# Application Note

## Example MLX90381 I²C Communication Protocol

## Contents



## 1. Related Melexis Products

### Related Products

- MLX90381 - Triaxis® pico-resolver

### Related Documents

- Datasheet MLX90381
- Application Note MLX90381 I²C Communication Protocol for End of Line Calibration

### Related Tools

- MLX90381_Arduino_or_Mbed_UI.exe [1]
- MLX90381_PTC_HW_I2C_GUI.ino [1]
- MLX90381_PTC_HW_I2C_GUI.NUCLEO_L152RE.bin [1]

## 2. Other Components Needed

- Arduino® or Mbed™ µC board without a pull-up on the I²C bus.
- 2 pull-down resistors in the range of 110kΩ, to detect the diagnostic state of the sensor.

[1] *Available via Softdist. Request an access to your local representative*

## 3. I²C Unique Slave Circuit

The MLX90381 is EoL (End of Line) programmable (limited to customer memory area) through the OUT1 and OUT2 pins of the sensor. The communication protocol is derived from I²C (100kHz standard speed). The I²C SCL and SDA pins are shared with normal application pins OUT1 and OUT2. The double function of the output pins requires the MLX90381 be a unique slave in the circuitry, see Figure 1.

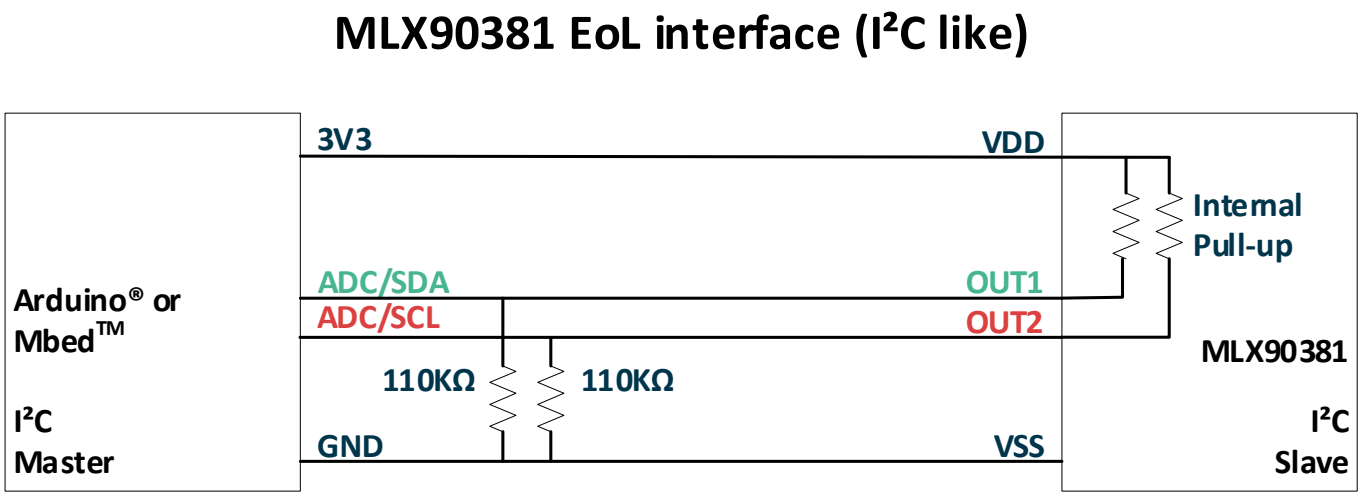



*Figure 1: MLX90381 EoL interface (I²C like)*

The double function of the output pins makes that the Arduino® or Mbed™ cannot have pull-up resistors on the I²C bus. If your Mbed™ or Arduino® board has pull-ups on the I²C bus. You will have to remove them to work with the MLX90381.

The reason for this is that the MLX90381 has an over-current detection on its output drivers. When these are triggered, the sensor goes in a diagnostic state, the outputs are set in high-Z mode. This state prevents the communication with the sensor.

The MLX90381 has internally 2 pull-up resistors on the I²C bus which are connected to the outputs when the sensor is in digital communication mode. When the sensor is in analog application mode the pull-ups are disconnected.

