

Klimator IoT Sensors

Device model descriptions for the BA-project Spring 2024

Revision history

Date	Author	Comments	Revision
2024-02-27	Mohamed Elmi	Adjusted for the BA-project spring 2024	3
2023-01-23	Mohamed Elmi	Added data sizes for measurement parameters. Renamed rainFall to precipitation.	2
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Introduction

This document describes the device models of the Klimator IoT sensors, their measurement parameters in terms of parameter name, measurement unit and measurement precision. In addition, any device model specific features are described.

The device model descriptions are grouped into appropriate categories.

Potential faults and errors

Heartbeat

The devices are expected to communicate back to our backend at minimum once a day, typically around every 15min for weather stations in the winter season. The water level devices are expected to communicate back in and around every 15min, but the customer can also set a custom transmission interval.

The person-counter devices are different in that they measure and transmit once every hour if there has been any activity in that interval otherwise, they send an empty "heartbeat" message after 24 hours of non-activity registered.

Overall, it is safe to use 24 hours as the minimum "heartbeat" interval.

Faulty measurements

Weather stations

For the weather stations we are interested in having the following ranges for the parameters.

Road temperature

For the p100 thermocable used for these devices, we are interested in the ranges -30 to +60. We have experienced that it generates faulty < -30C values for broken thermocable that needs to be replaced. Naturally it is possible to have perfectly < -30C values if the conditions are there and there is no brake in the thermocable.

Air temperature

We are also aiming for the ranges -30C to +40 to be on the safe side of the current climate and that it is not stuck in given value.

Humidity

We have measured in the ranges 30 – 100%. If it is stuck on given value especially 100% then we have experienced that it is due to faulty sensor.

Water level

The water level devices that use an ultrasonic sensor, during installation we measure the distance from the sensor down to the bottom of the place it is measuring for. This distance from the sensor to the bottom we call boundary distance. Due to various reasons the ultrasonic wave can be reflected off surfaces close by and generates a distance that is larger than the boundary distance. We regard any distance larger than the boundary distance as a reflection.

Also, we have specific distance values generated by the sensor that are particularly faulty. These are anything less than 26cm and everything above 495cm.

Person counter

Due to the installation procedure and placement, we expect any counts above 100 persons in 10min intervals to be of faulty measurement that are triggered by external factors such as IR radiation and irregular movements in front of the sensor.

Message drop

The vast majority of our device models generate an incremental sequence number for measurements and transmissions. This is used to figure out if we have any break in the sequence and have a tolerance of around 10%. The message drops can be caused by various issues, such as low network coverage. It is also possible that the device firmware crashes and restarts the sequence number or that it has been serviced.

Battery

There are different types of batteries used in our device models that use different chemistries thus it is not safe to expect all of them to follow a linear discharge curve. For this project we can assume that the safe range is 7.4v – 3v.

Weather stations

WSense

WSense represent the weather station device with multiple sensors. The device continuously measures the various parameters based on the defined measurement interval and transmits measurements after the defined transmission interval.

Parameters

Name	Unit	Precision	Data size	Description	Type
airTemperature	°C	0.1°C	2 bytes	Measured air temperature.	Measurement
roadTemperature	°C	0.1°C	2 bytes	Measured road temperature.	Measurement
airHumidity	%	1 %	1 byte	Relative air humidity	Measurement
batteryLevel	V	0.01V	2 bytes	Battery voltage at the time of transmission	Measurement
seqNumber	N/A	1	4 bytes	Sequence number of the measurement	Metadata
rssi	dBm	1 dBm	1 byte	Receiver strength string indicator	Network
time	date-time	N/A	24 bytes	Measurement timestamp in ISO 8061 compliant format	Metadata
createdAt	date-time	N/A	24 bytes	Timestamp when created in the backend in ISO 8061 compliant format	Metadata

Payload structure

```
[{
  "networkId": "14484CA85F912",
  "airTemperature": -1.5,
  "roadTemperature": -2.5,
  "airHumidity": 95,
  "batteryLevel": 6.5,
  "time": "2023-12-01T00:03:00.000Z",
  "createdAt": "2023-12-01T00:04:38.502Z"
},
{
  "networkId": "14484CA85F912",
  "createdAt": "2023-12-01T00:04:36.418Z",
  "time": "2023-12-01T00:04:36.322Z",
  "rssi": 25,
  "rsrq": 4,
  "seqNumber": 6687,
  "acxti": 1,
  "acmi": 5,
  "firmwareVersion": 1.7,
  "eventNumber": null,
  "messageType": "cfg"
}]
```

Device object structure

```
{
  "name": "Mårbyleden, Märsta",
  "networkId": "14484CA85F912",
  "geo": {
    "lat": 59.62838453711938,
    "lon": 17.885008770989145
  },
  "properties": {
    "probeTempOffset": -0.9
  },
  "lastSeenAt": "2023-03-08T15:08:06.328Z"
}
```


WRSense

WRSense represent the weather station device with multiple sensors. The device continuously measures the various parameters based on the defined measurement interval and transmits measurements after the defined transmission interval. In addition, this device model has also a rain sensor attached to it.

