User Manual

SN-ERHTP-10-XX

Version 1.1

REVISION HISTORY

Version	Date	Notes
1.0	09 Jan 2020	Initial Release
1.1	01 Oct 2020	Updated Sensor Maintenance section

Table of Contents

RELATIVE HUMIDITY, TEMPERATURE AND BAROMETRIC PRESSURE SENSOR (RHTP) WITH SINGLE-WIRE INTERFACE

The Evvos RHTP sensor is designed to provide high-quality environmental data, real-time measurements and calculation of multiple parameters.

Applications

- Environmental monitoring
- Weather forecasting solutions
- Precision agriculture & farming
- Industrial data acquisition
- Precision agriculture/farming
- Cold chain and HVAC applications
- Internet of things

Measured and calculated parameters

- Ambient temperature
- Relative humidity
- Barometric pressure
- Absolute humidity
- Dew point
- Vapor pressure
- Saturated vapor pressure

Spec highlights

- Stainless steel enclosure and filter cap
- Waterproof protection of internal electronics—only sensor elements are exposed
- UV-protected and oil-resistant flexible cable
- Multiple electrical interfacing options and combinations
- Low-power consumption suitable for battery-powered applications

Description

The RHTP sensor is a robust, high-accuracy, digital probe. It measures multiple environmental parameters. Due to its low power consumption, versatile electrical interfacing options and wide power supply range, the probe is compatible with a variety of battery-operated dataloggers and industrial data acquisition systems. A stainless-steel enclosure in combination with weatherproof electronic circuitries and durable cable, ensure proper long-term operation even in harsh outdoor and industrial conditions. For improved reliability and accuracy, the probe is equipped with a power-adjustable heater to prevent condensation on humidity sensor and deterioration of its data quality.

Electrical Interfacing Options

- Datalogger version: single-wire

Absolute Maximum Ratings

Parameter	Conditions	Min	Max	Units
Supply voltage (Vin)	@25°C	-0.3	25	V
Voltage at any interface pin	Supply voltage 5 Vdc to 24 Vdc	-0.3	5.5	V
Operating temperature range	Supply voltage 3.3 Vdc to 24 Vdc	-40	85	°C
Operation humidity range	Non-condensing environment	0	100	%
Operating pressure range	Full operating temperature range	300	20 000	hPa
Storage temperature	Non-condensing environment	-20	65	°C
Storage humidity	Non-condensing environment	-	60	%
Storage pressure	Non-condensing environment	300	1100	hPa
ESD on any interface pin	Protection by 170 W TVS diode	-	30	kV
ESD on voltage supply pin	Protection by 350 W TVS diode	-	30	kV
Bending radius of cable	@25°C	15	-	mm

Recommended Operating Conditions

Parameter		Min	Nom	Max	Units
Supply voltage (Vin)	@25°C, single-wire interface	-	3.3	12	Vdc
I/O voltage on any interface pin	Single-wire interface	2.8	3.0	3.3	Vdc
Operating temperature range	Humidity range: non-condensing	-20	25	65	°C
Operation humidity range	Temperature range 0°C to 65°C	20	-	80	%
Operating pressure range	Temperature range 0°C to 65°C	700	-	1300	hPa

NOTE:
Maximum accuracy and life expectancy are achieved under recommended operating conditions.

Electrical Characteristics of Probe

Parameter	Conditions	Min	Nom	Max	Units
Supply voltage (Vin)	All electrical interfaces except USB	3.3	12	25	Vdc
Quiescent current consumption	Full voltage supply range. Single-wire interface	1.2	1.4	2.5	mA
Shutdown current	@12 Vdc supply voltage, electrical interface dependent	20	40	200	uA
Internal voltage regulator accuracy	Full operating temperature range	-	1.4	2	%
Internal voltage regulator line regulation	Full operating temperature range, Full supply voltage range	-	-	0.4	%/V
Reset time		15	20	25	ms
Power-up time		150	200	250	ms
MCU clock frequency	Full supply voltage range	32	8000	16000	kHz
Max sampling rate	. Single-wire interface	0.5	1	10	S/s
Non-volatile memory write/erase cycles		100 000	-	-	cycles
Heater current consumption	Full supply voltage range	-	60	100	mA
Heater duty cycle adjustment	Dependent on supply voltage	0	-	75	%
Heater output power	@12 Vdc supply voltage	-	200	400	mW

