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**NOKEVAL**



# Cell-Sky-Link-RS485-3G

## Manual

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Firmware versions 1.3.0-1.3.0

# Contents

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Introduction .....	3
Installation .....	5
Configuring the device .....	8
Usage .....	17
Maintenance.....	19
Troubleshooting.....	20
Specifications.....	21
Warnings.....	23
Trademarks .....	23
Manufacturer.....	23

# Introduction

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Cell-Sky-Link-RS485-3G is a base station for 2.4 GHz and 433.92MHz Nokeval-transmitters and part of Nokeval Sky and Ovazone product families. It receives and buffers radio packets to its non-volatile memory and transmits them over GSM mobile data networks to Ovaport network service, thus enabling reliable remote data acquisition from the field straight to the Ovaport servers located in a data center.

## Serial interface

The base station can be connected to standard Modbus RTU transmitters and to **Nokeval devices with SCL protocol** using the integrated RS485 bus. The base station's reliability is increased by the backup batteries, which enable uninterrupted data acquisition also during external power interruptions.

## Sky radio

Nokeval's third generation Sky radio devices use the Semtech LoRa modulation technique on the 433 MHz ISM band that allows unforeseen wireless range for battery powered transmitters. The protocol used is defined by Nokeval, called Sky, which means that these devices are 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 should 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 these 433 MHz radio devices, make sure it is legal in your country.**

## Ovanet radio

Ovanet is Nokeval's second generation radio network, which uses Wirepas Pino technology and Nokeval's own additions. The network uses 2.4-2.48 GHz band, which is available all over the world. The product names basically begin with the Ovazone prefix.

Every device in the network, also battery powered ones, will function as a repeater by assisting devices located far away from the gateway, effectively forming a mesh network.

The network has node devices producing measurement data, and one or more gateways. The gateway connects the network to other systems. Examples of the gateway devices are Ovazone-Wave-Link and Ovazone-Cell-Link. They are used to deliver the data of the radio network to the Ovaport service.

Each device, including nodes and gateways, must be set with the same Ovanet network. The Ovanet network number must be chosen between 1-16777214. It should be generated with a random number generator to minimize the probability of accidentally choosing the same network number as in another network located nearby. By default, the devices are set to the network number 6829663, which can be used if there are no other Ovanet or Wirepas Pino networks within a couple hundred meters range. If

two networks have the same number by accident, the node devices may connect to a wrong network and the data is not delivered to the desired gateway.

Each device has a unique Ovanet address. This is set at the factory and there is no need to change it. The address is visible in the back label of the device.

The devices automatically change their radio frequency seeking suitable frequencies in the crowded 2.4 GHz band. However, at power-up the devices need to find other devices in the network, for which a common radio frequency is needed. All the devices of the network need to be set to the same radio channel between 1-28. Usually the default channel 1 is ok.

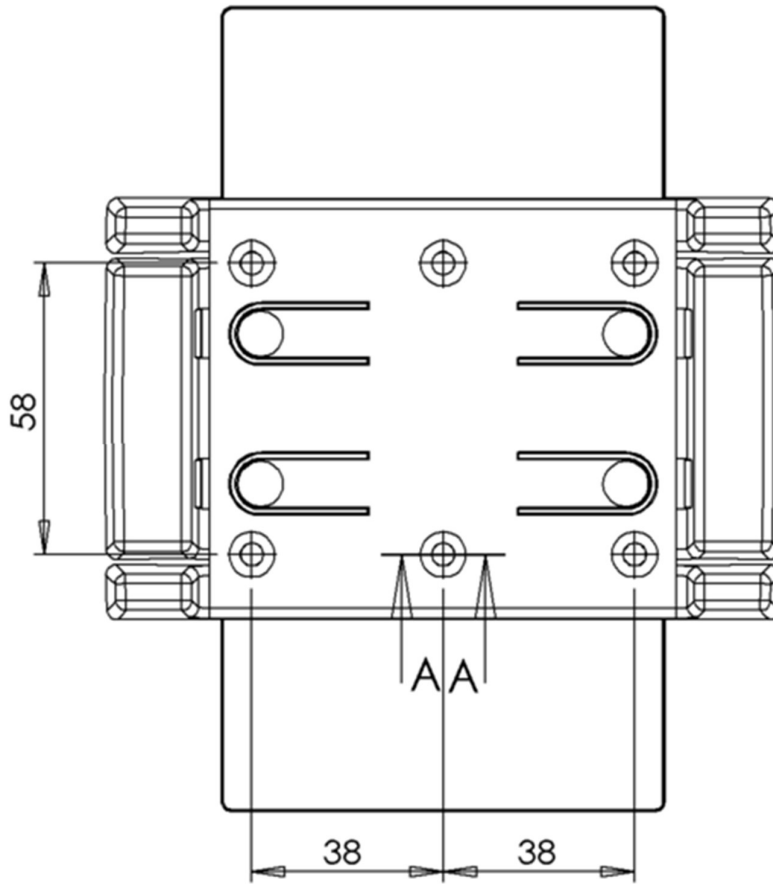
There is no need to configure any other radio network settings. The network searches automatically for the best connections and updates them if needed.

