



POWERED BY
NOKEVAL



Kube-Sky-RHT -P -CO2 -PIDVOC

Manual

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Introduction

The Kube-Sky-RHT series consists of several models of wireless indoor air quality transmitters. All models have a LoRa based Nokeval Sky radio with a very good range.

Models

The Kube-Sky-RHT is the basic model. It measures temperature and humidity only. With moderate settings, the battery life will exceed five years.

When the model name has a -CO₂ suffix, the device also measures carbon dioxide concentration up to 5000 ppm. **This model needs to see fresh air at least once a week to be able to auto calibrate itself.** The minimum time spent in the fresh air should be at least five measurement intervals. This model is not suitable for premises that are continuously occupied; such premises result carbon dioxide measurement to show smaller values than should. The CO₂ model can be used with batteries, however the battery life will be shorter than on the basic model. An external power supply can be used to overcome this.

The model with -PIDVOC suffix has a high quality photoionization detector for detecting volatile organic compounds. The sensor is factory calibrated for isobutylene, and it can operate in a continuous exposure unlike many sensors that will auto-zero themselves. The sensitivity goes to tens of ppb. This model must be powered with an external supply.

Sky radio

The Sky devices use the Semtech LoRa modulation technique that allows unforeseen wireless range in a battery powered transmitter. The protocol used is defined by Nokeval, called Sky, which means that this device is not compatible with the LoRaWAN infrastructure.

The modulation has some parameters to define its operation. With the “maximal” settings, a very long range can be reached, but at the expense of high battery and radio band consumption. One radio transmission can last approx. 2 seconds (compared to 20 ms of the Nokeval MTR series). This means that the number of transmitters within the range must be limited in order to avoid collisions and to allow radio time for each. It is not practical to use a short interval between transmissions; 10 to 30 minutes is the recommended interval range.

When the maximal range is not necessary, the parameters must be adjusted for lower battery and band consumption. All the devices within one network must share the parameters, because the receiver can only listen with one set of parameters at a time. Consequently the parameters must be selected according to the most distant device. It is also possible to adjust the transmission power. The devices that are closer to the receiver can use a lower power setting.

Before using the 433 MHz radio, make sure it is legal in your country.

Installation

Attachment

Place the device to the measuring location with one of the following ways:

- Mount the Kube wall holder to a wall with two countersunk head screws (ST 3.0 x 20) using appropriate screw anchor depending wall material. Mount the holder with its hooks pointing upwards, and snap the transmitter to it.
- Set the Kube standing on a shelf, on top of a cabinet or some other suitable surface. You may attach the provided self-adhesive bumpers to the bottom (the basic RHT only model may not be supplied with the bumpers).

Power supply

The RHT model comes with batteries installed, ready to be used. The CO2 model is supplied with the batteries.

If you are to supply the device with a USB charger, plug one to the micro USB connector at the bottom of the device. A 500 mA charger is more than sufficient. The indicator LED will light shortly.

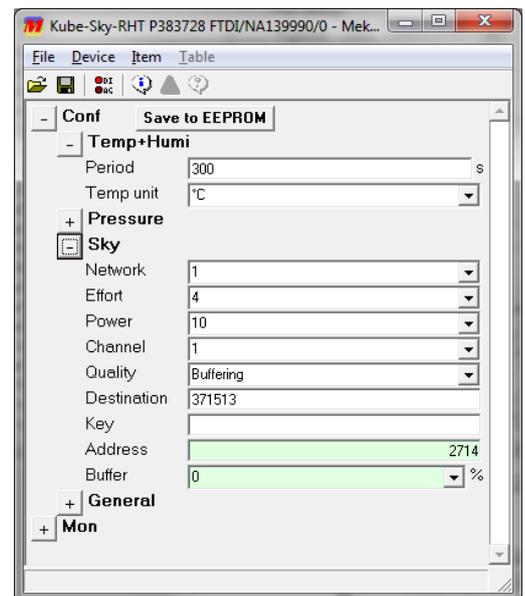
Alternatively, an external 5 V DC supply can be connected to the round holes of the push-in spring connector J11 with 0.2-0.5 mm² conductors, the positive wire to the left. Strip the wires approximately 6 mm. The cables can be detached by pushing a small flat screwdriver or some other spike to the rectangular holes.

