Nokeval
made to measure

Cell2-Sky-Link-RS485-LTE/LAN

User Manual

ID11200 V31 24.9.2021
Firmware versions 1.0-1.0

Table of contents

Introduction

Cell2-Sky-Link-RS485-LTE and **Cell2-Sky-Link-RS485-LAN** are base stations for Nokeval's 433.92MHz Sky-transmitters and are part of Nokeval **Sky** product families. They receive and buffer radio packets to non-volatile memory and transmit them over cellular mobile data networks (**LTE model**) or local area networks (**LAN model**) to Nokeval's cloud data collections services, like Ovaport, thus enabling reliable remote data acquisition from the field, straight to the cloud. The base station's reliability is increased by the backup batteries, which enable uninterrupted data acquisition also during external power interruptions.

Serial interface

The base station can also be connected to **standard Modbus RTU transmitters** and to **Nokeval devices with SCL protocol** using the integrated RS485 bus master.

Sky radio

Nokeval's third generation Sky radio devices use the Semtech's LoRa modulation technology on the European license-free 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 higher 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 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.

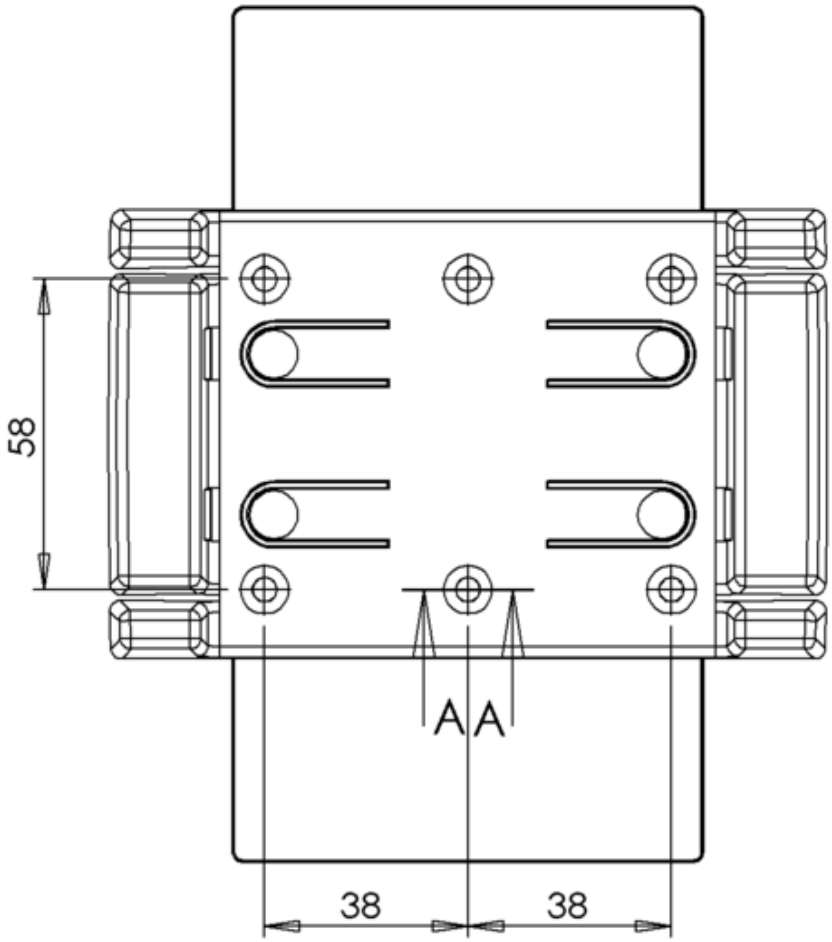
When the maximal range is not necessary, the parameters should be adjusted for lower battery and band consumption. All the devices within one network must share the parameters, because the receiver can only listen with one set of parameters at a time. Consequently, the parameters must be selected according 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.

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.



