LoRaWAN® BK-G Pulse Reader CM3061 Datasheet

LoRaWAN® BK-G Pulse Reader enables the automatic acquisition of gas consumption data from Elster diaphragm gas meters BK-G1,6 to BK-G100 that are equipped with the index Z3 /Z6 and transmits it wirelessly to the LoRaWAN® network or wM-Bus.

Features

- Hybrid radio: LoRaWAN® and wM-Bus
- Simple touch to connect configuration using NAS Connect Mobile app
- LoRaWAN® ready in wM-Bus mode (automatic switchover)
- Secure communications
- Monthly, daily, hourly, quarter-hourly metering
- Alerts: no usage, tamper
- Simple configuration profiles
- Pre-installed battery with expected life of n/a years
- Device Firmware Update using phone
- Maintenance free - install and forget
- Durable (IP68 rated)

Table of Contents

This document does not contain Payload Structure Definitions. It applies to firmware versions 2.3.x.

1 Quick Start Guide

Make sure NAS Connect for iPhone (QR code link on the right) is installed and logged in using services.nasys.no account.

1. Provisioning

Add CM3061's keys to available LoRaWAN network server before turning CM3061 on. Necessary keys are DevEUI, JoinEUI (AppEUI) and AppKey (all keys LSB). Device class Class-A, activation join OTAA, LoRaWAN MAC version 1.0.3, regional param rev A.

Make sure your account has sufficient rights to access your CM3061 using services.nasys.no .

2. Installation

⚠️Do not wake up CM30xx without external antenna attached, this can damage radio circuitry.

Fasten CM3061 tightly, as shown on the figure below. Attach the SMA antenna.
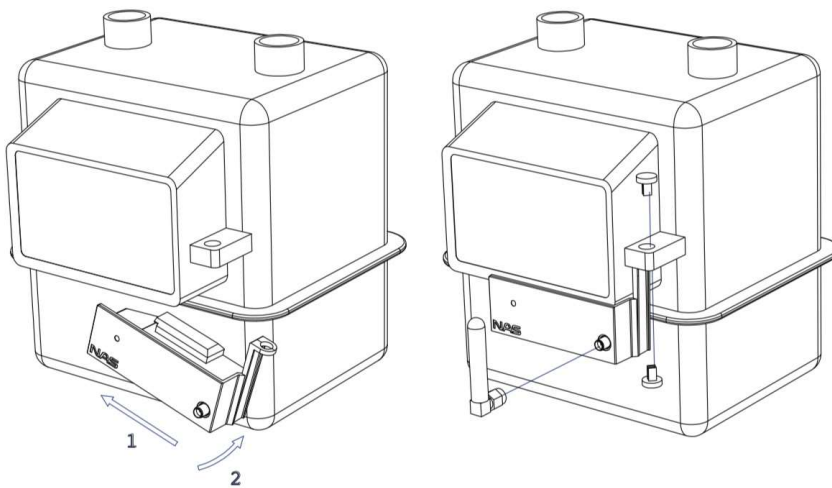
3. Configuration

Scan CM3061 with NAS Connect app near the 📶 logo. Configure relevant parameters (app screenshots below). Create Preset. Load Preset on other devices.

Notice: If installed during Summer Time it is recommended to manually set Winter Time by decreasing Time Zone value by 1 h.

