

# Weather station

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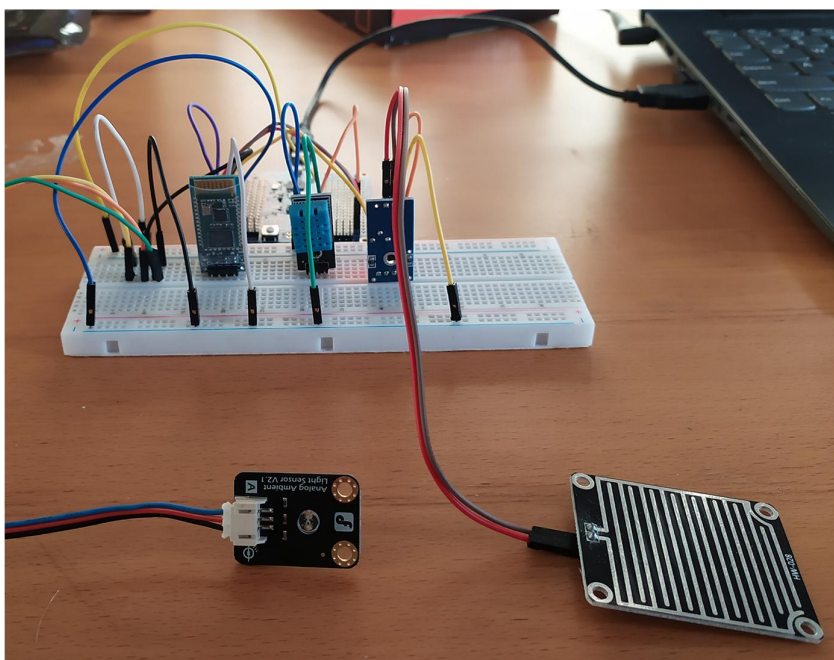
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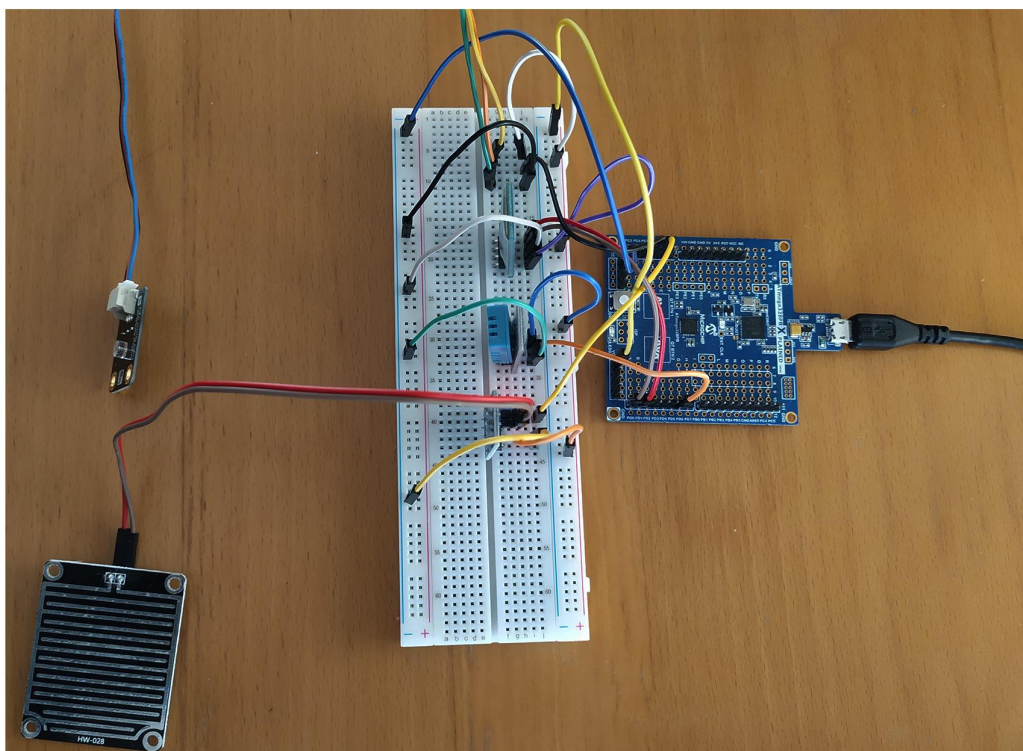
## ***Description:***

Building a simple "weather station" to measure basic parameters such as temperature, humidity, light intensity and the occurrence of rainfall. The device will be based on a microprocessor and sensors. Current data can be viewed using a smartphone application using Bluetooth communication or using USB connection and computer software like "putty". Data can also be saved to non-volatile memory and read at a later date.

