1. Features and Benefits

- +/-0.5% full scale lifetime accuracy
- Digital SPI and I2C output
- Option to output linear temperature measured by external NTC thermistor
- Flexible NTC input supports wide range of different NTC characteristics without calibration
- -40°C to 150°C temperature range
- Excellent harsh media resistance against halogens, acids, …
- Qualified according to AEC-Q100 and AEC-Q103-002
- Configurable diagnostic features like output out of range, over voltage, under voltage, …
- Factory calibrated and fully programmable for customized calibration curves
- ASIL compliant developed as an ASIL A SEooC as per ISO 26262

2. Application Examples

- Automotive applications with absolute pressure spans from 2 bar to 70 bar
- Battery thermal management

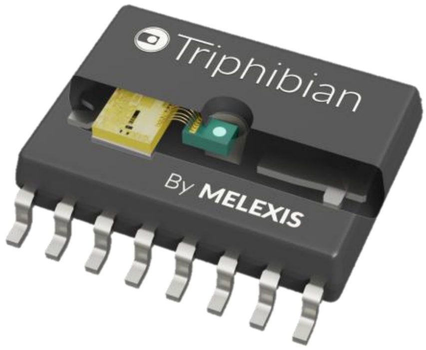
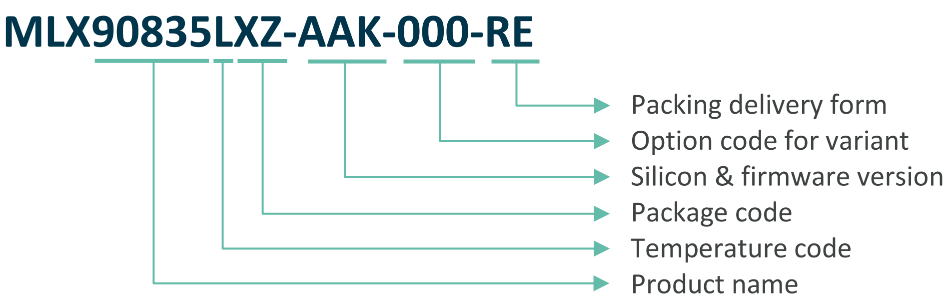


Figure 1: MLX90835

3. Ordering information

Ordering Code	Temperature	Package	Option code	Packing
MLX90835LXZ-AAK-000-RE	-40°C to 150°C	SOIC16 WB	0 to 35 bar absolute pressure	Reel
MLX90835LXZ-AAH-001-RE	-40°C to 150°C	SOIC16 WB	0 to 10 bar absolute pressure	Reel



4. General Description

The MLX90835 is a packaged, factory calibrated, absolute pressure sensor measuring spans from 2 bar to 70 bar. It supports both SPI and I2C digital interface protocols.
The MLX90835 consists of a MEMS pressure sensor element and an interface chip (CMOS technology). The DSP based signal interface provides outstanding initial accuracy. A smart package and die assembly concept enable high output stability over life, even in stringent automotive temperature stress conditions in a wide variety of media.

Contents

5. Glossary of Terms

Relative pressure: Pressure difference between applied pressure on the top side and atmospheric pressure on the bottom side
ADC: Analog to Digital Converter
Bar: Pressure unit (1bar = 100kPa)
DSP: Digital Signal Processor
EMC: Electro Magnetic Compatibility
ESD: Electrostatic discharge
FS: Full scale, span
I2C: Inter-Integrated Circuit protocol
LSB: Least Significant Byte
MSB: Most significant Byte
NTC: Negative Temperature Coefficient thermistor

OV: Over Voltage
PCB: Printed Circuit Board
RV: Reverse Voltage
SPI: Serial Peripheral Interface
SEooC: Safety Element out of Context
T_A: Ambient temperature

6. Absolute Maximum Ratings

Parameter	Symbol	Value	Units	Comment
Supply Voltage (overvoltage)	OV	6	V	Max 2 hours
Reverse Voltage Protection	RV	-0.3	V	
Positive output voltage		6	V	
Reverse output voltage [1]		-0.3	V	
Max voltage on NTC/UART input pin		-0.3 to 2	V	Max 1 minute at Ta = 25°C
Operating Ambient Temperature Range	T_A	-40 to 150	°C	
Storage Temperature Range		-40 to 150	°C	
Programming Ambient Temperature Range		-40 to 125	°C	
Proof pressure		TBD	Bar	
Burst pressure		TBD	Bar	

Table 1: 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.

[1] *Absolute maximum DC negative output at floating supply or supply shorted to output. Maximum DC negative output at operating supply: -5.5V.*

7. Pin Definitions and Descriptions

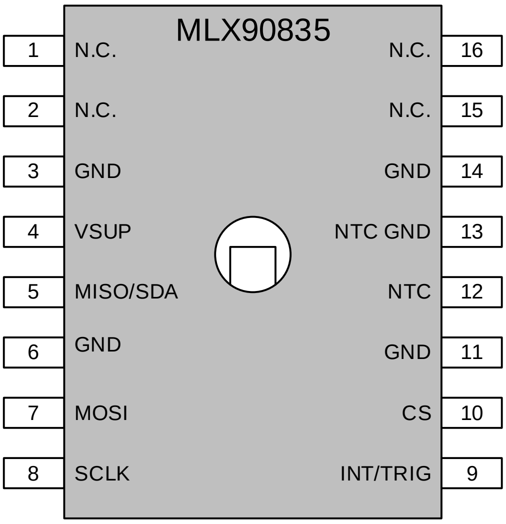


Figure 2: Package pinout

Pin number	Description	Pin number	Description
1	Not connected	16	Not connected
2	Not connected	15	Not connected
3	Ground	14	Ground
4	Supply	13	NTC ground
5	MISO / SDA	12	NTC
6	Ground	11	Ground
7	MOSI	10	$\overline{Chip\ Select}$
8	SCLK	9	Interrupt / Trigger

Table 2: Pinout definitions and descriptions

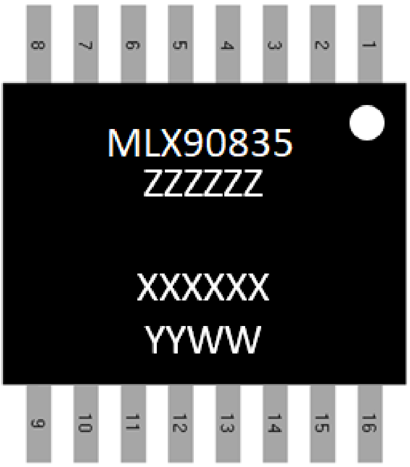


Figure 3: Package marking

Symbol	Function / Description
XXX	MEMS and ASIC traceability letter (2)
ZZZ	Last three characters of lot number
ABC	Sub lot indication
YYWW	Date code

Table 3: Package marking definition

2 *Linked to first three letters of option code.*

8. General Electrical Specifications

DC Operating Parameters T_A = -40°C to 150°C

Parameter	Symbol	Remarks	Min	Typ[3]	Max	Units
Nominal supply voltage	Vdd		3	3.3	3.6	V
Nominal supply current	Idd	Including external NTC, no additional load at the output.		10		mA
I2C bus voltage	V_{I2C}	I2C voltage on 3.3V bus	3	3.3	3.6	V
Power up time		Time from reaching minimum allowed supply voltage of 4.5V till the first falling edge of the first SENT frame			TBD	msec
Pressure response time					TBD	frames
Pressure output noise				TBD	TBD	LSB pk-pk
Pressure output update time		.			TBD	
Internal temperature start up time				TBD		ms
Internal temperature update time				TBD		ms
Internal temperature accuracy		On chip PTAT temperature	-TBD		TBD	°C
NTC temperature output noise					TBD	LSB pk-pk
NTC start up time				TBD		ms
NTC temperature update time				TBD		ms
NTC temperature response time		From temperature change to end of frame with output >= 90% of step size			100	ms
NTC temperature range	T_NTC		-50		210	°C
NTC resistance range	R_NTC		20		1M	ohm

Table 4: Electrical specifications

9. Detailed General Description

The MLX90835 consists of a pressure sensor element and a DSP-based interface chip.

The pressure sensor element consists of a diaphragm realized in the silicon. The diaphragm reacts to a change in relative pressure between the top and bottom side. The internal strain increases, in particular at the border of the diaphragm. Here, the piezo-resistive elements have been implanted into the silicon diaphragm forming a Wheatstone bridge, which act as a transducer.

The analog front-end of the interface chip applies filtering and converts the analog signal to a digital value. The DSP performs the compensations over temperature. Furthermore, the digital circuit provides some filtering, the possibility to linearize the pressure signal and also implements the clamping function. This chip

[3] *Typical values are defined at TA = +25°C and VDD = 5V.*

transmits its pressure output via I2C or SPI protocol. It is also possible to transmit linearized and calibrated temperature information measured by an external NTC thermistor. An analog interface is available for the external thermistor and the 16bits DSP performs the calibration and linearization of the measured thermistor temperature.

Several diagnostic functions (over-voltage, under-voltage, pressure error, …) have been implemented on the MLX90835 and can be enabled by programming EEPROM settings. Figure 4 shows the MLX90835 block diagram. Passive components are integrated in the package to bring excellent EMC performance without the need for additional components at module level.