Parameter	Conditions	Min	Nom	Max	Units
$V_{PULL-UP}$ (1)	Pull-up resistor by the host system	3	3.3	5.5	V
V_{LOG-HI} (2)		2.7	2.8	-	V
V_{LOG-LO} (3)		-	0.4	0.6	V
$V_{PULL-DN}$ (4)	1m standard length of cable	-	-	VLOG-LO	V

NOTE:
(1) $V_{PULL-UP}$ – voltage of data line at default state with no data transmission active
(2) V_{LOG-HI} – minimal required voltage for the sensor to detect a logic HIGH level
(3) V_{LOG-LO} – maximal allowed voltage for the sensor to detect a logic LOW level
(4) $V_{PULL-DN}$ – voltage of data line at pull-down state during active data transmission

Sensing Characteristics

Parameter	Conditions	Min	Max	Units
Absolute accuracy of relative humidity	Full temperature range	-3	+3	%
Absolute accuracy of barometric pressure	Full temperature range	-1.7	+1.7	hPa
Absolute accuracy of temperature (standard option)	0°C to 60°C	-0.5	+0.5	°C
	-20°C to 0°C	-0.65	+0.65	°C
	-40°C to -20°C	-0.75	+0.75	°C
Relative accuracy of voltage measurement for V_{MCU} (3)	Full temperature range	-6	+6	%
Relative accuracy of voltage measurement for V_{SEN} (4)	Full temperature range	-6	+6	%
Relative accuracy of voltage measurement for V_{IN} (5)	3.3Vdc < Vin < 24Vdc, full temperature range	-6	+6	%
Precision of temperature (standard option)	Calculation error included	-	0.02	°C
Precision of humidity	Calculation error included	-	0.07	%
Precision of pressure	Calculation error included	-	0.8	hPa
Conversion time	All primary parameters combined: temperature, humidity, pressure	500	1000	ms

NOTE:
(1) V_{MCU} – supply voltage for the onboard MCU
(2) V_{SEN} – supply voltage for the onboard sensing blocks
(3) V_{IN} – supply voltage for probe

Cable and Enclosure

Parameter	Value	Unit
Cable capacitance	160	pF/m
Cable inductivity	650	pH/m
Conductor stranding	0.14	mm^2
Cable diameter	4.6	mm
Minimal bending radius of cable	45	mm
UV resistant	Yes	-
Chemicals resistant	Yes	-
Cold resistant	Yes	-
Halogen-free	Yes	-
Shield	Yes	-
Sheath material	TPE	-
Sheath color	Black	-
Enclosure material	Stainless steel	-

Sensor Wiring

Wire function (interface-specific)	Wire color	Note
+V (system power supply)	Brown	
-V (system GND)	White	
-	Grey	Do not connect to any pin
SDA (single-wire IO)	Yellow	
-	Green	Do not connect to any pin

Single-Wire Interface

Brief Technical Description

Single-wire is a low-power half-duplex single-ended asynchronous serial interface that allows bidirectional data transfer over a single-line data bus. It is an effective interfacing solution for MCU-based host data acquisition systems with limited input/output capabilities. A host MCU is always the first to initiate communication and the RHTP sensor provides its measurement values as a response. Electrical communication layer is based on open-drain (open-collector) bi-directional I/O-port with a pull-up resistor provided by the host system. Recommended values for the pull-up resistor vary in the range 2 kΩ – 5.6 kΩ and depend on the length of the cabling between a host and a sensor. Longer the cable, lower the value of the pull-up resistor. At a cable length of 1m the recommended value for ensuring correct communication with single-wire interfaced RHTP sensor is 5 kΩ.

