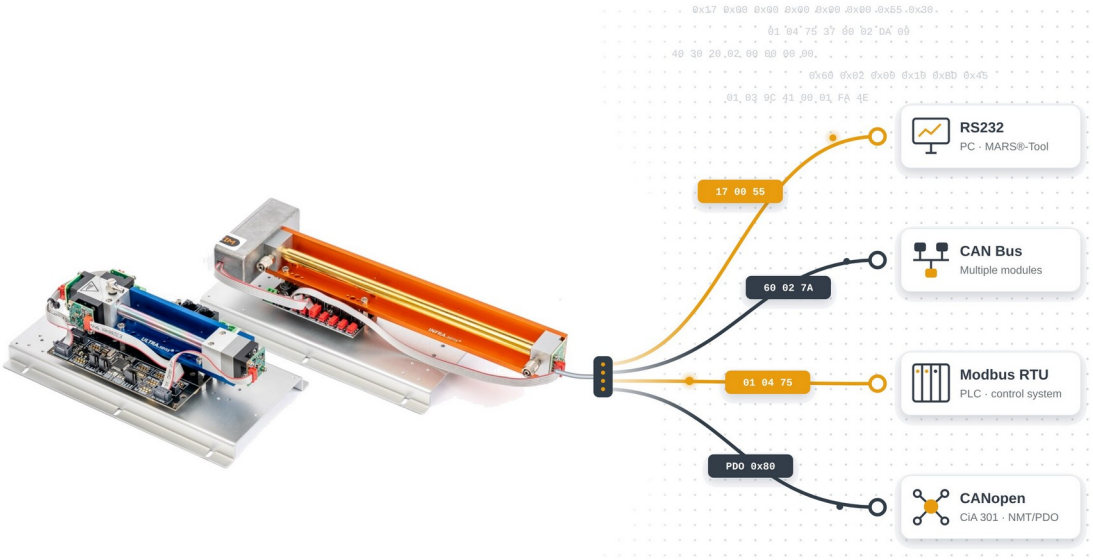
Communication Manual

Digital Interfaces of the OEM Gas Measurement Modules

RS232 · CAN Bus · Modbus RTU · CANopen



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This revision supersedes the previous individual documents: Manual RS232 COM 10, Manual CANbus COM 06 (Rev. 06-02.1), Manual MODBUS Rev. 1.7, and CANopen Object Dictionary V1.8.

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0 About This Manual

This communication manual describes the digital interfaces of the Wi.Tec gas measurement modules: frame structure, commands, registers, and objects for RS232, CAN bus, Modbus RTU, and CANopen. It supplements the Operating Manual for Gas Measurement Modules, which covers installation, electrical connection, commissioning, and calibration. Keep both documents together.

0.1 Scope

Interface	Protocol	Firmware / Version	Previous Document
RS232	Wi.Tec binary commands, ASCII response	current firmware	Manual RS232 COM 10
CAN bus	Wi.Tec CAN protocol (8-byte frames)	firmware > 5.43	Manual CANbus COM 06, Rev. 06-02.1
Modbus RTU (option)	Modbus RTU over RS485	firmware > 5540	Manual MODBUS Rev. 1.7
CANopen (option)	CANopen per CiA 301 (NMT, SDO, PDO)	Object Dictionary V1.8, firmware ≥ 5.549	CANopen Object Dictionary V1_8

Table 1: Scope of this manual

This manual applies to INFRA.sens®, ULTRA.sens®, KOMBI.sens®, and the auxiliary sensors HUMI.sens®, O2.sens, and P.sens with base boards V1.8.x, V1.9.x, and IR-compact V2.0.x, as well as to modules in the Thermobox V5. Additional Modbus registers are described for TDLAS modules (CH_4) (Section 7.4).

0.2 Target Audience

This manual is intended for integrators and for control and software engineers who integrate gas measurement modules into their own control systems (PLC, microcontroller, PC software). Basic knowledge of serial data transmission, the hexadecimal number system, and the IEEE 754 floating-point format is required; Chapter 8 additionally requires basic knowledge of CANopen.

0.3 Related Documents

Document	Content	Availability
Operating Manual for Gas Measurement Modules	Electrical connection and pin assignments (Chapter 7), calibration with zero and span gas (Chapter 10), status messages (Chapter 11)	included with delivery
Module data sheet	Measuring range, channel assignment, options	included with delivery
MARS®-Tool light manual	Operation of the PC software, setting baud rate, CAN IDs, and Modbus address	download (www.witec-sensorik.de)

Table 2: Related documents

0.4 Conventions

- Hexadecimal values are prefixed with "0x", e.g., 0x17. Frames are shown byte by byte in transmission order, e.g., `17 00 00 00 00 00 55 00`.
- Gas measurement channels are designated CH1 through CH4. The gas measured on each channel is shown on the nameplate and can be read via the Device ID (Section 9.2).
- Access rights: R = read only, W = write only, RW = read/write (CANopen: ro, wo, rw).
- Decimal numbers use a decimal point (1.00482). Thousands are separated by commas (115,200).

0.5 Revision History

Revision	Date	Change
0.1	10/2026	Preliminary version. Consolidates the previous manuals Manual RS232 COM 10, Manual CANbus COM 06 (Rev. 06-02.1), Manual MODBUS Rev. 1.7, and CANopen Object Dictionary V1.8 and updates them to the current firmware.
1.0	11/2026	First released edition. Chapter 8 (CANopen) updated to firmware 5.549: NMT state Stopped, heartbeat setting 0x1017, SDO abort codes, PDO parameters 0x1800–0x1A03.

Table 3: Revision history

1 Safety

In addition, observe the safety instructions in Chapter 1 of the Operating Manual for Gas Measurement Modules. Safety messages in both documents are structured in accordance with ISO 3864-2 / ANSI Z535.6.

1.1 Intended Use

The interfaces are used to read measured values and status information and to calibrate and configure the gas measurement modules from a higher-level controller or a PC. Use only the commands, registers, and objects described in this manual. Undocumented commands may change factory settings.

1.2 Safety Messages for Communication

⚠ WARNING

Incorrect measurements caused by unintended write commands

Calibration and configuration commands overwrite calibration data in the internal EEPROM. Setting the zero point without zero gas or sending an incorrect span gas value results in permanently incorrect readings. If the module is used for safety functions such as gas alarms, hazards may go undetected.

- ▶ Send calibration commands only when the correct zero or span gas is applied and stable (Operating Manual, Chapter 10).
- ▶ Interlock write access in the controller to prevent accidental triggering.
- ▶ Verify the reading with span gas after every calibration.

! NOTICE

Damage to the interfaces

Incorrectly connected wires, potential differences between bus nodes, and electrostatic discharge can destroy the interface components on the base board.

- ▶ Connect or disconnect data lines only with the power supply switched off.
- ▶ Check the pin assignment before switching on (Section 2.3 and Operating Manual, Chapter 7).
- ▶ Never connect GND_M of the Modbus interface to earth or PE (Section 7.9).

2 Interface Overview

2.1 Available Interfaces

Interface	Physical Layer	Factory Setting	Typical Application
RS232	RS232, point-to-point	115,200 baud (fixed), 8N1	Commissioning, service, MARS®-Tool, short cable runs
CAN bus	CAN (ISO 11898), bus	250 kbit/s, receive ID 0x300, transmit ID 0x208	Multiple modules on one controller
Modbus RTU (option)	RS485, bus	Address 1, baud rate and parity as ordered	Connection to PLCs and control systems
CANopen (option)	CAN (ISO 11898), bus	Node ID 4, heartbeat 500 ms	Integration into CANopen networks

Table 4: Digital interfaces of the gas measurement modules

2.2 Selecting an Interface

- **RS232** is available on every base board and is used primarily for commissioning and service. At 115,200 baud, the cable length is limited to approximately 2 m (6.5 ft) (Section 4.6).
- **CAN bus** is available on every base board. Multiple modules can be daisy-chained via the parallel-connected sockets.
- **Modbus RTU** is an option. RS232 and Modbus share the same serial interface of the microcontroller; the active interface is selected with DIP switches (Section 7.9).
- **CANopen** is a firmware option for the CAN interface. The proprietary CAN protocol and CANopen cannot be active at the same time.

> **Information**
> If a module in the Thermobox is configured for Modbus, communication via RS232 is no longer possible because the selector switch is located inside the Thermobox. The Thermobox must be opened for service access with the MARS®-Tool.

2.3 Connectors by Version

The table shows where the interfaces are brought out on each version. For connector locations and complete pin assignments, see the Operating Manual, Section 7.3.

Version	RS232	CAN Bus	Modbus RTU
Base board V1.9.x	CON3: D-sub 9, pin 2 TxD, pin 3 RxD, pin 5 GND	X1, X4 (RJ45) and X2, X3 (4-pin)	–
Base board V1.8.x	CON3: 10-pin header, pin 3 TxD, pin 5 RxD, pin 9 GND	X1, X4 (RJ45) and X2, X3 (4-pin)	–
Base board IR-compact V2.0.x	RS232 (2.54 mm, 3-pin): pin 1 RxD, pin 2 TxD, pin 3 GND	CAN (2.54 mm, 3-pin)	–
Connector Board MBB V1.0	D-sub 9	–	MODBUS 1 and 2 (RJ45)
Thermobox V5	D-sub 9: pin 2 TxD, pin 3 RxD, pin 5 GND	CAN (3.5 mm, 4-pin)	–
Thermobox V5 with Modbus connection	D-sub 9 (usable only if internally switched to RS232)	CAN (3.5 mm, 4-pin)	MODBUS (4-pin)

Table 5: Interface locations by version

2.4 Connecting to a PC

A USB/RS232 adapter or a CAN-USB adapter is required to connect to a PC. The following figures show the RS232 connection for the three basic configurations.

