S2W-Humi

USER MANUAL

ELBIS P.C.

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Introduction

1 Introduction

1.1 About

1. About this guide

This document provides the specifications of the **S2W-Humi** and **S2W-Humi-Ext** Wi-Fi **IoT** sensors.

2. Revision of document

For revision history of this document, please refer to the **last page**.

3. Documentation change notification

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1.2 Overview

- **ELBIS® S2W-Humi** is a small, standalone, integrated **IoT** device that measures temperature and humidity of an area.
- The device is intended for indoor or outdoor[1] use. It can operate in noisy and harsh environments including moisture, greasy, and dirty environments.
- It can be used as a standalone temperature and humidity sensor without need of extra access point.
- It uses Wi – Fi technology to connect directly to the router and then to the **S2W**[2] cloud platform.
- It operates with external power supply or 3xAAA batteries that can provide autonomous operation up to one year.
- It uses the best practice of **cyber security**, that place the device in one of the **highest levels** of **cyber protection**.
- The device is based on **S2W main board**[3], the best in the class of integrated and autonomous sensing devices.

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(1) For outdoor use, extra accessory for IP65 is needed
(2) S2W platform is an IoT cloud platform created by ELBIS. For more details visit https://elbis.gr/iiot/s2w/
(3) S2W main board is referred to the core MCU

1.3 Features

- Standalone temperature and humidity Wi – Fi Sensor based on SHT21 chip.
- High Accuracy measurements
- Device Size: 107mm x 60mm x 23mm
- Wide USB power supply range (3V – 5V) or 3xAAA batteries
- On board LED indication for connectivity, power supply and data transfer
- Alarm and Fault alerts
- Low power consumption
- Over the Air update
- High level security through most common IoT communication protocols (HTTPS, MQTT)
- Easy installation
- No need for extra access point
- 4.000 values memory
- Real time clock
- One year battery life[1]
- Low cost

(1) Tested in an area with strong Wi – Fi signal coverage. 3xAAA 1000mAh batteries were used. Taking of measurements every 20 minutes and sending every 9 measurements to the cloud.

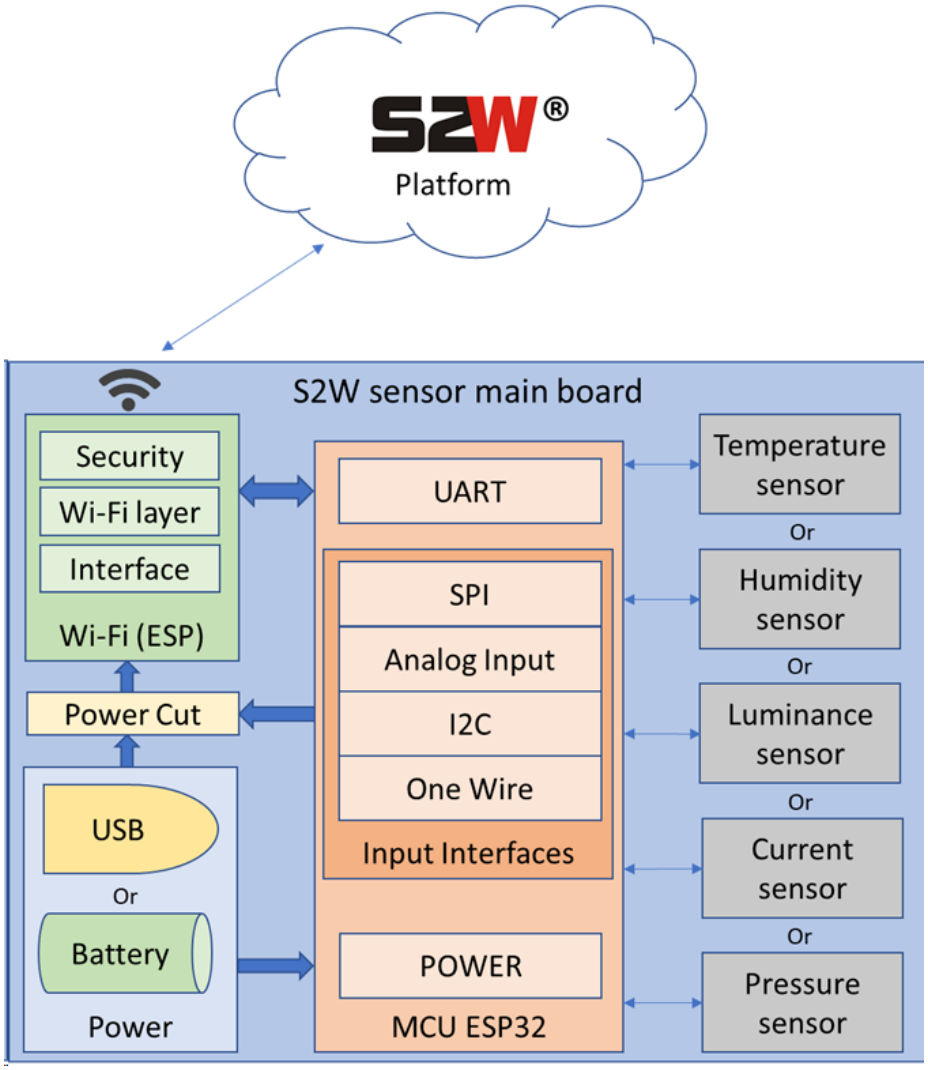
1.4 Applications

- Logistics
- Wineries
- Industrial Units
- Storage Cold Rooms
- Hotels
- Dining Areas

S2W-Humi device

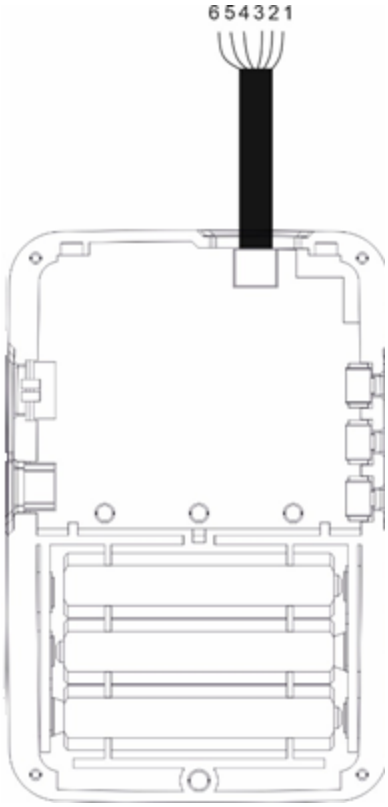
2 S2W-Humi device

2.1 Block Diagram

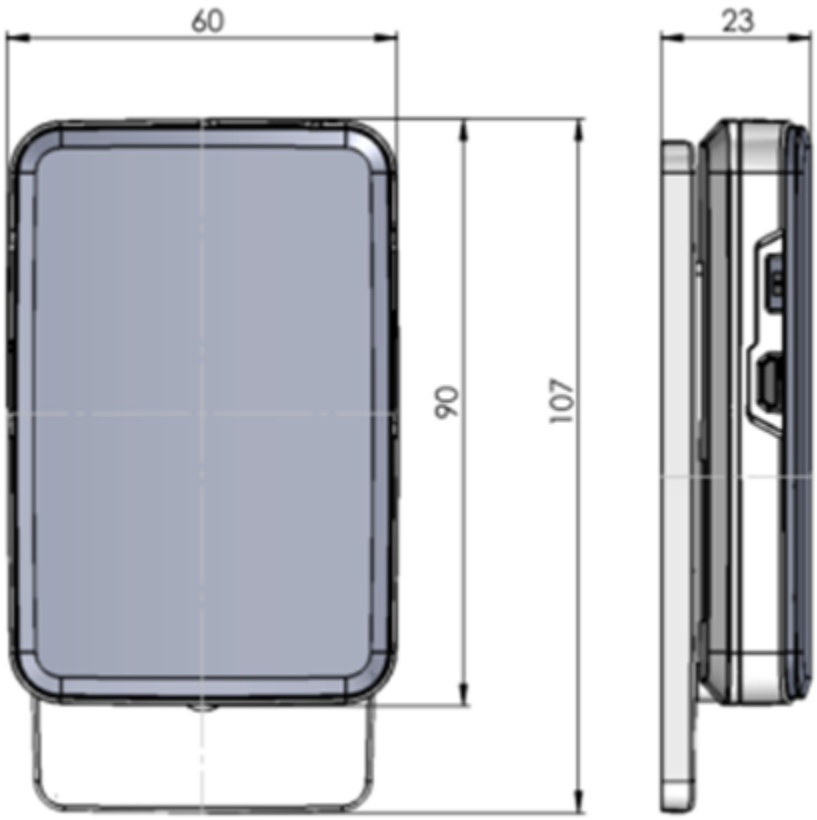


2.2 Pinout

Wire Number	Description
1	Vo (Sensor Power supply)
2	SCL/CLK (I^2C clock / SPI clock)
3	1-Wire/CS (1-wire interface data bus / SPI Chip Select)
4	Int/ADC/MISO (External Interrupt / Analog Input / SPI Master Input Slave Output)
5	GND (Sensor Ground)
6	SDA/MOSI (I^2C data / SPI Master Output Slave Input)



