MLX90636

Ultra-Miniature Thermometer
Datasheet

Melexis
INNOVATION WITH HEART

General description

Features & benefits

- Small size of 1.8x1.8mm^2
- Factory calibrated Object temperature Measurement accuracy of ±0.2°C
- Sleep current less than 1.5µA
- I2C interface
- Software definable I2C address
- Field of View of 50°
- Wide refresh rate range
- Integrated post-calibration option
- Ambient operating temperature range from -20°C to 85°C
- Package RoHS compliant LGA 5-pin

Applications examples

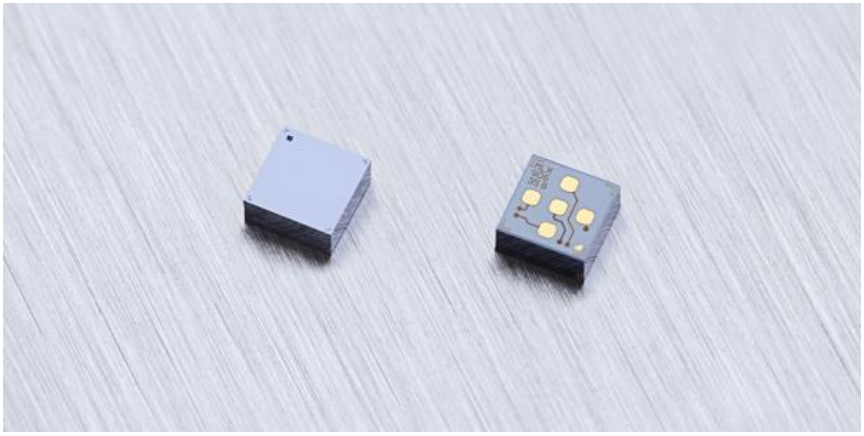
- High precision non-contact temperature measurements
- Body temperature measurement
- Non-contact thermometer for mobile and IoT application
- Wearables
- Healthcare

Description

The MLX90636 is a non-contact infrared temperature sensor in a small SMD Chip-scale 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.
The MLX90636 is highly resistant to temperature fluctuations in its environment, ensuring accurate measurements. Localized thermal variations, such as air turbulence, will not affect the thermopile's output signal.
The supply voltage of the MLX90636 is either 2.8 or 3.3V. For the I2C communication with the master microcontroller, the MLX90636 supports either 1.2V, or 1.8V I2C bus voltage.
An optical filter is integrated in the sensor to provide ambient light immunity. The wavelength pass band of this optical filter is from 2 till 20µm.

Available support & tools

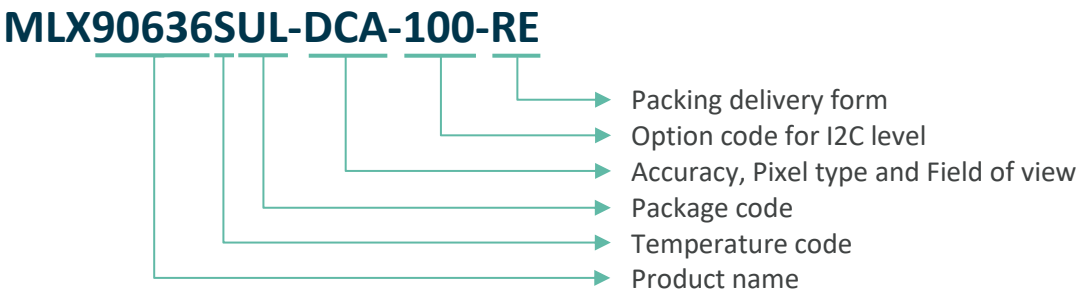
- www.melexis.com/technical-inquiry



Ordering information

Product code	Temperature	Package	Type	Output	Packing
MLX90636SUL-DCA-100-RE	-20 to 85 °C	LGA-5	3.3V, medical accuracy, FOV 50°	1.8V I2C	Reel
MLX90636SUL-ECA-100-RE	-20 to 85 °C	LGA-5	2.8V, medical accuracy, FOV 50°	1.8V I2C	Reel
MLX90636SUL-ECA-200-RE	-20 to 85 °C	LGA-5	2.8V, medical accuracy, FOV 50°	1.2V I2C	Reel

Table 1 – Product codes



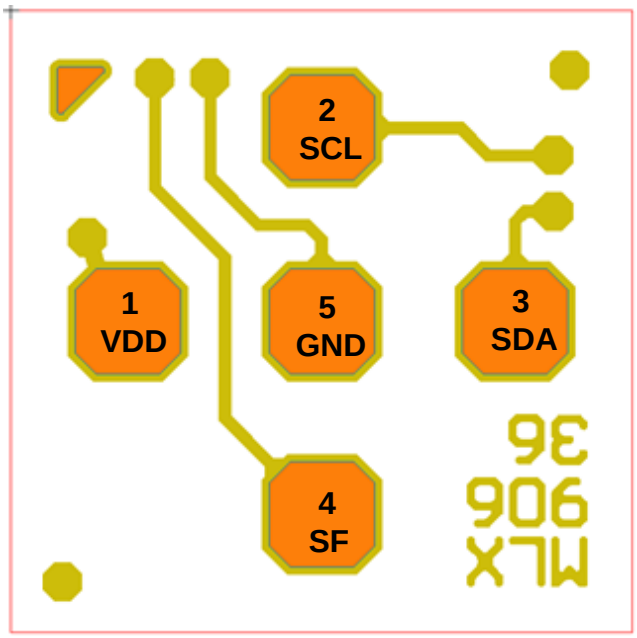
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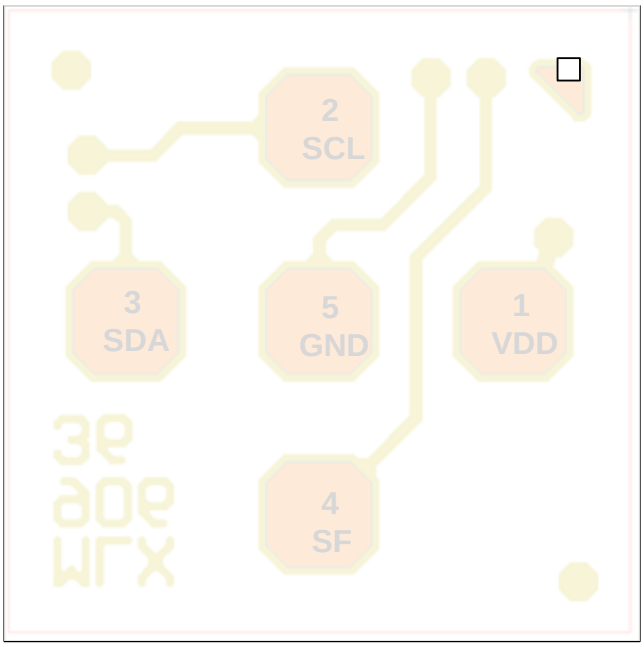
1 Pins description and block diagram

1.1 Pins description

1.1.1 Pins description for LGA-5 package



MLX90636 Backside view



MLX90636 Top view

Figure 1 Package views

Pin #	Name	I/O [1]	Description
1	VDD	S	Supply
2	SCL	I	I2C Clock line
3	SDA	I/O	I2C Data line
4	SF	I	Ground
5	GND	S	Ground

Table 2 – LGA-5 package pins description

For optimal EMC behavior connect the unused pins (Not Used) to the ground (See section 4.2 Recommended Application diagram).

