HTS-2 / HTBS-2

HIGH-PRECISION TEMPERATURE AND HUMIDITY SENSOR WITH OPTIONAL PRESSURE MEASUREMENT FOR METEOROLOGICAL APPLICATIONS

OPERATING INSTRUCTION| DOCUMENT NO. MS-HT(B)S-2-OI005-34 | © 2025 METEOSENSE

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1. Introduction

The HTS-2 / HTBS-2 is a high-precision, ultra-low-power temperature and humidity sensor with optional pressure measurement designed for professional meteorological and environmental monitoring applications. It offers exceptional energy efficiency, consuming less than 14 µA in sleep mode, making it ideal for battery-powered and remote deployments.

Equipped with multiple industry-standard digital interfaces—including RS-485, and SDI-12—the HTS-2 / HTBS-2 ensures seamless integration into a wide range of data acquisition systems and telemetry networks. Its compact design and robust construction allow for reliable operation in diverse environmental conditions.

Key Features:

- Ultra-Low Power Consumption: Draws less than 14 µA in sleep mode, extending battery life in remote installations.
- Multiple Communication Interfaces: Supports RS-485 and SDI-12 protocols for versatile connectivity.
- High Accuracy: Provides precise temperature and humidity measurements suitable for professional applications.
- Robust Design: Engineered to withstand harsh environmental conditions, ensuring long-term reliability.
- Easy Integration: Compatible with various data loggers and monitoring systems, facilitating straightforward deployment.

The HTS-2 / HTBS-2 is an excellent choice for applications requiring accurate temperature and humidity measurements with minimal power consumption, such as weather stations, environmental monitoring, and remote sensing projects.

2. Safety Instructions

Before installing or operating the HTS-2 / HTBS-2 sensor, please read and follow these safety instructions carefully to ensure proper operation and to prevent damage to the device or injury.

⚠ General Safety

- The sensor must be installed and used only by qualified personnel familiar with electronic measurement systems and electrical safety standards.
- Operate the sensor only within the specified voltage, temperature, and environmental limits outlined in the technical specifications.
- Do not open, modify, or disassemble the sensor. There are no user-serviceable parts inside.

Electrical Safety

- Power the sensor only with a regulated DC power supply within the specified voltage range (typically 5–45 V DC).
- Ensure correct wiring of power and communication lines according to the pinout provided. Incorrect wiring may damage the device.

- Always disconnect power before making or changing wiring connections.

ESD Protection

- Handle the sensor with proper electrostatic discharge (ESD) precautions.
- Use a grounded workstation and wear an antistatic wrist strap when installing or handling the sensor to avoid damaging sensitive electronic components.

Environmental Conditions

- Use the sensor only within the specified operating temperature range (–40 °C to +80 °C).
- Do not expose the sensor to corrosive chemicals, flammable materials, or extreme mechanical shock.
- Avoid direct water ingress into the sensor housing or connectors unless properly sealed according to IP protection standards.

Fire & Heat Hazards

- Do not install the sensor near heat sources or open flames.
- Never short-circuit the power supply or allow conductive materials to bridge electrical terminals.

Installation & Maintenance

- Mount the sensor securely to avoid mechanical stress or vibration.
- Maintenance or cleaning should only be performed with the device powered off and using dry, lint-free materials.

3. Warranty

Limited Warranty

MeteoSense warrants that the HTS-2 / HTBS-2 sensor is free from defects in materials and workmanship under normal use for a period of two (2) years from the date of purchase by the original end user.

If a defect arises during the warranty period, MeteoSense will, at its discretion, repair or replace the product at no charge, provided the product has been used in accordance with the guidelines in this manual.

Warranty Conditions:

- The warranty applies only to the original purchaser and is non-transferable.
- The warranty does not cover damage resulting from misuse, improper installation, accident, modification, or unauthorized repair.
- MeteoSense is not liable for any indirect, incidental, or consequential damages resulting from the use or inability to use this product.
- Claims must be submitted in writing along with proof of purchase (invoice or receipt).

Warranty Service:

To request warranty service, please contact MeteoSense support at:

📧 support@meteosense.de

🌍 www.meteosense.de

Include a description of the issue and the serial number of the device.

4. Mounting Location and Installation

To ensure accurate measurements and long-term durability, the HTS-2 / HTBS-2 should be installed in a suitable, protected environment.

Recommended Mounting Location

For optimal performance:

- Install the sensor in a Stevenson screen (weather shelter) or a protective enclosure with sufficient ventilation.
- Avoid direct exposure to sunlight, precipitation, and wind gusts, as these can affect pressure readings or degrade sensor components over time.
- Mount the sensor at a representative height for air pressure measurement, away from large heat sources, fans, or artificial pressure variations.

If mounted outdoors, ensure the enclosure offers adequate protection against condensation, insects, and temperature extremes.

Mounting Options

The HTS-2 / HTBS-2 features a compact cylindrical design with a diameter of 20 mm, making it optimally suited for installation inside standard Gill radiation shields used in meteorological applications.

Before connecting the HTS-2 / HTBS-2 to a power source or data acquisition system, carefully read the wiring instructions below to avoid damage to the sensor or connected equipment.

5. Technical Specifications

HTS-2 / HTBS-2 Electrical & General Specifications	
DC Input Voltage	5 VDC … 45 VDC (Peak up to 60 VDC)
ESD Protection I/O	15 kV
Reverse Polarity Protection	Yes
Power Consumption Low Power	14 µA at 12V
Power Consumption SDI-12	0.23 mA at 12V
Power Consumption RS-485	0.83 mA at 12V
Number of Sensors HTS-2	1
Number of Sensors HTBS-2	2
Temperature	
Measurement principle Temperature	Band-gap sensor
Temperature Compensation Range	-40°C … +80°C
Temperature Range	-40°C … +80°C
Temperature Units	°C, °F, K
Temperature Accuracy	±0.1°C
Temperature Repeatability (High)	±0.023°C
Temperature Resolution	0.01°C
Temperature Response Time (τ63%)	~1 – 2 s
Long-term Temperature Drift	<0.03°C/year
Humidity	
Measurement principle Humidity	Capacitive polymer sensor
Humidity Range	0…100 %RH
Relative Humidity Accuracy	±1.0 (typ.) %RH
Relative Humidity Repeatability (High)	±0.05 %RH
Relative Humidity Resolution	0.01 %RH
Relative Humidity Response Time (τ63%)	~4 – 7 s
Long-term Relative Humidity Drift	<0.2 %RH/year
Pressure (HTBS-2 only)	
Measurement principle Pressure	Capacitive MEMS sensor
Measurement principle Temperature (pressure sensor)	Band-gap sensor