2.3 Dimensions



2.4 Absolute maximum ratings

Symbol	Parameter	Min	Max	Unit
Vdd	Power supply voltage	-0.3	5.3	V
I_{max}	Overall current consumption	-	1.100	mA
T_{oper}	Operating temperature	-20	+50	°C
T_{store}	Storage temperature	-20	+50	°C
T_{probe}	Measuring Temperature	-40	+125	°C
H_{probe}	Measuring Humidity	0	100	%RH

2.5 Electrical Characteristics (3.3V, 25°C)

Symbol	Parameter	Min	Typical	Max	Unit
Vdd	Power supply voltage	3	3.3	5	V
Vbat	Battery power supply	3	3.3	4.8	V
$I_{transmit}$	Transmit 802.11b, DSSS 1 Mbps, POUT = +19.5 dBm	-	240	-	mA
$I_{transmit}$	Transmit 802.11g, OFDM 54 Mbps, POUT = +16 dBm	-	190	-	mA
$I_{transmit}$	Transmit 802.11n, OFDM MCS7, POUT = +14 dBm	-	180	-	mA
$I_{receive}$	Receive 802.11b/g/n	92	-	105	mA
$I_{measurement}$	One measurement current consumption	22	-	29	mA
$I_{send\ data}$	Connection and send one packet of data consumption	$22 + I_{transmit}$	-	$29 + I_{transmit}$	mA
I_{sleep}	Sleep mode consumption	-	10	-	uA

	One measurement discharge	0.006	-	0.008	mAh
	Send one packet discharge[1]	0.84	-	1.25	mAh
C_{IN}	Pin capacitance	-	2	-	pF
V_{IH}	High-level input voltage	0.75×Vdd[2]	-	Vdd+0.3[5]	V
V_{IL}	Low-level input voltage	-0.3		0.25×Vdd[5]	V
I_{IH}	High-level input current	-	-	50	nA
I_{IL}	Low-level input current	-	-	50	nA
V_{OH}	High-level output voltage	0.8×Vdd[5]	-	-	V
V_{OL}	Low-level output voltage	-	-	0.1×Vdd[5]	V

I_{OH}	High-level source current High-level source current (VDD1 = 3.3 V, VOH >= 2.64 V, output drive strength set to the maximum)	-	40	-	mA
I_{OL}	Low-level sink current Low-level sink current (VDD1 = 3.3 V, VOL = 0.495 V, output drive strength set to the maximum)	-	28	-	mA

(1) Check **Waveform 1.**
(2) VDD is the I/O voltage for a particular power domain of pins.

2.6 Thermal Characteristics

Symbol	Parameter	Min	Typical	Max	Unit
$T_{oper.}$	Operating temperature[1]	-20	-	+50	°C
T_{store}	Storage temperature	-20	-	+50	°C
$T_{probeOper.}$	Probe operating temperature	-40	-	+125	°C
$H_{probeOper.}$	Probe operating Humidity	0	-	100	%RH
$T_{probeStore}$	Probe storage temperature	-40	-	125	°C

(1) It is referred to the device with the ABS enclosure. The separated probe is working in a more wide temperatures range (see table 1)

2.7 Recommended Operation Conditions

Symbol	Parameter	Min	Typical	Max	Unit
Vdd	Power supply voltage	3.0	5.0	5.3	V
I_{Vdd}	Current delivered by external power supply	0.5	-	-	A
T	Operating temperature	-40	-	85	℃

2.8 Wi-Fi Radio

Parameter	Condition	Min	Typical	Max	Unit
Operating frequency range[1]	-	2412	-	2484	MHz
Out impedance[2] **TX power[3]** **Sensitivity**	-	-	Note 2	-	Ù
	11n, MCS7	12	13	14	dBm
	11b mode	17.5	18.5	20	dBm
	11b, 1 Mbps	-	-98	-	dBm
	11b, 11 Mbps	-	-89	-	dBm
	11g, 6 Mbps	-	-92	-	dBm

	11g, 54 Mbps	-	-74	-	dBm
	11n, HT20, MCS0	-	-91	-	dBm
	11n, HT20, MCS7	-	-71	-	dBm
	11n, HT40, MCS0	-	-89	-	dBm
	11n, HT40, MCS7	-	-69	-	dBm
Adjacent channel rejection	11g, 6 Mbps	-	31	-	dB
	11g, 54 Mbps	-	14	-	dB
	11n, HT20, MCS0	-	31	-	dB
	11n, HT20, MCS7	-	13	-	dB

(1) Device should operate in the frequency range allocated by regional regulatory authorities. Target operating frequency

range is configurable by software.

(2) For the modules that use IPEX antennas, the output impedance is 50 Ù. For other modules without IPEX antennas, users do not need to concern about the output impedance.

(3) Target TX power is configurable based on device or certification requirements

2.9 BLE Radio

Parameter	Conditions	Min	Typ	Max	Unit
Sensitivity @30.8% PER	-	-	-97	-	dBm
Maximum received signal @30.8% PER	-	0	-	-	dBm
Co-channel C/I	-	-	+10	-	dB
Adjacent channel selectivity C/I	F = F0 + 1 MHz	-	-5	-	dB
	F=F0-1MHz	-	-5	-	dB
	F=F0+2MHz	-	-25	-	dB
	F=F0-2MHz	-	-35	-	dB
	F=F0+3MHz	-	-25	-	dB
	F=F0-3MHz	-	-45	-	dB

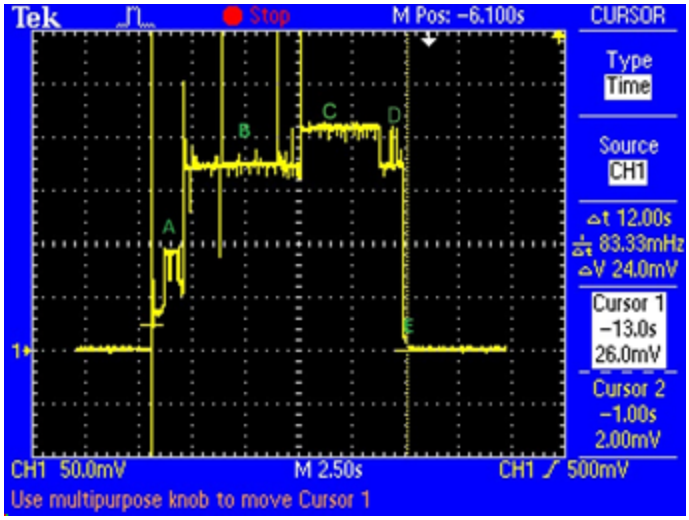
Out-of-band blocking performance	30 MHz ~ 2000 MHz	-10	-	-	dBm
	2000 MHz ~ 2400 MHz	-27	-	-	dBm
	2500 MHz ~ 3000 MHz	-27	-	-	dBm
	3000 MHz ~ 12.5 GHz	-10	-	-	dBm
Inter-modulation	-	-36	-	-	dBm

2.10 Transmitter

Parameter	Conditions	Min	Typ	Max	Unit
RF transmit power	-	-	0	-	dBm
Gain control step	-	-	3	-	dBm
RF power control range	-	-12	-	+9	dBm

Adjacent channel transmit power	F = F0 ± 2 MHz	-	-52	-	dBm
	F = F0 ± 3 MHz	-	-58	-	dBm
	F = F0 ± 3 MHz	-	-60	-	dBm
Δ f1avg	-	-	-	265	kHz
Δ f2max	-	247	-	-	kHz
Δ f2avg/Δ f1avg	-	-	-0.92	-	-
ICFT	-	-	-10	-	kHz
Drift rate	-	-	0.7	-	kHz/50 µs
Drift	-	-	2	-	kHz

2.11 Power Consumption Waveforms



In this waveform we can see all the stages of the device from wake up to sleep again.