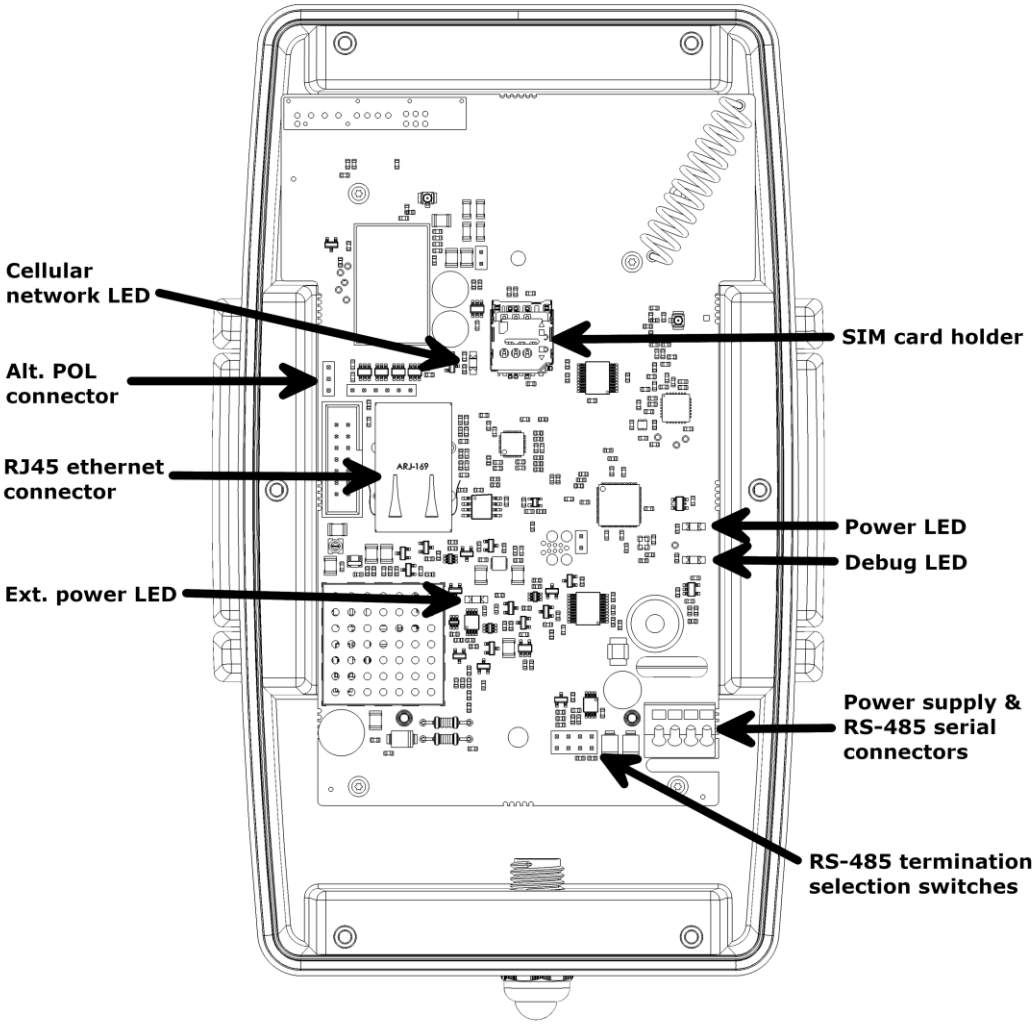
Installation location

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

The base station must be installed vertically. The base station is splash waterproof, 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 waterproof.

The location must have LTE/GSM/GPRS network coverage for the LTE model. This can be verified before the final installation steps by powering on the base station and checking the signal strength indicator LEDs (see page 21). Installation location must have one free AC socket for the power supply.

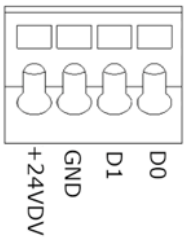
Connections



Power supply & serial RS-485 connector

Inside the device, at the bottom right of the circuit board, is a four-pole spring cage / plug-in terminal block connector. It is a combined power supply and serial data connector.

The table below describes the function of each connector pole.



Symbol	Description
+24VDC	Power supply positive connection, 18…28 VDC
GND	Power supply negative connection, RS-485 bus ground
D1	RS-485-bus D1 connection
D0	RS-485 bus D0 connection

Micro-SIM

Insert micro-sized SIM card with a PIN code request set to off.

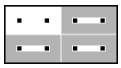
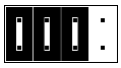
Cellular network LED

- LTE Cat NB1/M1: LED lit continuously
- LTE Cat NB1/M1 roaming: LED flashes once per second
- eGPRS: LED flashes once every 2 second
- eGPRS roaming: LED flashes twice every 2 second

