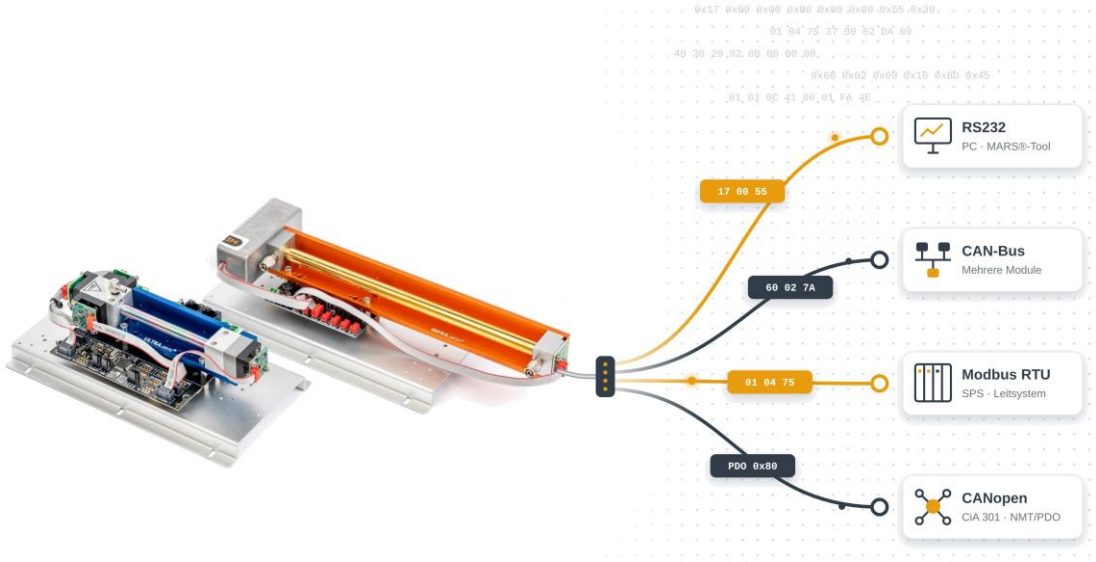
Communications Manual

Digital Interfaces of the OEM Gas Measurement Modules

RS232 · CAN bus · Modbus RTU · CANopen



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With the publication of this revision, the following individual documents are no longer valid: Manual RS232 COM 10, Manual CANbus COM 06 (Rev. 06-02.1), Manual MODBUS Rev. 1.7, and CANopen Object Dictionary V1.8.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: telegram structure, commands, registers, and objects for RS232, CAN bus, Modbus RTU, and CANopen. It supplements the Gas Measurement Modules Operating Instructions, which describe installation, electrical connection, commissioning, and calibration. Keep both documents together.

0.1 Scope

Interface	Protocol	Firmware / Version	Previous Document
RS232	Wi.Tec binary commands, response as ASCII	Current firmware	RS232 COM 10 Manual
CAN bus	Wi.Tec CAN Protocol (8-byte telegrams)	Firmware > 5.43	CANbus COM 06 Manual, Rev. 06-02.1
Modbus RTU (optional)	Modbus RTU via RS485	Firmware > 5540	MODBUS Manual Rev. 1.7
CANopen (Option)	CANopen according to CiA 301 (NMT, SDO, PDO)	Object Directory V1.8 (August 30, 2024)	CANopen Object Dictionary V1.8

Table1 : 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 the 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) (Chapter 7.4).

0.2 Target Audience

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

0.3 Related Documents

Document	Contents	Availability
Gas Measurement Modules Operating Instructions	Electrical Connection and Pin Assignments (Chapter 7), Calibration with Zero and Test Gas (Chapter 10), Status Messages (Chapter 11)	Included with the delivery
Module data sheet	Measurement range, channel assignment, options	Included with the delivery
MARS®-Tool light manual	Operating the PC software, setting the baud rate, CAN IDs, and Modbus address	Download (www.witec-sensorik.de)

Table2 : Applicable Documentation

0.4 Notation Conventions

- Hexadecimal values begin with “0x,” e.g., 0x17. Telegrams are displayed byte by byte in transmission order, e.g., `17 00 00 00 00 00 55 00`.
- Gas measurement channels are labeled CH1 through CH4. Which gas is measured on which channel is indicated on the nameplate and can be read via the device ID (Chapter 9.2).
- Access rights: R = read-only, W = write-only, RW = read and write (for CANopen: ro, wo, rw).
- In the text, decimal numbers are written with a comma (1,00482). The module transmits ASCII values with a decimal point (1.00482).

0.5 Revision History

Revision	Date	Change
0.1	10/2026	Preliminary version. Combines 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 with the current firmware version.

Table3 : Revision History

1 Safety

Please also observe the safety instructions in Chapter 1 of the Gas Measurement Modules Operating Instructions. The safety instructions are structured there, as well as here, in accordance with ISO 3864-2 / ANSI Z535.6.

1.1 Intended Use

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

1.2 Safety Instructions for Communication

⚠ WARNING

Measurement errors due to unintended write commands

Calibration and configuration commands overwrite calibration data in the internal EEPROM. A zero point set without zero gas, or an incorrect test gas value, will result in permanently incorrect measured values. If the module is used for safety functions, such as gas detection, hazards may go undetected.

- Send calibration commands only when the appropriate zero or test gas is present and stable (Operating Instructions, Chapter 10).
- Lock write access in the controller to prevent accidental triggering.
- Check the measured value with test gas after each calibration.

! NOTE

Damage to the Interfaces

Improperly connected cables, potential differences between devices, and electrostatic discharge can destroy the interface modules on the base board.

- Connect or disconnect data cables only when the power is off.
- Check the pin assignment before turning on the power (Chapter 2.3 and the Operating Instructions, Chapter 7).
- Never connect GND_M of the Modbus interface to ground or PE (Chapter 7.9).

2 Overview of Interfaces

2.1 Available Interfaces

Interface	Physical Characteristics	Factory Setting	Typical Application
RS232	RS232, point-to-point	115,200 baud, 8N1	Commissioning, service, MARS® tool, short cables
CAN bus	CAN (ISO 11898), bus	250 kBaud, receive ID 0x300, transmit ID 0x208	Multiple modules on a single controller
Modbus RTU (optional)	RS485, bus	Address 1, baud rate and parity as specified in the order	Connection to PLCs and control systems
CANopen (optional)	CAN (ISO 11898), bus	Node ID 4, heartbeat 500 ms	Integration into CANopen networks

Table4 : Digital Interfaces of the Gas Measurement Modules

2.2 Selecting the Interface

- **RS232** is available on every base board and is primarily used for commissioning and service. At 115,200 baud, the cable length is limited to approximately 2 m (Chapter 4.6).
- **A CAN bus** is available on every base board. Multiple modules can be daisy-chained via the sockets connected in parallel.
- **Modbus RTU** is an option. RS232 and Modbus use the same serial interface of the microcontroller; the active interface is selected using DIP switches (Chapter 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, as the switch is located inside the Thermobox. The Thermobox must be opened for service access via the MARS® tool.

2.3 Connections by Model

The table shows where the interfaces are located on the individual models. Location of the connectors and complete pin assignments: Operating Instructions, Chapter 7.3.