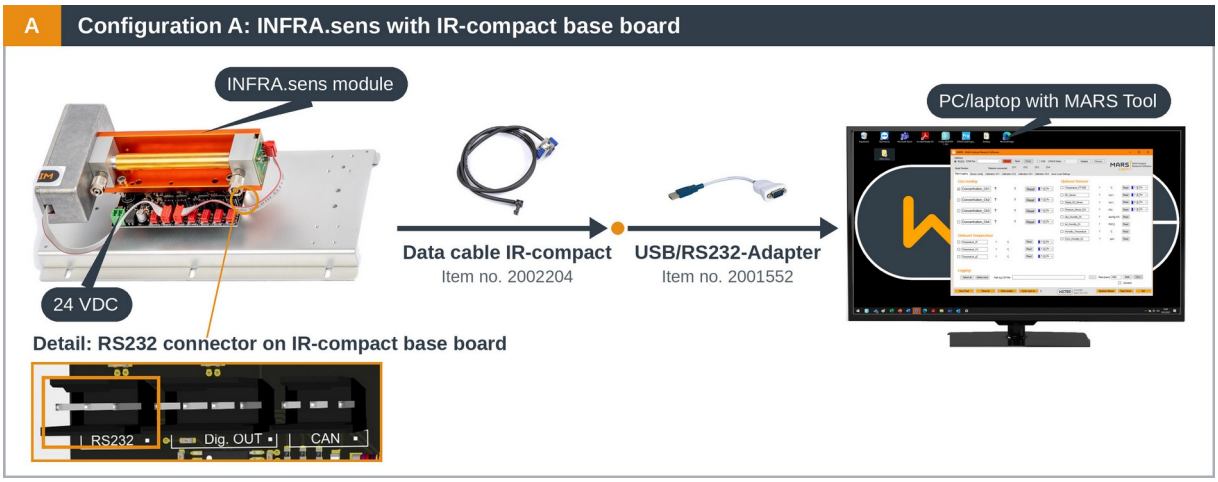

Figure 1: Configuration A: INFRA.sens with base board IR-compact – IR-compact data cable at the RS232 connector of the base board, USB/RS232 adapter at the PC

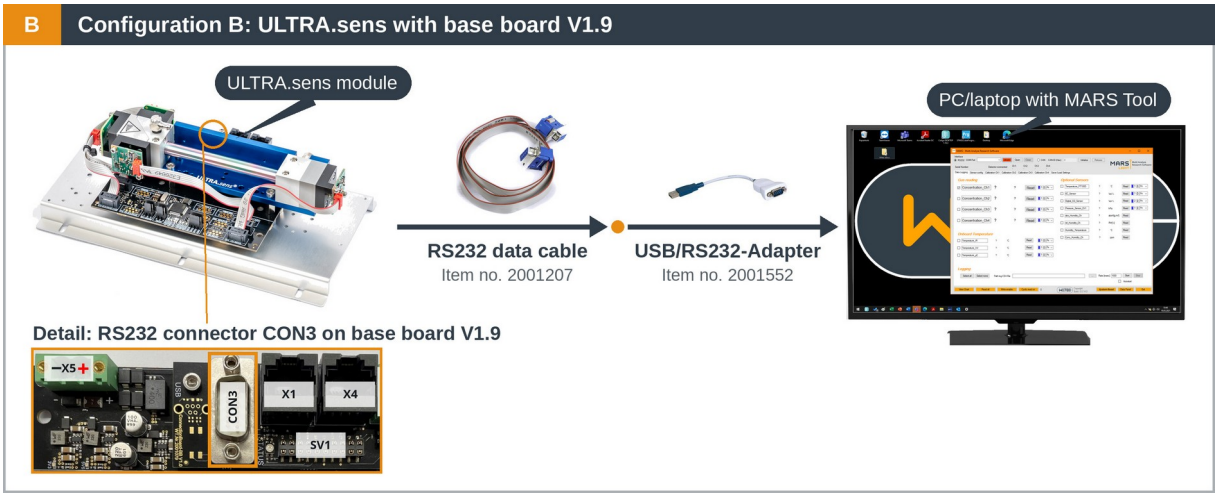

Figure 2: Configuration B: ULTRA.sens with base board V1.9 – RS232 data cable at D-sub socket CON3, USB/RS232 adapter at the PC

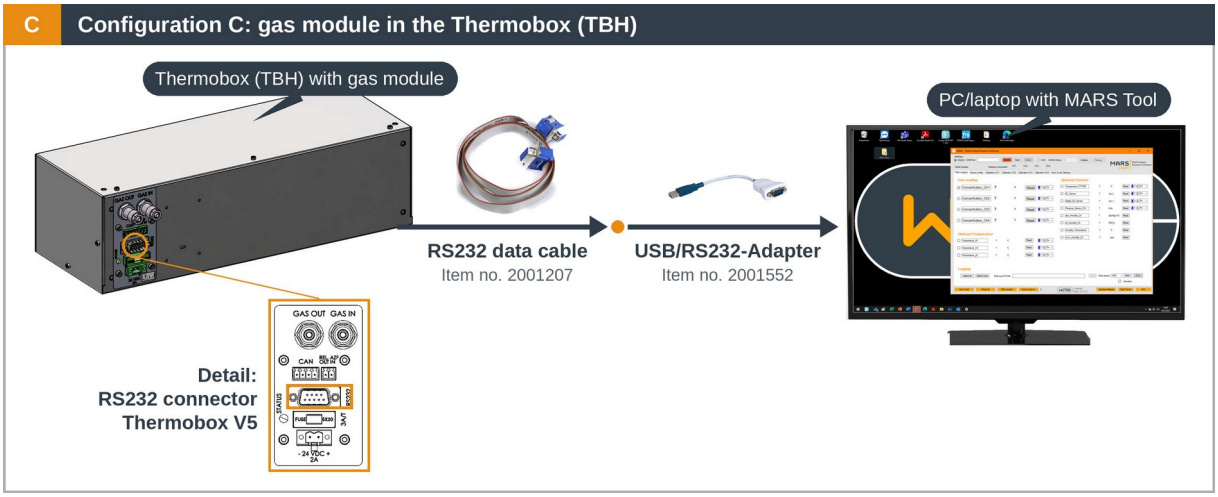

Figure 3: Configuration C: gas measurement module in the Thermobox (TBH) – RS232 data cable at the D-sub socket of the Thermobox, USB/RS232 adapter at the PC

2.5 Communication Accessories

Item	Part No.	Note
USB/RS232 adapter	2001552	
RS232 data cable for base board IR-compact V2.0.x	2002204	available on request
RS232 data cable for base board V1.9.x and Thermobox	2001207	available on request
RS232 data cable for base board V1.8.x	2000592	available on request
CAN-USB adapter	2002089	
Adapter plug for CAN-USB adapter, D-sub 9 to RJ45	2002127	
CAN bus data cable for base board IR-compact, direct to CAN-USB adapter	2002205	

Table 6: Communication accessories

3 Data Formats and Channel Assignment

3.1 Number Representation and Byte Order

Interface	Byte Order	Example: 6050.0 as FLOAT
RS232 (command to the module)	Little endian: least significant byte first (LSB first)	`00 10 BD 45`
CAN bus (both directions)	Little endian: least significant byte first (LSB first)	`00 10 BD 45`
Modbus RTU	Big endian: high-order byte and high-order register first	`45 BD 10 00`
CANopen (SDO, PDO)	Little endian per CiA 301	`00 10 BD 45`

Table 7: Byte order of the interfaces

In RS232 mode, the module does not respond in binary but with an ASCII string (Section 4.3). Appendix A contains IEEE 754 conversion examples.

3.2 Data Types

Data Type	Size	Description
UINT8	1 byte	Unsigned integer, 0–255
UINT16	2 bytes	Unsigned integer, 0–65,535
UINT32	4 bytes	Unsigned integer
FLOAT	4 bytes	Single-precision floating-point number per IEEE 754
BOOL	1 byte (CAN) or 1 register (Modbus)	Switching or trigger value (0 or 1)

Table 8: Data types

3.3 Channel Assignment

The gas measurement channels are permanently assigned to the measuring principles. CH1 and CH2 belong to the IR section (INFRA.sens), CH3 and CH4 to the UV section (ULTRA.sens). On a KOMBI.sens, all four channels can be used. The interfaces address the channels differently:

Channel	RS232 / CAN: Command, Frame Index	Modbus: Register	CANopen: Object
CH1 (IR)	0x17, index 0	3005	0x2030 (element 1)
CH2 (IR)	0x17, index 1	3007	0x2040 (element 1)
CH3 (UV)	0x0F, index 0	3001	0x2010 (element 0)
CH4 (UV)	0x0F, index 1	3003	0x2020 (element 0)

Table 9: Addressing the concentration values per channel

4 RS232 (ASCII Protocol)

Over RS232, the controller sends binary 8-byte commands to the module. The module responds with a human-readable ASCII string. The responses can therefore be displayed directly in a terminal program or in the MARS®-Tool.

4.1 Interface Parameters

Parameter	Value
Baud rate	115,200 baud (fixed, not adjustable)
Data bits	8
Stop bits	1
Parity	none
Data format, command (to the module)	UINT: LSB first; FLOAT: IEEE 754, little endian
Data format, response (from the module)	ASCII string, max. 15 bytes including CR/LF

Table 10: RS232 interface parameters

4.2 Frame Structure

Each command consists of exactly 8 bytes. The same structure applies to the CAN bus (Section 5.2).

Byte	1	2	3	4	5	6	7	8
Field	Cmd	Index	Data 0	Data 1	Data 2	Data 3	R/W	Selector
Example	0x17	0x00	0x00	0x00	0x00	0x00	0x55	0x00

Table 11: Command structure (example: read concentration CH1)

Byte	Field	Meaning
1	Command	Command identifier (Chapter 6). The module repeats it in the response (CAN) so that the controller can match the response to the request.
2	Frame index	Sub-index if a command covers several values, e.g., channel 0–3 for span calibration.
3–6	Data 0 – Data 3	Payload for write commands, LSB first: FLOAT and UINT32 in Data 0–3, UINT16 in Data 0–1, UINT8 in Data 0. 0x00 for read commands.
7	Read/Write	0x55 = read, 0x7A = write. In the response, this byte contains the device status: 0x03 = normal.
8	Selector	Not evaluated for RS232 (placeholder, 0x00 in the examples). Fixed at 0x30 for the CAN bus.

Table 12: Meaning of the command bytes

4.3 Module Response

The module responds with the requested value as an ASCII string terminated by CR (0x0D) and LF (0x0A). The string is no longer than 15 bytes including CR/LF. Concentrations are output in the configured unit of measurement (ppm or vol%), temperatures in °C.

Information

The module also responds to write commands in ASCII, e.g., with the calculated correction factor after a span calibration (Section 4.4).

The module responds to pure trigger commands with the set state as an ASCII character: "1" = True, "0" = False, each followed by CR LF. Exceptions: set zero point, emitter on/off, and UV LED on/off return a value (Chapter 6).

The module does not respond to unknown commands. Therefore, implement a response timeout in the controller.

4.4 Examples

Action	Direction	Frame	Meaning
Read concentration CH1	to module	`17 00 00 00 00 00 55 00`	Command 0x17, index 0, read
	from module	<value> CR LF	Concentration CH1 in ppm or vol % as ASCII
Read temperature CH1	to module	`18 00 00 00 00 00 55 00`	Command 0x18, index 0, read
	from module	<value> CR LF	Temperature of the IR detector in °C as ASCII
Set zero point, all channels	to module	`11 00 00 00 00 00 7A 00`	Command 0x11, index 0, write (trigger command)
	from module	0 CR LF	Zero point set
Span calibration CH3	to module	`60 02 00 10 BD 45 7A 30`	Command 0x60, index 2 (= CH3), span gas 6050.0 ppm, write
	from module	1.00482 CR LF	Calculated correction factor

Table 13: RS232 example frames

Span calibration example: span gas with a certified concentration of 6050.00 ppm is applied to the module (channel 3, UV low); the module reads 6021.00 ppm. The controller sends the setpoint 6050.0 (FLOAT, LSB first: `00 10 BD 45`). The module calculates the correction factor 1.00482, stores it in the internal EEPROM, and returns it.

Information

The selector byte is not evaluated for RS232; the span calibration example can therefore also be used unchanged for the CAN bus.

4.5 Querying with a Terminal Program

For simple queries without the MARS®-Tool, a terminal program that can send bytes in hexadecimal, e.g., HTerm, is sufficient.