A. Wake up from sleep, start up device and reading sensor
B. Initialize Wi-Fi and connecting to backend.
C. Sending data to the cloud and reading settings from the cloud.
D. Prepare to sleep and falling to sleep.

All above stages are completed in 12 Seconds.

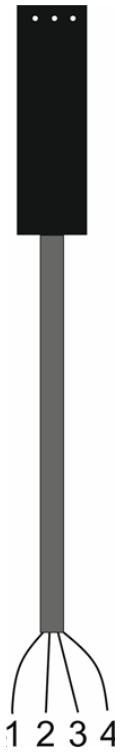
Sen-Humi Sensor

3 Sen-Humi Sensor

3.1 General Description

The **Sen-Humi** sensor probe is based on SHT21 digital temperature and humidity chip. It consists of **ABS cover** and **1 meter cable** with four (4) internal wires. Provides 8-bit to 12-Bit% RH relative humidity and 12-bit to 14-bit Celsius temperature measurements. The **Sen-Humi** communicates over a **I^2C interface** that requires two (2) data lines for communication with a central microprocessor. In addition, the **Sen-Humi** is fully calibrated.
Each **Sen-Humi** has a unique **serial code**, which allows multiple **Sen-Humi** to function on the **same bus**.
Applications that can benefit from this feature include HVAC environmental controls, temperature and humidity monitoring systems inside buildings, equipment, or machinery, and process monitoring and control systems.

3.2 Pin Configurations



Pin Number	Description
1	VDD (Supply voltage)
2	SCL (I^2C clock)
3	SDA (I^2C data)
4	VSS (Ground)

3.3 Benefits and Features

- I^2C Interface Requires Only two Port Pin for Communication
- Highest range Humidity measurement 0 - 100 %RH
- Very high Accuracy ±2% from 20 to 80%RH
- Humidity Programmable Resolution from 8 Bits to 12 Bits
- Measures Temperatures from -40°C to +125°C
- ±0.5°C Accuracy from -20°C to +80°C
- Temperature Programmable Resolution from 12 Bits to 14 Bits
- No External Components Required
- Simplifies Distributed Temperature and Humidity Sensing Applications with Multidrop Capability
- Each Device Has a Unique Serial Code Stored in On-Board ROM

3.4 Absolute Maximum Ratings

Parameter	min	max	Units
VDD to VSS	-0.3	5	V
Digital I/O Pins (SDA, SCL) to VSS	-0.3	VDD + 0.3	V
Input Current on any Pin	-100	100	mA

Table 3 Electrical absolute maximum ratings

3.5 DC Electrical Characteristics

Parameter	Conditions	min	typ	max	Units
Output Low Voltage, VOL	VDD = 3.0 V, -4 mA < IOL < 0mA	0	-	0.4	V
Output High Voltage, VOH		70% VDD	-	VDD	V
Output Sink Current, IOL		-	-	-4	mA
Input Low Voltage, VIL		0	-	30% VDD	V
Input High Voltage, VIH		70% VDD	-	VDD	V
Input Current	VDD = 3.6 V, VIN = 0 V to 3.6 V	-	-	±1	uA

Table 4 DC characteristics of digital input/output pads. VDD = 2.1V to 3.6V, T = -40°C to 125°C, unless otherwise noted.

Parameter	min	typ	max	Units
SCL frequency, f_{SCL}	0	-	0.4	MHz
SCL High Time, t_{SCLH}	0.6	-	-	µs
SCL Low Time, t_{SCLL}	1.3	-	-	µs
SDA Set-Up Time, t_{SU}	100	-	-	ns
SDA Hold Time, t_{HD}	0	-	900	ns
SDA Valid Time, t_{VD}	0	-	400	ns
SCL/SDA Fall Time, t_F	0	-	100	ns
SCL/SDA Rise Time, t_R	0	-	300	ns
Capacitive Load on Bus Line, C_B	0	-	400	pF

Table 5 Timing specifications of digital input/output pads for I²C fast mode. Entities are displayed in Figure 12. VDD = 2.1V to 3.6V, T = -40°C to 125°C, unless otherwise noted. For further information regarding timing, please refer to http://www.standardics.nxp.com/support/i2c/.

3.6 Sensor Performance

Relative Humidity

Parameter	Condition	min	typ	max	Units
Resolution [1]	12 bit		0.04		%RH
	8 bit		0.7		%RH
Accuracy tolerance [2]	typ		±2.0		%RH
	max	see Figure 2			%RH
Repeatability			±0.1		%RH
Hysteresis			±1		%RH
Nonlinearity			<0.1		%RH
Response time [3]	τ 63%		8		s
Operating Range	extended [4]	0		100	%RH
Long Term Drift [5]	normal		< 0.5		%RH/yr

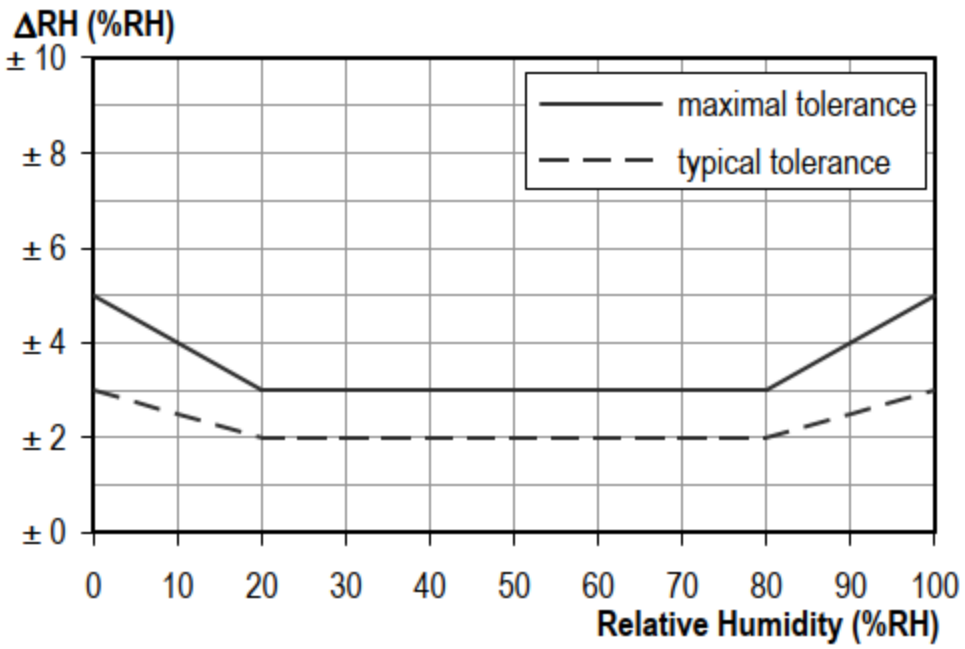


Figure 2 Typical and maximal tolerance at 25°C for relative humidity. For extensive information see Users Guide, Sect. 1.2.

Temperature

Parameter	Condition	min	typ	max	Units
Resolution [1]	14 bit		0.01		°C
	12 bit		0.04		°C
Accuracy tolerance [2]	typ		±0.3		°C
	max	see Figure 3			°C
Repeatability			±0.1		°C
Operating Range	extended [4]	-40		125	°C
Response Time [7]	τ 63%	5		30	s
Long Term Drift			< 0.04		°C/yr

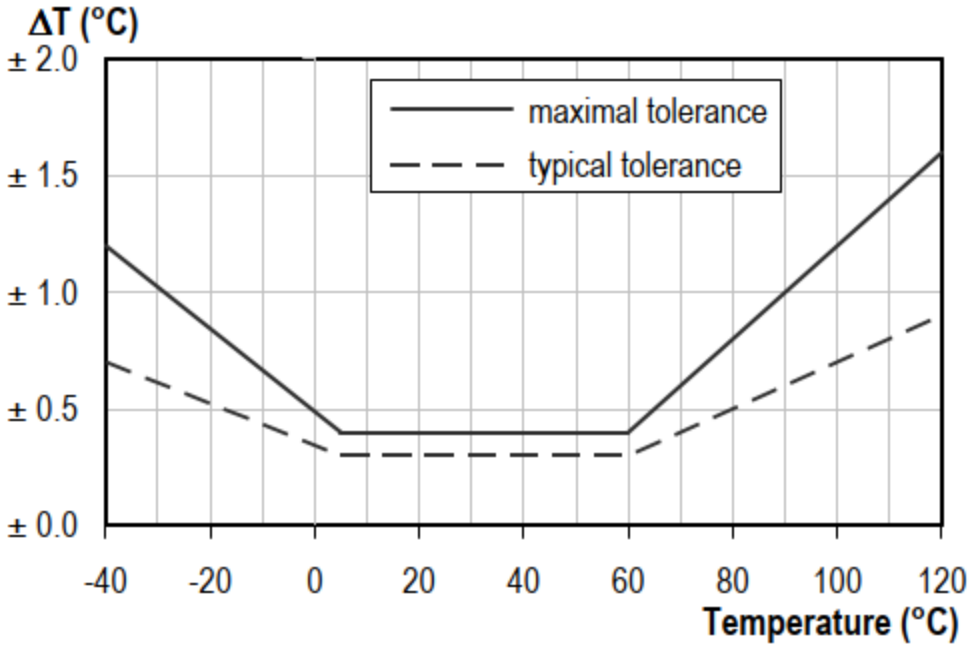


Figure 3 Typical and maximal tolerance for temperature sensor in °C.