Model	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)	–
IR-compact Base Board V2.0.x	RS232 (2.54 mm, 3-pin): Pin 1 RxD, Pin 2 TxD, Pin 3 GND	CAN (2.54 mm, 3-pin)	–
MBB V1.0 Connector Board	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 when switched internally to RS232)	CAN (3.5 mm, 4-pin)	MODBUS (4-pin)

Table5 : Location of Interfaces by Model

2.4 Connection to the 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.

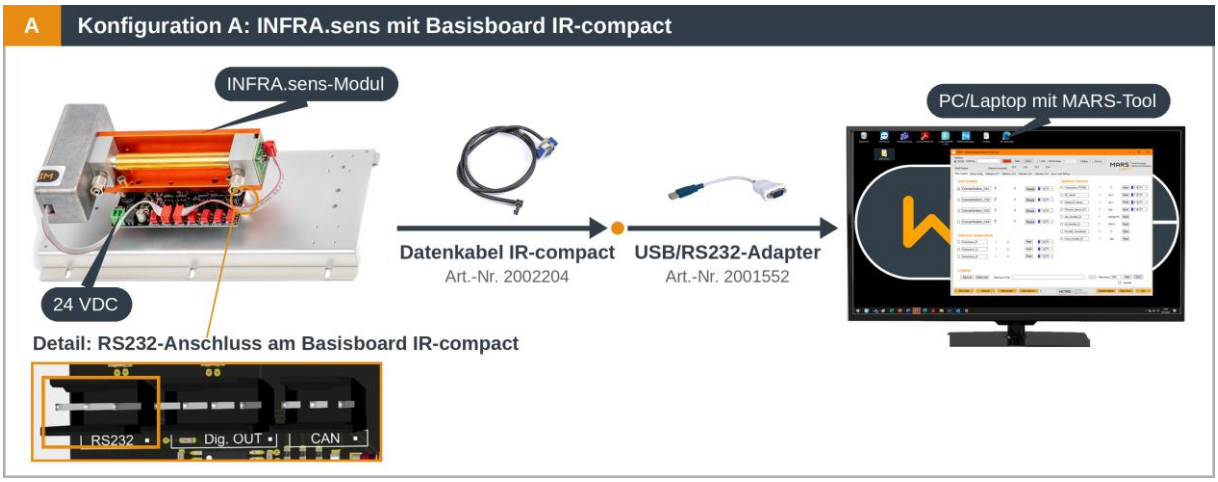


Figure1 : Configuration A: INFRA.sens with IR-compact base board – IR-compact data cable connected to the base board's RS232 port, USB/RS232 adapter connected to the PC

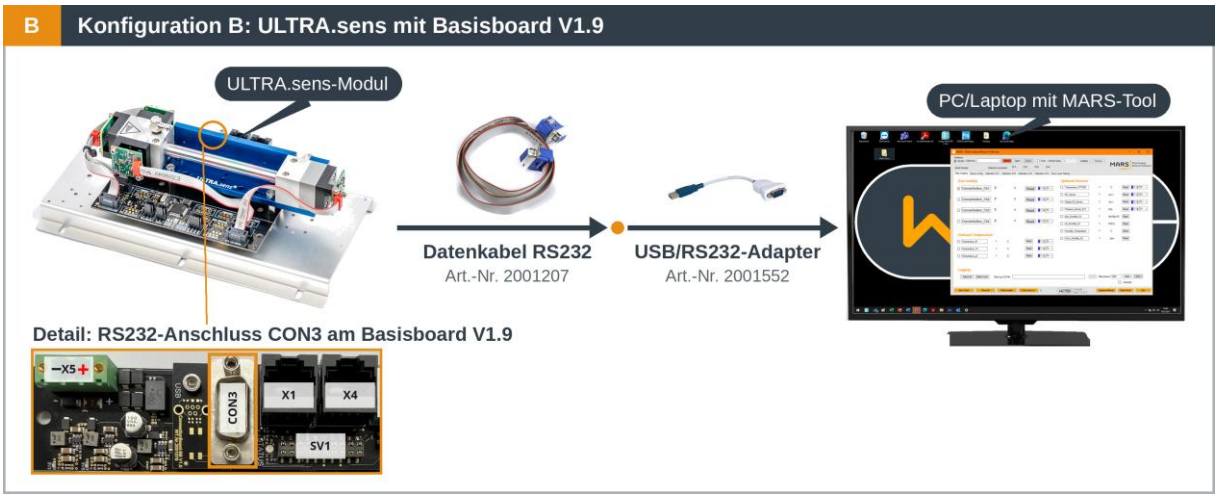


Figure2 : Configuration B: ULTRA.sens with V1.9 base board – RS232 data cable connected to the CON3 D-Sub jack, USB/RS232 adapter connected to the PC

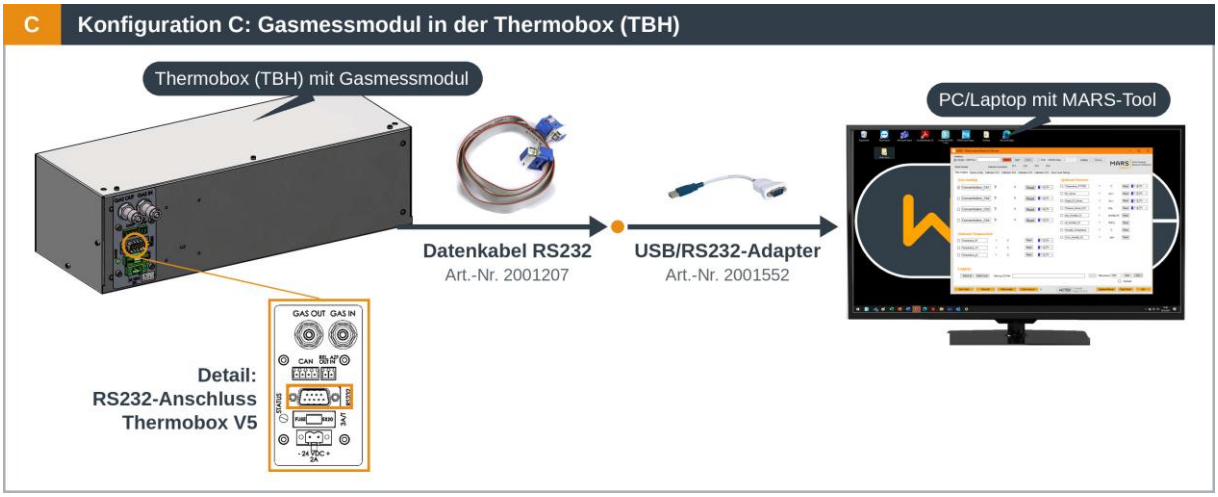


Figure3 : Configuration C: Gas measurement module in the Thermobox (TBH) – RS232 data cable connected to the Thermobox's D-Sub jack, USB/RS232 adapter connected to the PC

2.5 Communication Accessories

Item	Part No.	Note
USB/RS232 adapter	2001552	
RS232 Data Cable for IR-compact V2.0.x Base Board	2002204	Available by special order only
RS232 data cable for V1.9.x base board and Thermobox	2001207	Available by special order only
RS232 data cable for base board V1.8.x	2000592	Available by special order only
CAN-USB Adapter	2002089	
Adapter plug: CAN-USB adapter, D-Sub 9 to RJ45	2002127	
CAN bus data cable for IR-compact base board, connects directly to CAN-USB adapter	2002205	

Table6 : Accessories for Communication

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: most significant byte and most significant register first	`45 BD 10 00`
CANopen (SDO, PDO)	Little-endian according to CiA 301	`00 10 BD 45`

Table7 : Byte Order of the Interfaces

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

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 according to IEEE 754
BOOL	1 byte (CAN) or 1 register (Modbus)	Switching or trigger value (0 or 1)

Table8 : Data Types

3.3 Channel Assignment

The gas measurement channels are permanently assigned to the measurement methods. CH1 and CH2 belong to the IR section (INFRA.sens), while CH3 and CH4 belong to the UV section (ULTRA.sens). With a KOMBI.sens, all four channels can be assigned. 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)

Table9 : Concentration Values per Channel

4 RS232 (ASCII protocol)

The controller sends 8-byte binary commands to the module via RS232. The module responds with a 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
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

Table10 : RS232 Interface Parameters

4.2 Telegram Structure

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

Table11 : Command Structure (Example: Read CH1 Concentration)

Byte	Field	Meaning
1	Command	Command identifier (Chapter 6). The module repeats it in the response (CAN) so that the controller can map the response.
2	Frame Index	Subindex if a command includes multiple values, e.g., channels 0–3 for endpoint adjustment.
3–6	Data 0 – Data 3	Payload data when writing, LSB first: FLOAT and UINT32 in Data 0–3, UINT16 in Data 0–1, UINT8 in Data 0. 0x00 when reading.
7	Read/Write	0x55 = read, 0x7A = write. The response contains the device status here: 0x03 = normal.
8	Selector	Not relevant for RS232 (placeholder; 0x00 in the examples). Fixed at 0x30 for the CAN bus.