# 4. Explanation

## 4.1. Firmware

The firmware of the µC, to communicate with the MLX90381, contains 4 basic functions:

- **byte PTCentry()**
  This sequence sends the PTC entry command to the sensor to activate the I²C communication. This instruction is the only instruction which is not an I²C function. The reason for this is the dual function of the output pins of the sensor, SIN - COS and SDA - SCL.
- **byte ReadMemory(int StartAddr, byte NbWords)**
  This sequence sets the read memory instruction on the I²C lines.
- **byte WriteRegister(short StartAddr, byte NbWords)**
  This sequence sets the Write Register instruction on the I²C lines. This is a write instruction without a >10ms delay.
- **byte WriteMTP(short StartAddr, byte NbWords)**
  This sequence sets the Write MTP memory instruction on the I²C lines. This is a write instruction with a >10ms delay. Minimum 10 milliseconds are required to erase and write the MTP cells of one address!

Next to that the firmware has a command set to communicate with the user interface:

- S: Program register.
  Programs address 0x20 till 0x2A of the register.
- C: Check register data.
  Reads the content of the customer area of the registers.
- P: Program MTP.
  Programs address 0x00 till 0x0A of the MTP.
- R: Read MTP.
  Reads the content of the full MTP of the sensor.
- L: Program MEMLOCK.
  Programs address 0x0C of the MTP with the lock bit set.
  Note: MEMLOCK is a permanent LOCK of the MTP.
- W: Enter new data to program address by address.
  This method transfers data to be programmed in the register or MTP.
- M: Measure outputs in MTP application mode.
  Resets the sensor to application mode with the MTP settings active.

## 4.2. Setup

Setup the connection between the µC and the sensor as shown in Figure 1: MLX90381 EoL interface (I²C like). The firmware for the boards uses the default I²C port for the connections with the sensor. The sensor can be supplied with the 3V3 supply of the µC board.

Upload firmware on the µC.
For this you can follow the instructions on the website of Arduino® or Mbed™.

Startup the user interface for programming MLX90381 sensors with an Arduino® or Mbed™. Fill in the COM port number to which the board is connected and press the *Connect µC* button. If the connection is successfully made, the Status COM will change to Connected.