[1] [S] Supply, [I] input, [O] output

1.2 Block diagram

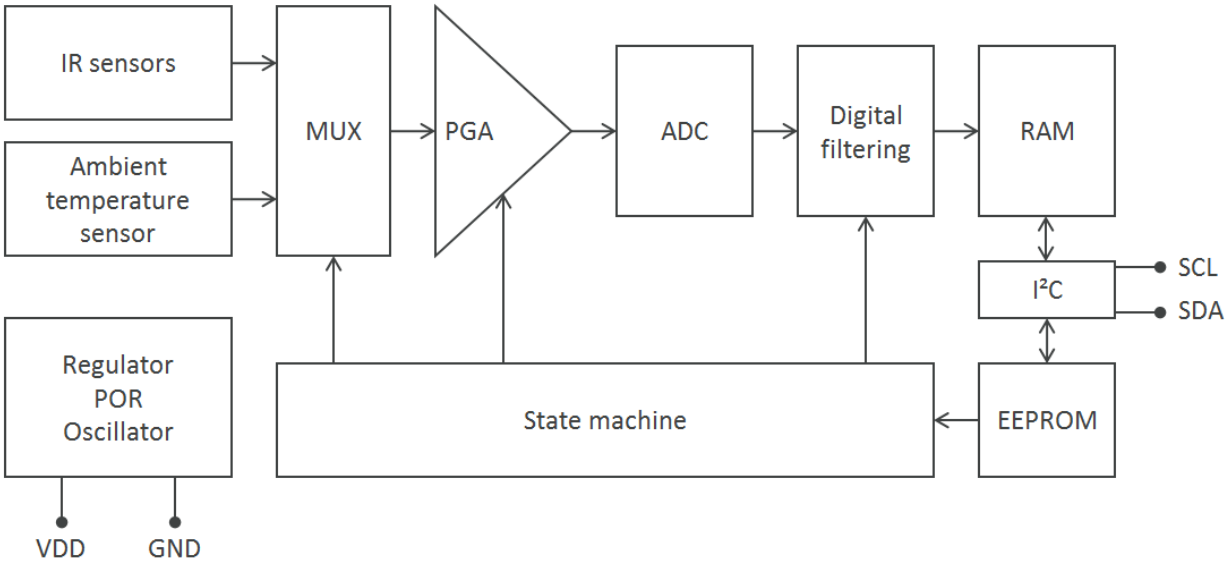


Figure 2 Block Diagram

2 Conditions and specifications

2.1 Absolute Maximum Ratings (AMR)

Parameter	Symbol	Min.	Max.	Unit	Condition
Over voltage all pins	V_{AMR}		5	V	
Reverse Voltage all pins	V_R		-0.5	V	
SF-pin Voltage	V_{SF}		0	V	
DC current into SCL pin			10	µA	
DC current into SDA pin			25	mA	
ESD voltage	$V_{ESD-HBM}$		+/- 2	kV	HBM (AEC-Q100-002), all pins
	$V_{ESD-CDM}$		+/- 750	V	CDM (AEC-Q100-011)
	Air discharge		4	kV	IEC61000-4-2
	Contact discharge		2	kV	IEC61000-4-2
Operating Temperature Range		-20	+85	°C	Ambient temperature
Storage Temperature Range		-40	+85	°C	Ambient temperature
EEPROM re-writes			10		

Table 3 – Absolute Maximum Ratings

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

2.2 Electrical operating conditions & specifications

Unless otherwise specified, the electrical specifications are valid for a temperature 25 °C, and a supply voltage 3.3/2.8 V.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Supply voltage	V_{DD}	3	3.3	3.6	V	-DCA version
		2.7	2.8	3		-ECA version
Supply voltage rising	T_{POR}[2]			20	ms	10% to 90% of specified supply voltage

Table 4 – Electrical operating conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition	
Supply Current	I_{DD}		0.7	0.8	mA	No load	
Sleep Current	I_{DDpr}		0.8	1.5	µA	No load, erase/write EEPROM operations	
POR level							
POR level	V_{POR_up}	1.3		2.4	V	Power-up (full temp range)	
POR level	V_{POR_down}	1.1		2.1	V	Power-down (full temp range)	
POR hysteresis	V_{POR_hys}	200			mV	Full temp range	
Power-on time	T_{valid}		100	200	µs	I2C available	
I2C interface							
Input high voltage	V_{IH}	0.7*V_{I2C}		V_{I2C}+0.5	V	V_{I2C} = 1.8V	Full temperature and supply
		0.8*V_{I2C}		V_{I2C}+0.3	V	V_{I2C} = 1.2V	
Input low voltage	V_{IL}	-0.5		0.3*V_{I2C}	V	V_{I2C} = 1.8V	Full temperature and supply
		-0.3		0.25*V_{I2C}	V	V_{I2C} = 1.2V	
Output high voltage	V_{OH}	0.7*V_{I2C}		V_{I2C}	V	V_{I2C} = 1.8V	Full temperature and supply
		0.8*V_{I2C}		V_{I2C}	V	V_{I2C} = 1.2V	
Output low voltage	V_{OL}	0		0.4	V	V_{I2C} = 1.8V	Full temperature and supply, I_{SDA} = 3mA
		0		0.25*V_{I2C}	V	V_{I2C} = 1.2V	
SDA pin leakage	$I_{SDA, leak}$			50	nA	V_{SDA}=1.8V, Ta=+85°C	
SCL pin leakage	$I_{SCL, leak}$			50	nA	V_{SCL}=1.8V, Ta=+85°C	
SDA pin capacitance				10	pF		
SCL pin capacitance				10	pF		
Slave address	SA		32		hex		

Table 5 – Electrical specifications

[2] During Tpor it is advised that I2C communication is not present. A failure to secure so, may lead to increased current consumption. It can be minimized by adding a 10kOhm resistor in series to the SF pin.

2.3 Accuracy specifications

The calculated ambient temperature has an accuracy of ±3˚C between -20˚C and 85˚C of ambient temperature. Between 15˚C and 45˚C the accuracy is ±1˚C.
All accuracy specifications apply under settled isothermal conditions only.

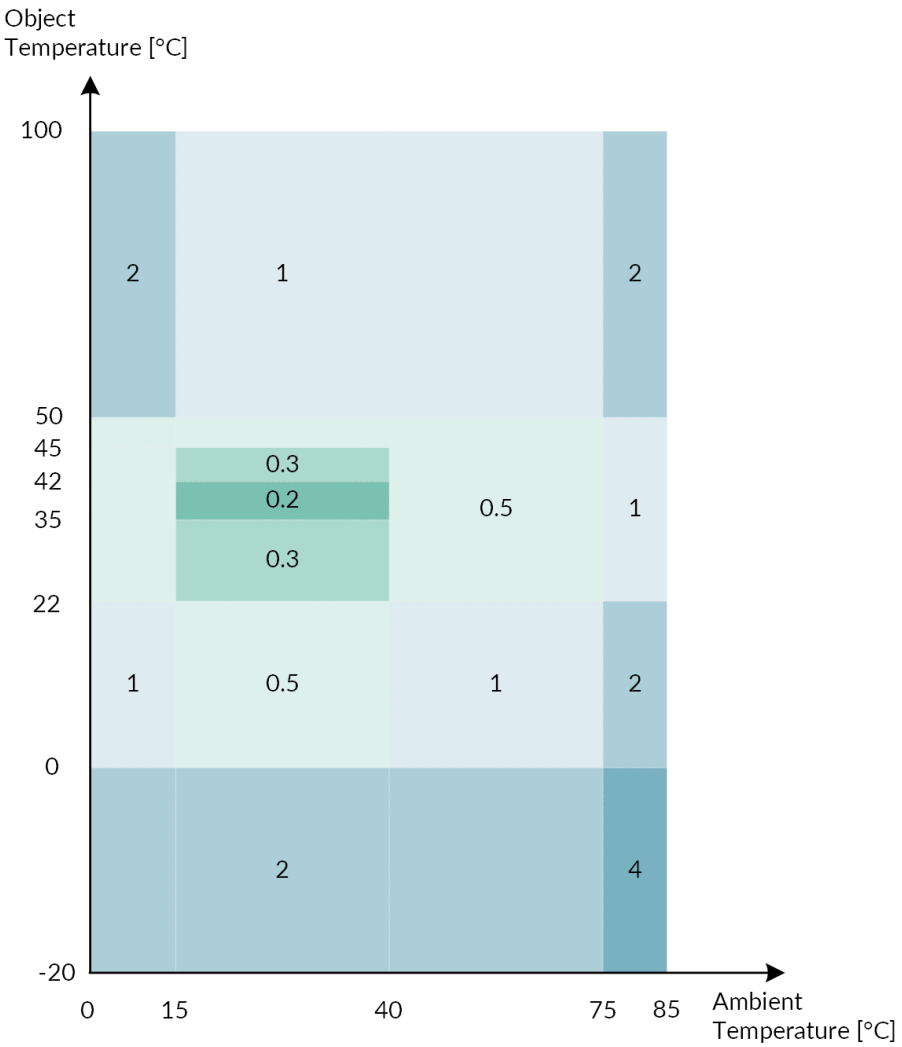


Figure 3 Accuracy diagram of the MLX90636

The MLX90636 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.

