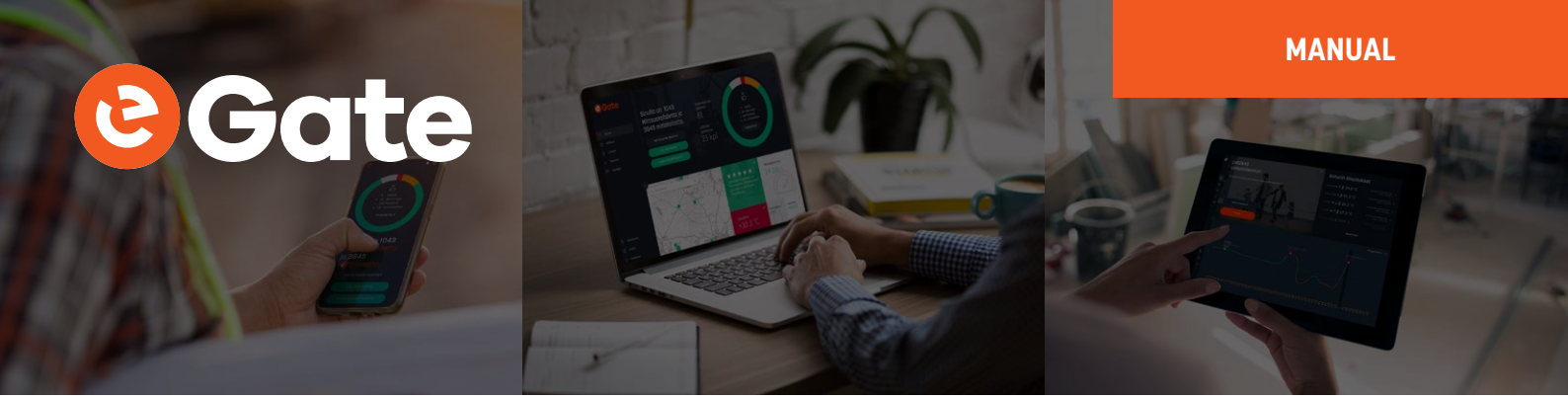
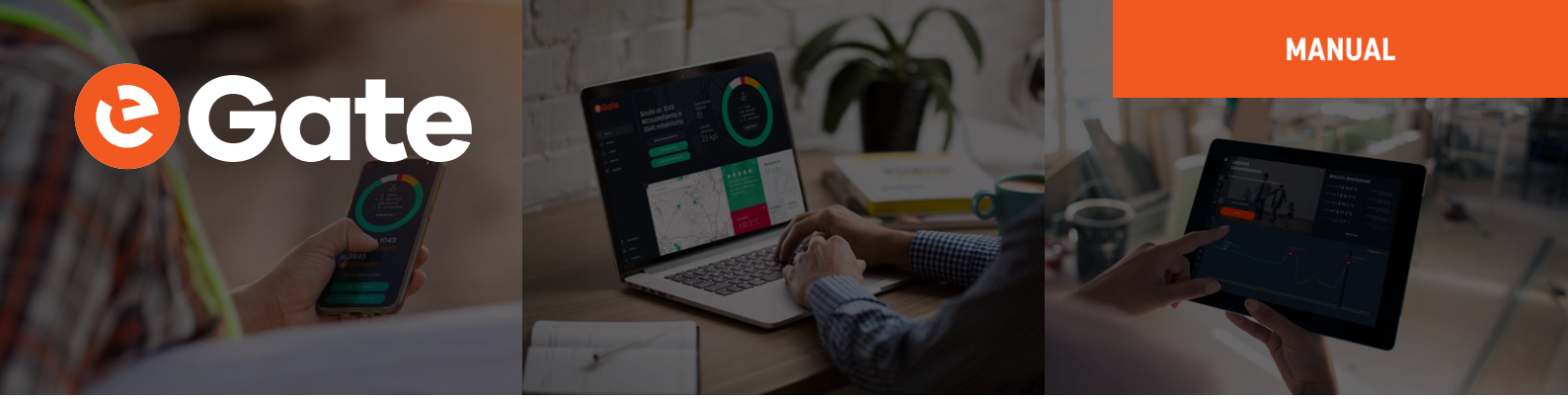


MANUAL

eGate-Kube-Sky-RHT
eGate-Kube-Sky-RHT-CO2
eGate-Kube-Sky-RHT-PIDVOC
eGate-Kube-Sky-RHT-DP
eGate-Kube-Sky-RHT-PM0413
eGate-Kube-Sky-RHT-PM0440



Introduction

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

Models

The eGate-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 but 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 from an external supply.

The model with -dP suffix is equipped with a differential pressure sensor. The device has a relay for controlling e.g. a signal lamp when the differential pressure exceeds or falls to meet a configured limit. The differential pressure can be measured with battery or external power.

The models with -PM0413 and -PM0440 suffixes are equipped with a particulate matter sensor. The -PM0413 can measure particulate matter of sizes between 0.4-12.4µm, and the -PM0440 model can measure between 0.35-40µm. The PM2.5 and PM10 values are international standard values for 3 - Introduction

particulate matter. The -PM0440 model also provides a non-standard PM40 value which includes all particulate matter up to 40µm. These models must be powered from 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. 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.

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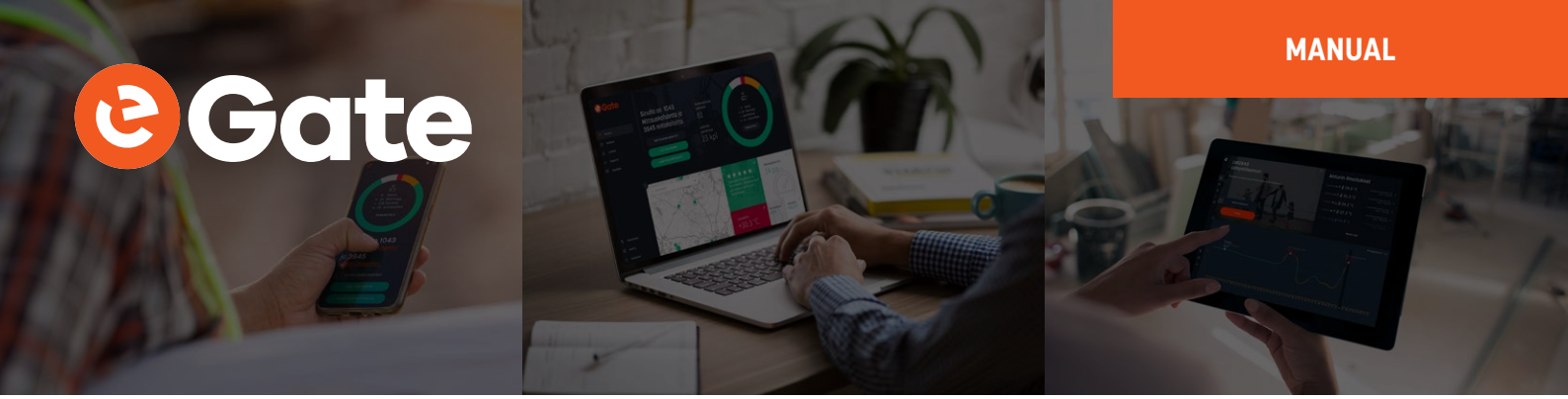

Installation

Mounting

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

- Select the installation place so that air can flow freely on all sides of the transmitter and that it represents the air that is to be measured. Avoid heat sources and direct sunlight.
- Mount the Kube wall holder with two countersunk screws (ST 3.0 x 20). Mount the holder with its hooks pointing upwards.
- Place the Kube freely on any surface.

Power supplies

The RHT model comes with batteries installed, ready to be used.