Schematics

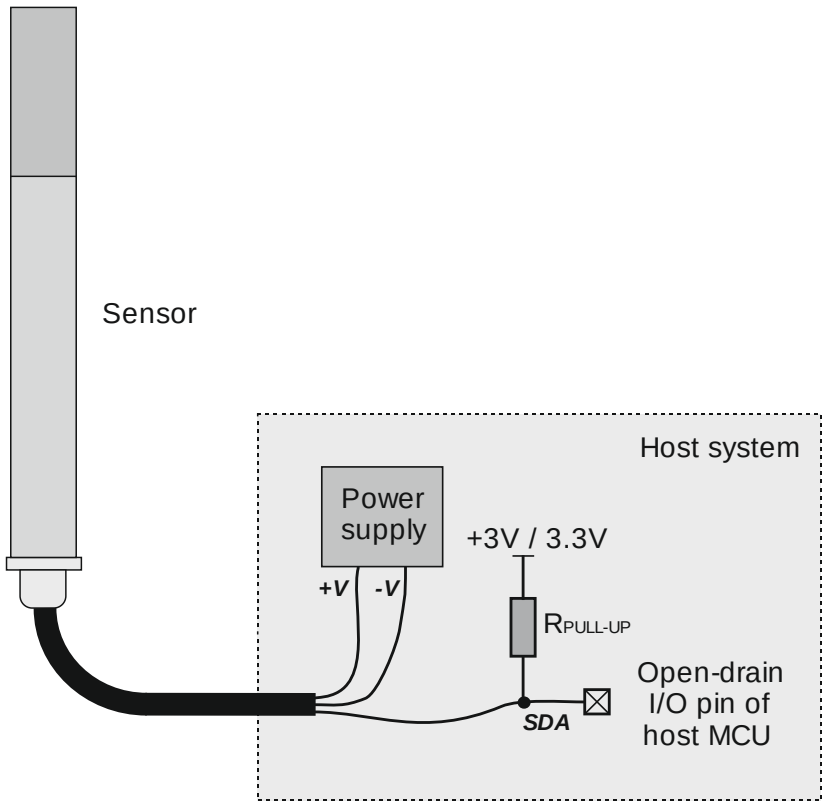


Fig. 1 Electrical connections between RHTP and a host data acquisition system

Data transfer protocol

The host MCU initiates the communication with the RHTP sensor by pulling the data line low for a specific time and then releases the line (DATA REQUEST). The sensor replies by pulling the line and releasing it (START DATA) and then continues with transmission of data packages of 16-bit values for environmental parameters and a parity check. After the last data package (PARITY) the sensor generates an additional signal to flag the end of its transmission (END DATA). Data packages with measured values of the environmental parameters are always transmitted in the following order (listed from first to last):

1) RELATIVE HUMIDITY
2) AIR TEMPERATURE
3) BAROMETRIC PRESSURE
4) PARITY

Transmission of data packages starts with the most significant bit from the high byte of the value (bit 0) and ends with the least significant bit from the low byte (bit 15).