2 Specifications

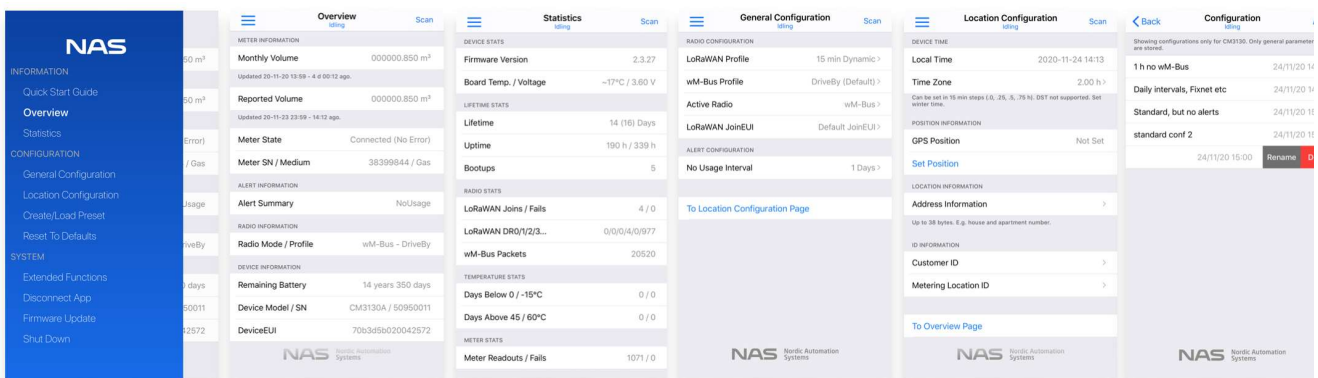| Parameter	Typical
Dimensions (L×W×H)	unavailable:DINS:length×unavailable:DINS:width×unavailable:DINS:height mm
Weight	80 g
Enclosure Material	ABS(LG380LK)+engraving add.
IP rating	IP68
ATEX Approved	unavailable:ATEX
Operating Temperature	-5 °C ... +65 °C
Communication range	up to 15 km*
Antenna Connector	SMA
LoRaWAN Device Class	Class A
LoRaWAN Version	1.0.3a
LoRaWAN Activation	OTAA
LoRaWAN Transmit Power	+16 dBm (EIRP)
LoRAWAN Receive Sensitivity	-137 dBm @ SF12, BW 125kHz
wM-Bus Mode	C1 mode-5 encryption
OMS version	4.1.2
Expected battery life	n/a years**
Max. Storage Period	1 year 10°C ... 30°C

*Communication range depends on the location of the sensor and the nearest base station, surroundings etc.

**Battery life varies with extreme temperatures. Except if *radio_lorawan_profile* is *lorawan_1_h_static* or *lorawan_15_min_static* profile.

3 Metering

3.1 Timings

CM3061 is updating meter readouts every 15 minutes . Meter readouts are timed 2 seconds early (xx:59:58, xx:14:58, xx:29:58, xx:44:58) so that monthly readout would have the date of previous month. *meter_actuality_duration__minutes* indicates the age of the readout value.

3.2 Alerts

Alerts are updated together with timed meter readouts. *active_alerts* are reported as a flags in next packets. In LoRaWAN mode confirmed *usage_with_status_packet* clears pending *active_alerts* flags. In wM-Bus mode *active_alerts* flags are immediate values and not accumulated.

Timed meter readouts to detect alert conditions are performed even in *wmbus_privacy* and *lorawan_24_h_privacy* modes.

Alert	Condition	Reset at
alert_no_usage	no flow within *alert_no_usage_interval__days* period	any flow
alert_low_battery	<182 days left of expected CM3061's lifetime	never
alert_tamper	strong external magnetic field	reduced external magnetic field

3.3 Measurement Method

CM3061 reads the volume by sensing rotating magnet with reed switch.

This method has some inherent limitations: only relative counting which can introduce error. This method is not guaranteed to ensure Liter-to-Liter precision.

alert_tamper detection is based on reed switch (detecting external strong magnetic field) positioned apart from main reading reed. Meter removal is not detected by CM3061, it can be verified by broken seal.

3.4 Configuration

meter_accumulated_volume__L - since CM30xx counts revolutions it has no absolute reference, current meter reading has to be entered

meter_serial - serial number of the water meter can be configured, it is reported in *usage_with_status_packet*.

4 LoRaWAN

CM3061 implements LoRaWAN specification v1.0.3 class A device. CM3061 listens for downlinks only briefly after uplink. LoRaWAN payloads are all LSB.