Electrical Specification

Parameter	Condition	min	typ	max	Units
Supply Voltage, VDD		2.1	3.0	3.6	V
Supply Current, IDD [6]	sleep mode		0.15	0.4	µA
	measuring	200	300	330	µA
Power Dissipation [6]	sleep mode		0.5	1.2	µW
	measuring	0.6	0.9	1.0	mW
	average 8bit		3.2		µW
Heater	VDD = 3.0 V	5.5mW, ΔT = + 0.5-1.5°C			
Communication	digital 2-wire interface, I²C protocol				

Table 1 Electrical specification. For absolute maximum values see Section 4.1 of Users Guide.

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(1) Default measurement resolution is 14bit (temperature) / 12bit (humidity). It can be reduced to 12/8bit, 11/11bit or 13/10bit by command to user register.
(2) Accuracies are tested at Outgoing Quality Control at 25°C and 3.0V. Values exclude hysteresis and long term drift and are applicable to non-condensing environments only.
(3) Time for achieving 63% of a step function, valid at 25°C and 1m/s airflow.
(4) Normal operating range: 0-80%RH, beyond this limit sensor may read a reversible offset with slow kinetics (+3%RH after 60h at humidity >80%RH). For more details please see Section 1.1 of the Users Guide.
(5) Value may be higher in environments with vaporized solvents, out-gassing tapes, adhesives, packaging materials, etc. For more details please refer to Handling Instructions.
(6) Min and max values of Supply Current and Power Dissipation are based on fixed VDD = 3.0V and T<60°C. The average value is based on one 8bit measurement per second.
(7) Response time depends on heat conductivity of sensor substrate.

3.7 Extended Specification

For details on how Sensirion is specifying and testing accuracy performance please consult Application Note "Statement on Sensor Specification".

1.1 Operating Range

The sensor works stable within recommended Normal Range – see Figure 4. Long term exposure to conditions outside Normal Range, especially at humidity >80%RH, may temporarily offset the RH signal (+3%RH after 60h). After return into the Normal Range it will slowly return towards calibration state by itself. See Section 2.3 "Reconditioning Procedure" for eliminating the offset. Prolonged exposure to extreme conditions may accelerate ageing.

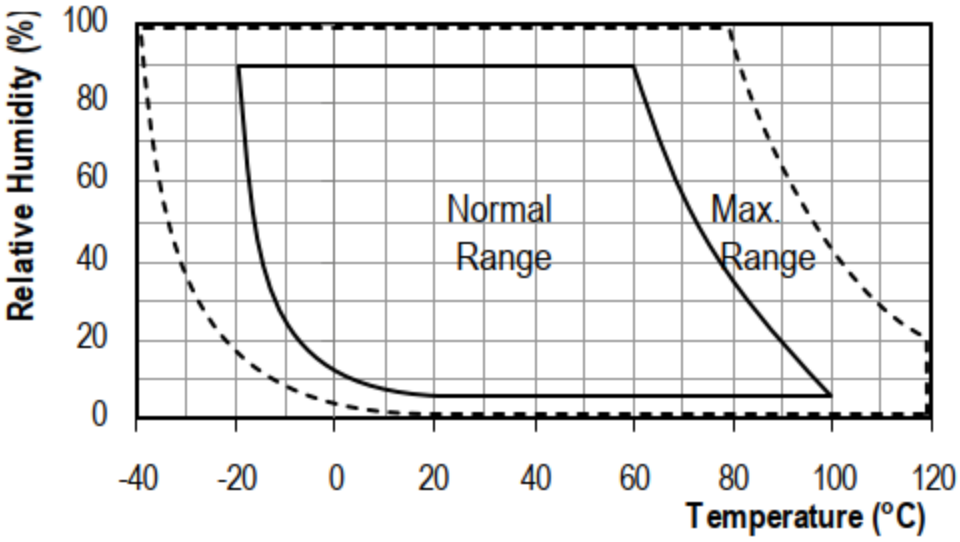

Figure 4 Operating Conditions

1.2 RH accuracy at various temperatures

Maximal tolerance for RH accuracy at 25°C is defined in Figure 2. For other temperatures maximal tolerance has been evaluated to be within limits displayed in Figure 5.

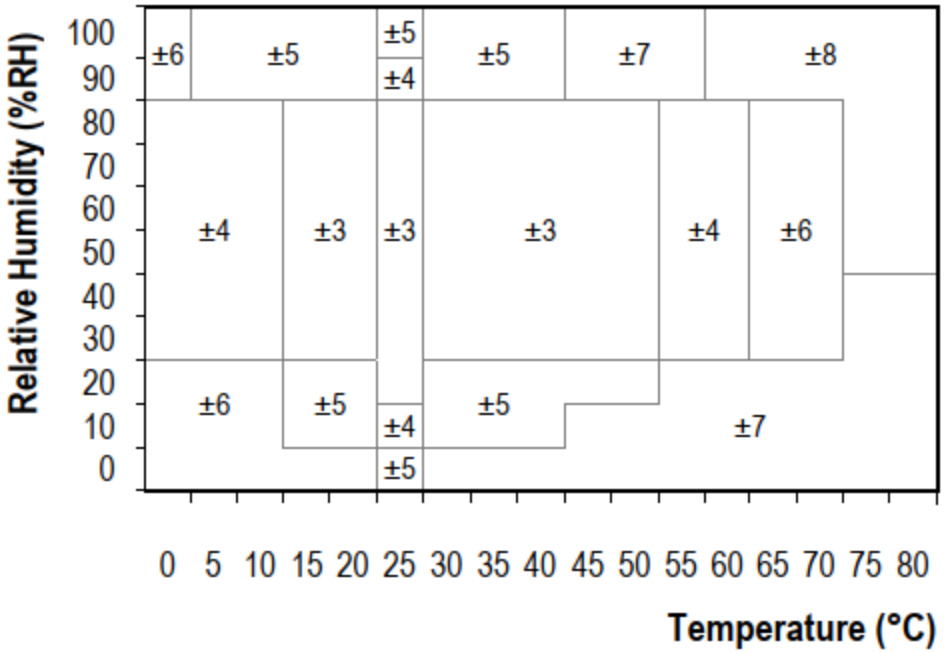

Figure 5 Maximal tolerance of relative humidity measurements given in %RH for temperatures 0 – 80°C.

Please note that above values are maximal tolerances (not including hysteresis) against a high precision reference such as a dew point mirror. Typical deviations are at ±2%RH where maximal tolerance is ±3%RH and about half the maximal tolerance at other values.

1.3 Electrical Specification

Current consumption as given in Table 1 is dependent on temperature and supply voltage VDD. For estimations on energy consumption of the sensor Figures 6 and 7 may be consulted. Please note that values given in these Figures are of typical nature and the variance is considerable.