Prerequisite: The module is powered and connected to the PC via an RS232 data cable and the USB/RS232 adapter (Section 2.4); on Modbus versions, the interface is switched to RS232 (Section 7.9).

1. Determine the COM port of the USB/RS232 adapter in the Windows Device Manager.
2. In the terminal program, select the COM port and set 115,200 baud, 8 data bits, no parity, 1 stop bit.
3. Set the input format to "Hex" and the receive display to "ASCII".
4. Open the connection and send the command `17 00 00 00 00 00 55 00`.

   ✔️ **Result:** The module responds with the concentration of CH1 as a readable number followed by a line break.

4.6 Cable Length

The RS232 interface operates at a fixed rate of 115,200 baud. At this baud rate, the RS232 cable is limited to approximately 2 m (6.5 ft). For longer distances, use CAN or Modbus or install an RS232 isolator/repeater; use shielded, low-capacitance cables.

5 CAN Bus (Wi.Tec Protocol)

The CAN protocol uses the same command set as RS232 (Chapter 6). Unlike RS232, the module responds in binary: the response contains the value as data bytes plus a status code.

5.1 Interface Parameters

Parameter	Factory Setting	Configurable
Baud rate	250 kbit/s	yes, with the MARS®-Tool
Receive ID (frames to the module)	0x300	yes, with the MARS®-Tool
Transmit ID (responses from the module)	0x208	yes, with the MARS®-Tool
Frame length	8 bytes, including 4 payload bytes (Data 0–3)	–
Data format	LSB first; FLOAT per IEEE 754	–

Table 14: CAN interface parameters

Information

If several modules are operated on one bus, each module requires its own receive and transmit IDs. Set the IDs individually via RS232 with the MARS®-Tool before connecting the modules to the bus.

5.2 Frame Structure

Frames to the module have the same structure as for RS232 (Section 4.2); byte 8 (selector) is fixed at **0x30**. The module response is structured as follows:

Byte	1	2	3	4	5	6	7	8
to module	Cmd	Index	Data 0	Data 1	Data 2	Data 3	R/W	0x30
from module	Cmd	Index	Data 0	Data 1	Data 2	Data 3	Status	n/a

Table 15: Structure of CAN frame and response

- Command and frame index are repeated in the response.
- Data 0–3 contain the value in the specified data type, LSB first.
- Status: device status, 0x03 = normal. This status code is not identical to the status byte (Section 9.1).
- Byte 8 is not used in the response (n/a).

5.3 Examples

Action	Direction	Frame (Bytes 1–8)	Meaning
Read concentration CH1	to module	`17 00 00 00 00 00 55 30`	Command 0x17, index 0, read
	from module	`17 00 D0 D1 D2 D3 ST xx`	Concentration as FLOAT in Data 0–3
Read temperature CH1	to module	`18 00 00 00 00 00 55 30`	Command 0x18, index 0, read
	from module	`18 00 D0 D1 D2 D3 ST xx`	IR detector temperature as FLOAT
Span calibration CH3	to module	`60 02 00 10 BD 45 7A 30`	Span gas 6050.0 ppm on CH3, write
	from module	`60 02 F1 9D 80 3F ST xx`	Correction factor 0x3F809DF1 = 1.00482

Table 16: CAN example frames (ST = status)

5.4 Hardware Connection

Version	Connector	Pin Assignment
Base board V1.8.x and V1.9.x	X1, X4: RJ45 (connected in parallel)	Pin 1 GND, pin 4 CAN-H, pin 5 CAN-L
	X2, X3: 4-pin, 3.5 mm (IMO 20.1550M/4-E)	Pin 1 GND, pin 2 CAN-L, pin 3 CAN-H
Base board IR-compact V2.0.x	CAN: 3-pin, 2.54 mm	Pin 1 CAN-L, pin 2 CAN-H, pin 3 GND
Thermobox V5	CAN: 4-pin, 3.5 mm (Würth 691366110004)	Pin 1 GND, pin 2 CAN-L, pin 3 CAN-H; pin 1 is on the right
Thermobox, earlier version	CAN: D-sub 9, female	Pin 2 CAN-L, pin 3 GND, pin 7 CAN-H

Table 17: Pin assignment of the CAN connectors

Mating connectors for the 3-pin CAN connector of the IR-compact base board: WR-WTB 2.54 mm female IDC connector (Würth), part no. 661003151922 for AWG 22–24 wire, part no. 661003152022 for AWG 26–28.

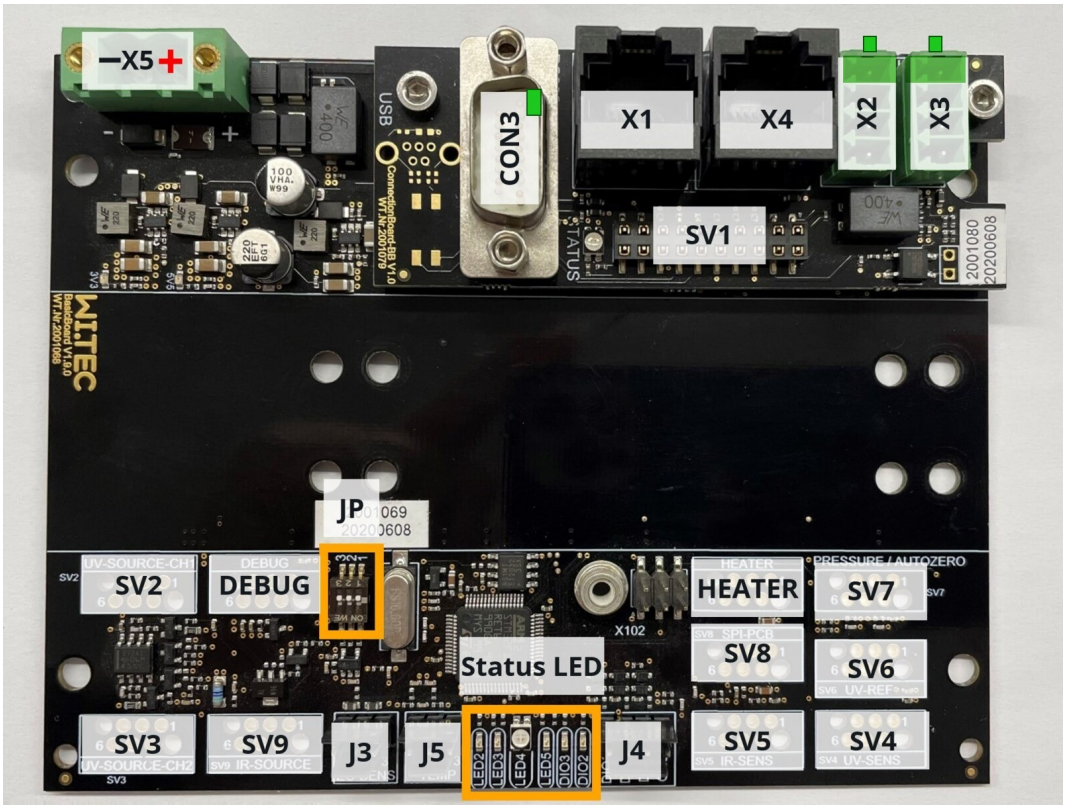

Figure 4: Base board V1.9.x – connector locations (CAN: X1, X4, X2, X3; RS232: CON3; pin 1 marked in green)

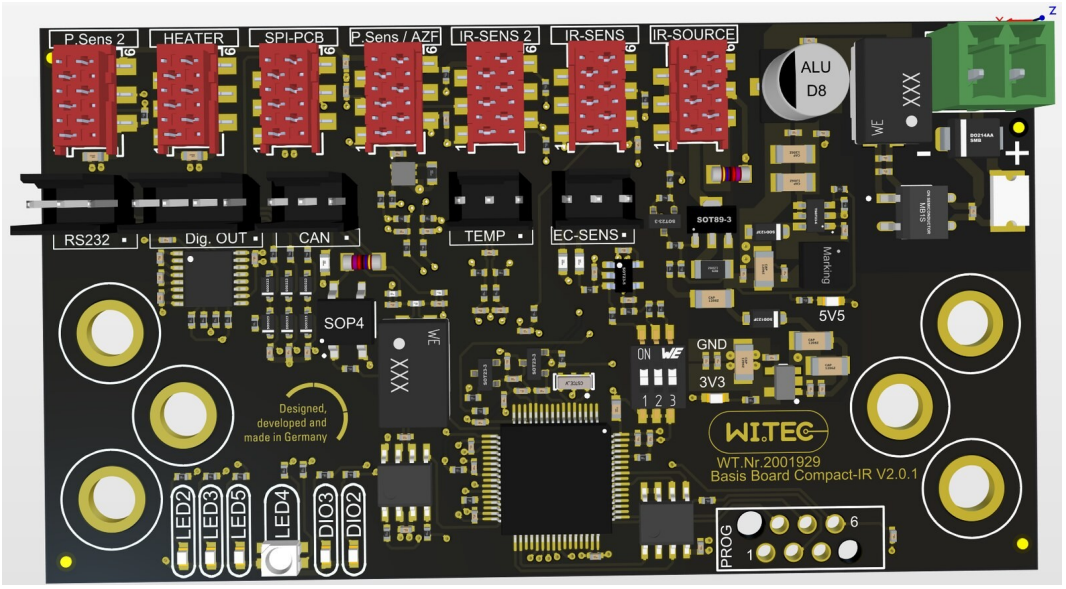

Figure 5: Base board IR-compact V2.0.x – the connectors are labeled directly on the PCB

5.5 Bus Termination

A 120 Ω termination resistor must be active at the first and last node of the CAN bus. It is integrated on the base boards:

Base Board	120 Ω Termination Resistor
V1.8.x	enabled with jumper JP2
V1.9.x	enabled by software
IR-compact V2.0.x	enabled by software

Table 18: CAN bus termination on the base boards

Information

On V1.9.x and IR-compact V2.0.x, the termination resistor is enabled with command **0x52**, frame index **0x04** (BOOL, RW): 1 = 120 Ω enabled (set), 0 = disabled (reset). The current state can be read with Read/Write = 0x55.

Example (CAN) – enable termination resistor: `52 04 01 00 00 00 7A 30`; disable: `52 04 00 00 00 00 7A 30`.

6 RS232 and CAN Command List

The commands apply equally to RS232 and CAN. Format "UINT8/BOOL" means that one byte is transmitted in Data 0.

Information

Responses to trigger commands (RS232 as ASCII with CR LF):

- Set zero point (0x11): "0"
- IR source on (0x29): currently configured IR frequency in Hz; off (0x30): "0"
- UV LED on (0x25, 0x26): configured LED current in µA; off (0x27, 0x28): "0"
- Other trigger commands: set state, "1" = True, "0" = False

Setting the zero point and switching the emitters or UV LEDs are dedicated commands: the content of Data 0–3 is not evaluated. For example, send 0x00.