The CO2 and dP models are supplied with the batteries outside the device. Open the enclosure (with the two screws on the bottom) and insert the batteries in the holders, the + end to the holder with a red plastic piece.

The RHT, CO2, and dP models can alternatively be operated with an external supply. When an external supply is used, the batteries can be omitted or used as a backup supply.

The PIDVOC and PM models don't work without an external power supply.

The external supply can be connected with two alternative ways:

1. Use the micro USB socket in the bottom of the device.
2. Connect a 5 V DC power in the round holes of the push-in spring connector J11 with 0.2–0.5 mm^2 conductors, the positive wire to the left. Strip the wires approximately 6 mm. The wires can be detached by pushing a small flat screwdriver or some other spike in the rectangular holes.

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

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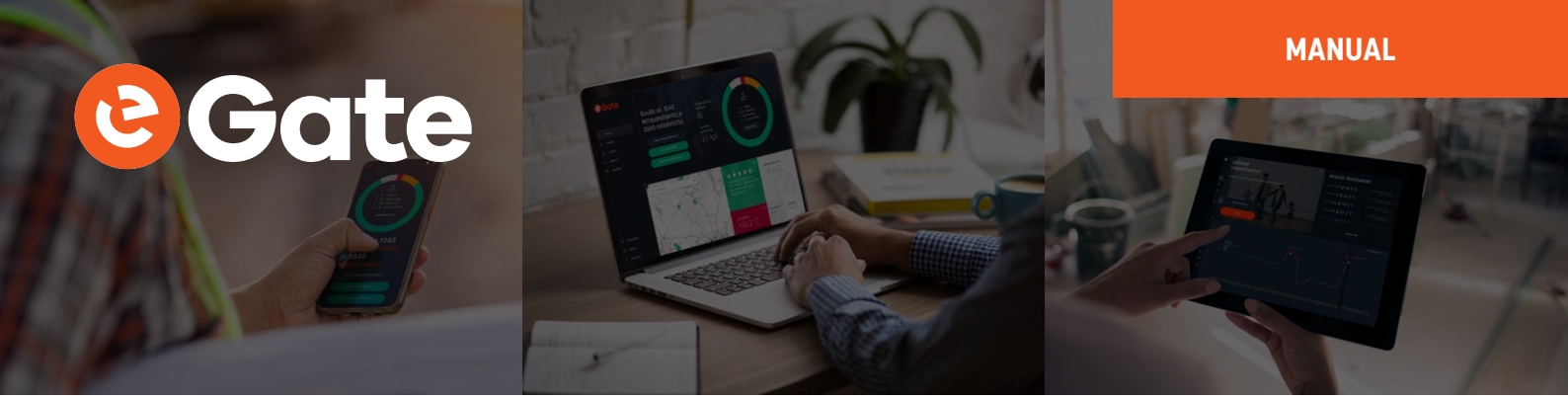
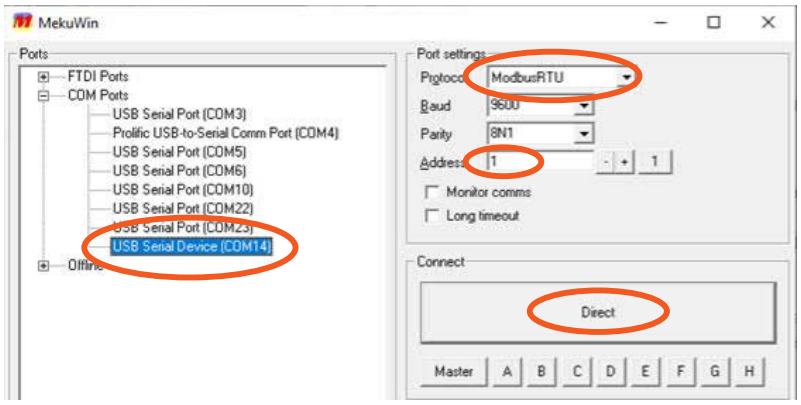
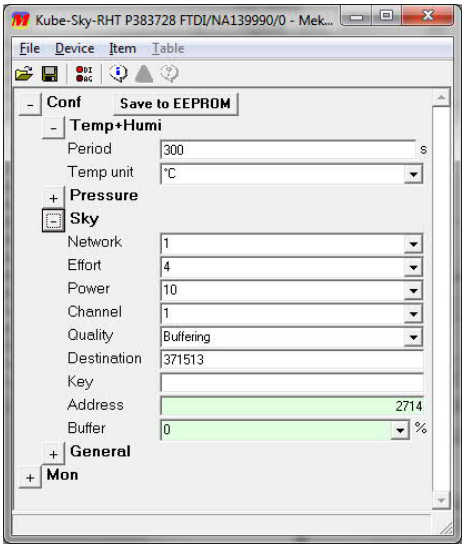


Settings

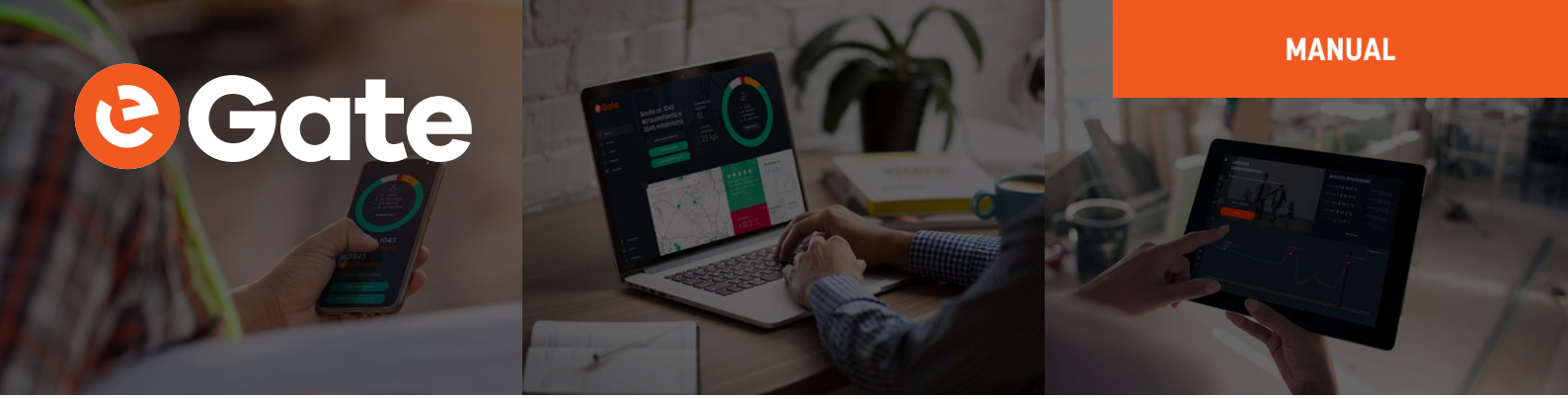
The device usually works with its default settings, but you can change the settings:

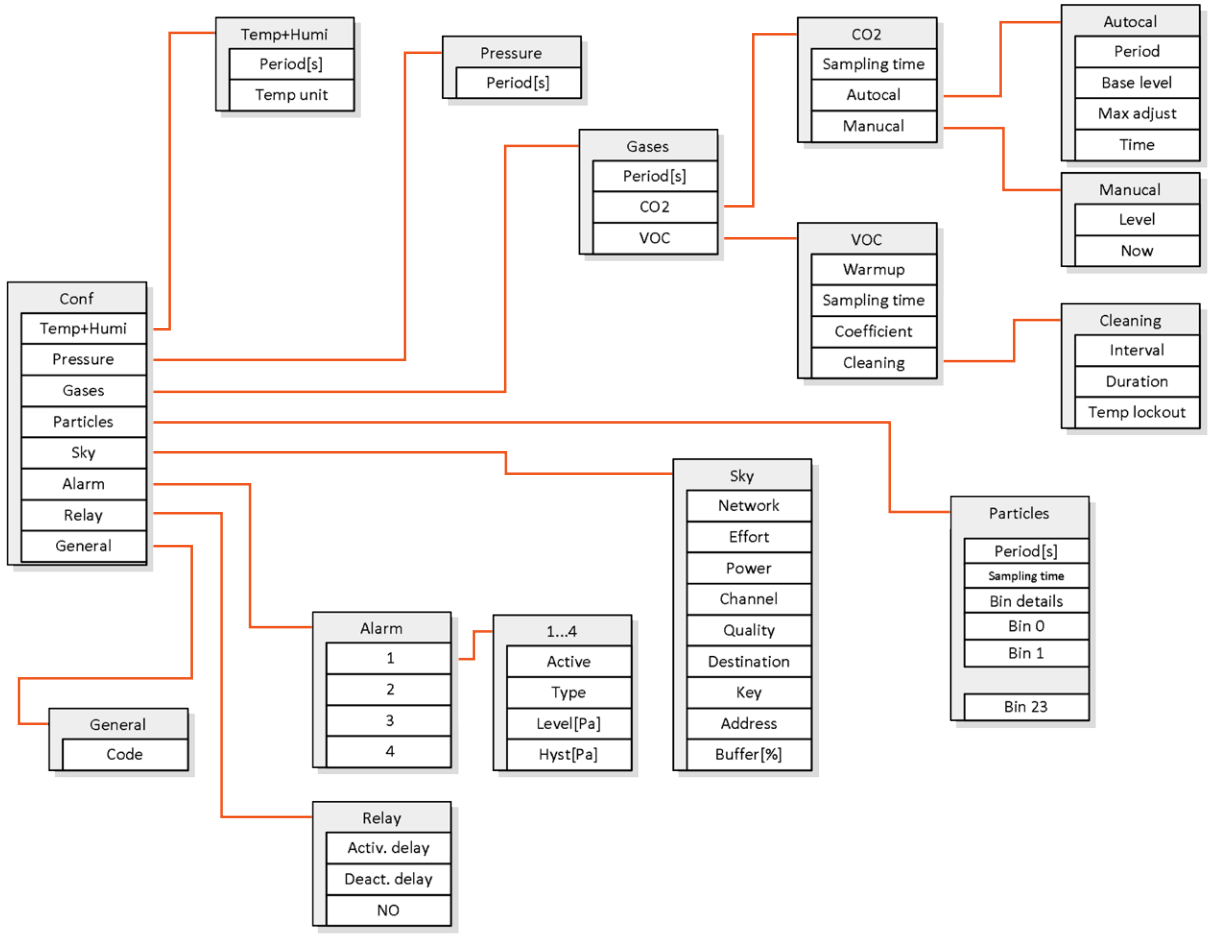
- Connect a micro-USB cable to the connector, and the other end of the cable to a computer.
- If Windows requests for a driver, download it at www.nokeval.com > Support, unzip it to a temporary folder, and show that directory as the location for the driver. If there are problems during the installation, try pushing the Kube button every 5–15 seconds or keeping it pressed so that Kube will not shut down its USB port.
- Launch the Mekuwin program (available for free at www.nokeval.com).
- In Mekuwin, choose Port=Kube (COMxx). If the port is not visible, try pushing the Kube button to wake it up.
- Choose Protocol = Modbus, Address = 1.
- Click Direct.
- A new window will open. It has branches for different settings.





The configuration menu is presented in the picture below. The different versions may have slight differences and lacking features. The menu is divided to submenus for each quantity group (Temp+Humi, Pressure, Gases, Particles). In addition to those, there are submenus for wireless network settings, alarm function settings, relay settings, and general settings.





Commissioning the radio

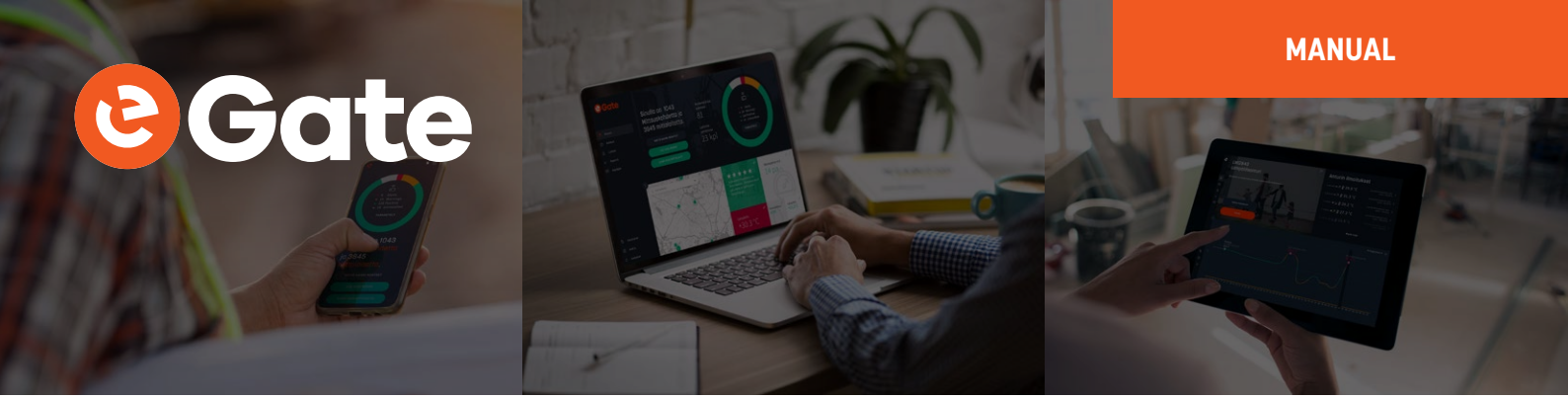
To get the radio working with your receiver, adjust the following settings in the Sky menu to match the corresponding settings of your receiver, otherwise the communication will fail:

- Network (default 1)
- Effort (default 4)
- Channel (default 1)
- Key (default empty)

The address of this Kube can be seen in the Address box. The address is factory set and can't be changed here.
If you want to ensure that every measurement is delivered despite of radio collisions and disturbances, set the following settings (this will typically double the battery consumption):

- Quality = Buffering (def ault Unidirectional which means send and forget)
- Destination = the radio address of your (nearest) receiver

To learn about the more detailed radio settings, see the chapter Detailed radio settings on page 13.



Setting the measurement intervals

Each quantity group (Temp+Humi, Pressure, Gases, Particles) has a setting to define how often to start the sensors and take a measurement. The setting is named Period and is set in seconds. Do not use unnecessarily short interval as it both consumes the batteries quickly and increases the likelihood of radio collisions.

The defaults are:·

- Temperature+humidity: 900 sec i.e. 15 min
- CO2: 1800 sec i.e. 30 min
- VOC: 3600 sec i.e. 1 hour
- Pressure (dP): 300 sec i.e. 5 min
- Particles: 900 sec i.e. 15 min

The allowed range is 5…7200 seconds. A quantity group can be switched off by setting its Period to 0.

Other settings and considerations

The next chapters cover the different sensors, their menus and other things to consider. There is also achapter detailing the radio settings. In the typical use, especially with the RHT and CO2 models, it is not necessary to read them.