HTS-2 / HTBS-2 Electrical & General Specifications	
Temperature Compensation Range for Pressure	-40°C … +80°C
Pressure Response Time (τ99%)	~100ms
Pressure Range	400 hPa … 1200 hPa
Pressure Units	hPa, mbar, bar, mmhg, Torr, atm, psi, Pa
Relative Pressure Accuracy 900 – 1100 hPa, 25 °C	±0.004 hPa
Relative Pressure Accuracy 700 – 1100 hPa, 15 – 55 °C,	±0.055 hPa
Absolute Pressure Accuracy 400 – 1100 hPa, –5 – 65 °C	±0.25–0.30 hPa
Absolute Pressure Accuracy 400 – 1100 hPa, –40 – 85 °C inkl. Drift, TCO, thermal drift	±0.8 hPa
Pressure Noise	0.0021–0.0025 hPa
Offset Temperature Coefficient (TCO) 300 – 1100 hPa, –5 – 65 °C	±0.005 hPa/K
Max. thermal hysteresis 400 – 1100 hPa, 65 – 85 °C	+0.17 hPa
Max. thermal hysteresis 400 – 1100 hPa, -40 – 5°C	-0.095 hPa
Long-Term Drift	±0.08–0.10 hPa
Short-Term Drift	±0.009–0.010 hPa
Resolution	1/64 hPa ≈ 0.0156 hPa
Hysteresis	0.02 hPa
Outputs	
Interfaces	RS-485, SDI-12, USB-CDC
Protocols	Modbus RTU/ASCII, SDI-12 1.4
Baud Rate RS-485	9.6, 34, 56, 96, 115.2 kbit/s
Baud Rate SDI-12	1.2, 2.4, 4.8 kbit/s
Output Interval Continuous Mode RS-485/SDI-12	1 s … 86400 s
Output Interval USB Streaming	1s … 3600s
Housing	
Housing	Anodized Aluminium
IP rating according to IEC 60529	IP65
Filter	Stainless Steel 1.4404, IP65
Housing dimensions	Ø20mm x 130mm
Connection	M12x5 A male

5.1 Power Supply

- Input voltage range: 5 to 45 V DC (protected up to 60 V)
- Use a regulated DC power supply within this range.
- The sensor is protected against reverse polarity and overvoltage.
- For low-power applications, ensure the supply is capable of supporting both sleep and active current demands (typ. < 14 µA sleep, ~1 mA active).

5.2 Electrical Interface

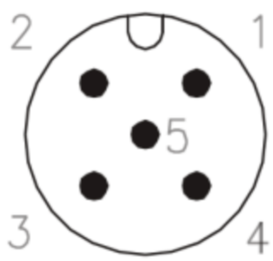
The HTS-2 / HTBS-2 features a single multi-interface port that supports:

- RS-485 (Modbus RTU or ASCII)
- SDI-12 (Version 1.4)

Communication mode can be configured via USB to RS-485 converter (see section 7).

5.3 Pin Assignment

Standard Cable Pinout:



Pin Nr.	Signal	Description
1	VIN+	Power supply (+5 to +45 V DC)
2	GND-	Ground
3	RS-485 A	Data+
4	RS-485 B	Data–
5	SDI-12	

⚠️ ***Important:*** *Do not connect the shield wire to system ground (GND).*
It must be connected only to the metal housing of the sensor.
Connecting the shield to GND may cause ground loops, signal interference, or even damage to the sensor electronics under certain conditions.
Proper bonding to the housing ensures effective shielding and protects the device from external electrical disturbances.

⚠️ ***Warning:*** *Only one communication protocol should be used at a time. Do not connect RS-485 and SDI-12 interfaces simultaneously.*

5.4 Wiring Recommendations

- Keep cable lengths as short as possible for best signal quality.
- For RS-485, use twisted pair shielded cable and terminate the bus properly if needed.
- Avoid routing power and signal lines in parallel with high-voltage cables.
- If installed outdoors, use weatherproof cable glands and seal unused wires.

6. Communication Protocols

The HTS-2 / HTBS-2 supports multiple digital communication protocols to ensure compatibility with a wide range of data acquisition systems:

- Modbus RTU, Modbus ASCII, continuous ASCII (RS-485)
- SDI-12
- USB

Each protocol can be selected via USB setup see section 7 for details.

6.1 Modbus protocol

This sensor communicates using the Modbus protocol over an RS-485 interface, and operates as a Modbus slave device.

Modbus is a widely adopted, open communication protocol and maintained by the Modbus Organization (www.modbus.org). It is a de facto standard for industrial and environmental sensor integration

6.1.1 Modbus RTU

Protocol Details:

- Protocol version: Modbus Application Protocol Specification V1.1b3
- Communication model: Master-slave
- Transmission mode: RTU (Remote Terminal Unit)
- Physical interface (model-dependent):
  - RS-485 (2-wire, half-duplex: A/B differential pair)
- Byte order: Big-Endian (MSB first)
- Data format: Binary
- Error checking: 16-bit CRC (Cyclic Redundancy Check)

Each Modbus RTU message consists of the following elements:

1. Slave address
2. Function code
3. Data (registers or commands)
4. CRC checksum

The sensor only responds to direct queries from a Modbus master and does not send unsolicited data. This ensures deterministic and reliable communication within multi-device RS-485 networks.