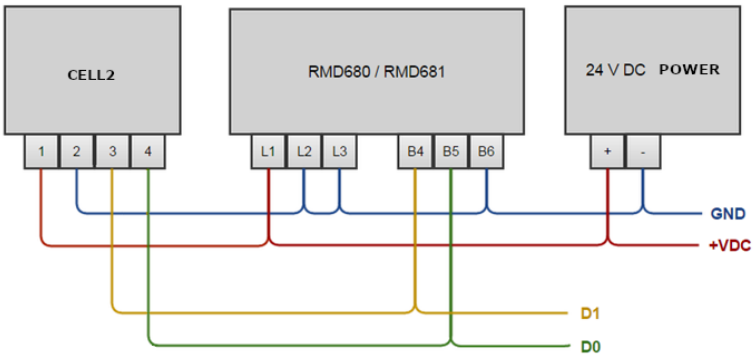
RS-485

RS-485 serial communication can be used to read results from external devices. The protocol can be Modbus, Nokeval SCL or also ASCII protocol for Vaisala WXT500 series weather transmitter.

The RS-485 bus termination can be set with jumpers on the circuit board, as shown below. Extra jumpers can be put at the places marked in gray. These do not affect the connection.

Off	
AC termination	
Failsafe biasing	
AC termination & Failsafe biasing	

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.

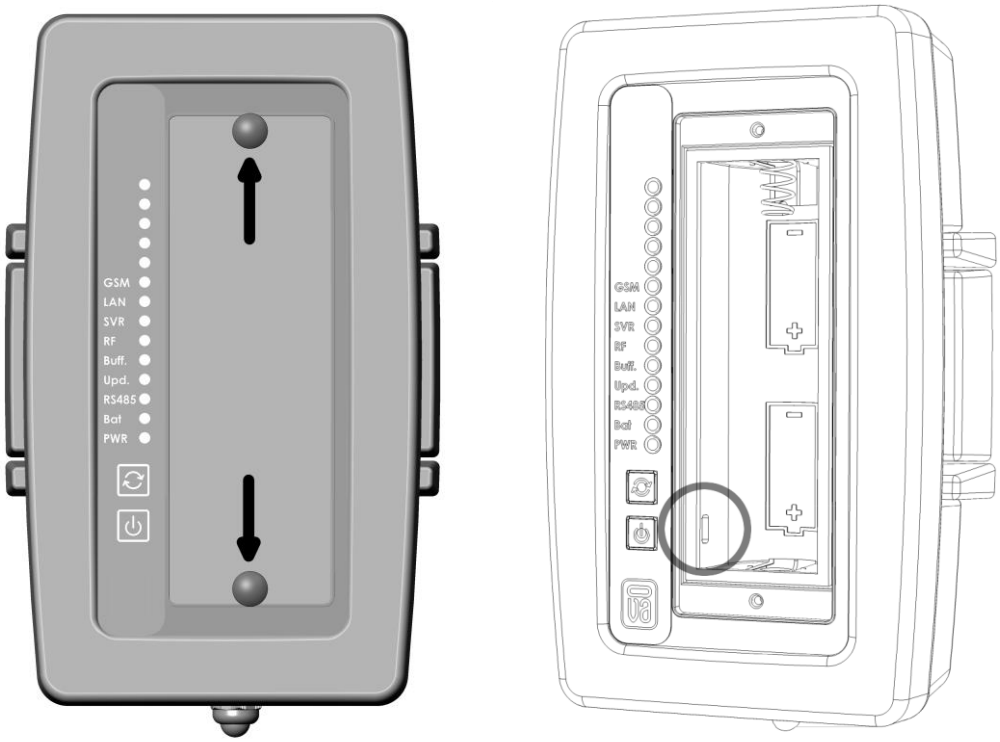
To ensure EMC compliance the RS-485 bus cable should no more than 30 meters long.

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 a 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.

Backup battery case and POL connector

The battery cover can be opened by removing the two screws on the cover of the device. The screws indicated by the arrows are shown in the picture below. The device uses two D-size heavy-duty alkaline batteries. There is also a Meku POL configuration connector inside the battery case. See "Configuring the device" in the next section of the manual. The location of the POL connector is marked with a circle in the figure below.



Configuring the device

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 for free.