## Pictures of the device



Picture no. 1 - front view



Picture no. 2 - upper view

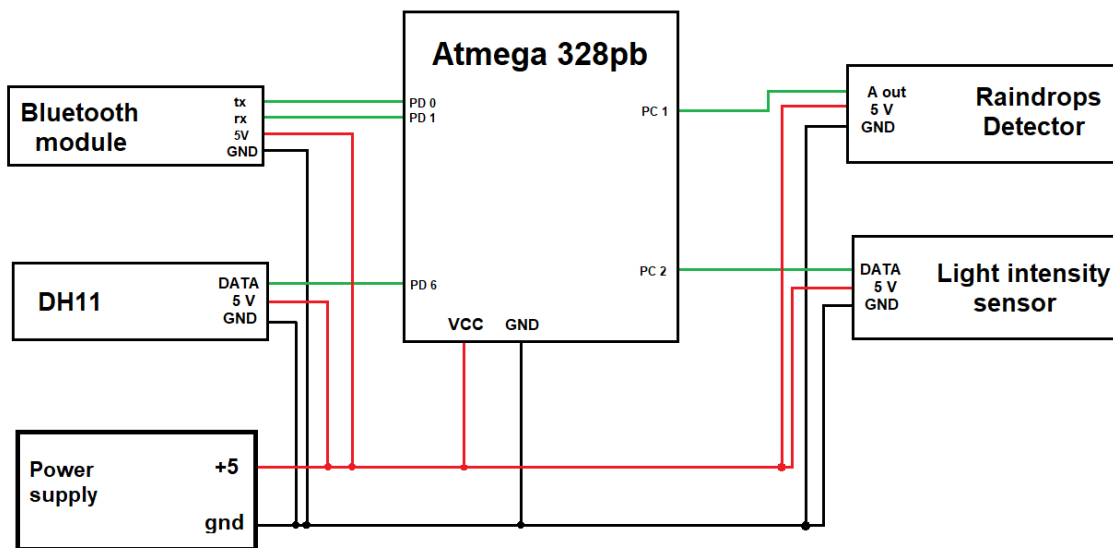
## Measure range:

	measure range		accuracy	
	minimum	maximum	minimum	maximum

Temperature	0°C	50°C	1°C	2°C
Humidity	(0°C) 30% (25°C) 20% (50°C) 20%	90% 90% 80%	1%	5%
Raindrop	5V	0V	0.005 V	0.01 V
Light sensitivity	0V	5V	0.005 V	0.01 V

Table no. 1 - measure rang of all sensors

### Electric scheme:



### Used components:

Test an evaluation board - ATmega328PB XPLAINED mini

- High Performance, Low Power AVR® 8-Bit Microcontroller Family
  - Advanced RISC Architecture
  - 32KBytes of In-System Self-Programmable Flash program memory
  - 1 KBytes EEPROM
  - 2KBytes Internal SRAM
  - By default, the ATmega328PB device and mEDBG (debugger) on Xplained MINI kit uses on-board **16MHz** crystal as the clock source.
1. Humidity and temperature sensor - DHT11
    - DHT11's power supply is 3-5.5V DC
    - Single-bus data format is used for communication and synchronization between MCU and DHT11 sensor. One communication process is about 4ms
  2. Light intensity sensor ALS-PT19
    - Wide supply voltage range, 2.5V to 5.5V
    - Guaranteed temperature performance, -40°C to 85°C
    - Low sensitivity variation across various light sources
  3. Raindrops Detection Sensor Module