LoRaWAN parameter NbTrans (formerly NbRep) determines transmission count of unconfirmed packets, it can be adjusted by backend (to increase Quality of Service). CM3061 overrides NbTrans to be 1 at all times to avoid increased battery consumption.

4.1 Joining

After boot-up CM3061 performs LoRaWAN Over-the-Air Activation(OTAA) join procedure. The data-rates used and duration of the cycle are region dependant. In LoRaWAN (except US915, AU915 and AS923 regions) the join cycle consists of 5 join request messages (DR4, DR3, DR2, DR1, DR0). The whole cycle can take up to 3 minutes in total. At successful join CM3061 will decrement DataRate by one when higher DataRates (DR3 → DR2, DR4 → DR3).

When using ≤8 channel gateway in AU915 or US915 region with 64 channels, joining is roulette unless join channel group mask is manually set (see *lorawan_ch_mask_group*).

4.2 Recovery / Rejoin Mechanisms

LoRaWAN link quality can be assessed after join by looking at DataRate (DR0 - worst, DR5 - best). Additionally Send Usage With LinkCheck button on Extended Functions page sends LoRaWAN LinkCheck MAC command to get the number of gateways and SNR.

LoRaWAN connection is daily monitored using *usage_with_status_packets* confirmations (ACKs).

Mechanism	Mode	Precondition	Reason	Action	Following action
ADR recovery	Hybrid / LoRa only	LoRaWAN joined	No downlink in 48 h	ADR disabled temporarily, data-rate decreased, TX power increased*	no downlink: DR decrease in 48 h downlink received: ADR re-enabled
Network lost rejoin	Hybrid	LoRaWAN joined	No downlink in 7 days	LoRaWAN Rejoin	join failure: fall back to wM-Bus, rejoin after 7 days
	LoRa only	LoRaWAN joined			join failure: rejoin after 24 h
Periodic rejoin	LoRa only	LoRaWAN not joined	Join failed 24 h ago	LoRaWAN Rejoin	join failure: rejoin after 24 h
	Hybrid	wM-Bus active	wM-Bus active for 7 days	LoRaWAN Rejoin	join failure: fall back to wM-Bus, rejoin after 7 days

*ADR recovery step decreases DataRate by dividing DataRate index by two (e.g. DR4 → DR2) and increases TX power by dividing power reduction value (relative to max power of region) by two (e.g. 3 dBm → 9 dBm, 9 → 12, 11 → 13).

4.3 Profile Timings

LoRaWAN timed payloads are transmitted with specific time offset after meter readout to reduce packet collisions. The time offset is calculated randomly once at boot (system reset) ranging from 30 sec to 14 min 30 sec.

Dynamic profiles ensure battery lifetime by lowering transmission interval at lower data-rates (which means longer air-times). Static profiles do not alter transmission intervals at the expense of reduced battery lifetime.

In *lorawan_24_h_privacy* (GDPR) mode reported meter readout value is updated once a month to hide the consumption patterns.

LoRaWAN Profile	LoRaWAN packet interval	Metering value update interval	Internal meter readout interval	Reduced lifetime
lorawan_24_h_privacy	24 h	monthly	15 min	no
lorawan_24_h	24 h	24 h	15 min	no
lorawan_12_h	12 h	12 h	15 min	no
lorawan_1_h_dynamic	1 h / 2 h (DR0)	1 h / 2 h (DR0)	15 min	no
lorawan_15_min_dynamic	15 min / 1 h (DR1, DR2) / 2 h (DR0)	15 min / 1 h (DR1, DR2) / 2 h (DR0)	15 min	no
lorawan_1_h_static	1 h	1 h	15 min	yes
lorawan_15_min_static	15 min	15 min	15 min	yes

4.4 Packets Overview

CM3061 sends out *usage_packet*s on configured interval with the exception of midnight and noon when *usage_with_status_packet* is sent instead. This payload contains everything that is needed for billing purposes. *usage_with_status_packet differs from usage_packet* only by added *device_status* block.

