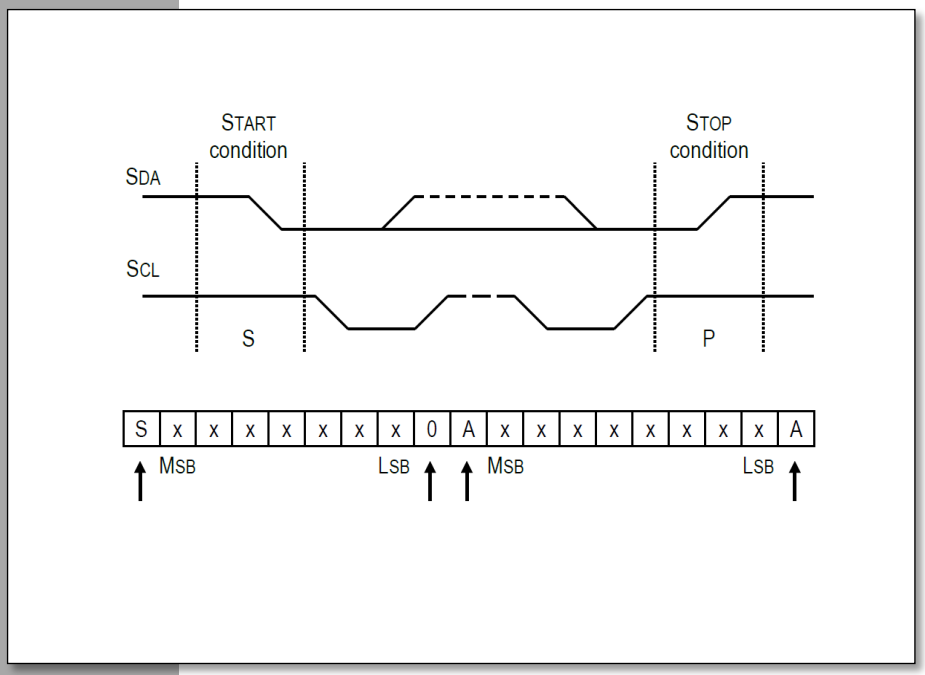
MI3

Miniature Infrared Sensor

– OEM Version –



Protocol Manual

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Specifications subject to change without notice.

CE

The device complies with the requirements of the European Directives.

EC – Directive 2004/108/EC (EMC)

Content

1 Safety Instructions

This document is part of the operating instructions for the MI3. All tips and notices regarding safety, technical data, and acceptable operation must be read in addition to that manual addendum.

2 Description

The MI3 sensing head contains a fully functional infrared pyrometer. Individual sensing heads can run standalone without the need to install an additional communication box. The temperature readings and all sensor parameters are accessible via a digital communication bus.

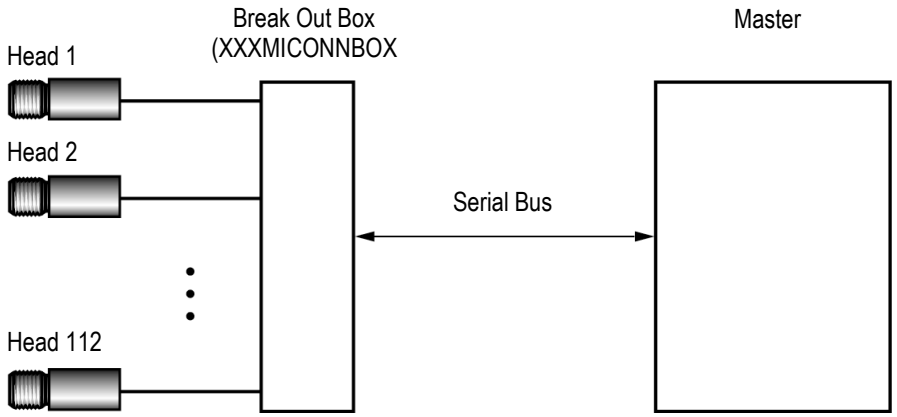


Figure 1: OEM Sensing Heads Configuration

3 Technical Data – Sensing Head

3.1 Communication

Serial bus	I²C interface standard from PHILIPS[1], two wires, bidirectional
Power	2.5 to 3.3 V
Bus mode	100 kHz[2]

3.2 Measurement Specification

Temperature Range

LT02, LT10	-40 to 600°C (-40 to 1112°F)
LT20, LTF	0 to 1000°C (32 to 1832°F)
G5	250 to 1650°C (482 to 3002°F)

Spectral Response

LT	8 to 14 µm
G5	5 µm

Response Time[3]

LTS	130 ms
LTF (fast)	20 ms
G5	130 ms

Accuracy[4]

LT, G5	± 1% of reading or ± 1°C, whichever is greater

Repeatability

LT, G5	± 0.5% of reading or ± 0.5°C, whichever is greater

Temperature Coefficient

LT, G5	± 0.05 K / K or ± 0.05% / K of reading whichever is greater

[1] PHILIPS is a registered trademark of Koninklijke Philips Electronics.N.V.

[2] for the maximal allowed cable length of 30 m (98 ft). Faster clock speeds (400 kHz) are possible for shorter cable lengths but not guaranteed.

[3] 90% response

[4] at ambient temperature 23°C ±5°C (73°F ±9°F), ε = 1.0, and calibration geometry

3.3 Optical Specification

Optical Resolution D:S[1]