- The output in the form: digital switching outputs (0 and 1) and analog voltage output
- Operating voltage: 3.3V-5V
- 4. Bluetooth module HC-06
  - Has a built-in 2.4GHz antenna; user needn't test the antenna.
  - Has the external 8Mbit FLASH
  - Can work at the low voltage (3.1V~4.2V). The current in pairing is in the range of 30~40mA. The current in communication is 8mA.
  - Standard HCI Port (UART or USB)

## ***Implementation:***

DHT11 communicates with the MCU using a one-wire serial transmission. We can divide transmission into five stages:

1. 8 bit - integral humidity data
2. 8 bit - decimal humidity data
3. 8 bit - integral temperature data
4. 8 bit - decimal humidity data
5. 8 bit - checksum

At the beginning we have the initialization phase, then the sensor sends data, MCU decides whether it is logic "1" or "0" based on the pulse length.

Other sensors are connected with an analog-digital converter built in board. After the raw conversion, the result is divided by 1024 (10-bit ADC resolution) and separated into integer parts and decimal parts.

Then all information is saved in structure and can be saved or printed on a terminal or Bluetooth application.

## ***Validation***

### ***Labview implementation***

The four graphs below show the measurement characteristics of our sensors. It was done in the LabVIEW environment, the LabVIEW project is included in the files.

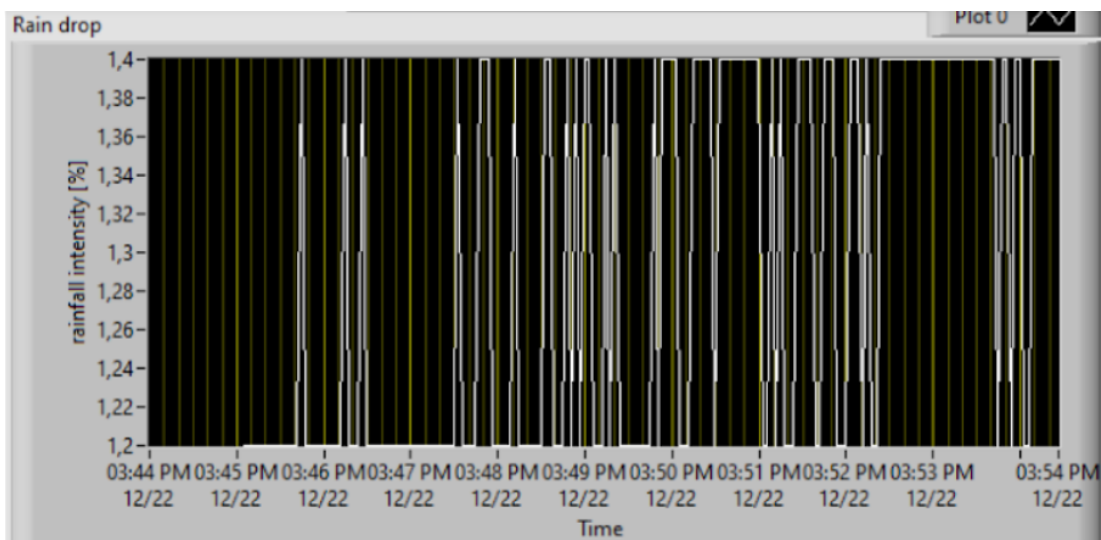


Photo no. 1 - Graph of raindrop intensivist displayed on Labview program.