To check that the device is powered, push the button once and check that the indicator LED lights.

Configuration

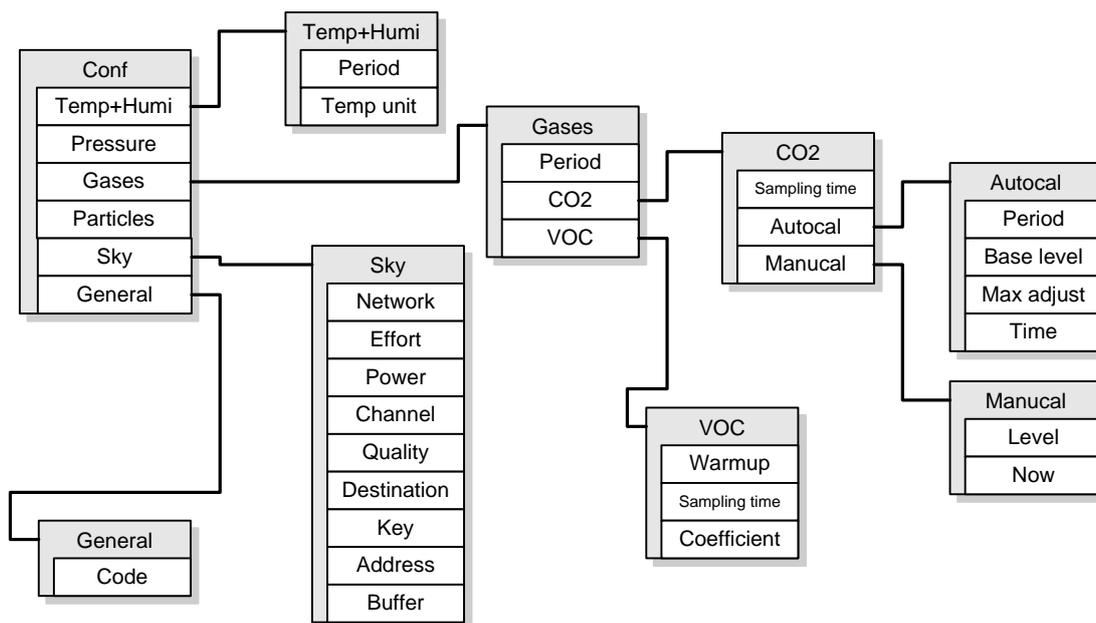
The device works with its default settings, but you can change the settings if needed:

- Connect a Micro-USB-B cable to the connector, and the other end of the cable to a computer.
- If Windows requests for a driver, download it at www.nokeval.com > Support, unzip it to a temporary folder, and show that directory as the location for the driver.
- Launch the Mekuwin program (available for free at www.nokeval.com).
- In Mekuwin, choose Port=Kube (COMxx), Protocol=Modbus, Address=1. Click Direct.
- A new window will open. It has branches for different configurations.



Menu chart

This is the configuration menu of firmware V1.0. The different versions may have slight differences and lacking features. The menu is divided to submenus for each quantity group. In addition to those, it has a submenu for the wireless network settings and another submenu for general settings.



Sensor menu settings

Period

This setting determines the measuring and transmitting period of the various quantity groups, such as gases, particles, or pressure. Temperature and humidity form one group. The allowed range is 5...7200 seconds. This setting has strong impact on the battery life. Avoid using too short periods, because it will cause faster battery exhaustion. By setting the period to value 0, the measurement is turned off.

The default is 300 for temperature, humidity and lux, and 1800 for gases and particles.

Temp unit

Temperature unit °C or °F.

Gases-> CO2 -> Sampling time

This setting determines how many seconds CO₂ concentration is measured. The bigger the value, the less noisy reading, but the battery is exhausted faster. A good value is 30 seconds when externally powered, or 15 for battery power.