Connection settings

Communication settings for configuration:

- baud rate 9600
- protocol SCL
- address 0

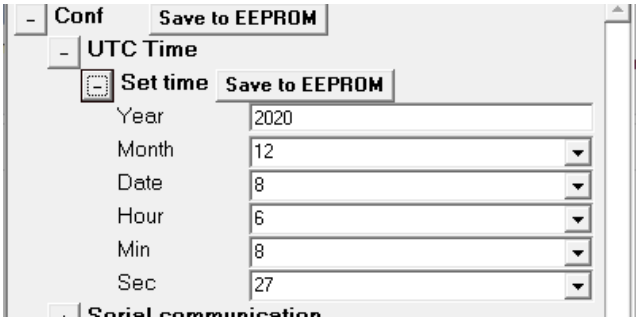
Programming connector

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

Time settings

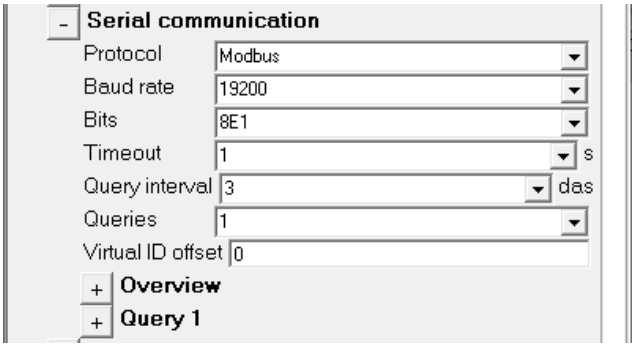
The device can forward packets only if it has a time set. It receives time information from internet, so you do not need normally to use this manual setting.



Serial settings

The device can retrieve measurement results with the following serial communication protocols: Modbus RTU, Nokeval SCL or Vaisala's WXT5x0 ascii protocol.

Basic settings for serial communication



Protocol

- Modbus
- WXT5x0 Ascii
- SCL

Baud rate

300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 125000, 230400.

Bits

- 8N1 (8 data bits, No Parity, 1 stop bit)
- 8N2 (8 data bits, No Parity, 2 stop bit)
- 8E1 (8 data bits, Even Parity, 1 stop bit)
- 8O1 (8 data bits, Odd Parity, 1 stop bit)

Timeout [s]

1 – 5 s

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.

Query interval [das]

1 – 29 das

Query interval time between queries. Presented in decaseconds (das, a unit of time equal to 10 seconds). For example, value 3 = 30 seconds.

Queries

1 - 64

The number of different 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.

Virtual ID offset

0

A setting that shifts (sums) the value of all virtual IDs. Practical to move virtual IDs to a different area if there are many gateways in the same destination with similar serial communication settings.

Overview

Displays the serial communication status for each query:

- 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 query or “internal status” result.
- Blocked – The result is not fetched, because virtual ID has overlapping with some other query or “internal status” result.

- Unrecognized data - Modbus reply is wrong type or wrong length.
- Timeout – No response was received from the device.
- Exception – Device returned error code.
- CRC error
- Unknown error

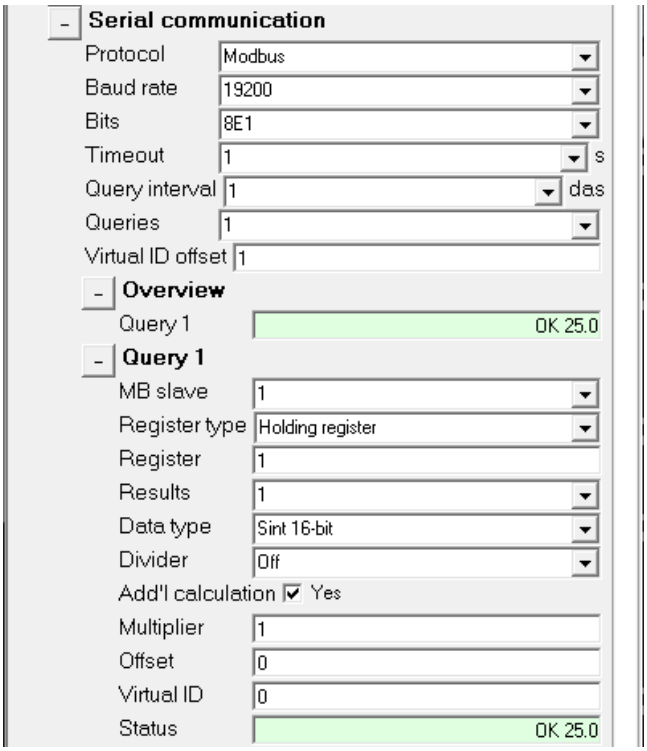
Overview views queries and replies status and the first result. For example, "OK 24.2", "Timeout", CRC error", "Unrecognized data" and so on.

Query 1 – 64

Settings for each selected query.

Modbus RTU

If Modbus is used, choose Modbus protocol and desired serial basic settings. Bits settings for Modbus is usually 8E1.



Query 1 – 64, submenus for each selected query.

MB Slave

1 - 247

Modbus device address.