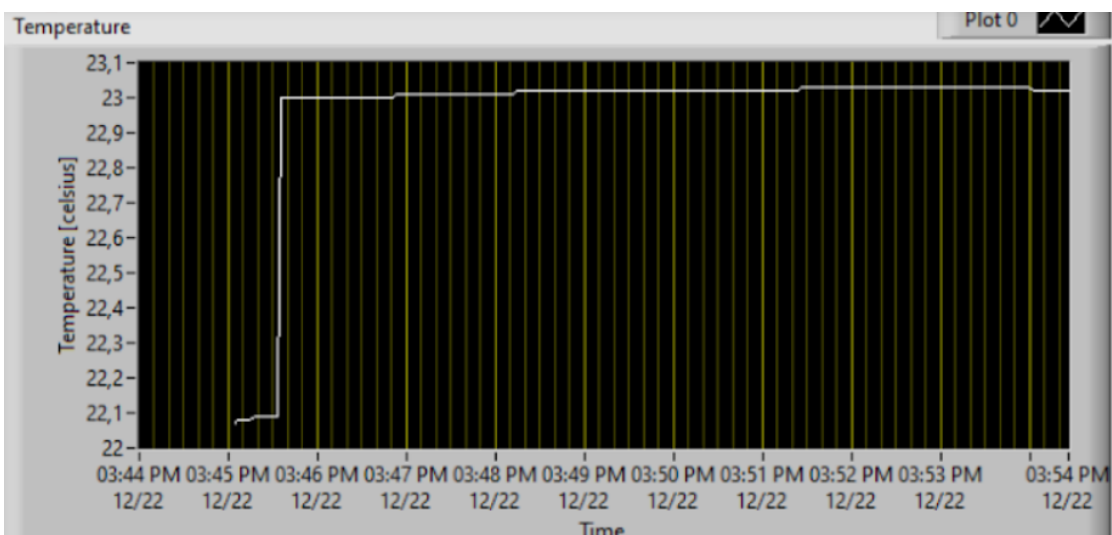


Photo no. 2 - Graph of temperature intensivist displayed on Labview program.

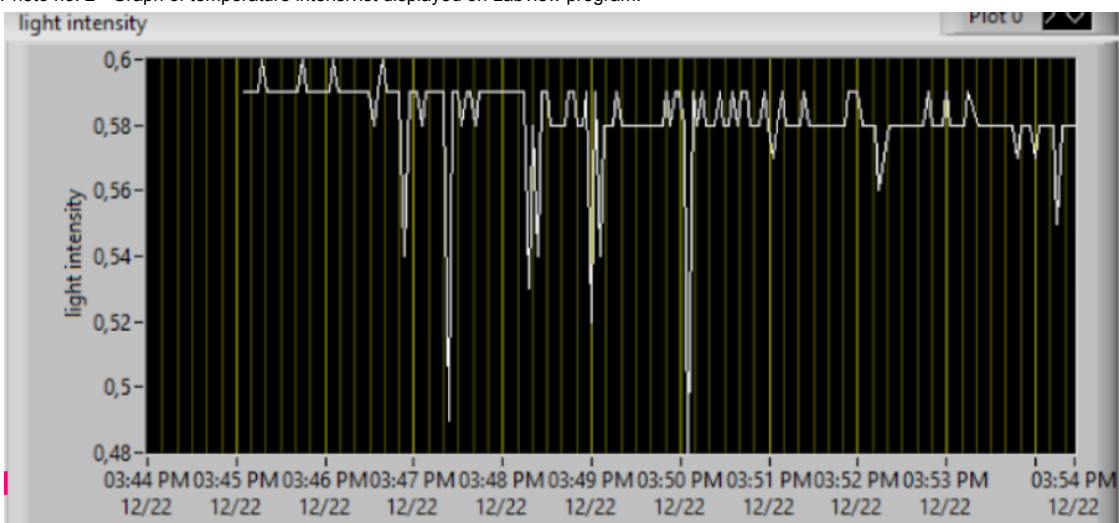


Photo no. 3 - Graph of light intensivist displayed on Labview program.