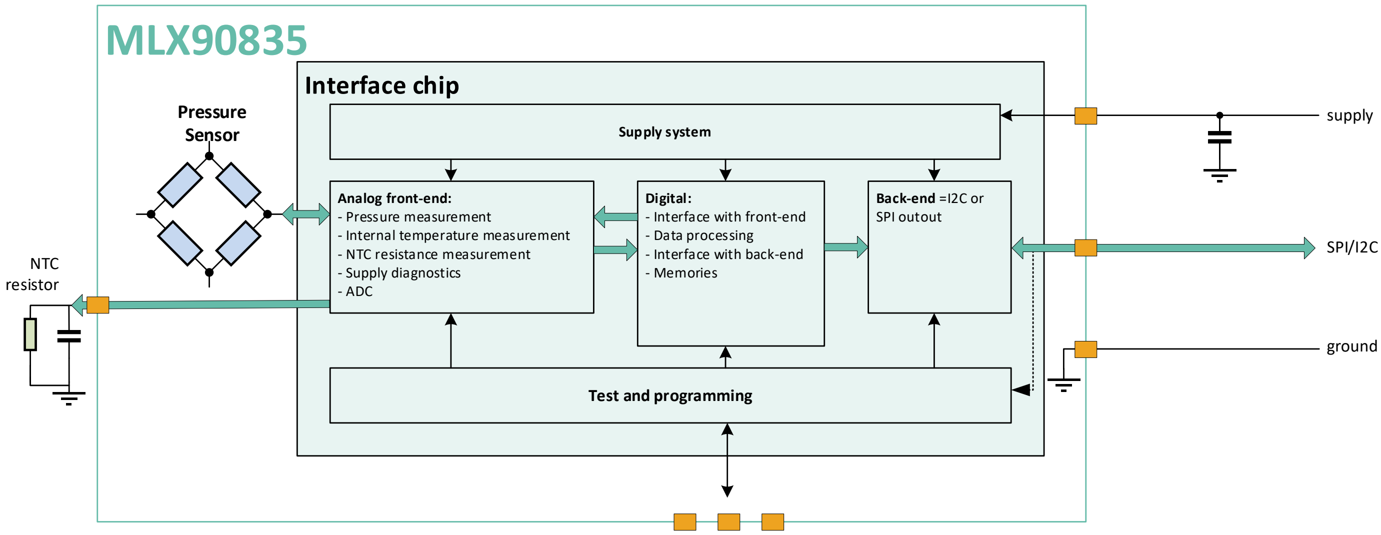


Figure 4: MLX90835 functional block diagram

10. Default programmed settings

The MLX90835 is calibrated at the final manufacturing test steps. During the calibration, settings are stored in the on chip EEPROM to define the pressure transfer curve. Besides pressure, the internal temperature and optionally the NTC temperature calibrations are performed.

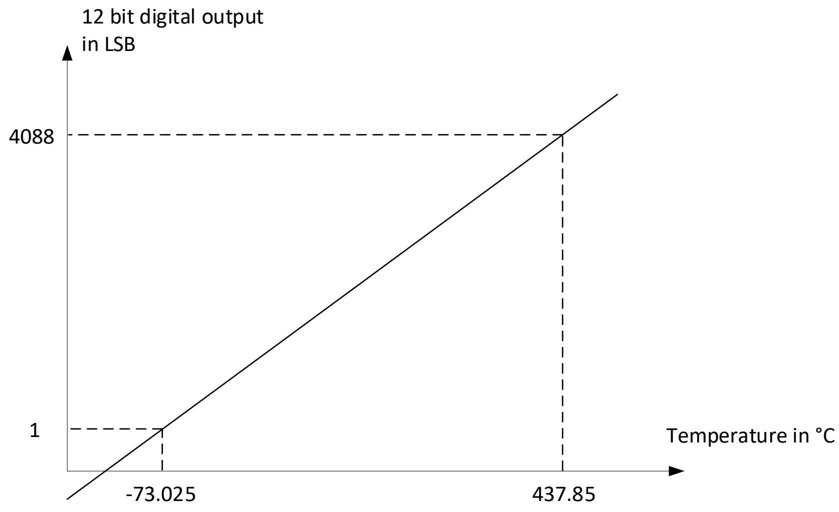


Figure 5: NTC and internal temperature transfer function

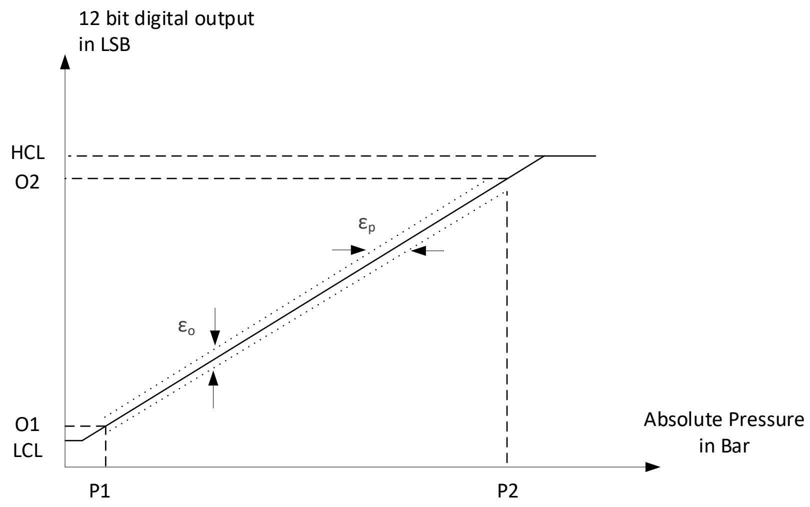


Figure 6: Pressure transfer function description

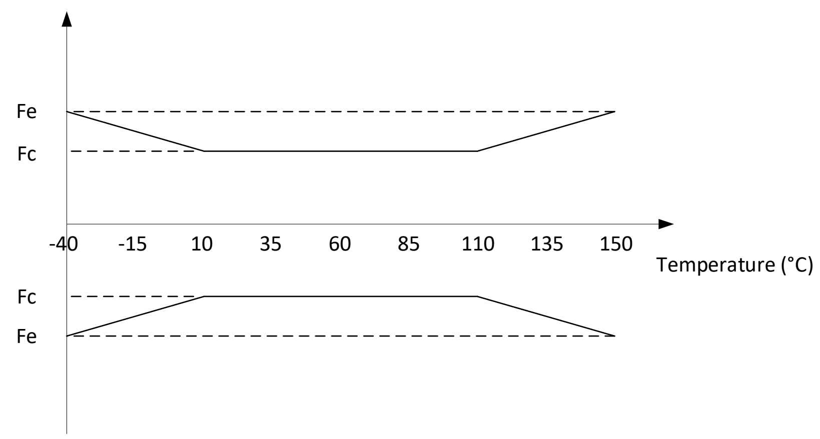


Figure 7: Pressure accuracy temperature factor

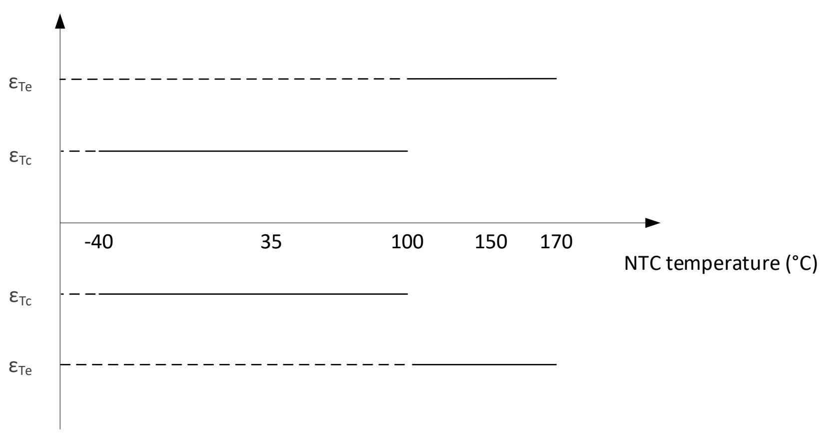


Figure 8: NTC temperature accuracy

Figure 9: Ambient temperature accuracy factor on NTC

NTC Accuracy Parameter	Symbol	Remarks	Min	Typ	Max	Unit
Center NTC temperature accuracy	ε_{Tc}	Overall accuracy using the default NTC as described in Table 8. See Figure 8: NTC temperature accuracy	TBD		TBD	°C
Extended NTC temperature accuracy	ε_{Te}		TBD		TBD	°C

Table 5: NTC accuracy

10.1. MLX90835LXZ-AAK-000-RE

Transfer Curve Parameter	Symbol	Remarks	Value			Unit
Pressure 1	P1	See Figure 6: Pressure transfer function description .	0			Bar
Pressure 2	P2		35			Bar
Output 1	O1		193			%FS
Output 2	O2		3896			%FS
Low clamping level	LCL		1			LSB
High clamping level	HCL		Maximum[4] - 1			LSB
Pressure Accuracy Parameter	**Symbol**	**Remarks**	**Min**	**Typ**	**Max**	**Unit**
Output accuracy	ε_o	Overall accuracy expressed as output value (FS range from 193 to 3896)	TBD		TBD	%FS
Pressure accuracy	ε_p	Overall accuracy expressed as pressure value	TBD		TBD	mBar
Center temperature accuracy factor	Fc	See Figure 7: Pressure accuracy temperature factor			1	
Extended temperature accuracy factor	Fe				1.5	