Gases-> CO2 -> Autocal -> Period (h)

This setting determines how many hours passes before the device performs an auto calibration. A good period setting is 192 hours which is a little more than a week as the device timer is not accurate, assuming that the fresh air occurs only once a week. If you do not want the auto calibration, set 0 (zero) here. Then it is advisable to perform a manual calibration regularly.

Gases-> CO2 -> Autocal -> Base level

The device looks for the lowest reading from the period and if that differs from this setting, the device adjusts the future measurement readings down or up as needed. This is what the auto calibration means. The base level is typically 400, which is the clean air concentration or a little more.

Gases-> CO2 -> Autocal -> Max adjust

This setting limits the maximum adjust that is done at a time. Good value is 50.

Gases-> CO2 -> Manual

This allows manually calibrating the CO2 offset. Enter the real CO2 level and press the Now button. Wait for a moment.

Radio settings

The Sky menu contains the settings for the wireless network.

Network: To prevent mixing the different networks (and users) data, the network address should be set to some value not used nearby. In most cases a random value 1 to 255 is OK. All the devices within one network must share the value. The receiver will only accept packets that have the matching network address. If an encryption key is used, it is not necessary to use an unique network address as the encryption itself will prevent the networks from mixing. Default 1.

Effort: The modulation effort. The bigger value, the longer range but the more battery and radio band consumption. This single setting controls the LoRa bandwidth and spreading parameters as in the table below. Increasing the effort one step will coarsely add 2.5 dB in the link budget, or 30% of open-space range, but also double the battery consumption caused by the radio.

The range estimates are only estimates, the real range depends heavily on objects on the radio path. Especially metal walls will severely attenuate the radio waves.

Effort setting	Bandwidth	Spreading factor	Estimated indoor range 40...35 dB/decade	Estimated outdoor range 30 dB/decade
1	250 kHz	7	90...260 m	1100 m
2	250 kHz	8	100...300 m	1300 m
3	250 kHz	9	120...360 m	1600 m
4	250 kHz	10	140...420 m	1900 m
5	250 kHz	11	160...500 m	2300 m
6	250 kHz	12	180...590 m	2800 m
7	125 kHz	12	220...720 m	3500 m

The default Effort is 4, which is good for many tasks. Each device in the network must share the value.

The Effort setting can be set to Custom position; then it is possible to set the bandwidth and spreading parameters independently, as well as adjust the frequency steplessly within 433.3 to 434.5 MHz. Normally this should not be necessary.

Power: The transmission power; 10 means the maximum power and each step reduces one dB. A lower value should be selected to conserve battery and to avoid disturbing other users of the band whenever possible. However this setting will not affect the battery consumption as much as the Effort setting, which means that the first mean to lower the battery consumption should be lowering the effort if possible. While each device in the network must share the Effort setting, the Power can be adjusted individually. In practice, the Effort is defined by the most distant device, and the Power of the nearer devices can be lowered.

Channel: The radio frequency channel. If several LoRa/Sky networks exists within the same area, a different frequency should be selected for each network. The radio frequency is $433.3 + 0.2 \text{ MHz} \cdot \text{channel}$ (channel-1), i.e. the first channel is 433.3 MHz, second 433.5 etc. When using Efforts below 7 (bandwidth of 250 kHz), the nearby networks (systems) should have channels of at least two steps apart, e.g. 1 and 3 to avoid overlap. The channel 4 uses 433.9 MHz which is the most crowded frequency on this band, so it should be avoided. To sum up, good channels are 1, 3, 5, and 7. Each device must use the same channel.

Quality: This setting has three options affecting the reliability of the packet delivery:

- Unidirectional: This device will transmit each reading once not expecting any acknowledgement. If the packet is lost due to a collision with another transmission or any disturbance, it is lost.