The open space range between the nodes is at most about 200 meters and indoor range is some tens of meters depending on the construction materials. Placing the devices near a metal surface will decrease the range.

# Installation

## Wall holder

Install the base station to a wall or some other suitable surface with the separate wall holder. See the following dimensional drawing for the wall holder's mounting hole distances. Use fastening accessories suitable for the wall material, like plugs and screws. The screws need to have a countersunk head.



## Installation location

Choose an installation location that it is central in relation to the radio transmitters.

The base station must be installed vertically. The base station is splash proof, but the location must be chosen so that the unit will not be exposed to water or hot steam. Please note that the AC socket and the power supply are not splash proof.

The location must have GSM/GPRS/3G network coverage. This can be verified before the final installation steps by powering on the base station and checking the signal strength indicator LEDs. Installation location must have one free AC socket for the power supply.

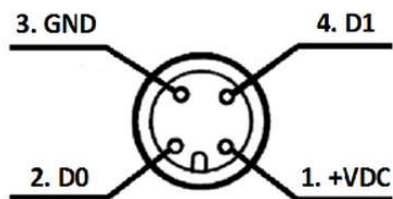
## Connections

Every Cell-Sky-Link-RS485-3G base station model has one or two connectors in the lower part of the enclosure. Every model has an M12 type female connector (receptacle) and a detachable male

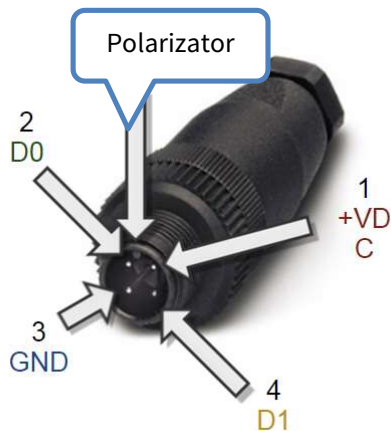
connector (plug). The connector has four pins and it is a combined power supply and serial connector. The table below describes the function of each pin.

Pin	Symbol	Description
1	+VDC	Power supply positive pin, 18...28 VDC
2	D0	RS-485 bus D0 pin
3	GND	Power supply negative pin, RS-485 bus ground
4	D1	RS-485-bus D1 pin