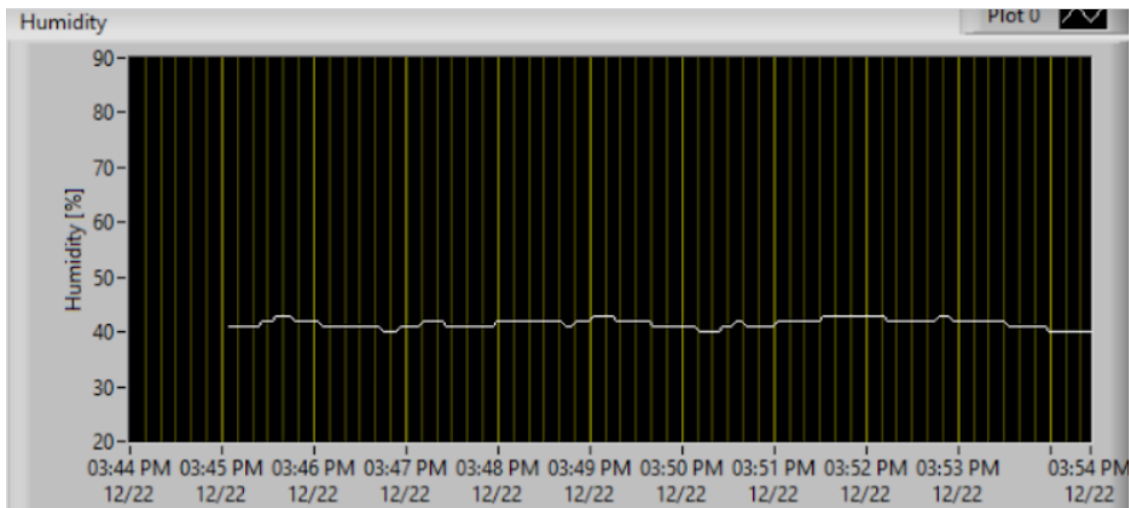


Photo no. 4 - Graph of humidity intensivist displayed on Labview program.

## Terminal

Below is a screenshot of the measurement test for our sensors. Use putty to connect to the appropriate COM port.

The putty program should be configured as follows: Connection type: Serial, Serial line on which the evacuation board is connected (check in the device manager), Speed: 9600 and Window-> Translation-> Remote character set: Win1250

n	Humidity [%]	Temperature [°]	RAIN_VOLTAGE [V]	LIGHT_VOLTAGE [V]