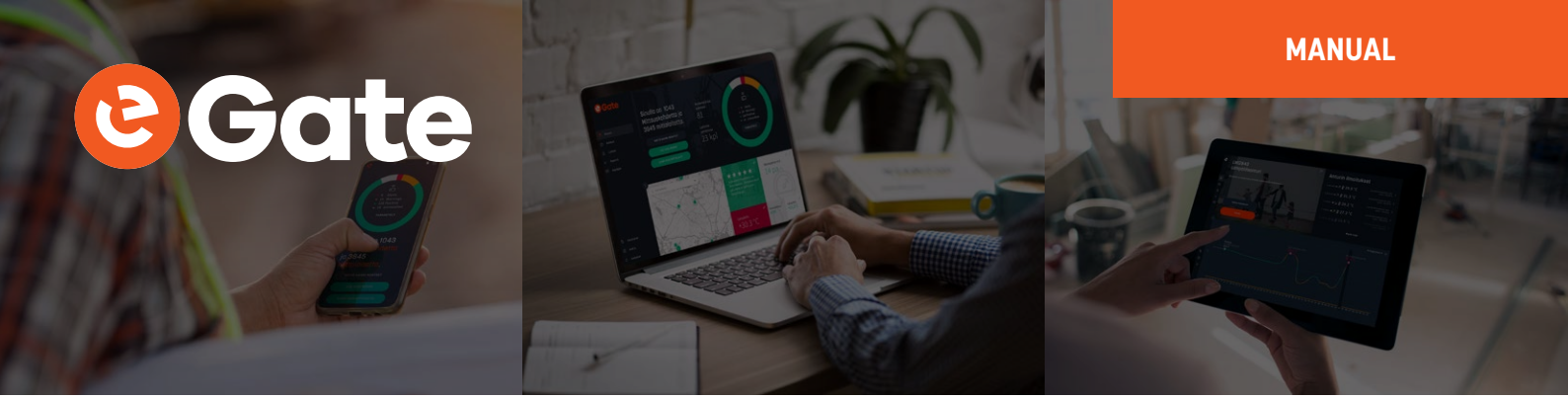
Which logical channels carry which quantity is specified on page 14. This information may be needed when configuring the receiving system.

You may also find useful to check the chapter Maintenance on page 15 to understand the button, the LED and some other aspects.

Protecting the settings

To protect the settings from being easily adjusted, enter a password at General / Code (up to six digits or letters). Next time taking a Mekuwin session the settings can’t be adjusted without knowing the password.

If the password is set but lost, disconnect an external power supply, remove at least one battery, interconnect the second (from top) and fifth contact of the card edge connector with e.g. tweezers, keep the button pushed, and connect a battery or an external supply. After a second you may remove the tweezers and release the button. Now the password is temporarily reset until the next power off.



RHT measurement

Principle

The temperature is measured with a digital sensor on the circuit board. The humidity is measured with acapacitive polymer sensor.

Settings in Temp+Humi menu

Period

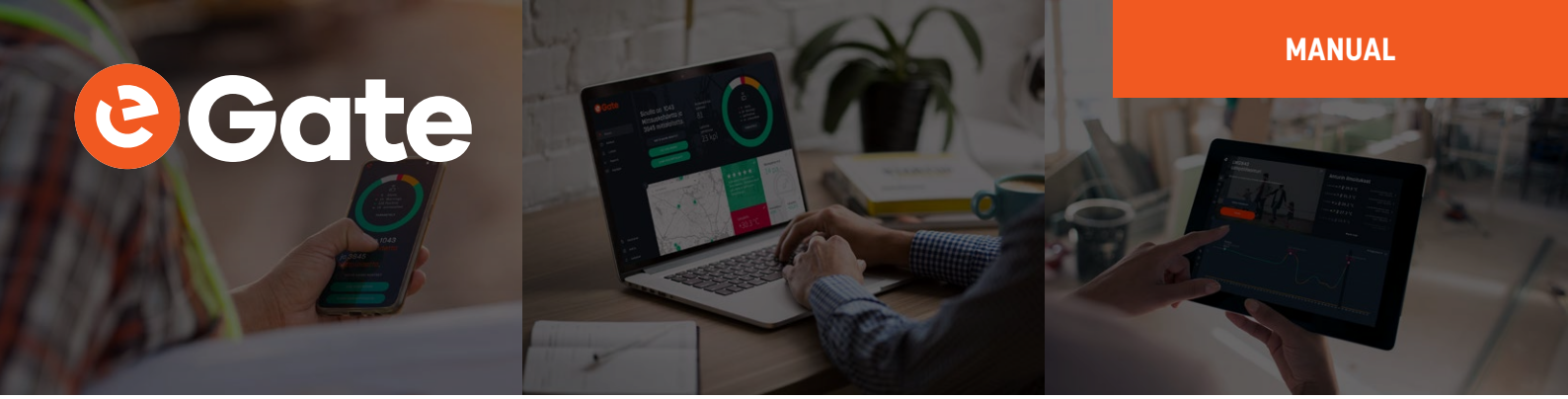
See Setting the measurement intervals on page 6.

Temp unit

Temperature unit °C or °F. The humidity is always in %RH.

Recalibration

These sensors do not normally need regular recalibration.



Differential pressure measurement

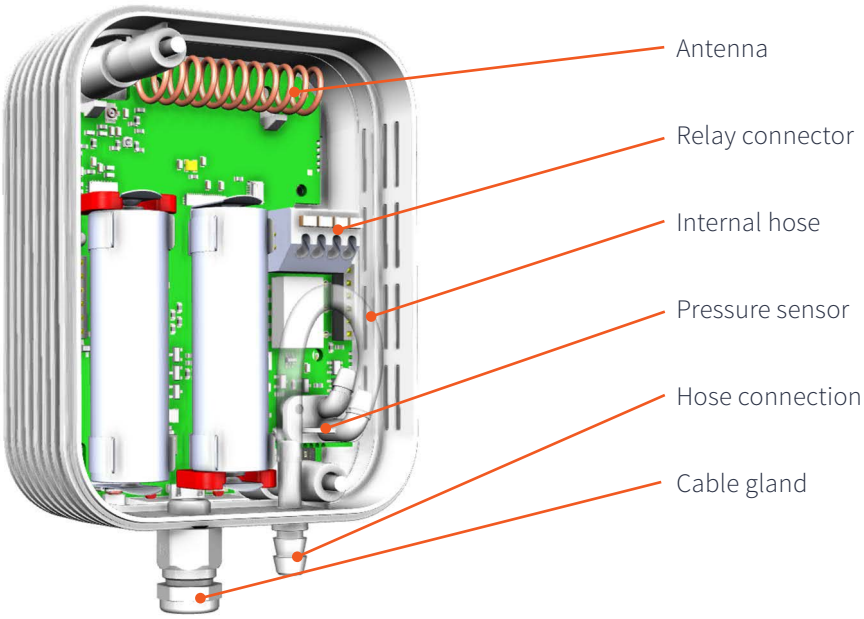
Principle

The sensor inside the Kube has two hose outlets. Inside the sensor, these are connected through a small orifice. A pressure difference between the outlets will cause a small flow of air, which is measured. One of the outlets is brought out of the enclosure via an internal hose. Kube can measure up to 125 Pa in either direction.

Pressure connection

Connect a hose with an internal diameter of 5 mm in the hose connection at the bottom of the case. The pressure is delivered via an internal hose to the pressure sensor. The internal hose can be moved among the two outlets to select which way the pressure is to be measured.

Upper outlet	Lower outlet
The external hose in higher pressure than the Kube itself: a positive reading.	The Kube in higher pressure than the external hose: a positive reading.



dP settings

The pressure sensor has no other settings than the measurement interval (Setting the measurement intervals on page 6).