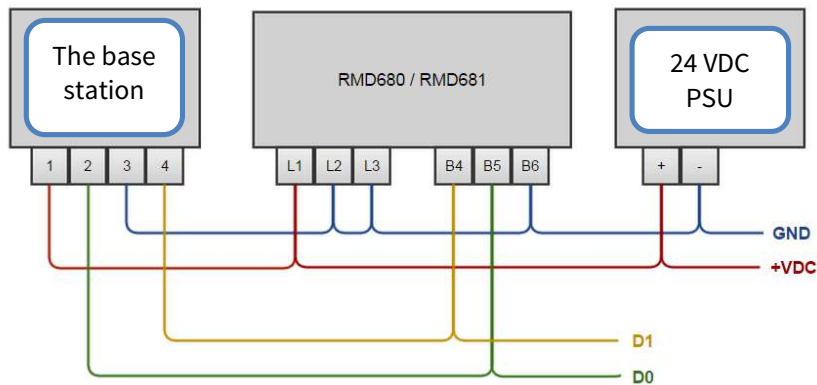
The diagram below presents the connector pinout looking towards the base station's female connector. The same pinout is valid for an opened male connector looking towards the terminal screws. Please note the polarizator location in the diagram between pins 1 and 2. The detachable M12 connector supplied with the base station has numbering inside the connector next to the screw terminals.



The picture below shows the male connector pinout looking into the connector.



This example picture illustrates how the base station can be connected to an RMD680 / RMD681 transmitter by sharing one 24 VDC power supply.



## RS-485 bus information

RS-485 is a serial bus type commonly used in the industry. It is based on two data lines D0 and D1, which are connected in **parallel** with all the devices connected to RS-485 bus and D0 and D1 pins. To even up the electric potential between different devices, a third wire is also needed. In the above example picture the blue ground wire evens the potential differences between the devices. Branches in the bus should be avoided, in other words the bus cabling should circulate through all the devices without branches. The maximum recommended length of the bus is 1 km. The cable should be twisted pair and the wire diameter should be at least 0.5 mm.

**To ensure EMC compliance the RS-485 bus cable should no more than 30 meters long.**

The bus is bidirectional. Only one device at a time can send data, during which other devices listen. Only one device connected to the bus is set as master, in other words as a chairman, which starts all conversations on the bus. Other devices are slaves and they only answer to queries of the master. Each device connected to the bus has its unique bus address, which the master device uses to direct its commands to a specific device.

The base station functions as an RS-485 bus-master and queries the measurement data from other devices on the bus. In a typical application, such as the one presented in the diagram above, the base station regularly queries the RMD680 / RMD681 transmitter's measurement data and sends it to the Ovaport server.

## Radio receiver antenna connector

The base station top part has the radio receiver's female BNC connector. The base station is supplied with a suitable antenna. Attach the antenna to the connector to complete the installation.

# Configuring the device

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There is usually no need to configure the device since most of the settings are already at their best defaults. However, if you want to see what kind of settings there are or edit settings, use MekuWin program and DCS772 (USB-POL converter). You can download MekuWin from Nokeval's web site [www.nokeval.com](http://www.nokeval.com) for free.

## Connection settings

Communication settings for configuration:

- baud rate 9600
- protocol SCL
- address 0

## Programming connector

The device has a 3PIN POL programming connector under the backup battery compartment lid. Remove the battery compartment lid to access the programming connector. Use POL-3PIN adaptor to connect the DCS772 to the device. The 3PIN POL programming connector can be connected in both ways.

## Conf menu

The configuration menu settings are explained in the following chapters.