6.1.2 Modbus ASCII

Protocol Details:

- Protocol version: Modbus Application Protocol Specification V1.1b3
- Communication model: Master-slave
- Transmission mode: ASCII (American Standard Code for Information Interchange)
- Physical interface (model-dependent):
  - RS-485 (2-wire, half-duplex: A/B differential pair)
- Message framing:
  - Start character: :
  - Payload: ASCII-encoded hexadecimal characters
  - End characters: Carriage Return + Line Feed (CR LF)
- Error checking: LRC (Longitudinal Redundancy Check)

Each Modbus ASCII message consists of:

1. A start delimiter (:)
2. The slave address
3. The function code
4. The data, encoded as ASCII hexadecimal
5. An LRC checksum
6. A message terminator (CR LF)

Compared to RTU mode, ASCII mode provides greater readability and ease of debugging, but at the cost of lower data throughput.

The sensor only responds to Modbus master requests and remains silent otherwise.

6.1.3 Modbus Commands

- Read Holding Registers: 0x03 (descriptive data register)
- Read Input Register: 0x04 (descriptive data register)
- Write Single Register: 0x06 (device parameter register

Modbus Function Codes 0x03, 0x04 and 0x06

- 0x03 – Read Holding Registers:
  This function code is used to read holding registers, which are typically read/write and contain operational data such as configuration values, setpoints, counters, or calculated results. These registers are commonly addressed from range 40001 onward in Modbus conventions.
- 0x04 – Read Input Registers:
  This function code is used to read input registers, which are typically read-only and contain real-time data such as sensor readings (e.g., voltage, temperature, or current). These registers are commonly addressed from range 30001 onward in Modbus conventions.
- 0x06 – Write Single Register:
  This function code is used to write a single value to a holding register. Holding registers are read/write and typically store configuration parameters or control values (e.g., setpoints, thresholds). These registers are usually addressed from 40001 onward.

Logical vs. Protocol-Level Addresses

Modbus documentation and software tools often reference logical register numbers, such as 30201. However, the actual Modbus protocol transmits zero-based addresses relative to the register type.
For example:

- Logical Address: 30201 (Input Register)
- Function Code: 0x04
- Protocol Address (offset): 30201 – 30001 = 200 → sent in frame as 0x00C8

The value 200 is the zero-based address used in the Modbus message. It must be interpreted in the context of the selected function code.

6.1.4 Registers Values (0x03/0x04)

Register	Sensor parameter name	Unit	Divisor	Data type	Access
200	Realtime Pressure High	Pa	10	UINT16	Read Only
201	Realtime Pressure Low	Pa	10	UINT16	Read Only
202	Realtime Temperature	°C	100	INT16	Read Only
203	Realtime Humidity	Rh%	100	UINT16	Read Only
204	Dew Point	°C	100	INT16	Read Only
205	Enthalpy	kJ/kg	100	UINT16	Read Only
206	Wet-Bulb-Temperature	°C	100	INT16	Read Only
207	Heat Index	°C	100	INT16	Read Only
208	Absolute Humidity	g/m^3	100	UINT16	Read Only

Register 200 and 201 only available for HTBS-2

Note: *The HTS-2 / HTBS-2 supports selectable Temperature units, including: degrees Celsius, degrees Fahrenheit and Kelvin.*

Note: *The HTBS-2 supports selectable pressure units, including: hPa, mbar, bar, mmHg, Torr, atm, psi, and Pa.*

Note: *All register addresses in this document refer to the zero-based Modbus register addresses used in protocol communication. Some tools may display them as one-based (e.g. address 200 shown as "Register 201").*

6.1.5 Modbus RTU Examples (0x03/0x04)

Master Request

Slave Address	Function	Start Address	Quantity Of Regs	CRC
01	04	00 CA (202)	00 01	F0 35

->

Slave Response

Slave Address	Function	Byte Count	Data Bytes	CRC
01	04	02	A439 (2212)	AC b6

The master requests the current temperature from register 202, reading 1 registers. The slave responds in 1 × 16-bit words (big-endian).

Note: *Customers can use a Modbus RTU request to read multiple registers at once. For example, the entire range from address 200 to 208 can be accessed in a single Read Input Registers (0x04)request.*

6.1.6 Modbus Diag. Registers (0x03/0x04)

Modbus Diagnostics / MB State Registers

The device provides a dedicated diagnostic register block (“MB states”) that exposes internal Modbus communication statistics and the last processed request information. These registers are intended for commissioning, debugging, and field troubleshooting.

Register	Communication Counter	Data typ	Access
300	Valid requests received (CRC and framing OK) High	UINT16	Read Only
301	Valid requests received (CRC and framing OK) Low	UINT16	Read Only
302	Number of transmitted normal responses High	UINT16	Read Only
303	Number of transmitted normal responses Low	UINT16	Read Only
304	Number of transmitted exception responses High	UINT16	Read Only
305	Number of transmitted exception responses Low	UINT16	Read Only
306	Function Code 0x03 counter High	UINT16	Read Only
307	Function Code 0x03 counter Low	UINT16	Read Only
308	Function Code 0x04 counter High	UINT16	Read Only
309	Function Code 0x04 counter Low	UINT16	Read Only
310	Function Code 0x06 counter High	UINT16	Read Only
311	Function Code 0x06 counter Low	UINT16	Read Only
312	UART communication error counter High	UINT16	Read Only
313	UART communication error counter Low	UINT16	Read Only
314	Protocol resynchronization counter High	UINT16	Read Only
315	Protocol resynchronization counter Low	UINT16	Read Only
316	Illegal Function exception counter High	UINT16	Read Only
317	Illegal Function exception counter Low	UINT16	Read Only
318	Illegal Data Address exception counter High	UINT16	Read Only
319	Illegal Data Address exception counter Low	UINT16	Read Only
320	Illegal Data Value exception counter High	UINT16	Read Only
321	Illegal Data Value exception counter Low	UINT16	Read Only
322	Last received function code	UINT16	Read Only
323	Last transmitted exception code	UINT16	Read Only
324	Last requested start register address	UINT16	Read Only
325	Last quantity/value field of request	UINT16	Read Only
326	Last received slave address (0 = Broadcast)	UINT16	Read Only
327	Last internal error/status flags	UINT16	Read Only
328	Device uptime in seconds High	UINT16	Read Only
329	Device uptime in seconds Low	UINT16	Read Only