## 4.3. User Interface Description

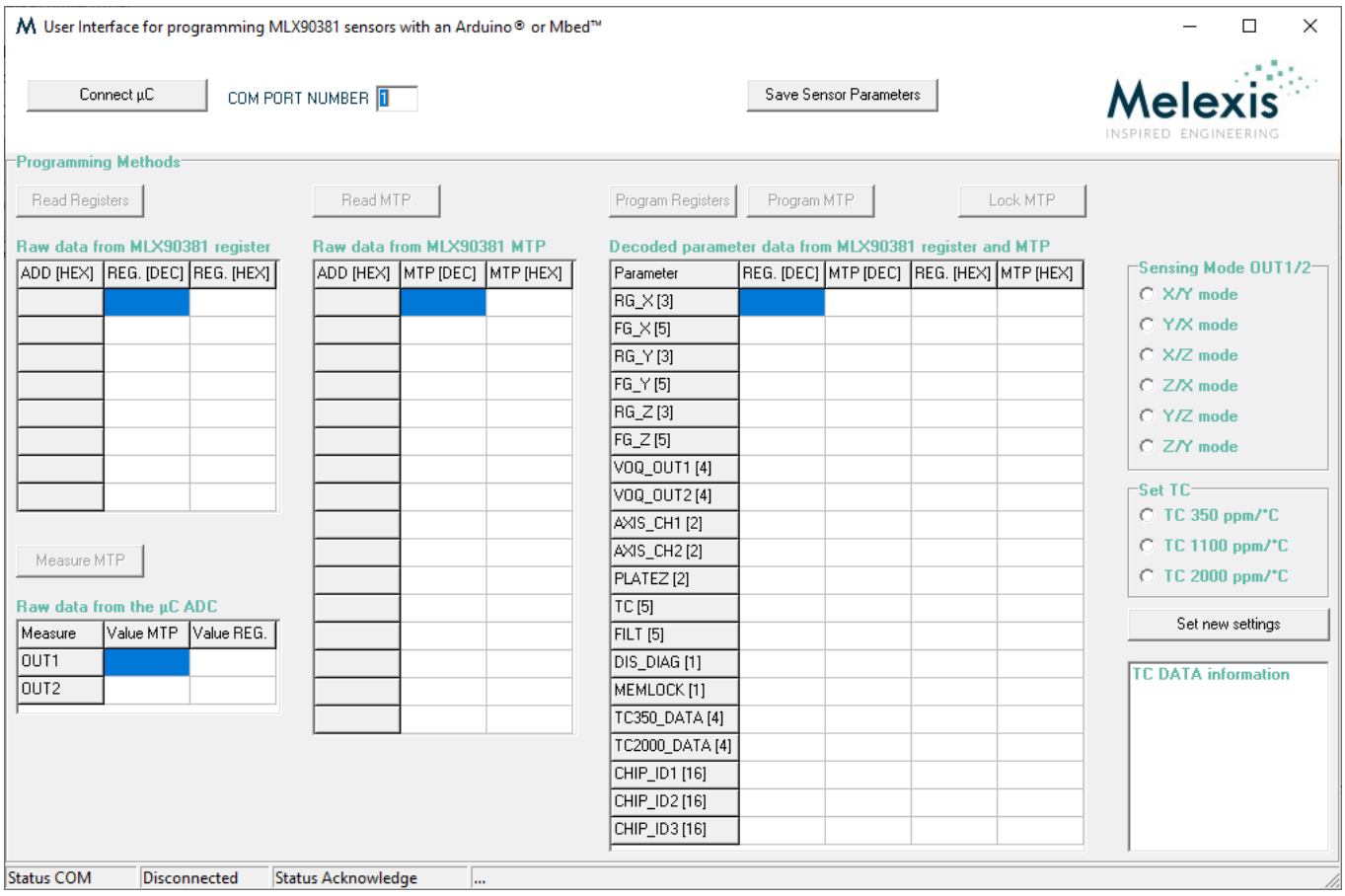



*Figure 2*

The user interface is a simple interface to program the MTP of the MLX90381 via I²C commands.

At the top you find a field to list the COM port to which the µC is connected and a button *Connect µC*.

*Connect µC* will open the listed COM port and verify if the correct firmware is uploaded in the µC. If the firmware is recognized, the other buttons are enabled.

If the firmware is incorrect you will get a notification to verify the firmware of the µC.

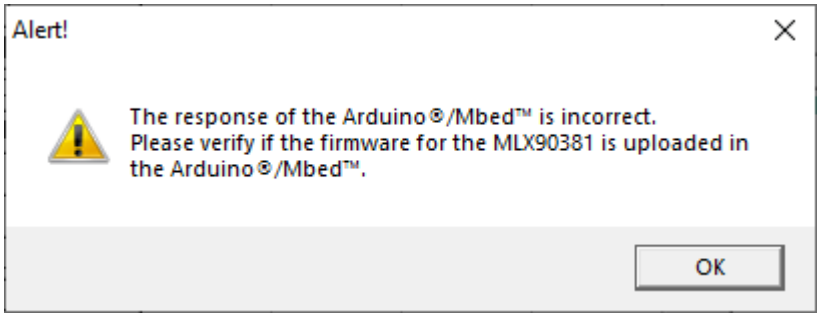



*Figure 3*

At the bottom of the UI, you find the status of the COM port and the status of the I²C communication. The returned I²C communication status can be:

**byte PTCentry()** returns:

- FE: I²C interface activation fail
- FF: I²C interface activation success

The I²C library of the Arduino® returns:

- 0 : Success
- 1 : Data too long to fit in transmit buffer
- 2 : Received NACK on transmit of address
- 3 : Received NACK on transmit of data
- 4 : Other

The I²C library of the Mbed™ returns:

- 0 : success ACK
- 1 : Received NACK

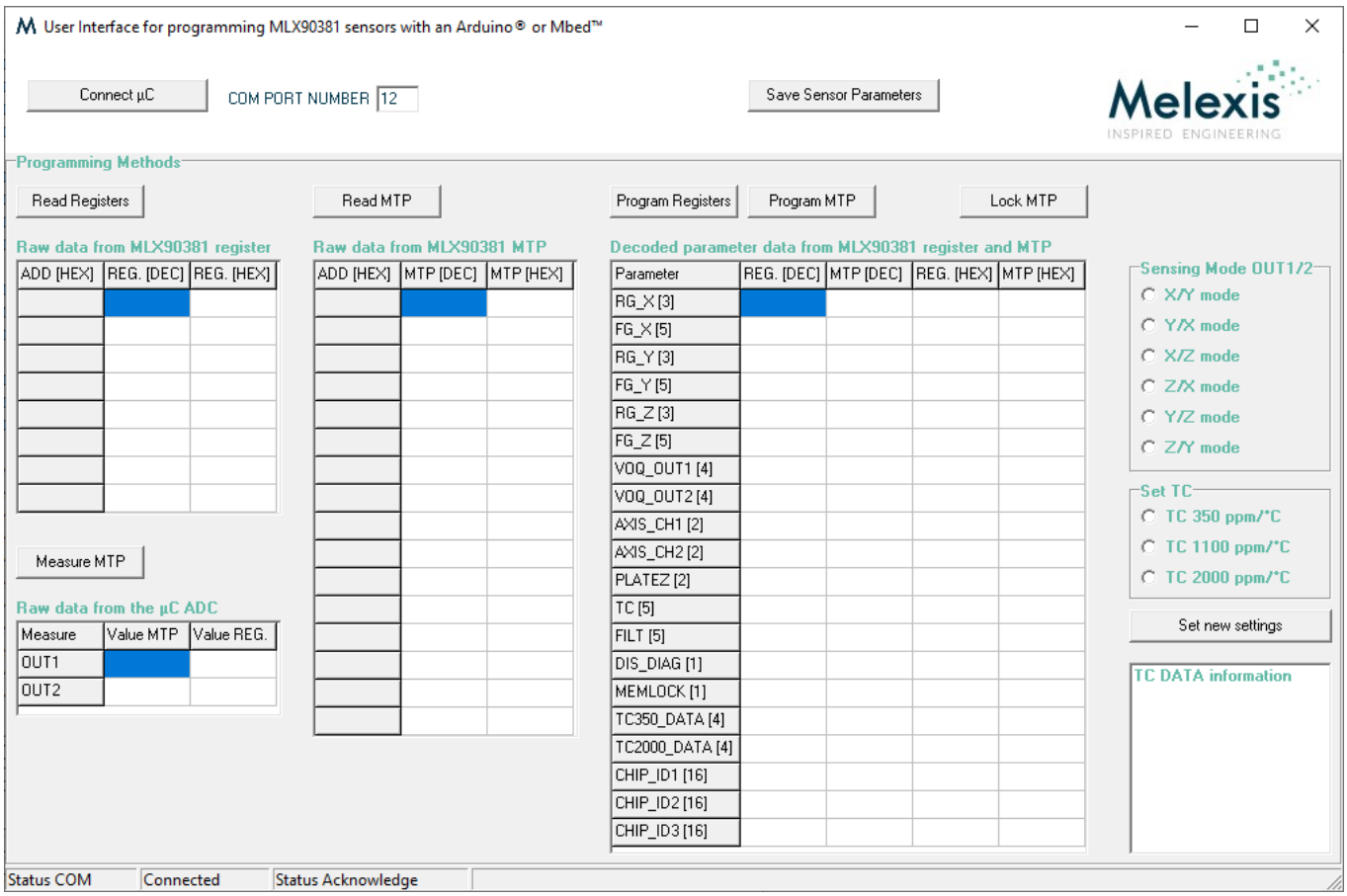



*Figure 4*

The user interface has 8 methods:

- *Read Registers*
  Reads the content of the customer aria of the registers.
- *Read MTP*
  Reads the content of the full MTP of the sensor.
- *Program Registers*
  Programs address 0x20 till 0x2A of the register and performs a measurement of the 2 outputs with the µC ADC.
- *Program MTP*
  Programs address 0x00 till 0x0A of the MTP.
- *Lock MTP*
  Programs address 0x0C of the MTP **with** the MEMLOCK bit set to 1.
- *Measure MTP*
  Resets the sensor to application mode with the MTP settings active. Then measures the 2 outputs with the µC ADC.
- *Set new settings*
  Sets the selected *Sensing Mode OUT1/2* and the Temperature Coefficient for the sensor. To store this in the sensor, press *Program Registers* or *Program MTP* after pressing *Set new settings*.
- *Save Sensor Parameters*
  Saves the decoded sensor parameters in a text file.