3 Functional description & interfaces

3.1 Detailed description

The MLX90636 is a far infrared, non-contact temperature sensor in a small SMD Chip-scale (CSP) package. The device is factory calibrated to a high accuracy with calibration constants stored in the EEPROM memory. 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 MLX90636 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 I2C. The ambient and object temperature can be calculated externally based on these calibration constants and the measurement data.

The MLX90636 is highly resistant to temperature fluctuations in its environment, ensuring accurate measurements. Localized thermal variations, such as air turbulence, will not affect the thermopile's output signal. However, extreme temperature changes can impact results. The accuracy of the thermometer may be affected by temperature variations in the package itself. These variations can be caused by factors such as: 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.

The supply voltage of the MLX90636 is either 2.8, or 3.3V. For the I2C communication with the master microcontroller, the MLX90636 supports a either 1.2V, or 1.8V I2C reference voltage.
The communication to the chip is done by I2C up to fast mode plus (FM +) for the 1.8V version and up to Fast Mode (FM) – for the 1.2V version. Through I2C the external unit can have access to the following blocks:

- Control registers of internal state machines
- RAM for pixel and auxiliary measurement data
- EEPROM - used to store the trimming values, calibration constants and various device/measurement settings.

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 20µm.

3.1.1 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
		EEPROM	
Read-only	0x0026	EE_Fa [31:16]	Fa calibration constant (16-bit, Most Significant Word)
Read-only	0x0028	EE_Fa [15:0]	Fa calibration constant (16-bit, Least Significant Word)
Read-only	0x002A	EE_FaScale [15:0]	Fa calibration constant scaling coefficient(16-bit)
Read-only	0x002C	EE_Ga [15:0]	Ga calibration constant (16-bit)
Read-only	0x002E	EE_Fb [15:0]	Fb calibration constant (16-bit)
Read-only	0x0030	EE_Ea [31:16]	Ea calibration constant (16-bit, Most Significant Word)
Read-only	0x0032	EE_Ea [15:0]	Ea calibration constant (16-bit, Least Significant Word)
Read-only	0x0034	EE_Eb [31:16]	Eb calibration constant (16-bit, Most Significant Word)
Read-only	0x0036	EE_Eb [15:0]	Eb calibration constant (16-bit, Least Significant Word)
Read-only	0x0038	EE_P_G [15:0]	P_G calibration constant (16-bit)
Read-only	0x003A	EE_P_O [15:0]	P_O calibration constant (16-bit)
Read-only	0x003C	EE_Aa [15:0]	Aa calibration constant (16-bit)
Read-only	0x003E	EE_CRC [15:0]	CRC Field
Read-only	0x0040	EE_Gb [15:0]	Gb calibration constant (16-bit)
Read-only	0x0042	EE_Ba [15:0]	Ba calibration constant (16-bit)
Read-only	0x0044	EE_Bb [15:0]	Bb calibration constant (16-bit)
Read-only	0x0046	EE_Ca [15:0]	Ca calibration constant (16-bit)
Read-only	0x0048	EE_Cb[15:0]	Cb calibration constant (16-bit)
Read-only	0x004A	EE_ Da[15:0]	Da calibration constant (16-bit)
-	-	Melexis reserved	
R/W	0x001E	EE_Ha [15:0]	Ha Customer calibration constant (16 bit)
R/W	0x0020	EE_Hb [15:0]	Hb Customer calibration constant (16 bit)
R/W	0x0022 and 0x0024	Customer data	Customer data storage area
-	-	Melexis reserved	
R/W	0x001A	EE_CONTROL1	EEPROM Control register 1, measurement settings (see section Measurement Settings)
R/W	0x001C	EE_ CONTROL2	EEPROM Control register 2, measurement control, I²C slave address (see section Measurement Settings)
		REGISTER	
R/W	0x000C	REG_EESTATUS	EEPROM enable register
R/W	0x0014	REG_CONTROL1	Control register, table select
R/W	0x0016	REG_CONTROL2	Control register, measurement mode
-	-	Melexis reserved	
R/W	0x0000	REG_STATUS	Status register: data available
		RAM	
Read-only	0x0002	RAM_1	Raw data 1
Read-only	0x0004	RAM_2	Raw data 2
Read-only	0x0006	RAM_3	Raw data 3
Read-only	0x0008	RAM_4	Raw data 4
Read-only	0x000A	RAM_5	Raw data 5

Table 6 Memory organization

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_Fa (32bit) = EE_Fa_MS (at 0x0026) << 16 | EE_Fa_LS (at 0x0028)

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)

3.1.1.1 Customer Data storage Area (0x0022 and 0x0024)

The EEPROM area dedicated for customer data storage consists of 2 EEPROM cells of 16-bit words in the address range from 0x0022 and 0x0024.

The customer data area in the MLX90636 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 MLX90636 related calibration or tracing information. It is important that only the final data is written to the MLX90636 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.

3.1.2 Control and configuration

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

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

3.1.2.1 EEPROM Control register 1, refresh rate settings

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Melexis_reserved	Melexis_reserved					Melexis_reserved		Melexis_reserved			RC14		Refresh_Rate		

Table 7 Registers EE_Control1 and REG_Control1 bitmap

Refresh rate	Refresh rate [Hz]	Time [ms]
0	0.2	4176
1	0.5	2128
Default Setting = 2	**0.9**	**1104**
3	1.7	592
4	3.0	336
5	4.8	208
6	6.9	144
7	8.9	112

Table 8 Refresh Rate settings

Note that register REG_Control1 is initialized during POR by the EEPROM word EE_CONTROL1.

3.1.2.2 EEPROM Control register 2, measurement settings

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
sob	Melexis_reserved	Melexis_reserved	mode		Burst_count					Configurable 6-bit I2C address					

Table 9 : Register EE_Control2 bitmap

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
sob	Melexis_reserved	Melexis_reserved	mode		Burst_count					Not Used					

Table 10 : Register REG_Control2 bitmap

EE_CONTROL2 controls the measurement.

Bits	Parameter	Description	See section
15	sob	Starts a full measurement when being in (sleeping) step mode	Operating Modes
12:11	mode[1:0]	Defines the operating mode	Operating Modes
10:6	burst_count[4:0]	Burst count	Operating Modes

Table 11 Register REG_CONTROL2 explained

Note that this register is initialized during POR by the EEPROM word EE_CONTROL2.

Start of Burst (SOB) conversion in (sleeping) step mode allows to execute the set of measurement s for a certain amount of times, which is defined by parameter burst_count[4:0]. SOB is cleared by state machine when a correct measurement was received and started.
When a SOB is received during an ongoing burst measurement, then the current burst will be aborted. The new settings will be read and a new burst of measurements is started according to the new settings.

Burst count: defines how many times the measurement table needs to be executed in case of burst conversion (initiated by SOB-bit). Burst count=X means that the measurements are executed X+1 times.

3.1.2.3 Operating modes

Mode[1:0] defines the operating mode the device has to operate in:

- mode[1:0] =00: Enables Halt mode. All EEPROM write operations should be done in this mode;
- mode[1:0] =01: Enables the sleeping step mode. In this mode the device will be by default in Sleep state. On request (SOB bit), the device will switch to Active state, the state machine will do one/multiple measurement(s), will go into sleep state and will wait for next command;
- mode[1:0] = 10: Enables the step mode. In this mode the state machine will do one or multiple measurement(s) upon request (SOB bit) and will wait for next command. The device remains in Active state all time in this mode.
- mode[1:0] = 11: Enables the continuous mode. In this mode the state machine will cycle measurements continuously. The device remains in Active state all time in this mode.

By default, the sleeping step mode measurement is enabled.
Whenever changes happen in settings that influence the measurements (e.g. refresh rate) or burst count, then the new settings shall be applied at start of the new burst.