6.1 Measured Values

Description	Cmd	Index	Format	Unit	Access
Concentration CH1	0x17	0	FLOAT	ppm or vol%	R
Concentration CH2	0x17	1	FLOAT	ppm or vol%	R
Concentration CH3	0x0F	0	FLOAT	ppm or vol%	R
Concentration CH4	0x0F	1	FLOAT	ppm or vol%	R
Temperature CH1 (IR detector)	0x18	0	FLOAT	°C	R
Temperature CH2 (external PT1000)	0x1F	0	FLOAT	°C	R
Temperature CH3 (UV detector PCB)	0x1A	0	FLOAT	°C	R
Temperature CH4 (microcontroller board)	0x20	0	FLOAT	°C	R
Pressure (option P.sens)	0x19	0	FLOAT	mbar	R
Relative humidity (option HUMI.sens)	0x1B	0	FLOAT	% RH	R
Absolute humidity (option HUMI.sens)	0x1B	1	FLOAT	g/m³	R
H_2O concentration (option HUMI.sens)	0x1B	2	FLOAT	ppm	R
Dew point (option HUMI.sens)	0x1B	3	FLOAT	°C	R
Humidity sensor temperature (option)	0x1C	0	FLOAT	°C	R

Table 19: Commands – measured values

6.2 Calibration

Description	Cmd	Index	Format	Unit	Access
Set and store zero point, all channels	0x11 (alt. 0x08)	0	UINT8/BOOL	–	W
Set and store zero point CH1	0x11	1	UINT8/BOOL	–	W
Set and store zero point CH2	0x11	2	UINT8/BOOL	–	W
Set and store zero point CH3	0x11	3	UINT8/BOOL	–	W
Set and store zero point CH4	0x11	4	UINT8/BOOL	–	W
Span calibration CH1–CH4 (send span gas concentration)	0x60	0–3	FLOAT	ppm or vol%	W
Span correction factor CH1–CH4	0x63	0–3	FLOAT	– (factory setting 1.00)	RW
Temperature compensation zero point CH1–CH4 on/off	0x57, 0x59, 0x5B, 0x5D	3	UINT8/BOOL	–	W
Temperature compensation span CH1–CH4 on/off	0x58, 0x5A, 0x5C, 0x5E	3	UINT8/BOOL	–	W

Table 20: Commands – calibration

For command 0x60, the frame index is the channel: 0 = CH1, 1 = CH2, 2 = CH3, 3 = CH4. The calibration procedure is described in Section 6.8.

6.3 Auxiliary Sensors

Description	Cmd	Index	Format	Unit	Access
Electrochemical sensor: measured value	0x1D	0	FLOAT	vol% or ppm	R
Electrochemical sensor: span calibration	0x1D	1	FLOAT	vol% or ppm	W
Electrochemical sensor: reset span calibration	0x1D	2	UINT8/BOOL	–	W
Electrochemical sensor: zero calibration	0x1D	3	FLOAT	vol% or ppm	W
Electrochemical sensor: raw value (12-bit ADC)	0x1D	4	UINT16	0–4095	R
Digital O_2 sensor: concentration	0x1D	5	FLOAT	vol%	R
Digital O_2 sensor: span calibration (e.g., 20.95)	0x1D	6	FLOAT	vol%	W
Digital O_2 sensor: zero calibration	0x1D	7	UINT8	–	W
Digital O_2 sensor: reset calibration	0x1D	8	UINT8	–	W
External PT1000: offset	0x1F	1	FLOAT	°C	RW
External PT1000: gain	0x1F	2	FLOAT	–	RW

Table 21: Commands – auxiliary sensors

6.4 Auto-Zero Function and Radiation Sources

Description	Cmd	Index	Format	Unit	Access
AZF: freeze reading	0x73	0	UINT8/BOOL	–	W
AZF: purge time	0x73	1	UINT16	s	RW
AZF: interval	0x73	2	UINT16	min	RW
AZF: switch valve/pump or relay	0x73	3	UINT8/BOOL	1 = ON, 0 = OFF	W
UV LED 1 on	0x25	0	UINT8/BOOL	–	W
UV LED 1 off	0x27	0	UINT8/BOOL	–	W
UV LED 2 on	0x26	0	UINT8/BOOL	–	W
UV LED 2 off	0x28	0	UINT8/BOOL	–	W
IR source on	0x29	0	UINT8/BOOL	–	W
IR source off	0x30	0	UINT8/BOOL	–	W

Table 22: Commands – Auto-Zero Function (AZF, option) and radiation sources

Information

When a radiation source is switched off, the associated channel does not deliver valid readings. After it is switched back on, the source needs a warm-up time until the reading is stable.

6.5 Raw Signals and Diagnostics

Description	Cmd	Index	Format	Range	Access
ADC raw value CH1 reference	0x14	0	FLOAT	0–1.25 V	R
ADC raw value CH1 measurement	0x15	0	FLOAT	0–1.25 V	R
ADC raw value CH2 reference	0x10	0	FLOAT	0–1.25 V	R
ADC raw value CH2 measurement	0x13	0	FLOAT	0–1.25 V	R
ADC raw value CH3 reference	0x10	1	FLOAT	0–1.25 V	R
ADC raw value CH3 measurement	0x13	1	FLOAT	0–1.25 V	R
Modulation CH1	0x16	0	FLOAT	0–1	R
Modulation CH2	0x16	1	FLOAT	0–1	R
Modulation CH3	0x12	0	FLOAT	0–1	R
Modulation CH4	0x12	1	FLOAT	0–1	R

Table 23: Commands – raw signals

The modulation is the relative signal reduction caused by the sample gas. It is calculated from the ADC raw values of the reference and measurement channels, each referred to the values at the zero point (index 0):

$$\mathbf{Mod = (U_ref / U_ref,0 - U_meas / U_meas,0) / (U_ref / U_ref,0)}$$

At the zero point, the modulation is 0; it increases with increasing gas concentration.

6.6 Configuration

Description	Cmd	Index	Format	Unit / Range	Access
UV LED 1: operating mode	0x21	0	UINT8	0 = DC, 1 = AC, 2 = pulse	RW
UV LEDs: on time in pulse mode (applies to UV LED 1 and 2)	0x21	1	UINT16	s	RW
UV LEDs: cycle time in pulse mode (applies to UV LED 1 and 2)	0x21	2	UINT16	min	RW
UV LED 2: operating mode	0x22	0	UINT8	0 = DC, 1 = AC, 2 = pulse	RW
IR source: modulation frequency	0x23	0	UINT16	0–10 Hz	RW
Filter depth modulation CH3, CH4	0x35	0	UINT8	0–255	RW
Filter depth concentration CH3, CH4	0x35	1	UINT8	0–255	RW
Filter depth modulation CH1, CH2	0x35	2	UINT8	0–255	RW
Filter depth concentration CH1, CH2	0x35	3	UINT8	0–255	RW
UV LED 1: current	0x36	0	UINT16	0–20,000 µA	RW
UV LED 2: current	0x38	0	UINT16	0–20,000 µA	RW
Channel merging CH1 to CH2 on/off	0x37	6	UINT8/BOOL	–	RW
Channel merging CH3 to CH4 on/off	0x33	7	UINT8/BOOL	–	RW
CAN termination resistor 120 Ω on/off (V1.9.x, IR-compact)	0x52	4	BOOL	1 = on, 0 = off	RW
Software restart	0x04	0	UINT8/BOOL	–	W

Table 24: Commands – configuration

Pulse mode is available for UV LED 1 and UV LED 2. Both LEDs use the same pulse parameters from command 0x21, index 1 (on time) and index 2 (cycle time).

6.7 Device Information

Description	Cmd	Index	Format	Unit / Range	Access
Serial number	0x40	0	UINT16	–	R
Device ID (Config ID)	0x62	0	UINT32	Section 9.2	R
Hardware revision	0x41	0	UINT16	–	R
Software revision	0x0B	0	UINT16	–	R
Operating hours	0x43	0	UINT16	h	R
Measuring range CH1	0x47	2	FLOAT	ppm or vol%	R
Measuring range CH2	0x47	3	FLOAT	ppm or vol%	R
Measuring range CH3	0x47	0	FLOAT	ppm or vol%	R

Description	Cmd	Index	Format	Unit / Range	Access
Measuring range CH4	0x47	1	FLOAT	ppm or vol%	R
Unit of measurement CH1	0x61	2	UINT16	0 = ppm, 1 = vol%	R
Unit of measurement CH2	0x61	3	UINT16	0 = ppm, 1 = vol%	R
Unit of measurement CH3	0x61	0	UINT16	0 = ppm, 1 = vol%	R
Unit of measurement CH4	0x61	1	UINT16	0 = ppm, 1 = vol%	R
Source power UV LED 1	0x49	0	UINT8	0–100 %	R
Source power UV LED 2	0x49	1	UINT8	0–100 %	R
Source power IR source/EDL	0x49	2	UINT8	0–100 %	R
Status byte	0x50	0	UINT8	Section 9.1	R

Table 25: Commands – device information

Note the different index order for measuring range (0x47) and unit of measurement (0x61): index 0 and 1 belong to CH3 and CH4, index 2 and 3 to CH1 and CH2.

> **Information**
> Commands 0x95 and 0x96 are reserved for customer-specific data areas (up to 255 values each) and are not currently implemented.

6.8 Calibration via the Interface

Zero and span gases, flow rate, and waiting times are described in Chapter 10 of the Operating Manual. Calibration via the interface proceeds as follows:

Prerequisite: The module has been operating under stable conditions for at least 30 minutes; zero gas and span gas of known concentration are available.

1. Apply zero gas and wait until the reading is stable (read the concentration cyclically with 0x17 or 0x0F).
2. Set the zero point: for all channels `11 00 00 00 00 00 7A 30` (CAN) or with selector 0x00 (RS232); for a single channel, frame index 1–4.
3. Apply span gas and wait until the reading is stable.
4. Send the span gas concentration with command 0x60 and the channel as frame index (example in Section 4.4 or 5.3).
5. Check the returned correction factor. Values far from 1.0 indicate an incorrect span gas, an incorrect unit, or a contaminated optical path.
6. Shut off the span gas and verify the reading with zero gas.

✔ **Result:** The zero point and correction factor are stored in the EEPROM and are retained after power-off.

> **Information**
> An invalid correction factor can be read with 0x63 and reset to the factory setting of 1.00.

7 Modbus RTU

With the Modbus option, the module communicates via Modbus RTU over a two-wire RS485 line (firmware > 5540). The module operates as a slave.

7.1 Interface Parameters

Parameter	Value
Transmission mode	Modbus RTU
Baud rate	9,600, 19,200, 38,400, 57,600, or 115,200 baud – set by Wi.Tec during production
Data bits	8
Parity	none, even, or odd – set by Wi.Tec during production
Stop bits	with even/odd parity: 1 stop bit (11 bits per character); without parity: 2 stop bits (default) or 1 stop bit – set by Wi.Tec during production
Slave address	1 (factory setting), configurable 1–247 (Section 7.8)
Floating-point format	IEEE 754, big endian (high-order register first)

Table 26: Modbus interface parameters

Information

Specify the baud rate and parity when ordering. They can be changed afterwards only by Wi.Tec.