LTS	2:1, 10:1, 22:1 typ. (21:1 guaranteed)
LTF	10:1
G5	10:1

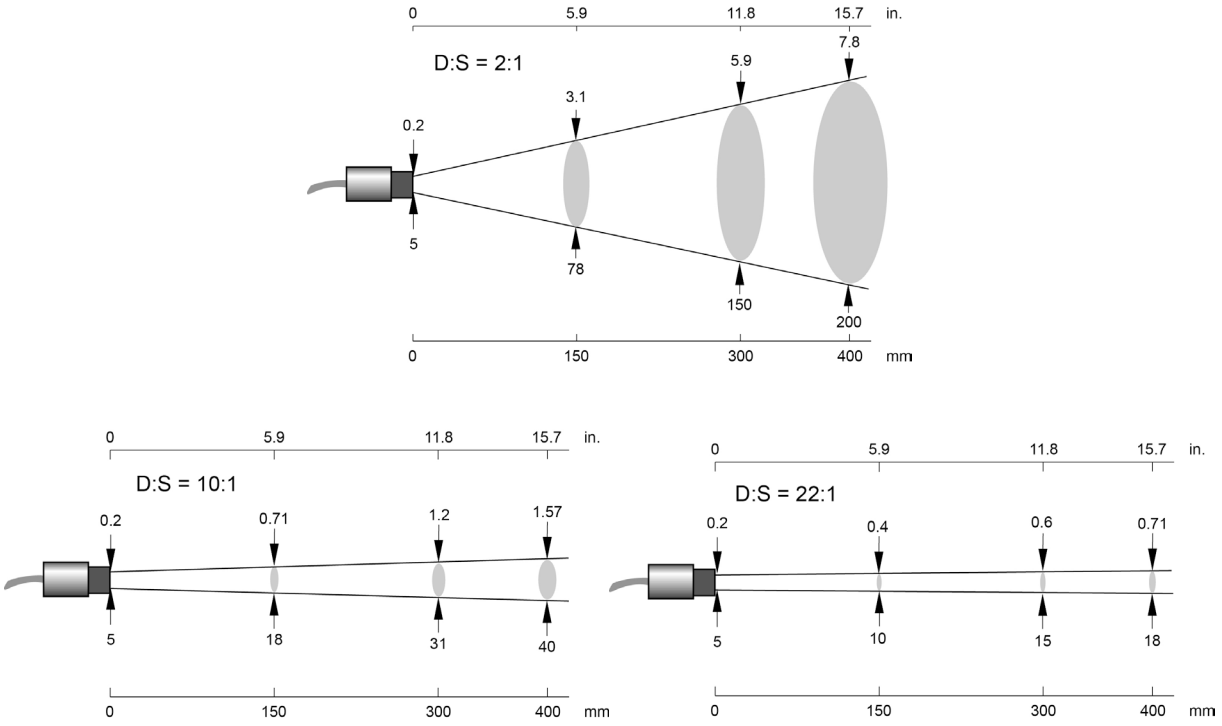


Figure 2: Spot Size Charts

3.4 Environmental Specification

Ambient Temperature	-10 to 120°C (14 to 248°F)
Storage Temperature	-20 to 120°C (-4 to 248°F)
Rating	IP65 (NEMA-4) / IEC 60529
Relative Humidity	10% to 95% non-condensing
EMC	EN 61326-1:2006
Vibration	11 to 200 Hz, 3 g above 25 Hz operating, 3 axes / IEC 60068-2-6
Shock	50 g, 11 ms, operating, 3 axes / IEC 60068-2-27
Weight	50 g (1.8 oz)
Material	
Head	Stainless steel
Head Cable	PUR (Polyurethane), Halogen free, Silicone free

[1] At 90% energy in minimum and distance 400 mm (15.7 in.)

3.5 Dimensions

3.5.1 Sensing Heads LT, G5

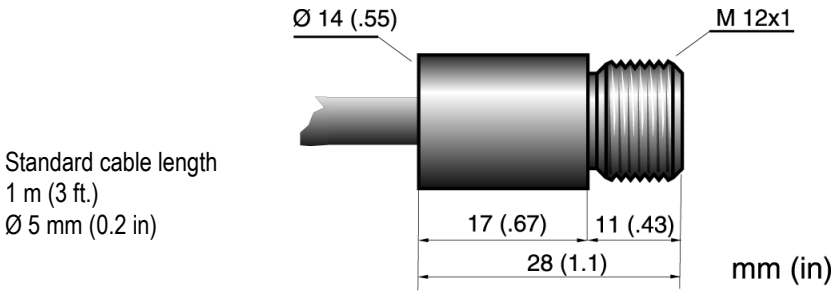


Figure 3: Dimensions of LT, G5 Sensing Heads

4 Installation

4.1 Head Cables

For the sensing head, a shielded 4-wire cable is used for power supply and communication. To avoid inaccurate measurement and communication, the cable shield should be connected to the housing of the master system. The sensor cable may be shortened, if necessary, but keep a minimal length of 20 cm (7.9 in).

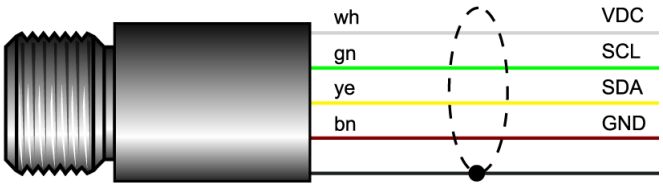


Figure 4: Head Cable Connections

Each sensing head requires a power supply of 2.5 V_{DC} (± 5%), 10 mA.

4.2 Interface Wiring

The sensing head communication is based on a serial communication compatible to the I²C interface standard from PHILIPS. The sensing head interface consists of two wires – clock line (SCL) and data line (SDA). Both lines are bidirectional and must be connected to the positive power supply via an external pull-up resistor.
Bus mode: <Standard> up to 100 kHz.

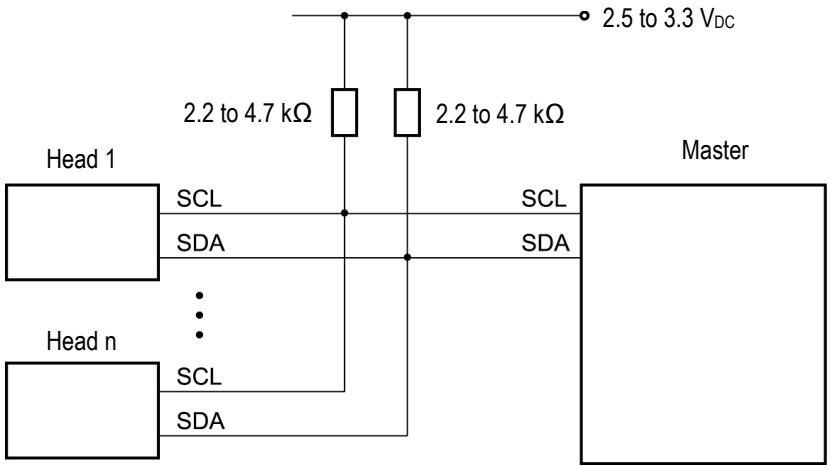


Figure 5: Serial Bus Structure

Wait at least 1 s between a power on and the first data transfer to the head!

5 Programming

5.1 Serial Communication

A device generating a message is a “transmitter”. A device receiving it is the “receiver”. The device that controls the serial bus is the “master” and the devices controlled by the master are the “slaves”.
While the clock line is operated by the master, only the data line can be operated by either master or slave, depending on the communication direction (read or write) set by the master together with the slave address.
Generally one master on the bus is addressing one slave by sending the slave address into the bus. Because it is generally possible to run a multiple number of masters on the bus, each has to wait for a free bus to start its transfer.
The data on the SDA line must remain stable during the HIGH period of the clock pulse, as changes in the data line at this time will be interpreted as control signals (start/stop condition) – see the following figure.

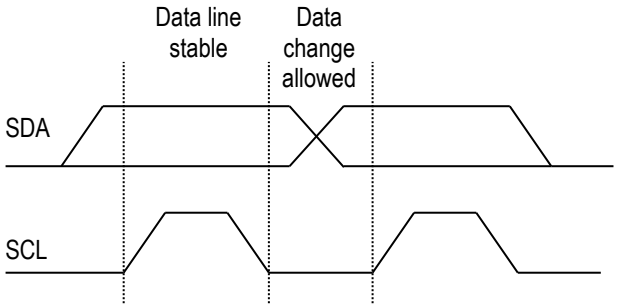


Figure 6: Signals during Data Transfer

Data and clock lines remain HIGH when the bus is not busy. A HIGH-to-LOW transition of the data line while the clock is HIGH is defined as the start condition (S). A LOW-to-HIGH transition of the data line while the clock is HIGH is defined as the stop condition (P).

