read-only     | 0x2422  | EE_Db [15:0]     | Db calibration constant (16-bit, Least Significant Word)  |

|           |                 |                  |  |
|-----------|-----------------|------------------|--|
| Read-only | 0x2423          | EE_Db [31:16]    | Db calibration constant (16-bit, Most Significant Word)  |
| Read-only | 0x2424          | EE_Ea [15:0]     | Ea calibration constant (16-bit, Least Significant Word)   |
| Read-only | 0x2425          | EE_Ea [31:16]    | Ea calibration constant (16-bit, Most Significant Word)  |
| Read-only | 0x2426          | EE_Eb [15:0]     | Eb calibration constant (16-bit, Least Significant Word)   |
| Read-only | 0x2427          | EE_Eb [31:16]    | Eb calibration constant (16-bit, Most Significant Word)  |
| Read-only | 0x2428          | EE_Fa [15:0]     | Fa calibration constant (16-bit, Least Significant Word)   |
| Read-only | 0x2429          | EE_Fa [31:16]    | Fa calibration constant (16-bit, Most Significant Word)  |
| Read-only | 0x242A          | EE_Fb [15:0]     | Fb calibration constant (16-bit, Least Significant Word)   |
| Read-only | 0x242B          | EE_Fb [31:16]    | Fb calibration constant (16-bit, Most Significant Word)  |
| Read-only | 0x242C          | EE_Ga [15:0]     | Ga calibration constant (16-bit, Least Significant Word)   |
| Read-only | 0x242D          | EE_Ga [31:16]    | Ga calibration constant (16-bit, Most Significant Word)  |
| Read-only | 0x242E          | EE_Gb [15:0]     | Gb calibration constant (16-bit)   |
| Read-only | 0x242F          | EE_Ka [15:0]     | Ka calibration constant (16-bit)   |
| Read-only | 0x2430          | EE_Kb [15:0]     | Kb calibration constant (16-bit)   |
| -         | -               | Melexis reserved |  |
| R/W       | 0x2481          | EE_Ha [15:0]     | Ha Customer calibration constant (16 bit)  |
| R/W       | 0x2482          | EE_Hb [15:0]     | Hb Customer calibration constant (16 bit)  |
| -         | -               | Melexis reserved |  |
| R/W       | 0x24C0...0x24CF | Customer data    | Customer data storage area   |
| -         | -               | Melexis reserved |  |
| R/W       | 0x24D4          | EE_CONTROL       | EEPROM Control register, measurement control   |
| R/W       | 0x24D5          | EE_I2C_ADDRESS   | I <sup>2</sup> C slave address >> 1<br><u>Example:</u> standard address (= 0x003A) >> 1 = 0x001D |
| -         | -               | Melexis reserved |  |
| R/W       | 0x24E1          | EE_MEAS_1        | Measurement settings 1 (see section <a href="#">Measurement settings</a> )                       |
| R/W       | 0x24E2          | EE_MEAS_2        | Measurement settings 2 (see section <a href="#">Measurement settings</a> )                       |
| -         | -               | Melexis reserved |  |

| REGISTER  |        |                  |                                     |
|-----------|--------|------------------|-------------------------------------|
| R/W       | 0x3000 | REG_I2C_ADDRESS  | I <sup>2</sup> C slave address >> 1 |
| R/W       | 0x3001 | REG_CONTROL      | Control register, measurement mode  |
| -         | -      | Melexis reserved |                                     |
| R/W       | 0x3FFF | REG_STATUS       | Status register: data available     |
| RAM       |        |                  |                                     |
| Read-only | 0x4000 | RAM_1            | Raw data 1                          |
| Read-only | 0x4001 | RAM_2            | Raw data 2                          |
| Read-only | 0x4002 | RAM_3            | Raw data 3                          |
| Read-only | 0x4003 | RAM_4            | Raw data 4                          |
| Read-only | 0x4004 | RAM_5            | Raw data 5                          |
| Read-only | 0x4005 | RAM_6            | Raw data 6                          |
| Read-only | 0x4006 | RAM_7            | Raw data 7                          |
| Read-only | 0x4007 | RAM_8            | Raw data 8                          |
| Read-only | 0x4008 | RAM_9            | Raw data 9                          |
| ...       | ...    | ...              | ...                                 |
| Read-only | 0x4033 | RAM_52           | Raw data 52                         |
| Read-only | 0x4034 | RAM_53           | Raw data 53                         |
| Read-only | 0x4035 | RAM_54           | Raw data 54                         |
| Read-only | 0x4036 | RAM_55           | Raw data 55                         |
| Read-only | 0x4037 | RAM_56           | Raw data 56                         |
| Read-only | 0x4038 | RAM_57           | Raw data 57                         |
| Read-only | 0x4039 | RAM_58           | Raw data 58                         |
| Read-only | 0x403A | RAM_59           | Raw data 59                         |
| Read-only | 0x403B | RAM_60           | Raw data 60                         |

Table 7: Memory table

**Important!**

The width of the EEPROM is 16 bit.  
Some calibration parameters are 32 bit and split up into two 16 bit numbers in EEPROM.  
The least significant 16 bits of the parameter starts on the address shown in the Memory table.  
Example: To retrieve value EE\_Aa (32bit) = EE\_Aa\_MS (at 0x2415) << 16 | EE\_Aa\_LS (at 0x2414)  
(Section [Example Temperature Calculation](#))

**Important!**

The EEPROM needs to be unlocked before each write command, e.g. all addresses with R/W access need the customer key for modification.  
(Section [EEPROM unlock for customer access](#))

## 7.1. Product ID

A unique 48-bit product ID is stored in the EEPROM.

Addresses 0x2405 (ID0), 0x2406 (ID1) and 0x2407 (ID2) should be readout to know the ID of the product.

$$\text{ProductID}[47:0] = \text{ID2}[15:0] \ll 32 \mid \text{ID1}[15:0] \ll 16 \mid \text{ID0}[15:0]$$

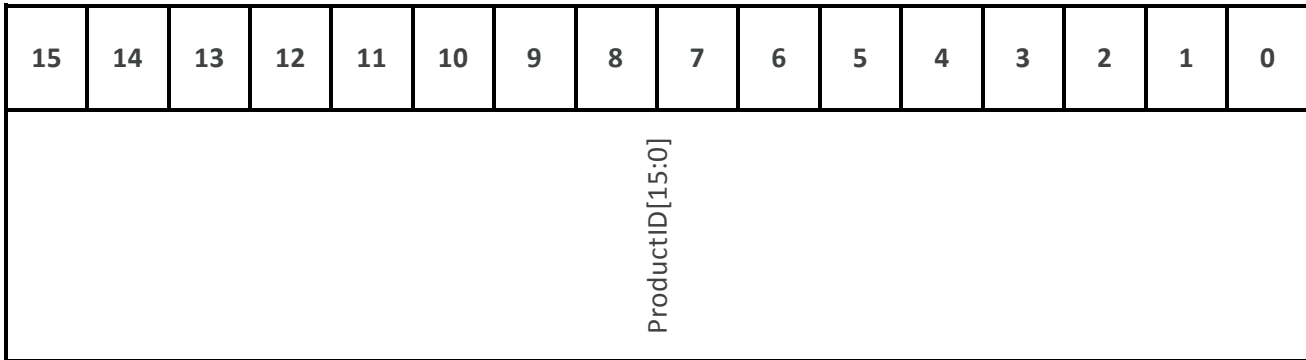


Figure 4: ID0

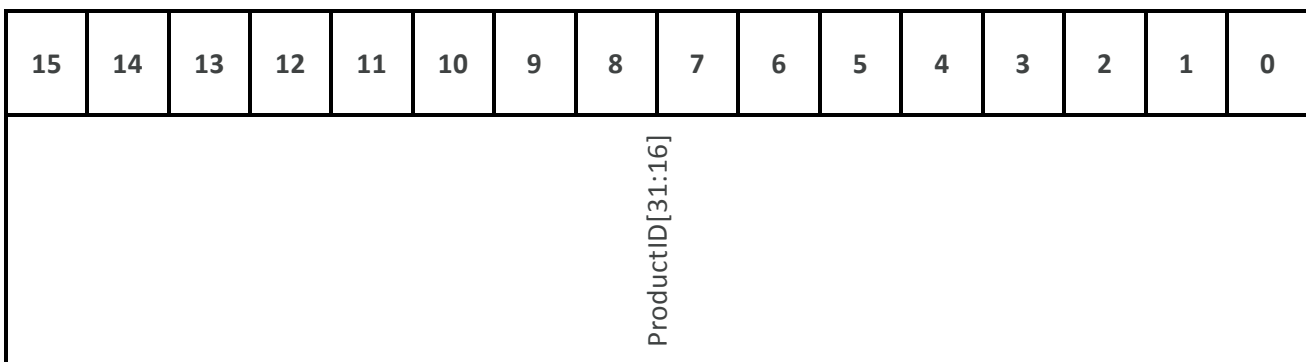


Figure 5: ID1

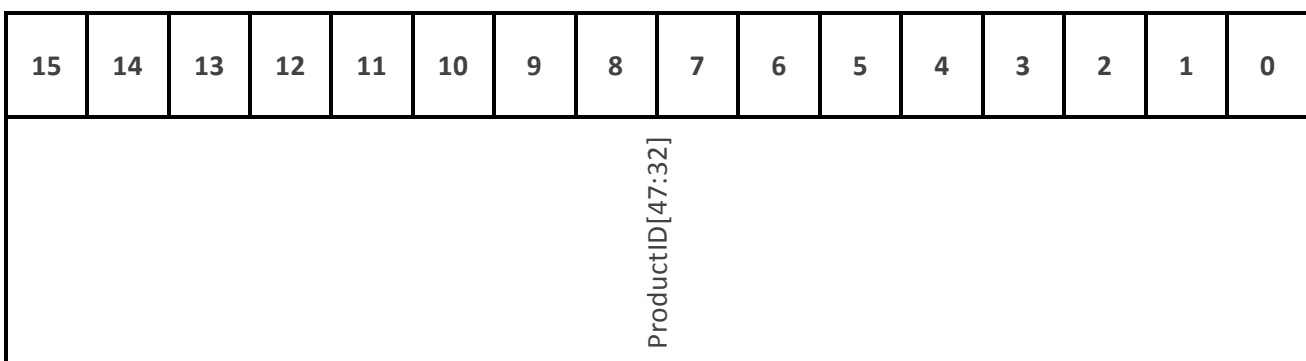


Figure 6: ID2

## 7.2. Product Code (0x2409)

| 15               | 14               | 13               | 12               | 11               | 10               | 9   | 8 | 7       | 6 | 5 | 4              | 3 | 2 | 1 | 0 |
|------------------|------------------|------------------|------------------|------------------|------------------|-----|---|---------|---|---|----------------|---|---|---|---|
| Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved | FOV |   | Package |   |   | Accuracy range |   |   |   |   |

Figure 7 EE\_PRODUCT\_CODE

- FOV
  - 0: -
  - 1: 70°
- Package
  - 0: -
  - 1: SFN 3x3
- Accuracy range
  - 0: -
  - 1: Medical
  - 2: Standard

## 7.3. Customer Data storage Area (0x24C0 to 0x24CF)

The EEPROM area dedicated for customer data storage consists of 16 EEPROM cell of 16-bit words in the address range from 0x24C0 to 0x24CF.

The customer data area in the MLX90632 EEPROM is not meant for storing intermittent data during production, calibration or normal application use. The purpose of having such an area is to enable the customer to store additional MLX90632 related calibration or tracing information. It is important that only the final data is written to the MLX90632 EEPROM in one go. In order to verify that the writing process was successful, the whole EEPROM data should be read-out prior to writing and compared to the EEPROM content after writing - only the customer data values should be different.

**Important note:** The maximum number of EEPROM re-writes is 10. Therefore, it is highly recommended that the writing of the data is done 1 time only.

## 8. Control and configuration

Several bits in the EEPROM or register are available to control and configure the measurements:

### 8.1. Measurement control

|                  |                  |                  |                  |     |                  |                  |             |   |   |   |     |      |   |                  |   |
|------------------|------------------|------------------|------------------|-----|------------------|------------------|-------------|---|---|---|-----|------|---|------------------|---|
| 15               | 14               | 13               | 12               | 11  | 10               | 9                | 8           | 7 | 6 | 5 | 4   | 3    | 2 | 1                | 0 |
| Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved | sob | Melexis reserved | Melexis reserved | meas_select |   |   |   | soc | mode |   | Melexis reserved |   |

Figure 8: Register Measurement control settings

REG\_CONTROL controls the measurement handling and data storage.  
Changes will take immediate effect.

| Bits | Parameter   | Description  | See section                     |
|------|-------------|--|---------------------------------|
| 11   | sob         | starts a full measurement when being in (sleeping) step mode   | <a href="#">Operating Modes</a> |
| 8:4  | meas_select | select the type of measurement to be performed                 | <a href="#">Operating Modes</a> |
| 3    | soc         | starts a single measurement when being in (sleeping) step mode | <a href="#">Operating Modes</a> |
| 2:1  | mode[1:0]   | defines the operating mode (step mode or continuous mode)      | <a href="#">Operating Modes</a> |

Table 8: Register REG\_CONTROL explained

Note that this register is initialized during POR by the EEPROM word EE\_CONTROL.