## Mon menu

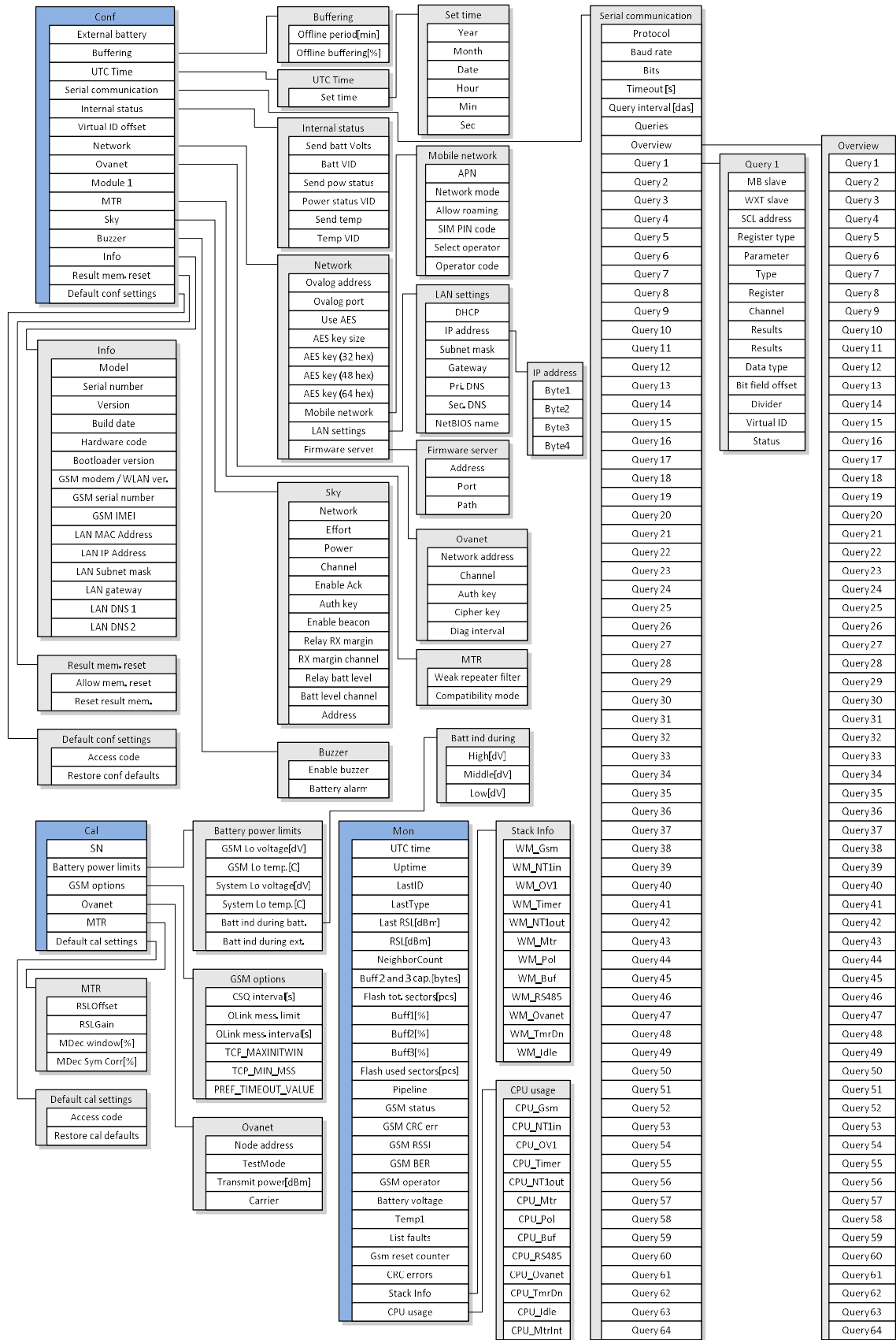
The monitor menu settings are mainly for manufacturer use, and most of them are not explained in this manual. Support for purpose of these settings is available upon request from [support@nokeval.com](mailto:support@nokeval.com)

## Cal menu

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



# Menu chart



## External battery

Config → External battery →

If the external power supply is a battery, this can save power by connecting to the server only from time to time.

Config → Buffering → Offline period →

If external battery function is on. If offline period reaches this value, connect to the server to empty the buffer.

Config → Buffering → Offline buffering →

If external battery function is on. If the buffer reaches this value, connect to the server to empty the buffer.

## Ovanet settings

Config → Ovanet → Enable fault LED →

If Ovanet is not used and there is no Ovanet radio module in slot 2, take selection off. It disables the front panel error message LED.

Config → Ovanet → Network address →

The network address that must be the same for all devices on the same network. 1...16777214. Please note that all addresses are not valid. Addresses that contain 8-bit sequence 10101010 or 01010101 are not valid. If the display shows zero, it means that the value could not be read from the radio module.

Config → Ovanet → Channel →

The network channel that must also be the same for all devices on the same network. 1...28. If the display shows zero, it means that the value could not be read from the radio module.