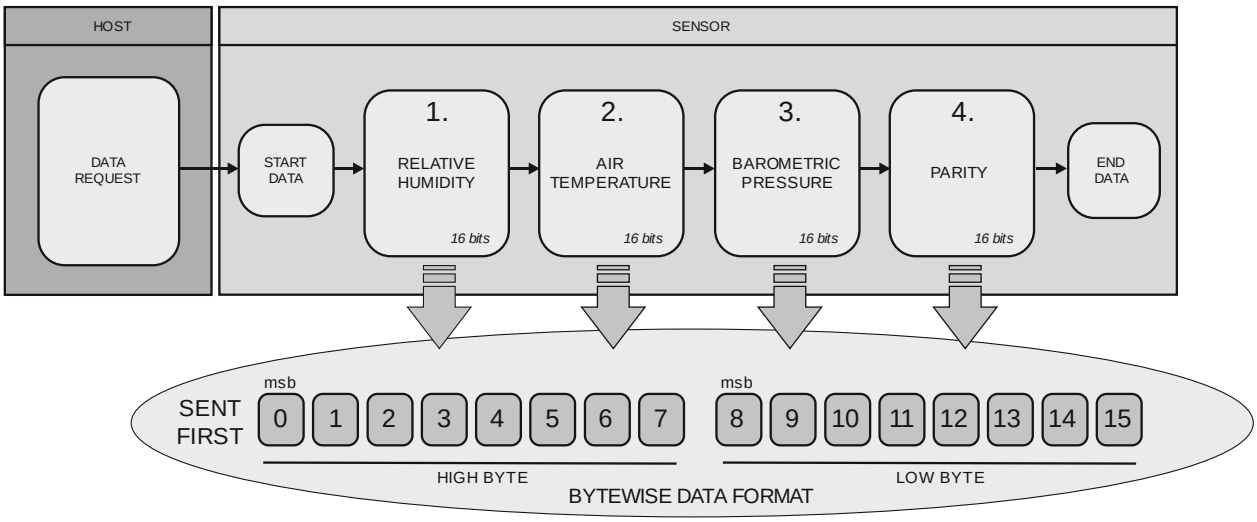


Fig. 2 Sequence of a data transmission cycle

Single-Wire Interface Timings

Single-wire is an asynchronous interface, hence, observing timings and timing tolerances closely plays crucial role for correct data reception by the host.

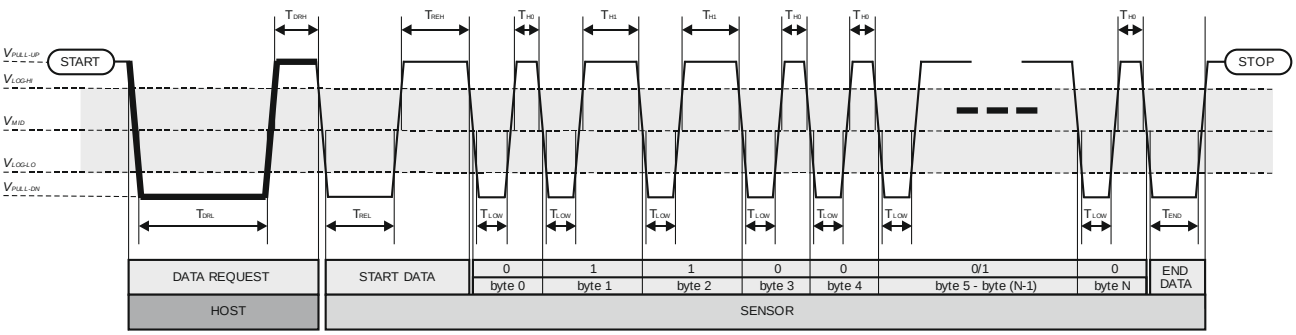


Fig. 3 Timing requirements of single-wire data transmission

Parameter	Description	Min	Nom	Max	Units
T_{DRL}	DATA REQUEST low level	800	1000	1200	µs
T_{DRH}	DATA REQUEST high level	20	30	200	µs
T_{REL}	START DATA low level	75	80	85	µs
T_{REH}	START DATA high level	75	80	85	µs
T_{LOW}	Low level for transmission of any bit	48	50	55	µs
T_{H0}	High level for transmission of “0”-bit	22	26	30	µs
T_{H1}	High level for transmission of “1”-bit	68	70	75	µs
T_{END}	END DATA low level	45	50	55	µs
T_{SMP}	Offset interval for SAMPLE of bit value			60	µs

Each bit in the data packages is encoded by two timings: a low level (T_{LOW}) and a high level (T_{H0} or T_{H1}). A low-level (V_{LOG-LO}) marks the beginning of a bit transmission. A high-level (V_{LOG-HI}) transition marks the start of T_{SMP} counting by the host system. Sampling the voltage level of the line at the end of T_{SMP} determines bit value – 0 or 1. Consecutive bits must be stored in a 16-bit buffer observing the order of their reception by the host. In order to perform correct reception of single-wire data a host must be able to measure small intervals precisely (see T_{SPM} timing).
NOTE: Reading the RHTP sensor at a rate higher than its maximal sample rate results in multiple readings of the same values.