Register type

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

- Nopsa radio data

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. Nopsa radio data reads data from specific Nokeval radio receivers, such as the FT20.

Register

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

Results

1 - 62

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

Data type

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

- 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

Sint is signed integer, Uint is unsigned integer.
Float is 32-bits, single-precision floating-point number.

BE = Big-endian, first 16-bit word is most significant.
LE = Little-endian, first 16 bits word is least significant.

Bit field offset

0 - 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.

Divider

Off, 10 – 1000000.

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

Additional calculation (Multiplier, Offset)

This allows you to multiply and/or addition the value.

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.

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 - No response was received from the device.
- 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 Nokeval FT20, TTM20X, Eurotherm 2216e and Nokeval 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

Config / Modbus	
Baud rate	19200
Bits	8E1
Timeout[s]	1
Query interval[das]	3
Queries	4
Overview	->
Query 1	->
Query 2	->
Query 3	->
Query 4	->

Example of the Modbus settings for RMD681

Config / Modbus / Query 1	
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

Config / Modbus / Query 2	
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

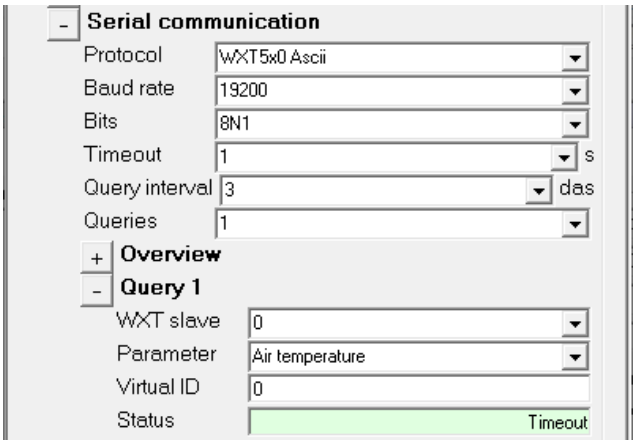
Config / Modbus / Query 3	
Slave	2
Register Type	Holding Register
Register	0
Results	1
Data type	Sint 32-bit LE
Divider	10
Virtual ID	6
Status	OK 26.8

Example of the Modbus settings for Eurotherm 2216e

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

WXT5x0 Ascii

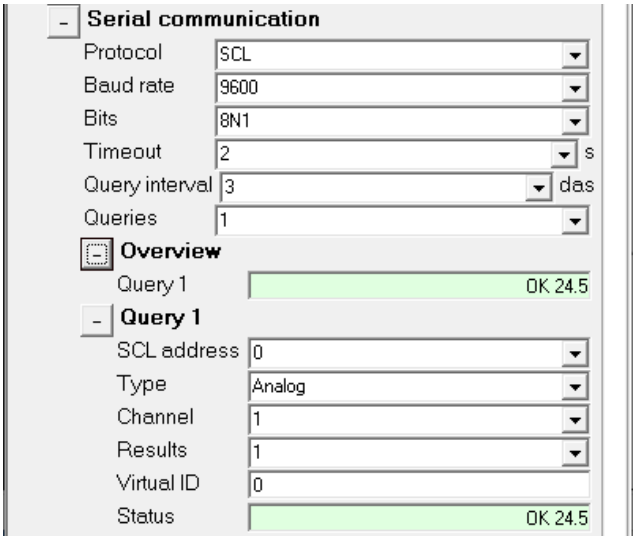
ASCII protocol for Vaisala WXT500 series weather transmitter.



Set the serial communication settings and number of queries. For each query, set the device address and the desired parameter.

SCL

Nokeval SCL protocol.



Set the serial communication settings and number of queries. SCL bits is usually 8N1.

Query 1 – 64, submenus for each selected query.

SCL address

0 – 123. Device address.

Type

- Analog
- Digital
- Nopsa radio data

Analog: Reads measurement results using the MEA command.
Digital: Reads digital data using the DI command. The result is either 0 or 1.
Nopsa radio data: Reads data from specific Nokeval radio receivers, such as the FT20.

Channel

1 – 64. The channel on the device being read.

Results

1 – 8. The number of subsequent results that can be read.