Parameters

Name	Unit	Precision	Data size	Description	Type
airTemperature	°C	0.1°C	2 bytes	Measured air temperature.	Measurement
roadTemperature	°C	0.1°C	2 bytes	Measured road temperature.	Measurement
airHumidity	%	1 %	1 byte	Relative air humidity	Measurement
precipitation	mm	0.2mm	2 bytes	Measured precipitation in between measurement intervals.	Measurement
batteryLevel	V	0.01V	2 bytes	Battery voltage at the time of transmission	Measurement
seqNumber	N/A	1	4 bytes	Sequence number of the measurement	Metadata
transmissionSeqNumber	N/A	1	4 bytes	Transmission sequence number	Metadata
rsi	dBm	1 dBm	1 byte	Receiver strength string indicator	Network
time	date-time	N/A	24 bytes	Measurement timestamp in ISO 8061 compliant format	Metadata
createdAt	date-time	N/A	24 bytes	Timestamp when created in the backend in ISO 8061 compliant format	Metadata

Payload structure

```
[
  {
    "roadTemperature": 1.04,
    "seqNumber": 1,
    "airTemperature": 2.79,
    "airHumidity": 85,
    "precipitation": 0,
    "batteryLevel": 5.02,
    "rssi": -76,
    "rssiMapped": 19,
    "transmissionSeqNumber": 1,
    "firmwareVersion": "v2.5",
    "networkId": "E067-6EB9-0614-9339",
    "deviceTypeNumber": 11,
    "time": "2023-12-25T19:01:13.000Z",
    "createdAt": "2023-12-25T19:03:47.094Z"
  },
  {
    "roadTemperature": 0.93,
    "seqNumber": 2,
    "airTemperature": 2.46,
    "airHumidity": 86,
    "precipitation": 0,
    "batteryLevel": 5.03,
    "rssi": -75,
    "rssiMapped": 19,
    "transmissionSeqNumber": 2,
    "firmwareVersion": "v2.5",
    "networkId": "E067-6EB9-0614-9339",
    "deviceTypeNumber": 11,
    "time": "2023-12-25T19:05:34.000Z",
    "createdAt": "2023-12-25T19:08:41.772Z"
  }
]
```

Device object structure

```
{
  "name": "Kirkholt + Kamera + regn",
  "networkId": "14484CA85F3FB",
  "geo": {
    "lat": 57.30122089593072,
    "lon": 10.156051102833912
  },
  "properties": {
    "batteryLevel": 5.03,
    "firmwareVersion": "v2.5",
    "probeTempOffset": 0.5
  }
}
```

Water level sensors

USense

USense represent the water level sensors that use ultrasonic sensor to measure the distance from sensor to water surface, which then is computed to actual relative water level.

Parameters

Name	Unit	Precision	Data size	Description	Type
waterLevel	m	0.01m	2 bytes	Computed water level based on measured distance to water surface. In proper elevation if elevation parameter is set, otherwise elevation 0 is assumed – effectively the relative water level.	Measurement
distance	m	0.01m	2 bytes	Distance from sensor to water level surface.	Measurement
batteryLevel	V	0.01V	2 bytes	Battery voltage at the time of transmission	Measurement
seqNumber	N/A	1	4 bytes	Sequence number of the measurement	Metadata
rss	dBm	1dBm	1 byte	Receiver strength string indicator	Network
time	date-time	N/A	24 bytes	Measurement timestamp in ISO 8061 compliant format	Metadata
createdAt	date-time	N/A	24 bytes	Timestamp when created in the backend in ISO 8061 compliant format	Metadata

Device object structure

```
{
  "name": "Svanevej 17 - Overløb",
  "networkId": "14484CA7BED21",
  "geo": {
    "lat": 55.79046820230201,
    "lon": 9.734068773521798
  },
  "properties": {
    "boundary_distance": 186,
    "overflowThreshold": 64,
    "firmwareVersion": 1.4,
    "batteryLevel": 6.1
  }
}
```

Payload structure

```
[
  {
    "networkId": "14484CA7BED21",
    "createdAt": "2023-12-11T08:02:00.088Z",
    "time": "2023-12-11T08:01:59.943Z",
    "rssi": 13,
    "seqNumber": 3,
    "firmwareVersion": 1.4,
    "messageType": "cfg"
  },
  {
    "networkId": "14484CA7BED21",
    "distance": 1.66,
    "waterLevel": 0.03,
    "batteryLevel": 6.3,
    "time": "2023-12-11T08:02:05.000Z",
    "createdAt": "2023-12-11T08:02:25.120Z"
  }
]
```

Person counters

PeopleSense

PeopleSense represents the sensor used to count people passing in front of the sensor. The sensor aggregates the counts in 10min intervals and sends measurements once in hour if there has been any activity.

Parameters

Name	Unit	Precision	Data size	Description	Type
personCount	N/A	1	2 bytes	10min aggregated count of persons passing in front of the sensor.	Measurement
batteryLevel	V	0.01V	2 bytes	Battery voltage at the time of transmission	Measurement
seqNumber	N/A	1	4 bytes	Sequence number of the measurement	Metadata
rssi	dBm	1dBm	1 byte	Receiver strength string indicator	Network
createdAt	date-time	N/A	24 bytes	Timestamp when created in the backend in ISO 8061 compliant format	Metadata

Device object structure

```
{
  "name": "Tirsbæk Strand",
  "networkId": "1FA5528",
  "geo": {
    "lat": 55.7090972,
    "lon": 9.6317105
  },
  "properties": {}
}
```

Payload structure

```
[
  {
    "rssi": -140,
    "batteryLevel": 5.65,
    "networkId": "1FA5528",
    "personCount": 2,
    "seqNumber": 1237,
    "time": "2023-12-01T05:29:52.000Z",
    "createdAt": "2023-12-01T06:19:54.066Z"
  },
  {
    "rssi": -140,
    "batteryLevel": 5.65,
    "networkId": "1FA5528",
    "personCount": 5,
    "seqNumber": 1237,
    "time": "2023-12-01T05:39:52.000Z",
    "createdAt": "2023-12-01T06:19:54.067Z"
  }
]
```