Config → Ovanet → Auth key →

If encryption is used, enter an authentication key text that is the same on all network devices. Otherwise, leave blank.

Config → Ovanet → Cipher key →

If encryption is used, enter a cipher key text that is the same on all network devices. Otherwise, leave blank.

Config → Ovanet → Diag interval →

Advanced mode for the network analysis. Normal state is Off.

## MTR & Nokeval Sky settings

Config → Module 1 →

Selects whether Nokeval Sky or MTR is in use at Module slot 1.

Config → MTR → Weak repeater filter →

When checked, repeated data packet from repeater will not be save to buffer if received signal level is weaker than already received. Default checked.

Config → MTR → Compatibility mode →

When checked, the receiver uses an alternate signal processing algorithm. Try different setting if you have problems with reception in low signal level conditions. Default checked.

Config → Sky → Network →

0..255. The network address that must be the same for all devices on the same network.

Config → Sky → Effort →

1..7, Custom.

Small value: Less power consumption, faster data rate, shorter radio range.

Large value: More power consumption, slower data rate, longer radio range.

Custom: Expert settings for frequency, bandwidth and spreading factor.

Config → Sky → Power →

0..10 dBm. Output power range.

Config → Sky → Channel →

1..7. Disabled if effort “custom” is selected.

Config → Sky → Enable Acknowledgement →

Reserved for future use.

Config → Sky → Auth. key →

Key for Message Integrity Check and data encryption.

Config → Sky → Enable beacon →

Enable beacon for coverage mapping.

Config → Sky → Relay RX margin →

Received signal margin can be stored in the buffer as its own channel. The reading should be a positive value. If the reading is close to zero, the strength of the received signal is at the reception limits.

Config → Sky → RX margin channel →

Select channel for the received signal margin.

Config → Sky → Relay batt level →

Battery level can be stored in the buffer as its own data channel. Utility data packet that includes battery information is a separate data packet than the measuring data packet. Therefore, it arrives at the receiver at a different time and less frequently.

Config → Sky → Batt level channel →

Select channel for the battery level.

## Configuring if Modbus use is needed

If Modbus is used, then the device must be reconfigured for Modbus use in Serial Communication sub menu:

Config → Serial communication → Protocol →

- Modbus
- WXT5x0
- Ascii
- SCL.

**Choose Modbus.**

Config → Serial communication → Baud rate →

- 300
- 600
- 1200
- 2400
- 4800
- 9600
- 19200
- 38400
- 57600
- 115200
- 230400

**Choose the desired baud rate.**

Config → Serial communication → Bits →

- 8N1
- 8N2
- 8E1
- 8O1

Usually **choose 8E1.**

Config → Serial communication → Timeout [s] →

- 1
- 2
- 3
- 4
- 5

After the command, the response is expected to receive from device in the timeout period. If the time is exceeded and no response received, an error is set.

Usually **choose 1.**

Config → Serial communication → Query interval [das] →

- 1
- 2
- ...
- 29

Query interval time between Modbus queries. Presented in dekaseconds. For example value 3 = 30 seconds.

Config → Serial communication → Queries →

- 1
- 2
- ...
- 64

The number of different Modbus queries. The maximum is 64. Each device that is being queried needs at least one query and if the same device is queried for multiple information which is not in subsequent registers or they have different data types, multiple queries are needed.

Config → Serial communication → Overview →

- Not used (Results setting zero)
- OK
- Incorrect settings - Conf settings are incorrect
- Limited - Only part of the sequential results is fetched, because virtual ID has overlapping with some other Modbus query or "internal status" result.
- Blocked - The result is not fetched, because virtual ID has overlapping with some other Modbus query or "internal status" result.
- Unrecognized data - Modbus reply is wrong type or wrong length.
- Timeout - Modbus replay was not received.
- Exception - Modbus device returned error code.
- CRC error
- Unknown error

Overview views Modbus queries and replies status and the first result. For example, "OK 24.2", "Timeout", "CRC error", "Unrecognized data" and so on.