Table12 : Meaning of the Bytes in the Command

4.3 Module Response

The module responds with the requested value as an ASCII string, terminated with CR (0x0D) and LF (0x0A). The string is at most 15 bytes long, including CR/LF. Concentrations are output in the set measurement unit (ppm or vol.%), temperatures in °C.

Information

The module also responds to write commands with ASCII, e.g., with the calculated correction factor following an endpoint adjustment (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. As an exception, zero point set, emitter on/off, and UV LED on/off return a value (Chapter 6).

The module does not respond to unknown commands. Therefore, include a timeout for the response in the control system.

4.4 Examples

Action	Direction	Telegram	Meaning
Read CH1 concentration	to module	`17 00 00 00 00 00 55 00`	Command 0x17, Index 0, read
	from module	<Value> CR LF	CH1 concentration in ppm or vol. % as ASCII
Read CH1 temperature	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 for all channels	to module	`11 00 00 00 00 00 7A 00`	Write command 0x11, index 0 (trigger command)
	from module	0 CR LF	Zero point set
Adjust CH3 endpoint	to module	`60 02 00 10 BD 45 7A 30`	Command 0x60, Index 2 (= CH3), test gas 6050.0 ppm, write
	from module	1.00482 CR LF	Calculated correction factor

Table13 : Sample RS232 Telegrams

For example, endpoint calibration: A test gas with a certified concentration of 6050.00 ppm is applied to the module (Channel 3, UV low), and the module displays 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 sends it back.

Information

With RS232, the selector byte is not evaluated; therefore, the example of endpoint adjustment can also be used unchanged for the CAN bus.

4.5 Query Using a Terminal Program

For simple queries without the MARS® tool, a terminal program capable of sending bytes in hexadecimal format—such as HTerm—is sufficient.

Prerequisite: The module is powered and connected to the PC via an RS232 data cable and the USB/RS232 adapter (Chapter 2.4); for Modbus versions, the interface must be set to RS232 (Chapter 7.9).

1. Identify the COM port of the USB/RS232 adapter in the Windows Device Manager.
2. In the terminal program, select the COM port and set the baud rate to 115,200, 8 data bits, no parity, and 1 stop bit.
3. Set the input format to “Hex” and the display of received data 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

Baud rate (bit/s)	Max. cable length (typical)
2,400	900 m
4,800	300 m
9,600	152 m
19,200	15 m
57,600	5 m
115,200	2 m

Table14 : Typical RS232 Cable Lengths Based on Baud Rate

With the factory setting of 115,200 baud, the RS232 cable length is limited to approximately 2 m. For longer distances, use CAN or Modbus, or install an RS232 isolator/amplifier; use shielded, low-capacitance cables.

5 CAN Bus (Wi.Tec Protocol)

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

5.1 Interface Parameters

Parameters	Factory setting	Editable
Baud rate	250 kbaud	Yes, using the MARS® tool
Receive ID (telegrams to the module)	0x300	Yes, using the MARS® tool
Transmit ID (module responses)	0x208	Yes, using the MARS® tool
Telegram length	8 bytes, of which 4 are payload bytes (Data 0–3)	–
Data format	LSB first; FLOAT according to IEEE 754	–

Table15 : CAN Interface Parameters

Information

If multiple modules are operated on a single bus, each module requires its own receive and transmit IDs. Set the IDs individually via RS232 using the MARS® tool before connecting the modules.

5.2 Telegram Structure

Telegrams sent to the module are structured the same as for RS232 (Chapter 4.2); byte 8 (selector) is fixed **at 0x30**. The module's response has the following structure:

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 the module	Cmd	Index	Data 0	Data 1	Data 2	Data 3	Status	N/A

Table16 : Structure of CAN Telegrams and Responses

- The 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 (Chapter 9.1).
- Byte 8 is not used in the response (n/a).

5.3 Examples

Action	Direction	Telegram (Bytes 1–8)	Meaning
Read CH1 concentration	at 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 CH1 temperature	at 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
Adjust CH3 endpoint	at module	`60 02 00 10 BD 45 7A 30`	Test gas 6050.0 ppm for CH3, write
	from module	`60 02 F1 9D 80 3F ST xx`	Correction factor 0x3F809DF1 = 1.00482

Table17 : Sample CAN telegrams (ST = Status)

5.4 Hardware connection

Design	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
IR-compact V2.0.x base board	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, older version	CAN: D-Sub 9, female connector	Pin 2 CAN-L, Pin 3 GND, Pin 7 CAN-H

Table18 : Pin assignments for the CAN connectors

Matching mating connectors for the 3-pin CAN connector on the IR-compact base board: WR-WTB 2.54 mm female IDC connector (Würth), Part No. 661003151922 for AWG 22–24 wire strands, Part No. 661003152022 for AWG 26–28.

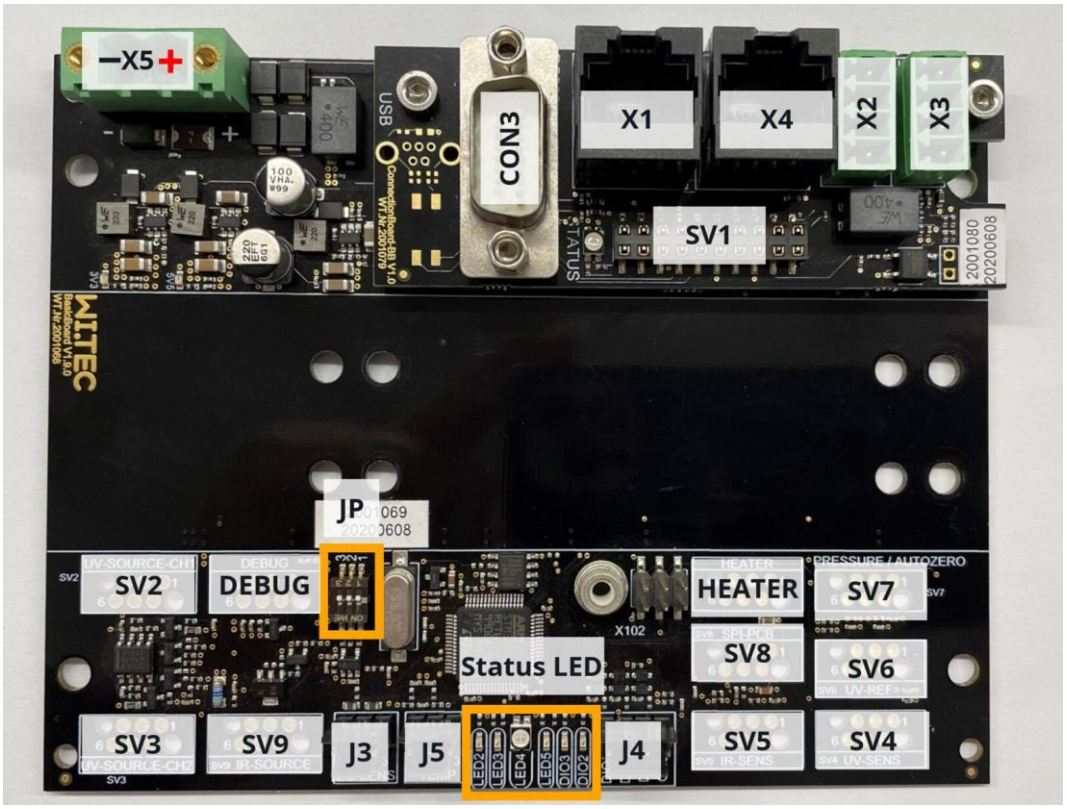


Figure4 : V1.9.x Base Board – Location of Connectors (CAN: X1, X4, X2, X3; RS232: CON3)