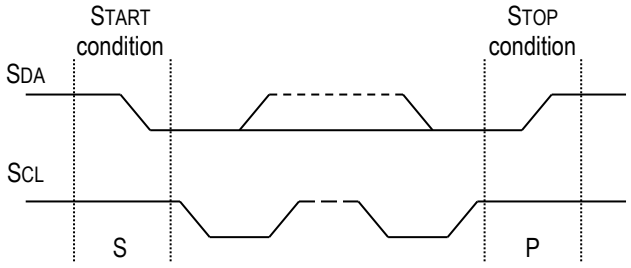


Figure 7: Start and Stop Condition

After the start condition, the master sends a byte, most significant bit (MSB) first, on the SDA line, along with eight SCL pulses. The first seven bits of this byte are the 7-bit slave address.
Each head (slave) is to be addressed individually, see section 5.2 Sensing Head Addressing, page 12.
The slave with the address matching the master 7-bit address is responding to the call.
The eighth bit, the least significant bit (LSB), is the R/W status bit. The R/W status bit determines the direction of the message. If this bit is cleared, the master writes data to an addressed slave. If this bit is set, the master expects to receive data from the slave.

If the slave address matches the address sent by the master, the slave must generate a message to acknowledge (ACK). Otherwise, it sends a message not to acknowledge (NACK). An ACK is seen as a LOW level on the SDA line on the ninth clock pulse, a NACK is seen as a HIGH level.
During data transfer, the ACK or the NACK is always generated by the receiver. The transmitter must release the SDA line during the ACK clock pulse. The clock pulse required for the ACK is always generated by the master.

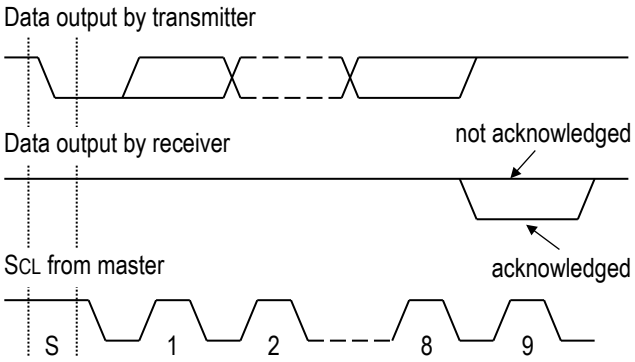


Figure 8: ACK / NACK

A master receiver must signal an end of data to the slave transmitter by generating NACK after the last byte that has been clocked out of the slave. In this case, the slave transmitter must leave the data line HIGH to enable the master to generate a stop condition.

5.2 Sensing Head Addressing

The sensing head does not respond to the <general call address> of the I²C specification standard.
The factory-default 7-bit address of the sensing head is 0x7F. This address can be changed by writing a new address into the address register of the sensing head. The <Sequential Write> transfer is to be used.
For the head addressing, some regulations regarding the address range are important to note:

7-bit Address	Use
0x00 – 0x04	reserved
0x08 – 0x77	defines the available address range, max. 112 sensing heads
0x78 – 0x7F	reserved for initial addressing of sensing head and master device

5.3 Write/Read Transfers

There is a number of registers implemented in the sensing head for data transfer. Data is transmitted to the registers using <data write sequence>. In this case, the sensing head is the slave-receiver. Please note, after a complete write sequence you have to wait 40 ms before the next write/read sequence can be executed.