Several measurement modes exist. These modes are controlled by bits mode[1:0] in register REG\_CONTROL. In continuous mode the measurements are constantly running while in step mode the state machine will execute only one measurement which is initiated by soc bit. After finishing the measurement it will go in wait state until the next measurement is initiated by soc. The measurements are following the measurement sequence as defined in the measurement table.

The different possible measurement modes are:

- mode[1:0] = 01: Enables the sleeping step mode. In this mode the device will be in sleep. On request (soc bit), the device will power-on, the state machine will do one measurement, will go into sleep and will wait for next command.
- mode[1:0] = 10: Enables the step mode. In this mode the state machine will do one measurement upon request (soc bit) and will wait for next command. The device remains powered all time in this mode.
- mode[1:0] = 11: Device is in continuous mode. Measurements are executed continuously. The device remains powered all time in this mode.



By default, the device is in continuous mode.

Switching between the step modes and continuous mode has only effect after the current measurement has finished (not waiting till end of measurement table was reached).

There are only two possible measurements to select from:

- `meas_select[4:0] = 0x00`: Enables the medical measurement. In order to calculate the correct temperatures, the appropriate raw data values and formulas should be used. Refer to the [medical measurement temperature calculations](#)
- `meas_select[4:0] = 0x11`: Enables the extended range measurement. In order to calculate the correct temperatures, the appropriate raw data values and formulas should be used. Refer to the [extended range measurement temperature calculations](#)

*Note: If other values are being used for `meas_select`, the resulting calculated temperatures will be invalid.*

In order to switch to the desired measurement type the following routine should be performed:

1. Send an addressed reset to the MLX90632 device
2. Read the register (REG\_CONTROL) value
3. Modify the REG\_CONTROL value to:
  - a. `mode[1:0] = 00`
  - b. `meas_select = 0x00` for medical or `0x11` for extended range
4. Read the register (REG\_CONTROL) value
5. Modify the REG\_CONTROL value `mode[1:0]` to the desired mode

The next measurement will be of the type that was programmed

By default, the medical measurement is enabled

## 8.2. Device status

|                  |                  |                  |                  |                  |             |            |           |                  |                |   |   |   |   |   |                  |          |
|------------------|------------------|------------------|------------------|------------------|-------------|------------|-----------|------------------|----------------|---|---|---|---|---|------------------|----------|
| 15               | 14               | 13               | 12               | 11               | 10          | 9          | 8         | 7                | 6              | 5 | 4 | 3 | 2 | 1 | 0                |          |
| Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved | device_busy | eprom_busy | brown_out | Melexis reserved | cycle_position |   |   |   |   |   | Melexis reserved | new_data |

Figure 9: Register Device status settings

REG\_STATUS allows checking in which state the device is and indicates when measurements are finished. Changes will take immediate effect.

| Bits | Parameter      | Description   | See section                             |
|------|----------------|---|---|
| 10   | device_busy    | Read-only<br>Flag indicating that a measurement is being executed (1 = measurement ongoing)<br>In sleep mode, this flag is always low.<br>In continuous mode, this flag is always high.<br>In soc-step mode, this flag is high during one measurement.<br>In sob-step mode, this flag is high till all measurements are finished. | <a href="#">Operating Modes</a>         |
| 9    | eprom_busy     | Read-only<br>Flag indicating that the eeprom is busy (0: not busy)<br>Eeprom being busy is defined as follows:<br>- at start-up, the eeprom is busy and remains busy till initialization phase (eeprom copy) has finished<br>- during eeprom write/erase, the eeprom is busy  |   |
| 8    | brown_out      | Bit is set to 0<br>Customer should set bit to 1<br>When device is reset, the bit is set to 0 and reset can be detected  |   |
| 6:2  | cycle_position | Read-only<br>Indicates from which measurement (in the measurement table) the last written data is coming:<br>- cycle_position[4:0]=x, corresponds to measurement x, x=0->31   | <a href="#">Temperature calculation</a> |
| 0    | new_data       | Customer should set bit to 0<br>When a measurement is done, the bit is set to 1<br>Customer can readout the data and reset the bit to 0   | <a href="#">Operating Modes</a>         |

Table 9: Register REG\_STATUS explained

## 8.3. Measurement settings

### 8.3.1. Refresh rate

|                  |                  |                  |                  |                  |              |   |   |                  |                  |                  |                  |                  |                  |                  |                  |                  |
|------------------|------------------|------------------|------------------|------------------|--------------|---|---|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| 15               | 14               | 13               | 12               | 11               | 10           | 9 | 8 | 7                | 6                | 5                | 4                | 3                | 2                | 1                | 0                |                  |
| Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved | Refresh rate |   |   | Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved |

Figure 10: EEPROM Measurement settings

The refresh rate is the speed that the RAM will be updated with results and is configurable in “Measurement settings 1” and “Measurement settings 2”.

The refresh rate can be set with 3 bits and is located in EEPROM addresses 0x24E1 and 0x24E2.

Changing the refresh rate will take immediate effect.

It is important to know that the refresh rate should be kept the same for both measurements.

The table below shows the available refresh rates and the corresponding result to be written in EEPROM addresses EE\_MEAS\_1 and EE\_MEAS\_2.

| EE_MEAS_1[10:8]<br>EE_MEAS_2[10:8] | Refresh rate [Hz] | Time [ms]  | Burst meas time [ms] | EE_MEAS_1 (0x24E1) | EE_MEAS_2 (0x24E2) |
|------------------------------------|-------------------|------------|----------------------|--------------------|--------------------|
| 0                                  | 0.5               | 2000       | 4000                 | 0x800D             | 0x801D             |
| 1                                  | 1                 | 1000       | 2000                 | 0x810D             | 0x811D             |
| <b>2</b>                           | <b>2</b>          | <b>500</b> | <b>1000</b>          | <b>0x820D</b>      | <b>0x821D</b>      |
| 3                                  | 4                 | 250        | 500                  | 0x830D             | 0x831D             |
| 4                                  | 8                 | 125        | 250                  | 0x840D             | 0x841D             |
| 5                                  | 16                | 62.5       | 125                  | 0x850D             | 0x851D             |
| 6                                  | 32                | 31.25      | 62.5                 | 0x860D             | 0x861D             |
| 7                                  | 64                | 15.625     | 31.25                | 0x870D             | 0x871D             |

Table 10: EEPROM Refresh rate For Medical and Standard explained

| EE_MEAS_17[10:8]<br>EE_MEAS_18[10:8]<br>EE_MEAS_19[10:8] | Refresh rate [Hz] | Time [ms]  | Burst meas time [ms] | EE_MEAS_17 (0x24F1) | EE_MEAS_18 (0x24F2) | EE_MEAS_19 (0x24F3) |
|--|-------------------|------------|----------------------|---------------------|---------------------|---------------------|
| 0  | 0.16              | 6000       | 6000                 | 0x8000              | 0x8012              | 0x800C              |
| 1  | 0.32              | 3000       | 3000                 | 0x8100              | 0x8112              | 0x810C              |
| 2  | 0.65              | 1500       | 1500                 | 0x8200              | 0x8212              | 0x820C              |
| <b>3</b>   | <b>1.3</b>        | <b>750</b> | <b>750</b>           | <b>0x8300</b>       | <b>0x8312</b>       | <b>0x830C</b>       |
| 4  | 2.6               | 375        | 375                  | 0x8400              | 0x8412              | 0x840C              |
| 5  | 5                 | 200        | 200                  | 0x8500              | 0x8512              | 0x850C              |
| 6  | 10                | 100        | 100                  | 0x8600              | 0x8612              | 0x860C              |
| 7  | 20                | 50         | 50                   | 0x8700              | 0x8712              | 0x870C              |

*Table 11: Extended range EEPROM Refresh rate explained*

## 9. I<sup>2</sup>C commands

This device is based on I<sup>2</sup>C specification Rev.5 – October 9<sup>th</sup> 2012. I<sup>2</sup>C FM+ mode is supported.

The sensor uses the following I<sup>2</sup>C features:

- Slave mode only
- 7-bits addressing
- Modes: Standard-mode, Fast-mode, Fast-mode Plus
- Incremental addressing – allowing a block of addresses to be accessed inside one I<sup>2</sup>C sequence

The following I<sup>2</sup>C commands are implemented:

- Read/write access to internal memories and registers
  - ❑ Addressed write
  - ❑ Addressed read
- Global reset
- Addressed reset
- EEPROM unlock for CUST access
- Direct read

## 9.1. I<sup>2</sup>C address

By default, the device responds to the 7-bit slave address 0x3A.  
Configuration of the 7-bit slave address is possible at EEPROM address 0x24D5.

The least significant bit (bit0) of the address is determined by the status of the ADDR-pin (either connected to ground or supply) and is taken in after power-up or reset command if the change is made in EEPROM.

- Bit0 = '0' if ADDR-pin is connected to GND
- Bit0 = '1' if ADDR-pin is connected to VDD

The remaining 6-bits can be used to configure the I2C address of the device.

| 15               | 14               | 13               | 12               | 11               | 10               | 9                | 8                | 7                | 6   | 5 | 4 | 3 | 2 | 1 | 0                           |
|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|---|---|---|---|---|---|-----------------------------|
| Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved | Melexis reserved | Configurable 6-bit slave address (0x1D)   |   |   |   |   |   | External status of ADDR-pin |
|                  |                  |                  |                  |                  |                  |                  |                  |                  | I2C slave address(7-bit)<br>= 0x3A if ADDR-pin=0(GND)<br>=0x3B if ADDR-pin=1(VDD) |   |   |   |   |   |                             |

Figure 11: EEPROM I2C address configuration

**Important!** The device will not respond if the I<sup>2</sup>C address is changed to 0 (and ADDR pin is low).  
The only way to get the device to respond is to pull the ADDR pin high.  
The slave address will be changed to 1 and communication is possible.

**Important!** The device shall not execute measurements when performing EEPROM memory operations (I<sup>2</sup>C read/write instructions in EEPROM address range)! Hence, the device shall be put in halt mode or in a stepping mode before doing EEPROM read/write operations.

### 9.1.1. Slave Address change flow

- ⇒ Put device in Halt mode, use current slave address
  - Read Control Register
  - Mask Control register value – change only the power mode bits
  - Write the new value to Control register
- ⇒ Write Slave address to EEPROM, use current slave address
  - Send EEPROM unlock key
  - Write 0x0000 to address 0x24D5

**Important!** Do not power down the device at this point

- Wait at least 5ms
- Send EEPROM unlock key
- Write New slave address [6:1] to address 0x24D5
- Wait at least 5ms
- It is advised to read back and verify the written address value at this point

It is now safe to power-down the device

⇒ After power-down of the device the new slave address will be in operation.

## 9.1.2. Slave Address change example

```
#include <mlx90632.h>

#define OLD_SLAVE_ADDRESS 0x3A
#define NEW_SLAVE_ADDRESS 0x42
#define ADDR_PIN 0
//i2c read/write functions – i2ca parameter is the Slave address
int32_t mlx90632_i2c_read_SA(uint8_t i2ca, int16_t register_address, uint16_t *value)
int32_t mlx90632_i2c_write_SA(uint8_t i2ca, int16_t register_address, uint16_t value)

int32_t mlx90632_i2c_write_EE(uint8_t i2ca, int16_t register_address, uint16_t value)
{
    //Send EEPROM unlock key
    //Write 0x0000
    //Wait 5ms
    //Send EEPROM unlock key
    //write value
    //wait 5ms
}
int main()
{
    uint16_t rData;
    //Put the device in Halt mode
    mlx90632_i2c_read_SA(OLD_SLAVE_ADDRESS, MLX90632_REG_CTRL, &rData);
    rData = rData & (~MLX90632_CFG_PWR_MASK);
    rData |= (MLX90632_PWR_STATUS_HALT);

    mlx90632_i2c_write_SA(OLD_SLAVE_ADDRESS, MLX90632_REG_CTRL, rData);
    //write new Slave address to EEPROM
    mlx90632_i2c_write_EE(OLD_SLAVE_ADDRESS, MLX90632_EE_I2C_ADDRESS, NEW_SLAVE_ADDRESS>>1);
    //it is now safe to power down the device in order load the new Slave address
    //After POR the new slave address should be used for i2c communication
    mlx90632_i2c_read_SA(NEW_SLAVE_ADDRESS, MLX90632_REG_CTRL, &rData);
}
```

## 9.2. Addressed read

The addressed read command allows doing an incremental read-out, starting from any given address within the memory space.