Virtual ID

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

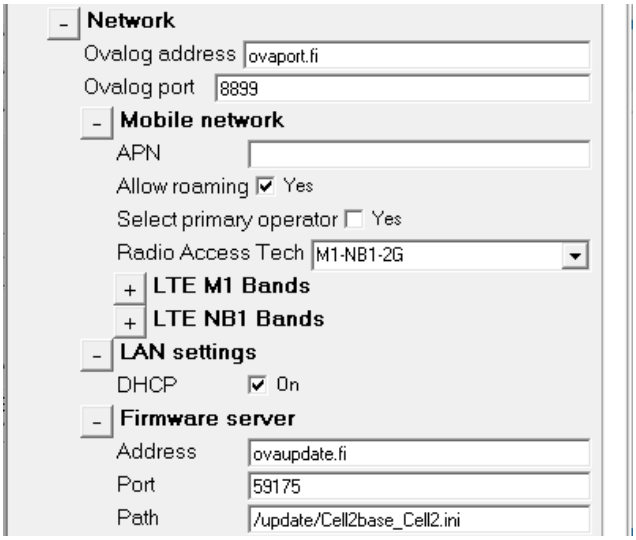
Status

- 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 SCL query or “internal status” result.
- Blocked – The result is not fetched, because virtual ID has overlapping with some other SCL query or “internal status” result.
- Unrecognized data - SCL reply is wrong type or wrong length.
- Timeout - No response was received from the device.
- Exception – SCL device returned error code.
- CRC error
- Unknown error

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

Network



Ovalog address and Ovalog port

The address and TCP port of the server to which the measurement results are sent.

Mobile network

APN: Cellular network access point name for internet connection. Can usually left blank.
Allow roaming: Set if it is necessary to connect to visitor networks.
Select primary operator: Selecting the primary operator might speed up the connection establishment. MCC and MNC numeric codes are entered sequentially without spaces in the **Operator MCC-MNC code** field.
Radio Access Tech: Select radio technologies , LTE Cat M1, LTE Cat NB1 and eGPRS, in order of priority:

M1-NB1-2G
M1-2G-NB1
M1-NB1
M1-2G
M1
NB1-M1-2G
NB1-2G-M1
NB1-M1
NB1-2G
NB1

2G-M1-NB1
2G-NB1-M1
2G-M1
2G-NB1
2G

LTE M1/NB1 Bands: B3 (1800 MHz), B8 (900 MHz), B20 (800 MHz) and B28 (700 MHz).

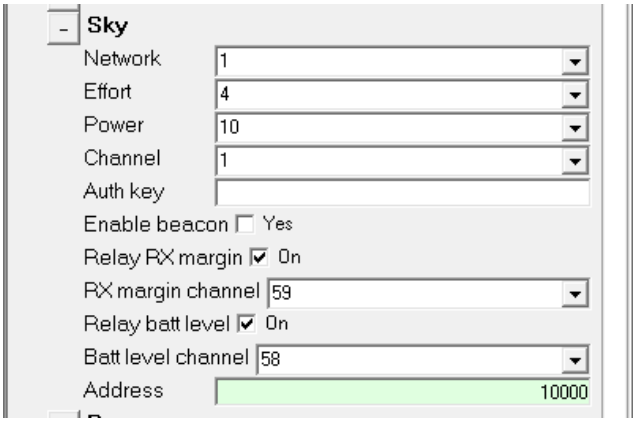
LAN settings

DHCP: Dynamic Host Configuration Protocol (default on).
If DHCP is disabled, lines will appear where the IP address, subnet mask, gateway and DNS server addresses can be set.

Firmware server

These settings must be as shown in the image above.

Nokeval Sky settings



Network

0..255.

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

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.

Power

0..10 dBm.

Output power range.

Channel

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

The frequency channels are spaced at 200 kHz. At Efforts below 7, two adjacent channels may interfere.

Channel	Center frequency MHz
1	433.3
2	433.5
3	433.7
4	433.9
5	434.1
6	434.3
7	434.5

Auth. key

Key for Message Integrity Check and data encryption.

Enable beacon

Enable beacon for coverage mapping. Default Off.

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.

RX margin channel

Select channel for the received signal margin. Default 59.

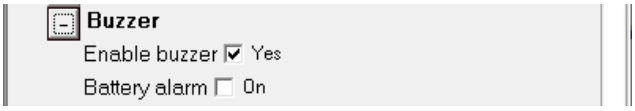
Relay batt level

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.

Batt level channel

Select channel for the battery level. Default 58.