After every LoRaWAN join, CM3061 sends out a *boot_packet*. If any configuration parameter is changed (via app or LoRaWAN downlink) or configuration restored at boot, CM30xx sends out corresponding configuration packet.

Packet	fPort	Condition for sending	Confirmed, retries	Direction	Contains
usage_packet	25	timed, 1 - 94 times per day,	no	up	*active_alerts*, *meter_actuality_duration__minutes* , *meter_accumulated_volume__L*
usage_with_status_packet		*device_status* block added at 00:00 and 12:00	yes, 0		*usage_packet* + *meter_serial*, *battery_*, *temperature_* and *radio_* parameters
boot_packet	99	first packet after a successful join.	yes, 1	up	*device_serial*, *device_firmware_version*, *wakeup_info* etc
shutdown_packet	99	right before shutdown or switch from LoRaWAN to wM-Bus	yes, 1	up	*shutdown_reason*, full *usage_with_status_packet*
general_configuration_packet	50	*general_configuration_request* or any contained configuration changed	no	both	*radio_lorawan_profile*, *radio_wmbus_profile*, *meter_* and *alert_* configurations
location_configuration_packet	50	*location_configuration_request* or any contained configuration changed	no	both	*gps_position_*, *time_zone*, *address*, *id_customer*, *id_location*
configuration_request	49	-	-	down	either request for *general_configuration_packet* or *location_configuration_packet*
enter_dfu_command	60	-	-	down	-
local_time_request	60	-	-	down	-
local_time_response	60	response for *local_time_request*	no	up	*device_local_time__s*
faulty_downlink_packet	99	when any configuration or command packet has an error	no	up	*packet_fport*, *packet_error_reason*

Note: LoRaWAN DeviceTimeReq MAC command is added to *boot_packet* and *usage_with_status_packets* once every 96h to synchronise CM30xx time. This *usage_with_status_packets* has been reported to be hidden in certain networks (e.g. TTN) due to added MAC command, in that case please contact the service provider.

5 wM-Bus

wM-Bus operates in C1 mode, using mode-5 encryption. wM-Bus is only available on CM3061A (LoRaWAN EU868 region), disabled in all other regions.

wM-Bus Serial is the second half of CM3061 DevEUI (e.g. 70b3d5b020042593 → 20042593).

5.1 Profile Timings

In *wmbus_privacy* (GDPR) mode reported meter readout value is updated once a month to hide the consumption patterns.

wM-Bus Profile	Internal meter readout interval	Metering value update interval	wM-Bus packet interval	Battery life ensured
wmbus_privacy	15 min	monthly	17 s	yes
wmbus_driveby	15 min	24 h	17 s	yes
wmbus_fixnet	15 min	15 min	60 s	yes

5.2 Reported Parameters List

Details about the parameters contained in wM-Bus frame.

Parameter	Updated	Data Record Header	Total length
meter_actuality_duration__s	always (for *volume*)	0x02 0x74	5
meter_accumulated_volume__L	*wmbus_fixnet* - 15 min, *wmbus_driveby* - 24 h, *wmbus_privacy* - n/a	0x04 0x1x	6
meter_key_date_accumulated_volume__L	monthly	0x44 0x1x	6
meter_key_date	monthly	0x42 0x6C	4
remaining_battery	always	0x02 0xFD 0x74	5
manufacturer_specific (Alerts and *battery_remaining__semesters*)	always	0x0F 0x01	4

6 Configuration

CM3061 can be configured using NAS Connect app at installation and in case of need also remotely via LoRaWAN. Changes of parameters in the App will trigger a LoRaWAN uplink packet with the corresponding configuration right after leaving corresponding page in app. Common settings can be stored in NAS Connect app using "Create/Load Preset" button so that specific presets could be easily loaded on to other CM3061 devices. Creating preset stores current configuration as a preset, so apply desired configurations first. "Reset To Defaults" button in app resets all the configurations to factory defaults.