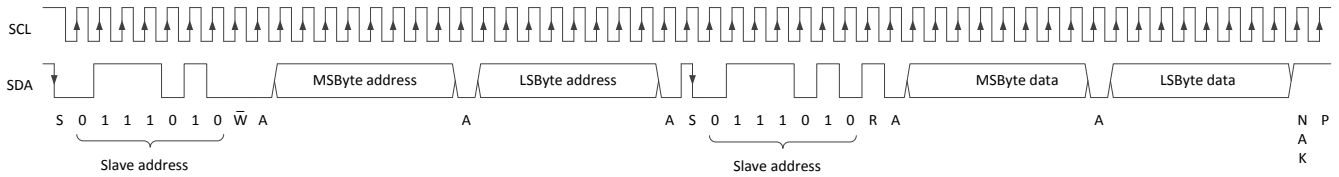


Figure 12: Addressed read

**Important!**

An addressed read is only valid when combining directly an addressed write and a direct read through a repeated START condition. In case the read and write part are separated by a STOP condition, or in case the read is not directly following the write, or in case the slave address is not identical for both, the command will not be seen as an addressed read. As a result, the second read will in practice act as a direct read.

As soon as incremental addressing leaves the address space, the slave will respond with all 8'hFF.

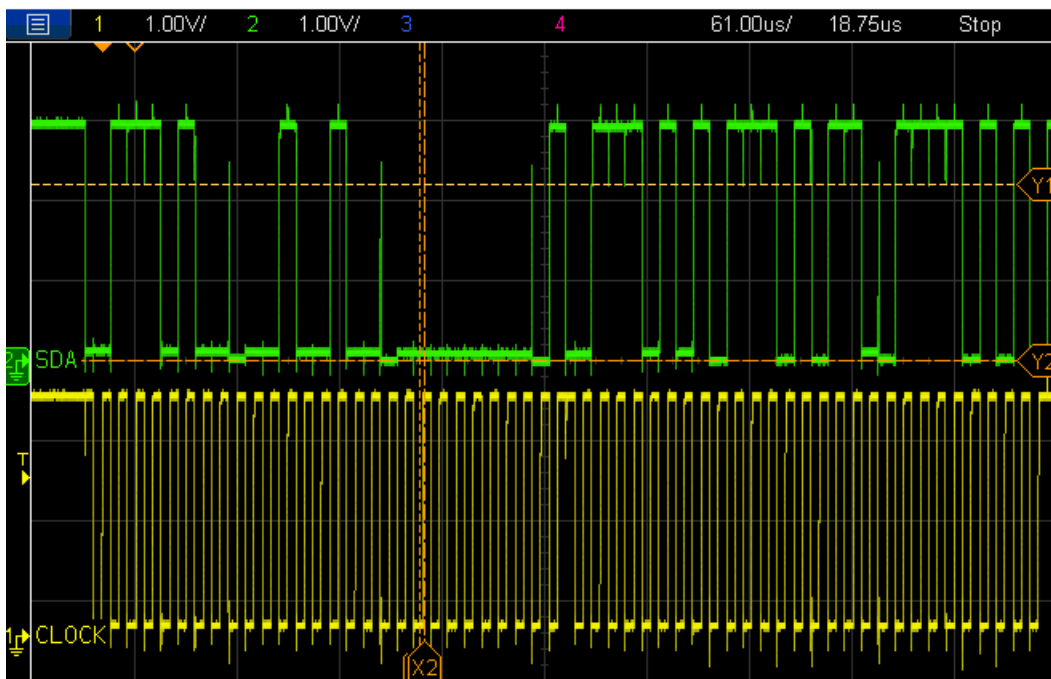


Figure 13 Addressed read - Oscilloscope Plot



### 9.3. Addressed write

The addressed write command allows doing an incremental write, starting from any given address within the memory space.

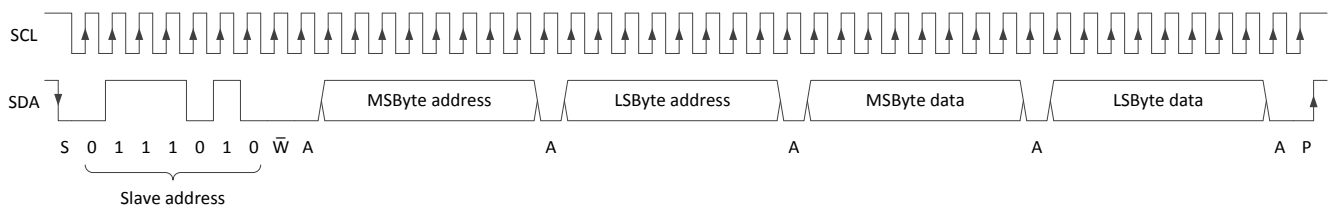


Figure 14: Addressed write

**Important!** The slave is sending ACK/NACK based on the fact whether it was able to write data (timing, end of register space, access rights). The slave will automatically increment the address of the write byte, independent if it gave an ACK or a NACK to the master. It is up to the master to re-write the byte afterwards.

Before writing to EEPROM it is necessary to erase the specific address location in EEPROM. This is done by first writing 0x0000. Then the new data can be written.

When the device is busy with the write operation to EEPROM, new write commands will be ignored. A read operation will return invalid data. The fact that the device is busy is indicated via the bit device\_busy in REG\_STATUS.

### 9.4. Global reset

This command resets all devices on the I<sup>2</sup>C bus (based on the general call address 0x00).

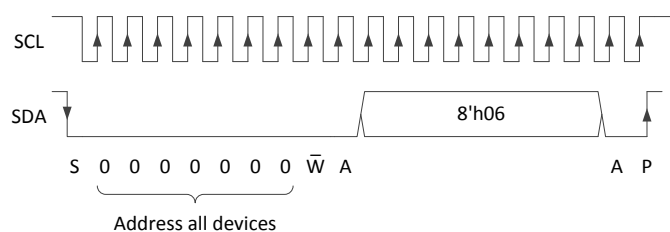


Figure 15: Global reset

Note: After this command, a delay at least 150us is needed before the next communication with the device.

## 9.5. Addressed reset

This command resets the addressed device only (based on the I<sup>2</sup>C address).

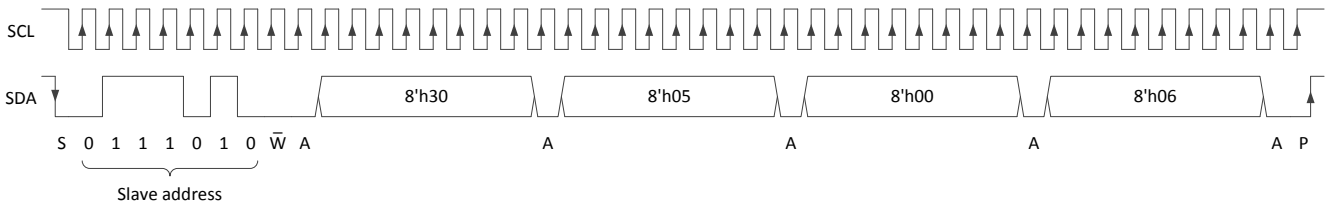


Figure 16: Addressed reset

Note: After this command, a delay at least 150us is needed before the next communication with the device.

## 9.6. EEPROM unlock for customer access

This command unlocks the EEPROM allowing only one write operation to an EEPROM word in the customer part of the EEPROM.

After the EEPROM write, the EEPROM access goes back to the “NoKey” access mode.

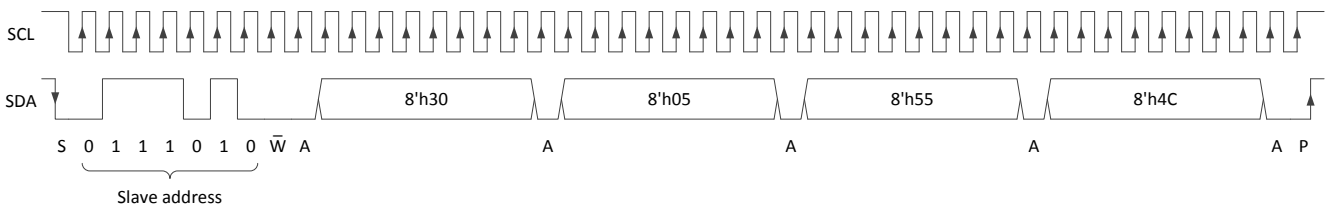


Figure 17: EEPROM unlock

## 9.7. Direct read

The direct read command allows an incremental read out at a default start address.

This default start address is fixed to the register location REG\_STATUS (0x3FFF).

According to the I<sup>2</sup>C specification, the master will keep sending an acknowledge (A) until it want to stop. This is indicated by sending a NAK. As a result, the slave will stop driving the SDA-bus as soon as a NAK is received by the master.

As soon as the incremental addressing leaves the address space, the slave will respond with all 8'hFF.

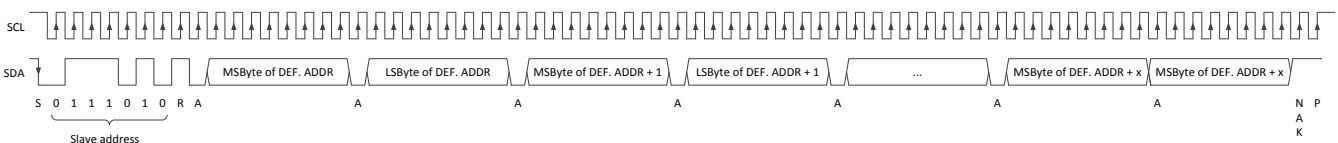


Figure 18: Direct read

## 10. Operating Modes

The device has 2 states of operation: **sleep state** and **active state**.

- **Sleep state**

In this state, most of the circuitry is disabled to limit the current consumption to a few uA.

- **Active state**

In this state, the sensor is active.

Several measurement modes exist. These modes are controlled by bits mode[1:0] in register REG\_CONTROL[2:1]. In continuous mode the measurements are constantly running while in step mode the state machine will execute only one measurement which is initiated by the soc bit or a whole set of measurements initiated by the sob bit. After finishing the measurement(s) it will go in wait state until the next measurement is initiated by the soc or sob bit. If soc is used to initiate a measurement, the measurements are following the measurement sequence as defined in the measurement table.

The different possible measurement modes are:

- mode[1:0] = 01: Enables the sleeping step mode.

The device will be in sleep mode. On request (soc or sob bit), the device will power-on, the state machine will perform one measurement (soc) or the full measurement table (sob), will go into sleep and wait for the next command.

In the sleeping step mode all the measurements from the measurement table will be performed so that all data necessary for the calculations is refreshed. The two ways of using the device in this mode are:

- SOB bit

The SOB bit initiates a full measurement table measurement. Once the measurement is started, the SOB bit is cleared and the *device\_busy* bit is set internally in the MLX90632. When all the measurements from the measurement table are performed, the *device\_busy* bit is cleared indicating the end of measurements – the new data can be read. The flow should be:

1. Set SOB bit
2. Wait for all the measurements from the measurement table to finish - depending on the refresh rates (see [Table 10](#) and [Table 11](#))
3. Make sure that the *device\_busy* bit is cleared
4. Read out the data
5. Calculate the temperatures

- SOC bit

The SOC bit initiates a single measurement from the measurement table. The measurements are being performed consecutively as set in the measurement table. Once the measurement is started, the SOC bit is cleared internally in the MLX90632 and could be set again so that the next measurement from the measurement table is started right after the current one is done. When the current measurement is done, the *new\_data* bit is set –

the new data can be read and the bit should be cleared. The flow should be:

1. Set SOC bit
2. Wait for the 1<sup>st</sup> measurement from the measurement table to finish - depending on the refresh rate (see [Table 10](#) and [Table 11](#))
3. Make sure that the new\_data bit is set and clear it
4. Set SOC bit
5. Wait for the 2<sup>nd</sup> measurement from the measurement table to finish - depending on the refresh rate (see [Table 10](#) and [Table 11](#))
6. Make sure that the new\_data bit is set and clear it
7. If medical mode is selected proceed with step 11 (e.g. skip 8..10)
8. Set SOC bit
9. Wait for the 3<sup>rd</sup> measurement from the measurement table to finish - depending on the refresh rate (see [Table 10](#) and [Table 11](#))
10. Make sure that the new\_data bit is set and clear it
11. Read out the data
12. Calculate the temperatures

- mode[1:0] = 10: Enables the step mode.