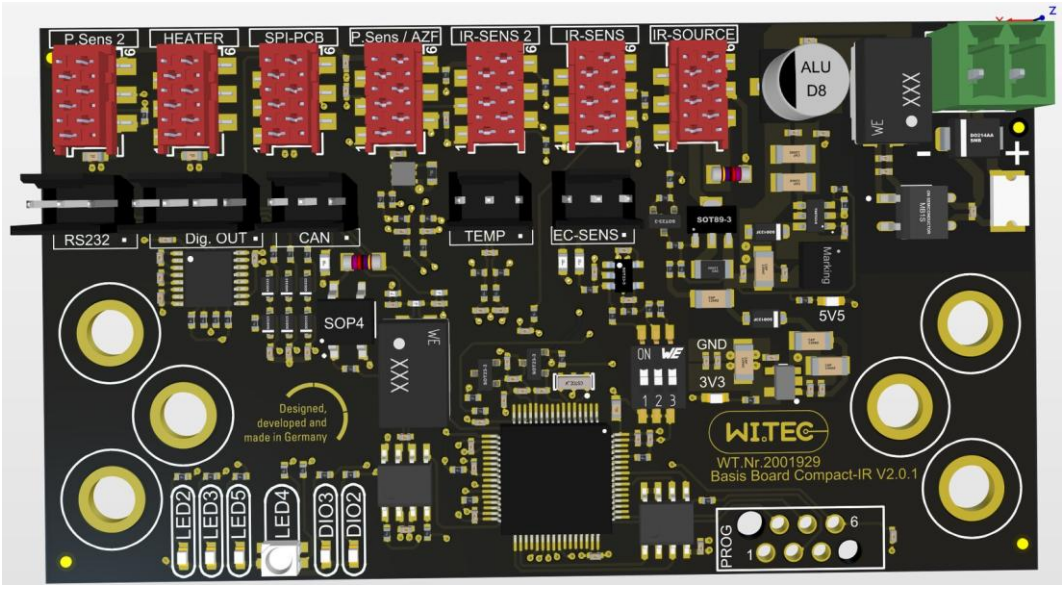


Figure5 : IR-compact V2.0.x base board – the connectors are labeled directly on the board

5.5 Bus Termination

A 120 Ω terminating resistor must be active at the first and last devices on the CAN bus. It is integrated into the base boards:

Base board	Terminating resistor 120 Ω
V1.8.x	Enableable via jumper JP2
V1.9.x	Enableable via software
IR-compact V2.0.x	Enableable via software

Table19 : CAN bus termination on the base boards

Information

In V1.9.x and IR-compact V2.0.x, the terminating resistor is enabled using command **0x52**, frame index **0x04** (BOOL, RW): 1 = 120 Ω enabled (set), 0 = disabled (reset). The current status can be read using 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. The "UINT8/BOOL" format 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”
- Turn on IR emitter (0x29): currently set IR frequency in Hz; turn off (0x30): “0”
- Turn on UV LED (0x25, 0x26): set LED current in µA; turn off (0x27, 0x28): “0”
- Other trigger commands: set state, “1” = True, “0” = False

Setting the zero point and switching the emitter or UV LEDs are separate commands: The contents of Data 0–3 are not evaluated in this case. Send, for example, 0x00.

6.1 Measurement Values

Description	Cmd	Index	Format	Unit	Access
Concentration CH1	0x17	0	FLOAT	ppm or vol. %	R
CH_2 concentration	0x17	1	FLOAT	ppm or vol. %	R
CH3 concentration	0x0F	0	FLOAT	ppm or vol. %	R
CH4 concentration	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 board)	0x1A	0	FLOAT	°C	R
CH4 Temperature (Microcontroller Board)	0x20	0	FLOAT	°C	R
Pressure (P.sens option)	0x19	0	FLOAT	mbar	R
Relative humidity (HUMI.sens option)	0x1B	0	FLOAT	% RH	R
Absolute humidity (HUMI.sens option)	0x1B	1	FLOAT	g/m³	R
H_2O concentration (HUMI.sens option)	0x1B	2	FLOAT	ppm	R
Dew point (HUMI.sens option)	0x1B	3	FLOAT	°C	R
Temperature of the humidity sensor (optional)	0x1C	0	FLOAT	°C	R

20 Table: Commands – Measured Values

6.2 Calibration

Description	Cmd	Index	Format	Unit	Access
Set and save zero point for all channels	0x11 (alt. 0x08)	0	UINT8/BOOL	–	W
Set and save CH1 zero point	0x11	1	UINT8/BOOL	–	W
Set and save CH2 zero point	0x11	2	UINT8/BOOL	–	W
Set and save CH3 zero point	0x11	3	UINT8/BOOL	–	W
Set and save CH4 zero point	0x11	4	UINT8/BOOL	–	W
Endpoint adjustment CH1–CH4 (send test gas concentration)	0x60	0–3	FLOAT	ppm or vol. %	W
Endpoint 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 for CH1–CH4 endpoints on/off	0x58, 0x5A, 0x5C, 0x5E	3	UINT8/BOOL	–	W

Table21 : Commands – Calibration

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

6.3 Additional Sensors

Description	Cmd	Index	Format	Unit	Access
Electrochemical sensor: measured value	0x1D	0	FLOAT	Vol. % or ppm	R
Electrochemical Sensor: Endpoint Calibration	0x1D	1	FLOAT	Vol. % or ppm	W
Electrochemical Sensor: Reset Endpoint Calibration	0x1D	2	UINT8/BOOL	–	W
Electrochemical sensor: Zero point adjustment	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: Endpoint adjustment (e.g., 20.95)	0x1D	6	FLOAT	Vol. %	W
Digital O_2 Sensor: Zero Point Adjustment	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

22 Table: Commands – Additional Sensors

6.4 Auto-Zero Function and Radiation Sources

Description	Cmd	Index	Format	Unit	Access
AZF: Freeze measured value	0x73	0	UINT8/BOOL	–	W
AZF: Flush 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
Turn on UV LED 1	0x25	0	UINT8/BOOL	–	W
Turn off UV LED 1	0x27	0	UINT8/BOOL	–	W
Turn on UV LED 2	0x26	0	UINT8/BOOL	–	W
Turn off UV LED 2	0x28	0	UINT8/BOOL	–	W
Turn on IR emitter	0x29	0	UINT8/BOOL	–	W
Turn off IR emitter	0x30	0	UINT8/BOOL	–	W

Table23 : Commands – Auto-Zero Function (AZF, Option) and Radiation Sources

Information

If a radiation source is turned off, the corresponding channel does not provide valid measurement values. After being turned back on, the radiation source requires a warm-up period before the measurement value stabilizes.

6.5 Raw Signals and Diagnostics

Description	Cmd	Index	Format	Section	Access
ADC Raw Value CH1 Reference	0x14	0	FLOAT	0–1.25 V	R
Raw ADC value CH1 measurement signal	0x15	0	FLOAT	0–1.25 V	R
ADC Raw Value CH2 Reference	0x10	0	FLOAT	0–1.25 V	R
Raw ADC value CH2 measurement signal	0x13	0	FLOAT	0–1.25 V	R
ADC Raw Value CH3 Reference	0x10	1	FLOAT	0–1.25 V	R
Raw ADC value CH3 measurement signal	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

Table24 : Commands – Raw Signals

Modulation is the relative signal attenuation caused by the sample gas. It is calculated from the raw ADC values of the reference and measurement channels, each relative 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 as the gas concentration rises.