Table 6: AAK-000 Default configuration

[4] *The maximum signals depends on the configured number of bits of the pressure signal (10 to 14 bit). As example, if the pressure signal is configured to be a 14bit signal the high clamping level would be 16382.*

10.2. MLX90835LXZ-AAH-001-RE

Transfer Curve Parameter	Symbol	Remarks	Value			Unit
Pressure 1	P1	See Figure 6: Pressure transfer function description .	0			Bar
Pressure 2	P2		10			Bar
Output 1	O1		193			%FS
Output 2	O2		3896			%FS
Low clamping level	LCL		1			LSB
High clamping level	HCL		Maximum[5] - 1			LSB
Pressure Accuracy Parameter	**Symbol**	**Remarks**	**Min**	**Typ**	**Max**	**Unit**
Output accuracy	ε_o	Overall accuracy expressed as output value (FS range from 193 to 3896)	TBD		TBD	%FS
Pressure accuracy	ε_p	Overall accuracy expressed as pressure value	TBD		TBD	mBar
Center temperature accuracy factor	Fc	See Figure 7: Pressure accuracy temperature factor			1	
Extended temperature accuracy factor	Fe				1.5	

Table 7: AAH-001 Default configuration

11. Digital

The digital is built around a 16-bit microcontroller. It contains besides the processor also ROM, RAM and EEPROM and a set of user and system IO registers. Temperature compensation of the pressure signal and pressure linearization is handled by the microcontroller. For the pressure compensation there are EEPROM parameters allocated to be able to cover a large variety of calibration approaches.
Both for gain and offset of the pressure signal, there is a separate temperature dependency which is programmable up to a third order compensation. This is reflected in EEPROM parameters for the offset (O0, O1, O2 and O3) and for the gain (G0, G1, G2 and G3).
If required, the linearity of the pressure signal can also be compensated with a first order temperature dependency through EEPROM parameters L0 and L1.
Linearization of the NTC temperature is also covered by the microcontroller.

[5] *The maximum signals depends on the configured number of bits of the pressure signal (10 to 14 bit). As example, if the pressure signal is configured to be a 14bit signal the high clamping level would be 16382.*

12. NTC Temperature Linearization

The MLX90835 has an input to connect an external NTC. If the NTC is enabled it will use the NTC characteristic in Table 8. This characteristic can be found for example in a TDK G1551 series 2.5K NTC.

T (°C)	R (Ω)	T (°C)	R (Ω)
-55	139867.5	75	455.425
-50	101912.5	80	393.35
-45	75035	85	340.975
-40	55802.5	90	296.65
-35	41900	95	258.95
-30	31750	100	226.8175
-25	24272.25	105	199.305
-20	18713.25	110	175.6725
-15	14544.75	115	155.31
-10	11393	120	137.7025
-5	8991.25	125	122.435
0	7146.5	130	109.155
5	5719.5	135	97.5725
10	4607.75	140	87.4375
15	3735.75	145	78.55
20	3047	150	70.7325
25	**2500**	155	63.84
30	2062.7	160	57.7475
35	1711.1	165	52.3475
40	1426.825	170	47.555
45	1195.725	175	43.2875
50	1006.9	180	39.435
55	851.8	185	36.0175
60	723.825	190	32.9725
65	617.725	195	30.2475
70	529.35	200	27.8

Table 8: Default NTC characteristic

The MLX90835 EEPROM configuration can be changed to work with an NTC with different coefficients. There is no additional calibration needed for this change.

13. Functional description

13.1. Measurements

The MLX90835 can measure and report the applied pressure, the device temperature and the temperature of an external NTC. The pressure measurement is always enabled while the temperature measurements can be disabled. Table 9 shows the possible configurations.

Measurement source	Configuration	Transmitted bytes when reading measurement data
Pressure	1: 10bit pressure	2 bytes
	2: 11bit pressure	2 bytes
	3: 12bit pressure	2 bytes
	4: 13bit pressure	2 bytes
	5: 14bit pressure	2 bytes
Device temperature	0: Disabled	0 bytes
	1: 8bit temperature	1 byte
	2: 9bit temperature	2 bytes
	3: 10bit temperature	2 bytes
	4: 11bit temperature	2 bytes
	5: 12bit temperature	2 bytes
External NTC temperature (Always disabled in WOC mode, see chapter 13.3.2)	0: Disabled	0 bytes
	1: 8bit NTC temperature	1 byte
	2: 9bit NTC temperature	2 bytes
	3: 10bit NTC temperature	2 bytes
	4: 11bit NTC temperature	2 bytes
	5: 12bit NTC temperature	2 bytes

Table 9: Measurement configuration

The functional mode of the device decides when a measurement is done and reported. This can be continuously or only at specific prompts. Chapter 13.3 describes these modes.

13.2. Operating states

The MLX90835 has two operating states. The active state and standby state.

The device starts up in its active state, all circuits are enabled to allow correct measurements. Depending on the functional mode of the MLX90835 it will stay in this state or go to the standby state after finishing an action.

In standby the device is in a low power state, awaiting a trigger to change to the active state. Depending on the functional mode the trigger can be a SPI/I2C command, a trigger signal on the TRIG/INT pin or a timer.

13.3. Functional modes

The functional mode of the device controls when the device should do a measurement and when to transition between the two operating states. There are 5 functional modes:

13.3.1. Single measurement mode

In single measurement mode the device stays in standby state until it receives an external trigger

- SPI/I2C START_MEASUREMENT command
- A trigger signal on the TRIG/INT pin

After the trigger the device transitions from standby state to active state, perform a pressure measurement and then transition back to standby state. An interrupt is generated after the measurement to signal that the result can be read through I2C/SPI.

13.3.2. Wakeup on change (WOC) mode

In WOC mode the device will periodically transition from standby state to active state, perform a pressure measurement and then transition back to standby state. This sequence is triggered by a programmable internal timer.

The measurement is compared to a pressure window. If the measurement is outside this window an interrupt signal is generated. This interrupt is also generated in case an error occurs when measuring the pressure.

Measurement data in this mode cannot include data from an external NTC temperature.

13.3.3. Burst mode

In burst mode the device will periodically transition from standby state to active state, perform a pressure measurement and then transition back to standby state. This sequence is triggered by a programmable internal timer. An interrupt is generated after the measurement to signal that the result can be read through I2C/SPI.

13.3.4. Continuous mode

In continuous mode the device is permanently in active state. The device continuously measures the pressure. The measurement result readable through I2C/SPI is updated after receiving an external trigger on TRIG/INT or automatically after a programmable amount of measurements.

13.3.5. Idle mode

In idle mode the device is permanently in active state but not performing any measurement. From idle mode the device accepts commands to start another functional mode.

13.4. Commands

When the master wants the MLX90835 to do something it needs to send a command over SPI or I2C. Each command consists of two bytes. The MSByte contains the actual command, the LSByte is the bitwise inversion of the MSByte to verify the correct transmission.

Command	Command value	Description	Available	Comment
READ_STATUS_BYTE	0x0F	Return status register content	Always	
START_SINGLE_MEASUREMENT_MODE	0x1E	Start single measurement functional mode	Idle mode	
START_WOC_MODE	0x2D	Start wake up on change functional mode	Idle mode	
START_BURST_MODE	0x3C	Start burst functional mode	Idle mode	
START_CONTINUOUS_MODE	0x4B	Start continuous functional mode	Idle mode	
START_IDLE_MODE	0x5A	Start idle functional mode	Always	
START_MEASUREMENT	0x69	Start measurement in single measurement mode	Single measurement mode	
MEMORY_FETCH	0x78	Request to prepare 2 bytes of data from memory to be read	Idle mode	
MEMORY_WRITE	0x87	Request to write 2 bytes of data	Idle mode	
ADDRESSED_RESET	0x96	Soft reset request (by device software)	Always	
GLOBAL_RESET	0xA5	Hard reset request (by device hardware)	Always	SPI only
READ	0xB4	Request to read data	Always	SPI only
CLEAR_ERROR_FLAGS	0xC3	Clear error flags EXEC_ERROR and COMM_ERROR in status register	Always	
CLEAR_RESET_FLAG	0xD2	Clear reset flag in status register	Always	

Table 10: Command table

13.5. Status byte

When the master sends a command the MLX90835 responds with a status byte about the execution of commands, its current state and whether data is available.

Bit	Name	Description
7	RESET	Bit that indicates that a reset or power-on occurred. The master should clear this with a CLEAR_RESET_FLAG command
6:4	CURRENT_MODE	3bit value to indicate the functional mode of the device: 0: Start-up 1: Continuous mode 2: Single measurement mode 3: Burst mode 4: WOC mode 5: Idle mode 7: Failsafe mode[6]
3	COMM_ERROR	Communication error of the current frame. Raised when the previous command is not yet processed. The master should clear this with a CLEAR_ERROR_FLAGS command.
2	EXEC_ERROR	Execution error of the previous frame. The command send in the previous sequence was not correct or not allowed. The master should clear this with a CLEAR_ERROR_FLAGS command.
1	DATA_READY	Bit indicates that new data is ready. 0: Measurement data has been read 1: Fresh measurement data is available. This bit is automatically cleared when reading data.
0	Parity	Parity bit of the status byte

Table 11: Status byte description

13.6. CRC

Each time data is transmitted a checksum is expected at the end of the transmission. When reading data, the MLX90835 calculates this value based on the status byte and all following data bytes. When writing data to the MLX90835 the master is expected to calculate this on all data bytes. This excludes the command byte and in case of I2C the slave address.