The state machine will do one measurement upon request (soc bit) and will wait for the next command. The device remains powered all the time in this mode.

- mode[1:0] = 11: Device is in continuous mode.

Measurements are executed continuously. The device remains powered all time in this mode.

By default, the device is in continuous mode.

Switching between the step modes and continuous mode has only effect after the current measurement has finished (not waiting until the end of the measurement table was reached).

There are two possible measurement types to select from:

- meas\_select[4:0] = 0x00: Enables the medical measurement. In order to calculate the correct temperatures, the appropriate raw data values and formulas should be used. Refer to the [medical measurement temperature calculations](#)
- meas\_select[4:0] = 0x11: Enables the extended range measurement. In order to calculate the correct temperatures, the appropriate raw data values and formulas should be used. Refer to the [extended range measurement temperature calculations](#)

*Note: If other values are being used for meas\_select, the resulting calculated temperatures will be invalid.*

# 11. Temperature calculation

## 11.1. Medical measurement

To calculate the ambient and object temperature, a set of 2 measurements is required:

- Measurement 1: RAM\_4, RAM\_5, RAM\_6;
- Measurement 2: RAM\_7, RAM\_8, RAM\_9;

One should notice this requires double the measurement time than specified ( $= 2 * 500\text{ms}$ ) for the very first calculation.

After the first calculation, TA and TO can be calculated with the next measurement.

Example:

|     |  |    |   |    |       |
|-----|--|----|---|----|-------|
| t0: | Measurement 1<br>(cycle_pos = 1)       | => | no calculation of TA or TO possible<br>because not all parameters are known |    |       |
| t1: | Measurement 2<br>(cycle_pos = 2)       | => | calculate TA (RAM_6, RAM_9)<br>calculate TO (RAM_7, RAM_8, RAM_6, RAM_9)    | => | 1s.   |
| t2: | Measurement 3 (= 1)<br>(cycle_pos = 1) | => | calculate TA (RAM_6, RAM_9)<br>calculate TO (RAM_4, RAM_5, RAM_6, RAM_9)    | => | 0.5s. |
| t3: | Measurement 4 (= 2)<br>(cycle_pos = 2) | => | calculate TA (RAM_6, RAM_9)<br>calculate TO (RAM_7, RAM_8, RAM_6, RAM_9)    | => | 0.5s. |
| t4: | ...                                    |    |   |    |       |

To calculate the new ambient and object temperature RAM\_6 and RAM\_9 have to be used. The choice between [RAM\_4 and RAM\_5] or [RAM\_7 and RAM\_8] depends on the current measurement. REG\_STATUS[6:2] (= "cycle\_pos") returns the current position of the measurement defined in the measurement table.

Using the current data and the data from measurement (x-1), TA and TO can be calculated every 500ms. The complete measurement sequence can be automated by using the new\_data bit in combination with cycle\_pos bits.

The sequence should look like the following:

- Write new\_data = 0
- Check when new\_data = 1
- Read cycle\_pos to get measurement pointer
  - ☐ If cycle\_pos = 1
    - Calculate TA and TO base on RAM\_4, RAM\_5, RAM\_6, RAM\_9
  - ☐ If cycle\_pos = 2
    - Calculate TA and TO base on RAM\_7, RAM\_8, RAM\_6, RAM\_9
- Return to top

## 11.1.1. Pre-calculations

### 11.1.1.1. Ambient

$$VR_{TA} = RAM\_9 + Gb * \frac{RAM\_6}{12}$$

$$Gb = EE\_Gb * 2^{-10}$$

$$AMB = \left[ \frac{RAM\_6}{12} \right] / VR_{TA} * 2^{19}$$

The parameter EE\_Gb is a signed 16-bit number.

### 11.1.1.2. Object

$$S = \frac{RAM\_4 + RAM\_5}{2}$$

OR

$$S = \frac{RAM\_7 + RAM\_8}{2}$$

$$VR_{TO} = RAM\_9 + Ka * \frac{RAM\_6}{12}$$

$$Ka = EE\_Ka * 2^{-10}$$

$$S_{TO} = \left[ \frac{S}{12} \right] / VR_{TO} * 2^{19}$$

The parameter EE\_Ka is a signed 16-bit number.

## 11.1.2. Ambient temperature

$$Ta \text{ (sensor temperature in } ^\circ\text{C)} = P\_O + \frac{AMB - P\_R}{P\_G} + P\_T * (AMB - P\_R)^2$$

### With:

Ta in degrees Celsius

$$P\_R = EE\_P\_R * 2^{-8}$$

$$P\_O = EE\_P\_O * 2^{-8}$$

$$P\_G = EE\_P\_G * 2^{-20}$$

$$P\_T = EE\_P\_T * 2^{-44}$$

The parameters EE\_P\_R, EE\_P\_O, EE\_P\_G and EE\_P\_T are signed 32-bit numbers.

### 11.1.3. Object temperature

**TO (object temperature in °C)**

$$= \sqrt[4]{\frac{S_{TO}}{\epsilon * Fa * Ha * (1 + Ga * (TO_{DUT} - TO_0) + Fb * (TA_{DUT} - TA_0))}} + Ta_{[K]}^4 - 273.15 - Hb$$

**With:**

$$Fa = EE\_Fa * 2^{-46}$$

$$Fb = EE\_Fb * 2^{-36}$$

$$Ga = EE\_Ga * 2^{-36}$$

$$Ha = EE\_Ha * 2^{-14}$$

$$Hb = EE\_Hb * 2^{-10}$$

$$TO_0 = 25^{\circ}C$$

$$TA_0 = 25^{\circ}C$$

$$TA_{DUT} = \frac{(AMB - Eb)}{Ea} + 25$$

$$Ea = EE\_Ea * 2^{-16}$$

$$Eb = EE\_Eb * 2^{-8}$$

$$Ta_{[K]} = TA_{DUT} + 273.15 \text{ in Kelvin}$$

$$TO_{DUT} = \text{Object temperature in } 25^{\circ}C$$

$$\epsilon = 1 = \text{Object Emissivity parameter (not stored in EEPROM, but part of the 'app')}$$

The parameters EE\_Ea, EE\_Eb, EE\_Fa, EE\_Fb, EE\_Ga are signed 32-bit numbers.

The parameters EE\_Gb, EE\_Ka, EE\_Ha and EE\_Hb are signed 16-bit numbers.

**Note:**

One can see that to compute “To (object temperature)”, “To” already needs to be known.

“To (object temperature)” is computed in an iterative manner. In the first iteration “To” is assumed to be 25°C.

In the 2<sup>nd</sup> iteration the result of first iteration is used, and in the 3<sup>rd</sup> iteration the end result is obtained.

(See example on next page).

### 11.1.4. Example Medical measurement Temperature Calculation

Assumed are the following calibration parameters read from EEPROM:

| ADDR   | PARAM          | DATA (hex) | hex to dec   | Conversion to use in formula                       |
|--------|----------------|------------|--|--|
| 0x240C | EE_P_R [15:0]  | 0103       | EE_P_R = 005D0103 <sub>hex</sub> = 6095107 <sub>dec</sub>  | <b>P_R = 6095107 * 2<sup>-8</sup> = 23809.01</b>   |
| 0x240D | EE_P_R [31:16] | 005D       |  |  |
| 0x240E | EE_P_G [15:0]  | FAE5       | EE_P_G = 051CFAE5 <sub>hex</sub> = 85785317 <sub>dec</sub> | <b>P_G = 85785317 * 2<sup>-20</sup> = 81.81125</b> |
| 0x240F | EE_P_G [31:16] | 051C       |  |  |
| 0x2410 | EE_P_T [15:0]  | 0000       | EE_P_T = 00000000 <sub>hex</sub> = 0 <sub>dec</sub>        | <b>P_T = 0 * 2<sup>-44</sup> = 0</b>               |
| 0x2411 | EE_P_T [31:16] | 0000       |  |  |
| 0x2412 | EE_P_O [15:0]  | 1900       | EE_P_O = 00001900 <sub>hex</sub> = 6400 <sub>dec</sub>     | <b>P_O = 6400 * 2<sup>-8</sup> = 25</b>            |
| 0x2413 | EE_P_O [31:16] | 0000       |  |  |

|        |               |      |  |  |
|--------|---------------|------|--|--|
| 0x2424 | EE_Ea [15:0]  | CFAE | EE_Ea = 0051CFAE <sub>hex</sub> = 5361582 <sub>dec</sub>   | <b>Ea</b> = 5361582 * 2 <sup>-16</sup> = <b>81.81125</b>   |
| 0x2425 | EE_Ea [31:16] | 0051 |  |  |
| 0x2426 | EE_Eb [15:0]  | 0103 | EE_Eb = 005D0103 <sub>hex</sub> = 6095107 <sub>dec</sub>   | <b>Eb</b> = 6095107 * 2 <sup>-8</sup> = <b>23809.01</b>    |
| 0x2427 | EE_Eb [31:16] | 005D |  |  |
| 0x2428 | EE_Fa [15:0]  | 6351 | EE_Fa = 03506351 <sub>hex</sub> = 5559995 <sub>dec</sub>   | <b>Fa</b> = 55599953 * 2 <sup>-46</sup> = <b>7.9E-07</b>   |
| 0x2429 | EE_Fa [31:16] | 0350 |  |  |
| 0x242A | EE_Fb [15:0]  | 71F1 | EE_Fb = FE2571F1 <sub>hex</sub> = -31100431 <sub>dec</sub> | <b>Fb</b> = -31100431 * 2 <sup>-36</sup> = <b>-0.00045</b> |
| 0x242B | EE_Fb [31:16] | FE25 |  |  |
| 0x242C | EE_Ga [15:0]  | A7A4 | EE_Ga = FDFFA7A5 <sub>hex</sub> = -33577052 <sub>dec</sub> | <b>Ga</b> = -33577052 * 2 <sup>-36</sup> = <b>-0.00049</b> |
| 0x242D | EE_Ga [31:16] | FDFF |  |  |
| 0x242E | EE_Gb [15:0]  | 2600 | EE_Gb = 2600 <sub>hex</sub> = 9728 <sub>dec</sub>          | <b>Gb</b> = 9728 * 2 <sup>-10</sup> = <b>9.5</b>           |
| 0x242F | EE_Ka [15:0]  | 2A00 | EE_Ka = 2A00 <sub>hex</sub> = 10752 <sub>dec</sub>         | <b>Ka</b> = 10752 * 2 <sup>-10</sup> = <b>10.5</b>         |
| 0x2481 | EE_Ha [15:0]  | 4000 | EE_Ha = 4000 <sub>hex</sub> = 16384 <sub>dec</sub>         | <b>Ha</b> = 16384 * 2 <sup>-14</sup> = <b>1</b>            |
| 0x2482 | EE_Hb [15:0]  | 0000 | EE_Hb = 0000 <sub>hex</sub> = 0 <sub>dec</sub>             | <b>Hb</b> = 0 * 2 <sup>-10</sup> = <b>0</b>                |

Table 12: Example EEPROM calibration parameters



The returned values from the RAM (0x4000 to 0x4008):

| ADDR   | PARAM | DATA (hex) | DATA (dec) |
|--------|-------|------------|------------|
| 0x4003 | RAM_4 | FF9B       | -101       |
| 0x4004 | RAM_5 | FF9D       | -99        |
| 0x4005 | RAM_6 | 57E4       | 22500      |
| 0x4006 | RAM_7 | FF97       | -105       |
| 0x4007 | RAM_8 | FF99       | -103       |
| 0x4008 | RAM_9 | 59D8       | 23000      |

Table 13: Example RAM data

#### 11.1.4.1. Ambient temperature calculation

$$VR_{TA} = RAM_9 + Gb * \frac{RAM_6}{12} = 23000 + 9.5 * \frac{22500}{12}$$

$$VR_{TA} = 40812.5$$

$$AMB = \left[ \frac{RAM_6}{12} \right] / VR_{TA} * 2^{19} = \left[ \frac{22500}{12} \right] / 40812.5 * 2^{19}$$

$$AMB = 24086.73813$$

$$Ta \text{ (sensor temperature in } ^\circ\text{C)} = P_O + \frac{AMB - P_R}{P_G} + P_T * (AMB - P_R)^2$$

$$Ta = 25 + \frac{24086.73813 - 23809.01}{81.81125} + 0 * (24086.73813 - 23809.01)^2$$

$$Ta = 28.395^\circ\text{C}$$

$$Ta = 28.4^\circ\text{C}$$

### 11.1.4.2. Object temperature calculation

$$S = \frac{RAM\_4 + RAM\_5}{2} = \frac{(-101) + (-99)}{2}$$

$$S = -100$$

OR

$$S = \frac{RAM\_7 + RAM\_8}{2} = \frac{(-105) + (-103)}{2}$$

$$S = -104$$

Assumed is that RAM\_4 and RAM\_5 are updated lastly by the device (cycle\_pos = 1)

$$VR_{TO} = RAM\_9 + Ka * \frac{RAM\_6}{12} = 23000 + 10.5 * \frac{22500}{12}$$

$$VR_{TO} = 42687.5$$

$$S_{TO} = \left[ \frac{S}{12} \right] / VR_{TO} * 2^{19} = \left[ \frac{-100}{12} \right] / 42687.5 * 2^{19}$$

$$S_{TO} = -102.35$$

$$TO_0 = 25^{\circ}C$$

$$TA_0 = 25^{\circ}C$$

$$TA_{DUT} = \frac{(AMB - Eb)}{Ea} + 25 = \frac{(24086.73813 - 23809.01)}{81.81125} + 25 = 28.3947$$

$$Ta_{[K]} = TA_{DUT} + 273.15 = 28.3947 + 273.15 = 301.5447$$

To (object temperature in °C)

$$= \sqrt[4]{\frac{S_{TO}}{\epsilon * Fa * Ha * (1 + Ga * (T_{DUT} - T_{O_0}) + Fb * (T_{A_{DUT}} - T_{A_0}))}} + T_{a[K]}^4 - 273.15 - Hb$$

The emissivity parameter (ε) is controlled by the user and is assumed in this example equal to 1.