- **Bidirectional:** After transmitting a packet, this device will listen for an acknowledgement from a receiver and retransmit up to two times if not getting acknowledged. If there is no acknowledgement, this device will discard the packet and try only once for the next time. This setting increases the probability of successful delivery significantly but does not guarantee it.
- **Buffering:** This device will keep retransmitting each reading until acknowledged. The readings will be buffered until delivered as far as the buffer is not full. The buffer can hold approx 400 packets. When the buffer is more than half full, the measurement intervals will be temporarily increased to slow down the filling of the buffer.

Each device can have an individual choice.

Destination: When using the Bidirectional or the Buffered quality, the receiver that is supposed to acknowledge must be manually defined. Enter the radio address of the receiver here. The system can have several receivers, each picking the same radio packets, but only one can acknowledge to avoid collisions.

Key: An authentication and encryption key for the radio. If an authentication is not desired, leave this blank. Then it is quite easy to eavesdrop and disrupt the radio traffic. To get a secured operation, enter any text string (up to 16 characters). Use the same key in the receiver, and consequently in all the other transmitters.

Address: The radio address of this device. Can't be changed here.

Buffer: How many percents of the buffer is used. Should be 0 when the network is operating smoothly.

Other settings

General -> Code

If a password (six letters or digits) is entered here, the same password has to be known when next time accessing the settings.

Monitor menu

In the mon(itor) menu, you can watch the measurement readings.

Temperature: The temperature reading in °C.

Humidity: The relative humidity reading in %RH.

Barometer: The air pressure reading. The feature is not in use yet.

CO2: The carbon dioxide concentration in ppm.

VOC: The volatile organic compound measurement reading in ppm. The feature is not in use yet.

Batt: The estimated remaining battery capacity in percents.

ExtPow: Is an external power supply connected.

Switches: The button status for the manufacturer's testing.

Cal menu

The calibration menu settings are only for the manufacturer use, and they are not explained in this manual.

Quantity channels

The device sends the measurement data with its device address using the channels as follows:

Channel	Physical quantity	Unit
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1	Temperature	°C or °F
2	Relative humidity	%RH
4	Absolute air pressure	mbar
5	Carbon dioxide concentration	ppm
6	Volatile organic compound concentration (isobutylene)	ppm
7	Differential pressure	Pa
21	PM1 particulate matter	µg/m ³
22	PM2.5 particulate matter	µg/m ³
23	PM10 particulate matter	µg/m ³
24	40µm particulate matter	

These channel numbers are used when configuring the device for the Ovaport service or any other type of receiving system.

Maintenance

Not used for a while

If the device is not used for months, it is recommended to remove at least one battery, this will stop all the operation.

Checking the status

Now and then, it is advisable to press the button to light up the indicator located next to the USB connector. If it lights green, everything is fine. If the indicator blinks red, count the number of blinks and compare to the table below.

Red blinks	Meaning	What to do
2	Battery low	Replace the batteries soon.
3	Radio error – the radio is not operating	Send the device for repair.
4	Network error – the device is not acknowledged by the receiver	Check that the Sky settings match the receiver (also the Destination), and that the receiver is operating and not too far away.
5	Internal A/D converter failure	Send the device for repair.
6	Temperature/humidity sensor failure	Send the device for repair.
7	Absolute pressure sensor failure	Send the device for repair.
8	Absolute pressure sensor failure	Send the device for repair.
9	Sensor module failure (CO2, VOC etc)	Send the device for repair.

If the indicator doesn't light up at all, the device is not operating, probably due to a lacking power.

Active state

By pressing the button twice, the device goes for 15 minutes to an active state, where it lights the indicator continuously and sends the measurement readings frequently, e.g. the temperature and humidity at every 15 seconds. This may be useful when troubleshooting the system.

Press the button once to exit this state. Even without pressing the button, the device will return to the normal state in 15 minutes.

Changing the batteries

- Remove the device from the wall holder where applicable by pushing it upwards.
- Remove the two PZ1 screws and open the cover.
- Replace the batteries with two new LR6 (alkaline AA) batteries observing the polarity. Avoid touching the electronics.

Cleaning

If there is visible dust inside the device, blow it away periodically with pressurized air while avoiding too strong pressure. The enclosure exterior can be wiped with a damp cloth soaked in soap or isopropanol, but no drop of liquid must enter the device.