6.1.7 Holding Registers parameters (0x06)

Register	Sensor parameter name	Values	Standard	Access
0	Modbus slave Address	1-247	1	Write only
50	Baudrate	96 = 9600 192 = 19200 384 = 38400 576 = 57600 1152 = 115200	96	Write only
100	Parity	1 = even 0 = None	0	Write only
110	Power Mode	1 = always on 3 = standby	1	Write only
120	Units Temperature	1 = °C 2 = °F 3 = K	1	Write only
130	Units Pressure (HTBS-2 only)	4 = hPa 5 = mbar 6 = bar 7 = mmHg 8 = Torr 9 = atm 10 = psi 11 = Pa	1	Write only

6.1.8 Modbus RTU Example (0x06)

Master Request

Slave Address	Function	Start Address	Value	CRC
01	06	00 00 (0)	00 02	08 0b

->

Slave Response

Slave Address	Function	Byte Count	Data Bytes	CRC
01	06	00	00 00 02 (2)	08 0b

Change the address from 1 to 2.

Note: *All configuration changes made via USB, Modbus, or SDI-12 do not require a manual restart.*
The sensor automatically performs an internal reboot after applying the new settings.
During this brief restart:

- *Measurement and communication resume automatically within 11 seconds.*

6.1.9 Broadcast Function (0x06)

A broadcast is a Modbus request that is sent to the slave address 0 (Unit ID = 0x00). This message is not addressed to a single device, but to all slaves on the bus.

Note: Slaves do not send any response to broadcast messages. This prevents multiple devices from replying at the same time and causing bus collisions.

Slave Behavior for Broadcast Messages

When the slave receives a valid Modbus message with address 0, the following rules apply:

- The request is processed, provided the function code is supported and the data is valid.
- No response frame is transmitted.
- Invalid broadcast messages are silently ignored.

Supported Functions for Broadcast

Broadcast is mainly used for write operations, allowing multiple slaves to be configured or controlled simultaneously.

Note: Read functions such as 0x03 – Read Holding Registers or 0x04 – Read Input Registers are not suitable for broadcast, since no response is permitted.

6.1.10 Broadcast Example (0x06)

Master Request

Slave Address	Function	Start Address	Value	CRC
00	06	00 32 (50)	00 60	29 fc

->

Slave Response

Slave Address	Function	Byte Count	Data Bytes	CRC

Change the baudrate to 9600.

6.1.11 Continuous ASCII Mode RS-485

Start Char	Address	Value	Term
:	1	+2212+5534+1013123 (22,12°C, 55,34Rh, 1013,123hPa)	<CR><LF>

The device supports a continuous ASCII output mode, which can be enabled via the USB interface.

When activated, the sensor automatically transmits an ASCII-formatted string at the configured transmission interval, without requiring a Modbus or command-based request.

This mode is ideal for systems that need real-time data streams (e.g., data loggers, terminal displays, or microcontrollers).

- The mode and transmission interval can be configured via USB.
- Refer to Directory 7 – Interface Settings in the USB configuration menu for detailed options and parameter definitions.

Power Mode Recommendation

⚠️ ***Important:*** *If the selected transmission interval is 5 seconds or less, we recommend enabling the Normal Power Mode to ensure reliable operation and fast response times. For intervals greater than 5 seconds, the device can safely operate in Sleep Mode to reduce power consumption during idle periods. Power mode settings can be configured under USB.*

6.1.12 RS-485 Sleep Mode

The sensor supports a low-power Sleep Mode to reduce energy consumption during periods of inactivity. This mode is particularly relevant when operating via RS-485 .

Behavior in Sleep Mode

When in Sleep Mode, the sensor's communication interface enters a passive state and does not respond immediately. It must first be woken up by activity on the bus. The following applies:

- The sensor can be woken up by any signal on the bus — it does not require a valid Modbus request.
- Even a brief break condition, a malformed message, or an empty polling attempt is sufficient to trigger wake-up.
- After detecting activity, the sensor becomes fully responsive again after approximately 300 ms.
- The second message (i.e., the actual request) will then be answered normally.

Communication Timing & Recommendations

- When Sleep Mode is enabled, allow at least 15 seconds of bus inactivity between requests to ensure the sensor has time to enter low-power mode.
- If multiple slaves are connected on the same RS-485 bus, it is sufficient to wake only one device (e.g., the first addressed slave). All other connected sensors will detect the bus activity and wake up in parallel.
- Starting from baud rates ≥ 57600, wake-up timing is more sensitive and depends on bus structure and line length.
  In such cases, additional delays or retries may be necessary to ensure stable communication

6.2. SDI-12

This sensor communicates using the SDI-12 protocol (Serial Data Interface at 1200 Baud), compliant with the SDI-12 Specification Version 1.4.
It supports both standard commands and a range of extended functions, enabling flexible integration into environmental monitoring systems.

The sensor responds to all mandatory commands defined by the SDI-12 standard, such as measurement initiation (aM!), concurrent measurements (aC!), and data retrieval (aD0!, aD1!, etc.).
In addition, it implements optional extended commands, including:

- Additional measurement commands (M1!, M2!, …) to access stored statistical values (e.g., minimum, maximum, average pressure over the past 24 hours)
- CRC-enabled commands (aMC!, aCC!, etc.) that return data with a 16-bit CRC checksum for enhanced communication reliability
- Self-verification (aV!) which provides a simple status response confirming internal function checks
- Sensor discovery (?!), address changes, and other utility functions required for sensor configuration

All command formats and response structures follow the SDI-12 1.4 guidelines. This ensures compatibility with any data logger or data acquisition system that implements the SDI-12 standard.

For detailed information on the protocol, timing, and electrical requirements, please refer to the official SDI-12 documentation available at: www.sdi-12.org

6.2.1 SDI-12 Commands

This sensor supports standard SDI-12 commands as defined in version 1.4 of the specification.
In addition to basic measurement and identification functions, the sensor provides access to stored statistical pressure data—such as minimum, maximum, and average values over the last 24 hours—via extended measurement commands.

For improved communication reliability, the sensor also supports CRC-enabled command variants, which return measurement data with a 16-bit checksum.
Configuration and utility features such as address assignment and sensor discovery are fully supported.