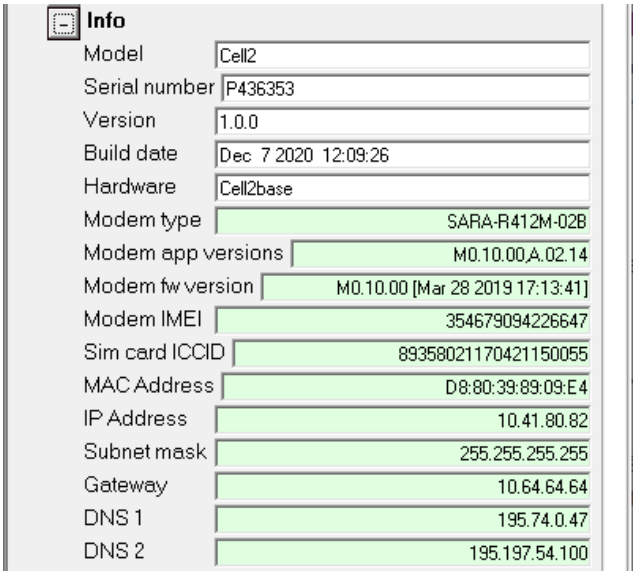
Buzzer



Enable buzzer. Pressing the button causes a beep sound.

Battery alarm. If turned on, low battery voltage will also cause a beep.

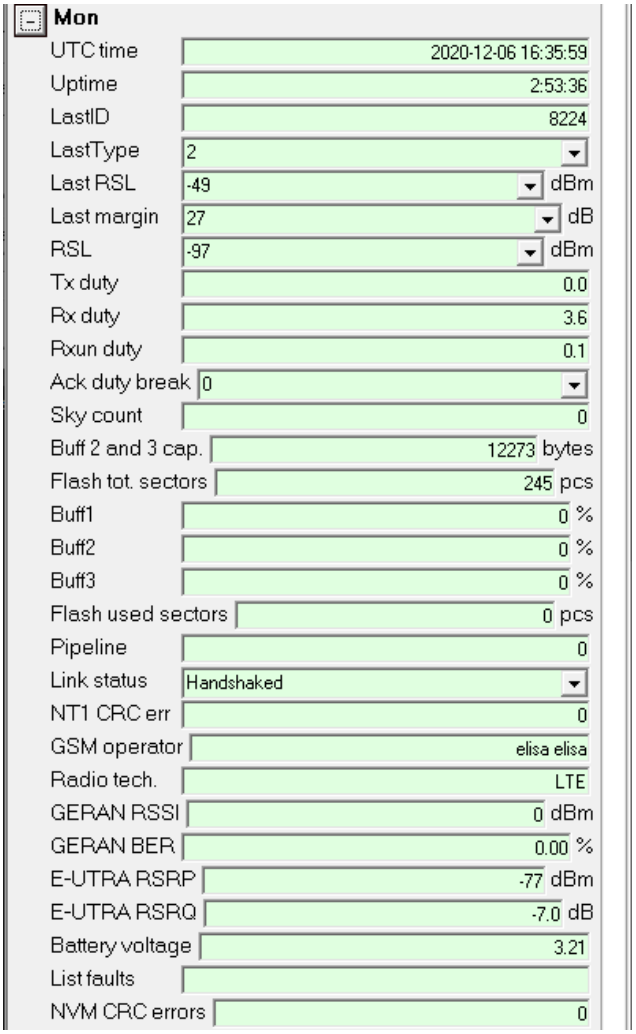
Info



Info menu items are not configurable. They display various information about the device.

Mon menu

The monitor menu generally shows the status of the device and is mainly for manufacturer use. Many menu items purposes are clear by name, and most of them are not explained in this manual.



Buffer memory: Buff1, Buff2, Buff3 and Flash sectors:

If data arrives to the gateway faster than it can be send to the cloud, it stores the data in a buffer memory.

First, the data passes through the device's RAM memories Buff1, Buff2 and Buff3. Data from memory Buff3 is sent to cloud. 0% means empty, 100% means full. If Buff3 and Buff2 become full, the device will start storing data of Buff2 to flash memory. One sector at a time.

The size of one flash sector corresponds to the size of one buff2 or buff3. "Flash tot. Sectors" indicates the total number of sectors available and "Flash used sectors" indicates how many of them have been used to store data.

Cal menu

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

Usage

The base station does 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.

LEDs

The top five LEDs on the white background indicate the signal strength of the cellular network, the more LEDs light the better the signal.

The LEDs below them indicate the status of the various functions. They either light steadily or flash at two-second intervals as follows.