The checksum is an 8bit DOWCRC with polynomial 0x31.

[6] *The failsafe mode is not one of the usual functional modes, but is entered when the memory checksum fails. This can occur when an EEPROM address is updated without writing the correct checksum in the memory. When the checksum is corrected normal operation resumes.*

13.7. Diagnostics

Diagnostics can be flagged by replacing measurement data with a high or low error code. The low error code is always 0. The high error code is 2^{n_bits}-1, n_bits is the length of the measurement. As example, when the pressure measurement is configured as a 14bit value the high error code is 16383. Any value in between the two error codes are valid measurements.

The low and high diagnostic can be configured independently for each measurement source (pressure, NTC temperature and device temperature). If multiple diagnostics are triggered at once the low error code has priority.

In total there are six possible diagnostic sources. Three of them are universal for any measurement data (supply too high, supply too low, internal error) and three are specific for the measurement (pressure error, device temperature error, NTC temperature error). Table 12 shows the possible configurations for each diagnostic and measurement source.

Diagnostic	Pressure measurement	Device temperature measurement	NTC temperature measurement
Supply too high	Disabled/High/Low	Disabled/High/Low	Disabled/High/Low
Supply too low	Disabled/High/Low	Disabled/High/Low	Disabled/High/Low
Internal error	Disabled/High/Low	Disabled/High/Low	Disabled/High/Low
Pressure error	Disabled/High/Low		
Device temperature error		Disabled/High/Low	
NTC temperature error			Disabled/High/Low

Table 12: Diagnostic configuration

Table 13 shows an example of a diagnostic configuration where the pressure measurement is configured as 14bit value, device temperature as an 8bit value and the NTC measurement is disabled. Supply and internal errors are for both measurements mapped to the low error code. Pressure error is mapped to the high error code of the pressure measurement. Device temperature error is mapped to the high error code of the temperature measurement.

Diagnostic	14bit pressure error code	8bit Device temperature error code	Disabled NTC
Supply too high	0	0	
Supply too low	0	0	
Internal error	0	0	
Pressure error	16383		
Device temperature error		255	
NTC temperature error			

Table 13: Example diagnostic configuration with a 14bit pressure measurement and an 8bit device temperature measurement

The diagnostics are checked and refreshed each measurement cycle.

13.8. Trigger/interrupt pin

In addition to the pins for SPI or I2C communication there is a trigger/interrupt pin. This pin can be used as a digital input to trigger a new measurement, a push-pull output to interrupt the master that data is available or as an open-drain bidirectional pin to enable both triggers and interrupts.

The EEPROM setting TRIG_INT_CONFIG sets the mode according to Table 14.

TRIG_INT_CONFIG	Pressure measurement
0b00	Trigger and interrupt function disabled. Output in tristate
0b01	Digital input mode
0b10	Push-pull digital output
0b11	Bi-directional pin with open-drain output

Table 14: Trigger/interrupt pin configuration

13.8.1. Digital input mode

A falling edge at this pin will trigger a new measurement.

13.8.2. Push-pull digital output

In digital output mode the MLX90835 will generate a transition on the interrupt pin when a new measurement is available. After the measurement is read the opposite transition is made. In case a new measurement is available while the previous one was not read it will generate a pulse.

INT_OUT_POL_CONF	Pressure measurement
0b00	Transition to 0 will indicate that new data is ready and transition to 1 will indicate that data is read.
0b01	Transition to 1 will indicate that new data is ready and transition to 0 will indicate that data is read.

Table 15: Push-pull digital output configuration

13.8.3. Bi-directional pin with open-drain

In functional modes with trigger by pin enabled the master can start a measurement by pulling the pin low. The MLX90835 will then hold the pin low during the execution of the measurement and will release the pin once the data is available.

13.9. SPI communication

The SPI protocol mode can be configured (CPOL/CPHA). MSbits are sent first. CS must be driven low to enable SPI communication.

13.9.1. Command implementation

All SPI communication starts with a command described in chapter 13.4. The MLX90835 replies with a status byte after receiving the command byte.

Below is a list of block charts showing the protocol for various commands.

SPI byte	Description
Command	Command byte, least significant 4 bits are the inverse of the 4 most significant bits
XX	XX: on MOSI, not checked by MLX90835
0x00	0x00: on MISO, no information
Data	1 data byte
Status	Response from device after receiving command byte
CRC	CRC covering the status byte and all data bytes in a sequence

Table 16: SPI block diagram legend

13.9.1.1. General SPI sequence

The short SPI sequence consists of a command byte from the master followed by a status byte from the MLX90835. Clocking the status byte is optional.

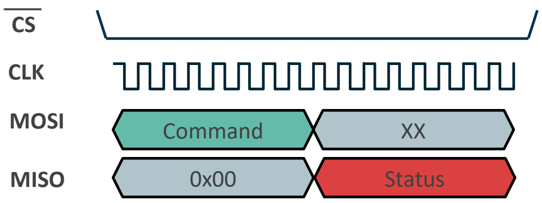


Figure 10: General SPI sequence

This sequence is used for reading the status byte, changing the functional mode, starting a measurement in single measure mode or doing a reset. The list below shows the supported commands.

- READ_STATUS_BYTE (0x0F)
- START_SINGLE_MEASUREMENT_MODE (0x1E)
- START_WOC_MODE (0x2D)
- START_BURST_MODE (0x3C)
- START_CONTINUOUS_MODE (0x4B)
- START_IDLE_MODE (0x5A)
- START_MEASUREMENT (0x69)
- ADDRESSED_RESET (0x96)
- GLOBAL_RESET (0xA5)
- CLEAR_ERROR_FLAGS (0xC3)
- CLEAR_RESET_FLAG (0xD2

13.9.1.2. Reading data sequence

When data is available it can be read with the sequence below. The number of data bytes depends on the configuration and which data is requested. If measurement data is prepared there can be two bytes of pressure data and optionally also device and external NTC temperature data. The number of bytes for each measurement is described in Table 9. If a MEMORY_FETCH command was sent before there will only be two data bytes from the requested memory address.

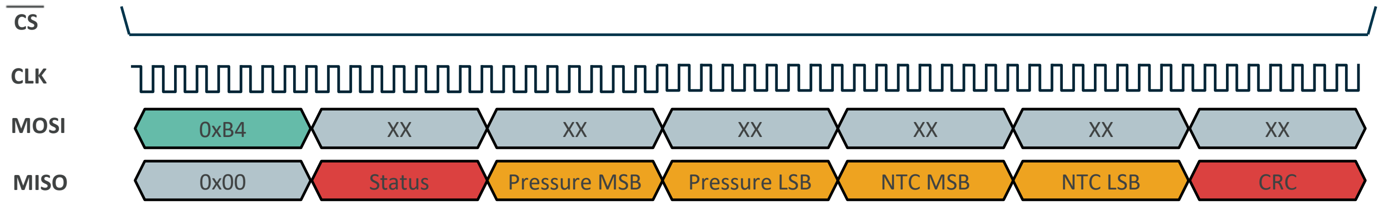


Figure 11: SPI read measurement sequence

13.9.1.3. Reading memory data sequence

The reading data sequence can also be used to read the memory of the MLX90835. The data first has to be prepared with the MEMORY_FETCH command with the requested address. When the memory data can be read the DATA_READY flag will be set in de status byte. The memory address can then be read with the READ command in the same way as measurement data. A memory address has a 2x8bit data content.