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: Duty cycle in pulse mode (applies to UV LEDs 1 and 2)	0x21	1	UINT16	s	RW
UV LEDs: Cycle time in pulse mode (applies to UV LEDs 1 and 2)	0x21	2	UINT16	min	RW
UV LED 2: Operating Mode	0x22	0	UINT8	0 = DC, 1 = AC, 2 = Pulse	RW
IR emitter: Modulation frequency	0x23	0	UINT16	0–10 Hz	RW
Filter Depth Modulation CH3, CH4	0x35	0	UINT8	0–255	RW
Filter depth, CH3 and CH4 concentration	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 terminating resistor 120 Ω on/off (V1.9.x, IR-compact)	0x52	4	BOOL	1 = on, 0 = off	RW
Software reset	0x04	0	UINT8/BOOL	–	W

Table25 : Commands – Configuration

Pulse operation is available for UV-LED 1 and UV-LED 2. Both LEDs use the same pulse parameters from command 0x21, index 1 (duty cycle) 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	Chapter 9.2	R
Hardware Revision	0x41	0	UINT16	–	R
Software Revision	0x0B	0	UINT16	–	R
Operating hours	0x43	0	UINT16	h	R
CH1 Measurement Range	0x47	2	FLOAT	ppm or vol. %	R
CH2 measurement range	0x47	3	FLOAT	ppm or vol. %	R

Description	Cmd	Index	Format	Unit / Range	Access
CH3 measurement range	0x47	0	FLOAT	ppm or vol. %	R
CH4 measurement range	0x47	1	FLOAT	ppm or vol. %	R
Unit of measurement CH1	0x61	2	UINT16	0 = ppm, 1 = vol.%	R
Measurement unit CH2	0x61	3	UINT16	0 = ppm, 1 = vol.%	R
Measurement unit CH3	0x61	0	UINT16	0 = ppm, 1 = vol.%	R
CH4 measurement unit	0x61	1	UINT16	0 = ppm, 1 = vol.%	R
UV LED 1 Emitter Power	0x49	0	UINT8	0–100%	R
UV-LED 2 Emitter Power	0x49	1	UINT8	0–100%	R
IR Emitter Power/EDL	0x49	2	UINT8	0–100%	R
Status byte	0x50	0	UINT8	Chapter 9.1	R

Table26 : Commands – Device Information

Note the different index order for Measurement Range (0x47) and Measurement Unit (0x61): Indexes 0 and 1 belong to CH3 and CH4, indexes 2 and 3 to CH1 and CH2.

Information

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

6.8 Calibration via the Interface

Chapter 10 of the operating instructions describes zero and calibration gases, flow rate, and waiting times. Calibration via the interface proceeds as follows:

Prerequisite: The module must have been operating under stable conditions for at least 30 minutes; zero gas and calibration gas with known concentrations must be available.

1. Inject zero gas and wait until the measured value is stable (read the concentration cyclically using 0x17 or 0x0F).
2. Set the zero point: for all channels, enter `11 00 00 00 00 00 7A 30` (CAN) or 0x00 (RS232) using the selector; for a single channel, use frame index 1–4.
3. Apply test gas and wait until the measured value stabilizes.
4. Send the test gas concentration using command 0x60 with the channel as the frame index (see examples in Sections 4.4 and 5.3).
5. Check the reported correction factor. Values significantly different from 1.0 indicate an incorrect test gas, an incorrect unit, or a contaminated optical path.
6. Stop the test gas and verify the measured value using 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

Parameters	Value
Transmission Mode	Modbus RTU
Baud rate	9,600, 19,200, 38,400, 57,600, or 115,200 baud—set by Wi.Tec during manufacturing
Data bits	8
Parity	None, even, or odd—set by Wi.Tec during manufacturing
Stop bits	For Even/Odd: 1 stop bit (11 bits per character); for no parity: 2 stop bits (default) or 1 stop bit – set by Wi.Tec during manufacturing
Slave address	1 (factory setting), adjustable from 1 to 247 (Chapter 7.8)
Floating-point format	IEEE 754, Big Endian (most significant register first)

Table27 : Modbus Interface Parameters

Information

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

7.2 Function codes and addressing

Abbreviation	Function Code	Usage
R1	0x03 Read Holding Registers	Device information, read slave address (registers 4001–4047)
R2	0x04 Read Input Registers	Measurement 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., test gas concentration)

Table28 : Supported Function Codes

In the telegram, the register number from the register lists is transmitted unchanged as the address. There is no offset and no preceding register identifier:

Register (List)	Address in the telegram (decimal)	Address in the telegram (hex)
3007	3007	0x0BBF
4001	4001	0x0FA1
4003	4003	0x0FA3

Table29 : Addressing Examples

Information

Many controllers and Modbus tools internally convert register addresses, e.g., “Register 30008” → Address 7 or “Register 3008” → Address 3007. Configure the controller so that the telegram contains the exact register number from the list. Verify the setting by performing a read operation on the serial number (Register 4001, `01 03 0F A1 00 01 D6 FC`).

Older firmware versions (e.g., software revision 5517) used addresses 30001 and higher or 40001 and higher (telegram address 0x7537 for register 3007).

7.3 Telegram Structure

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

Table30 : Structure of a Read Request (Example: Serial Number, Register 4001)

The checksum is a CRC-16 according to the Modbus specification and is transmitted with the least significant 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 can be written per request.

If an error occurs, the module responds with the function code + 0x80 and an error code:

Error Code	Description	Cause
0x01	Illegal Function	Function code not supported (only 0x03, 0x04, 0x06, 0x10)
0x02	Illegal Data Address	Register does not exist, read access exceeds the end of the register, or write access to an input register
0x03	Illegal Data Value	Invalid telegram length or number of registers

Table31 : Modbus Error Codes

Telegrams sent to broadcast address 0 are transmitted but not acknowledged.

7.4 Register List: Measured Values

Description	Register	Number	Format	Unit	Access	FC
CH3 concentration	3001	2	FLOAT	ppm, vol.%, µg	R	04
CH4 concentration	3003	2	FLOAT	ppm, vol.%, µg	R	04
CH1 concentration	3005	2	FLOAT	ppm, vol.%, µg	R	04
CH2 concentration	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 Signal	3013	2	FLOAT	V	R	04
ADC 2 Reference	3015	2	FLOAT	V	R	04
ADC 2 Measurement Signal	3017	2	FLOAT	V	R	04
ADC 3 Reference	3019	2	FLOAT	V	R	04
ADC 3 Measurement Signal	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
UV-LED Emitter Power 1	3029	1	UINT16	%	R	04
UV-LED 2 Emitter Power	3030	1	UINT16	%	R	04
IR Emitter Power	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	Number	Format	Unit	Access	FC
TDLAS: Actual temperature of the measurement cell	3052	2	FLOAT	°C	R	04
TDLAS: Setpoint temperature of the heater	3054	2	FLOAT	°C	R	04
Digital O_2 Sensor: Calibration Status	3056	1	UINT16	Code 0–7	R	04

Table32 : Input Registers (Measured Values, Function Code 0x04)

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

Bit	Mask	Meaning when set to 1
Bit 0	0x0001	Laser TEC temperature (Peltier control) is normal
Bit 1	0x0002	Laser is on
Bit 2	0x0004	Communication with the pressure sensor is OK
Bit 3	0x0008	No error reported

Table33 : TDLAS Status Word (Register 3047)

Register 3056 indicates the status of the digital O_2 sensor calibration (registers 4029–4037). Calibration runs in the background; query the register after triggering until “2 – successful” or an error code appears:

Code	Meaning	Code	Meaning
0	No adjustment active	4	Timeout
1	Calibration in progress	5	Invalid value
2	Successfully completed	6	Not supported by the sensor
3	Error	7	Not confirmed by the sensor

Table34 : Calibration Status of Digital O_2 Sensor (Register 3056)

7.5 Register List: Calibration and Control

Description	Register	Number	Format	Unit	Access	FC
Set and save the zero point for all channels	4011	1	UINT16	1 = trigger	W	06
Set and save CH1 zero point	4012	1	UINT16	1 = trigger	W	06
Set and save CH2 zero point	4013	1	UINT16	1 = trigger	W	06
Set and save CH3 zero point	4014	1	UINT16	1 = trigger	W	06
Set and save CH4 zero point	4015	1	UINT16	1 = trigger	W	06
CH1 Endpoint Adjustment	4016	2	FLOAT	ppm or vol.%	W	16
CH2 Endpoint Adjustment	4018	2	FLOAT	ppm or vol.%	W	16

Description	Register	Number	Format	Unit	Access	FC
Endpoint adjustment CH3	4020	2	FLOAT	ppm or vol.%	W	16
Endpoint adjustment 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 (custom 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 Point Adjustment	4029	2	FLOAT	Value: Any	W	16
Digital O_2 Sensor: Endpoint Calibration	4031	2	FLOAT	Vol. % O_2	W	16
EC Sensor: Zero Point Adjustment	4033	2	FLOAT	–	W	16
EC Sensor: Endpoint Adjustment	4035	2	FLOAT	–	W	16
Digital O_2 Sensor: Reset Calibration	4037	2	FLOAT	–	W	06/16
EC Sensor: Reset Calibration	4039	2	FLOAT	–	W	06/16
Reset CH1 calibration	4041	2	FLOAT	–	W	06/16
Reset CH2 Calibration	4043	2	FLOAT	–	W	06/16
Reset CH3 Calibration	4045	2	FLOAT	–	W	06/16
Reset CH4 calibration	4047	2	FLOAT	–	W	06/16

35 Table: Registers for Adjustment and Control (Function Codes 0x06 and 0x10)

Information

Reset Calibration (Registers 4037–4047): The sent value 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 is also possible.