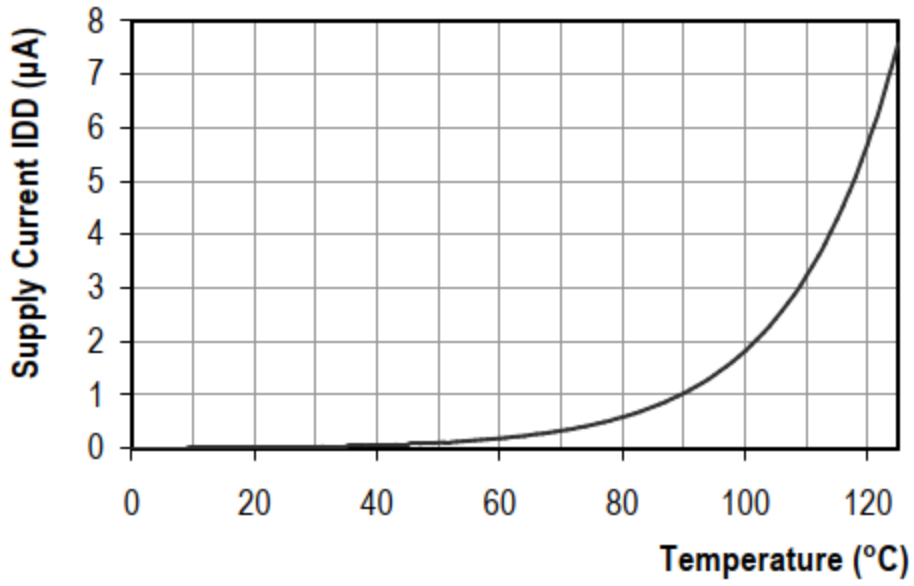

Figure 6 Typical dependency of supply current (sleep mode) versus temperature at VDD = 3.0V. Please note that the variance of these data can be above ±25% of displayed value.

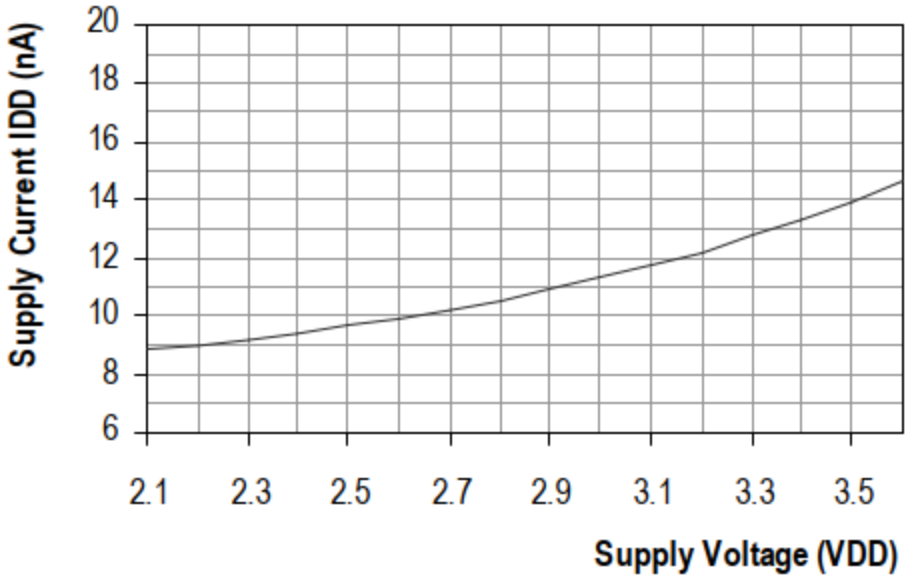

Figure 7 Typical dependency of supply current (sleep mode) versus supply voltage at 25°C. Please note that deviations may be up to ±50% of displayed value. Values at 60°C scale with a factor of about 15 (compare Table 1).

Installation

4 Installation

4.1 Batteries Power Supply

For the installation you will need to unscrew from the back side of the device one screw and add 3 batteries **3xAAA** (**Figure 1,2**). The sensor or the appliance must be placed away from doors or windows, appliances, heat pipes, cooling devices or anything that can affect the credibility of the measurements, for the correct recording of values.

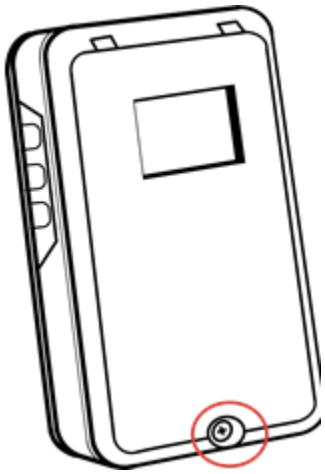

Figure 1

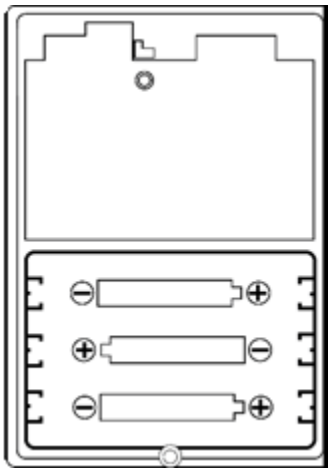

Figure 2

4.2 USB Power Supply

You can also connect the USB cable from the left side (**Figure 3**). The USB cable is included in the package. The end user has only to supply an **AC** to **DC** adapter (220V to 5V).

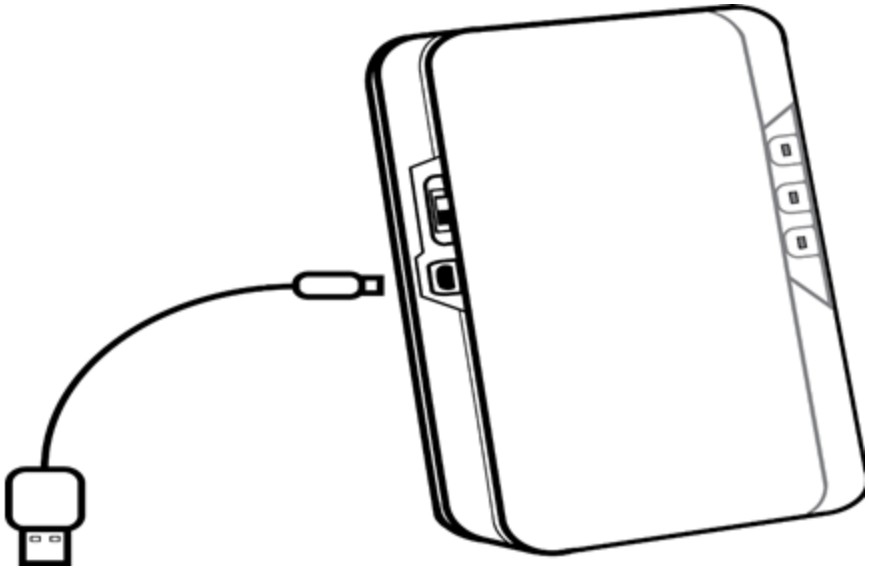

Figure 3

4.3 Wall Mount

Inside the packaging device you will also find a wall mount for the **S2W** device (**Figure 4**). For wall mounting you will need only one screw M3x.

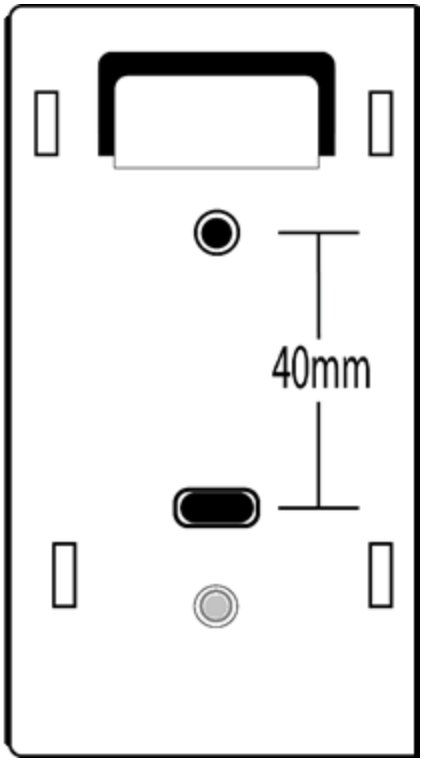

Figure 4

4.4 First Steps

To activate the S2W device, make sure that the power switch is downwards. (see **Figure 5**).

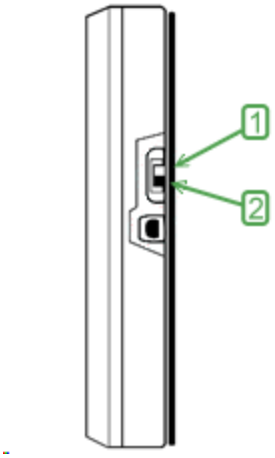

Figure 5 (Power Switch **1:Off, 2:On)**

When we switch on the device, three red LED lights will start flashing in the front side of the device (**Figure 6**). You will observe that the first LED from the left side of the device will be flashing continuously, while the second one will be flashing twice every 30 seconds.