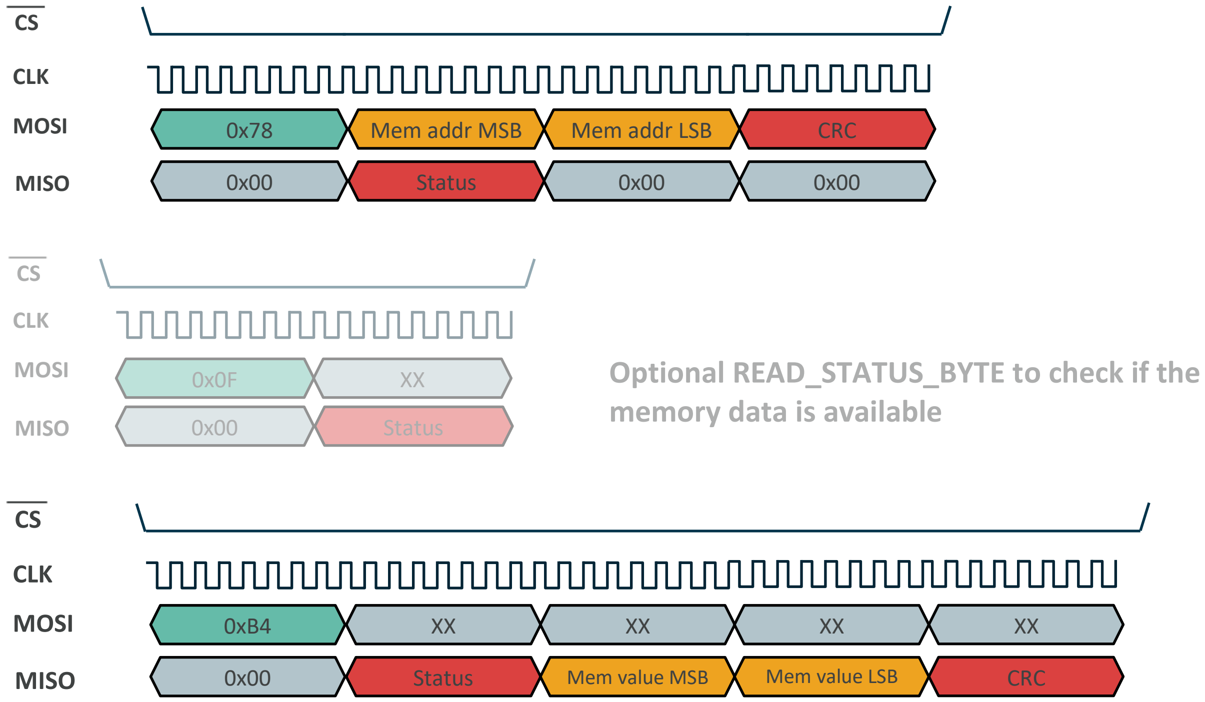


Figure 12: SPI memory fetch and read sequence

13.9.1.4. Writing to memory sequence

Writing to memory is done with the MEMORY_WRITE command. The master must also send the address to be written and the data in the same sequence. Each sequence writes to a single 16bit address.

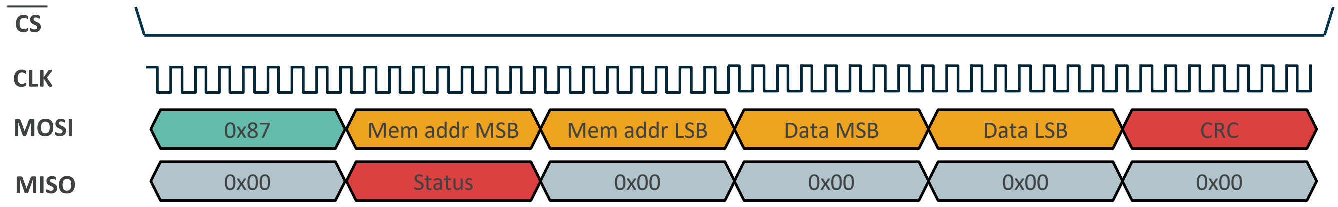


Figure 13: SPI write memory sequence

13.9.1.5. Writing to EEPROM memory sequence

Writing to EEPROM is a special variation on the sequence described in 13.9.1.4 because the data in the EEPROM is stored as 32bit words instead of 16bit. To write correctly to EEPROM the WRITE_MEMORY command must be sent two times in a row with consecutive memory addresses. If the second write address does not match correctly the MLX90835 cancels the write.

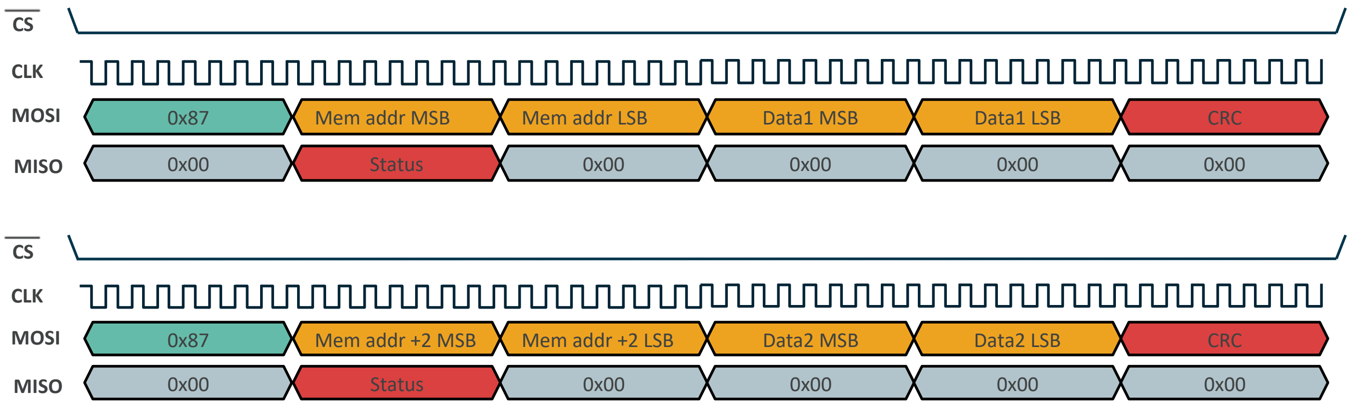


Figure 14: SPI write to EEPROM sequence

13.10. I2C communication

The I2C interface supports a transmission speed up to 100kbit/s. The master addresses a MLX90835 on its I2C bus and can choose to send a command or initiate a read from the device.

13.10.1. I2C implementation

There are three types of I2C messages implemented in the MLX90835. A read, command and global reset.
The next parts describe the different messages with the following table

I2C block	Description
S or Sr	Start or repeated start from the master. Rising edge during high period of SCL.
7b slave addr W	Address device on I2C bus to write to
7b slave addr R	Address device on I2C bus to write to read from
ak	Acknowledge from the receiver to continue receiving data
nak	Not acknowledge from the receiver to stop receiving data
P	Stop from the master. Falling edge during high period of SCL

13.10.2. Global reset

It is possible to reset all MLX90835 devices on the I2C bus by sending a global reset. In that case the devices are not addressed individually but with the global address 0x00. The master must send a byte with value 0x06 to the global address to start the global reset. This results in a full hardware reset of the MLX90835.

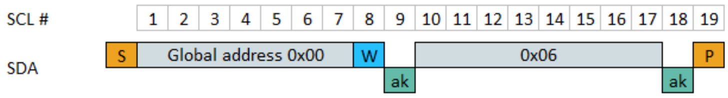


Figure 15: Global reset I2C sequence

13.10.3. Read message

A read message starts by writing a byte of value 0x81 to indicate that the master wants to read from the slave. This is followed by a repeated start with a read bit. Next the MLX90835 responds first with a status byte, then the data bytes and finally a CRC.
Between each byte an acknowledge is sent by the receiver of the data.

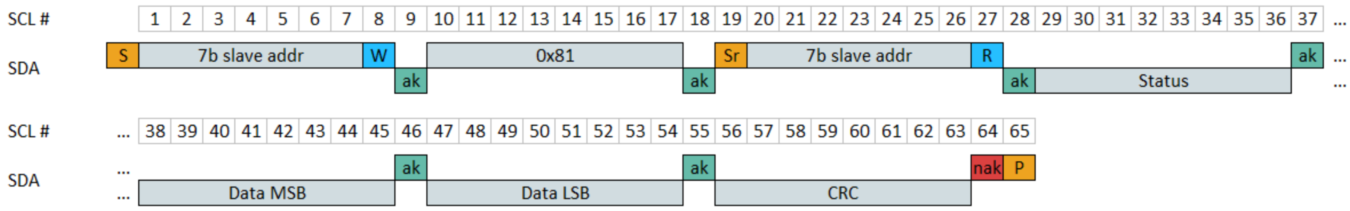


Figure 16: I2C read sequence

The data received depends on which data is prepared. If a memory fetch command was sent before it will contain the two bytes of data of the requested memory address. If a measurement was done it contains the data of a measurement. Measurement data can consist of more than two bytes if the NTC or internal temperature readout is also enabled.

13.10.4. Command message

A command message starts with the slave address with a write bit, then a byte with value 0x80 is sent to indicate that the master will follow up with a command byte. Depending on the chosen command additional bytes are transmitted in sequence. After all bytes related to the command are sent by the master it can stop the I2C communication or request a status byte from the MLX90835 with a repeated start.

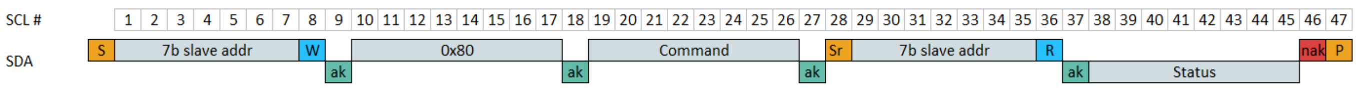


Figure 17: Standard command message followed by a read of the status byte

The following commands support the standard command message format:

- READ_STATUS_BYTE (0x0F)
- START_SINGLE_MEASUREMENT_MODE (0x1E)
- START_WOC_MODE (0x2D)
- START_BURST_MODE (0x3C)
- START_CONTINUOUS_MODE (0x4B)
- START_IDLE_MODE (0x5A)
- START_MEASUREMENT (0x69)

- ADDRESSED_RESET (0x96)
- CLEAR_ERROR_FLAGS (0xC3)
- CLEAR_RESET_FLAG (0xD2

13.10.5. Reading from memory sequence

The reading data sequence can also be used to read the memory of the MLX90835. The data first has to be prepared with the MEMORY_FETCH command with the requested address. When the memory data can be read the DATA_READY flag will be set in de status byte. The memory address can then be read with the READ command in the same way as measurement data. A memory address has a 2x8bit data content.