3.1.2.4 Device Status

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Melexis_reserved									busy	brown_out	meas_pos			eoc	new_data

Table 12 Register REG_Status - 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
6	busy	Read-only flag Flag indicating that a measurement is being executed: - 0: no measurement is ongoing - 1: measurement is ongoing In sleep mode, this flag is always low. In (burst-)step mode, this flag is high till all measurements are finished.	Operating Modes
5	brown_out	Bit is set to 0 Customer should set bit to 1 When device is reset, the bit is set to 0 and reset can be detected	
4:2	meas_pos	Measurement position - Read-only flags Indicates from which measurement in the measurement sequence the last written data is coming: MEAS_POS[2:0]=x, corresponds to measurement x in the measurement sequence (counting starts at 1)	
1	eoc	End Of Conversion flag This flag must be reset through I2C. The flag is set by internal logic when the end of the measurement sequence is reached. When external CPU reads the data available in RAM, it must reset this flag. Note: clearing the flag is done by writing a 1 to it.	
0	new_data	This flag must be reset through I2C. The flag is set by internal logic when new data is transferred to storage memory (i.e. after execution of one measurement). When external CPU reads the data available in RAM, it must reset this flag.	Operating Modes

		Note: clearing the flag is done by writing a 1 to it.	

Table 13 Register REG_STATUS explained

3.1.2.5 EEPROM Status

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Melexis_reserved											Active	Reserved			

Table 14 EEPROM status

While mode[1:0] =01 or mode[1:0] = 10, setting Active = 1, enables the EEPROM block, e.g. data can be read. One should wait at least 100us after setting Active bit before reading data.

3.1.2.6 CRC field

The 8-bit CRC(Cyclic Redundancy Check) value, calculated on EEPROM range (0x0026~0x003C + 0x0040 + 0x004C~0x004E) is stored at the CRC field, as shown below. The CRC uses the 8-bit algorithm, with seed=0x36, poly=0xA6

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Melexis_reserved	Melexis_reserved	Melexis_reserved	Melexis_reserved	CRC[7:4]				Melexis_reserved	Melexis_reserved	Melexis_reserved	Melexis_reserved	CRC[3:0]			

Table 15 CRC field

3.1.3 I2C commands

This device is based on I2C specification Rev.5 – October 9th 2012. I2C FM+ mode is supported.

The sensor uses the following I2C features:

- Slave mode only
- 7-bits addressing
- Modes:
  - Standard-mode, Fast-mode – for 1.2V I2C version
  - Standard-mode, Fast-mode, Fast-mode Plus – for 1.8V I2C version
- Incremental addressing – allowing a block of addresses to be accessed inside one I2C sequence

The following I2C 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

It is required to start with a Stop condition or a dummy command before any other command after powering up the device.

3.1.3.1 I2C address

The 7-bit address is for slave recognition on I2C bus. By default, the device responds to the 7-bit slave address 0x32.
Configuration of the 7-bit slave address is possible using the 6 LSB in EEPROM register EE_Control2.
These bits are the 6 MSB of the I2C Address of the device.
7-bit I2C Address = {I2C_ADDRESS[5:0], 0}
Note: if I2C address 0 is programmed in EEPROM, then the I2C Address becomes the default address 7'h32=7'b0110010 .

3.1.3.2 Slave Address change flow

⇨ Put device in Halt mode, use current slave address

- Read Control Register 2
- Mask Control register 2 value – change only the mode bits
- Write the new value to Control register 2

⇨ Write Slave address to EERPOM, use current slave address

- Send EEPROM unlock key (See EEPROM unlock for customer access)
- Wait at least 10ms
- Write New slave address [5:0] to address EE_Control2
- Wait at least 10ms
- 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-up of the device the new slave address will be in operation.

3.1.3.3 Addressed read

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

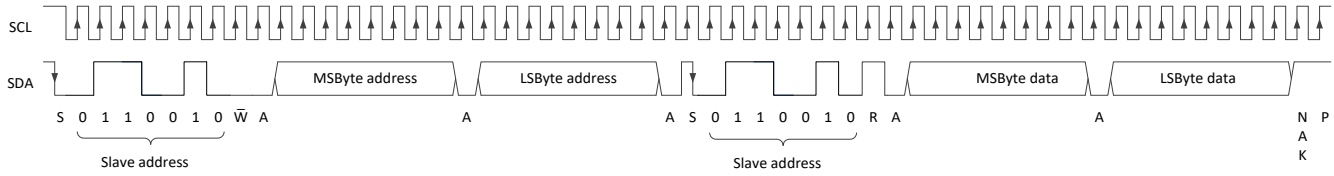


Figure 4 Addressed read

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.

3.1.3.4 Addressed write

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

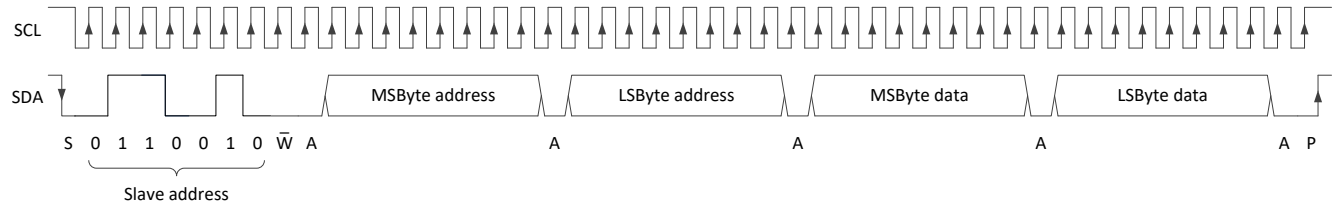


Figure 5 Addressed write

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.

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 busy in REG_STATUS.

3.1.3.5 Global reset

This command resets all devices on the I2C bus (based on the general call address 0x00).

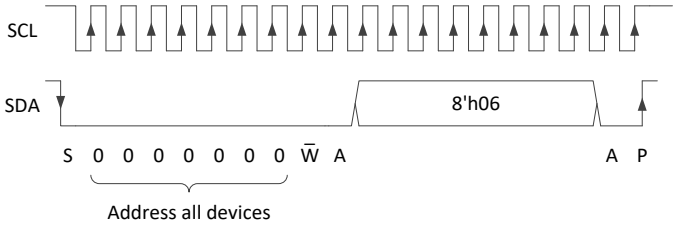


Figure 6 Global reset

Note: After this command, the device reloads all control parameters from the EEPROM and a delay of at least 200us is needed before the next communication with the device.

3.1.3.6 Addressed reset

This command resets the addressed device only (based on the I2C address).

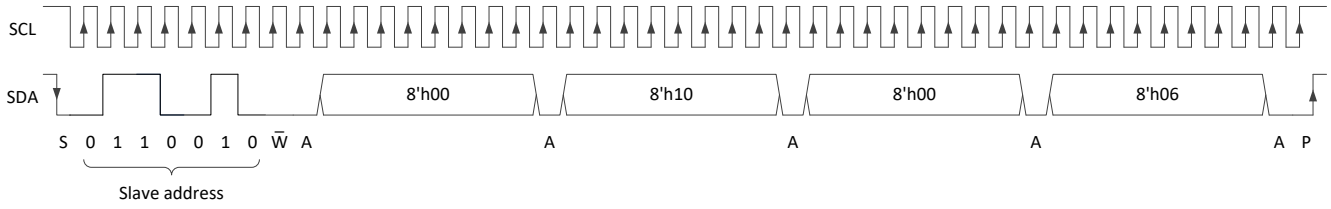


Figure 7 Addressed reset

Note: After this command, the device reloads all control parameters from the EEPROM and a delay of at least 200us is needed before the next communication with the device.

3.1.3.7 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.

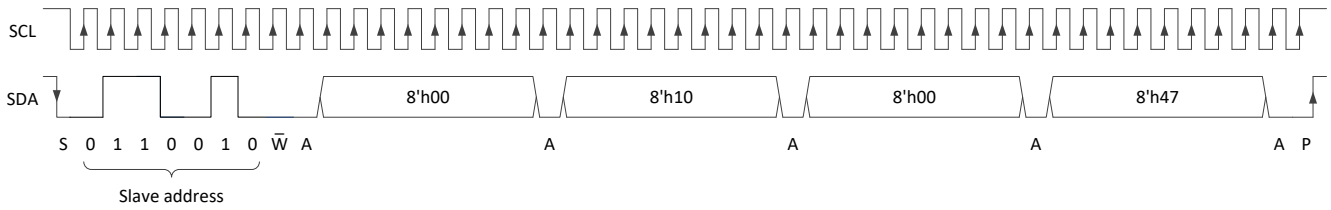


Figure 8 EEPROM unlock

3.1.3.8 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 (0x0000).