7.2 Function Codes and Addressing

Code	Function Code	Use
R1	0x03 Read Holding Registers	Device information, read slave address (registers 4001–4047)
R2	0x04 Read Input Registers	Measured values, raw signals, and status (registers 3001–3056)
W1	0x06 Write Single Register	Triggers and 16-bit values (e.g., zero point, LED current)
W2	0x10 Write Multiple Registers	FLOAT values across 2 registers (e.g., span gas concentration)

Table 27: Supported function codes

The register number from the register lists is transmitted unchanged as the address in the frame. There is no offset and no register type prefix:

Register (List)	Address in Frame (Decimal)	Address in Frame (Hex)
3007	3007	0x0BBF
4001	4001	0x0FA1
4003	4003	0x0FA3

Table 28: Addressing examples

Information

Many controllers and Modbus tools convert register addresses internally, e.g., "register 30008" → address 7 or "register 3008" → address 3007. Configure the controller so that the frame contains exactly the register number from the list. Verify the setting by reading the serial number (register 4001, `01 03 0F A1 00 01 D6 FC`).

Earlier firmware versions (e.g., software revision 5517) used the addresses 30001 ff. and 40001 ff. (frame address 0x7537 for register 3007).

7.3 Frame Structure

Byte	1	2	3	4	5	6	7	8
Field	Slave	FC	Addr. High	Addr. Low	Qty. High	Qty. Low	CRC Low	CRC High
Example	0x01	0x03	0x0F	0xA1	0x00	0x01	0xD6	0xFC

Table 29: Structure of a read request (example: serial number, register 4001)

The checksum is a CRC-16 per the Modbus specification and is transmitted low byte first. The response contains the slave address, function code, number of data bytes, the data (big endian), and the CRC. Up to 125 registers can be read or 120 registers written per request.

In the event of an error, the module responds with the function code + 0x80 and an exception code:

Exception Code	Name	Cause
0x01	Illegal Function	Function code not supported (only 0x03, 0x04, 0x06, 0x10)
0x02	Illegal Data Address	Register does not exist, read range exceeds the end of the register block, or write access to an input register
0x03	Illegal Data Value	Invalid frame length or register count

Table 30: Modbus exception codes

Frames sent to broadcast address 0 are executed but not answered.

7.4 Register List – Measured Values

Description	Register	Count	Format	Unit	Access	FC
Concentration CH3	3001	2	FLOAT	ppm, vol%, µg	R	04
Concentration CH4	3003	2	FLOAT	ppm, vol%, µg	R	04
Concentration CH1	3005	2	FLOAT	ppm, vol%, µg	R	04
Concentration CH2	3007	2	FLOAT	ppm, vol%, µg	R	04
Pressure	3009	2	FLOAT	mbar	R	04
ADC 1 reference	3011	2	FLOAT	V	R	04
ADC 1 measurement	3013	2	FLOAT	V	R	04
ADC 2 reference	3015	2	FLOAT	V	R	04
ADC 2 measurement	3017	2	FLOAT	V	R	04
ADC 3 reference	3019	2	FLOAT	V	R	04
ADC 3 measurement	3021	2	FLOAT	V	R	04
Temperature IR detector	3023	2	FLOAT	°C	R	04
Temperature UV detector	3025	2	FLOAT	°C	R	04
Temperature microcontroller	3027	2	FLOAT	°C	R	04
Source power UV LED 1	3029	1	UINT16	%	R	04
Source power UV LED 2	3030	1	UINT16	%	R	04
Source power IR source	3031	1	UINT16	%	R	04
Electrochemical sensor (analog)	3033	2	FLOAT	%	R	04
Digital O_2 sensor	3035	2	FLOAT	%	R	04
HUMI.sens relative humidity	3037	2	FLOAT	%	R	04
HUMI.sens absolute humidity	3039	2	FLOAT	g/m³	R	04
HUMI.sens H_2O concentration	3041	2	FLOAT	ppm	R	04
HUMI.sens temperature	3043	2	FLOAT	°C	R	04
TDLAS: CH_4 concentration	3045	2	FLOAT	ppm	R	04
TDLAS: status word	3047	1	UINT16	–	R	04
TDLAS: gas temperature	3048	2	FLOAT	°C	R	04
TDLAS: gas pressure	3050	2	FLOAT	mbar	R	04

Description	Register	Count	Format	Unit	Access	FC
TDLAS: actual sample cell temperature	3052	2	FLOAT	°C	R	04
TDLAS: heater setpoint temperature	3054	2	FLOAT	°C	R	04
Digital O_2 sensor: calibration status	3056	1	UINT16	code 0–7	R	04

Table 31: Input registers (measured values, function code 0x04)

Registers 3045–3054 are used only by TDLAS modules; on other modules they return 0. The TDLAS status word (register 3047) indicates the state of the laser and the pressure measurement; in normal operation, all four bits are set:

Bit	Mask	Meaning When 1
Bit 0	0x0001	Laser TEC (Peltier control) temperature OK
Bit 1	0x0002	Laser enabled
Bit 2	0x0004	Communication with pressure sensor OK
Bit 3	0x0008	No failure reported

Table 32: TDLAS status word (register 3047)

Register 3056 shows the calibration status of the digital O_2 sensor (registers 4029–4037). Calibration runs in the background; after triggering, poll the register until "2 – completed successfully" or an error code appears:

Code	Meaning	Code	Meaning
0	no calibration active	4	timeout
1	calibration in progress	5	invalid value
2	completed successfully	6	not supported by sensor
3	error	7	not confirmed by sensor

Table 33: Calibration status of the digital O_2 sensor (register 3056)

7.5 Register List – Calibration and Control

Description	Register	Count	Format	Unit	Access	FC
Set and store zero point, all channels	4011	1	UINT16	1 = trigger	W	06
Set and store zero point CH1	4012	1	UINT16	1 = trigger	W	06
Set and store zero point CH2	4013	1	UINT16	1 = trigger	W	06
Set and store zero point CH3	4014	1	UINT16	1 = trigger	W	06
Set and store zero point CH4	4015	1	UINT16	1 = trigger	W	06
Span calibration CH1	4016	2	FLOAT	ppm or vol%	W	16
Span calibration CH2	4018	2	FLOAT	ppm or vol%	W	16

Description	Register	Count	Format	Unit	Access	FC
Span calibration CH3	4020	2	FLOAT	ppm or vol%	W	16
Span calibration CH4	4022	2	FLOAT	ppm or vol%	W	16
Sample control (UV LEDs)	4024	1	UINT16	0, 1, 2	RW	03/06
UV LED 1: current	4025	1	UINT16	µA	RW	03/06
UV LED 2: current	4026	1	UINT16	µA	RW	03/06
Persistent storage (free customer value)	4027	2	UINT32	–	RW	03/16
Change slave address (Slave ID Update)	4028	1	UINT16	1–247	RW	03/06
Digital O_2 sensor: zero calibration	4029	2	FLOAT	any value	W	16
Digital O_2 sensor: span calibration	4031	2	FLOAT	vol% O_2	W	16
EC sensor: zero calibration	4033	2	FLOAT	–	W	16
EC sensor: span calibration	4035	2	FLOAT	–	W	16
Digital O_2 sensor: reset calibration	4037	2	FLOAT	–	W	16/06
EC sensor: reset calibration	4039	2	FLOAT	–	W	16/06
Reset calibration CH1	4041	2	FLOAT	–	W	16/06
Reset calibration CH2	4043	2	FLOAT	–	W	16/06
Reset calibration CH3	4045	2	FLOAT	–	W	16/06
Reset calibration CH4	4047	2	FLOAT	–	W	16/06

Table 34: Registers for calibration and control (function codes 0x06 and 0x10)

Information

Reset calibration (registers 4037–4047): The value sent is not evaluated. You can send 0.0, 1.0, 0, or 1; instead of function code 0x10 (W2) with a FLOAT value, function code 0x06 (W1) with a single register can also be used.

- **Zero point (4011–4015):** Only the value 1 triggers the zero calibration. The module then resets the register to 0 automatically.
- **Sample control (4024):** 0 = UV LEDs on with the stored current, 1 = UV LEDs off, 2 = LED current set via registers 4025 and 4026. Values in 4025/4026 are applied only when sample control = 2 and are then stored in the EEPROM.
- **Persistent storage (4027):** freely usable 32-bit value, e.g., for a customer-specific identifier. It is stored in the EEPROM and retained after power-off.
- **Digital O_2 sensor (4029–4037):** Calibration runs in the background; register 3056 shows the progress.

Registers 4011–4015 trigger the zero calibration. For span calibration, the span gas concentration is written as a FLOAT across two registers. For gases and waiting times, see the Operating Manual, Chapter 10.

7.6 Register List – Device Information

Description	Register	Count	Format	Unit	Access	FC
Serial number	4001	1	UINT16	–	R	03
Hardware revision	4002	1	UINT16	–	R	03
Software revision	4003	1	UINT16	–	R	03
Operating hours	4004	2	UINT32	h	R	03
Manufacturing date	4010	1	UINT16	–	R	03

Table 35: Holding registers (device information, function code 0x03)

7.7 Examples

Examples with slave address 1. Tx = request from the controller, Rx = response from the module. The responses were taken from a recording; the values depend on the individual module.

Query	Direction	Frame	Evaluation
Serial number, register 4001 (holding)	Tx	`01 03 0F A1 00 01 D6 FC`	Address 0x0FA1 = 4001, 1 register
	Rx	`01 03 02 5B C8 82 E2`	2 data bytes: 0x5BC8 = 23496
Software revision, register 4003 (holding)	Tx	`01 03 0F A3 00 01 77 3C`	Address 0x0FA3 = 4003, 1 register
	Rx	`01 03 02 15 8D 76 B1`	0x158D = 5517
Concentration CH2, register 3007 (input)	Tx	`01 04 0B BF 00 02 42 0B`	Address 0x0BBF = 3007, 2 registers
	Rx	`01 04 04 BC A6 38 52 AC 0A`	FLOAT 0xBCA63852 = −0.0203

Table 36: Modbus example frames

The value −0.0203 in the third example is zero-point noise.

7.8 Changing the Modbus Address

The slave address is set to 1 at the factory. It can be changed in two ways:

- via RS232 with the MARS®-Tool, parameter "MODBUS_ID" on the "Production" tab (switch the interface to RS232 for this purpose, Section 7.9), or
- via Modbus with register 4028 (Slave ID Update).

Prerequisite: The module is accessible via Modbus; the new address is not yet assigned on the network.

1. Write the new address (1–247) to register 4028 using function code 0x06.
2. Switch the module off and on again.
3. Address the module at the new address, e.g., read the serial number (register 4001).

✔️ **Result:** The module responds at the new slave address.

7.9 Hardware Connection

7.9.1 Connector Board MBB V1.0 (without Thermobox)

Modules with the Modbus option without Thermobox are equipped with the Connector Board MBB V1.0. The two RJ45 sockets MODBUS 1 and MODBUS 2 are connected in parallel: two analyzers can be connected with a standard patch cable, and the controller is connected to the free socket.