- **Zero Point (4011–4015):** Only the value 1 triggers the zero-point adjustment. The module then resets the register itself to 0.
- **Sample Control (4024):** 0 = Turn on UV LEDs at the stored current; 1 = Turn off UV LEDs; 2 = Specify LED current via registers 4025 and 4026. Values in 4025/4026 are only applied when Sample Control = 2 and are then stored in EEPROM.
- **Persistent Storage (4027):** A freely usable 32-bit value, e.g., for a customer-specific identifier. It is stored in EEPROM and is retained after power-off.
- **Digital O_2 Sensor (4029–4037):** Calibration runs in the background; progress is indicated by register 3056.

Registers 4011–4015 trigger the zero-point calibration. For end-point calibration, the test gas concentration is written as a FLOAT value via two registers. Gases and waiting times: Operating Instructions, Chapter 10.

7.6 Register List: Device Information

Description	Register	Number	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
Date of Manufacture	4010	1	UINT16	–	R	03

Table36 : Holding Register (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 are taken from a log; the values depend on the specific module.

Query	Direction	Telegram	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
CH2 concentration, 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

Table37 : Modbus Example Telegrams

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 by default. It can be changed in two ways:

- via RS232 using the MARS® tool, parameter “MODBUS_ID” in the “Production” register (switch the interface to RS232 for this; see Section 7.9), or
- via Modbus using register 4028 (Slave ID Update).

Prerequisite: The module must be accessible via Modbus; the new address must not already be in use on the network.

1. Write the new address (1–247) to register 4028 using function code 0x06.
2. Turn the module off and then back on.
3. Access the module at the new address; for example, 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 but without a Thermobox are equipped with the Connector Board MBB V1.0. The two RJ45 jacks, MODBUS 1 and MODBUS 2, are connected in parallel: Two analyzers can be connected using a standard patch cable, and the control unit is connected via the free jack.

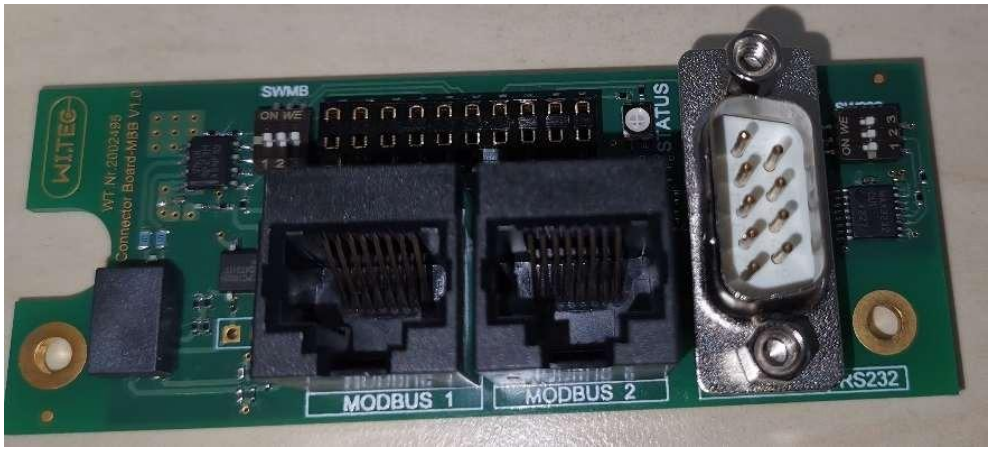


Figure6 : Connector Board MBB V1.0 with the RJ45 jacks MODBUS 1 and MODBUS 2, the RS232 jack, and the DIP switches SWMB and SW232

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

Table38 : Pin Assignment for the RJ45 Sockets MODBUS 1 and MODBUS 2

RS232/Modbus Switching: The board has two DIP switches, SWMB (SW1) for Modbus and SW232 (SW2) for RS232. The module reads the switch settings each time it is powered on and communicates using the appropriate protocol.

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

Table39 : DIP switches for selecting the interface

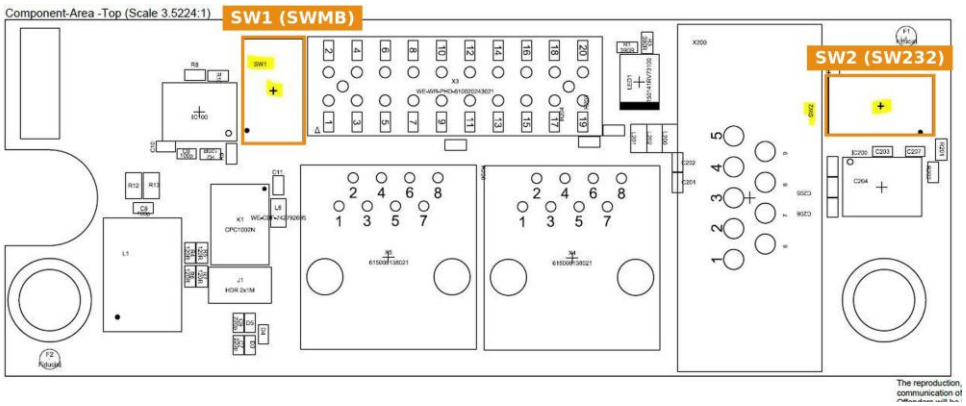


Figure7 : Layout diagram for the MBB V1.0 connector board with DIP switches SW1 (SWMB, Modbus) and SW2 (SW232, RS232)

Terminating resistor: The terminating resistor (150 Ω) integrated on the board is enabled via jumper JP1 or via RS232. It is recommended for cable lengths of approximately 30 m or longer 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 terminal block. For the upper connectors (Dig-OUT, MODBUS), pin 1 is on the left.

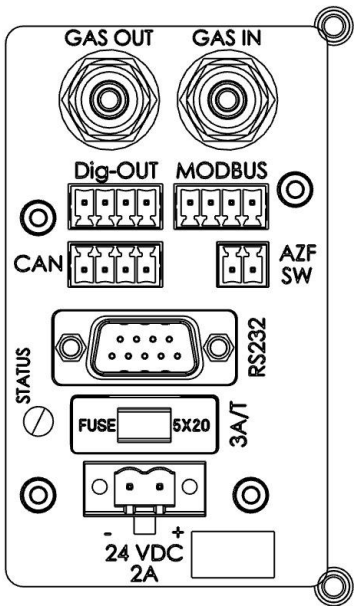


Figure8 : Terminal block of the Thermobox V5 with Modbus connection

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

Table40 : MODBUS Connector Pin Assignment (Thermobox V5)

! NOTE

Do not connect GND_M to ground

Connecting GND_M to ground (PE) compromises the insulation of the Modbus interface (critical insulation failure).

- ▶ Never connect GND_M to ground or PE.

7.9.3 Bus Configuration and Termination

- Communication takes place via the two lines A (D1, A+) and B (D0, B−). Use twisted-pair, shielded two-wire cable.
- Install a 120 Ω terminating resistor at both ends of the bus.
- GND_M is optional but is recommended as a common reference point for all devices 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 appear only once on the bus.