Config → Serial communication →

- Query 1
- Query 2
- ...
- Query 64

Query 1 and all the way to Query 64 contain submenus for Modbus commands.

Config → Serial communication → Query x → MB Slave →

- 1
- 2
- ...
- 247

Modbus device address.

Config → Serial communication → Query x → Register type →

- Input Register
- Holding Register
- Discrete input
- Coil status

Modbus command / register type (search info on this from the other device's manual). Discrete input and Coil status registers are bit data and the result will be either 0 or 1.

Config → Serial communication → Query x → Register →

Register address (search info on this from the other device's manual).

Config → Serial communication → Query x → Results →

- 1
- 2
- ...
- 62

The number of subsequent results that can be read. The maximum is 62.

Config → Serial communication → Query x → Data type →

- Sint 16-bit
- Uint 16-bit
- Sint 32-bit BE
- Uint 32-bit BE
- Sint 32-bit LE
- Uint 32-bit LE
- Float BE
- Float LE
- Bit field

Data type type when register type is Input Register or Holding Register (search info on this from the other device's manual).

Config → Serial communication → Query x → Bit field offset →

- 0
- 1
- ...
- 15

The first readable bit of the register when register Data type is Bit Field (starting from the least significant bit).

The number of readable subsequent bits is set in the Results menu. The direction to read starts from the least significant bit and continues to the next register. Data Type Bit field gives result of 0 or 1.

Config → Serial communication → Query x → Divider →

- Off
- 10
- 100
- 1000

When needed, divides the result with decades (moves comma left). Usable with integers.

Config → Serial communication → Query x → Virtual ID →

The Virtual ID of the first result of the Modbus query. In the Ovaport Measuring points settings the "device address" and this virtual ID must match each other.

Config → Serial communication → Query x → Status →

- Not used (Results setting zero)
- OK
- Incorrect settings - Conf settings are incorrect
- Limited - Only part of the sequential results is fetched, because virtual ID has overlapping with some other Modbus query or "internal status" result.
- Blocked - The result is not fetched, because virtual ID has overlapping with some other Modbus query or "internal status" result.
- Unrecognized data - Modbus reply is wrong type or wrong length.
- Timeout - Modbus reply was not received.
- Exception - Modbus device returned error code.
- CRC error
- Unknown error

Overview views Modbus queries and replies status and the first result. For example "OK 24.2", "Timeout", "CRC error", "Unrecognized data" and so on.

### Examples of the Modbus settings

The following examples are in the test connection where FT20, TTM20X, Eurotherm 2216e and RMD681 were connected to Modbus line and where Virtual IDs were set as follows.

The device / reading	Slave Address	Virtual IDs
Internal measurements		0..2
FT20	4	3..5
TTM20X	2	6
Eurotherm 2216e	1	7
RMD681	3	8..15
<b>Config / Modbus</b>		
Baud rate	19200	
Bits	8E1	
Timeout[s]	1	
Query interval[ <i>das</i> ]	3	
Queries	4	
Overview	->	
Query 1	->	
Query 2	->	
Query 3	->	

Query 4	->
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#### Example of the Modbus settings for RMD681

<b>Config / Modbus / Query 1</b>	
Slave	3
Register Type	Input Register
Register	0
Results	8
Data type	Float LE
Divider	-
Virtual ID	8
Status	OK 25.2

#### Example of the Modbus settings for FT20

<b>Config / Modbus / Query 2</b>	
Slave	4
Register Type	Input Register
Register	1000
Results	3
Data type	Sint 16-bit
Divider	10
Virtual ID	3
Status	OK 15.3

#### Example of the Modbus settings for TTM20X

<b>Config / Modbus / Query 3</b>	
Slave	2
Register Type	Holding Register
Register	0
Results	1
Data type	Sint 32-bit LE
Divider	10
Virtual ID	6
Status	OK 26.8

#### Example of the Modbus settings for Eurotherm 2216e

<b>Config / Modbus / Query 4</b>	
Slave	1
Register Type	Input Register
Register	1
Results	1
Data type	Sint 16-bit
Divider	Off
Virtual ID	7
Status	OK 28.0



# Usage

The base station will not require any continuous operation or intervention by the user. The device works independently and will not usually require attention after installation. However, from time to time, check that the device is still functional.