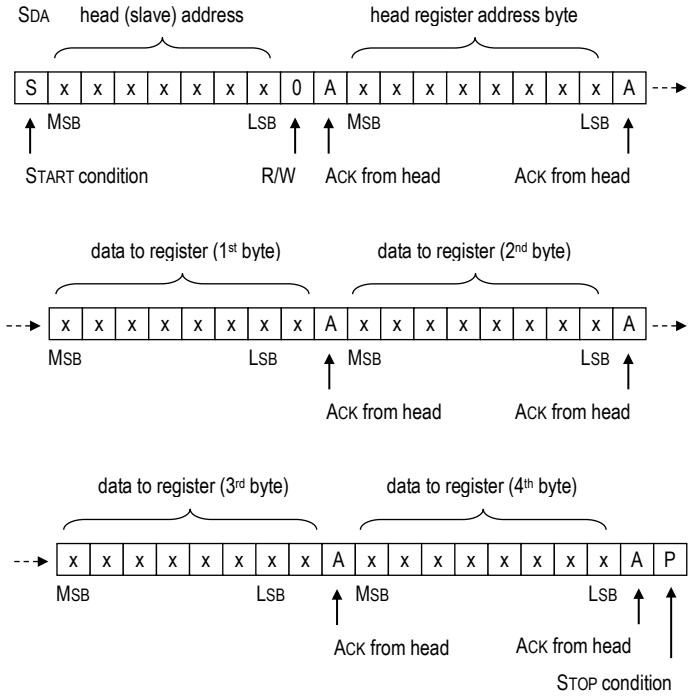


Figure 9: Data Write Sequence

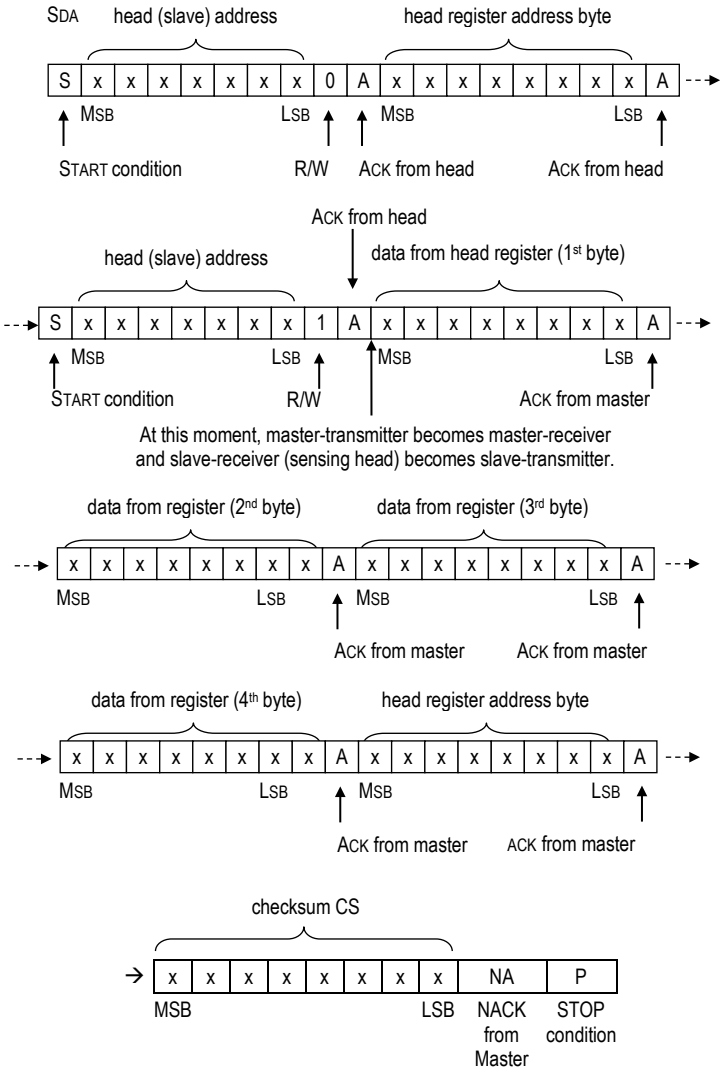


Figure 10: Data Read Sequence

Data is read from the head registers using <data read sequence>.
Transfer of data can be stopped at any moment by a stop condition. When this occurs, data present at the last acknowledged phase is valid.
Checksum CS is a 2-digit hexadecimal checksum that is the twos complement of the sum of all data bytes, including heads register address byte and a number of bytes:
CS = 0x00 – (1th byte+2th byte+3th byte+4th byte+heads register address byte+5).

5.4 Head Data Registers

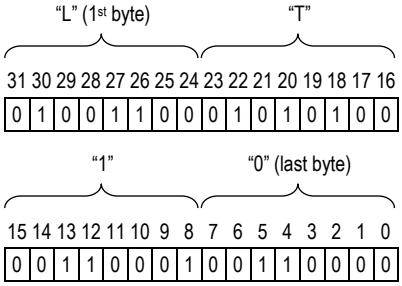
Following the successful acknowledgment of the head address byte, the bus master sends the address of the register that is to be accessed, see Figure 9.
The implemented data registers of the sensing head are listed in the following table.

Register Address	Function	Data Size [Byte]	Data Format	Access
0x01	Name	4	char[4]	R/W
0x02	Head ID	4	unsigned	R
0x03	Serial Number	4	unsigned	R
0x04	Version	4	char[4]	R
0x05	Target Temp.	4	float	R
0x06	Ambient Temp.	4	float	R
0x07	Target/Amb. Temp.	4	signed int[2]	R
0x08	Emissivity	4	float	R/W
0x09	Transmissivity	4	float	R/W
0x0A	Bottom Temp.	4	float	R
0x0B	Top Temp.	4	float	R
0x0C	Status	4	unsigned	R/W
0x0D	head address	4	unsigned	R/W
0x11	Special Code	4	char[4]	R
0x12	Head IDENT0	4	char[4]	R
0x13	Head IDENT1	4	char[4]	R
0x14	Head IDENT2	4	char[4]	R
0x15	Head IDENT3	4	char[4]	R
0x1A	Adjust Gain	4	float	R/W
0x1B	Adjust Offset	4	float	R/W
0x1C	Detector Power	4	signed	R
0x1D	Ambient background	4	float	R/W
0x1F	Factory default	4	unsigned	W
0x28	Flicker filter threshold	2	unsigned int	R/W
0x3E	Laser control	1	unsigned byte	R/W
0x40	Cali Date	4	unsigned	R
0x41	Cali Time	4	unsigned	R
0x42	Cali Ambient Low Temp.	4	float	R
0x43	Cali Ambient High Temp.	4	float	R
0x44	Cali Source Temp. 1	4	float	R
0x45	Cali Measure Temp. 1	4	float	R
0x46	Cali Source Temp. 2	4	float	R
0x47	Cali Measure Temp. 2	4	float	R
0x48	Cali Source Temp. 3	4	float	R
0x49	Cali Measure Temp. 3	4	float	R
0x4A	Cali Source Temp. 4	4	float	R
0x4B	Cali Measure Temp. 4	4	float	R
0x4C	Cali Source Temp. 5	4	float	R
0x4D	Cali Measure Temp. 5	4	float	R

Table 1: Head Data Registers

5.4.1 <Name> Register

Address: 0x01
Access: Read and write
Content of this register is the name of the sensing head as a character string in ASCII format (MSB first).
For example, the data representation of a sensing head name "LT10" is as follows:



5.4.2 <Head ID> Register

Address: 0x02
Access: Read only
Content of this register is the identification number (ID) of the sensing head as a 32 bit unsigned integer (LSB first).

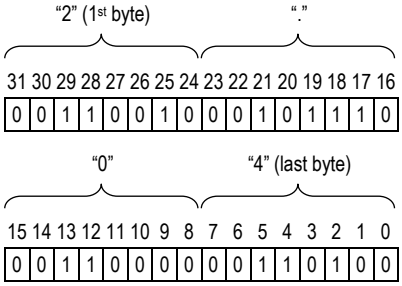
5.4.3 <Serial Number> Register

Address: 0x03
Access: Read only
Contents of this register is the serial number (SN) of the sensor head as a 32 bit unsigned integer (LSB first).

5.4.4 <Version> Register

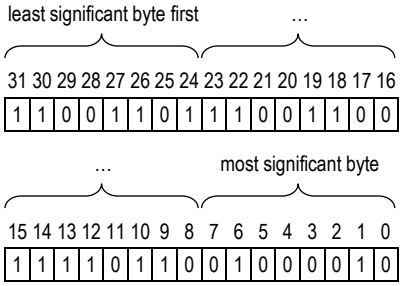
Address: 0x04
Access: Read only
Contents of this register is the firmware version of the sensor head as character string in ASCII format (MSB first).

For example, the data representation of a sensor heads name "2.04" is as follows:



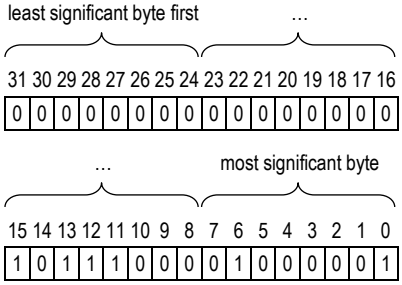
5.4.5 <Target Temp.> Register

Address: 0x05
Access: Read only
Content of this register is the target temperature using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first). For example, to transfer the value "+123.4", the following bit structure is transmitted:



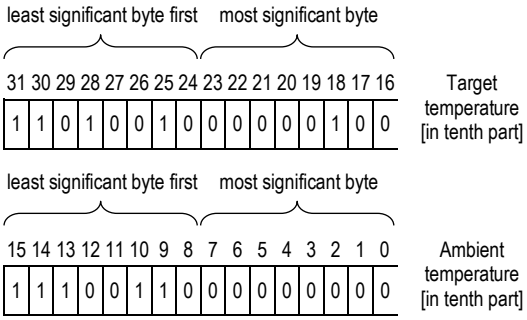
5.4.6 <Ambient Temp.> Register

Address: 0x06
Access: Read only
Content of this register is the ambient temperature using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).
For example, to transfer the value "+23.0", the following bit structure is transmitted:



5.4.7 <Target/Amb. Temp.> Register

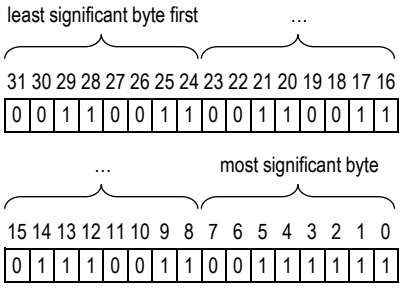
Address: 0x07
Access: Read only
Content of this register is the target and ambient temperature values, each multiplied by a factor of 10. The format is two 16 bit signed integer numbers (LSB first).
For example, to transfer the value of the target temperature "+123.4" and ambient temperature "+23.0", the following bit structure is transmitted:



5.4.8 <Emissivity> Register

Address: 0x08
Access: Read and write
Default: 0.950
Range: 0.1 to 1.1

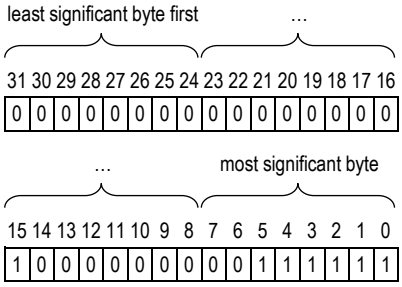
Content of this register is the emissivity value using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).
For example, to transfer the value "0.95", the following bit structure is transmitted:



5.4.9 <Transmissivity> Register

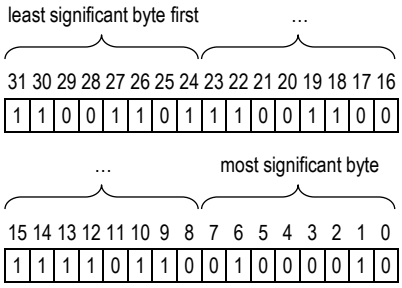
Address: 0x09
Access: Read and write
Default: 1.0
Range: 0.1 to 1.0

Content of this register is the transmissivity value using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).
For example, to transfer the value "1.0", the following bit structure is transmitted:
After reading this register, BIT3 and BIT4 are cleared automatically.



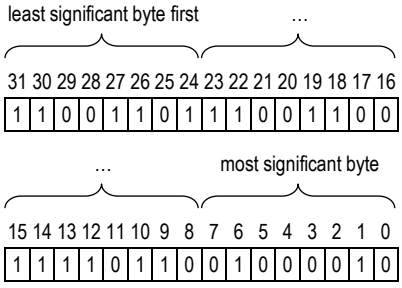
5.4.10 <Bottom Temp.> Register

Address: 0x0A
Access: Read and write
Default: 1.0
Range: 0.1 to 1.0
Contents of this register is the bottom temperature using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).
For example, to transfer the value +123.4 , the following value is transmitted:



5.4.11 <Top Temp.> Register

Address: 0x0B
Access: Read and write
Default: 1.0
Range: 0.1 to 1.0
Contents of this register is the top temperature using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).
For example, to transfer the value +123.4 , the following value is transmitted:



5.4.12 <Status> Register

Address: 0x0C
Access: Bits 31 – 8, 6 – 1 → read only (writing does not effect)
Bit 0, Bit 7 → read and write
Content of this register is the status of the sensing head.
After reading this register, BIT3 and BIT4 are cleared automatically.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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

Bit	Description
31 – 16	not used
15 – 8	reserved
7	Control ambient background compensation 0 off 1 on
6	reserved
5	Error flag (self test) 0 no error 1 self test error occured
4	Error flag (register writing) 0 no error 1 register write error occured
3	Error flag (parameter writing) 0 no error 1 parameter to write out of range
2	Error flag (ambient temperature) 0 no error 1 ambient temperature out of range
1	Error flag (target temperature) 0 no error 1 target temperature out of range
0	Temperature unit 0 C scale 1 F scale

Table 2: Status Register

5.4.13 <Address> Register

Address: 0x0D
Access: Read and write
Default: 0x7F
Content of this register is the slave address of the sensing head on the bus (LSB first).
For example, to transfer the sensing head address of "0x7F", the following bit structure is transmitted:

least significant byte first …

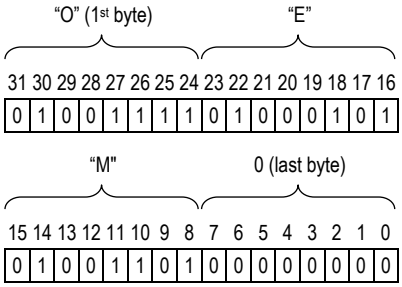
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0

… most significant byte

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

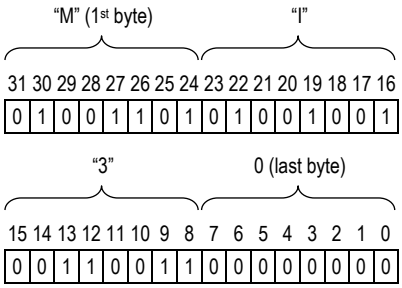
5.4.14 <Special Code> Register

Address: 0x11
Access: Read only
Content of this register is the special code of the sensing head as a character string in ASCII format (MSB first).



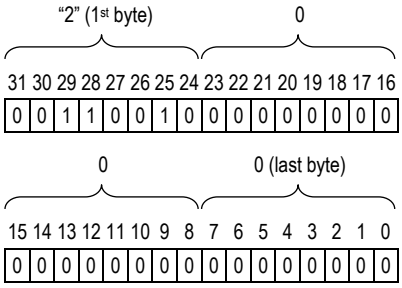
5.4.15 <Head IDENT0> Register

Address: 0x12
Access: Read only
Content of this register is the part 0 of the identification of the sensing head as a character string in ASCII format (MSB first).



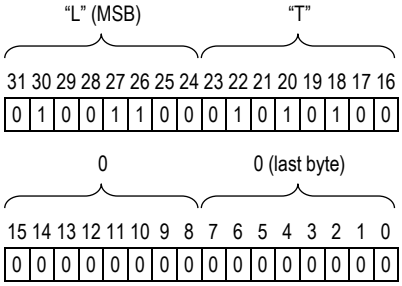
5.4.16 <Head IDENT1> Register

Address: 0x13
Access: Read only
Content of this register is the part 1 of the identification of the sensing head as a character string in ASCII format (MSB first).



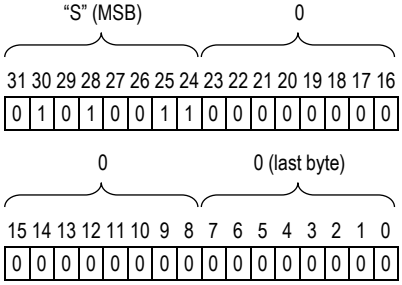
5.4.17 <Head IDENT2> Register

Address: 0x14
Access: Read only
Content of this register is the part 2 of the identification of the sensing head as a character string in ASCII format (MSB first).



5.4.18 <Head IDENT3> Register

Address: 0x15
Access: Read only
Content of this register is the part 3 of the identification of the sensing head as a character string in ASCII format (MSB first).