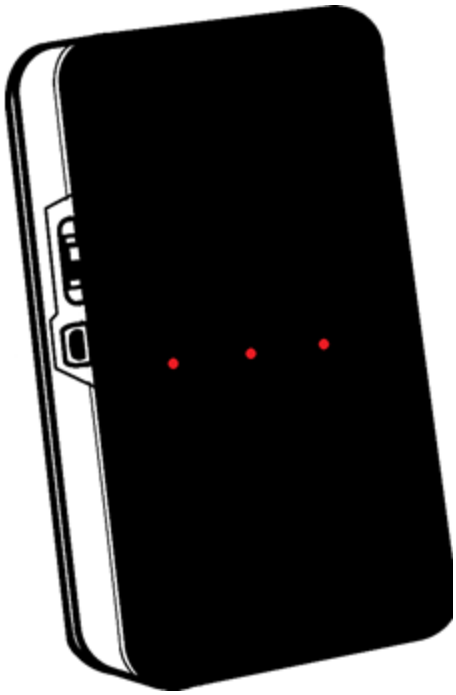

Figure 6 (Led flashing**)**

4.5 External Sensor (Sen-Humi)

S2W-Humi series is equipped with the temperature and humidity sensor on board as a basic model (S2W-Humi). If an extension is necessary, an external sensor can be plugged in at the top side of the device as shown in **Figure 7a**. In this way, the sensor can be extended to the point where we want to measure.

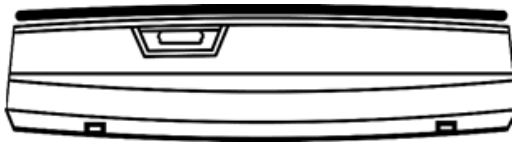

Figure 7a

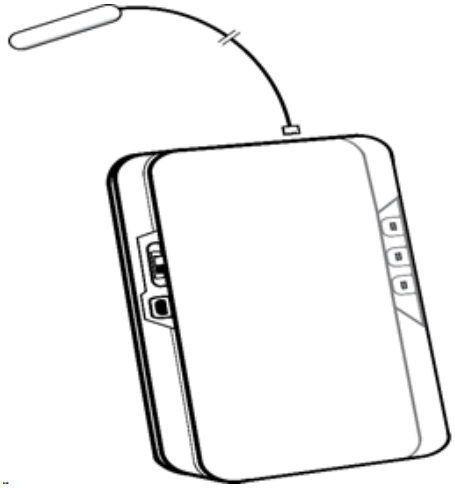

Figure 7b

4.6 Led table

Description	LED 1	LED 2	LED 3
Search WIFI-Link	•	•○	○
Wake Up/Measurement Send	•	•	○
Miniapp	•	••	○
Alarm	○	•	○
No Wi-Fi	•	••	○

(•) LED On

(○) LED Off

Cyber Security

5 Cyber Security

5.1 Platform Security Features

1. We use X509 certificates stored in S2W's flash in order to be able to connect to AWS MQTT Broker.
2. All flash partitions are encrypted using AES-256 algorithm with a 32-byte key
3. We enable ESP32's secure boot in order to prevent flash rewriting
4. We have VPCs defined which allow only certain instances to communicate in the same Virtual Private Circuit
5. We use this to provide DB-API communication and MQTT Core-API communication
6. We use digital certificates on our Servers in order to encrypt traffic to and from back-end.
7. Each Back-end service runs on its own Docker container in order to prevent access from outside the VPC which resides in the same instance
8. We have enabled Cross Origin Resource Sharing which prevents http calls from resources other than these that we define (Dashboard)

5.2 Security Requirements

1. WPA2 must be enabled in access point (router)
2. MQTT over TLS uses port 8883 (needs to be open)

5.3 Elbis security best practice for IoT sensors and platform

Link for Download: https://elbis.gr/

5.4 Network Specifications

- Wireless network at 2,4GHz
- Technical Specifications. The device must be supporting AES encryption and the encryption protocol must be WPA-PSKII.
- For the appropriate installation our company suggests a site survey at first
- For the proper operation of the device, the power signal should be over -75dbi

For the orderly operation of the device our company suggests the network to be separate (create a new subnet) from the existing installation so any changes or alterations to be avoided.

Front End Dashboard

6 Front End Dashboard

6.1 Overview

Dashboard is our app that provides access to data collected by the sensors. Users can watch charts or raw data and can even download these data in CSV format. Also, users can display events in charts, for example they can see alarms either high or low, user events (user pressed a button), sensor connectivity events, in case a sensor's cable has been disconnected, and Internet Connectivity events which show if an S2W is connected to the internet. Users can see all their S2W devices in one place and can search for them and even apply filters based on device's type or online status. Furthermore, users can send settings to their devices, these settings might be, sensor data dispatch interval, alarm limits, S2W device name, alarm delays, alarm hysteresis. Also, users can define who can receive notifications about alarms or any change of status (online/offline).

6.2 Dashboard Images

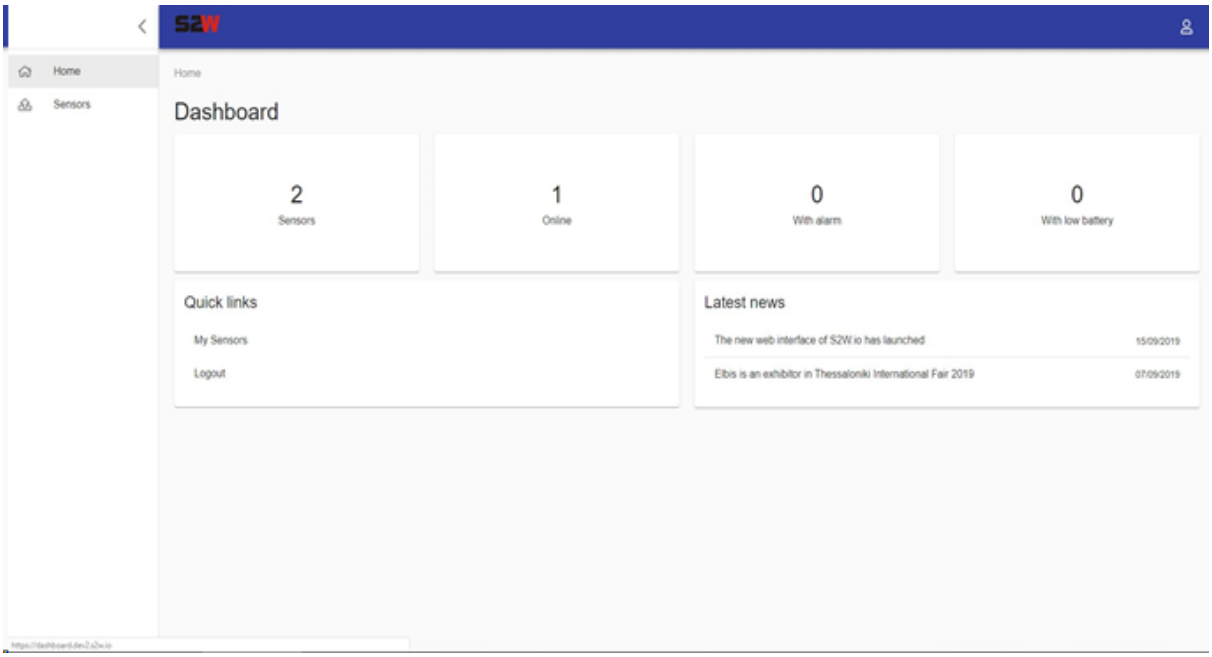

Figure 8: Dashboard Homepage. In this page you can view all your sensors, connectivity status, battery status and temperature alarms.