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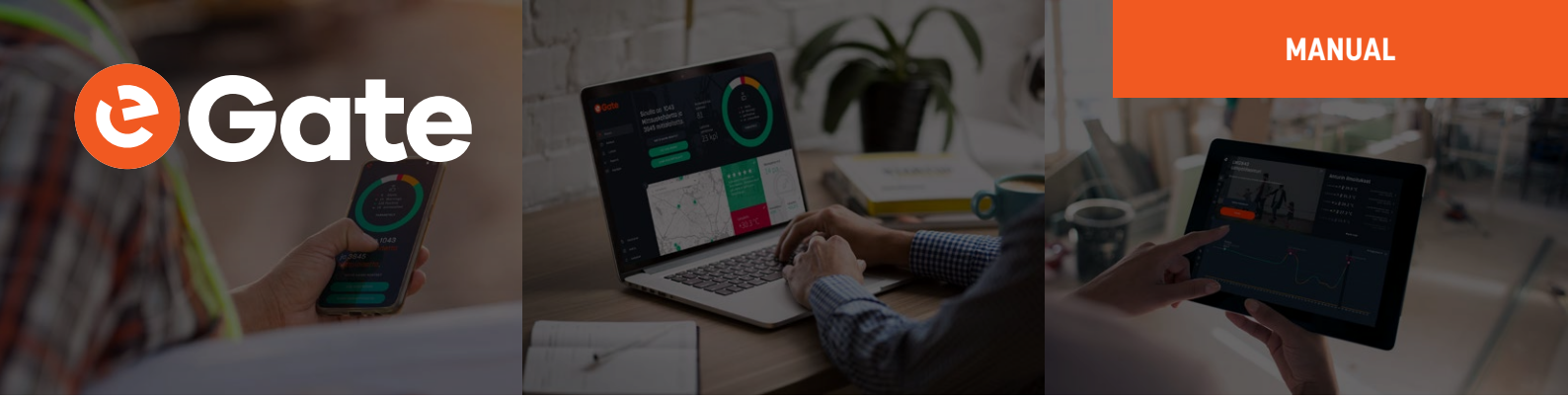


Alarm and relay settings

The Kube can give an alarm of too high or too low (or both) differential pressure. There are two alarm comparators. If any of them is alarming, the relay will operate. Configure the alarms and the relay witht hese settings:

Alarm / 1...2 / Active
Switching alarm on/off.

Alarm / 1...2 / Type
This setting determines the direction of the alarm:

- Low = alarms when the pressure is too low.
- High = alarms when the pressure is too high.

Alarm / 1...2 / Level
The level of the differential pressure when the alarm should be activated/deactivated (this can also be a negative value, depending on which way the differential pressure is measured). The allowed range is -125…125 Pa.

Alarm / 1...2 / Hyst
The amount of hysteresis added to the set level. The hysteresis is applied on both sides: e.g. Level=10, Hyst=2, the alarm changes its state at 12 and 8.

Relay / Activation delay
Sets the delay for the alarm activation (i.e. alarm trigger detected / alarm activated). The allowed range is 0…65535 seconds. By setting the delay to value 0, alarm is activated immediately.

Relay / Deactivation delay
Sets the delay for the alarm deactivation (i.e. alarm deactivation trigger detected / alarm deactivated). The allowed range is 0…65535 seconds. By setting the delay to value 0, alarm is deactivated immediately.

Relay / NC

- No (default) = normally open, the relay contacts are normally not conducting but will conduct when an alarm occurs
- Yes = opposite to previous

Relay connector

Inside the enclosure, there is a four-terminal spring-loaded relay connector, the terminals from left toright:

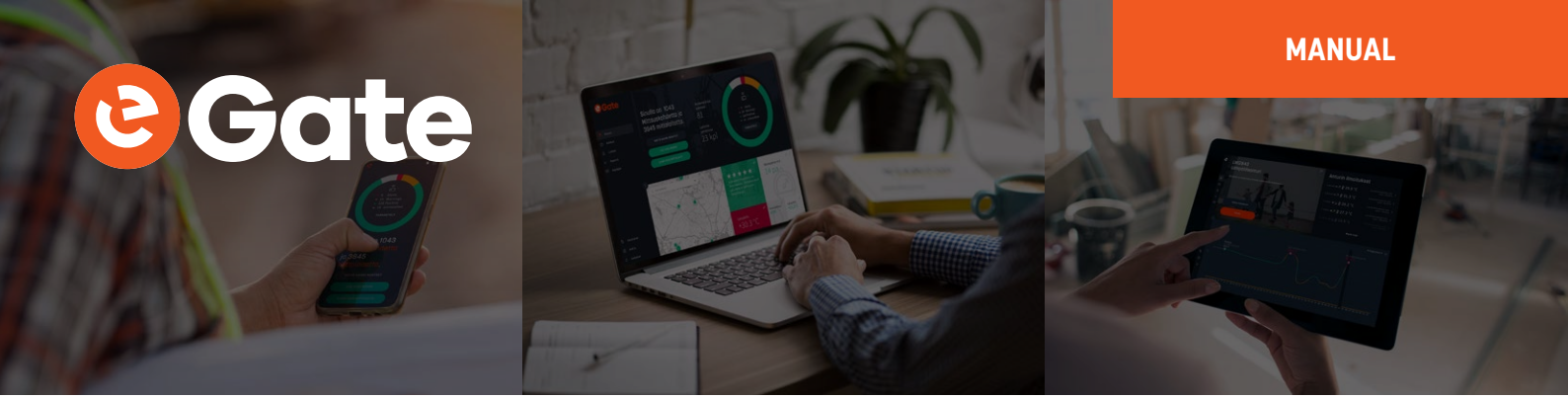
1. Common/ground (do not use)
2. Unused (an option for 24 VDC power input, not usable)
3. Relay
4. Relay

The relay contacts are between terminals 3 and 4. In addition, by shunting the jumper next to the connector, terminals 2 and 3 will be internally interconnected.

A cable gland is provided for a cable having an outer diameter of 2.5 to 3 mm.

Recalibration and maintenance

The sensor doesn't typically need recalibration. Should the sensor orifice become clogged, max 1 bar air can be used to try to flush it.



CO2 measurement

Principle

The CO2 sensor is based on the NDIR principle, measuring CO2 concentration using 4300 µm light which is absorbed by CO2.

Auto calibration

An auto calibration is necessary for most CO2 sensors; without it, they drift over time and eventually give incorrect readings. The auto calibration can work properly only if the device is exposed to a fresh air at least some hours during each week, in practice the room must be unoccupied now and then and its ventilation on.

Settings

The CO2 settings are in the Gases / CO2 menu.

Sampling time

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

Autocal / Period (h)

This setting determines how many hours passes before the device performs an auto calibration. A good, and also the default, 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 Period to 0 (zero). Then it is advisable to perform a manual calibration regularly.

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.

Autocal / Max adjust

This setting limits the maximum adjust that is done at a time. Good value is 50. Default value is 100.

Manucal

This menu allows manually calibrating the CO2 offset. Enter the real CO2 level and press the Now button. Wait for a moment (2x Sampling time). Check that the reading corresponds to expected after it has updated.