5.4.19 <ADJ Gain > Register

Address: 0x1A
Access: Read and write
Range: 0.8 to 1.2
Default: 1.0
Content of this register is the Gain value using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).

5.4.20 <ADJ Offset > Register

Address: 0x1B
Access: Read and write
Range: -200.0 to +200.0
Default: 0
Content of this register is the Offset value using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).

5.4.21 <Detector Power > Register

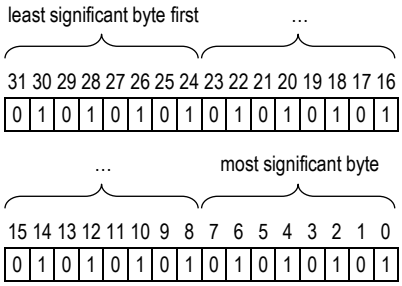
Address: 0x1C
Access: Read only
Content of this register is the detector power value as a 32 bit signed integer (LSB first).

5.4.22 <Ambient background > Register

Address: 0x1D
Access: Read and write
Range: Bottom Temp. limit to Top Temp. limit
Default: 23°C (73°F)
Content of this register is the ambient background value using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).

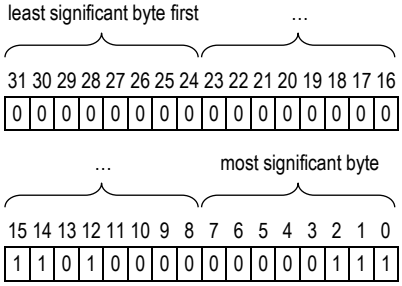
5.4.23 <Factory default > Register

Address: 0x1F
Access: Write only
Writing the value 0x55555555 to the register resets the sensing head back to the factory default state.



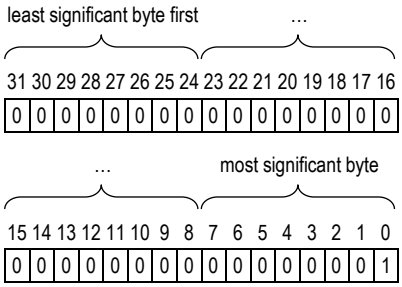
5.4.24 <Flicker Filter > Register

Address: 0x28
Access: Read and write
Content of that register is the threshold value for the Flicker Filter. Format is a 16 bit unsigned integer number from 0 up to 32767 (LSB first).
For example, to transfer the value of the threshold 2000, the following value is transmitted:



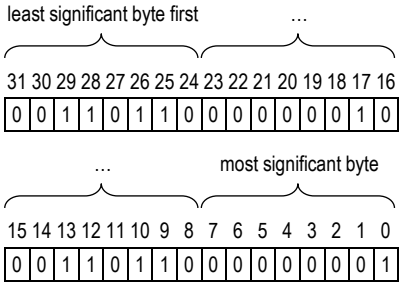
5.4.25 <Laser Control > Register

Address: 0x3E
Access: Read and write
Content of that register is the value for the laser control:
0 – laser off
1 – laser on
2 – laser flash
For example, to activate the laser, the following value is to be passed:



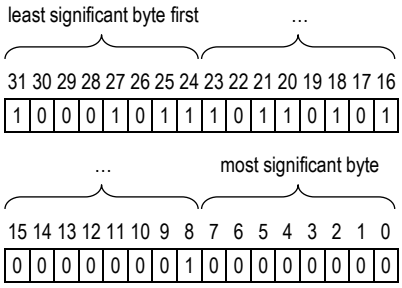
5.4.26 <Cali Date> Register

Address: 0x40
Access: Read only
Content of this register is the Cali Date of the sensor head in °C as a 32 bit unsigned integer (LSB first).
For example, to transfer the date 20120118 (format: yyyymmdd), the following bit structure is transmitted:



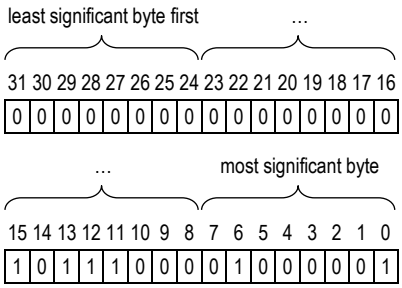
5.4.27 <Cali Time> Register

Address: 0x41
Access: Read only
Content of this register is the Cali Time of the sensor head in °C as a 32 bit unsigned integer (LSB first).
For example, to transfer the time 112011 (format: hhmmss), the following bit structure is transmitted:



5.4.28 <Cali Ambient Low Temp.> Register

Address: 0x42
Access: Read only
Content of this register is the Cali Ambient Low Temperature in °C using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).
For example, to transfer the value +23.0, the following bit structure is transmitted:



5.4.29 <Cali Ambient High Temp.> Register

Address: 0x43
Access: Read only
Content of this register is the Cali Ambient High Temperature in °C using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).

5.4.30 <Cali Source Temp. 1> Register

Address: 0x44
Access: Read only
Content of this register is the Cali Source Temperature 1 in °C measured by <Cali Ambient Low Temp.> using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).

5.4.31 <Cali Measure Temp. 1> Register

Address: 0x45
Access: Read only
Content of this register is the Cali Measure Temperature 1 in °C measured by <Cali Ambient Low Temp.> using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).

5.4.32 <Cali Source Temp. 2> Register

Address: 0x46
Access: Read only
Content of this register is the Cali Source Temperature 2 in °C measured by <Cali Ambient Low Temp.> using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).

5.4.33 <Cali Measure Temp. 2> Register

Address: 0x47
Access: Read only
Content of this register is the Cali Measure Temperature 2 in °C measured by <Cali Ambient Low Temp.> using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).

5.4.34 <Cali Source Temp. 3> Register

Address: 0x48
Access: Read only
Content of this register is the Cali Source Temperature 3 in °C measured by <Cali Ambient Low Temp.> using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).

5.4.35 <Cali Measure Temp. 3> Register

Address: 0x49
Access: Read only
Content of this register is the Cali Measure Temperature 3 in °C measured by <Cali Ambient Low Temp.> using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).

5.4.36 <Cali Source Temp. 4> Register

Address: 0x4A
Access: Read only
Content of this register is the Cali Source Temperature 4 in °C measured by <Cali Ambient High Temp.> using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).

5.4.37 <Cali Measure Temp. 4> Register

Address: 0x4B
Access: Read only
Content of this register is the Cali Measure Temperature 4 in °C measured by <Cali Ambient High Temp.> using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).

5.4.38 <Cali Source Temp. 5> Register

Address: 0x4C
Access: Read only
Content of this register is the Cali Source Temperature 5 in °C measured by <Cali Ambient High Temp.> using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).

5.4.39 <Cali Measure Temp. 5> Register

Address: 0x4D
Access: Read only
Content of this register is the Cali Measure Temperature 5 in °C measured by <Cali Ambient High Temp.> using the IEEE 754 format for floating point numbers, which is a 32 bit quantity (LSB first).