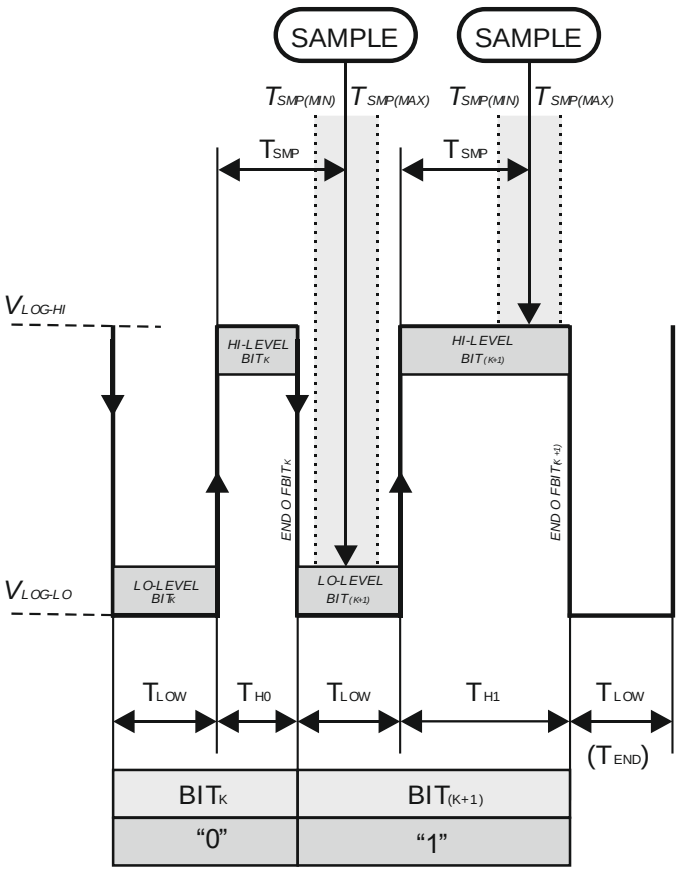


Fig. 4 Bit sampling with single-wire interface

Data Decoding

NOTE: All values below in decimal code unless explicitly noted.

RELATIVE HUMIDITY [%]

RH = (([byte 0] * 256 + [byte 1]) / 10)

AIR TEMPERATURE [°C]

Step 1: **value = ([byte 2] * 256 + [byte 3])**

Step 2A: (positive temperatures including 0.0°C): if value < 32768, then

AT = (value / 10)

Step 2B: (sub-zero temperatures): if value > 32768, then

AT = ((value – 32768) / 10)

BAROMETRIC PRESSURE [hPa]

BP = (([byte 4] * 256 + [byte 5]) / 10)

PARITY [unitless]

Parity = (([byte 0] * 256 + [byte 1]) + ([byte 2] * 256 + [byte 3]) + ([byte 4] * 256 + [byte 5]))

Example of Data Decoding

	RELATIVE HUMIDITY		AIR TEMPERATURE		BAROMETRIC PRESSURE		PARITY	
	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
BINARY	0000 0011	0101 1001	0000 0001	0011 1010	0010 0110	1100 1111	0010 1011	0110 0010
DECIMAL	857		314		9935		11106	
DECODED	**85.7 %**		**31.4 °C**		**993.5 hPa**		**11106**	

	RELATIVE HUMIDITY		AIR TEMPERATURE		BAROMETRIC PRESSURE		PARITY	
	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
BINARY	0000 0001	1100 1001	1000 0000	1101 0110	0010 0100	0010 0100	1010 0110	1011 0100
DECIMAL	457		32982		9237		42676	
DECODED	**45.7 %**		**-21.4 °C**		**923.7 hPa**		**42676**	

Sensor Maintenance

Installation Precautions

Do not connect sensor's casing to live wires.
In outdoor installations, the sensor must be mounted in a solar shield or else measurement values may not be accurate.