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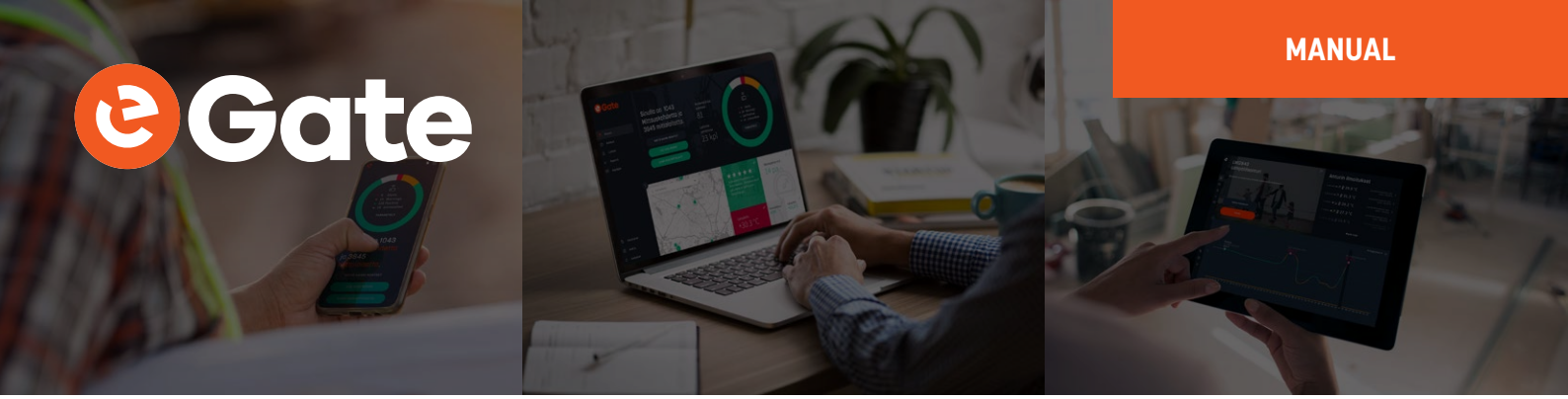


PID VOC measurement

Principle

The volatile organic compound concentration is measured with a photoionization detector (PID). An ultraviolet lamp (10.6 eV) ionizes the VOC molecules, which allows a weak current to flow from an electrode to another. These sensors are expensive but give a good sensitivity for VOC's and low sensitivity for humidity and other gases.

Calibration and cleaning

An automatic baseline calibration is not usually needed, nor provided by the Kube. If one was used, the device would not be able to measure continuous VOC concentrations as the automatic calibration would cancel them off.

A manual calibration with two known concentrations should be performed regularly. In a clean atmosphere, e.g. an office, the interval can be relaxed even to some years, but the more contaminated air, the more often the sensor needs service.

In dirty atmospheres, the lamp and the other parts of the sensor may need cleaning, and at some stage, replacement. Refer to the Alphasense PID-AH2 maintenance instructions.

Settings

The VOC settings are under Gases/VOC.

Warmup

The photoionization sensor needs some time to stabilize its lamp. The time is defined with this setting, in seconds. The default is 30 seconds. Too short time will give inaccurate readings. Too long time will wear the lamp and heat up the temperature sensor leading to too high temperature readings.

Sampling time

This setting defines how long the sensor is read and averaged. The longer time, the lower noise. The default 10 seconds is adequate in most cases.

Coefficient

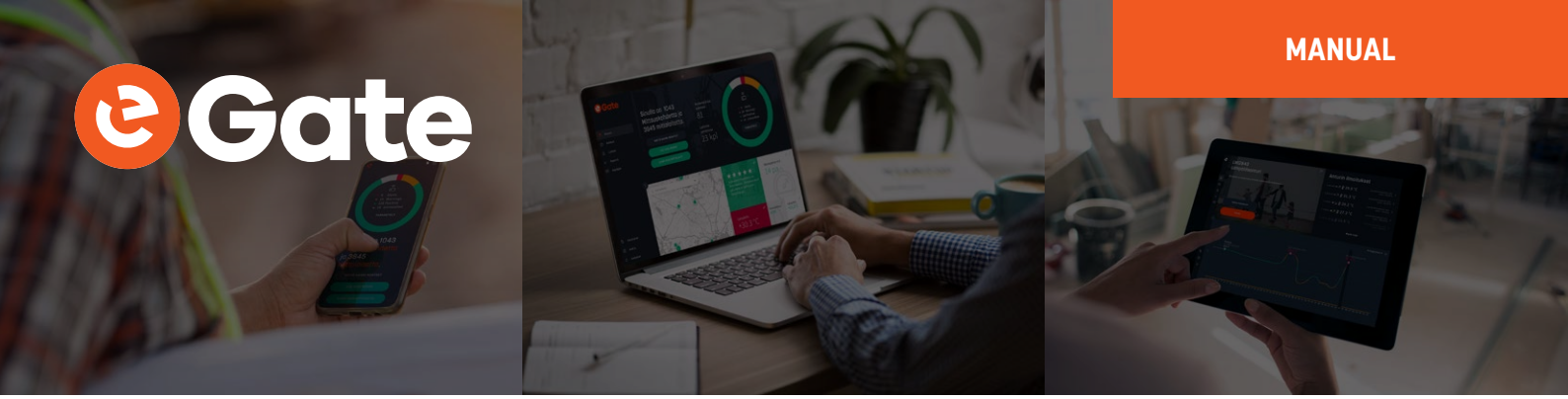
The default calibration for the VOC is with isobutylene in ppm's. The VOC sensor reacts to other gases with a different sensitivity. If the target gas is known, the VOC reading can be corrected for it by setting a coefficient (multiplier) for the reading. Similarly a different measurement unit can be obtained by adjusting the coefficient. Some examples:

Main gas \ Unit	ppm	µg/m3
Isobutylene	1	
Toluene	0.56	2110

Cleaning

The sensor may need a longer lamp operating time now and then to keep it clean. This menu has three settings to define the periodic self-cleaning:

- Interval (hours): How often to perform the cleaning. One week (168 hours) is recommended.
- Duration (seconds): How long to keep the lamp on. 1200 seconds recommended.
- Temp lockout (seconds): As the cleaning will heat the device, the temperature and humidity measurements will be locked out during and after the cleaning to avoid incorrect readings. This setting defines the lockout time after the cleaning, 1200 seconds by default.

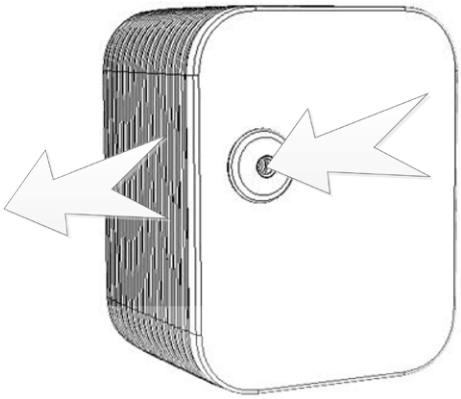


Particle measurement

Principle

A small fan sucks air from the opening in the cover. Inside the device the air passes through a laser beam. The particles will cause a flash when passing the laser, allowing them to be counted and their sizes (diameter) estimated.

The mass of the particles is estimated by assuming that they have a density of 1.65 g/ml and making assumptions of their shape. The result is not accurate if the density, shape, or refractive index deviates significantly from the estimates used in the calibration.



Settings

Period

See Setting the measurement intervals on page 6.

Sampling time

This setting determines how many seconds particulate matter is measured. The bigger the value, the less noisy reading. A good value, and also the default, is 30 seconds. Outside the sampling time, the laser and the fan are stopped.

Particles / Bin details

Option to get detailed amounts of particles in each bin separately in addition to the PM2.5, PM10, and PM40 values. Typically not needed. The default is off.