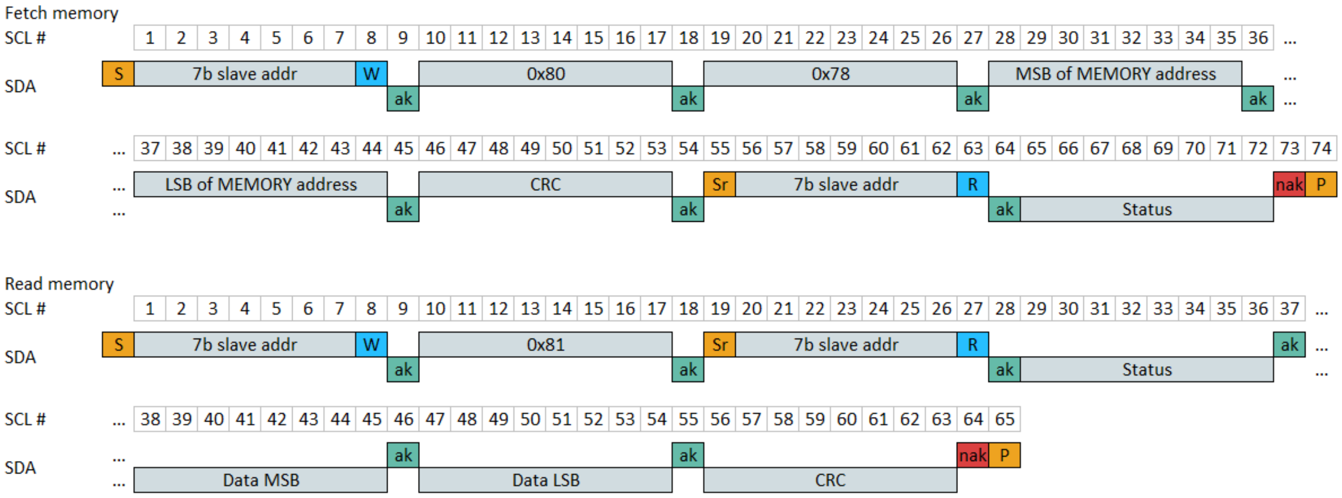


Figure 18: I2C reading from memory sequence

13.10.6. Memory write sequence

To write to the memory the master must send the MEMORY_WRITE command followed by the 16bit memory address, the 16bit data to be written and a CRC byte. Afterwards the master can optionally request the status byte from the slave.

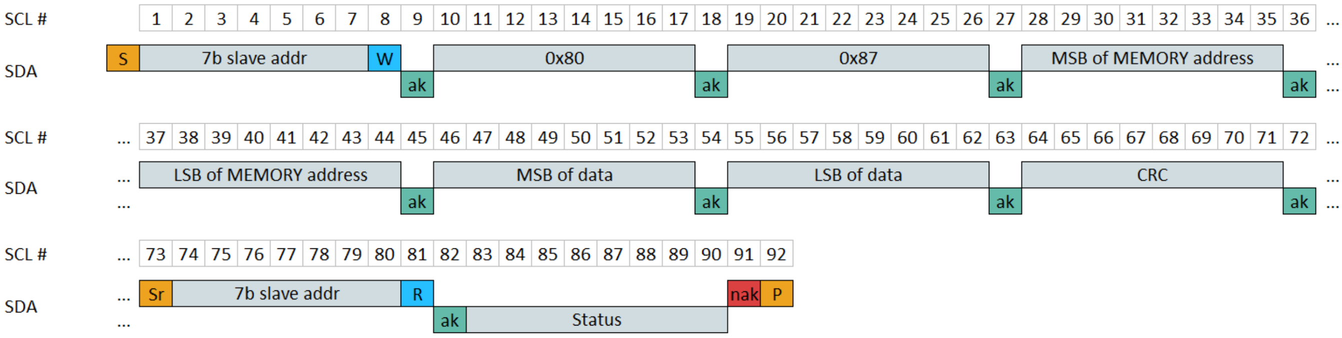


Figure 19: I2C memory write sequence

13.10.7. EEPROM memory write sequence

Writing to EEPROM is a special variation on the sequence described in 13.10.6 because the data in the EEPROM is stored as 32bit words instead of 16bit. To write correctly to EEPROM the WRITE_MEMORY command must be sent two times in a row with consecutive memory addresses. If the second write address does not match correctly the MLX90835 cancels the write.

14. End-User programmable parameters

Table 17 describes the user configurable settings in the EEPROM of the device.

BitFieldName	Description	Address	Bits [15:0]
PAVG_GAIN_SEL	Enable to double the pressure ADC measurement after centering	0x1002	[11]
PRES_LOWNOISE_MODE	Setting which increases the over sampling rate to decrease noise	0x1002	[5]
INT_OUT_POL_CONF	Configuration of the polarity of TRIG/INT pin in push pull digital output mode (INT functionality): 0: transition to 0 will indicate that new data is ready and transition to 1 will indicate that data is read 1: transition to 1 will indicate that new data is ready and transition to 0 will indicate that data is read Only used when TRIG_INT_CONFIG = 2	0x1002	[4]
TRIG_INT_CONFIG	Configuration of the TRIG/INT pin: 00: TRIG/INT pin functionality disabled. This setting will configure the pin as an output in tristate. 01: Digital input (falling edge will trigger a measurement) 10: Push pull digital output: interrupt output that indicates that a new measurement is available 11: Bi-directional pin with open-drain output with both functionalities of other settings	0x1002	[3:2]
FUNCTIONAL_MODE	Functional mode after start-up: 0: Continuous mode 1: Single-measurement mode 2: Burst mode 3: WOC mode	0x1002	[1:0]
PRES_N_AVG	Pressure ADC filtering. Sets number of samples used to calculate the average ADC value used for the pressure calculation. Sample size = 2^value	0x1004	[15:14]
VSTEMP_N_AVG	STEMP ADC filtering. Sets number of samples used to calculate the average ADC value used for the pressure calculation. Sample size = 2^value	0x1004	[13:11]
VSTEMP2_N_AVG	STEMP2 ADC filtering. Sets number of samples used to calculate the average ADC value used for the pressure calculation. Sample size = 2^value	0x1004	[10:8]
VANA_DIV_N_AVG	VANA_DIV ADC filtering. Sets number of samples used to calculate the average ADC value used for the pressure calculation. Sample size = 2^value	0x1004	[7:6]
VPTAT_N_AVG	VPTAT ADC filtering. Sets number of samples used to calculate the average ADC value used for the pressure calculation. Sample size = 2^value	0x1004	[5:3]

BitFieldName	Description	Address	Bits [15:0]
RNTC_N_AVG	RNTC ADC filtering. Sets number of samples used to calculate the average ADC value used for the pressure calculation. Sample size = 2^value	0x1004	[2:0]
TMEMS_FILT_DEPTH	MEMS temperature IIR low pass filter depth	0x1006	[14:12]
TINT_FILT_DEPTH	Internal temperature IIR low pass filter depth	0x1006	[11:9]
TNTC_OUT_N_BIT	Set number of bits of the NTC temperature readout. 0: NTC temperature output reporting disabled 1: 8 bits NTC temperature output 2: 9 bits NTC temperature output 3: 10 bits NTC temperature output 4: 11 bits NTC temperature output 5: 12 bits NTC temperature output 6-7: 12 bits NTC temperature output	0x1006	[8:6]
TDEV_OUT_N_BIT	Set number of bits of the device temperature readout. 0: device temperature output reporting disabled 1: 8 bits device temperature output 2: 9 bits device temperature output 3: 10 bits device temperature output 4: 11 bits device temperature output 5: 12 bits device temperature output 6-7: 12 bits device temperature output	0x1006	[5:3]
P_OUT_N_BIT	Set number of bits of the pressure readout 0: 10 bits pressure output 1: 10 bits pressure output 2: 11 bits pressure output 3: 12 bits pressure output 4: 13 bits pressure output 5: 14 bits pressure output 6-7: 14 bits pressure output	0x1006	[2:0]
VBE_N_AVG	VBE ADC filtering. Sets number of samples used to calculate the average ADC value used for the pressure calculation. Sample size = 2^value	0x1008	[15:14]
WOC_BASE	Wake on change (WOC) base value. Wake on change is triggered when the lower or upper limit is exceeded Lower limit = base - threshold Upper limit = base + threshold	0x1008	[13:0]
CONT_MODE_N_MEAS	Continuous mode only: Selects the pressure output update interval If 0: If the trigger pin is enabled the pressure output is updated every trigger. Otherwise every pressure measurement >0: Pressure output is updated every 2^value-1 pressure measurement periods. Max = 1024	0x100A	[15:12]
WUT_CONFIG	Configuration of the period of the internal wake-up timer for burst and WOC mode 0-31: 100us * 256 * 2^(WUT_CONFIG)	0x100A	[11:7]
WOC_THRESHOLD	Wake on change (WOC) threshold value. Wake on change is triggered when the lower or upper limit is exceeded Lower limit = base - threshold Upper limit = base + threshold threshold = (WOC_THRESHOLD + 1) * 2^4 = [16, 32, ..., 2048]	0x100A	[6:0]