T<sub>DUT</sub> = 25 for the first calculation

$$T_o = \sqrt[4]{\frac{-102.35}{1 * (7.9E - 07) * 1 * (1 + (-0.00049) * (25 - 25) + (-0.00045) * (28.3947 - 25))}} + (301.5447)^4 - 273.15 - 0$$

$$T_o = 27.2048027^\circ\text{C}$$

The object temperature needs to be calculated 3 times in order to get the end result.

Next object temperature calculation uses previous obtained object temperature.

$$T_o = \sqrt[4]{\frac{-102.35}{1 * (7.9E - 07) * 1 * (1 + (-0.00049) * (27.2048027 - 25) + (-0.00045) * (28.3947 - 25))}} + (301.5447)^4 - 273.15 - 0$$

$$T_o = 27.2035098^\circ\text{C}$$

$$T_o = \sqrt[4]{\frac{-102.35}{1 * (7.9E - 07) * 1 * (1 + (-0.00049) * (27.2035098 - 25) + (-0.00045) * (28.3947 - 25))}} + (301.5447)^4 - 273.15 - 0$$

$$T_o = 27.20351053^\circ\text{C}$$

$$T_o = 27.2^\circ\text{C}$$

## 11.2. Extended range measurement

This measurement type option is implemented in order to give additional range to the medical devices.

When using the extended range measurement the following should be done:

1. Switch the device to extended range measurement mode
2. Wait for the whole measurement to finish
3. Use the following routine to read the data of interest and calculate the temperatures.

All the necessary functions are available at <https://github.com/melexis/mlx90632-library>

To calculate the ambient and object temperature, a set of 3 measurements is required:

- Measurement 1: RAM\_52, RAM\_53, RAM\_54;
- Measurement 2: RAM\_55, RAM\_56, RAM\_57;
- Measurement 3: RAM\_58, RAM\_59, RAM\_60;

All three measurements should be available for proper temperature calculation.

### 11.2.1. Pre-calculations

#### 11.2.1.1. Ambient

$$VR_{TA} = RAM_{57} + Gb * \frac{RAM_{54}}{12}$$

$$Gb = EE\_Gb * 2^{-10}$$

$$AMB = \left[ \frac{RAM_{54}}{12} \right] / VR_{TA} * 2^{19}$$

The parameter EE\_Gb is a signed 16-bit number.

#### 11.2.1.2. Object

$$S = \frac{RAM_{52} - RAM_{53} - RAM_{55} + RAM_{56}}{2} + RAM_{58} + RAM_{59}$$

OR

$$VR_{TO} = RAM_{57} + Ka * \frac{RAM_{54}}{12}$$

$$Ka = EE\_Ka * 2^{-10}$$

$$S_{TO} = \left[ \frac{S}{12} \right] / VR_{TO} * 2^{19}$$

The parameter EE\_Ka is a signed 16-bit number.

### 11.2.2. Ambient temperature

$$T_a \text{ (sensor temperature in } ^\circ\text{C)} = P_O + \frac{AMB - P_R}{P_G} + P_T * (AMB - P_R)^2$$

**With:**

Ta in degrees Celsius

$$\begin{aligned} P_R &= EE\_P\_R * 2^{-8} \\ P_O &= EE\_P\_O * 2^{-8} \\ P_G &= EE\_P\_G * 2^{-20} \\ P_T &= EE\_P\_T * 2^{-44} \end{aligned}$$

The parameters EE\_P\_R, EE\_P\_O, EE\_P\_G and EE\_P\_T are signed 32-bit numbers.

### 11.2.3. Object temperature

**TO (object temperature in °C)**

$$= 4 \sqrt[4]{\frac{S_{TO}}{\epsilon * \frac{Fa}{2} * Ha * (1 + Ga * (TO_{DUT} - TO_0)) + Fb * (TA_{DUT} - TA_0)}} + Ta_{[K]}^4 - 273.15 - Hb$$

**With:**

$$\begin{aligned} Fa &= EE\_Fa * 2^{-46} \\ Fb &= EE\_Fb * 2^{-36} \\ Ga &= EE\_Ga * 2^{-36} \\ Ha &= EE\_Ha * 2^{-14} \\ Hb &= EE\_Hb * 2^{-10} \\ TO_0 &= 25^\circ\text{C} \\ TA_0 &= 25^\circ\text{C} \end{aligned}$$

$$TA_{DUT} = \frac{(AMB - Eb)}{Ea} + 25$$

$$Ea = EE\_Ea * 2^{-16}$$

$$Eb = EE\_Eb * 2^{-8}$$

$$Ta_{[K]} = TA_{DUT} + 273.15 \text{ in Kelvin}$$

$$TO_{DUT} = \text{Object temperature in } 25^\circ\text{C}$$

$$\epsilon = 1 = \text{Object Emissivity parameter (not stored in EEPROM, but part of the 'app')}$$

The parameters EE\_Ea, EE\_Eb, EE\_Fa, EE\_Fb, EE\_Ga are signed 32-bit numbers.

The parameters EE\_Gb, EE\_Ka, EE\_Ha and EE\_Hb are signed 16-bit numbers.

**Note:**

One can see that to compute “To (object temperature)”, “To” already needs to be known. “To (object temperature)” is computed in an iterative manner. In the first iteration “To” is assumed to be 25°C. In the 2<sup>nd</sup> iteration the result of first iteration is used, and in the 3<sup>rd</sup> iteration the end result is obtained. (See example on next page).

## 11.2.4. Example Extended range measurement Temperature Calculation

Assumed are the following calibration parameters read from EEPROM:

| ADDR   | PARAM          | DATA (hex) | hex to dec   | Conversion to use in formula                       |
|--------|----------------|------------|--|--|
| 0x240C | EE_P_R [15:0]  | 0103       | EE_P_R = 005D0103 <sub>hex</sub> = 6095107 <sub>dec</sub>  | <b>P_R = 6095107 * 2<sup>-8</sup> = 23809.01</b>   |
| 0x240D | EE_P_R [31:16] | 005D       |  |  |
| 0x240E | EE_P_G [15:0]  | FAE5       | EE_P_G = 051CFAE5 <sub>hex</sub> = 85785317 <sub>dec</sub> | <b>P_G = 85785317 * 2<sup>-20</sup> = 81.81125</b> |
| 0x240F | EE_P_G [31:16] | 051C       |  |  |
| 0x2410 | EE_P_T [15:0]  | 0000       | EE_P_T = 00000000 <sub>hex</sub> = 0 <sub>dec</sub>        | <b>P_T = 0 * 2<sup>-44</sup> = 0</b>               |
| 0x2411 | EE_P_T [31:16] | 0000       |  |  |
| 0x2412 | EE_P_O [15:0]  | 1900       | EE_P_O = 00001900 <sub>hex</sub> = 6400 <sub>dec</sub>     | <b>P_O = 6400 * 2<sup>-8</sup> = 25</b>            |
| 0x2413 | EE_P_O [31:16] | 0000       |  |  |
| 0x2424 | EE_Ea [15:0]   | CFAE       | EE_Ea = 0051CFAE <sub>hex</sub> = 5361582 <sub>dec</sub>   | <b>Ea = 5361582 * 2<sup>-16</sup> = 81.81125</b>   |
| 0x2425 | EE_Ea [31:16]  | 0051       |  |  |
| 0x2426 | EE_Eb [15:0]   | 0103       | EE_Eb = 005D0103 <sub>hex</sub> = 6095107 <sub>dec</sub>   | <b>Eb = 6095107 * 2<sup>-8</sup> = 23809.01</b>    |
| 0x2427 | EE_Eb [31:16]  | 005D       |  |  |
| 0x2428 | EE_Fa [15:0]   | 6351       | EE_Fa = 03506351 <sub>hex</sub> = 5559995 <sub>dec</sub>   | <b>Fa = 5559995 * 2<sup>-46</sup> = 7.9E-07</b>    |
| 0x2429 | EE_Fa [31:16]  | 0350       |  |  |
| 0x242A | EE_Fb [15:0]   | 71F1       | EE_Fb = FE2571F1 <sub>hex</sub> = -31100431 <sub>dec</sub> | <b>Fb = -31100431 * 2<sup>-36</sup> = -0.00045</b> |
| 0x242B | EE_Fb [31:16]  | FE25       |  |  |
| 0x242C | EE_Ga [15:0]   | A7A4       | EE_Ga = FDFFA7A5 <sub>hex</sub> = -33577052 <sub>dec</sub> | <b>Ga = -33577052 * 2<sup>-36</sup> = -0.00049</b> |
| 0x242D | EE_Ga [31:16]  | FDFF       |  |  |
| 0x242E | EE_Gb [15:0]   | 2600       | EE_Gb = 2600 <sub>hex</sub> = 9728 <sub>dec</sub>          | <b>Gb = 9728 * 2<sup>-10</sup> = 9.5</b>           |
| 0x242F | EE_Ka [15:0]   | 2A00       | EE_Ka = 2A00 <sub>hex</sub> = 10752 <sub>dec</sub>         | <b>Ka = 10752 * 2<sup>-10</sup> = 10.5</b>         |
| 0x2481 | EE_Ha [15:0]   | 4000       | EE_Ha = 4000 <sub>hex</sub> = 16384 <sub>dec</sub>         | <b>Ha = 16384 * 2<sup>-14</sup> = 1</b>            |
| 0x2482 | EE_Hb [15:0]   | 0000       | EE_Hb = 0000 <sub>hex</sub> = 0 <sub>dec</sub>             | <b>Hb = 0 * 2<sup>-10</sup> = 0</b>                |

Table 14: Example EEPROM calibration parameters

The returned values from the RAM (0x4033 to 0x403A):

| ADDR   | PARAM  | DATA (hex) | DATA (dec) |
|--------|--------|------------|------------|
| 0x4033 | RAM_52 | FE64       | -412       |
| 0x4034 | RAM_53 | FEAB       | -341       |
| 0x4035 | RAM_54 | 57E4       | 22500      |
| 0x4036 | RAM_55 | FEA3       | -349       |
| 0x4037 | RAM_56 | FE6A       | -406       |
| 0x4038 | RAM_57 | 59D8       | 23000      |
| 0x4039 | RAM_58 | 000B       | 11         |
| 0x403A | RAM_59 | 0009       | 9          |