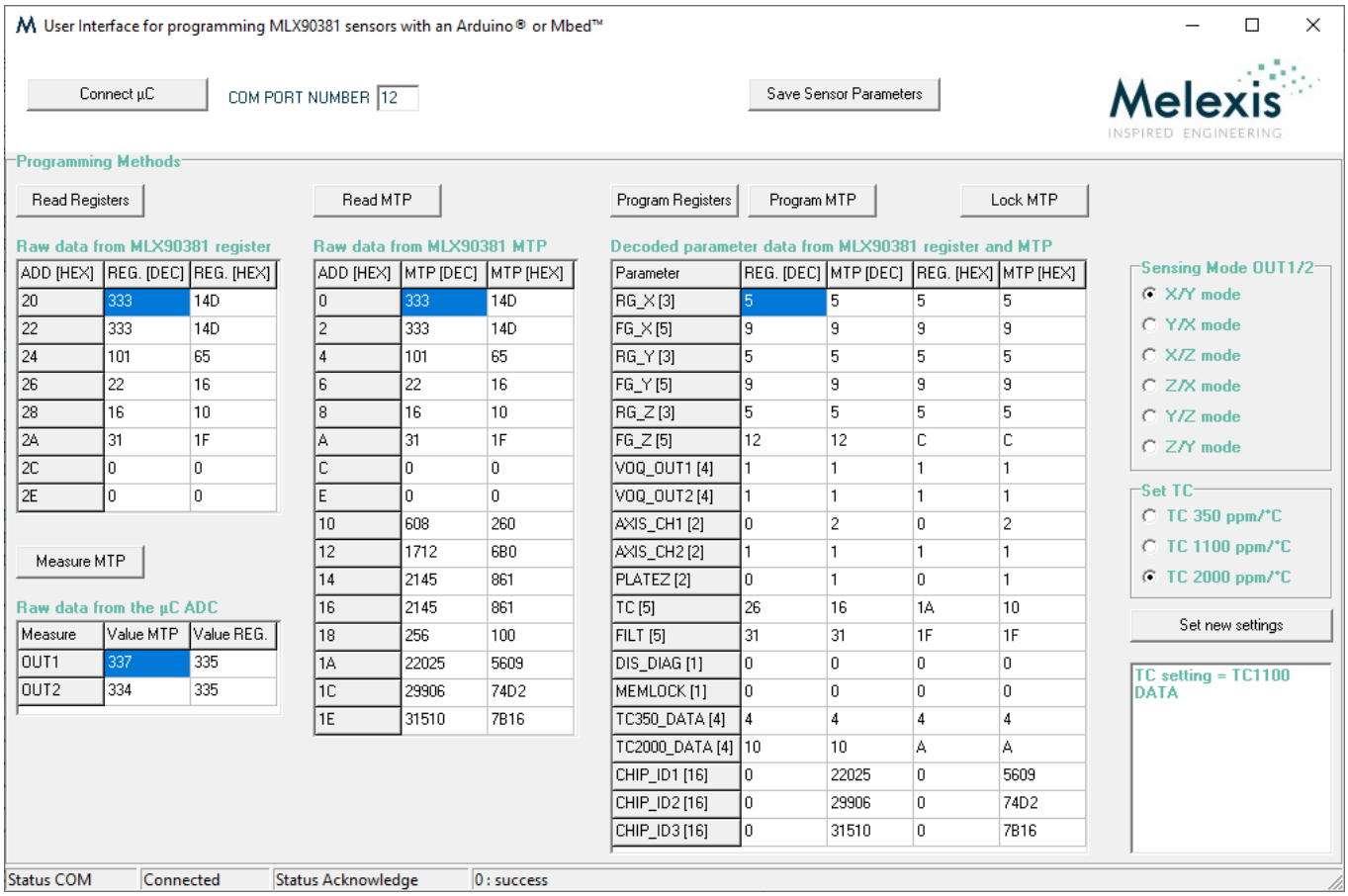



*Figure 5: Program Register with different Sensing Mode OUT1/2*

The user interface has 4 tables:

- *Raw data from MLX90381 registers*
  Lists the data of each customer register address.
- *Raw data from MLX90381 MTP*
  Lists the data of each MTP address.
- *Decoded parameter data from MLX90381 register and MTP*
  Lists the value of each customer programmable parameter of the MLX90381. The table contains 2 columns for the Registers and the MTP of the sensor.
  Only the Reg.[DEC] and REG.[HEX] column of this table can be edited to change the parameters of the MLX90381 for both the Program Registers and Program MTP method.
  The parameters TC350_DATA and TC2000_DATA are information bits. The data can be used to change the TC parameter of the sensor to a different temperature coefficient. The parameters TC350_DATA and TC2000_DATA cannot be changed. Also, the and CHIP_ID1-3 cannot be changed. DIS_DIAG and MEMLOCK are parameters of address 0x0C and can only be changed by the Lock MTP function.
- *Raw data from the µC ADC*
  Column Value MTP lists the results of *Measure MTP*.
  Column Value REG. lists the results of the µC ADC measurement, performed by the *Program Register* method after the new settings are loaded in the sensor.

When the *Read Register* or *Read MTP* method is executed the UI will decode the raw content of the Register or MTP into the different sensor parameter.

When the *Read MTP* method is executed the UI will also estimate if there are valid parameters in the sensor for TC350_DATA and TC2000_DATA. As listed in the datasheet, the TC350_DATA and TC2000_DATA parameters are only available in the MLX90381GLW-ACA. This is listed in box below the *Set new settings* button.

In the table *Decoded parameter data from MLX90381 register and MTP* only the columns REG.[DEC] (the decimal values) or REG.[HEX] (the hexadecimal value) of the sensor parameters can be edited.

The sensor parameters can be changed according the description in the datasheet of the MLX90381.