BitFieldName	Description	Address	Bits [15:0]
P_THRD_LOCK_HIGH	Pressure adaptive filter high threshold Threshold = value*4	0x100C	[15:10]
P_THRD_LOCK_LOW	Pressure adaptive filter low threshold Threshold = value*4	0x100C	[9:5]
P_CNT_LOCK_STATE	Number of successive measurements within the low and high thresholds needed to increase the filter depth.	0x100C	[4:2]
P_LPF_DEPTH	Pressure measurement filter depth	0x100C	[1:0]
NTC_ALPF_DEPTH_DEC	Step size when decreasing the filter depth of the NTC low pass filter if there is a large change in temperature measured	0x100E	[15:14]
NTC_ALPF_DEPTH_MIN	Minimum filter depth of the NTC low pass filter	0x100E	[13:11]
NTC_ALPF_DEPTH_MAX	Maximum filter depth of the NTC low pass filter	0x100E	[10:8]
NTC_ALPF_THRESHOLD_MAX	NTC temperature change threshold to change filter depth. If difference in NTC temperance > value, decrease filter depth If difference in NTC temperature < value/2, increase filter depth Value = Temperature[degC]*8	0x100E	[7:0]
I2C_ADDRESS	I2C slave address. If this field is 0, the default I2C address will be programmed. Default I2C address = 0x33 / 0b 011 0011	0x1010	[10:4]
SPI_CPOL	SPI polarity 0: clock polarity in idle state = low 1: clock polarity in idle state = high	0x1010	[3]
SPI_CPHA	SPI clock phase. 0: data sampled on the rising edge and shifted out on the falling edge 1: data sampled on the falling edge and shifter out on the rising edge	0x1010	[2]
SPI_I2C_ENABLE	SPI/I2C select 0: auto-detection: I2C and SPI. 1: SPI only 2: I2C only 3: auto-detection: I2C and SPI.	0x1010	[1:0]
TEST_BRIDGE_RANGE1	Pressure front end test bridge. Set during calibration.	0x1012	[9:7]
PADC_RANGE1_CAP_SEL	Pressure front end range selection. Set during calibration.	0x1012	[6:4]
PADC_RANGE1_SEL2	Pressure front end range selection. Set during calibration.	0x1012	[3:2]
PADC_RANGE1_SEL1	Pressure front end range selection. Set during calibration.	0x1012	[1:0]
ENABLE_I2C_5VMODE	Enable I2C 5V mode: 0: 3.3V 1: 5V	0x1016	[0]
V_SUP_HIGH	Over voltage diagnostic level VSUP_USL = 10240 + V_SUP_HIGH * 37 = 10240 + [0,1, .. 255] * 37 = 10240, 10277, .. 19590 The range of the external supply matches with approximately 3V to 5.75V and with a resolution of 10,7mV.	0x1018	[15:8]
V_SUP_LOW	Under voltage diagnostic level VSUP_LSL = 8533 + V_SUP_LOW * 37 = 8533 + [0,1, .. 255] * 37 = 8533, 8570, .. 17833 The range of the external supply matches with approximately 2,5V to 5.26V and with a resolution of 10,7mV.	0x1018	[7:0]
P0	Pressure calibration parameter. Set during calibration.	0x101A	[15:0]

BitFieldName	Description	Address	Bits [15:0]
A0	Pressure calibration parameter. Set during calibration.	0x101C	[15:0]
A1	Pressure calibration parameter. Set during calibration.	0x101E	[15:0]
A2	Pressure calibration parameter. Set during calibration.	0x1020	[15:0]
A3	Pressure calibration parameter. Set during calibration.	0x1022	[15:0]
B0	Pressure calibration parameter. Set during calibration.	0x1024	[15:0]
B1	Pressure calibration parameter. Set during calibration.	0x1026	[15:0]
B2	Pressure calibration parameter. Set during calibration.	0x1028	[15:0]
B3	Pressure calibration parameter. Set during calibration.	0x102A	[15:0]
C0	Pressure calibration parameter. Set during calibration.	0x102C	[15:0]
C1	Pressure calibration parameter. Set during calibration.	0x102E	[15:0]
PRESS_HIGH_ERR_CODE_MASK	The mask for the global error flags to be reported by the high error code in pressure output data - bit #0 masks SUPPLY_HIGH global error - bit #1 masks SUPPLY_LOW global error - bit #2 masks OTHER_INTERNAL_ERROR global error - bit #3 masks PRESSURE_ERROR global error Note: the low error code always has priority over the high error code. Example: if SUPPLY_HIGH is enabled and the pressure output is set to 12 bit, the pressure output will be set to 4095 if a too high supply voltage is detected.	0x1048	[7:4]
PRESS_LOW_ERR_CODE_MASK	The mask for the global error flags to be reported by a 0 in pressure output data - bit #0 masks SUPPLY_HIGH global error - bit #1 masks SUPPLY_LOW global error - bit #2 masks OTHER_INTERNAL_ERROR global error - bit #3 masks PRESSURE_ERROR global error Note: the low error code always has priority over the high error code. Example: if SUPPLY_HIGH is enabled and the pressure output is set to 12 bit, the pressure output will be set to 0 if a too high supply voltage is detected.	0x1048	[3:0]
TDEV_HIGH_ERR_CODE_MASK	The mask for the global error flags to be reported by the high error code in device temperature output data - bit #0 masks SUPPLY_HIGH global error - bit #1 masks SUPPLY_LOW global error - bit #2 masks OTHER_INTERNAL_ERROR global error - bit #3 masks TDEV_ERROR global error Note: the low error code always has priority over the high error code. Example: if SUPPLY_HIGH is enabled and the pressure output is set to 12 bit, the device temperature output will be set to 4095 if a too high supply voltage is detected.	0x104A	[15:12]

BitFieldName	Description	Address	Bits [15:0]
TDEV_LOW_ERR_CODE_MASK	The mask for the global error flags to be reported by a 0 device temperature output data - bit #0 masks SUPPLY_HIGH global error - bit #1 masks SUPPLY_LOW global error - bit #2 masks OTHER_INTERNAL_ERROR global error - bit #3 masks TDEV_ERROR global error Note: the low error code always has priority over the high error code. Example: if SUPPLY_HIGH is enabled and the pressure output is set to 12 bit, the device temperature output will be set to 0 if a too high supply voltage is detected.	0x104A	[11:8]
TNTC_HIGH_ERR_CODE_MASK	The mask for the global error flags to be reported by the high error code in NTC temperature output data - bit #0 masks SUPPLY_HIGH global error - bit #1 masks SUPPLY_LOW global error - bit #2 masks OTHER_INTERNAL_ERROR global error - bit #3 masks TNTC_ERROR global error Note: the low error code always has priority over the high error code. Example: if SUPPLY_HIGH is enabled and the pressure output is set to 12 bit, the device temperature output will be set to 4095 if a too high supply voltage is detected.	0x104A	[7:4]
TNTC_LOW_ERR_CODE_MASK	The mask for the global error flags to be reported by a 0 in NTC temperature output data - bit #0 masks SUPPLY_HIGH global error - bit #1 masks SUPPLY_LOW global error - bit #2 masks OTHER_INTERNAL_ERROR global error - bit #3 masks TNTC_ERROR global error Note: the low error code always has priority over the high error code. Example: if SUPPLY_HIGH is enabled and the NTC output is configured to 12 bit, the NTC temperature output will be set to 0 if a too high supply voltage is detected.	0x104A	[3:0]
SHA	Steinhart-hart A coefficient of the NTC temperature calculation	0x1084	[15:0]
SHB	Steinhart-hart B coefficient of the NTC temperature calculation	0x1086	[15:0]
SHC	Steinhart-hart C coefficient of the NTC temperature calculation	0x1088	[15:0]