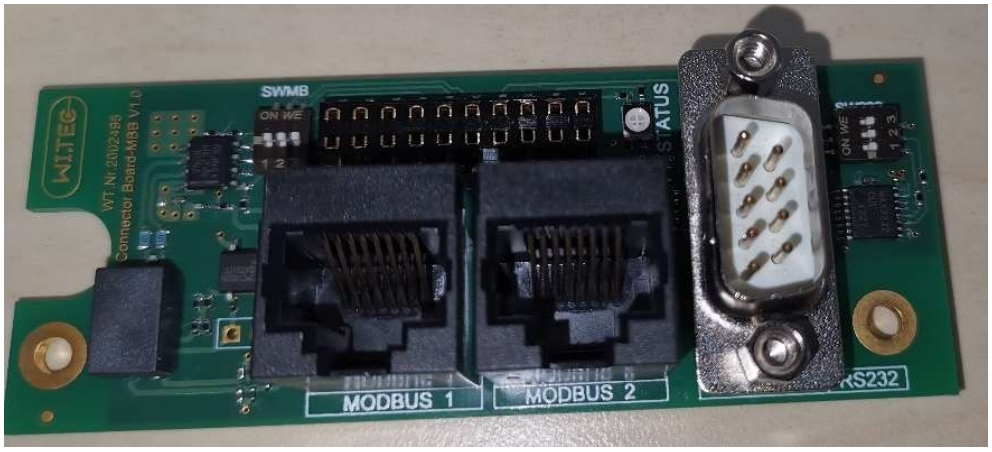

Figure 6: Connector Board MBB V1.0 with RJ45 sockets MODBUS 1 and MODBUS 2, the RS232 socket, and DIP switches SWMB and SW232

Pin (RJ45)	RS485 Signal	Pin (RJ45)	RS485 Signal
1	not connected	5	D0 (B−)
2	not connected	6	not connected
3	not connected	7	5 VDC – do not connect
4	D1 (A+)	8	Common

Table 37: Pin assignment of RJ45 sockets MODBUS 1 and MODBUS 2

RS232/Modbus selection: The board has two DIP switches, SWMB (SW1) for Modbus and SW232 (SW2) for RS232. The module reads the switch position at every power-up and communicates using the corresponding protocol.

Mode	SWMB (SW1), Pos. 1–3	SW232 (SW2), Pos. 1–3
Modbus	all ON	all OFF
RS232	all OFF	all ON

Table 38: DIP switches for interface selection

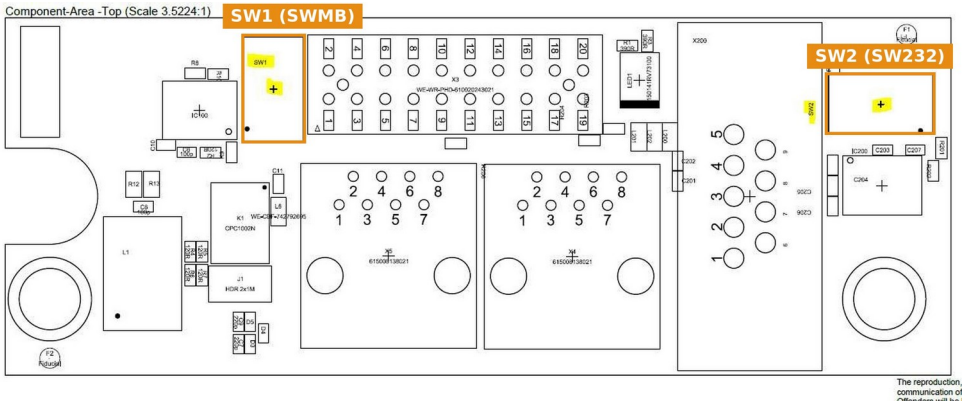

Figure 7: Assembly drawing of Connector Board MBB V1.0 with DIP switches SW1 (SWMB, Modbus) and SW2 (SW232, RS232)

Termination resistor: The termination resistor integrated on the board (150 Ω) is enabled with jumper JP1 or via RS232. It is recommended for cable lengths above approximately 30 m (100 ft) to prevent reflections.

7.9.2 Thermobox V5 with Modbus Connection

For modules in the Thermobox, the Modbus connection is made via the 4-pin MODBUS connector on the connection panel. On the upper connectors (Dig-OUT, MODBUS), pin 1 is on the left.

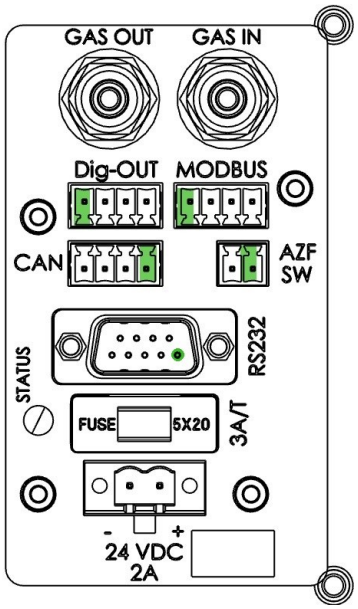

Figure 8: Connection panel of the Thermobox V5 with Modbus connection (pin 1 marked in green)

Pin	Signal	Note
1	GND_M	Reference potential of the Modbus interface
2	D0 (B−)	
3	D1 (A+)	
4	PE	

Table 39: Pin assignment of the MODBUS connector (Thermobox V5)

NOTICE

Do not connect GND_M to earth

Connecting GND_M to earth (PE) defeats the isolation of the Modbus interface (critical isolation violation).

▶️ Never connect GND_M to earth or PE.

7.9.3 Bus Layout and Termination

- Communication takes place over the two lines A (D1, A+) and B (D0, B−). Use twisted-pair, shielded two-wire cable.
- Provide a 120 Ω termination resistor at both ends of the bus.
- GND_M is optional but recommended as a common reference point for all nodes to reduce interference. In 24 V systems, connect GND_M to the common ground of the power supply, not to earth.
- Each slave address may occur only once on the bus.

8 CANopen

With the CANopen option, the module operates as a CANopen slave per CiA 301. Measured values are sent on SYNC as process data (PDO); parameters are read and written via service data (SDO). This chapter is based on Object Dictionary V1.8 as implemented in firmware 5.549.

> **Information**
> The information on SDO abort codes, heartbeat setting (0x1017), PDO parameters (0x1800–0x1A03), and NMT state Stopped applies from firmware 5.549 (software revision 5549, readable via 0x1018, sub-index 3). Earlier modules do not respond to requests for non-existent objects and do not support these objects.

8.1 Configuration

Parameter	Value
Baud rate	125 kbit/s, 250 kbit/s, 500 kbit/s, 1 Mbit/s
Node ID	4 (factory setting)
PDO transmission	synchronous, triggered by SYNC (COB-ID 0x080)
PDOs	2 standard PDOs with 2 FLOAT values each (8 bytes); optionally 2 extended PDOs (Section 8.4)
Monitoring	heartbeat, 500 ms (factory setting, configurable via 0x1017)
PDO 0 (COB-ID 0x180 + node ID)	Concentration CH3 [FLOAT], concentration CH4 [FLOAT]
PDO 1 (COB-ID 0x280 + node ID)	Concentration CH1 [FLOAT], concentration CH2 [FLOAT]

Table 40: CANopen configuration

Baud rate and node ID are set with the MARS®-Tool or specified when ordering. They can also be written via SDO using object 0x4000 (Section 8.7.1). The values are stored in the EEPROM and take effect after a restart.

8.2 Hardware Connection

The connection is the same as for the CAN bus (Sections 5.4 and 5.5).

Connector	Pin	Signal
RJ45 (X1, X4)	1	GND
	4	CAN-H
	5	CAN-L
Alternative 4-pin connector (X2, X3)	1	GND
	2	CAN-L
	3	CAN-H

Table 41: CANopen pin assignment

8.3 Network Management (NMT)

After power-up, the module sends a boot-up message and enters the Pre-Operational state. It sends process data only after the master issues the NMT command "Start Node". SDO access is already possible in the Pre-Operational state. In the Stopped state, the module sends only the heartbeat; PDOs, SYNC, and SDO are not processed.

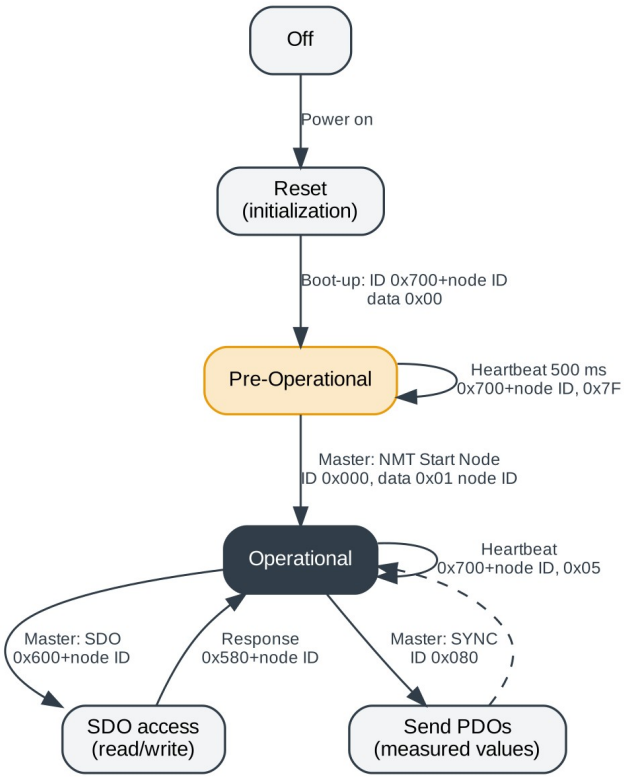

Figure 9: States and messages during startup (boot-up sequence)

Message	COB-ID	Length	Data	Meaning
Boot-up	0x700 + node ID	1	0x00	Module started
Heartbeat	0x700 + node ID	1	0x7F	Pre-Operational state (every 500 ms)
Heartbeat	0x700 + node ID	1	0x05	Operational state
Heartbeat	0x700 + node ID	1	0x04	Stopped state
SYNC (master)	0x080	0	–	Module sends PDOs

Table 42: NMT and monitoring messages

NMT commands from the master are sent with COB-ID 0x000 and 2 data bytes: byte 0 = command, byte 1 = node ID (0 = all nodes).

Command (Byte 0)	Name	Effect
0x01	Start Remote Node	Operational state, PDOs on SYNC
0x02	Stop Remote Node	Stopped state, heartbeat 0x04
0x80	Enter Pre-Operational	Pre-Operational state
0x81	Reset Node	complete restart of the module
0x82	Reset Communication	reinitialize communication, boot-up, Pre-Operational

Table 43: Supported NMT commands

The heartbeat is sent at the configured interval (object 0x1017, factory setting 500 ms; 0 disables the heartbeat).