Cleaning and Maintenance

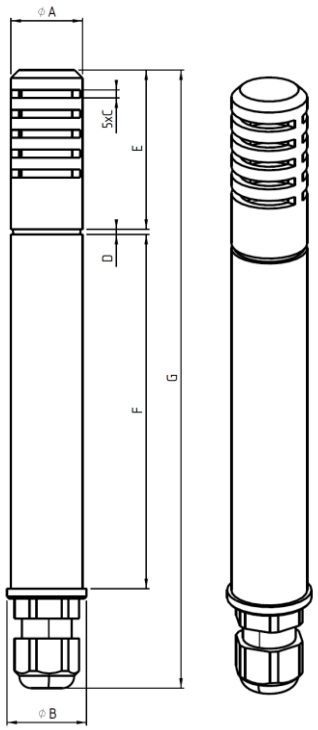
SN-ERHTP-10-XX probes do not require any unusual maintenance. However, if needed, the enclosure may be cleaned, and the filer cap should be replaced to maintain high accuracy of measurement over wide relative humidity, temperature and barometric pressure ranges.

- Never touch exposed sensing components. Any attempt to mechanically clean sensing components (brushing, rubbing) will damage them.
- Do not wash exposed electronic sensor parts, using water or any chemicals.
- Use a damp soft cloth to remove dust, mud and any dirt deposits from the exterior of the probe.
- Do not use any abrasive cleaning agents or solvents.
- The filter cap should be replaced every year if probe is installed outdoors or in dusty and polluted environment.
- Do not attempt to clean the filter cap as this will only lead to its clogging.
- Install filter cap only if it is completely dry.
- Do not touch exposed electronic parts.
- Do not remove protective filter cap for prolonged periods of sensor operation.

Compatibility

RHTP sensors are compatible with all versions of OneSense telemetry devices. Contact sales@evvos.com for more information.
Observe electrical specifications and interface requirements to ensure compatibility with third-party dataloggers.

Dimensions



Dimension	Min	Nom	Max	Unit
A	17.9	18	18.1	mm
	0.705	0.709	0.713	in
B	19.9	20	20.1	mm
	0.783	0.787	0.791	in
C	1.95	2	2.05	mm
	0.077	0.079	0.081	in
D	1.1	1.3	1.4	mm
	0.047	0.051	0.055	in
E	39.9	40	40.1	mm
	1.53	1.57	1.61	in
F	88.9	89	89.1	mm
	3.500	3.504	3.508	in
G	150	155	158	mm
	5.906	6.102	6.220	in

OneSense Product Line Highlights

OneSense Pulse

- 3 x Pulse Inputs
- 2 x 0-5V logic level compatible inputs
- 1 x 0-5V input user-configurable, dry contact or logic level compatible
- Selectable high-speed hardware counter with hysteresis input
- Selectable low-power digitally filtered software counter

OneSense Pulse and Current

- 1 x Pulse Input, 2nd Pulse Input (optional)
- 2 x 0-24mA analog inputs
- Buffered analog inputs
- 12-bit resolution, 16-bit resolution - optional
- Low-pass digital filtering
- Internal automatic self-calibration and self-compensation routines

OneSense Pulse and Voltage

- 1 x Pulse Input, 2nd Pulse Input (optional)
- 2 x 0-10V analog inputs
- Buffered analog inputs
- 12-bit resolution, 16-bit resolution - optional
- Low-pass digital filtering
- Internal automatic self-calibration and self-compensation routines
- Auxiliary low-voltage channel

OneSense Temperature

- 1 x Pulse Input, 2nd Pulse Input (optional)
- High precision industrial Pt100 or Pt1000
- Any thermocouple class (user selectable)
- Low-power digital: multiple 1-wireTM temperature sensors

OneSense Agriculture

- Variety of applications in agriculture and environmental monitoring
- Irrigation
- Greenhouses
- Weather monitoring Water/liquid level monitoring
- SDI-12, I2C, Voltage (0-5V), Pulse, 1-wire