Name	Command (a = slave Address)	Response
Acknowledge Active	a!	a<CR><LF>
Send Identification	aI!	
Change Address	aAb!	b<CR><LF>
Address Query	?!	a<CR><LF>
Start Measurement*	aM!	atttn<CR><LF>
Start Measurement with CRC*	aMC!	atttn<CR><LF>
Send Data	aD0!	a<values><CR><LF> or a<values><CRC><CR><LF>
Start Measurement Register 1-7	aM1!…aM7!	atttn<CR><LF>
Start Measurement Register 1-7 with CRC	aMC1!…aMC7!	atttn<CR><LF>
Start Verification*	aV!	
Start Concurrent Measurement	aC!	atttnn<CR><LF>
Start Concurrent Measurement with CRC	aCC!	atttnn<CR><LF>
Additional Concurrent Measurement Register 1-7	aC1!…aC7!	atttnn<CR><LF>
Additional Concurrent Measurement Register 1-7 with CRC	aCC1!…aCC7!	atttnn<CR><LF>
Change Units	aX1!…aX3!	au<CR><LF>

*This command results in a service request (a<CR><LF>)

6.2.1.1 SDI-12 Register

Command (a = slave Address)	Response Value/s
aM!, aMC!, aC!, aCC!	Realtime Temperature, Realtime Humidity, Realtime Pressure
aM1!, aMC1!, aC1!, aCC1!	Dew Point Enthalpy Wet-Bulb-Temperature Heat Index Absolute Humidity

6.2.1.2 Acknowledge Active Command (a!)

This command is used to ensure that a sensor is responding to a data recorder or another SDI-12 device. It asks a sensor to acknowledge its presence on the SDI-12 bus.

Examples of the Acknowledge Active Command (a!):

Command Recorder	Response Sensor a (address 1)	Response Sensor b (address 2)
1!	1<CR><LF>	
2!		2<CR><LF>

6.2.1.3 Send Identification Command (aI!)

This command is used to query sensors for their SDI-12 compatibility level, model number, and firmware version number.

Examples of the Send Identification Command (aI!)

Command Recorder	Response Sensor a (address 1)	Response Sensor b (address 2)
1I!	114METSENSEHTS2V1125W170000001<CR><LF>	
2I!		214METSENSEHTS2V1125W170000002<CR><LF>

Address	SDI-12 Version	Manufacturer	Model	Software Version	Serial Number
1	1.4	METEOSENSE	HTS2	V11	25W170000001

6.2.1.4 Address Query Command (?!)

Address Query Command (?!) in SDI-12 is used to discover sensors on the bus.

Examples of the Address Query Command (?!)

Command Recorder	Response Sensor a (address 1)	Response Sensor b (address 2)
?!	1<CR><LF>	
?!		2<CR><LF>

6.2.1.5 Change Address Command (aAb!)

This command changes the address of a sensor.

Examples of the Change Address Command (aAb!)

Command Recorder	Response Sensor a (address 1 -> address 2)
1A2!	2<CR><LF>

6.2.1.6 Start Measurement Command (aM!)

This command instructs the sensor to begin a measurement.
However, the sensor does not return the measurement data immediately.
Instead, it responds with the time required to complete the measurement and the number of values it will generate.
To retrieve the measurement(s), the Send Data (D0!) command must be issued.

Examples of the Start Measurement Command (aM!)

Command Recorder	Response Sensor a (address 1)
1M!	10022<CR><LF> *„2 values available in 2 seconds"*
1D0!	1+22.21+55.34<CR><LF> *„Sensor answer: 22,21°C, 55,34RH%"*

6.2.1.7 Start Concurrent Measurement Command (aC!)

This command instructs the sensor to perform a concurrent measurement.
A concurrent measurement means the sensor takes its readings at the same time as other SDI-12 sensors on the bus. However, the sensor does not return any measurement data immediately after this command.
Instead, it responds with the time required to complete the measurement and the number of values it will produce.
To retrieve the actual measurement data, a Send Data (D0!) command must be issued afterwards.

Examples of the Start Concurrent Measurement Command (aC!)

Command Recorder	Response Sensor a (address 1)	Response Sensor b (address 2)
1C!	100201<CR><LF> *„1 value available in 2 seconds"*	
2C!		200201<CR><LF> *„1 value available in 2 seconds"*
1D0!	1+22.21+55.34<CR><LF> *„Sensor answer: 22,21°C, 55,34RH%"*	
2D0!		2+22.45+55.54<CR><LF> *„Sensor answer: 22,45°C, 55,54RH%"*

6.2.1.8 Additional Measurement Commands (aM1!)

Additional M commands provide a way to request different temperature and humidity data stored in the sensor's registers.
For example, the primary M command could return the current temperature and humidity measurement, while aM1, aM2, etc., provide access to specific historical or statistical data. These additional commands may return the minimum, maximum, or average temperature and humidity recorded over the last 24 hours. This allows the data recorder to selectively retrieve different types of temperature and humidity information without triggering a new measurement cycle.

Examples of the Additional Measurement Commands (aM1!

Command Recorder	Response Sensor a (address 1)
1M1!	10025<CR><LF> *„5 value available in 2 seconds"*
1D0!	1-1.83+24.01+8.93+26.96+43.97<CR><LF> *„Sensor answer:* *Dew Point: -1.83 °C* *Heat Index: 24.01 °C* *Wet-Bulb Temp: 8.93 °C* *Enthalpy: 26.96 kJ/kg* *Absolute Humidity: 3.97 g/m3*

6.2.1.9 Additional Concurrent Measurement Commands (aC1!)

Additional aC1! commands work similarly to the standard aC! command,
but provide access to different types of stored temperature and humidity data, such as minimum, maximum, or average values over the last 24 hours.

Examples of the Start Additional Concurrent Measurement Commands (aC1! . . . aC7!)