1	46.0	23.1	4.34	0.36
2	46.0	23.1	3.71	0.35
3	46.0	23.1	4.26	1.84
4	46.0	23.1	1.48	4.83
5	46.0	23.2	2.66	0.53
6	46.0	23.2	2.95	1.6
7	46.0	23.4	3.33	1.21
8	46.0	23.4	3.66	0.30

Photo no. 5 - display all information in table format using computer program "putty"

## Bluetooth module

Below is a screenshot of the Bluetooth communication test. We download a free terminal application to display data on the terminal.

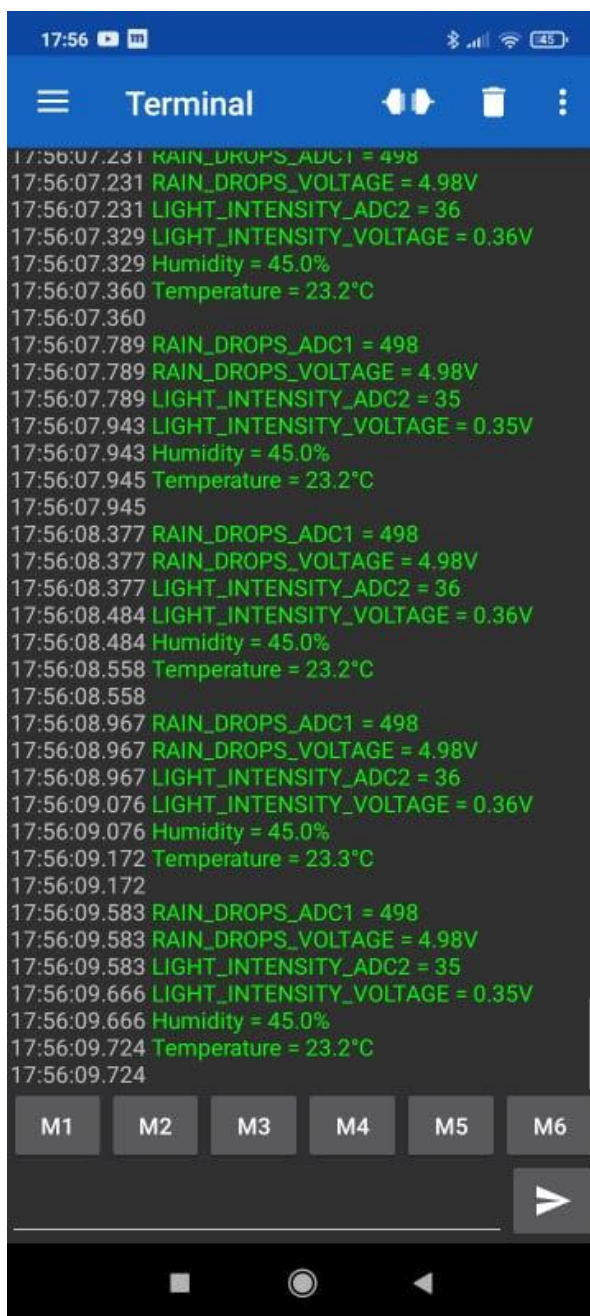
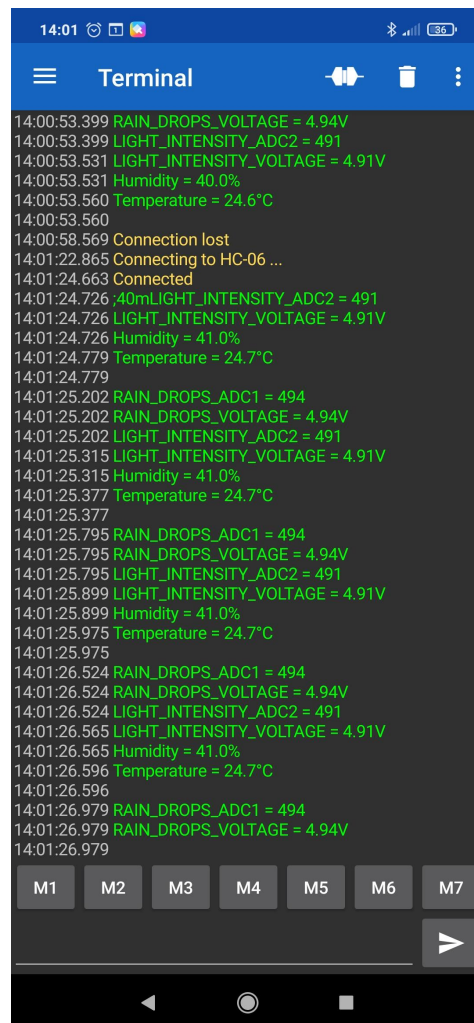