8 CANopen

With the CANopen option, the module functions as a CANopen slave in accordance with CiA 301. Measured values are transmitted on SYNC as process data (PDO); parameters are read and written via service data (SDO). This chapter is based on the object directory V1.8 as of the current firmware version.

8.1 Configuration

Parameters	Value
Baud rate	125 kBaud, 250 kBaud, 500 kBaud, 1 MBaud
Node ID	4 (factory setting)
PDO transmission	Synchronous, triggered by SYNC (COB-ID 0x080)
PDOs	2 standard PDOs, each with 2 FLOAT values (8 bytes); optionally 2 extended PDOs (Section 8.4)
Monitoring	Heartbeat, 500 ms
PDO 0 (COB-ID 0x180 + Node-ID)	CH3 concentration [FLOAT], CH4 concentration [FLOAT]
PDO 1 (COB-ID 0x280 + Node-ID)	CH1 concentration [FLOAT], CH2 concentration [FLOAT]

Table41 : CANopen Configuration

The baud rate and Node-ID are set using the MARS® tool or specified when ordering. Additionally, they can be written via SDO using object 0x4000 (Chapter 8.7.1). The values are stored in the EEPROM and take effect after a reboot.

8.2 Hardware Connection

The connection is made in the same way as for the CAN bus (Chapters 5.4 and 5.5).

Connectors	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

Table42 : 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 does not transmit process data until the master issues the NMT command “Start Node.” SDO access is already possible in the Pre-Operational state.

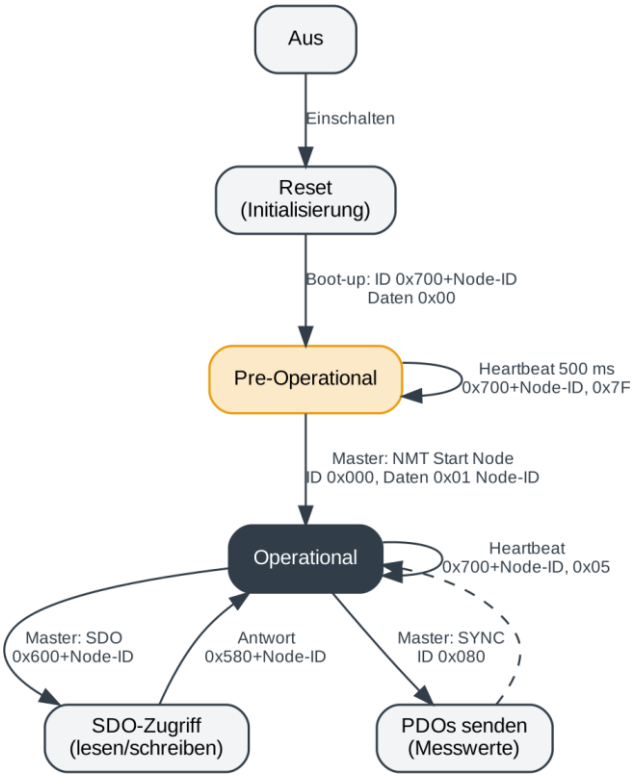


Figure9 : States and Messages During Startup (Boot-up Sequence)

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)
NMT Start Node (Master)	0x000	2	0x01, Node ID	Switch module to Operational
Heartbeat	0x700 + Node ID	1	0x05	Operational state (every 500 ms)
SYNC (Master)	0x080	0	–	Module sends PDOs

Table43 : NMT and Monitoring Messages

8.4 Process Data (PDO)

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

PDO	COB-ID	Bytes 0–3	Bytes 4–7
PDO 0	0x180 + Node ID	CH3 concentration [FLOAT]	CH4 concentration [FLOAT]
PDO 1	0x280 + Node ID	CH1 concentration [FLOAT]	CH2 concentration [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: Counters 1–12, Bytes 1–3: 0	Value by counter (table below)

44 : Contents of the PDOs

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

Counter	Content of Bytes 4–7	Counter	Content of Bytes 4–7
1	Board temperature [FLOAT, °C]	7	IR detector temperature [FLOAT, °C]
2	Status of radiation sources [UINT8]	8	Pressure [FLOAT, mbar]
3	Status of UV LED 1, UV LED 2, IR emitter [1 byte each]	9	Relative humidity [FLOAT, %]
4	Power of UV LED 1, UV LED 2, IR emitter [1 byte each, %]	10	Absolute humidity [FLOAT, g/m³]
5	UV Detector Temperature [FLOAT, °C]	11	Humidity Sensor Temperature [FLOAT, °C]
6	Measurement value valid per channel [1 byte each, 1 = valid]	12	Operating hours [UINT16, h, bytes 6–7]

Table45 : Multiplex content of PDO 3

PDO transmission can be enabled or disabled via object 0x2005, sub-index 2 (Enable PDO SYNC).

8.5 Service Data (SDO)

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

Byte	0	1	2	3	4–7
Contents	Command Byte	Index Low	Index High	Sub-Index	Data (Little Endian)

Table46 : Structure of an SDO Telegram

Command Byte	Direction	Meaning
0x40	Control → Module	Read object (upload request)
0x4F / 0x4B / 0x43	Module → Controller	Read response with 1 / 2 / 4 data bytes
0x2F / 0x2B / 0x23	Control → Module	Write object with 1 / 2 / 4 data bytes (download)
0x60	Module → Controller	Write confirmed
0x80	Module → Controller	Abort, e.g., code 0x08000020 “Data cannot be transferred or saved”

Table47 : SDO Command Bytes

Example for Node ID 4 – Read CH1 concentration (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)

Table48 : SDO Example: Read CH1 Concentration

Information

When writing, the module accepts all three command bytes 0x23, 0x2B, and 0x2F; the data bytes are interpreted according to the object’s data type. The module does not respond to requests for non-existent objects.

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	UINT32	rw
0x1006, 0x1007	0	Communication cycle, sync window	Write is acknowledged; no function	UINT32	where
0x1018	0	Identity – Number of entries	4	UINT8	ro
	1	Vendor ID	returns 0	UINT32	ro
	2	Product code	Device ID (Chapter 9.2)	UINT32	ro
	3	Revision number	Software revision, e.g., 5514 = 5.514	UINT32	ro
	4	Serial number	Serial number	UINT32	ro

Table49 : Communication Objects (CiA 301)

Sub-index 0 of the manufacturer-specific objects returns the number of entries in each case.

8.7 Manufacturer-specific objects

The measurement channels are divided into two elements: **Element 0** is the UV section with CH3 and CH4, and **Element 1 is** 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 (such 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	Hardware Revision	Hardware Revision	UINT16	ro
	5	Software Revision	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
Light source alarm	2	UV-LED 2 minimum power	Alarm threshold 25–100%	UINT8	rw
	3	IR lamp minimum power	Alarm threshold 25–100%	UINT8	rw
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 (radiator power below alarm threshold)	UINT8	ro
0x2005	1	Zero detector	Set zero point for 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	where
	4	Store zero detector	Currently without function	UINT8	where
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

Object	Sub-index	Name	Description	Data Type	Access
	3	IR Lamp Status	Same as sub-index 1	UINT8	ro
0x4000	1	Node ID	New node ID, effective after restart	UINT8	where
CANopen Communication	2	Baud Rate	New baud rate in kBaud as an integer: 125, 250, 500, or 1000; takes effect after a restart	UINT16	where

Table50 : Device objects 0x2000–0x200A and 0x4000

Examples for Node ID 4 (request to COB ID 0x604):

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

Table51 : SDO Examples: Change Baud Rate and Node ID

! NOTE

Invalid baud rate value

A value other than 125, 250, 500, or 1000 is not rejected. The module then starts at 500 kBaud and can no longer be reached if the bus baud rate differs.

- Write only 125, 250, 500, or 1000.
- After changing the baud rate or Node ID, adjust the master's settings and restart the module.