## Multifunction button

In normal mode, LED bar indicates GSM signal strength. Short press of the multifunction button switches the LED bar to indicate the RAM buffer consumption. Second short press switches the LED bar to indicate FLASH memory consumption. Third press returns the LED bar to indicate GSM signal strength again. See below LED F1.

Long press of the multifunction button sets the device to firmware OTA update mode. See below LED F2.

If the battery low alarm sounds, it can be acknowledged and muted by a short press of the multifunction button. See below LED BAT.

## LEDs

### GSM

Blinks green	GSM-modem is starting up.
Blinks yellow	There is no SIM-card in place.
Solid green	GSM-modem has 3G connection.
Solid yellow	GSM-modem has 2G connection.
Blinks red	GSM-modem replies: Registration denied.
Solid red	GSM-modem is unable to communicate with the internal processor.

### SRV

Off	There is no IP-address.
Blinks yellow	Base station tries to connect to Ovaport.
Blinks green	Base station in connection to Ovaport and tries to "handshake".
Solid green	Base station in connection to Ovaport and handshake is successful.

### RF1

Blinks green about every 10 s	Received a packet from a Sky radio (433 MHz) within 1 min 30 s.
Solid yellow	There are packets in the FLASH memory buffer that haven't been sent to Ovaport (also blinks green every 10 s if new packets arrive).
Solid red	FLASH memory buffer is full (also blinks green every 10 s if new packets arrive).

### RF2

Blinks green about every 10 s	Received a packet from the Ovanet radio network (2,4 GHz) within 1 min 30 s.
Off	No neighbours found in the Ovanet radio network.
Blinks yellow about every 10 s	The base station has neighbours (transit to blink green, once it gets measurement packets).
Solid red	Ovanet radio signals an error or internal processor cannot communicate with the Ovanet processor.

## RS485

Off	No queries are configured.
Blinks green	Queries are configured, and the base stations gets answers to them.
Blinks yellow	Queries are configured, but some of them don't work.
Solid red	None of the queries work.

## F1

GSM signal bar will display the fill state of RAM or FLASH memory buffer (to enter this state one must press multifunction button that is right above the power button)

Off	GSM signal bar will display the GSM signal strength.
Solid green	GSM signal bar will indicate the fill state of the RAM buffer*. RAM buffer status is displayed with green bars.
Blink green	GSM signal bar will indicate the fill state of the FLASH buffer*. FLASH buffer status is displayed with yellow bars.

\*In these states the following LEDs are turned off: RS485, RF2, RF1, SRV, GSM. Will return to normal state automatically in 30 s.

## F2

Long press of the multifunction button will trigger an OTA firmware update (if update is unsuccessful the device will return to normal state).

Off	Firmware update is not in progress.
Blinks green	Connecting to the firmware update server.
Solid green	Firmware update was found, and it's being downloaded.
Solid red	Cannot connect to the firmware update server.

## BAT

Solid green	Battery voltage is >2.8 V.
Solid yellow	Battery voltage is between 2.8-2.3 V.
Solid red	Battery voltage is between 2.3-2.1 V.
Blinks red & alarm sounds*	Battery voltage is <2.1 V.

\*Can be acknowledged and muted with a short press of the multifunction button.

## PWR

Blinks green	External power supply is connected and it's feeding power.
Blinks yellow	The device operates on backup battery power.
Solid red	The device is turning off.

# Maintenance

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## Cleaning

The device is made from shock-proof technical plastic and the seams are sealed with a rubber gasket. It can be cleaned by wiping with a damp cloth.

**The device is not meant to be immersed into water or other liquids.**

## Service

If Bat LED indicates low battery voltage (red, see above BAT LED), the backup batteries (2 pcs size D alkaline cell) need to be replaced.