8.4 Process Data (PDO)

On every SYNC message (COB-ID 0x080), the module sends the PDOs in the Operational state. Each PDO is 8 bytes long and contains two values, little endian:

PDO	COB-ID	Bytes 0–3	Bytes 4–7
PDO 0	0x180 + node ID	Concentration CH3 [FLOAT]	Concentration CH4 [FLOAT]
PDO 1	0x280 + node ID	Concentration CH1 [FLOAT]	Concentration CH2 [FLOAT]
PDO 2 (extended)	0x380 + node ID	O_2 sensor [FLOAT]	H_2O concentration HUMI.sens [FLOAT]
PDO 3 (extended)	0x480 + node ID	Byte 0: counter 1–12, bytes 1–3: 0	Value according to counter (table below)

Table 44: PDO contents

The extended PDOs 2 and 3 are optional and are enabled by Wi.Tec during production. PDO 3 transmits a different value with each SYNC using multiplexing; the counter in byte 0 indicates which value is contained in bytes 4–7:

Counter	Content of Bytes 4–7	Counter	Content of Bytes 4–7
1	PCB temperature [FLOAT, °C]	7	IR detector temperature [FLOAT, °C]
2	Radiation source status [UINT8]	8	Pressure [FLOAT, mbar]
3	Status UV LED 1, UV LED 2, IR source [1 byte each]	9	Relative humidity [FLOAT, %]
4	Power UV LED 1, UV LED 2, IR source [1 byte each, %]	10	Absolute humidity [FLOAT, g/m³]
5	UV detector temperature [FLOAT, °C]	11	Humidity sensor temperature [FLOAT, °C]
6	Reading valid per channel [1 byte each, 1 = valid]	12	Operating hours [UINT16, h, bytes 6–7]

Table 45: Multiplexed content of PDO 3

PDO transmission can be enabled and disabled via object 0x2005, sub-index 2 (Enable PDO SYNC). The communication parameters and mapping of the PDOs are fixed and can be read via objects 0x1800–0x1803 and 0x1A00–0x1A03 (Section 8.6).

8.5 Service Data (SDO)

Individual objects are read or written via SDO (expedited transfer). The controller sends to 0x600 + node ID; the module responds with 0x580 + node ID. Each SDO frame is 8 bytes long:

Byte	0	1	2	3	4–7
Content	Command byte	Index low	Index high	Sub-index	Data (little endian)

Table 46: Structure of an SDO frame

Command Byte	Direction	Meaning
0x40	controller → module	Read object (upload request)
0x4F / 0x4B / 0x43	module → controller	Read response with 1 / 2 / 4 data bytes
0x2F / 0x2B / 0x23	controller → module	Write object with 1 / 2 / 4 data bytes (download)
0x60	module → controller	Write confirmed
0x80	module → controller	Abort with abort code in bytes 4–7

Table 47: SDO command bytes

Abort Code	Meaning
0x05040001	Command invalid or not supported (e.g., segmented or block transfer)
0x06010001	Read access to a write-only object
0x06010002	Write access to a read-only object
0x06020000	Object does not exist
0x06090011	Sub-index does not exist
0x06090030	Value out of range
0x08000020	Data cannot be transferred or stored (e.g., O_2 calibration rejected)

Table 48: SDO abort codes

Example with node ID 4 – read concentration CH1 (object 0x2030, sub-index 2):

Direction	COB-ID	Data
Request	0x604	`40 30 20 02 00 00 00 00`
Response	0x584	`43 30 20 02 D0 D1 D2 D3` (FLOAT)

Table 49: SDO example: read concentration CH1

Information

Only expedited transfers (up to 4 bytes) are supported. For write access, the module accepts command bytes 0x23, 0x2B, and 0x2F (0x22 and 0x27 are treated like 0x23). An abort from the master (0x80) is not answered.

8.6 Communication Objects

Object	Sub-Index	Name	Description	Data Type	Access
0x1000	0	Device type	Device type, returns 0	UINT32	ro
0x1001	0	Error register	Error register, returns 0	UINT8	ro
0x1005	0	COB-ID SYNC	0x00000080; only this value can be written	UINT32	rw
0x1006	0	Communication cycle period	stored (until restart), no function	UINT32	rw
0x1007	0	Synchronous window length	stored (until restart), no function	UINT32	rw
0x1017	0	Producer heartbeat time	Heartbeat interval in ms, 0 = off; 500 ms after restart	UINT16	rw
0x1018	0	Identity – number of entries	4	UINT8	ro
	1	Vendor ID	Manufacturer ID with CiA – registration currently in progress	UINT32	ro
	2	Product code	Device ID (Section 9.2)	UINT32	ro
	3	Revision number	Software revision, e.g., 5514 = 5.514	UINT32	ro
	4	Serial number	Serial number	UINT32	ro

Table 50: Communication objects (CiA 301)

The PDO parameters are fixed. They can be read; write access is confirmed only with an unchanged value (for mapping, also sub-index 0 = 0); other values are rejected with 0x06090030.

Object	Sub-Index	Content	Value
0x1800–0x1803	0	Number of entries	5
TPDO 0–3 communication	1	COB-ID	0x180 / 0x280 / 0x380 / 0x480 + node ID; for PDO 2 and 3, bit 31 is set (invalid) if the extended PDOs are not enabled
	2	Transmission type	1 (synchronous, every SYNC)
	3, 5	Inhibit time, event timer	0
0x1A00	1–2	Mapping TPDO 0	0x20100220 (CH3), 0x20200220 (CH4)
0x1A01	1–2	Mapping TPDO 1	0x20300220 (CH1), 0x20400220 (CH2)
0x1A02	1–2	Mapping TPDO 2	0x20620120 (O_2), 0x20600320 (H_2O concentration)
0x1A03	1–5	Mapping TPDO 3	0x21000108 (counter), 3 × 0x00050008 (padding bytes), 0x21000220 (multiplexed value)

Table 51: PDO communication and mapping parameters

Sub-index 0 of the manufacturer-specific objects returns the number of entries. Object 0x2100 (multiplexed content of PDO 3) is accessible only via the PDO.

8.7 Manufacturer-Specific Objects

The measurement channels are organized into two elements: **element 0** is the UV section with CH3 and CH4, **element 1** the IR section with CH1 and CH2.

8.7.1 Device Objects

Object	Sub-Index	Name	Description	Data Type	Access
0x2000	1	Device Ident Number	Device ID (same as 0x1018, sub-index 2)	UINT32	ro
General Description	2	Device Serial Number	Serial number	UINT16	ro
	3	Manufacturer ID	0x02 = Wi.Tec	UINT16	ro
	4	Revision Hardware	Hardware revision	UINT16	ro
	5	Revision Software	Software revision	UINT16	ro
	6	Revision Protocol	CANopen protocol revision	UINT16	ro
0x2003	1	UV-LED 1 minimum power	Alarm threshold 25–100 %	UINT8	rw
Lightsource alarm	2	UV-LED 2 minimum power	Alarm threshold 25–100 %	UINT8	rw
	3	IR-Lamp minimum power	Alarm threshold 25–100 %	UINT8	rw

Object	Sub-Index	Name	Description	Data Type	Access
0x2004	1	PCB Temperature	PCB temperature in °C	FLOAT	ro
Device Status	2	System Operation Time	currently returns 0 – operating hours via PDO 3 or Modbus/RS232	UINT16	ro
	3	System Status	0x00 normal, 0x01 maintenance required (source power below alarm threshold)	UINT8	ro
0x2005	1	Zero detector	Set zero point of all channels: write 0x01	UINT8	rw
Device Control	2	Enable PDO SYNC	1 = send PDOs on SYNC, 0 = off	UINT8	rw
	3	Restart Device	Restart: write 0x01	UINT8	wo
	4	Store zero detector	currently no function	UINT8	wo
0x200A	1	UV-LED 1 Status	0x00 OK, 0x01 maintenance, 0x02 not connected, 0x03 off	UINT8	ro
Module Status	2	UV-LED 2 Status	same as sub-index 1	UINT8	ro
	3	IR-Lamp Status	same as sub-index 1	UINT8	ro
0x4000	1	Node ID	New node ID 1–127, takes effect after restart	UINT8	wo
CANopen Communication	2	Baud rate	New baud rate in kbit/s as integer: 125, 250, 500, or 1000; takes effect after restart	UINT16	wo

Table 52: Device objects 0x2000–0x200A and 0x4000

Examples with node ID 4 (request to COB-ID 0x604):

Action	Data	Meaning
Set baud rate to 250 kbit/s	`2B 00 40 02 FA 00 00 00`	250 = 0x00FA, LSB first
Set node ID to 5	`2F 00 40 01 05 00 00 00`	New node ID 5
Trigger restart	`2F 05 20 03 01 00 00 00`	Object 0x2005, sub-index 3

Table 53: SDO examples: changing baud rate and node ID

Invalid values (node ID outside 1–127, baud rate other than 125, 250, 500, or 1000) are rejected by the module with abort code 0x06090030.

NOTICE

Module no longer reachable after change

The new baud rate and node ID take effect after the next restart. If they do not match the master settings, the module can no longer be reached on the bus.

- ▶ Adjust the master settings before restarting.
- ▶ If in doubt, check the baud rate and node ID via RS232 with the MARS®-Tool.

8.7.2 Measurement Channels

The four channel objects have the same structure:

Object	Channel	Element
0x2010	CH3	Element 0 (UV)
0x2020	CH4	Element 0 (UV)
0x2030	CH1	Element 1 (IR)
0x2040	CH2	Element 1 (IR)

Table 54: Assignment of the channel objects

Sub-Index	Name	Description	Data Type	Access
1	Reading valid	Reading valid: 1 = yes, 0 = no	UINT8	ro
2	Actual Value	Measured value in ppm, vol%, or µg	FLOAT	ro
3	Lower measuring range limit	Lower measuring range limit, returns 0	FLOAT	ro
4	Upper measuring range limit	Upper measuring range limit	FLOAT	rw
5	Data Units	0x00 = ppm, 0x01 = vol%, 0x02 = µg	UINT8	rw
6	Endpoint Correction	Write span gas concentration (span calibration)	FLOAT	wo
7	Endpoint Correction Reset	0x01 resets the correction factor to 1	UINT8	wo
8	µg factor	Conversion factor to µg, active when Data Units = µg	FLOAT	rw
9	Zero Detector Channel	Set zero point of this channel: write 0x01	UINT8	wo

Table 55: Structure of channel objects 0x2010, 0x2020, 0x2030, 0x2040

8.7.3 Radiation Sources

Object	Sub-Index	Name	Description	Data Type	Access
0x2011	1	UV-LED 1 Current	0–20,000 µA	UINT16	rw
Element 0 Emitter	2	UV-LED 2 Current	0–20,000 µA	UINT16	rw
	3	UV-LED 1 on/off	1 = on, 0 = off	UINT8	rw
	4	UV-LED 2 on/off	1 = on, 0 = off	UINT8	rw
	5	UV-LED 1 Operating Time	Operating hours in h	UINT16	ro
	6	UV-LED 2 Operating Time	Operating hours in h	UINT16	ro
	7	UV-LED 1 percent of power	0–100 %	UINT8	ro
	8	UV-LED 2 percent of power	0–100 %	UINT8	ro
0x2031	1	IR-Lamp AC/DC Mode	0 = DC, 1–40 = AC	UINT16	ro
Element 1 Emitter	2	IR-Lamp on/off	1 = on, 0 = off	UINT8	rw
	3	IR-Lamp percent of power	0–100 %	UINT8	ro

Table 56: Radiation source objects

The operating mode of the UV LEDs (DC, AC, pulse) is set via RS232/CAN with commands 0x21 and 0x22 (Section 6.6).