Configuration downlink packet over LoRaWAN will either respond with the new configuration packet if parsing was successful or with an error code. Device configuration can be requested, see Configuration Request.

All configurations are divided into two categories: General Configuration and Location Configuration. There is separate LoRaWAN configuration packet and separate page in NAS Connect app for each of these categories. Changing a parameter using NAS Connect app sets corresponding LoRaWAN configuration packet pending, the packet is sent after leaving corresponding configuration page in the app.

6.1 *General_configuration_packet* Parameters

Configures *radio_* profiles, *meter_* and *alert_* parameters.

Parameter	Config via App/LoRaWAN	Part of Preset	Availability	Default	Comments
radio_lorawan_profile	yes/yes	yes		*lorawan_1_h_dynamic*	determines packet (and metering readout) interval. Options: *lorawan_disabled* , *lorawan_24_h_privacy* …. *lorawan_15_min_static*
radio_wmbus_profile	yes/yes	yes		*wmbus_driveby*	determines packet (and metering readout) interval. Options: *wmbus_disabled* , *wmbus_privacy* , *wmbus_driveby* , *wmbus_fixnet*
lorawan_joineui	yes/no	yes	not if *lorawan_disabled*	Distributed JoinEUI	not reset with Reset To Defaults button
lorawan_ch_mask_group	yes/no	yes	only in US915 and AU915 regions	all channels	pre-select channel mask to make join procedure faster, button disabled after joining
meter_serial	yes/yes	no		*not_set*	
meter_accumulated_volume__L	yes/yes	no		0	
meter_accumulated_volume_offset__L	yes/yes	no		0	
meter_multiplier	yes/yes	yes		1	
alert_no_usage_interval__days	yes/yes	yes	not with gas meters	*disabled*	
alert_tamper	yes/yes	yes		*enabled*	

6.2 *Location_configuration_packet* Parameters

Configures optional meta information that is stored inside CM3061 and reported over LoRaWAN when added and can be requested at any time over LoRaWAN.

id_customer and *id_location* can be used as customer EIC and metering EIC. All text fields are UTF-8 compatible strings (not null-terminated). Notice: all the lengths of the text fields are in bytes, not symbols (UTF-8 symbol can take multiple bytes).

The content may be sent in two portions if all the fields are filled and available payload length insufficient.

Parameter	Config via App/LoRaWAN	Part of Preset	Availability	Comments
gps_position	yes/yes	no	not if *lorawan_disabled*	phone's coordinates, stored only on manual button press, adjustments on map allowed
address	yes/yes	no		up to 38 bytes utf-8
id_customer	yes/yes	no		Customer ID, 16 bytes of utf-8
id_location	yes/yes	no		Metering Location ID, 16 bytes of utf-8

time_zone	yes/yes	yes		automatically set by App

7 Functionality Description

7.1 Hybrid Radio Mode

CM3061 has two radio stacks: wM-Bus and LoRaWAN and it can automatically switch back and forth between them on specific conditions, preferring LoRaWAN network if available.

Modes are determined by the combination of *radio_lorawan_profile* and *radio_wmbus_profile*. CM30xx operates in regular single radio mode if the other profile is *_disabled*.

Mode	Description	Case
Hybrid mode (wM-Bus active)	CM3061 transmits wM-Bus packets and tries to join to LoRaWAN weekly	Plans of installing LoRaWAN network in the future
Hybrid mode (LoRaWAN active)	CM3061 transmits LoRaWAN packets, if packet confirmations are missing for a week, try to rejoin. If join fails, enter wM-Bus	Falls back to wM-Bus if LoRaWAN network fails

7.2 Battery Lifetime

battery_remaining__years is reported in *usage_with_status_packet* and wM-Bus packet. All profiles except *lorawan_1_h_static* and *lorawan_15_min_static* are calculated to ensure specified battery lifetime. Operating CM3061 for more than 10 days in one of these static modes invalidates the remaining battery estimations. *active_alerts.low_battery* means that less than 182 days of battery is left. The flag remains on until the end of life.