According to the I2C 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.

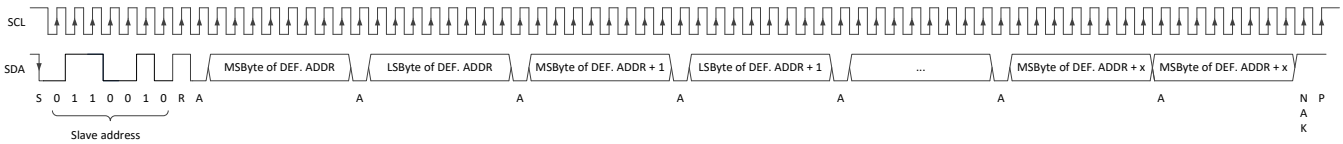


Figure 9 Direct read

3.2 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 µA.

- 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_CONTROL2[12:11]. The device will execute one 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 sob bit. The measurements are following the measurement sequence as defined in the measurement table.
Mode[1:0] defines the operating mode the device has to operate in:

- mode[1:0] =00: Enables Halt mode. In this mode all EEPROM write operations should be done;

The different possible measurement modes are:

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

The device will be in sleep mode. On request (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 busy bit is set internally in the MLX90636. When all the measurements from the measurement table are performed, the 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 8.1 Refresh rate settings)
    3. Make sure that the busy bit is cleared
    4. Read out the data
    5. Calculate the temperatures

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

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

- mode[1:0] = 11: Enables the continuos mode.

Measurements are executed continuously. The device remains powered all time in this mode.
By default, the device is in sleeping step mode.

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

3.3 Temperature calculation

3.3.1 Object temperature measurement

To calculate the ambient and object temperature, a set of 4 measured parameters is required: RAM_1, RAM_2, RAM_3, RAM_4 . Those are signed 16-bit numbers.

3.3.2 Pre-calculations

- Ambient

$$\mathrm{VR_{TA}} = \mathrm{RAM_3} + \mathrm{Gb} * \frac{\mathrm{RAM_2}}{12}$$

$$\mathrm{Gb} = \mathrm{EE_Gb} * 2^{-10}$$

$$\mathrm{AMB} = \left[\frac{\mathrm{RAM_2}}{12}\right] / \mathrm{VR_{TA}} * 2^{19}$$

The parameter EE_Gb is a unsigned 16-bit number.

- Object

$$\mathrm{S} = \frac{\mathrm{RAM_1} - \mathrm{RAM_4}}{2}$$

$$\mathrm{VR_{TO}} = \mathrm{RAM_3} + \mathrm{Gb} * \frac{\mathrm{RAM_2}}{12}$$

$$\mathrm{S_{TO}} = \left[\frac{\mathrm{S}}{3 * 2^{\mathrm{RC14}}}\right] / \mathrm{VR_{TO}} * 2^{19}$$

RC14=EE_CONTROL1[4:3]

3.3.3 Ambient Temperature

$$\mathbf{Ta\ (sensor\ temperature\ in\ °C)} = 30 + \frac{\mathbf{AMB} - \mathrm{P_O}}{\mathrm{P_G}}$$

where:

Ta in degrees Celsius

P_O = EE_P_O * 2^{-1}

P_G = EE_P_G * 2^{-9}

The parameters EE_P_O and EE_P_G are unsigned 16-bit numbers.

3.3.4 Object Temperature

$$\mathbf{TO\ (object\ temperature\ in\ °C)} = \sqrt[4]{\frac{\mathbf{S_{TO}}}{\boldsymbol{\varepsilon} * \mathbf{Fa} * \mathbf{Ha} * \left(\mathbf{1} + \mathbf{Ga} * (\mathbf{TO_{DUT}} - \mathbf{TO_0}) + \mathbf{Fb} * (\mathbf{TA_{DUT}} - \mathbf{TA_0})\right)} + \mathbf{Ta_{[K]}}^4} - \mathbf{273.15} - \mathbf{Hb}$$

With:

Fa = EE_Fa * $2^{-EE_FASCALE}$
Fb = EE_Fb * 2^{-24}
Ga = EE_Ga * 2^{-24}
Ha = EE_Ha * 2^{-14}
Hb = EE_Hb * 2^{-10}
TO_0 = 35°C
TA_0 = 30°C
TA_{DUT}= ((AMB-Eb))/Ea+30
Ea = EE_Ea * 2^{-16}
Eb = EE_Eb * 2^{-8}
Ta[K] = TA_{DUT} + 273.15 in Kelvin
TO_{DUT} = Object temperature in 35°C
Ɛ = 1 = Object Emissivity parameter (not stored in EEPROM, but part of the 'app')

The parameters EE_Ea, EE_Eb, EE_Fa are unsigned 32-bit numbers.
The parameters EE_Ga, EE_Hb , EE_Fb are signed 16-bit numbers.
The parameter EE_Ha is a signed 16-bit number.

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 35°C.
In the 2nd iteration the result of first iteration is used, and in the 3rd iteration the end result is obtained.