Command Recorder	Response Sensor a (address 1)	Response Sensor b (address 2)
1C4!	100205<CR><LF> *„5 value available in 2 seconds“*	
2C4!		200205<CR><LF> *„5 value available in 2 seconds“*
1D0!	1-1.83+24.01+8.93+26.96+43.97<CR><LF> *„Sensor answer:* *Dew Point: -1.83 °C* *Heat Index: 24.01 °C* *Wet-Bulb Temp: 8.93 °C* *Enthalpy: 26.96 kJ/kg* *Absolute Humidity: 3.97 g/m3*	
2D0!		2-1.83+24.01+8.93+26.96+43.97<CR><LF> *„Sensor answer:* *Dew Point: -1.83 °C* *Heat Index: 24.01 °C* *Wet-Bulb Temp: 8.93 °C* *Enthalpy: 26.96 kJ/kg* *Absolute Humidity: 3.97 g/m3*

6.2.1.10 Start Verification (aV!)

The aV! (Start Verification) command instructs the sensor to perform an internal self-check and prepare a verification response.
In this implementation, the sensor always responds with a single value of +1 to indicate that the verification was completed successfully.
The result can be retrieved using the standard D0! command.

Examples of Start Verification (aV!)

Command Recorder	Response Sensor a (address 1)	
1V!	10021<CR><LF>	*„1 value available in 2 seconds“*
1D0!	1+1<CR><LF>	*„Sensor answer: 1“*

6.2.1.11 Change Units (aX1!…aX11!)

The change units command allows switching the output unit.

The available units are:

1 = degrees Celsius,
2 = degrees Fahrenheit,
3 = Kelvin
4 = hPa
5 = mbar
6 = bar
7 = mmHg
8 = Torr
9 = atm
10 = psi
11 = Pa

Examples of Change Units (aX1!…aX11!)

Command Recorder	Response Sensor a (address 1)	
1X1!	11<CR><LF>	*„change unit to °C“*
1X2!	15<CR><LF>	*„change unit to °F“*

⚠️ ***Important:*** *When changing the unit of measurement (e.g., from °C to K etc.), the device will automatically clear its internal data memory. This is necessary because changing the unit affects the numeric formatting and string length of the stored values.*

6.2.1.12 Requesting a Cyclic Redundancy Check (CRC)

To improve error detection, certain SDI-12 commands request measurement data with a 16-bit CRC (Cyclic Redundancy Check) appended.
Using commands like aMC!, aMC1! and aCC!, aCC1!, the sensor returns the measurement data with a CRC value included in the response to the D command.
This provides increased reliability when transferring data.

6.2.2 Continuous ASCII Mode SDI-12

Start Char	Address	Value	Term
:	1	+22.21+55.65 (22,21°C, 55,65RH%)	<CR><LF>

The device supports a continuous ASCII output mode, which can be enabled via the USB interface.
When activated, the sensor automatically transmits an ASCII-formatted string at the configured transmission interval, without requiring a Modbus or command-based request.

This mode is ideal for systems that need real-time data streams over a serial USB connection (e.g., data loggers, terminal displays, or microcontrollers).

- The mode and transmission interval can be configured via USB.
- Refer to Directory 7 – Interface Settings in the USB configuration menu for detailed options and parameter definitions.

Power Mode Recommendation

⚠️ ***Important:*** *If the selected transmission interval is 5 seconds or less, we recommend enabling the Normal Power Mode to ensure reliable operation and fast response times. For intervals greater than 5 seconds, the device can safely operate in Sleep Mode to reduce power consumption during idle periods. Power mode settings can be configured under USB.*

6.2.3 SDI-12 Sleep Mode

The sensor supports Sleep Mode during operation over the SDI-12 interface. This helps reduce power consumption between measurement or polling intervals, especially in battery-powered or low-energy environments.

Behavior in Sleep Mode

- In SDI-12 operation, the sensor automatically enters low-power sleep mode after completing a command or response sequence.
- The sensor does not require an explicit wake-up signal like in RS-485 or RS-232.
- The SDI-12 protocol itself handles wake-up through the standard address + command pattern (e.g., 0M!, 0D0!, etc.).

Communication Timing Recommendation

⚠️ ***Important:*** *To ensure proper sleep behavior, the SDI-12 bus should remain idle for at least 10 seconds between commands.*
This allows the sensor to reliably enter and remain in low-power mode until the next request. There are no other restrictions regarding wake-up timing or retries. The sensor will always respond to valid SDI-12 commands, regardless of how long it has been idle.

7. USB Configuration

Your HTS-2 / HTBS-2 is configurable via USB using a **USB to RS-485 Converter.**

This type of USB Converter is widely supported and requires no driver installation on most systems:

- Windows (COMx)
- macOS (/dev/tty.usbmodemXXXX)
- Linux (/dev/ttyACM0, /dev/ttyUSBx)

Configuration via Serial Terminal

Before configuration, the RS-485 lines must be connected between the sensor and the RS-485-to-USB converter.

After connecting the sensor to the computer via the USB converter, it can be configured using any standard serial terminal application.
These tools allow commands to be sent directly to the sensor via the virtual serial interface.

Recommended terminal programs:

- Windows:
    - PuTTY
    - Tera Term
    - https://serialmonitor.org/
- macOS:
    - CoolTerm
    - https://serialmonitor.org/
- Linux:
    - minicom, screen, or gtkterm
    - https://serialmonitor.org/

Note: All configuration changes made via USB, Modbus, or SDI-12 do not require a manual restart.
The sensor automatically performs an internal reboot after applying the new settings.
During this brief restart:

- *Measurement and communication resume automatically within 11 seconds.*

7.1 USB Setup

Setup Mode Access Instructions

1. To access the setup mode, the terminal program must be configured to a baud rate of 9600.

2. First, disconnect the sensor from the power supply.
   Then reconnect the power supply to the sensor.

3. After power-up, the sensor sends a data string to the terminal and waits 10 seconds for the password to be entered.
   Enter the password 1234 to access the setup mode.

4. If no password is entered within 10 seconds, or if an incorrect password is entered, the sensor will boot in normal operating mode.