2G/4G

LED Off	The modem is off, or the device is an ethernet model.
Flashes once	Modem is starting up.
Flashes twice	Connects to the network
Steady green	Connected to 4G network
Steady yellow	Connected to 2G network
Continuous flashing five times per second	SIM status fail

LAN

LED Off	Ethernet circuit is not ready or device if a modem model.
Flashes twice	Ethernet link is up. Retrieves network parameters from dhcp server.
Steady green	Connected to the network at 100 Mbit/s.
Steady yellow	Connected to the network at 10 Mbit/s.
Continuous flashing five times per second	Ethernet link is down

Uplink

Led Off	Not connected
Flashes once	Connects to the Ovaport.
Flashes twice	Connection to the Ovaport. Waiting for a timestamp.
Solid green	Connection to the Ovaport is ready.

Mem

Solid green	More than 99 % of memory is free
Lights up every two second	Memory usage is less than 33 %

Flashes twice	Memory usage is over 33 % but less than 66%
Flashes three times	Memory usage is over 66 % but not yet full
Continuous flashing five times per second	Memory is full

Sky

Solid light **	Received at least one packet in the last 10 minutes.
Lights up every two second **	Received at least one packet in the last 30 minutes.
Flashes twice **	Received at least one packet in the last 60 minutes.
Flashes three times **	No packet has been received in the last 60 minutes

RS485

Off	No queries are configured for RS485 devices.
Solid light **	Queries are configured, and the base stations gets answers to them.
Flashes three times **	Queries are configured, but some of them do not work.
Continuous flashing five times per second	None of the queries work.

****** If the device has received a timestamp from the Ovaport and its clock is in time, the LED lights green, otherwise LED lights yellow. If the clock is not in time, data packets cannot be received or processed.

FOTA

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.
Lights up every two second	Firmware update is in progress.

Batt

Solid green	Battery voltage is >2.8 V.
Lights up every two second	Battery voltage is between 2.8-2.3 V.
Flashes twice	Battery voltage is between 2.3-2.1 V.
Continuous flashing five times per second & alarm sound*	Battery voltage is <2.1 V.

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

Power

Lights green every two second	External power supply is connected, and it is feeding power.
Flashes twice	The device operates on backup battery power.
Continuous flashing five times per second	The device is turning off.

Multifunction button

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

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

Status information

Cell2 sends status information to the Ovaport according to the table below.

Channel	Description
251	Sky radio background noise RSSI [dBm]
252	Cellular modem RSSI (2G) or RSRP (LTE) [dBm]
253	Cellular modem status: 0: Not connected 1: Unknown 2: 2G 3: 3G 4: LTE
254	External power detected
255	Battery voltage [V]
256	CPU core temperature [°C]

Maintenance

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

The base station cannot connect to GSM-network.
Is the SIM card installed inside the base station? Is the SIM card PIN code set to off? 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.

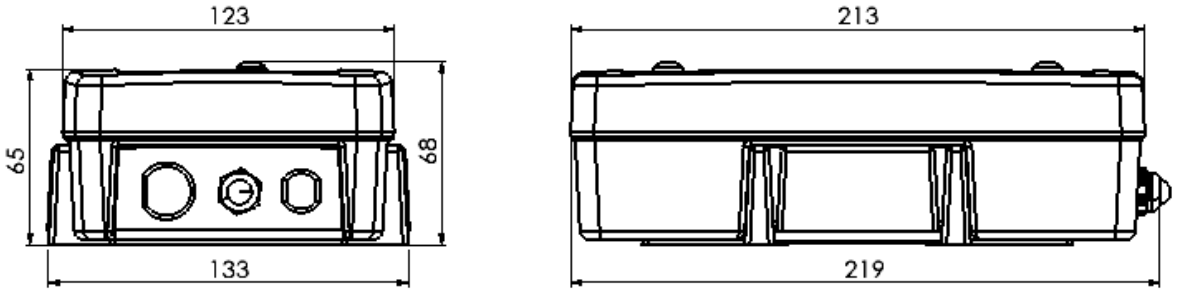
Specifications

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. Ovaport network service.

Measurements

Weight	About 850 g including the wall holder and an external antenna
Maximum dimensions	Height 219 mm Width 133 mm Depth 68 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 100 000 measurements

Backup batteries

Type	2 pcs size D heavy-duty alkaline batteries
Backup running time	About 2 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	Internal
Frequency	License-free 433.05 - 434.79 MHz
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

Network connection, depending on the device type

Mobile	LTE Cat M1, NB1 bands 3, 8, 20 and 2G Internal chip antenna Micro size SIM card.
Ethernet	10/100 Mbit/s auto-negotiation. DHCP client.

Power supply

Voltage	18...28 VDC
Current	< 500 mA

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

Warnings

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.

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