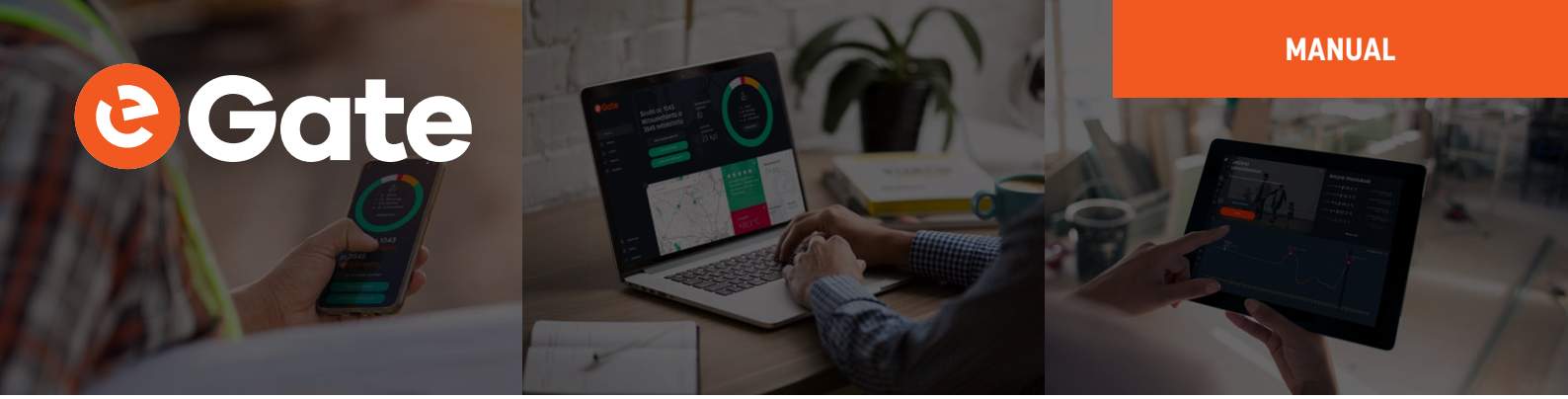
Particles / Bin 0 … Bin 23

Requires the Bin details setting to be enabled. The radio transmission of each detail bin can be separately enabled with these settings. Note that the bin ranges are different between PM0413 and PM0440, and that PM0413 only uses the first 16 bins. The bins are listed in Quantity channels on page 14. Unlike the PM values, which estimate the particulate mass, these bins count pieces per litre.

Channels	Particle sizes
26	0.35 … 0.46 µm
27	0.46 … 0.66 µm
28	0.66 … 1.0 µm
29	1.0 … 1.3 µm
30	1.3 … 1.7 µm
31	1.7 … 2.3 µm
32	2.3 … 3.0 µm
33	3.0 … 4.0 µm
34	4.0 … 5.2 µm
35	5.2 … 6.5 µm
36	6.5 … 8.0 µm
37	8.0 … 10.0 µm
38	10 … 12 µm
39	12 … 14 µm
40	14 … 16 µm
41	16 … 18 µm
42	18 … 20 µm
43	20 … 22 µm
44	22 … 25 µm
45	25 … 28 µm
46	28 … 31 µm
47	31 … 34 µm
48	34 … 37 µm
49	37 … 40 µm

Maintenance

The sensor doesn't need periodic recalibration. If it appears to have dust deposited inside, compressedair can be used with extreme care to blow it clean.



Detailed 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. All the devices within one network must share the same 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 a unique network address. Default 1.

Effort: This single setting controls the LoRa bandwidth and spreading parameters as in the table below. The bigger the value, the longer the range. But it will consume more battery and radio band. Increasing the effort one step will approximately add 2.5 dB in the link budget, but also double the battery consumption caused by the radio.

The selectable Efforts are tabulated below. The LoRa bandwidth and spreading factor are mentioned for curiosity. The estimated ranges are for reference only, in real world the range depends heavily on the objects on the radio path. No range can be guaranteed, a single metal wall may stop the radio signal totally.

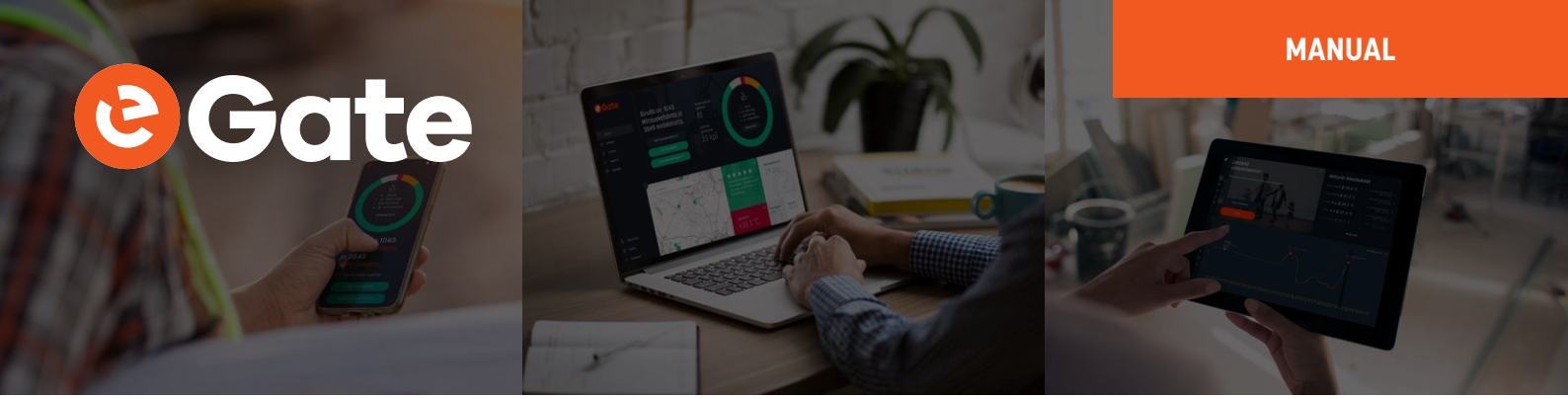
Effort setting	LoRa bandwidth	LoRa spreading factor	Estimated indoor range	Estimated real worldoutdoor range 30dB/decade
1	250 kHz	7		1100 m
2	250 kHz	8		1300 m
3	250 kHz	9		1600 m
4 (default)	250 kHz	10	30...300 m	1900 m
5	250 kHz	11		2300 m
6	250 kHz	12		2800 m
7	125 kHz	12		3500 m

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 MHz * (channel-1), i.e. the first channel is 433.3 MHz, second 433.5 etc. The channel 4 uses 433.9 MHz which is the most crowded frequency on this band, so it should be avoided.



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

- Unidirectional (default): This device will transmit each reading once not expecting any acknowledgement. If the packet is lost due to a collision with another transmission or anydisturbance, 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. 1000 packets (400 in devices manufactured before autumn 2019). When the buffer is more than half full, the measurement intervals will be temporarily increased to slow down the filling of the buffer.

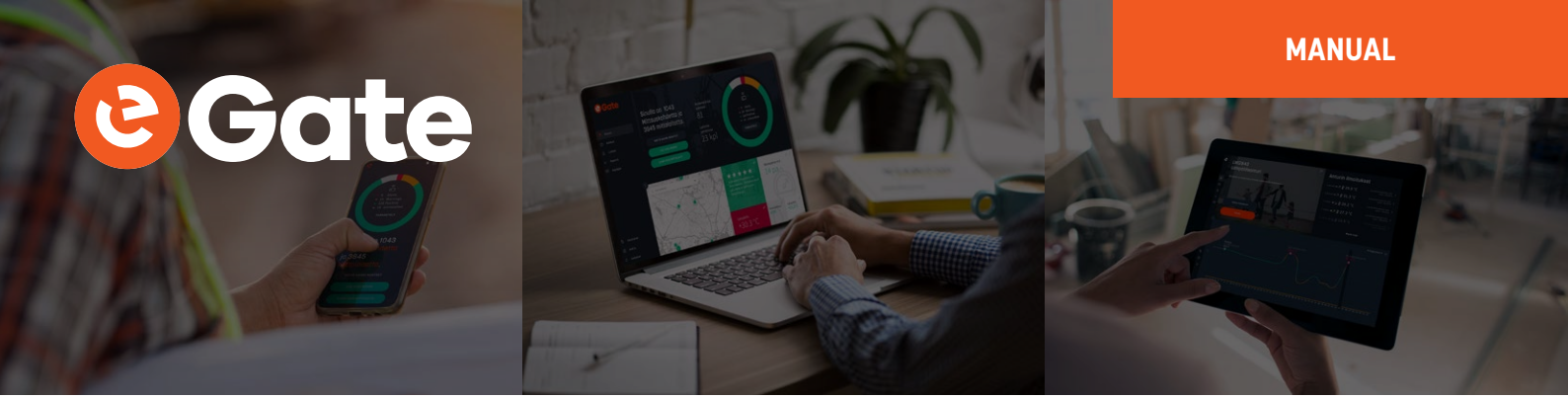
Each device can have an individual choice.