4 Application

4.1 Application description

4.2 Recommended Application diagram

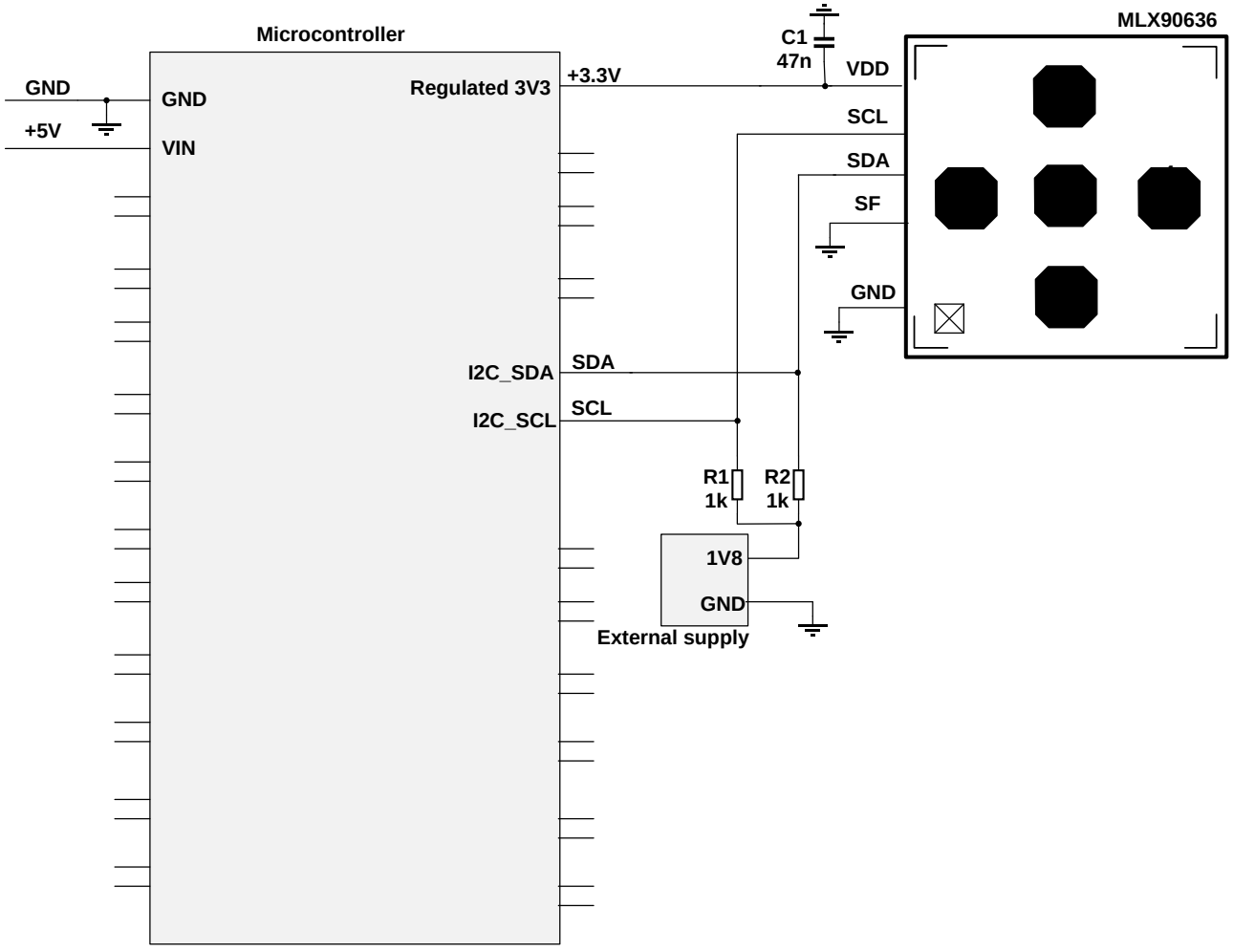


Figure 10 Typical application schematic

Note: C1 should be placed within 20mm from the device

4.3 Application comments

- 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.
- 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 MLX90636, it is recommended not to subject the MLX90636 to heat transfer and especially transient conditions.
- The MLX90636 is designed and calibrated to operate as a non-contact thermometer in settled conditions.
- Upon power-up the MLX90636 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.

- Capacitive loading on an I2C 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.
- A sleep mode is available in the MLX90636. This mode is entered and exited via the I2C compatible 2-wire communication.
- A power supply and decoupling capacitor is needed as with most integrated circuits. The MLX90636 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 47nF(or 100nF) 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.
- Do not perform measurements in oily or helium environments

4.4 Field of View (FoV)

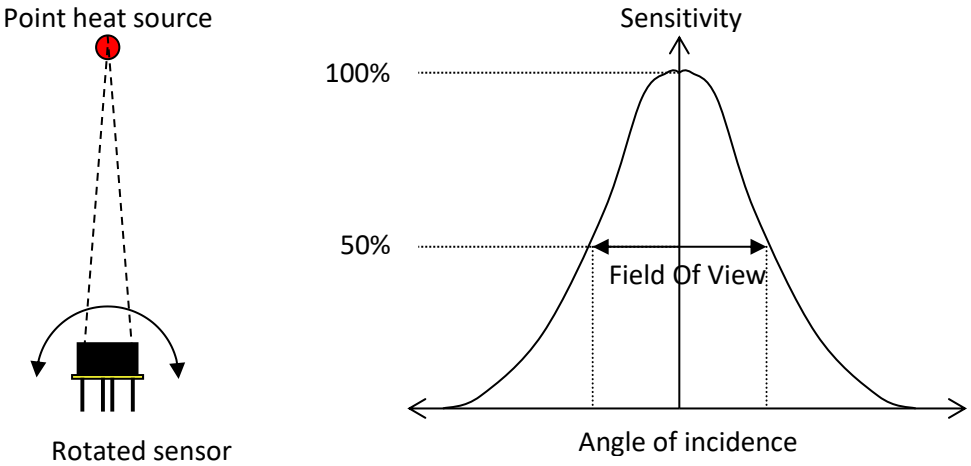


Figure 11 Field of View measurement principle

Parameter	50% of maximum	10% of maximum	Unit
Field Of View	50	95	° (angular degrees)

Table 16 Field Of View of the MLX90636

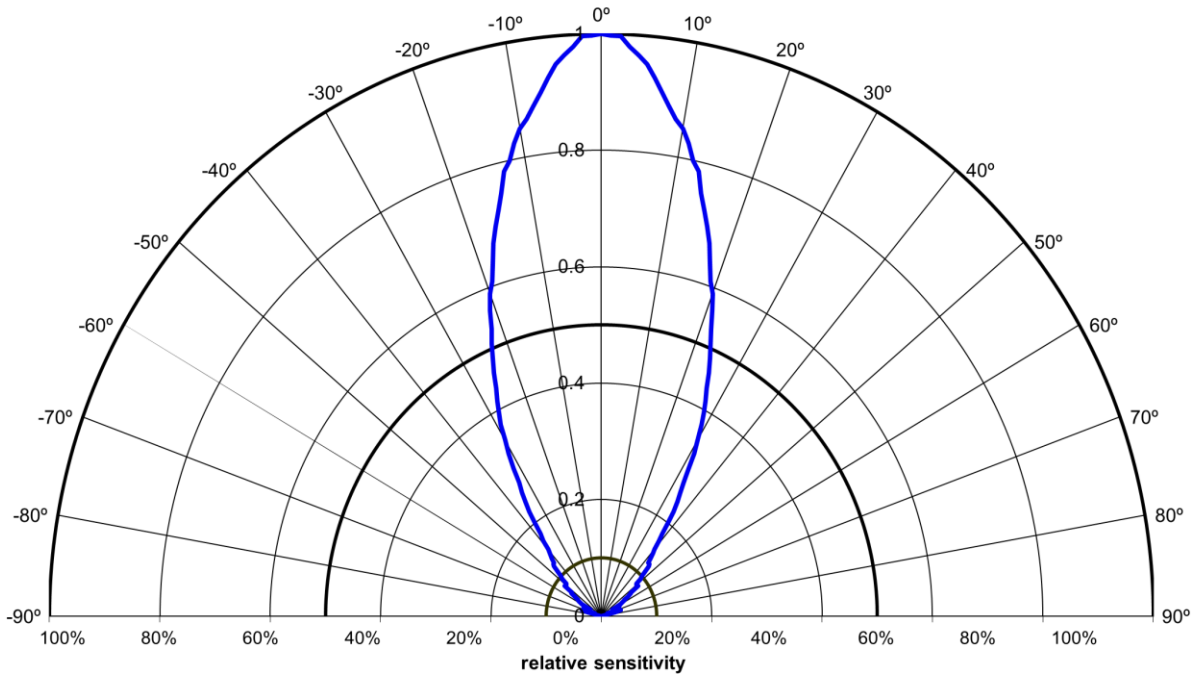


Figure 12 Field of View of MLX90636 (FoV = 50˚)

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 95° wide. For medical applications the obstacle free zone should be at least 135° wide.

4.5 Noise

Measurement conditions for noise performance are To = Ta = 25°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.