Photo no. 6 - display all information on a smartphone using application "Serial Bluetooth Terminal"



## Functionality tests.

### Bluetooth disconnection.



```

14:00:53.399 RAIN_DROPS_VOLTAGE = 4.94V
14:00:53.399 LIGHT_INTENSITY_ADC2 = 491
14:00:53.531 LIGHT_INTENSITY_VOLTAGE = 4.91V
14:00:53.531 Humidity = 40.0%
14:00:53.560 Temperature = 24.6°C
14:00:53.560
14:00:58.569 Connection lost
14:01:22.865 Connecting to HC-06 ...
14:01:24.663 Connected
14:01:24.726 LIGHT_INTENSITY_ADC2 = 491
14:01:24.726 LIGHT_INTENSITY_VOLTAGE = 4.91V
14:01:24.726 Humidity = 41.0%
14:01:24.779 Temperature = 24.7°C
14:01:24.779
14:01:25.202 RAIN_DROPS_ADC1 = 494
14:01:25.202 RAIN_DROPS_VOLTAGE = 4.94V
14:01:25.202 LIGHT_INTENSITY_ADC2 = 491
14:01:25.315 LIGHT_INTENSITY_VOLTAGE = 4.91V
14:01:25.315 Humidity = 41.0%
14:01:25.377 Temperature = 24.7°C
14:01:25.377
14:01:25.795 RAIN_DROPS_ADC1 = 494
14:01:25.795 RAIN_DROPS_VOLTAGE = 4.94V
14:01:25.795 LIGHT_INTENSITY_ADC2 = 491
14:01:25.899 LIGHT_INTENSITY_VOLTAGE = 4.91V
14:01:25.899 Humidity = 41.0%
14:01:25.975 Temperature = 24.7°C
14:01:25.975
14:01:26.524 RAIN_DROPS_ADC1 = 494
14:01:26.524 RAIN_DROPS_VOLTAGE = 4.94V
14:01:26.524 LIGHT_INTENSITY_ADC2 = 491
14:01:26.565 LIGHT_INTENSITY_VOLTAGE = 4.91V
14:01:26.565 Humidity = 41.0%
14:01:26.596 Temperature = 24.7°C
14:01:26.596
14:01:26.979 RAIN_DROPS_ADC1 = 494
14:01:26.979 RAIN_DROPS_VOLTAGE = 4.94V
14:01:26.979

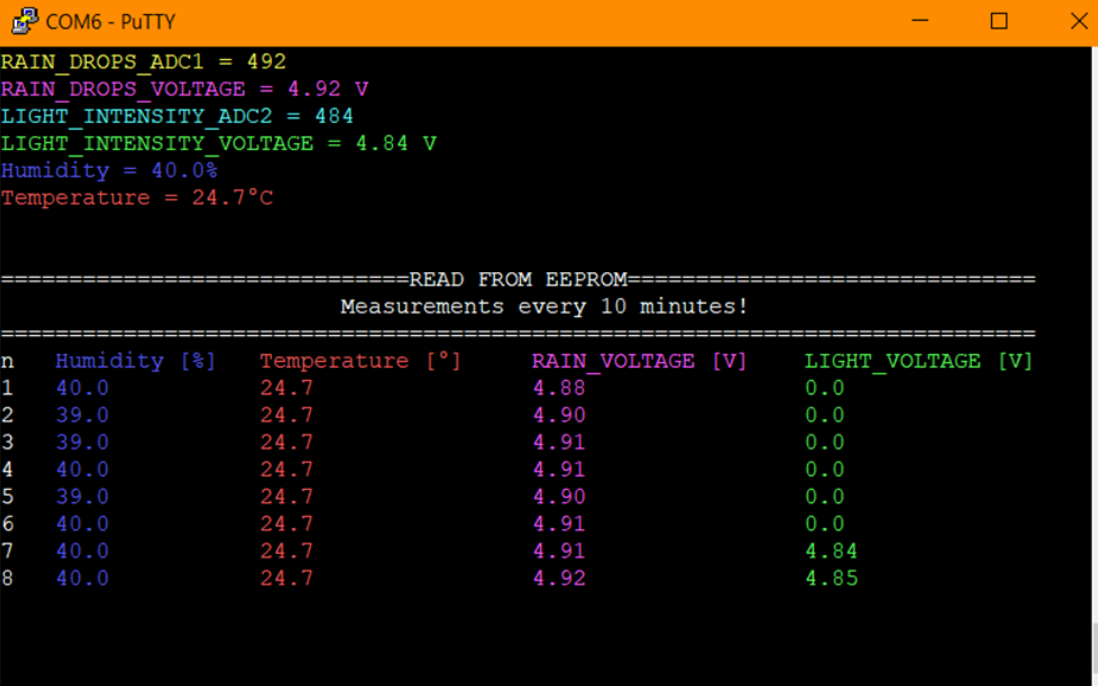
```

Photo no. 7 - lost connection with bluetooth sensor

After lost connection (lack of power, bluetooth error) application will wait for resuming. Other applications can not support this functionality therefore we need to manually reset the connection or renew the connections.

When we have a connection to the terminal (Serial port) we need to manually reset the connection in program such as "putty".