6 Development Kit

The interface development kit OEMMI3DEVKIT is an accessory for the comfortable testing of self-programmed OEMMI3 sensing heads.

6.1 Scope of Delivery

The kit includes the following components.

- Evaluation board
- USB cable
- Controller Software
- Documentation

6.2 System Overview

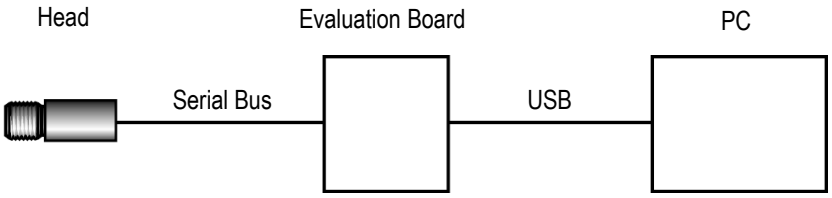


Figure 11: Principle Overview

6.3 Evaluation Board

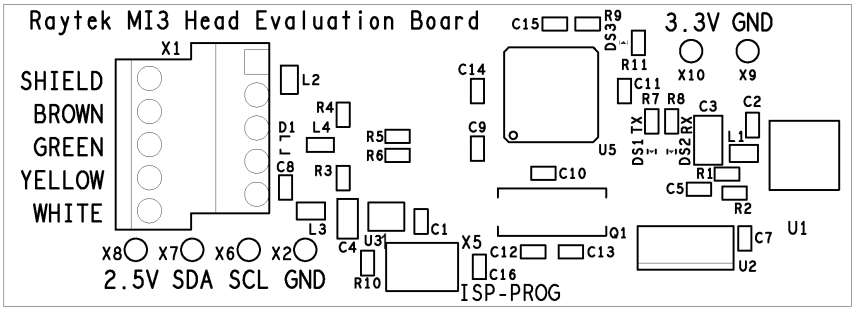


Figure 12: Evaluation Board Layout

The evaluation board is intended to support one sensing head only!

For the schematic for the evaluation board, see section 7 Appendix, page 31.

Connector	Pin	Description
X1	SHIELD	Shield from the sensing head cable
	BROWN	GND from the sensing head cable (corresponds to X2.GND)
	GREEN	SCL from the sensing head cable (corresponds to X6.SCL)
	YELLOW	SDA from the sensing head cable (corresponds to X7.SDA)
	WHITE	Power VDC from the sensing head cable (corresponds to X8.2.5V)
X2	GND	GND from the sensing head cable (corresponds to X1.BROWN)
X5		The multi-pin connector X5 can be used to programme the flash microcontroller U5 via an ATMEL® programming device (e.g. ATMEL system programmer AVRISP mkII).
X6	SCL	SCL from the sensing head cable (corresponds to X1.GREEN)
X7	SDA	SDA from the sensing head cable (corresponds to X1.YELLOW)
X8	2.5V	Power VDC from the sensing head cable (corresponds to X1.WHITE)
X9	GND	Ground
X10	3.3V	3.3 V power supply for the electronic circuit driven by 5V of the USB port
DS1	LED	ON while data being sent from the PC to the board
DS2	LED	ON while data being sent from the board to the PC
DS3	LED	Status indicator, DS3 blinks if board is ready to receive data from the PC

Table 3: Pin Assignment for the Evaluation Board

6.4 Controller Software

6.4.1 Driver Installation

The communication between the evaluation board and the Controller Software requires the installation of a corresponding USB driver.

Consider the following sequence for the installation:

1. Connect the evaluation board to the PC via the USB cable.
2. The <Found New Hardware Wizard> window pops up.
3. Ignore the <Automatic Hardware Installation>, navigate to the dedicated FTDI USB driver on the support CD, and execute it.
4. After finalizing the installation you will find a new (virtual) serial COM port under the Window Device Manager supporting the communication to the evaluation board.