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)

Table52 : Assignment of Channel Objects

Sub-Index	Name	Description	Data Type	Access
1	Reading valid	Measurement value 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 measurement range limit	FLOAT	rw
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 test gas concentration (endpoint adjustment)	FLOAT	where
7	Endpoint Correction Reset	0x01 resets the correction factor to 1	UINT8	where
8	µg factor	Conversion factor in µg, active when Data Units = µg	FLOAT	rw
9	Zero Detector Channel	Set the zero point for this channel: Write 0x01	UINT8	where

Table53 : 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 percentage of power	0–100%	UINT8	ro
	8	UV LED 2 percent of power	0–100%	UINT8	ro
	9	UV LED 1 Pulse Mode	0 = DC, 1 = AC	UINT16	rw
	10	UV-LED 2 Pulse Mode	0 = DC, 1 = AC	UINT16	rw
0x2031	1	IR Lamp AC/DC Mode	0 = DC, 1–40 = AC	UINT8	ro
Element 1 Emitter	2	IR lamp on/off	1 = on, 0 = off	UINT8	rw
	3	IR lamp power percentage	0–100%	UINT8	ro

Table54 : Radiation Source Objects

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	High modulation	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

Table55 : 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 through x^4 [FLOAT], ro
0x203F / 0x204F	Linearization CH1 / CH2	1–4: Coefficients x^1 through x^4 [FLOAT], ro
0x2050 / 0x2052	Temperature compensation of CH1 / CH2 zero point	1–3: Coefficients 0–2 [FLOAT], read-only 4: Compensation on/off [UINT8], rw
0x2054 / 0x2056	Temperature compensation of CH3 / CH4 zero point	1–3: Coefficients 0–2 [FLOAT], read-only 4: Compensation on/off [UINT8], rw
0x2051, 0x2053, 0x2055, 0x2057	Temperature compensation for CH1–CH4 endpoints	Not yet implemented

Table56 : Objects for linearization and temperature compensation

8.7.6 Additional 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	Humidity concentration	H_2O concentration in ppm	FLOAT	ro
	4	Temperature and 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 point adjustment with zero gas value; Read: Offset correction	FLOAT	rw
	4	Span calibration	Write: Calibration gas concentration in ppm or vol.%; Read: Span correction	FLOAT	rw
	5	Reset calibration data	Reset all calibration data (any value)	UINT8	where
0x2062	1	O2D sensor data	Measured value 0–100 vol.%	FLOAT	ro
O_2 digital	2	Set offset calibration	Start zero point adjustment (any value)	UINT8	where
	3	Set span calibration	Start end-point calibration: Reference concentration in vol. % O_2	FLOAT	where
	4	Reset calibration data	Reset calibration data (any value)	UINT8	where
	5	Calibration status	Calibration status, codes 0–7 as in Modbus register 3056 (Chapter 7.4)	UINT8	ro

Table57 : Objects of the Additional Sensors

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 using command 0x50.

Designation in previous manuals	Bit order in the byte	Meaning when set to 1
Bit 0	0x80	IR emitter/EDL detected
Bit 1	0x40	Not used (always 1)
Bit 2	0x20	UV LED 1 detected
Bit 3	0x10	UV LED 2 detected
Bit 4	0x08	IR emitter/EDL: Signal level too low
Bit 5	0x04	Not used (always 1)
Bit 6	0x02	UV LED 1: Signal level too low
Bit 7	0x01	UV LED 2: Signal level too low

Table58 : Meaning of the Bits in the Status Byte

! NOTE

Bit numbering in previous manuals

In previous RS232 and CAN manuals, “Bit 0” is the most significant bit. The specified status codes (e.g., 0xC7) are valid only with this bit order. Therefore, interpret the status byte in the controller using the “Significance in the Byte” column, e.g., “IR emitter detected” with the mask 0x80.

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

IR Detected	N/A	UV1 detected	UV2 detected	IR Level	N/A	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

IR Detected	N/A	UV1 detected	UV2 detected	IR Level	N/A	UV1 Level	UV2 Level	Hex	Dec
0	1	1	1	1	1	1	0	0x7E	126
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

Table59 : Documented status codes (Bit 0 … Bit 7 from left to right)

Example: CO_2 module without UV cuvette: **0xC7** = IR emitter detected, signal level within the normal range (> 50% intensity). **0xCF** = IR emitter detected, signal level below the 50% threshold. For modules without a UV component, the level bits for the UV LEDs are set.

9.2 Device ID (Config ID)

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

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

Table60 : Structure of the Device ID (MT = Measurement Method, GT = Gas Type)

Value	Gas Type (GT)	Measurement Method (MT)
0	None	None
1	SO_2	UV
2	CO_2	IR
3	CO	UV + IR
4	NO	WLD
5	NO_2	Pressure
6	N_2O	Temperature
7	H_2S	External sensor
8	CH_4	

Value	Gas Type (GT)	Measurement Method (MT)
9	C_nH_m	
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	

Table61 : Codes for Gas Type and Measurement Method

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

Information

Starting with software version V0.0.147.18548, the code “b” stands for H_2O (previously “HC”). Check the software revision for older modules.

9.3 Measurement Units

Code	RS232 / CAN (Command 0x61)	CANopen (sub-index 5 of the channel objects)
0	ppm	ppm
1	vol. %	vol. %
2	–	µg

Table62 : Unit Codes

10 Troubleshooting

Problem	Possible Cause	Solution
RS232: No response	Incorrect COM port or interface parameters; TxD/RxD swapped; cable too long; interface set to Modbus	Check COM port and 115,200 baud, 8N1; use Wi.Tec data cable; check cable length (Chapter 4.6); check DIP switches (Chapter 7.9)
RS232: Unreadable characters	Incorrect baud rate; display in the terminal program set to Hex instead of ASCII	Check baud rate; set the receive mode to ASCII
CAN: No response	Baud rate or IDs incorrect; selector not 0x30; bus termination missing; CAN-H/CAN-L swapped	Check baud rate and IDs in the MARS® tool; send byte 8 = 0x30; 120 Ω at both ends of the bus (command 0x52, Chapter 5.5); check wiring (Chapter 5.4)
CAN: Values are implausible	Byte order interpreted incorrectly	Evaluate Data 0–3 as FLOAT Little Endian (Chapter 3.1, Appendix A)
Modbus: No response	Incorrect slave address, baud rate, or parity; A and B swapped; interface set to RS232	Compare parameters with Wi.Tec order data; swap wires A/B; check DIP switches (Chapter 7.9)
Modbus: Error response “Illegal Data Address”	Controller converts register address (offset 30001/40001 or −1); incorrect function code	Check addressing (Chapter 7.2); read measured values with 0x04, device information with 0x03
Modbus: Sporadic CRC errors	Reflections, missing termination, interference on ground	Install terminating resistors; use shielded cable; route GND_M as a 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; 0x2005 sub-index 2 = 0x01
Status byte reports a level error	Emitter has aged or the beam path is contaminated	Operating Instructions, Chapters 11 and 12

Table63 : Communication Errors and Remedies

Appendix A – IEEE 754 Conversion

FLOAT values are transmitted as 32-bit floating-point numbers according to 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`
6,050.0	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`

Table64 : Examples of FLOAT Values

Freely available IEEE-754 calculators or a type conversion within the controller (e.g., “union” in C, “REAL_TO_DWORD” or “DWORD_TO_REAL” in IEC 61131-3) can be used for verification.

Appendix B – Glossary and Abbreviations

Term	Meaning
AZF	Auto-Zero function, automatic zero-point adjustment
Big-Endian / Little-Endian	The most significant or least significant byte is 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 for the channel configuration (gas type and measurement method per channel)
EC	electrochemical
EDL	Electrodeless Discharge Lamp, electrodeless gas discharge lamp
FC	Function Code, Modbus function code
LSB / MSB	least significant / most significant bit or byte
NMT	Network Management, network management in CANopen
PDO / SDO	Process Data Object / Service Data Object (CANopen)
RS485	Symmetrical two-wire serial interface, basis of Modbus RTU
RTU	Remote Terminal Unit, binary transmission mode of Modbus
PLC	Programmable Logic Controller
WLD	Thermal Conductivity Detector

Table65 : Glossary and Abbreviations