Table 15: Example RAM data

#### 11.2.4.1. Ambient temperature calculation

$$VR_{TA} = RAM_{57} + Gb * \frac{RAM_{54}}{12} = 23000 + 9.5 * \frac{22500}{12}$$

$$VR_{TA} = 40812.5$$

$$AMB = \left[ \frac{RAM_{54}}{12} \right] / VR_{TA} * 2^{19} = \left[ \frac{22500}{12} \right] / 40812.5 * 2^{19}$$

$$AMB = 24086.73813$$

$$Ta \text{ (sensor temperature in } ^\circ\text{C)} = P_O + \frac{AMB - P_R}{P_G} + P_T * (AMB - P_R)^2$$

$$Ta = 25 + \frac{24086.73813 - 23809.01}{81.81125} + 0 * (24086.73813 - 23809.01)^2$$

$$Ta = 28.395^\circ\text{C}$$

$$Ta = \mathbf{28.4^\circ\text{C}}$$



### 11.2.4.2. Object temperature calculation

$$S = \frac{RAM_{52} - RAM_{53} - RAM_{55} + RAM_{56}}{2} + RAM_{58} + RAM_{59}$$

$$S = \frac{(-412) - (-341) - (-349) + (-406)}{2} + 11 + 9$$

$$S = -44$$

$$VR_{TO} = RAM_{57} + Ka * \frac{RAM_{54}}{12} = 23000 + 10.5 * \frac{22500}{12}$$

$$VR_{TO} = 42687.5$$

$$S_{TO} = \left[ \frac{S}{12} \right] / VR_{TO} * 2^{19} = \left[ \frac{-44}{12} \right] / 42687.5 * 2^{19}$$

$$S_{TO} = -45.034$$

$$TO_0 = 25^{\circ}\text{C}$$

$$TA_0 = 25^{\circ}\text{C}$$

$$TA_{DUT} = \frac{(AMB - Eb)}{Ea} + 25 = \frac{(24086.73813 - 23809.01)}{81.81125} + 25 = 28.3947$$

$$Ta_{[K]} = TA_{DUT} + 273.15 = 28.3947 + 273.15 = 301.5447$$

$T_o$  (object temperature in °C)

$$= \sqrt[4]{\frac{S_{TO}}{\epsilon * \frac{Fa}{2} * Ha * (1 + Ga * (T_{O_{DUT}} - T_{O_0}) + Fb * (T_{A_{DUT}} - T_{A_0}))}} + T_{a[K]}^4 - 273.15 - Hb}$$

The emissivity parameter ( $\epsilon$ ) is controlled by the user and is assumed in this example equal to 1.  
 $T_{O_{DUT}} = 25$  for the first calculation

$$T_o = \sqrt[4]{\frac{-45.034}{1 * \frac{7.9E-07}{2} * 1 * (1 + (-0.00049) * (25 - 25) + (-0.00045) * (28.3947 - 25))}} + (301.5447)^4 - 273.15 - 0}$$

$$T_o = 27.34837117^\circ\text{C}$$

The object temperature needs to be calculated 3 times in order to get the end result.  
 Next object temperature calculation uses previous obtained object temperature.

$$T_o = \sqrt[4]{\frac{-45.034}{1 * \frac{7.9E-07}{2} * 1 * (1 + (-0.00049) * (27.34837117 - 25) + (-0.00045) * (28.3947 - 25))}} + (301.5447)^4 - 273.15 - 0}$$

$$T_o = 27.34715755^\circ\text{C}$$

$$T_o = \sqrt[4]{\frac{-102.35}{1 * \frac{7.9E-07}{2} * 1 * (1 + (-0.00049) * (27.34715755 - 25) + (-0.00045) * (28.3947 - 25))}} + (301.5447)^4 - 273.15 - 0}$$

$$T_o = 27.34715818^\circ\text{C}$$

$$T_o = 27.35^\circ\text{C}$$

## 12. Performance characteristics

### 12.1. Accuracy

The calculated ambient temperature has an accuracy of  $\pm 3^{\circ}\text{C}$  between  $-20^{\circ}\text{C}$  and  $85^{\circ}\text{C}$  of ambient temperature. Between  $15^{\circ}\text{C}$  and  $45^{\circ}\text{C}$  the accuracy is  $\pm 1^{\circ}\text{C}$ . All accuracy specifications apply under settled isothermal conditions only.

#### 12.1.1. Standard

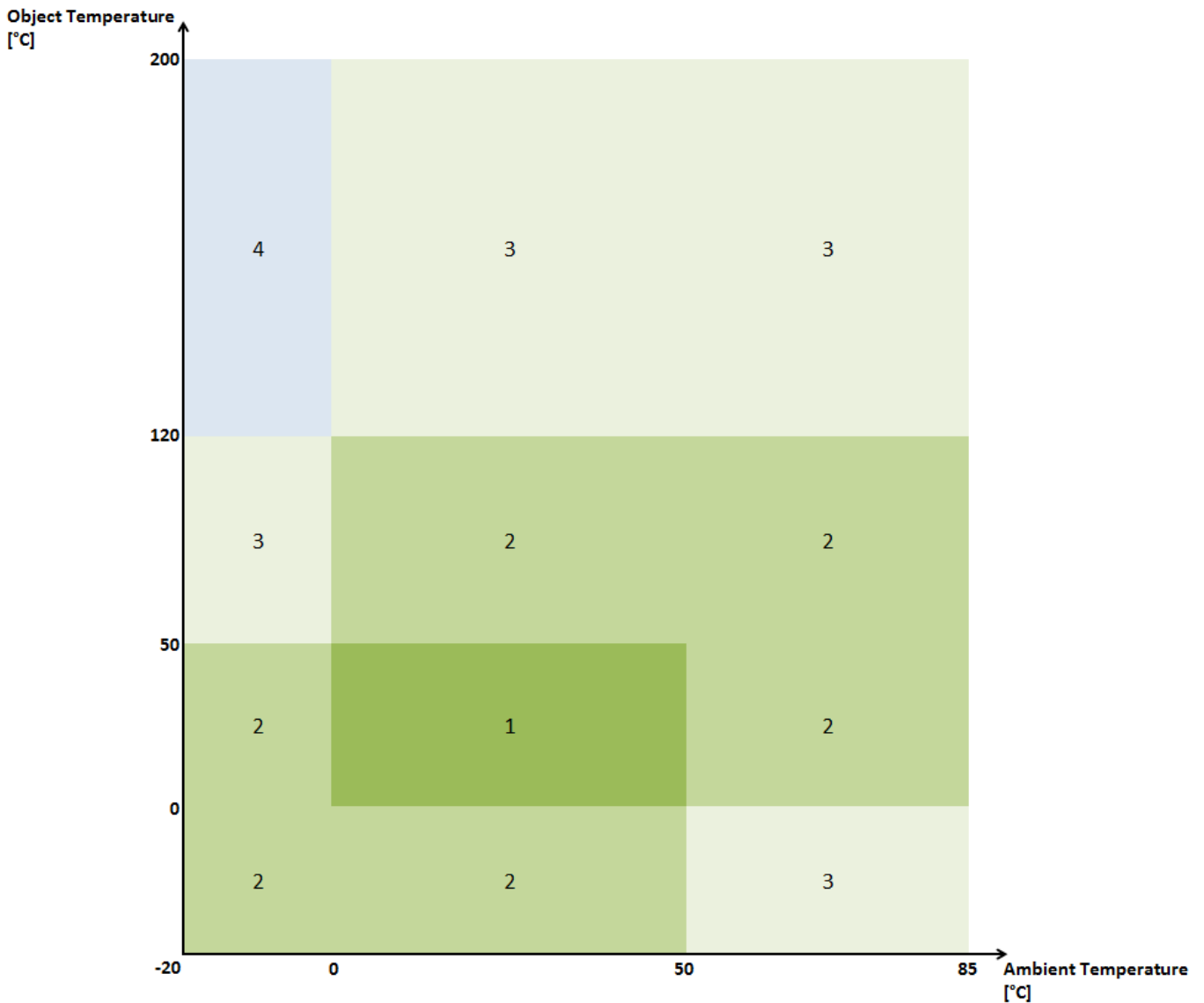


Figure 19: Standard accuracy table

## 12.1.2. Medical

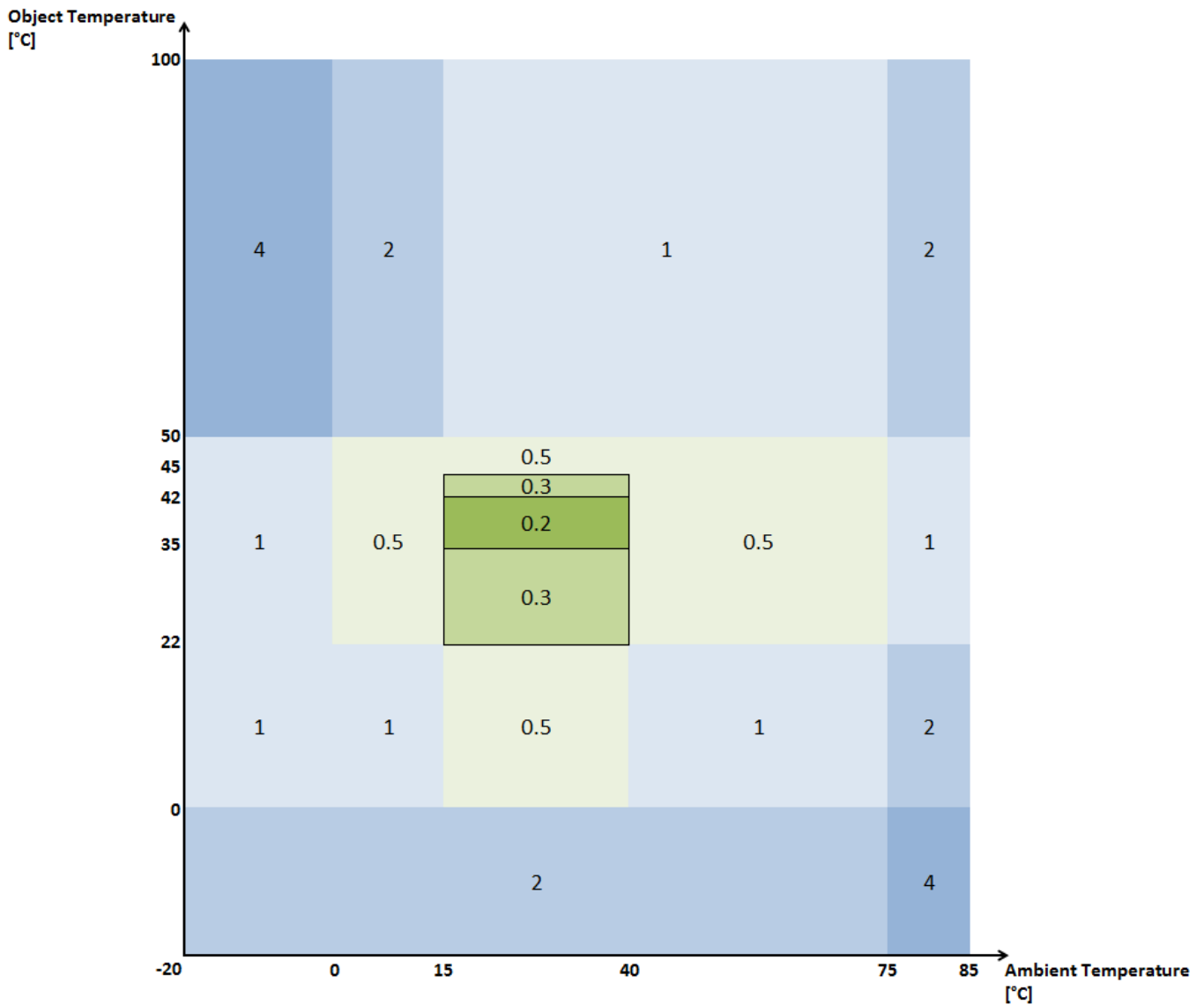


Figure 20: Medical accuracy table

The version MLX90632SLD-DCB complies with the ASTM standard section 5.4 (Designation: E1965 – 98 (Re-approved 2009) - Standard Specification for Infrared Thermometers for Intermittent Determination of Patient Temperature.