6.4.2 Main View

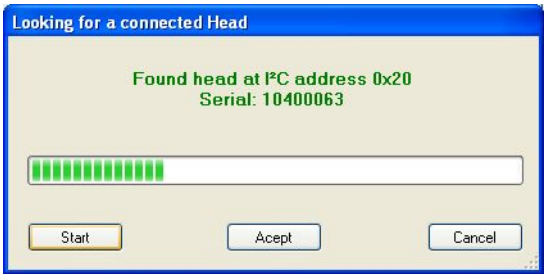


Figure 13: Search View in the Controller Software

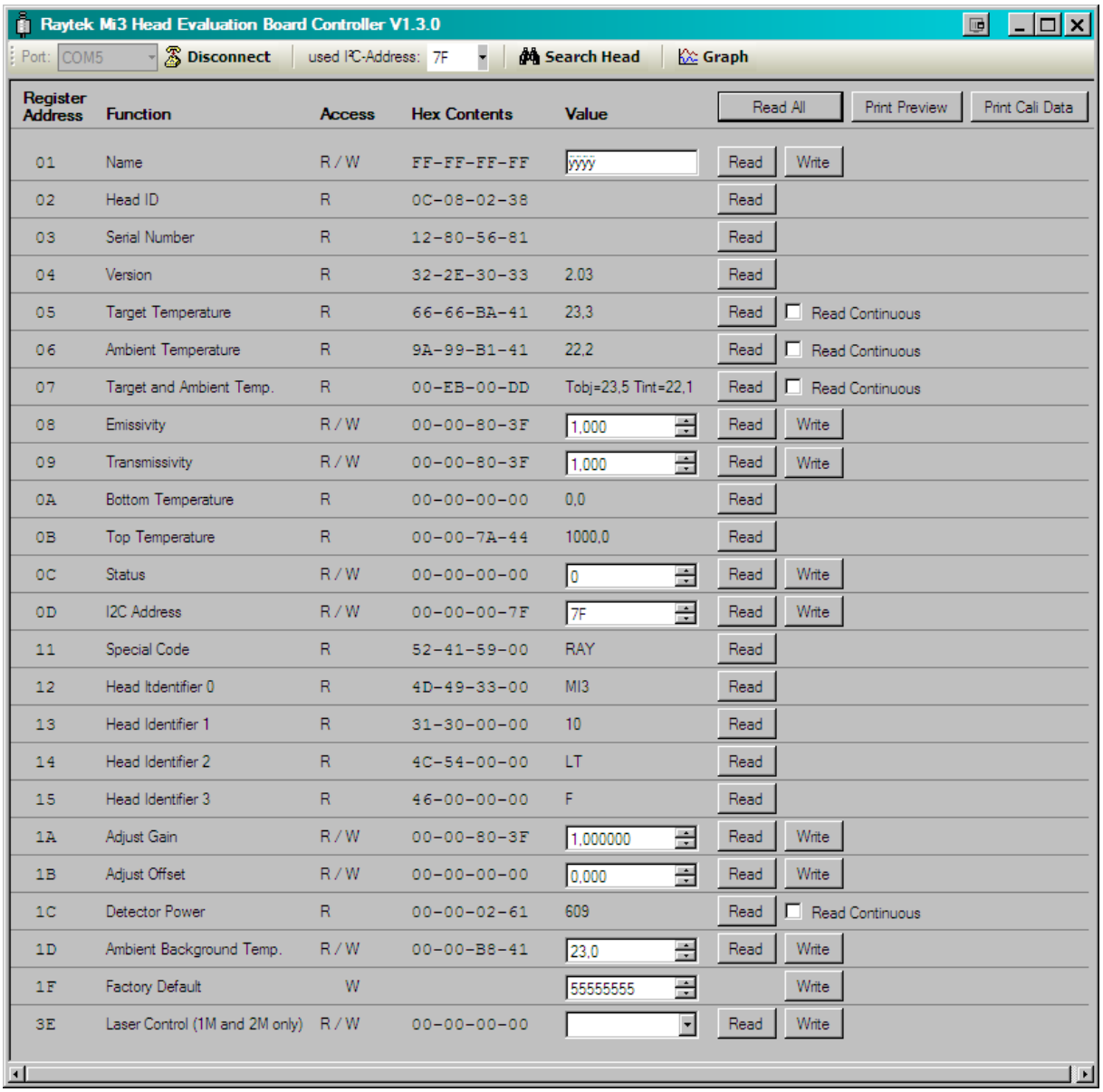


Figure 14: Main View for the Controller Software

Item	Description
<Port>	selects the right (virtual) serial COM port to communicate to the evaluation board.
<Disconnect>	halts the communication to the evaluation board.
<I²C address>	allows to select the used I²C address for the plugged head
<Search Head>	searches for a plugged head with an unknown/lost I²C address
<Graph>	displays the target/internal temperature curve over time, see exemplary screen shot in Figure 13.
<Register>	lists the available head registers in accordance to Table 1
<Access>	lists for each parameter the access mode: R – read only W – write only R/W – read/write access
<Hex Contents>	provides the "real" hex coded content for each register
<Value>	provides the "readable" interpretation for <Hex Contents>
<Read All>	reads the content of all registers at ones.
<Read Continuous>	reads exclusively the corresponding register
<Print Cali Data>	Prints out to document the head's measurement performance with production

Table 4: Description

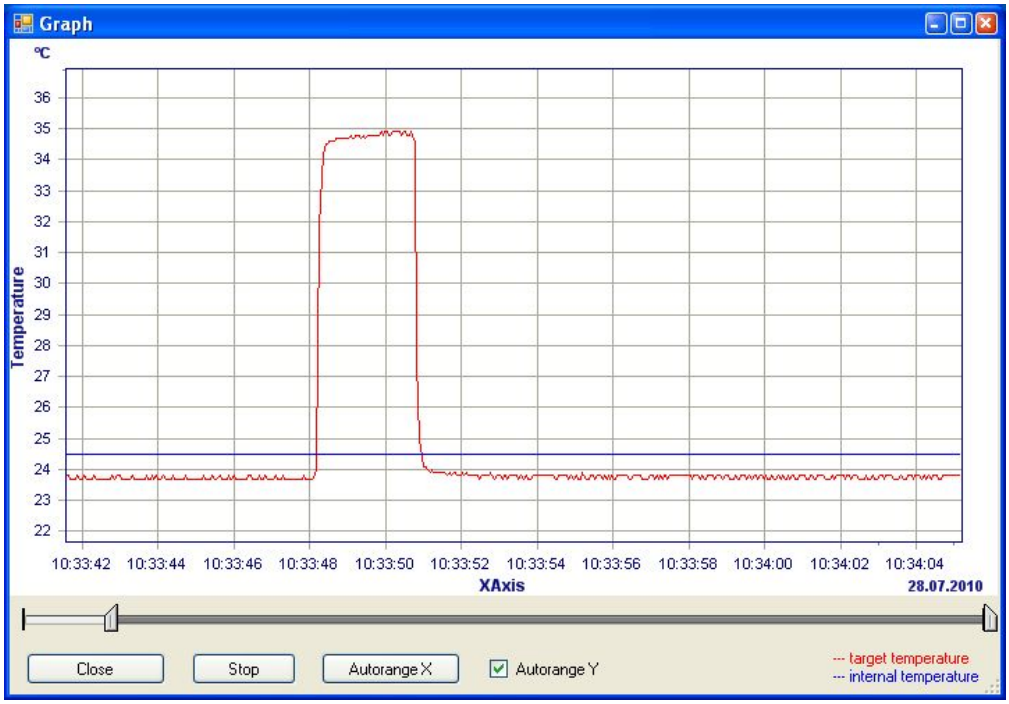


Figure 15: Graph View in the Controller Software

7 Appendix

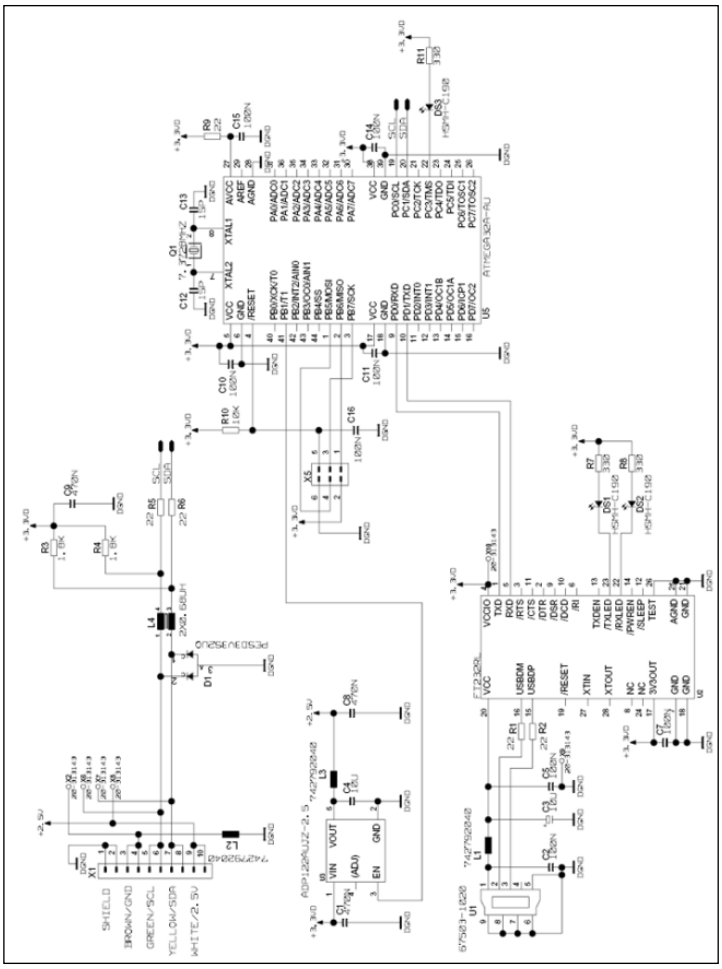


Figure 16: Schematic for the Evaluation Board

Appendix