8.7.4 Diagnostics

Sub-Index	Name	Element 0 (0x2012)	Element 1 (0x2032)	Access
1	Modulation low	0–1 [FLOAT]	0–1 [FLOAT]	ro
2	Modulation high	0–1 [FLOAT]	0–1 [FLOAT]	ro
3	ADC Value Reference	0–32,768 [UINT16]	0–65,535 [UINT16]	ro
4	ADC Value Sensor	0–32,768 [UINT16]	0–65,535 [UINT16]	ro
5	Filter Depth Modulation	0–255 [UINT8]	0–255 [UINT8]	rw
6	Filter Depth Concentration	0–255 [UINT8]	0–255 [UINT8]	rw
7	Detector temperature	UV detector in °C [FLOAT]	IR detector in °C [FLOAT]	ro
8	Pressure Sensor	–	Pressure in mbar [FLOAT]	ro

Table 57: Diagnostic objects 0x2012 and 0x2032

8.7.5 Linearization and Temperature Compensation

Object	Content	Sub-Indices
0x201F / 0x202F	Linearization CH3 / CH4	1–4: coefficients x^1 to x^4 [FLOAT], ro
0x203F / 0x204F	Linearization CH1 / CH2	1–4: coefficients x^1 to x^4 [FLOAT], ro
0x2050	Temperature compensation zero point CH1	1–3: coefficients 0–2 [FLOAT], ro 4: compensation on/off [UINT8], rw

Table 58: Objects for linearization and temperature compensation

Objects 0x2051–0x2057 (temperature compensation of other channels and span) from the previous object dictionary are not implemented; access is rejected with 0x06020000.

8.7.6 Auxiliary Sensors

Object	Sub-Index	Name	Description	Data Type	Access
0x2060	1	Relative humidity	Relative humidity in % RH	FLOAT	ro
Humidity Sensor	2	Absolute humidity	Absolute humidity in g/m³	FLOAT	ro
	3	Concentration humidity	H_2O concentration in ppm	FLOAT	ro
	4	Temperature humidity sensor	Temperature in °C	FLOAT	ro
0x2061	1	EC sensor raw value	ADC raw value 0–4095 (as FLOAT)	FLOAT	ro
EC Sensor	2	EC sensor calibrated value	Measured value 0–100 vol %	FLOAT	ro
	3	Offset calibration	write: zero calibration with zero gas value; read: offset correction	FLOAT	rw
	4	Span calibration	write: span gas concentration in ppm or vol %; read: span correction	FLOAT	rw
	5	Reset calibration data	reset all calibration data (any value)	UINT8	wo
0x2062	1	O2D sensor data	Measured value 0–100 vol %	FLOAT	ro
O_2 digital	2	Set offset calibration	start zero calibration (any value)	UINT8	wo
	3	Set span calibration	start span calibration: reference concentration in vol% O_2	FLOAT	wo
	4	Reset calibration data	reset calibration data (any value)	UINT8	wo
	5	Calibration status	calibration status, codes 0–7 as for Modbus register 3056 (Section 7.4)	UINT8	ro

Table 59: Auxiliary sensor objects

The O_2 calibration runs in the background. If the sensor rejects it, the module responds with an SDO abort (0x80, code 0x08000020). Sub-index 5 shows the progress.

9 Status Byte and Device ID

9.1 Status Byte

The status byte indicates whether the radiation sources are detected and whether their signal level is sufficient. It is read via RS232/CAN with command 0x50.

Designation in Previous Manuals	Bit Value in Byte	Meaning When 1
Bit0	0x80	IR source/EDL detected
Bit1	0x40	not used (always 1)
Bit2	0x20	UV LED 1 detected
Bit3	0x10	UV LED 2 detected
Bit4	0x08	IR source/EDL: signal level too low
Bit5	0x04	not used (always 1)
Bit6	0x02	UV LED 1: signal level too low
Bit7	0x01	UV LED 2: signal level too low

Table 60: Meaning of the status byte bits

NOTICE

Bit numbering in previous manuals

In the previous RS232 and CAN manuals, "Bit0" is the most significant bit. The status codes given there (e.g., 0xC7) are correct only with this assignment. Therefore, evaluate the status byte in the controller using the "Bit Value in Byte" column, e.g., "IR source detected" with mask 0x80.

The following table lists all documented status codes. The columns are arranged in the order of the previous manuals (Bit0 = most significant bit):

IR det.	n/u	UV1 det.	UV2 det.	IR level	n/u	UV1 level	UV2 level	Hex	Dec
0	1	0	0	1	1	1	1	0x4F	79
1	1	0	0	1	1	1	1	0xCF	207
1	1	0	0	0	1	1	1	0xC7	199
0	1	1	0	1	1	1	1	0x6F	111
0	1	1	0	1	1	0	1	0x6D	109
0	1	1	1	1	1	1	1	0x7F	127
0	1	1	1	1	1	0	0	0x7C	124
0	1	1	1	1	1	0	1	0x7D	125
0	1	1	1	1	1	1	0	0x7E	126

IR det.	n/u	UV1 det.	UV2 det.	IR level	n/u	UV1 level	UV2 level	Hex	Dec
1	1	1	0	1	1	1	1	0xEF	239
1	1	1	0	0	1	0	1	0xE5	229
1	1	1	0	0	1	1	1	0xE7	231
1	1	1	0	1	1	0	1	0xED	237
1	1	1	1	1	1	1	1	0xFF	255
1	1	1	1	0	1	0	0	0xF4	244
1	1	1	1	0	1	0	1	0xF5	245
1	1	1	1	0	1	1	1	0xF7	247
1	1	1	1	0	1	1	0	0xF6	246
1	1	1	1	1	1	0	0	0xFC	252

Table 61: Documented status codes (Bit0 … Bit7 from left to right)

Example CO_2 module without UV cell: **0xC7** = IR source detected, signal level in normal range (> 50 % intensity). **0xCF** = IR source detected, signal level below the 50 % threshold. On modules without a UV section, the level bits of the UV LEDs are set.

9.2 Device ID (Config ID)

The Device ID ("Config ID" in previous manuals) describes the channel configuration of the module. It is read via RS232/CAN with command 0x62 and via CANopen with object 0x1018, sub-index 2. The 32-bit number consists of eight hexadecimal digits:

Digit	1	2	3	4	5	6	7	8
Content	CH1 MT	CH2 MT	CH3 MT	CH4 MT	CH1 GT	CH2 GT	CH3 GT	CH4 GT

Table 62: Device ID structure (MT = measuring principle, GT = gas type)

Value	Gas Type (GT)	Measuring Principle (MT)
0	none	none
1	SO_2	UV
2	CO_2	IR
3	CO	UV + IR
4	NO	TCD
5	NO_2	pressure
6	N_2O	temperature
7	H_2S	external sensor
8	CH_4	
9	C_nH_m	

Value	Gas Type (GT)	Measuring Principle (MT)
a	Cl_2	
b	H_2O (up to firmware V0.0.147.18548: HC)	
c	ClO_2	
d	O_3	
e	SF_6	
f	CF_4	

Table 63: Codes for gas type and measuring principle

Example: Device ID 0x20102010 → CH1: IR, CO_2; CH2: none; CH3: UV, SO_2; CH4: none.

Information

From software version V0.0.147.18548, code b stands for H_2O (previously HC). On older modules, check the software revision.

9.3 Units of Measurement

Code	RS232 / CAN (Command 0x61)	CANopen (Sub-Index 5 of the Channel Objects)
0	ppm	ppm
1	vol%	vol%
2	–	µg

Table 64: Unit of measurement codes

10 Troubleshooting

Problem	Possible Cause	Remedy
RS232: no response	Wrong COM port or interface parameters; TxD/RxD swapped; cable too long; interface switched to Modbus	Check COM port and 115,200 baud, 8N1; use the Wi.Tec data cable; check cable length (Section 4.6); check DIP switches (Section 7.9)
RS232: garbled characters	Wrong baud rate; terminal program display set to hex instead of ASCII	Check baud rate; set receive display to ASCII
CAN: no response	Wrong baud rate or IDs; selector not 0x30; missing bus termination; CAN-H/CAN-L swapped	Check baud rate and IDs in the MARS®-Tool; send byte 8 = 0x30; 120 Ω at both bus ends (command 0x52, Section 5.5); check wiring (Section 5.4)
CAN: implausible values	Byte order interpreted incorrectly	Evaluate Data 0–3 as FLOAT, little endian (Section 3.1, Appendix A)
Modbus: no response	Wrong slave address, baud rate, or parity; A and B swapped; interface switched to RS232	Compare parameters with Wi.Tec order data; swap lines A/B; check DIP switches (Section 7.9)
Modbus: exception "Illegal Data Address"	Controller converts register address (offset 30001/40001 or −1); wrong function code	Check addressing (Section 7.2); read measured values with 0x04, device information with 0x03
Modbus: sporadic CRC errors	Reflections, missing termination, ground interference	Install termination resistors; use shielded cable; route GND_M as common reference ground, do not connect to PE
CANopen: no PDOs	Module still in Pre-Operational state; no SYNC; PDO SYNC disabled	Send NMT Start Node; send SYNC (0x080) cyclically; set 0x2005 sub-index 2 = 0x01
Status byte reports level error	Radiation source aged or optical path contaminated	Operating Manual, Chapters 11 and 12

Table 65: Communication problems and remedies

Appendix A – IEEE 754 Conversion

FLOAT values are transmitted as 32-bit floating-point numbers per IEEE 754. The table shows example values in both byte orders.

Value	Hex (32-Bit)	Little Endian (RS232, CAN, CANopen)	Big Endian (Modbus)
1000.0	0x447A0000	`00 00 7A 44`	`44 7A 00 00`
6050.0	0x45BD1000	`00 10 BD 45`	`45 BD 10 00`
20.95	0x41A7999A	`9A 99 A7 41`	`41 A7 99 9A`
1.00482	0x3F809DF1	`F1 9D 80 3F`	`3F 80 9D F1`
−0.0203	0xBCA63852	`52 38 A6 BC`	`BC A6 38 52`

Table 66: FLOAT value examples

For verification, use freely available IEEE 754 calculators or a type conversion in the controller (e.g., "union" in C, "REAL_TO_DWORD" or "DWORD_TO_REAL" in IEC 61131-3).

Appendix B – Glossary and Abbreviations

Term	Meaning
AZF	Auto-Zero Function, automatic zero calibration
Big endian / little endian	high-order or low-order byte transmitted first
CAN-H / CAN-L	signal lines of the CAN bus
CiA 301	CANopen application layer and communication profile
CR / LF	carriage return (0x0D) / line feed (0x0A), end of line
CRC	cyclic redundancy check, checksum
Device ID (Config ID)	identifier of the channel configuration (gas type and measuring principle per channel)
EC	electrochemical
EDL	electrodeless discharge lamp
FC	function code, Modbus function code
LSB / MSB	least / most significant bit or byte
NMT	network management (CANopen)
PDO / SDO	process data object / service data object (CANopen)
PLC	programmable logic controller
RS485	balanced two-wire serial interface, basis of Modbus RTU
RTU	remote terminal unit, binary transmission mode of Modbus
TCD	thermal conductivity detector

Table 67: Glossary and abbreviations