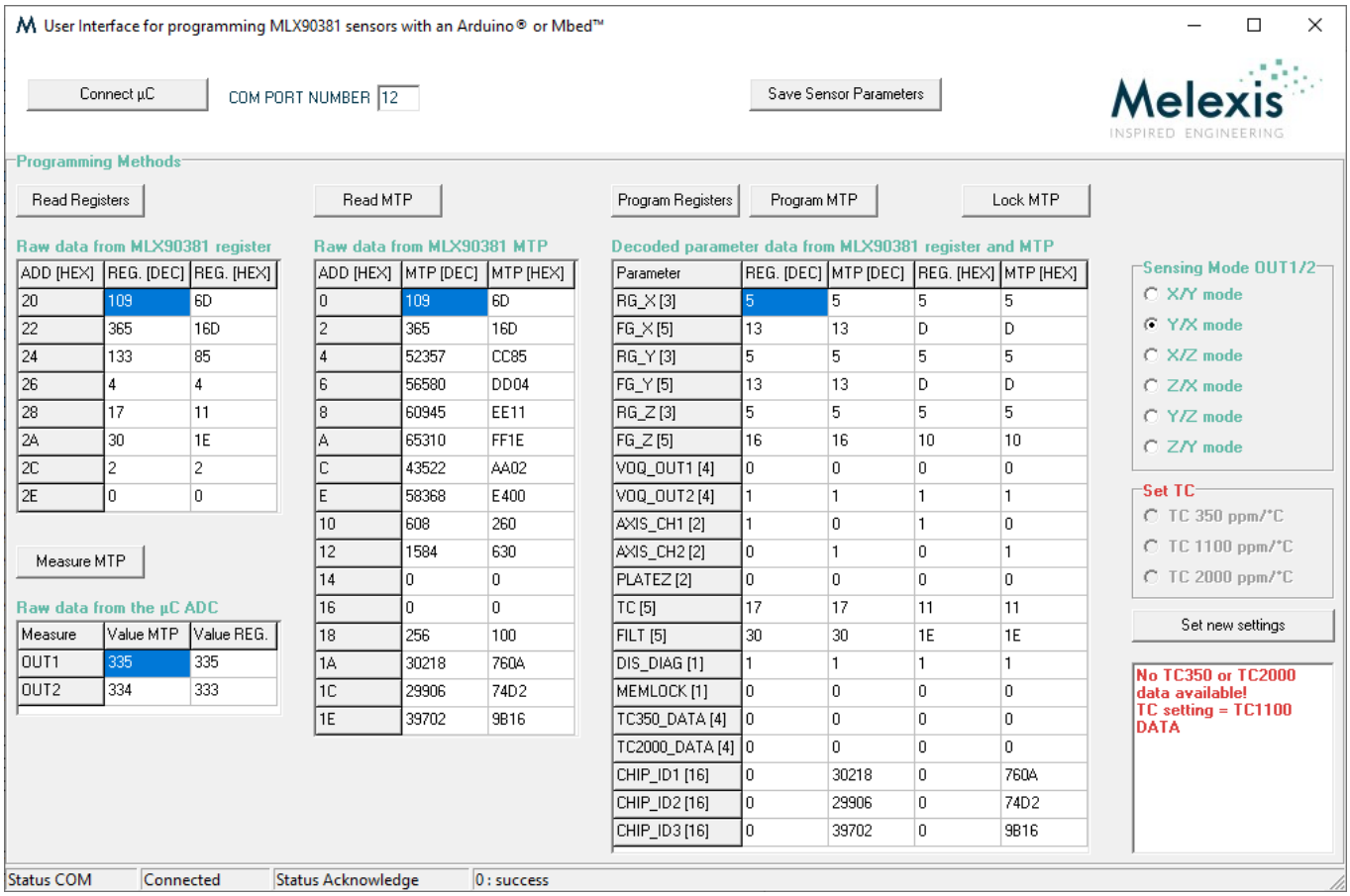



*Figure 6: Data of an MLX90381GLW-ABA without TC350_DATA and TC2000_DATA*

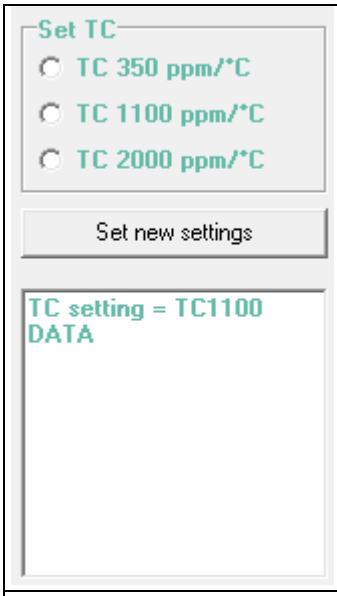
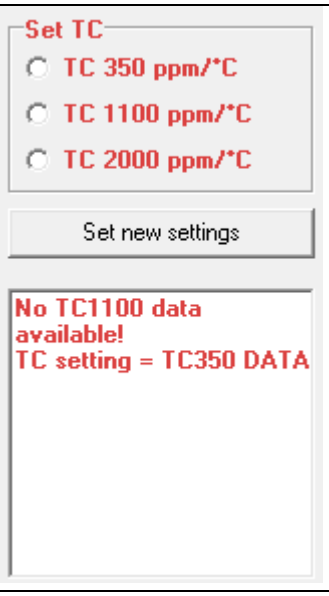
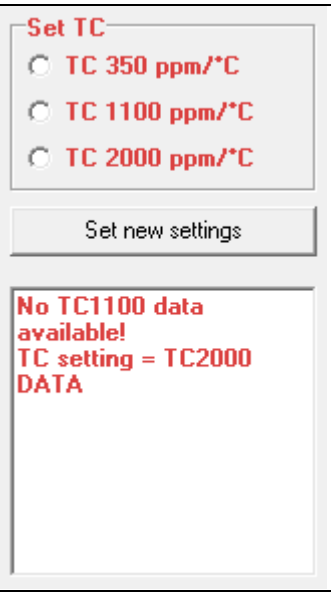
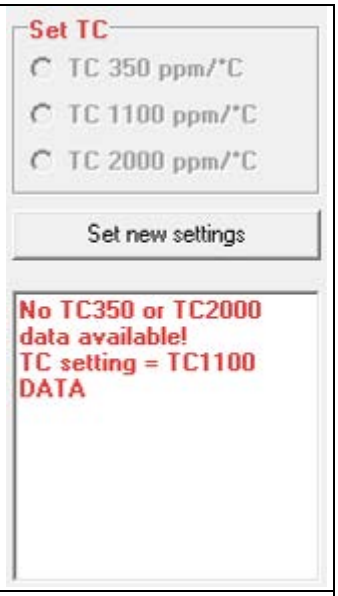
*Set new settings*: This button sets new settings for the *Sensing Mode OUT1/2* and *Set TC* in the *Decoded parameter data from MLX90381 register and MTP* table.