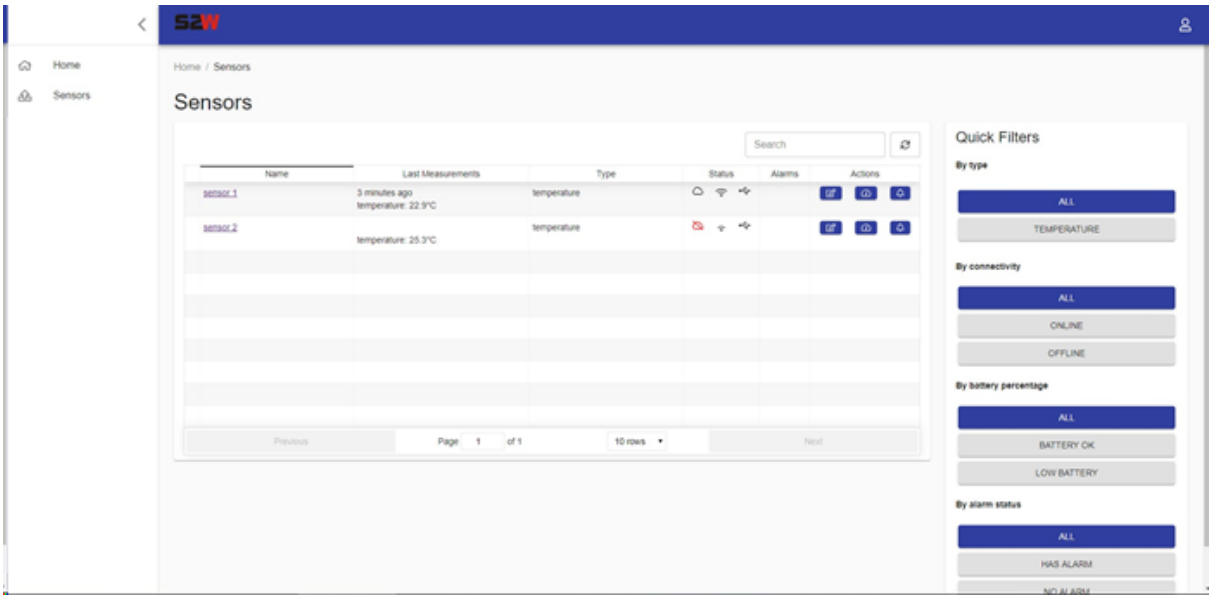

Figure 9: List of Sensors page. If you choose **Sensors**, you will be transferred to the main sensor page. Here, the user can view all the sensors with more than the basic information, e.g. when last measurement of temperature was taken, alarm limits and connectivity. At the right side of the page, you can view the quick filters that help you to categorize the sensors by different status..

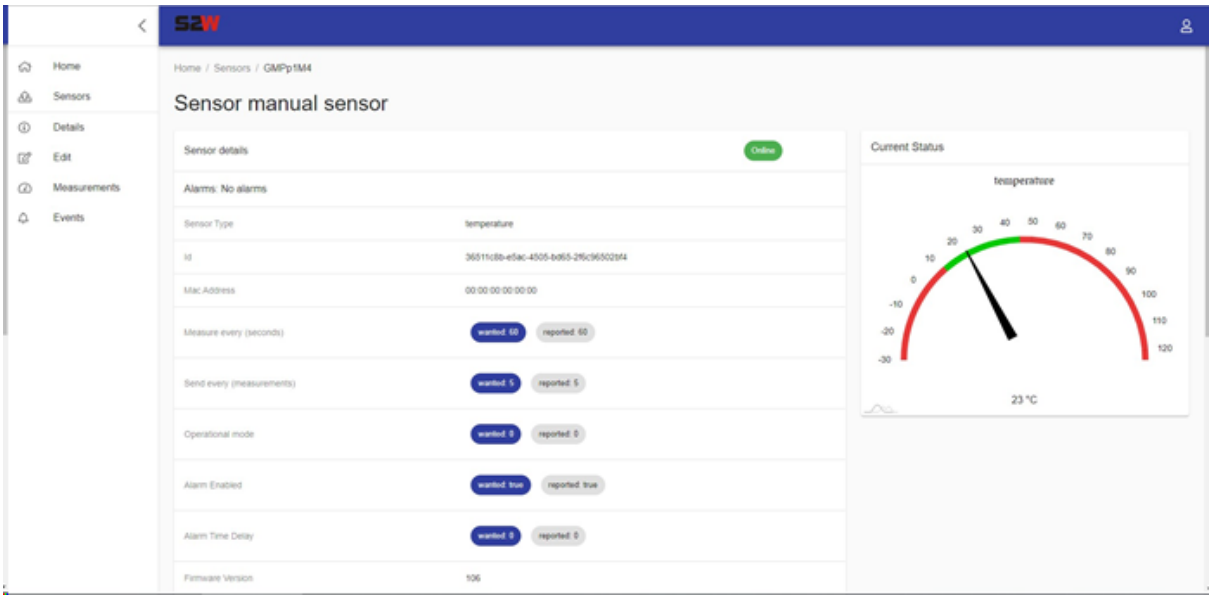

Figure 10: Sensor Details page

Figure 11: **Sensor Details page.** Click on the sensor you want, to see all the details of the sensor (sensor type, measurement time, operational mode, alarm delay etc). At the right side of the page there is a temperature gauge where you can see the last measurement. Also, at the bottom of the page there is a temperature measurement chart. Pick a date and view the waveform chart.

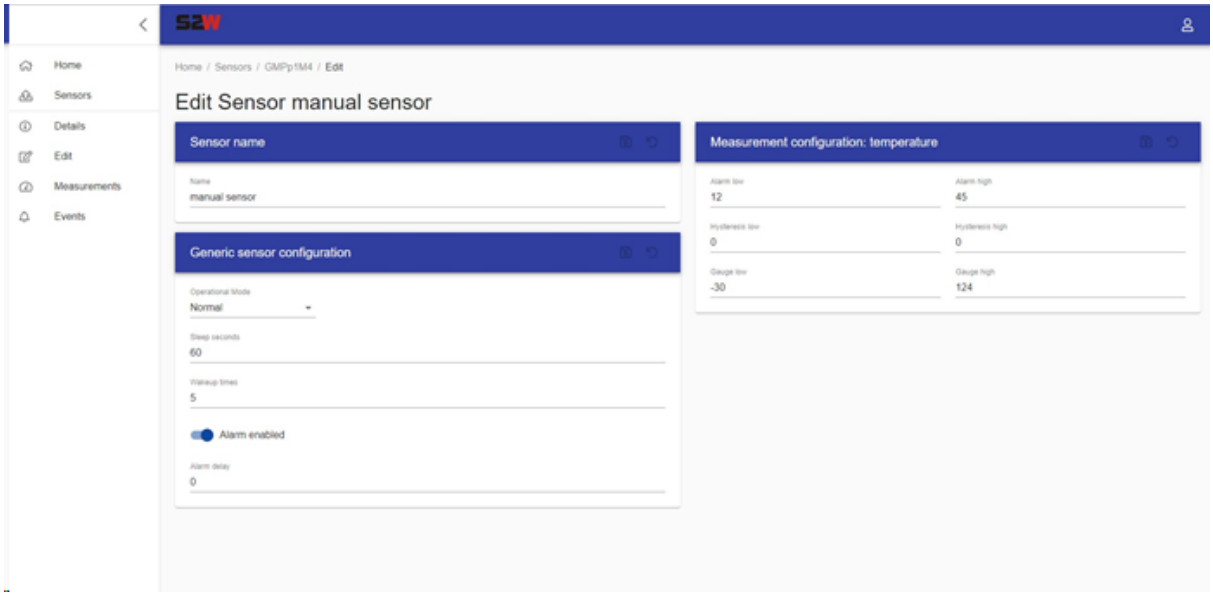

Figure 12: Edit Sensor page. By clicking on **Edit**, you can make a number of configurations, like sensor mame, time settings (sleep seconds, wakeup times) and measurement configuration (high alarm, low alarm, hysteresis, gauge limits).

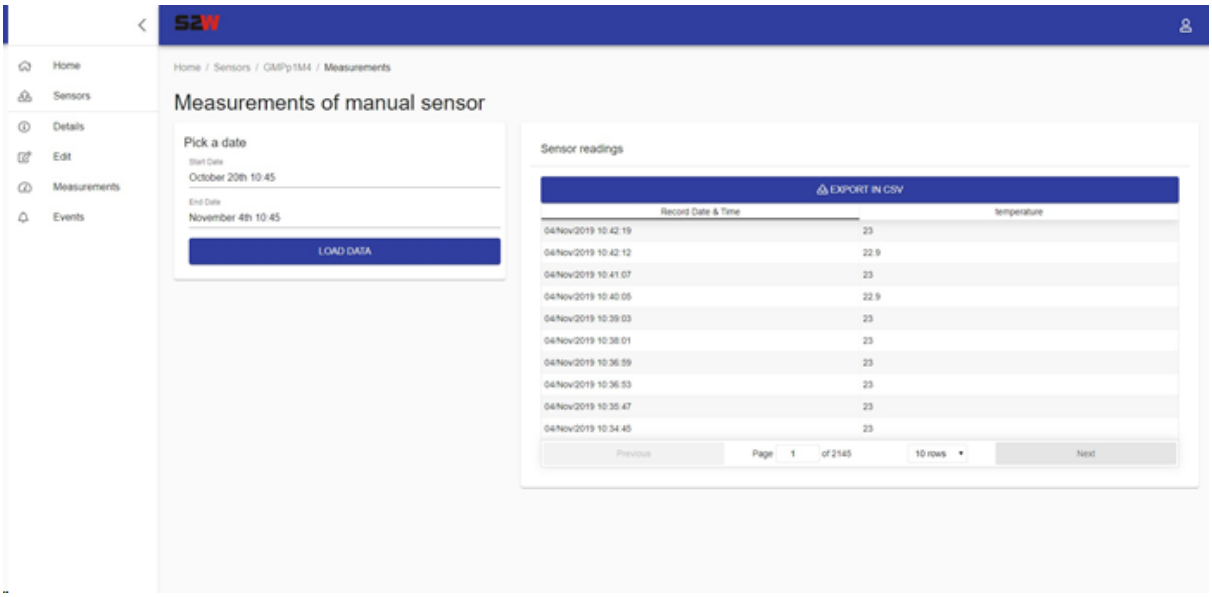

Figure 13: Sensor's Measurements page. At this page, user can handle all the data measurements history and can export them at an excel or pdf file for analysis and back up.