Battery lifetime estimations are based Medium Zone temperature profile as seen below.

-20°C	-10°C	0°C	10°C	20°C	30°C	40°C	50°C
1%	2%	12%	20%	21%	20%	16%	8%

7.3 CM3061 Local Time

Correct device clock is needed to take e.g. hourly readings on right time. The two methods to synchronise CM3061 clock are:

1. NAS Connect app - time is automatically synced if logged in user has configurator rights for the device.
2. LoRaWAN DeviceTimeReq - synchronises after successful join (with *boot_packet*) and regularly with 4 days interval (with *usage_with_status_packet*).

CM3061 is time zone aware (knows it offset from UTC), but not Summer Time aware. If installed during Summer Time it is recommended to manually set Winter Time by decreasing *time_zone* value by 1 h.

CM3061's local time can be requested for troubleshooting purposes over LoRAWAN using *local_time_request* command.

7.4 Boot-up Behaviour

At boot-up CM3061 runs a self-check routine. If there is some internal failure, CM3061 will shut down immediately except when NAS Connect app is connected for user to see the issue (shutdown will still be pending).

At the very end of battery life CM3061 falls into reset loop due to dropping battery voltage. After 4 sequent unfinished wake-ups, CM3061 sleeps for 4 hours and then reboots to retry again 4 times and so on. This 4 hours waiting can be cancelled by scanning CM3061 with NAS Connect app.

7.5 Shutdown Behaviour

In LoRaWAN mode a *shutdown_packet* sending is attempted within 5 seconds (LoRaWAN might be duty-cycle locked). *shutdown_packet* contains shutdown reason and last *usage_with_status_packet*. Shutdown does not erase settings.

7.6 LED Indications

Mode	Indication	Duration
Wakeup	red blinks once a second	5 sec
Shutdown	red blinks twice a second, end with long pulse	5 sec
NAS Connect app connected	blue blinks with 2 second interval	while app connected

Magnet switch active	blue blinks with 1 second interval	while magnet switch active

7.7 DFU

CM3061 firmware can be updated using free nRF Toolbox App. DFU mode can be activated via LoRaWAN or using NAS Connect app. Downgrade is not possible, nor LoRaWAN region change. CM3061 retains its configurations. All readouts (monthly etc) are reset to boot moment.

7.8 NAS Connect App

CM3061 can be conveniently configured using NAS Connect App featuring:

- Touch (scan NFC) to connect
- Real-time parameters, states, modes
- Convenient configuration
- Preset storage (create and load preset)
- CM3061 Quick start guide easily accessible
- Triggering DFU of CM3061
- Setting CM3061 GPS coordinates with phone
- Secure communication

The app consists of pages that can be navigated from left sidebar. Additionally some system functions of CM3061 can be accessed on sidebar.

CM3061 can only be turned on and shut down using NAS Connect App. It can be configured either using NAS Connect app or over LoRaWAN.

7.8.1 Privacy

NAS Connect does not store anything inside the phone except the login token in secure cell and stored configuration presets.

NAS Connect App needs user to have services.nasys.no account and Internet connection to access device above *guest_level*. The device challenges the server and the server provides *user_right_level*. This request is only to authenticate NAS Connect app access to CM30xx. The authentication request (after scanning CM30xx) is logged on server side, log containing username, timestamp, user right level, device DevEUI.

No parameter visible/configurable in the app is stored/logged/forwaded. Optional meta parameters like *gps_position_,* address, id_customer, id_location etc are only stored in CM30xx, they are transmitted over LoRaWAN once after setting them.

If user has rights above *guest_level* NAS Connect app updates CM30xx time at every connection.