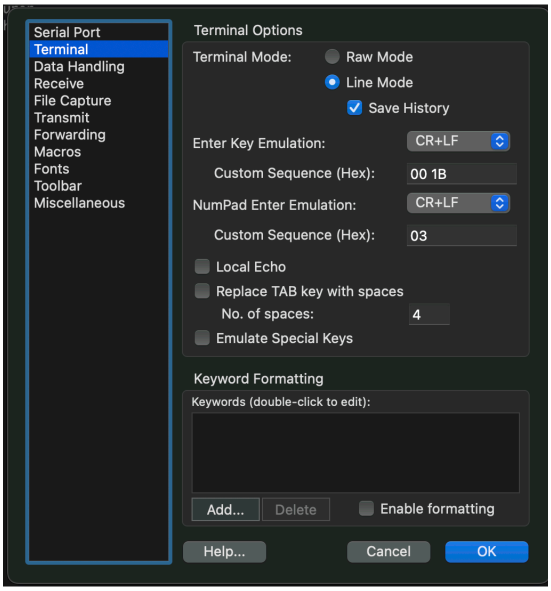
5. It is important to properly exit the setup mode after configuration. If the setup mode is not terminated correctly, the sensor may remain in setup mode.

Terminal Configuration

To ensure proper handling of input and line breaks, it is recommended to enable line mode (also called "local line editing" or "line mode") in your terminal program.

This ensures that:

- Numbers are not sent character-by-character
- The sensor only processes input after the full line is submitted with Enter



⚠️ **Important:** When entering setup mode, the baud rate is always set to 9600 by default.
For this reason, you must configure your terminal program to **9600 baud** before connecting to the device.
If the baud rate is not set correctly, communication with the device will not work properly and no readable data will be displayed.

Windows:

To configure or communicate with the sensor via USB, follow these steps to correctly identify the assigned serial port.

1. Connect the Device

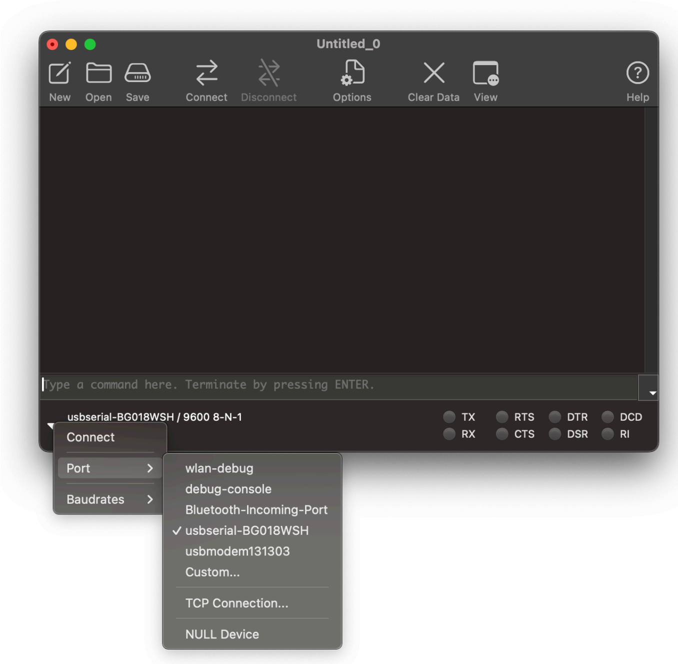
- Plug the RS-485 converter into your computer
- 2. Identify the COM Port (Windows)

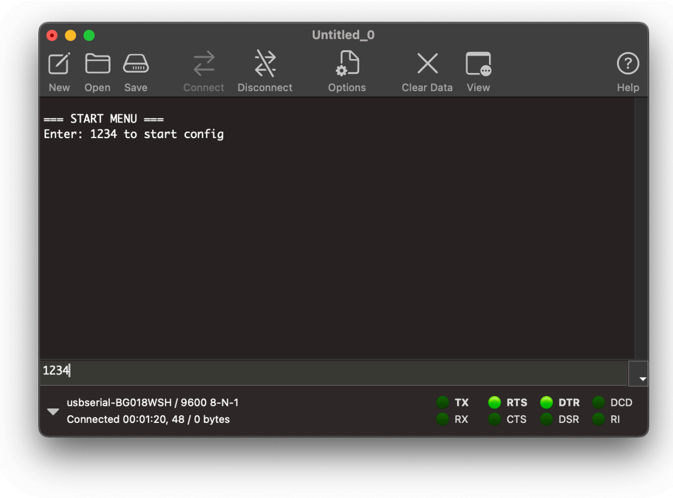
- Open the Device Manager (devmgmt.msc).
- Expand the section "Ports (COM & LPT)".
- Look for a device named:
  → usbserial (COMx)
  where x is the assigned COM port number.

Example: usbserial-BG01WSH (COM4)

You can now select this COM port in your Modbus/terminal software or sensor configuration tool.

Windows/macOS CoolTerm:





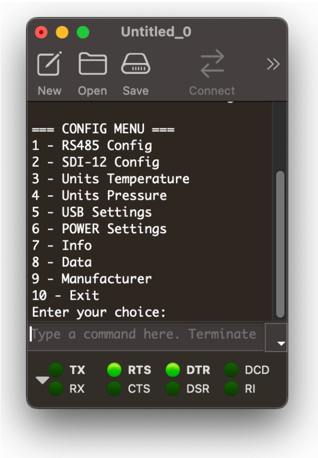
7.2 Menu Navigation

The sensor provides a simple text-based configuration menu via USB, which is accessed using any standard serial terminal program (e.g., Tera Term, PuTTY, CoolTerm).

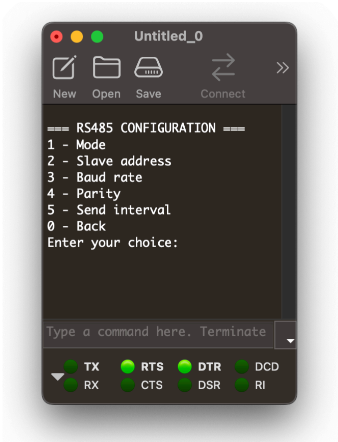
Input Method

- Menu navigation is controlled exclusively by entering numbers, followed by pressing the Enter key.
- For example, typing 2 and pressing Enter will open submenu item 2.