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 must be selected to 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. Once set, the key can't be viewed in the menu, it is replaced by ***.

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

Buffer: Displays how many percentages of the buffer is used. Should be 0 when the network is operating smoothly. This is for viewing only, can't be manually adjusted.

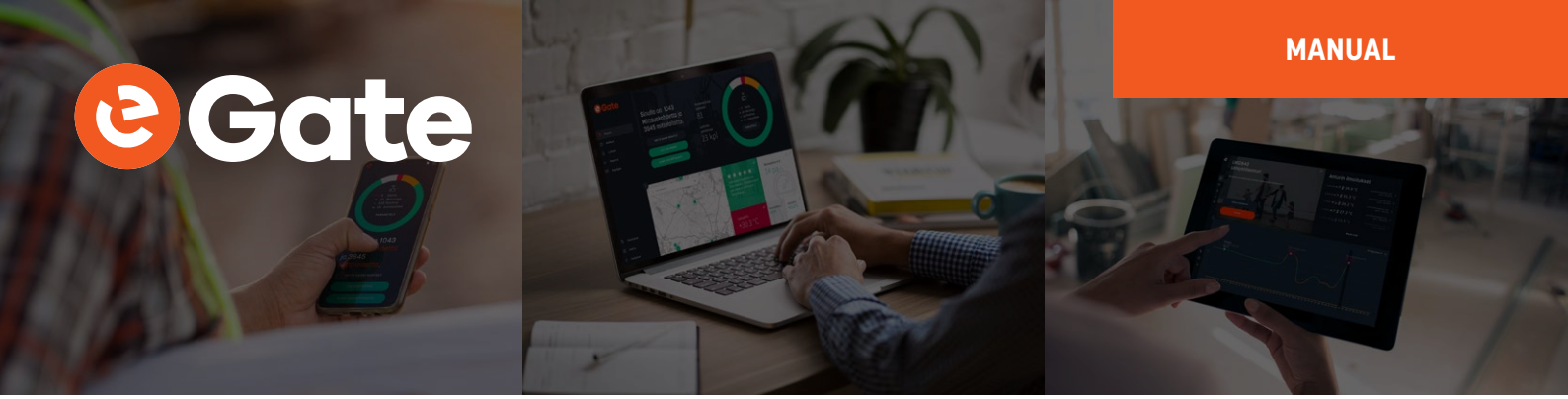


Quantity channels

The device sends the measurement quantities using the logical channels as in the table below. Note that each Kube model will send only the quantities it can measure, and which have not been disabled.

Channel	Physical quantity	Unit
1	Temperature	°Cor °F
2	Relative humidity	%RH
4	Absolute air pressure	mbar(i.e. hPa)
5	Carbon dioxide concentration	ppm
6	Volatile organic compound concentration	ppm isobutylene unless configured otherwise
7	Differential pressure	Pa
21	PM1 particulate matter	$\mu g/m^3$
22	PM2.5 particulate matter	$\mu g/m^3$
23	PM10 particulate matter	$\mu g/m^3$
24	“PM40”particulate matter	$\mu g/m^3$
26...49	Particle bins, see chapter Particle measurement on page 11	pcs/litre

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



Maintenance

Checking the status

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
V1.0-1.11	V1.12		
2	**2**	Battery low	Replace the batteries soon (or remove them if using with an external power supply and backup batteries are not necessary).
3	**3**	Radio error – the radio is not operating	Contact the supplier.
4	**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	**5**	Internal A/D converter failure	Contact the supplier.
6	**6, 7**	Temperature/humidity sensor failure	Contact the supplier.
7	**8**	Absolute pressure sensor failure	Contact the supplier.
8	**9**	Absolute pressure sensor failure	Contact the supplier.
9	**10**	Sensor module failure (CO2, VOC etc)	Contact the supplier.

If the indicator doesn't light up at all, the device is not operating, probably due to lack of power. Check the battery or other power supply.

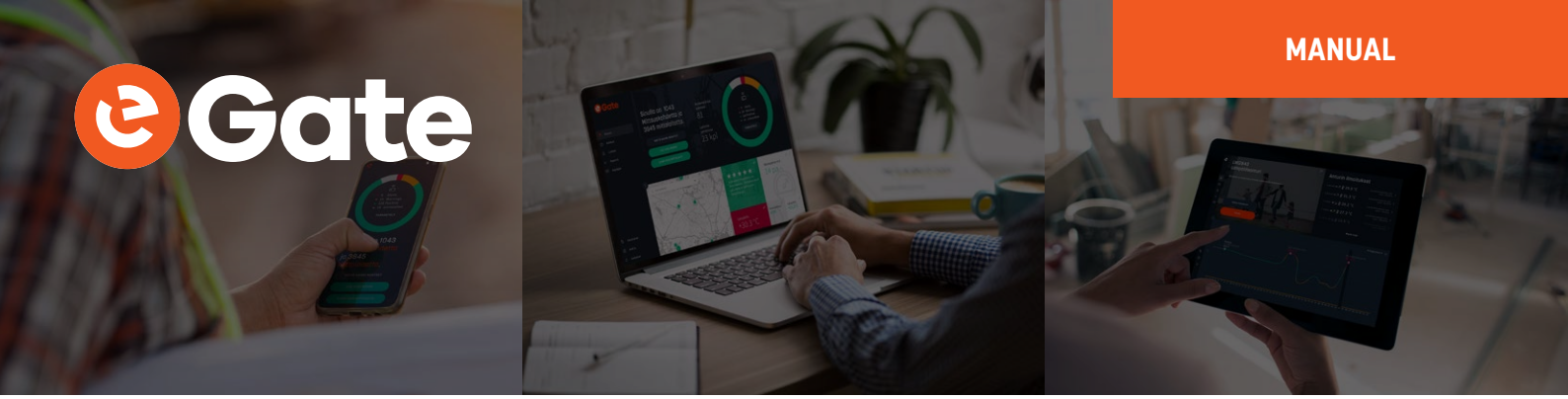
Active state

By pressing the button twice, the device goes to an active state and the indicator lights up green. In this state the measurement readings are taken and transmitted frequently:

- Temperature, humidity, and pressure at every 15 seconds
- CO2, VOC, and particles every 60 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.



Replacing the batteries

- Remove the device from the wall holder 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 (positive towards the red plastic pieces). Avoid touching the electronics.

Cleaning

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

Monitor menu

In Mekuwin Mon menu, you can monitor the measurement readings. The sensors are kept continuously on. The values update at the rate the sensor can produce new readings, e.g. 15 sec with CO2 at its default sampling time.

Temperature: The temperature reading in °C or °F according to the Temp unit setting.

Humidity: The relative humidity reading in %RH.

CO2: The carbon dioxide concentration in ppm.

DiffPress: The differential pressure reading in Pa.

VOC: The volatile organic compound measurement reading in ppm (or other unit if a coefficient used).

PM1, PM2.5, PM10, and PM40: Particle masses in µg/m^3.

Batt: The estimated remaining battery capacity in percent.

ExtPow: Is an external power supply connected.

RelayState: The state of the alarm relay.

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

Cal menu

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