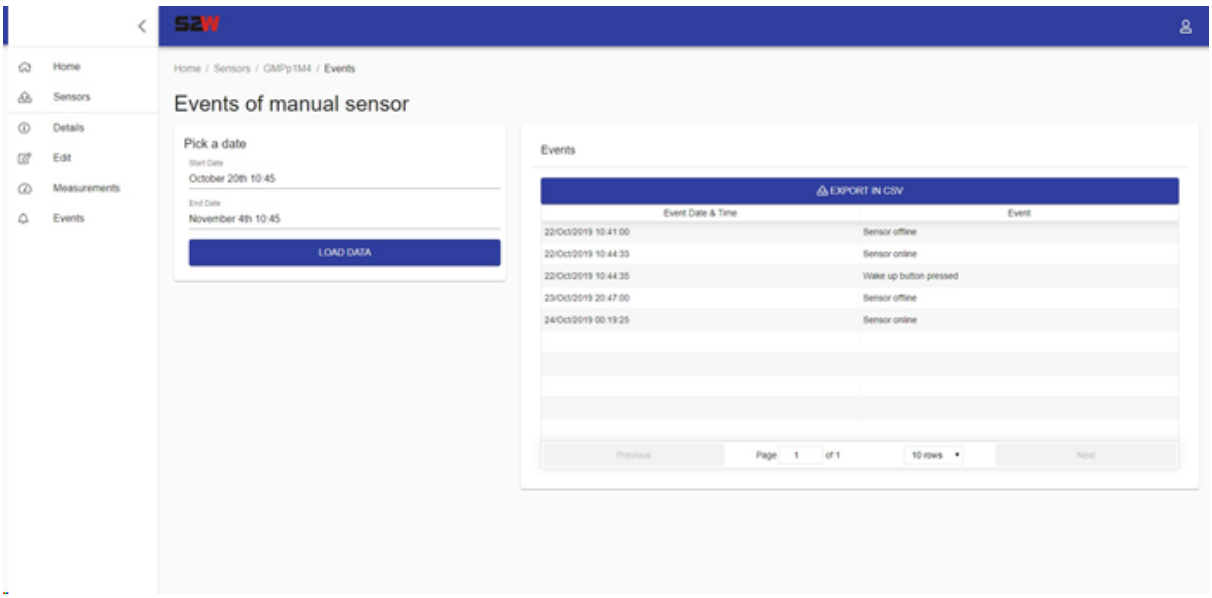

Figure 14: Sensor's Events page. At this page the user can view the events history of the sensor. By picking up the dates he wants, events like connectivity status or "wake up button pressed" will appear.

Application

7 Application

7.1 Description

The **S2W Sensors** application is available for free for both Android and iOS. You can download it from **Google Play Store** or **App Store**. You must create an account with your personal email and accept the confirmation.

1. https://play.google.com/store/apps/details?id=io.s2w (Figure 15)

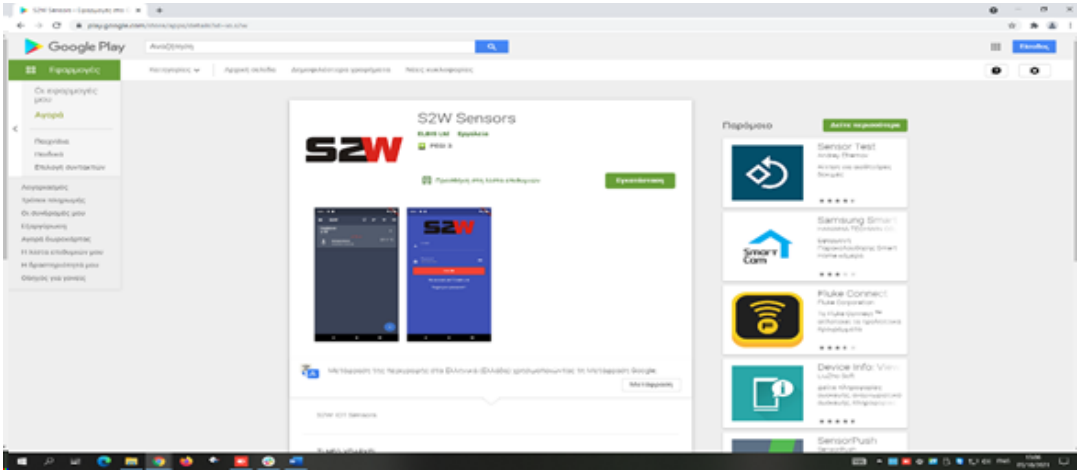

Figure 15

2. https://apps.apple.com/gr/app/s2w-sensors/id1474229047 (Figure 16)

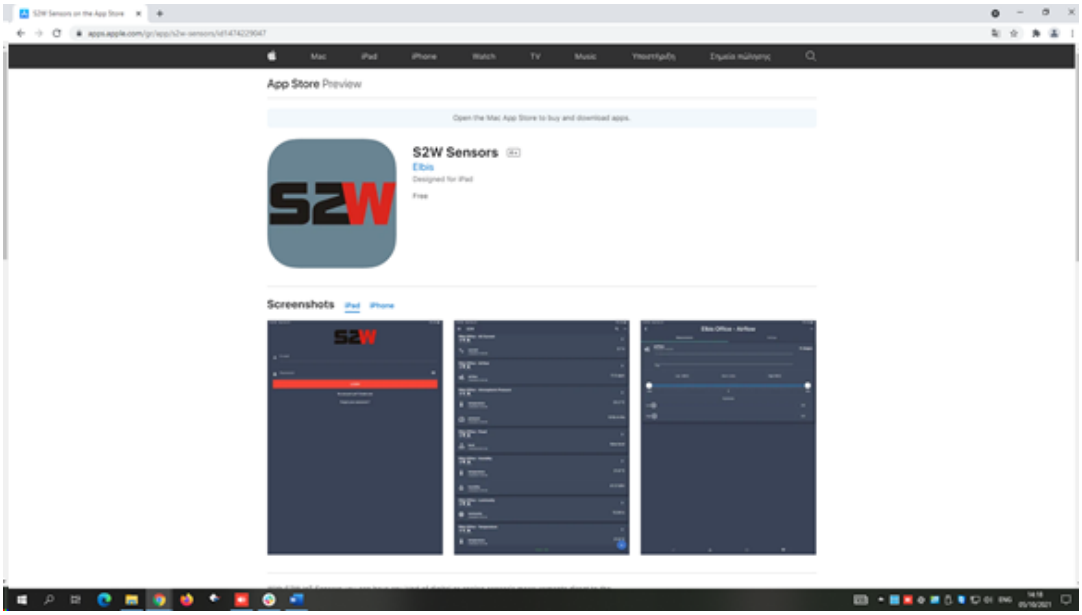

Figure 16

For the instructions manual about the application please visit our website: **www.elbis.gr**

References

8 References

8.1 References

The links below include further details about the MCU, Temperature sensor and Application guidelines.

- Esp32-WROOM-32 Datasheet: https://www.espressif.com/sites/default/files/documentation/esp32-wroom-32_datasheet_en.pdf
- SHT21 Datasheet: https://sensirion.com/products/catalog/SHT21/
- ELBIS official site: www.elbis.gr
- Elbis dashboard: https://dashboard.s2w.io/login