### Light sensor disconnection.



```

COM6 - PuTTY
RAIN_DROPS_ADC1 = 492
RAIN_DROPS_VOLTAGE = 4.92 V
LIGHT_INTENSITY_ADC2 = 484
LIGHT_INTENSITY_VOLTAGE = 4.84 V
Humidity = 40.0%
Temperature = 24.7°C

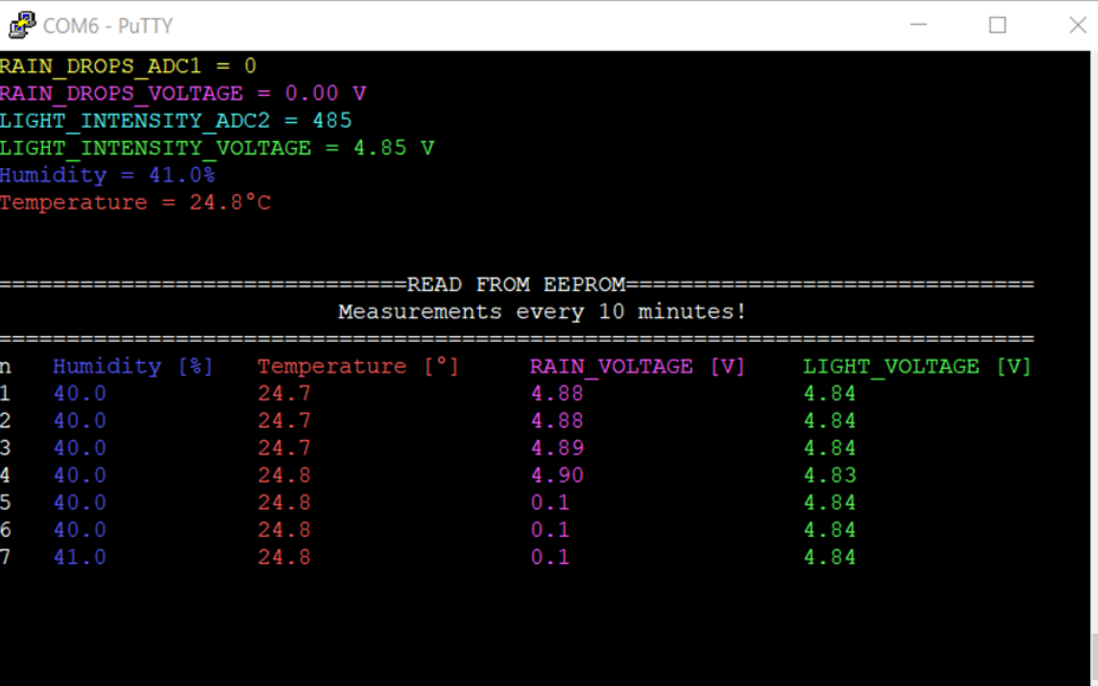
=====READ FROM EEPROM=====
Measurements every 10 minutes!
=====
n  Humidity [%]  Temperature [°]  RAIN_VOLTAGE [V]  LIGHT_VOLTAGE [V]
1  40.0          24.7            4.88              0.0
2  39.0          24.7            4.90              0.0
3  39.0          24.7            4.91              0.0
4  40.0          24.7            4.91              0.0
5  39.0          24.7            4.90              0.0
6  40.0          24.7            4.91              0.0
7  40.0          24.7            4.91              4.84
8  40.0          24.7            4.92              4.85

```

Photo no. 8 - lost connection with light sensor

After disconnecting the light sensor, the device will continue to send the rest of the data and the value of the light intensity will be zero.

### Raindrop sensor disconnection.



```

COM6 - PuTTY
RAIN_DROPS_ADC1 = 0
RAIN_DROPS_VOLTAGE = 0.00 V
LIGHT_INTENSITY_ADC2 = 485
LIGHT_INTENSITY_VOLTAGE = 4.85 V
Humidity = 41.0%
Temperature = 24.8°C

=====READ FROM EEPROM=====
Measurements every 10 minutes!
=====
n  Humidity [%]  Temperature [°]  RAIN_VOLTAGE [V]  LIGHT_VOLTAGE [V]
1  40.0          24.7            4.88              4.84
2  40.0          24.7            4.88              4.84
3  40.0          24.7            4.89              4.84
4  40.0          24.8            4.90              4.83
5  40.0          24.8            0.1               4.84
6  40.0          24.8            0.1               4.84
7  41.0          24.8            0.1               4.84

```

Photo no. 9 - lost connection with raindrop sensor

After disconnecting the raindrop sensor, the device will continue to send the rest of the data and the value of the raindrop will be close to zero.

*DHT11 (humidity and temperature) sensor disconnection.*

Loss of connection with the sensor is the most inexpedient situation because the program will stack in an infinite loop when is waiting for a response from DTH11. When such a situation occurs, you need to reboot the device.

**Power consumption.**

Situation	Average power consumption
All sensors are connected	15 mA
DTH11 sensor	0,5 mA
Bluetooth sensor	0,2 mA ~ *3 mA
light sensor	0,5 mA
raindrop sensor	4 mA

Table no. 2 - Power consumption of device sensors

\* 3 mA amper is power consumption while Bluetooth module sends data.