8 Frequently Asked Questions

Q: Where do I get the LoRaWAN keys (AppKey etc) for CM3061?
A: The keys are distributed by seller at purchase.

Q: CM3061 is not joining to LoRAWAN network?
A: Make sure there is a working LoRaWAN gateway nearby. Make sure the device is properly provisioned.
In case of poor LoRAWAN signal (e.g. inside basement), first try to join in better conditions (e.g. outside) to rule out network problems (correct keys, gateway etc) and then make rejoin in real location.
US915, AU915 and AS923 LoRAWAN region specifications define 64 channels and gateways have mostly 8 channels, so joining is a roulette. It can be accelerated (and battery saved) by choosing LoRaWAN Ch. Mask Group from app.
In case of testing in multiple overlapping LoRaWAN networks make sure the keys are deleted from all other network servers.

Q: CM3061 needs to be transferred to another LoRaWAN network, how to rejoin?
A: Make sure the keys are only present in desired network. If the CM3061 can be accessed with NAS Connect app, rejoin can be immediately triggered. If CM3061 is inaccessible, CM3061 will automatically attempt to rejoin in 7 days from last successful ACK.

Q: The packet comes from correct fPort but bytes do not match with payload structures document.
A: The payloads may be encrypted when length and fPort are correct but bytes seems totally random. The packets have to originate from application server (decrypted) not network server.

Q: "Could not connect to NAS device" message in NAS Connect app?
A: Try to scan CM3061 again. NFC reading is sensitive to distance, minimise motion during NFC scanning. Due to continuous NFC scanning on newer phones NFC tag is hidden after each scan for 2 seconds to avoid new connection. Is iPhone Settings → Privacy → Bluetooth → NAS Connect enabled?

Q: NFC of CM3061 not scanning at all?
A: Try again to find optimal position between CM3061 NFC antenna and phone.
Try to scan with some other NFC app, if that works try again with NAS Connect App. Swipe the reed with magnet to reset the NFC tag. If nothing helps, try to rescan after an hour.

Q: Can CM3061 battery be replaced?
A: No, CM30xx is potted in to achieve {nas:erp:meta:INPR} rating.

Q: Why NAS Connect app shows only few pages on CM3061?
A: Reduced functionality means guest access. To achieve higher access level, make sure:

○ the phone has Internet connection while connecting to CM3061 (no offline configuration at this point)
○ in NAS Connect app, user has to be logged in using services.nasys.no account
○ user account must have desired rights for the device in services.nasys.no

Q: What is causing CM3061 counting error?
A: Improper attachment on the meter, large external magnetic field, large vibrations .

9 Ordering Information

Example ordering code CM3061A#0001EU consists of following:

Product	Article region	Package quantity	SKU region
CM3061	A #	0001	EU

Article region	SKU region	LoRAWAN band
A	EU	EU868
B	AU	AU915
C	US	US915
D	AS	AS923
F	KR	KR920
I	IN	IN865
J	RU	RU864

9.1 Packaging

CM3061s are shipped either in a single or bulk package depending on order code package quantity.

Single package each CM3061 has separate unavailable:SPDM (mm) cardboard box.

Bulk package reduces waste by packing up to unavailable:BPNP CM3061s into larger unavailable:BPDM (mm) cardboard box. Minimum bulk order quantity is unavailable:MOQ.

CM3061 package includes:

- n x CM3061 Module
- n x External SMA antenna
- 1 x Printed Quick Start Guide
- n x QR LoRaWAN/wM-Bus keys on removable sticker (samples only)

AppKey: D31CA2C2A61B1C31EAEA39AB72176A6A
DevEUI: 70B3D5B020042594
AppEUI: 70B3D5B020000909

NAS Nordic Automation Systems

9.2 Contact Information

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10 Revision History

1.0 - First version

All content contained herein is subject to change without notice. Nordic Automation Systems reserves the right to change or modify the content at any time.