Recalibration

Temperature and humidity: These sensors do not normally need recalibration, but can be checked if desired.

CO2: This sensor does not normally need recalibration. Its gain is quite stable, while the offset (baseline) is automatically calibrated weekly (unless disabled intentionally).

VOC: This sensor may need periodic recalibration and service. The more dirty environment, the more often. Once per year is a good starting point.

Specifications

Environment

Storage	-30...+60 °C, non-condensing
Operation temperature	0...+60 °C
Operation humidity	Non-condensing
Protection class	IP20
Enclosure material	Plastic (ABS+PC)

Measurements

Weight	RHT: 130 g RHT-P-CO2: 140 g with batteries RHT-PIDVOC: TBD
Dimensions	Width: 75 mm Height: 95 mm Depth: RHT 28 mm, -CO2 and -VOC 48 mm, including the wall mount

Internal batteries

Type	LR6 (AA 1.5 V alkaline). For the advertized battery life, a high quality battery should be used, e.g. Energizer EN91
Battery life	TBD

External supply USB

Connector	Micro USB Type B 5 V 100 mA, no suspend function
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External supply with a cable

Connector	Push-in spring connector for 0.2-0.5 mm ² conductors
Voltage	5 V ±0.5 V
Consumption	Average about 5 mA, momentarily max 100 mA

Sky radio

Antenna	Internal
Center frequency	433.3...434.5 MHz user adjustable
Bandwidth	max 300 kHz OBW
Transmitting power	max 10 dBm E.I.R.P.
Open space range	about 10 km with maximal parameters
Indoor range	150 to 500 m typically

Temperature measurement

Measurement range	-20...+50 °C
Accuracy	±0,5 °C in the range of +10...+50 °C
Step response time	TBD (63 % of a step change)

Humidity measurement

Measurement range	0...100 %RH non-condensing
Accuracy	Typically ±3 %RH at humidity of 20...80 %RH and temperature of +15...+30 °C

Carbon dioxide concentration

Measurement range	0...5000 ppm
Accuracy	±50 ppm + 3% of the reading
Autocalibration	Must see fresh air once a week

Volatile organic compound concentration

Measurement range	0...10 ppm isobutylene
Accuracy	±50 ppb + 10% of the reading
Autocalibration	No autocalibration, must be periodically recalibrated and serviced
Nominal gas	Isobutylene C4H8
Coefficient for toluene	0.56 (multiply the Kube reading by this if you know the gas is toluene)
Coefficients for other	List available separately

Warnings



The device must not be disposed of in household waste. Observe local regulations concerning the disposal of electrical waste. The device contains a battery.

Manufacturer

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Finland

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Email sales@nokeval.com



Declaration of conformity



EU Declaration of Conformity

Object of declaration: Wireless measuring device
Model/Type: Kube-Sky-RHT
Kube-Sky-RHT-CO2
Description: Wireless 433.92MHz temperature, humidity and CO2 transmitter based on LoRa-modulation.
Manufacturer: Nokeval Oy
Rounionkatu 107, 37150 Nokia, Finland

www.nokeval.com
tel. +358 33424 800
support@nokeval.com

This declaration of conformity is issued under the sole responsibility of the manufacturer.

The object of the declaration described above is in conformity with the relevant Union harmonization legislation:

Directive (RED) 2014/53/EU
Directive (RoHS) 2011/65/EU

The conformity is given based on the following harmonized standards:

RED: EN 300 220-2 V3.1.1 (2017-02)
EN 301 489-1 V2.1.1 (2017-02)
EN 301 489-3 V2.1.1 (2017-03)
EMC: EN 61326-1:2013
LVD: EN 61010-1:2010
RoHS: EN 50581:2012

Product is marked with CE mark to indicate compliance.
Product is designed and manufactured in Finland.

Signed for and on behalf of Nokeval Oy:

At Nokia 16.10.2018

Jani Vähäsöyrinki, Managing Director

www.nokeval.com