The device does not require other regular service or maintenance.

# Troubleshooting

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**The base station cannot connect to GSM-network.**

Is the SIM card installed inside the base station? Is a PIN code set in the configuration menu? Is there a sufficient mobile data network coverage at the installation location? If needed, contact support.

**The firmware update was not successful.**

Backup battery level needs to be above certain level to start the search for the new firmware. If the search will not start, replace the batteries and try to find a place with a better GSM coverage or more reliable Ethernet connection. The battery level needs to be above certain level, to start the flashing of the new firmware.

If the update will not work at all, or you want to send the device for service, contact Nokeval support with the contact information given below.

# Specifications

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## Environment

Storage temperature	-30...+60 °C, non-condensing
Operating temperature	-20...+50 °C
Operating humidity	5...95 %RH, non-condensing
Protection class	IP65, except power supply which is IP20
Enclosure material	Plastic (PC+ABS), silicon rubber
Compatibility	Nokeval Sky series 433 MHz ISM band transmitters and optionally 2,4 GHz Ovazone series devices. Ovaport network service.

## Measurements

Weight	About 850 g including the wall holder and an external antenna
Maximum dimensions	Height 212 mm without the antenna, about 383 mm with the antenna Width 134 mm Depth 67 mm

## User interface

LEDs	14 dual-color LEDs
Buttons	2 buttons: power on/off and multifunction button

## Internal memory for buffered results

Type	Non-volatile FLASH memory
Capacity	About 500 000 measurements

## Backup batteries

Type	2 pcs size D heavy-duty alkaline batteries
Backup running time	About 5 days at +20°C temperature About 8 hours at -20°C temperature

## 433.92 MHz radio transceiver (Sky)

Description	Nokeval Sky protocol and radio transceiver using LoRa modulation
Antenna	External detachable quarter-wave whip antenna with BNC antenna connector
Frequency	License-free 433.3...434.5 MHz ERC/REC/70-03 sub-band f
Power	max 10 dBm E.I.R.P
Open space range	Up to 10 km, dependent on configuration parameters
Indoor range	Up to several hundred meters, dependent on configuration parameters

## 2.4 GHz radio transceiver (Ovanet)

Description	Nokeval Ovanet protocol with Wirepas Pino mesh network technology
Antenna	Internal antenna
Frequency	2.400-2.485 GHz worldwide license-free ISM band
Power	max 5 dBm E.I.R.P.
Open space range	Up to 200 m
Indoor range	10 to 30 m typical (node to node)

## GSM modem

Antenna	Internal chip antenna
Type	Four band EGSM/GPRS/HSDPA (3G)
SIM card	1.8/3 V auto detect, internal socket, locking mechanism

## Power supply

Voltage	18...28 VDC
Current	< 500 mA
Power	4 pin M12 receptacle, female

### **Other**

Firmware update	Over-The-Air (OTA) firmware update
RS485 external connector pins	Modbus RTU or Nokeval SCL protocols

### **Cloud connection**

Compatibility	Nokeval Ovaport cloud service
GSM connectivity	2G or 3G (EGSM/GPRS/HSDPA)

# Warnings

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**Warning! This device contains a license-free ISM band (433.92 MHz) SRD radio transceiver and a 2.4 GHz radio transceiver. Observe local regulations concerning the use of such radio transmitters. Never start or use this device near explosion hazard areas or in areas where the use of radio transmitters has been limited, such as in airplanes, near medical instruments, near flammable liquids or chemicals or near explosion work sites.**



**Do not leave the device in direct sunlight or some other place, like in a parked car, where temperature can rise to over +50°C. The battery may overheat and cause fire or explosion hazard.**

**Read this manual carefully before using the device.**

**Only Nokeval authorized services may repair or modify the device. The device contains no user serviceable parts.**



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

# Trademarks

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All trademarks mentioned are the legal property of their respective owners.

# Manufacturer

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Nokeval Oy  
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Finland

Phone: +358 3 342 4810 (Mon-Fri 8:30-16:00 EET)  
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