## 12.2. Field of View (FoV)

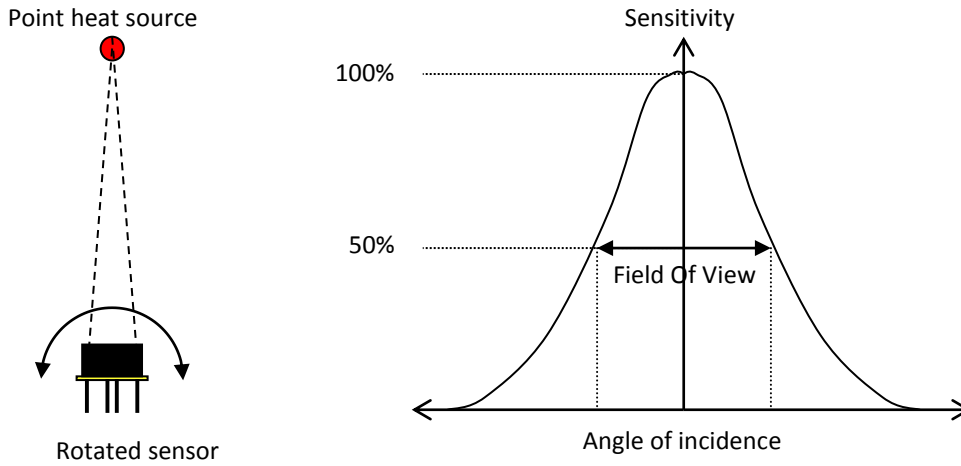


Figure 21: Field of View measurement principle

| Parameter     | 50% of maximum | 10% of maximum | Unit                |
|---------------|----------------|----------------|---------------------|
| Field Of View | 50             | 70             | ° (angular degrees) |

Table 16: Field Of View of the MLX90632

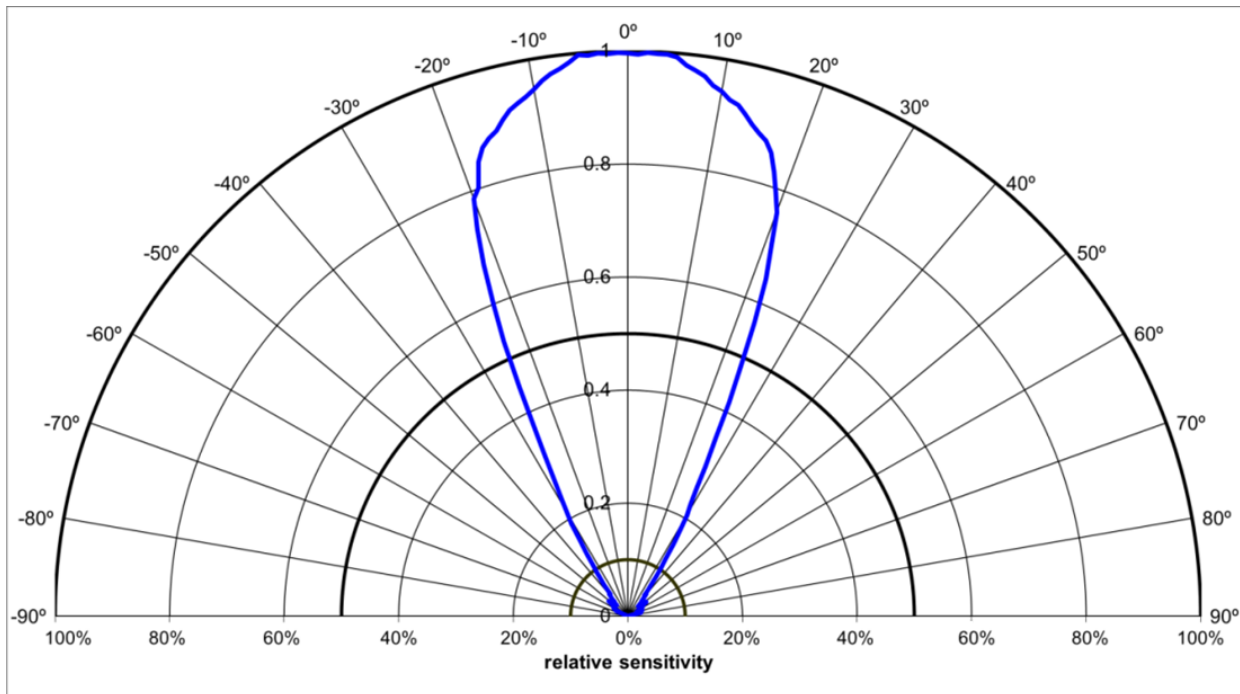


Figure 22: Field of View of MLX90632 (FoV = 50°)

The 50° is measured at the 50% level of sensitivity.

**For high accuracy applications, one should take care that the field of view is not obstructed by the enclosure of the application. For this, one has to take care that no obstruction is in a cone of at least 70° wide. For medical applications the obstacle free zone should be at least 110° wide.**

## 12.3. Noise

Measurement conditions for noise performance are  $T_o = T_a = 25^\circ\text{C}$ .

Note:

Due to the nature of thermal infrared radiation, it is normal that the noise will decrease for high temperature and increase for lower temperatures.

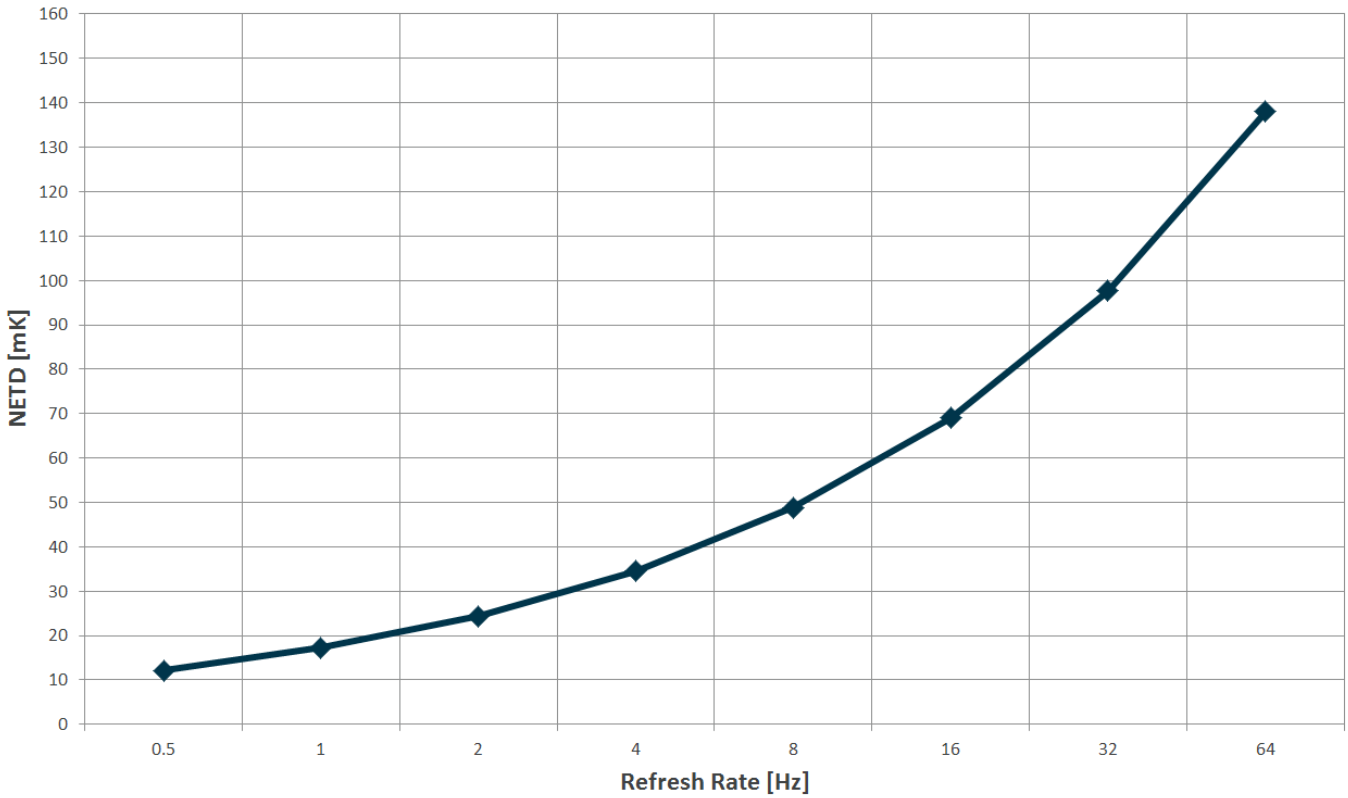


Figure 23: NETD vs. Refresh rate

## 13. Mechanical Drawing

### 13.1. Package dimensions

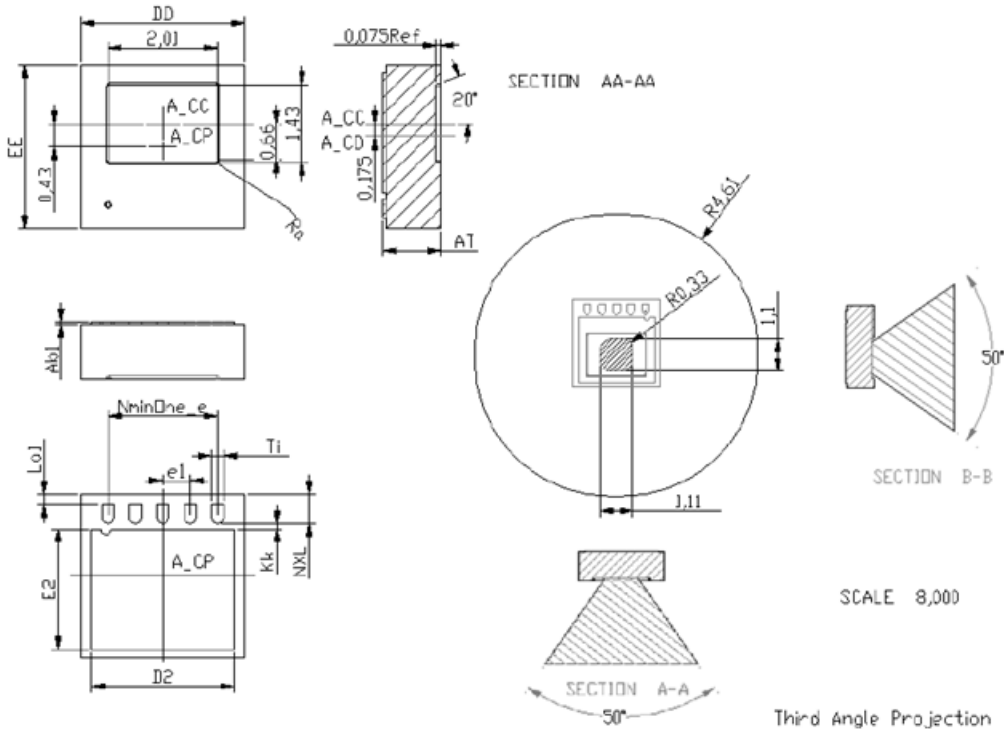


Figure 24: Package dimensions for MLX90632 (FoV = 50°)

| Symbol                  | Min      | Nom     | Max  |
|-------------------------|----------|---------|------|
| DD=EE                   | 2.9      | 3.0 BSC | 3.1  |
| AT                      | 0.90     | 0.95    | 1.00 |
| Ra                      | 0.05     |         |      |
| D2                      | 2.40     | 2.50    | 2.60 |
| E2                      | 2.00     | 2.10    | 2.20 |
| Lo1                     | 0.15 Max |         |      |
| Kk                      | 0.20     | 0.30    | --   |
| NXL                     | 0.35     | 0.40    | 0.45 |
| e1                      | 0.50 BSC |         |      |
| NminOne_e               | (5-1)*e1 |         |      |
| Ti                      | 0.18     | 0.25    | 0.30 |
| Tolerance (A_CC – A_CP) | -0.15    |         | 0.15 |
| Tolerance (A_CC – A_CD) | -0.1     |         | 0.1  |

Table 17: Package dimensions for MLX90632 (FoV = 50°)

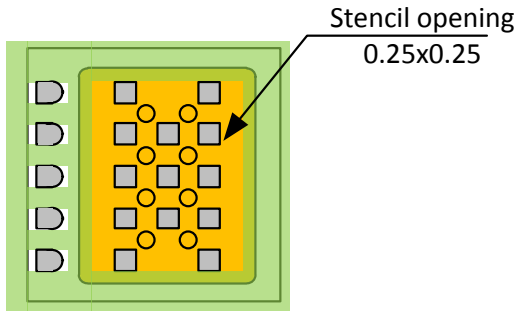
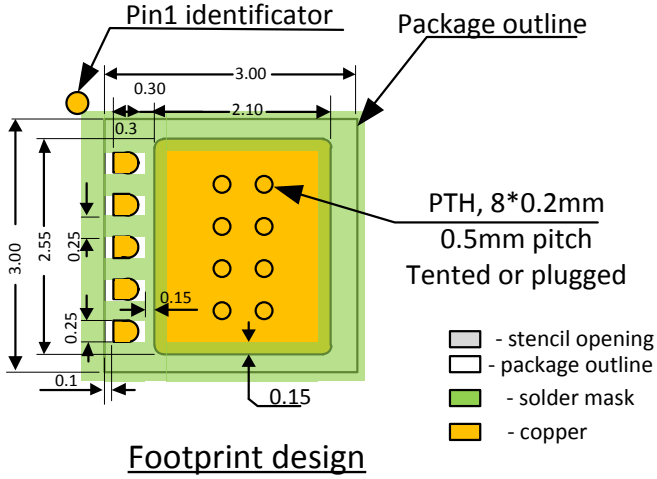
\*BSC ≡ basic dimension

\*A\_CC = Center of silicon Cap

\*A\_CD = Center of Die frame

\*A\_CP = Center of Package

## 13.2. PCB footprint



- Recommended 1)PCB finish: OSP, ENIG, ENEPIG  
 2)Stencil thickness max 100um  
 3)Solderpaste – noclean , halogen free