Example: Changing the Modbus Address via RS-485



1->



2->

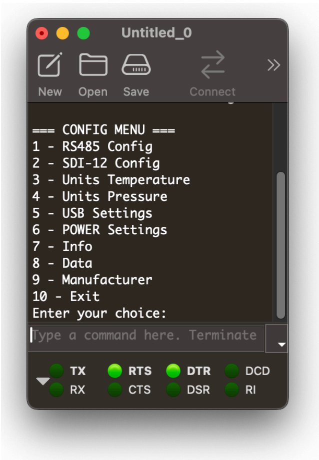
2

7.3 USB Data Streaming

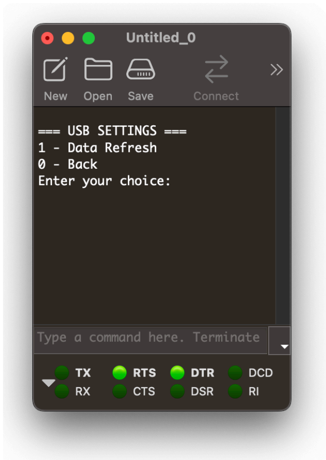
The sensor supports real-time data streaming via USB, allowing continuous transmission of measurement values.
This mode is particularly useful for:

- Live monitoring
- Serial data logging
- Integration with microcontrollers or software tools (e.g. Python, LabVIEW, terminal apps)

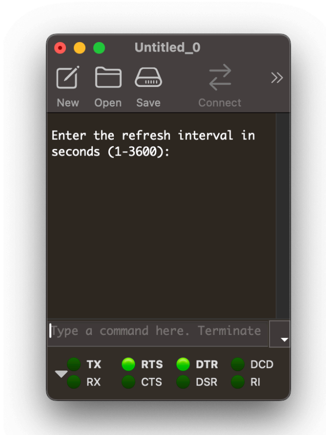
Example: Start USB Streaming



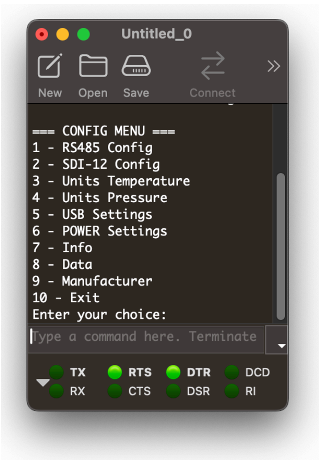
5->



1->



1->



8->

By default, the data is refreshed every 1 second.
You can configure the refresh interval to any value between 1 and 3600 seconds, depending

Note: Example screenshot showing data stream setup (pressure values shown as example)

8. Maintenance & Calibration

The HTS-2 / HTBS-2 sensor is largely maintenance-free. If needed, the sensor surface can be cleaned using a lint-free, slightly damp cloth. Do not use abrasive materials or harsh cleaning agents.

A check-up and recalibration should be carried out at least every two years by the manufacturer or an authorized service provider. More frequent calibration is typically not necessary, as the sensor features an integrated self-test function.

This self-test continuously monitors sensor performance. If the sensor detects a deviation that requires recalibration, it will indicate this via its LED status indicator. Please refer to the section *LED Codes* for detailed information on when immediate recalibration is necessary.

9. Troubleshooting

Symptom	Possible Cause	Recommended Action
Sensor does not respond to request	USB misconfiguration or wrong device settings	Check USB configuration settings
Sensor does not respond via Modbus (holding reg 0x06)	Sensor may be in sleep mode	Check USB configuration and ensure Power Mode = Normal
Sensor shows no activity at all	Startup failure or no LED feedback	Restart device; check if both red and blue LEDs flash at startup. If not: check USB config or contact support

9.1 Troubleshooting – LED Error Codes

The HTS-2 / HTBS-2 sensor is equipped with a red status LED to indicate error conditions at startup or during operation. The following blink patterns can help diagnose potential issues:

LED Pattern Red	Meaning	Device Behavior	Recommended Action
- - - —	Sensor 1 failure	Device still outputs data	Contact support
- - - — —	Sensor 2 failure	Device still outputs data	Contact support
— — —	One sensor significantly out of tolerance	Sensor still active	Recalibration recommended; contact support
———————	Two or more sensors out of tolerance, or invalid readings	Data may be inaccurate or corrupted	Contact support

10. Accessories / Spare Parts

Nr.	Part Name	Order Number
1	5-Pole M12 A Connector Female	CON-M12A-5
2	Sensor Circuit Board HTS-2	HTS-2-SPCB-1
3	Sensor Circuit Board HTBS-2	HTBS-2-SPCB-1
4	Filter	HTS-2—T05

11. Disposal and Recycling

The HTS-2 / HTBS-2 contains electronic components. It must not be disposed of with regular household waste.

At the end of its service life, the HTS-2 / HTBS-2 must be disposed of in accordance with local laws and environmental regulations for electronic equipment and batteries.

- Please take the device to an authorized collection point for electronic waste.
- The built-in battery must be handled and recycled separately in accordance with local battery recycling standards.
- Do not incinerate or expose the battery to fire or high temperatures.

As a manufacturer, we are registered under the German WEEE system (Stiftung EAR) and comply with all obligations regarding product take-back and recycling.

WEEE-Reg.-Nr. DE 21710845

By disposing of the HTS-2 / HTBS-2 correctly, you help protect the environment and support the sustainable reuse of valuable materials.

12. Contact & Support

For questions, technical support, or warranty claims regarding the HTS-2 / HTBS-2 please reach
out to us:

MeteoSense
Support Hotline (Germany): +49 (0) 176 47338802
📧 Email: support@meteosense.de
🌐 Website: www.meteosense.de

Support hours:
Mon–Fri, 9:00–17:00 (CET, UTC+1 / UTC+2 during summer time)

What we need from you:
When contacting support, please include the following details to help us assist you faster:
- Serial number of the Sensor
- Description of the issue or error behavior
- A brief summary of any troubleshooting steps you've already tried
- (Optional) Photos or short video showing the problem

We aim to respond to all support queries within 24 hours on business days.

S/N:

Notes:

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