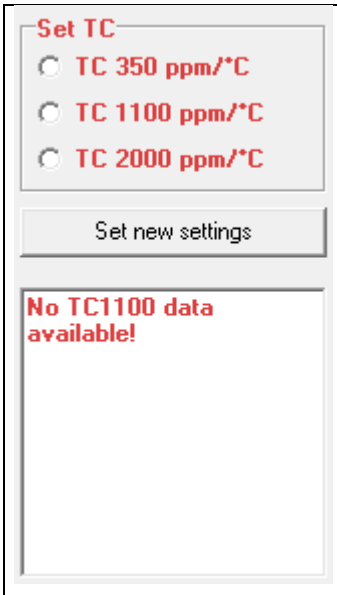
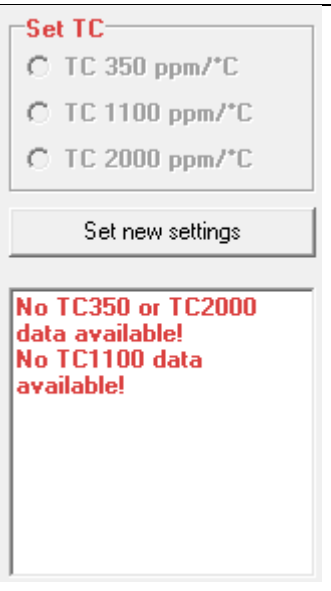
*Sensing Mode OUT1/2* sets the value for AXIS_OUT1, AXIS_OUT2 and PLATEZ according the description of chapter “15.1. Axis Selection: AXIS_CH1 - AXIS_CH2 – PLATEZ” in the datasheet of the MLX90381.

*Set TC* copies the value from the TC350_DATA or TC2000_DATA parameters to the TC parameter of the sensor according the description of chapter “15.5. Sensitivity Temperature Coefficient: TC” of the datasheet of the MLX90381.

**Important note:** The value for TC 1100 ppm/°C is stored in the TC parameter of the sensor. When the *Read MTP* method is executed the UI will hold a copy of the TC parameter in the UI program. This allows you the switch between the TC 350 ppm/°C, TC 1100 ppm/°C and TC 2000 ppm/°C. Once the MTP parameter of the TC is programmed and a *Read MTP* is executed, the original TC 1100 ppm/°C parameter stored in the UI is lost. This will be indicated in the box below the *Set new settings* button. If you need the original TC 1100 ppm/°C parameter later on, save a copy of the sensor parameters.

The estimation of the TC DATA settings can have the following outcomes:

| | | | |
|---|---|---|---|
|  |  |  |  |
| MLX90381GLW-ACA | MLX90381GLW-ACA | MLX90381GLW-ACA | MLX90381GLW-ABA |
| With TC350_DATA and TC2000_DATA available. | With TC350_DATA and TC2000_DATA available. | With TC350_DATA and TC2000_DATA available. | Without TC350_DATA and TC2000_DATA available. |
| Original TC Settings | TC1100_DATA is overwritten. | TC1100_DATA is overwritten. | Set TC is disabled. |
| Programmed<br>TC = TC1100_DATA | Programmed<br>TC = TC350_DATA | Programmed<br>TC = TC2000_DATA | Programmed<br>TC = TC1100_DATA |

| | | | |
|---|---|---|---|
|  | If you set the TC parameter to a value that does not resemble any default code the box below the *Set new settings* button will indicate that the TC1100_DATA is overwritten.<br>Note that if you overwrite the original TC parameter containing a 1100ppm/°C code. There is no way you can restore this unless you have logged the original value. |  | A MLX90381GLW-ABA engineering part can contain a TC parameter different from 1100ppm/°C. |

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