Figure 25: PCB footprint and stencil design for MLX90632

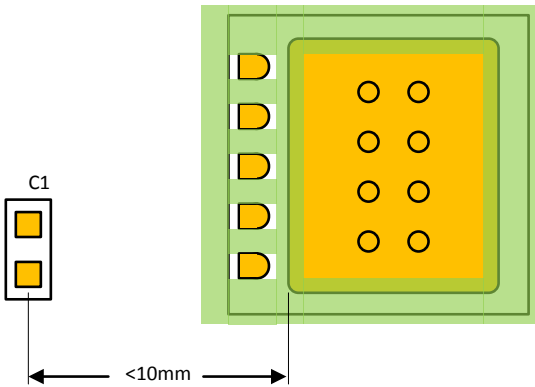


Figure 26a: Decoupling capacitor C1 placement



## 14. Application schematic

### 14.1. 3V3 I<sup>2</sup>C mode

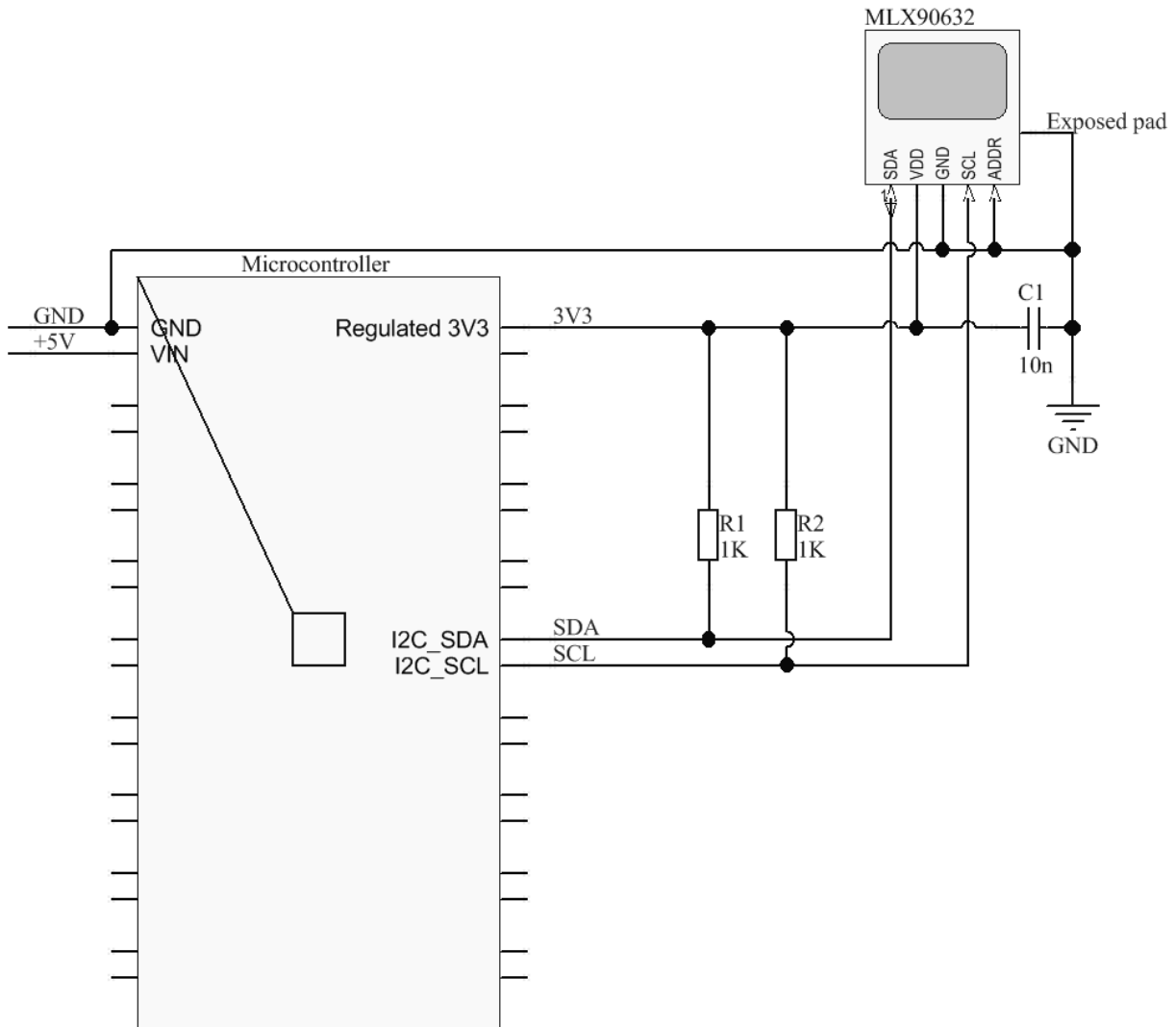


Figure 27: Typical application schematic for 3V3 I<sup>2</sup>C communication with MLX90632

Note: C1 should be placed within 10mm from the device

## 14.2. 1V8 I<sup>2</sup>C mode

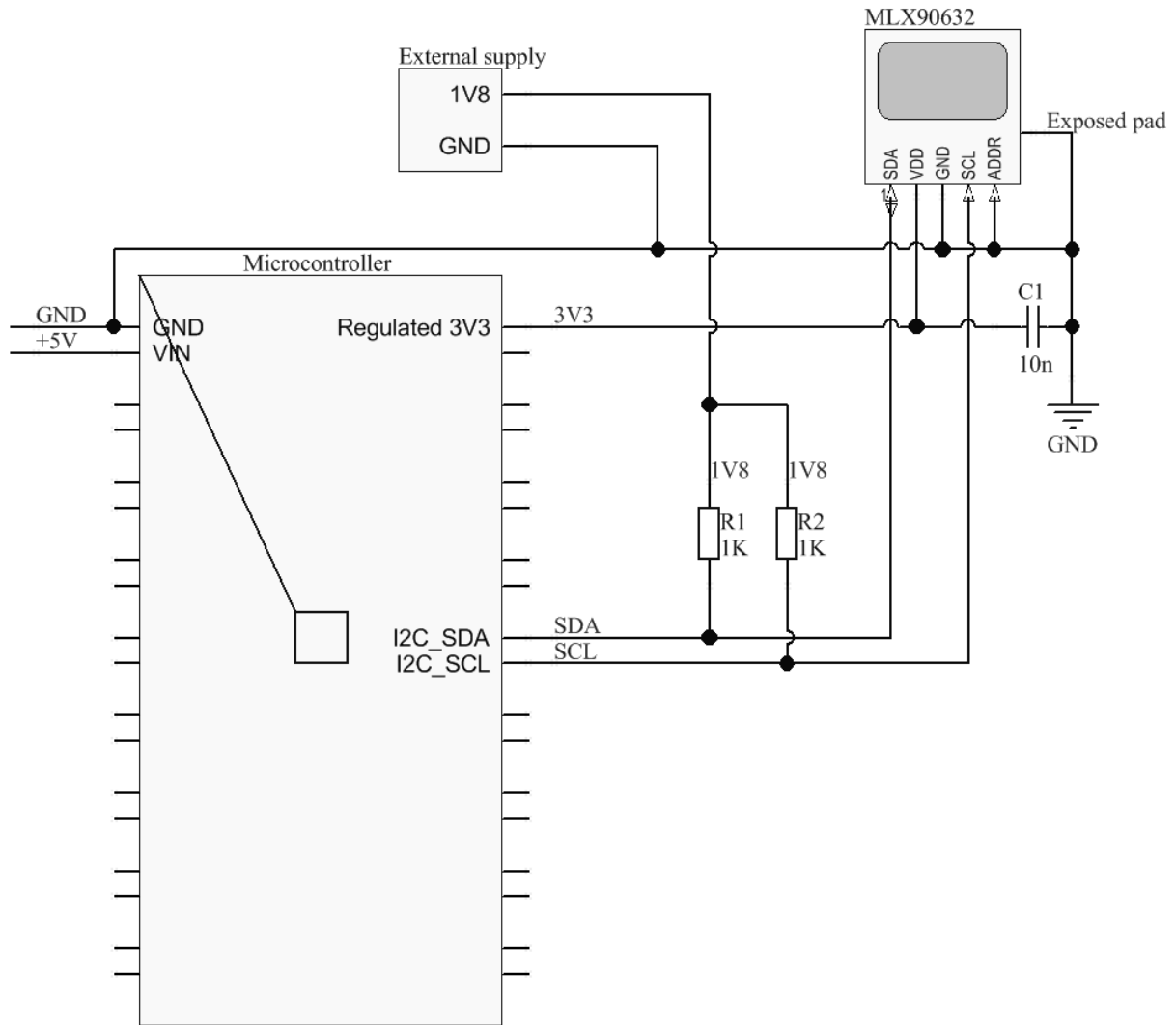


Figure 28: Typical application schematic for 1V8 I<sup>2</sup>C communication with MLX90632

Note: C1 should be placed within 10mm from the device

## 15. Software

MLX90632 library on Github:

<https://github.com/melexis/mlx90632-library>

Example usage of the MLX90632 Library with Keil IDE:

<https://github.com/melexis/mlx90632-example>

Evaluation board EVB90632:

<https://www.melexis.com/en/documents/tools/tools-evb90632-software-exe>

## 16. Standard information regarding manufacturability of Melexis products with different soldering processes

The MLX90632 is a MSL-3 device.

Our products are classified and qualified regarding soldering technology, solderability and moisture sensitivity level according to following test methods:

### Reflow Soldering SMD's (Surface Mount Device)s

- IPC/JEDEC J-STD-020  
Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices (Classification reflow profiles according to table 5-2)
- EIA/JEDEC JESD22-A113  
Preconditioning of Nonhermetic Surface Mount Devices Prior to Reliability Testing (Reflow profiles according to table 2)

### Wave Soldering SMD's (Surface Mount Device)s and THD's (Through Hole Device)s

- EN60749-20  
Resistance of plastic- encapsulated SMD's to combined effect of moisture and soldering heat
- EIA/JEDEC JESD22-B106 and EN60749-15  
Resistance to soldering temperature for through-hole mounted devices

### Iron Soldering THD's (Through Hole Device)s

- EN60749-15  
Resistance to soldering temperature for through-hole mounted devices

### Solderability SMD's (Surface Mount Device)s and THD's (Through Hole Device)s

- EIA/JEDEC JESD22-B102 and EN60749-21  
Solderability

For all soldering technologies deviating from above mentioned standard conditions (regarding peak temperature, temperature gradient, temperature profile etc.) additional classification and qualification tests have to be agreed upon with Melexis.

The application of Wave Soldering for SMD's is allowed only after consulting Melexis regarding assurance of adhesive strength between device and board.

Melexis recommends reviewing on our web site the General Guidelines [soldering recommendation](http://www.melexis.com/Quality_soldering.aspx) ([http://www.melexis.com/Quality\\_soldering.aspx](http://www.melexis.com/Quality_soldering.aspx)).

Melexis is contributing to global environmental conservation by promoting lead free solutions. For more information on qualifications of RoHS compliant products (RoHS = European directive on the Restriction Of the use of certain Hazardous Substances) please visit the quality page on our website: <http://www.melexis.com/quality.aspx>

## 17. ESD Precautions

Electronic semiconductor products are sensitive to Electro Static Discharge (ESD). Always observe Electro Static Discharge control procedures whenever handling semiconductor products.

## 18. Application comments

1. Significant contamination at the optical input side (sensor filter) might cause unknown additional filtering/distortion of the optical signal and therefore results in unspecified errors.
2. IR sensors are inherently susceptible to errors caused by thermal gradients. There are physical reasons for these phenomena and, in spite of the careful design of the MLX90632, it is recommended not to subject the MLX90632 to heat transfer and especially transient conditions.
3. The MLX90632 is designed and calibrated to operate as a non-contact thermometer in settled conditions.
4. Upon power-up the MLX90632 passes embedded checking and calibration routines. During these routines the output is not defined and it is recommended to wait for the specified POR time before reading the module. Very slow power-up may cause the embedded POR circuitry to trigger on inappropriate levels, resulting in unspecified operation which is not recommended.
5. Capacitive loading on an I<sup>2</sup>C bus can degrade the communication. Improvement is possible with use of current sources compared to resistors in the pull-up circuitry. Further improvement is possible with specialized commercially available bus accelerators.
6. A sleep mode is available in the MLX90632. This mode is entered and exited via the I<sup>2</sup>C compatible 2-wire communication.
7. A power supply and decoupling capacitor is needed as with most integrated circuits. The MLX90632 is a mixed-signal device with sensors, small analog signals, digital parts and I/O circuitry. In order to keep the noise low, power supply switching noise needs to be decoupled. High noise from external circuitry can also affect the noise performance of the device. In many applications a 10nF SMD ceramic capacitor close to the Vdd and Vss pins would be a good choice. It should be noted that not only the trace to the Vdd pin needs to be short, but also the one to the Vss pin.
8. Do not perform measurements in oily or helium environments

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