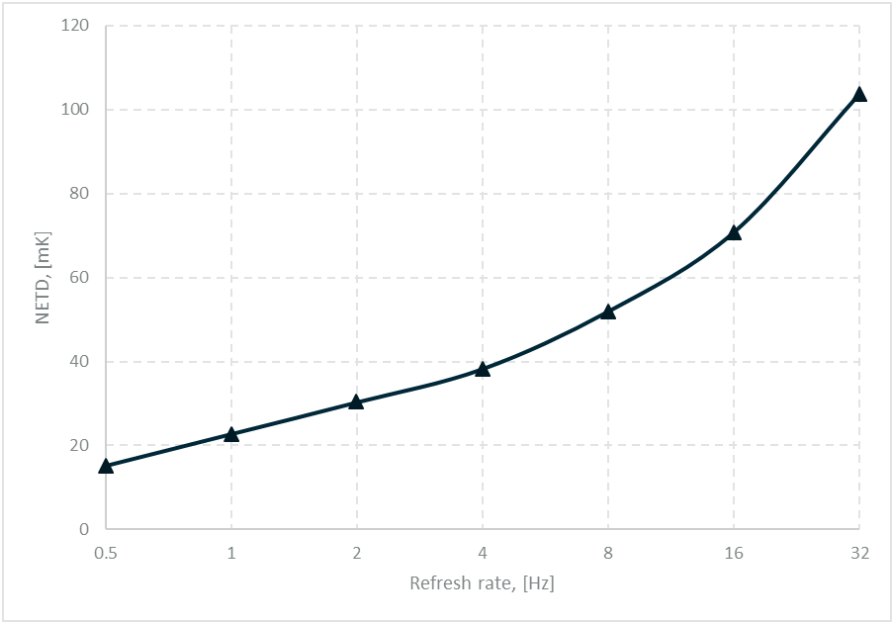


Figure 13 Noise as function of refresh rate

5 Package, IC handling and assembly

5.1 Package information

5.1.1 Package dimensions LGA-5

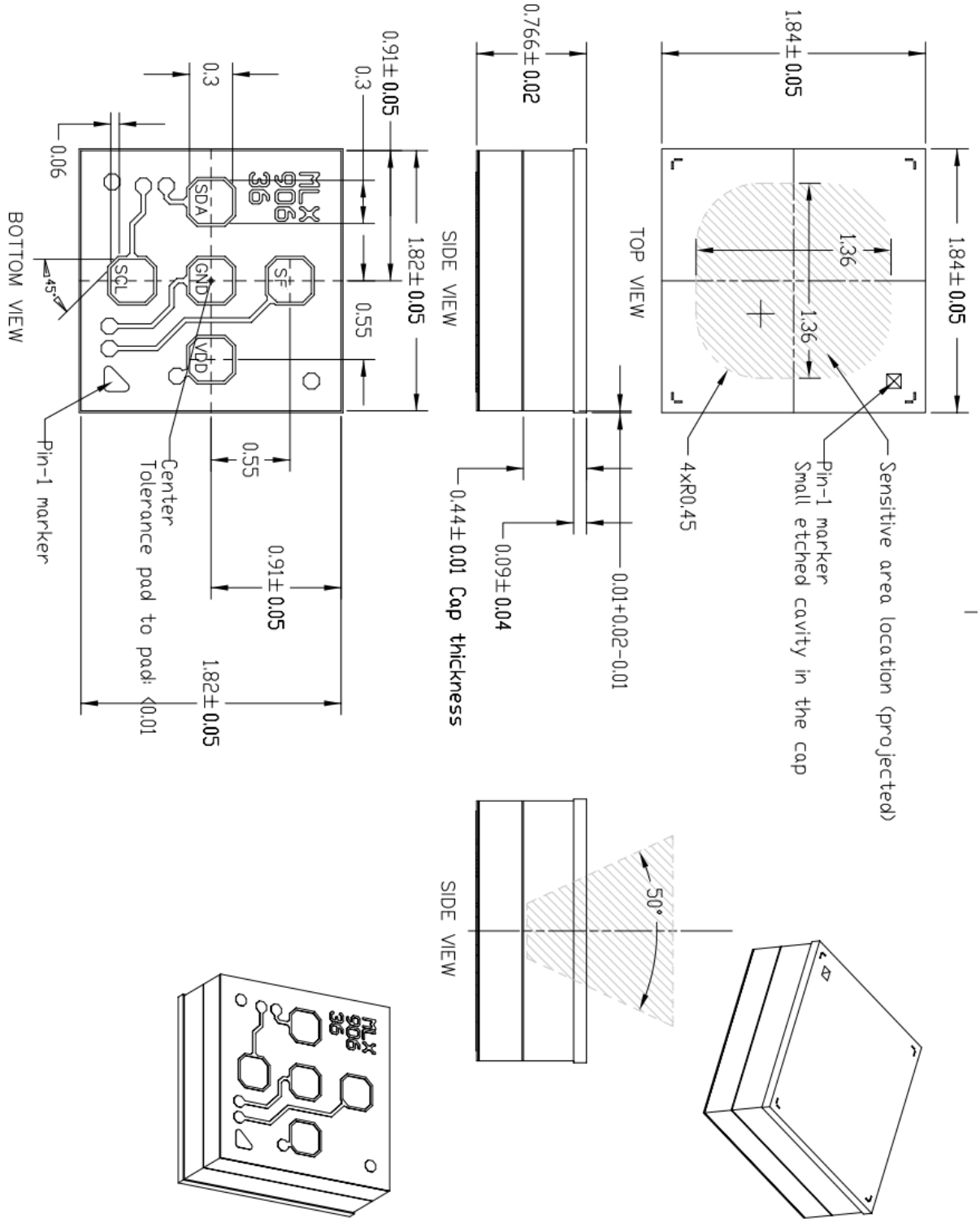


Figure 14 Package dimensions for MLX90636. All linear dimensions are in [mm]

5.1.2 Footprint design – NSMD (non-solder mask defined)

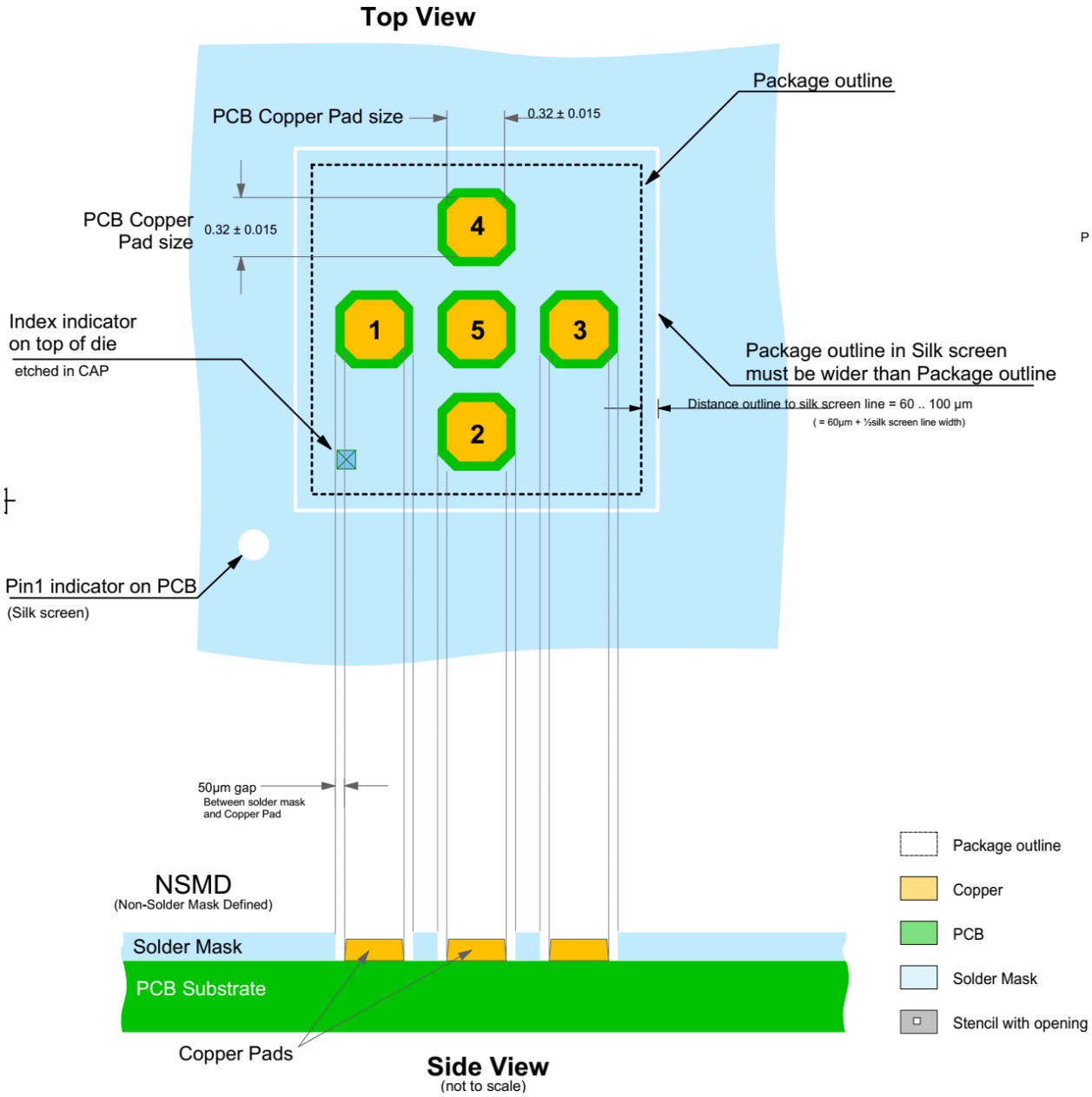


Figure 15 Example PCB footprint for MLX90636 (not to scale)