Table 17: EEPROM parameter description

15. Application Information

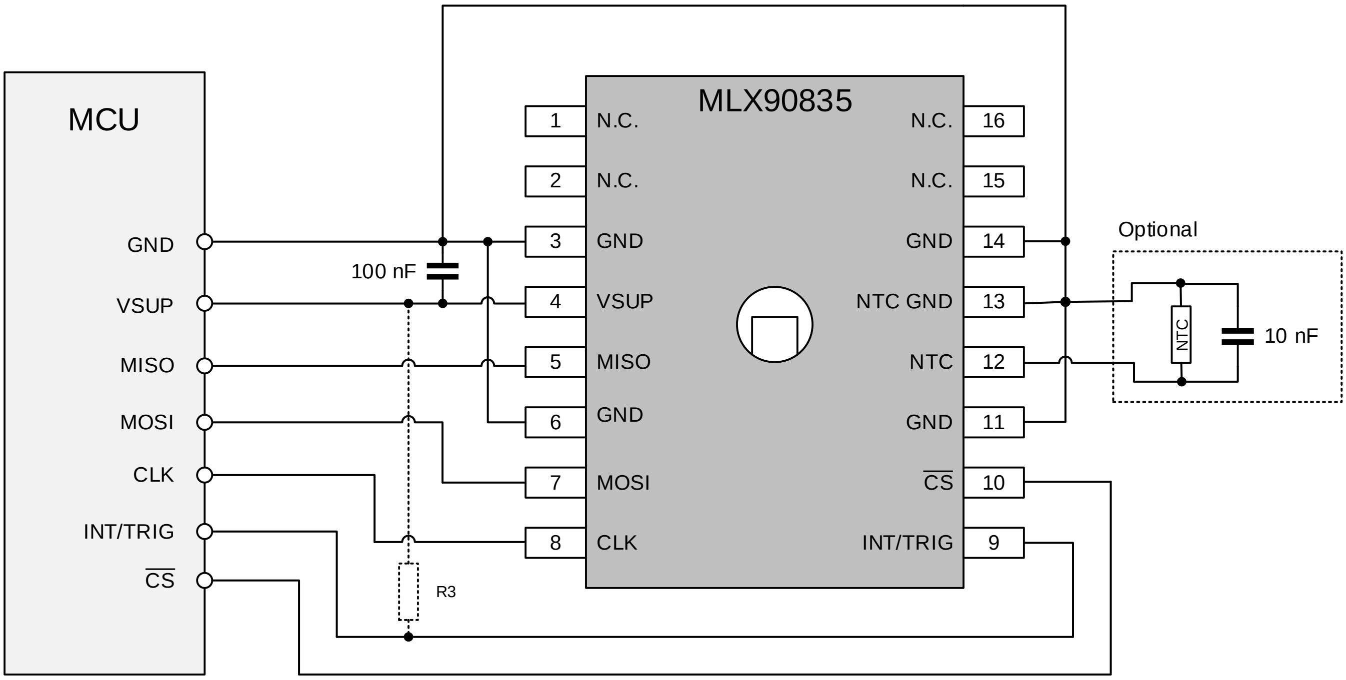


Figure 20: SPI application schematic

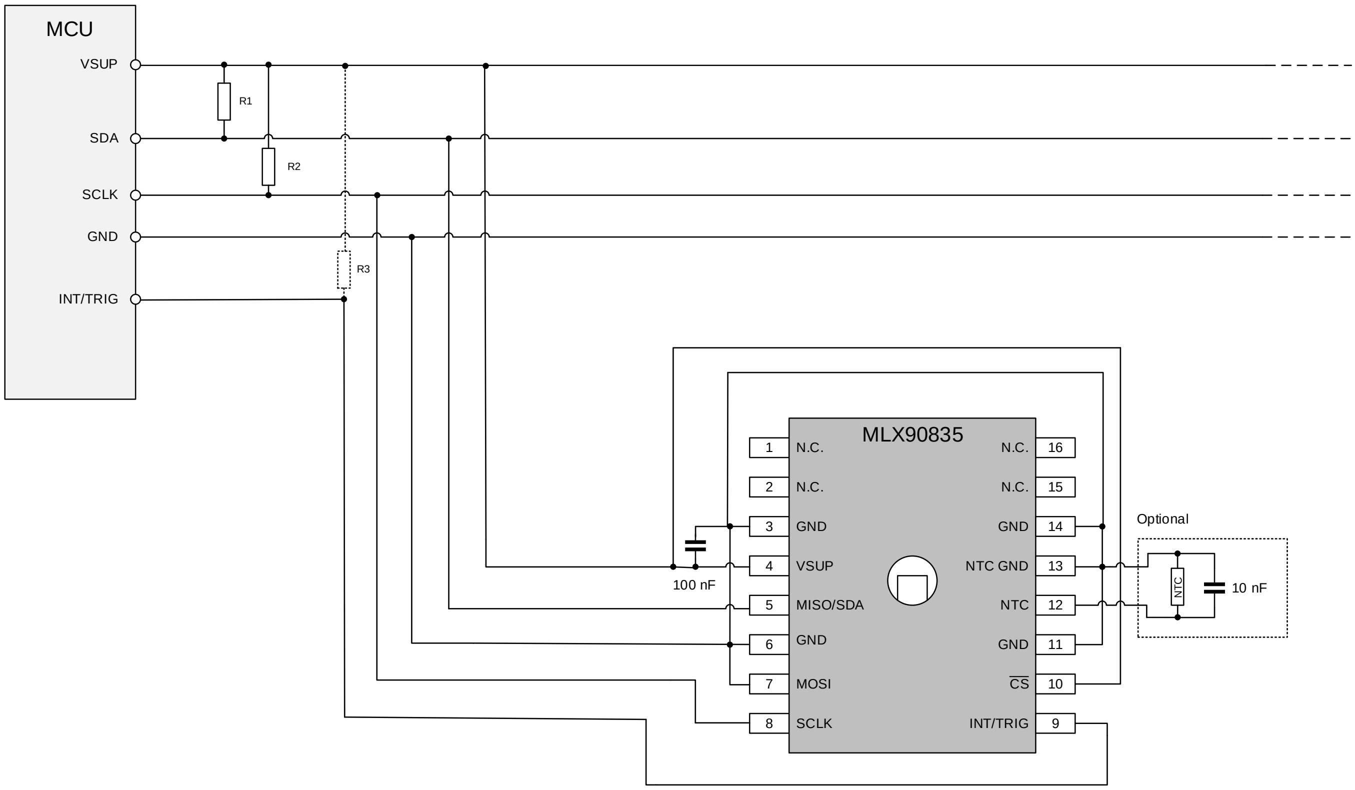


Figure 21: I2C wiring application schematic

16. Storage and handling of plastic encapsulated ICs

Plastic encapsulated ICs 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* (7)

17. 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* (7).

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.

For PCB-less assembly refer to the relevant application notes (7) 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*(7).

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 (7)

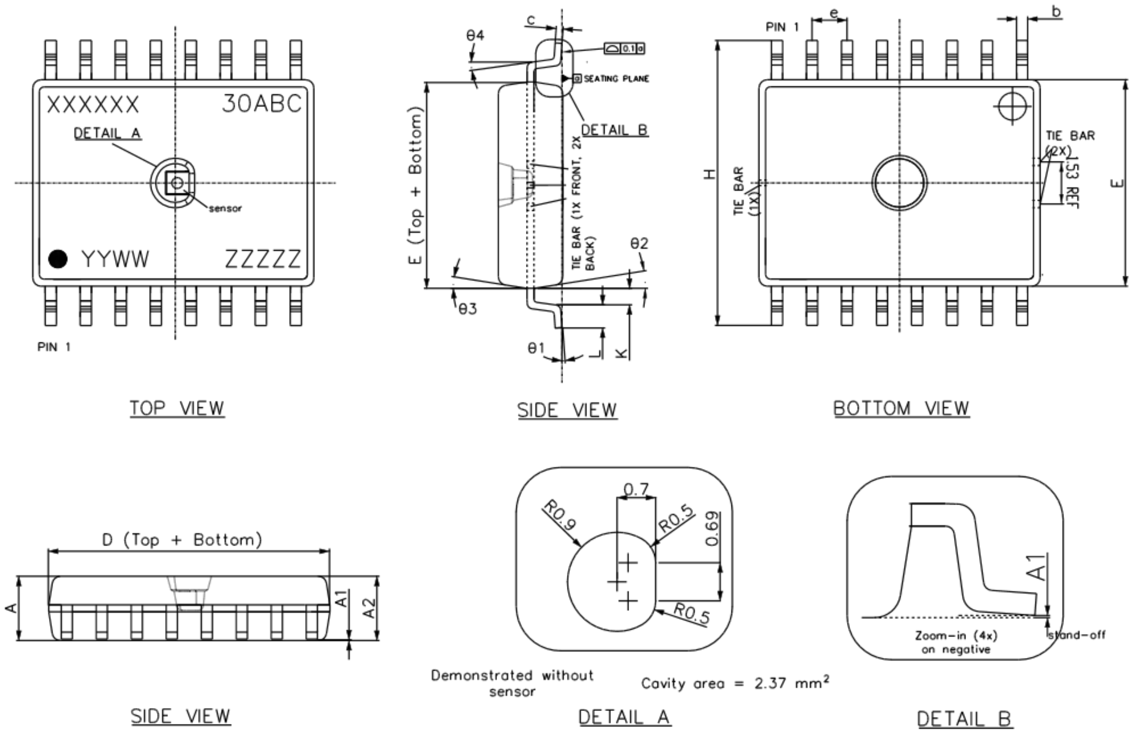
For other specific process, contact Melexis via www.melexis.com/technical-inquiry

18. 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

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

19. Package Information



SYMBOL	ALL DIMENSION ARE IN MILLIMETERS MINIMUM	NOMINAL	MAXIMUM	NOTES
A	2.23	2.33	2.43	
A1	−0.15	−0.1	−0.05	
A2	2.23	2.33	2.43	
b	0.31	0.41	0.51	
c	0.234	0.254	0.274	
D	10.13	10.2	10.27	2,4
E	7.4	7.5	7.6	3,4
H	10	10.3	10.6	3,4
e		1.27 BSC		
L	0.74	0.84	0.94	
K		0.6 REF		
Θ1	0°	–	8°	
Θ2	9°	14°	19°	
Θ3	9°	14°	19°	
Θ4	0°	–	10°	

NOTES

1. Package outline and dimensions are based on JEDEC MS−013, variant AA.
2. Dimension does not include mold flash, protrusion or gate burrs. Mold flash, protrusions and gate burrs shall not exceed 0.15 mm per end.
3. Dimension does not include interlead flash or protrusion. Interlead flash or protrusion shall not exceed 0,25 mm per side.
4. The package top may be smaller than the package bottom. Both dimensions are determined at the outer most extremes of the plastic body, exclusive of mold flash, tie bar burrs, gate burrs and interlead flash, but including any mismatch between top and bottom of the plastic body
5. Plating of the leads:
   Ni: 0.25 − 1.27 um
   Pd: 0.005 − 0.02 um
   Au−Ag: 0.005 − 0.064 um

20. Disclaimer

IATF 16949 and ISO 14001 Certified