5.1.3 Stencil design

Stencil Pad Opening size = PCB Copper Pad size - 10%PCB Copper Pad size

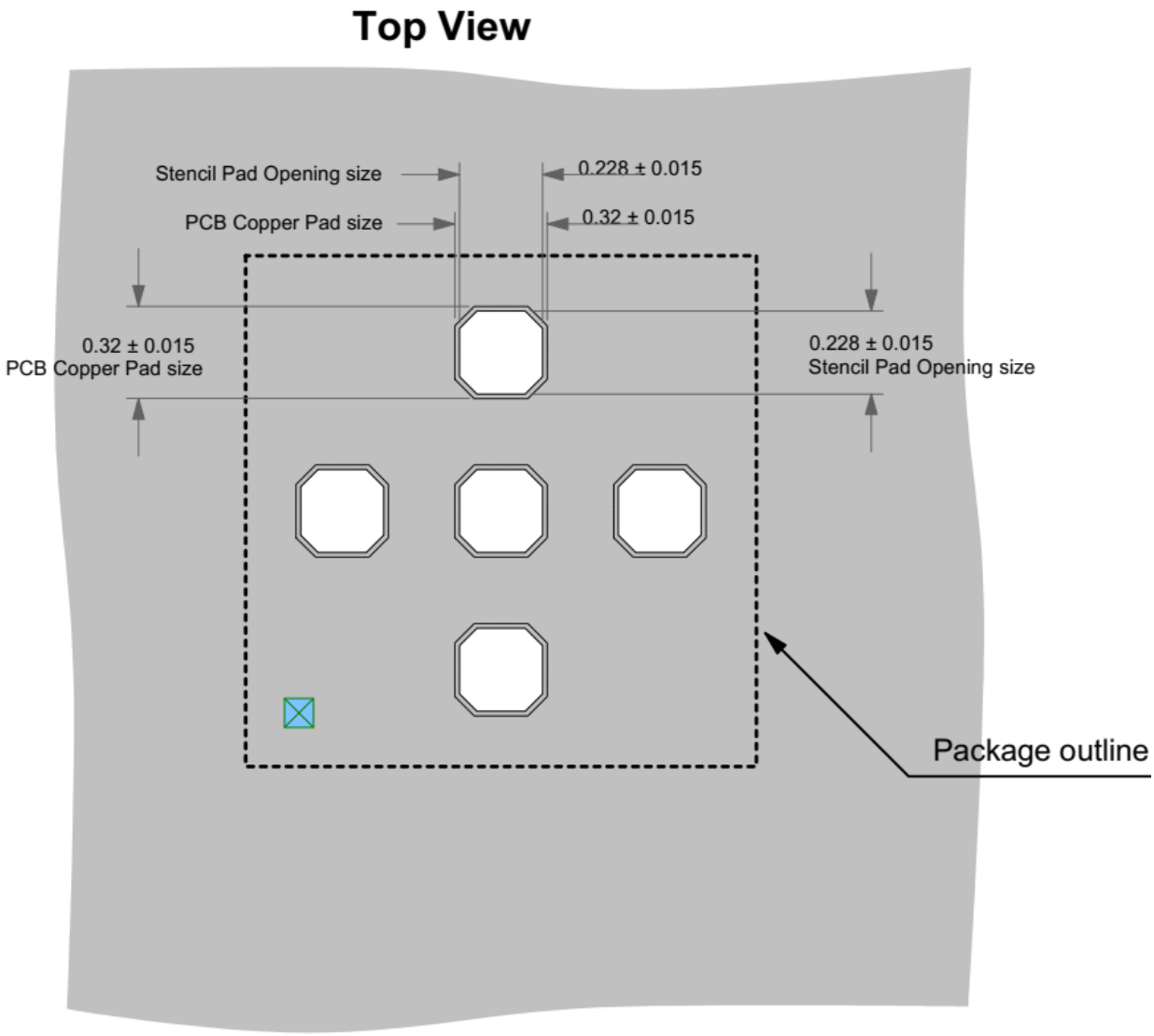


Figure 16 Stencil design

5.2 Soldering recommendations

It is advised to use solder paste with a "No-Clean, Halogen Free" flux.

It is recommended to perform the following screening test after soldering the device:

1) Bake the soldered chip at 150℃ for 3hrs;
2) Supply the chip with 3.0~4.9V for 10 seconds while measuring the sleep current with I2C (SCL,SDA) pulled to GND or VDD, see Figure 17 below;

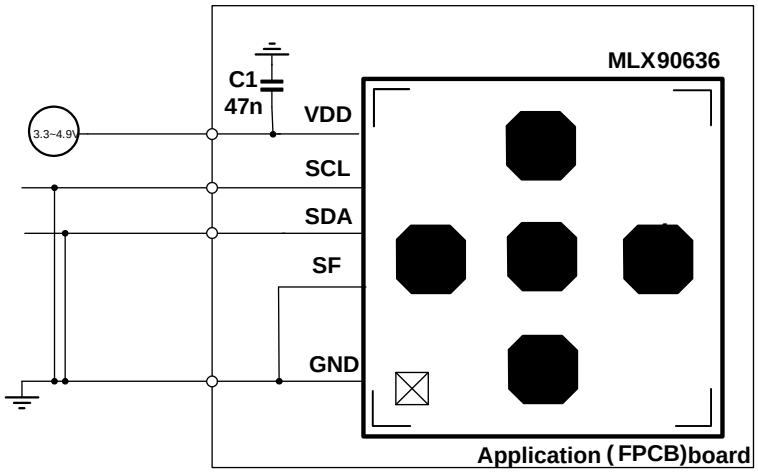


Figure 17 Schematic for screening

3) Screen out chips with a sleep current greater than 0.7uA@3V or 1uA@3.6V, or 2.2uA@4.9V measured at a chip temperature Ta within the range [15..40]°C.

5.3 Storage and handling

This IC shall be stored and handled according to their MSL categorization level (specified in the packing label) as per J-STD-033.

Electronic semiconductor products are sensitive to Electro Static Discharge (ESD). The component assembly shall be handled in EPA (Electrostatic Protected Area) as per ANSI S20.20

For more information refer to Melexis *Guidelines for storage and handling of plastic encapsulated ICs* [3]

5.4 Assembly of encapsulated ICs

For Surface Mounted Devices (SMD, as defined according to JEDEC norms), the only applicable soldering method is reflow.

For Through Hole Devices (THD), the applicable soldering methods are reflow, wave, selective wave and robot point-to-point. THD lead pre-forming (cutting and/or bending) is applicable under strict compliance with Melexis *Guidelines for lead forming of SIP Hall Sensors* [3].

Melexis products soldering on PCB should be conducted according to the requirements of IPC/JEDEC and J-STD-001. Solder quality acceptance should follow the requirements of IPC-A-610.

[3] www.melexis.com/ic-handling-and-assembly

For PCB-less assembly refer to the relevant application notes [3] or contact Melexis.

Electrical resistance welding or laser welding can be applied to Melexis products in THD and specific PCB-less packages following the *Guidelines for welding of PCB-less devices*[3].

Environmental protection of customer assembly with Melexis products for harsh media application, is applicable by means of coating, potting or overmolding considering restrictions listed in the relevant application notes [3]

For other specific process, contact Melexis via www.melexis.com/technical-inquiry

5.5 Environment and sustainability

Melexis is contributing to global environmental conservation by promoting non-hazardous solutions. For more information on our environmental policy and declarations (RoHS, REACH…) visit www.melexis.com/environmental-forms-and-declarations

6 Glossary of terms & references

6.1 Glossary

Terms	Description
POR	Power On Reset
IR	InfraRed
I2C	Inter-Integrated Circuit
SDA	Serial DAta – I2C compatible communication pins
SCL	Serial CLock – I2C compatible communication pins
ACK / NACK	Acknowledge / Not Acknowledge
SOC	Start Of Conversion
EOC	End Of Conversion
FOV	Field Of View
Ta	Ambient Temperature measured from the chip – (the package temperature)
To	Object Temperature, 'seen' from IR sensor
LGA	Land Grid Array
TBD	To Be Defined
LSB	Least Significant Bit
MSB	Most Significant Bit
EMC	Electro-Magnetic Compatibility
ESD	Electro-Static Discharge
HBM	Human Body Model
CDM	Charged Device Model

Table 17 Glossary of terms

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7 Revision history

Revision	Date	Change history
001	29-Apr-26	Creation

Table 18 – Revision history

8 Disclaimer

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