NautiFlow® NF1 Model
Electromagnetic Water Meter

User Instruction Manual

 NEF-NF1GN-PB-022022.08

Content

1 About This Document

1.1 Types of Severity Symbols

	Danger hazard severity panels indicate a high level of risk that can result in serious injury or death. The signal word "Danger" is to be limited to the most extreme situation. Danger panels are not to be used for property damage hazards unless personal injury risk appropriate to this level is also involved.
	Warning hazard severity panels indicate a moderate level of risk that if ignored, could result in death or serious injury. Warning panels should not be used for property damage unless personal injury risk appropriate to this level is also involved.
	Caution hazard severity panels indicate a low level of risk that if not avoided, minor or moderate injury could result. Caution panels without the alert symbol may be used to alert against unsafe practices that can result in property damage only.
	Notice severity panels are used to address practices not related to personal injury. The alert symbol is never used with Notice panels. As an alternative to the signal "Notice", the word "Caution" without the alert symbol may be used to indicate a message not related to personal injury.

1.2 Types of Information Symbols

	Permitted		Forbidden
	Preferred		Tip or Note

2 Introduction

2.1 Product Introduction

The NF1 Water Meter is an electromagnetic water metering product that adopts advanced technology, especially suitable for flow measurement in water supply network. The hardware features high accuracy, reliable performance and flexible connectivity, while the software provides a very user-friendly interface and comprehensive functions. It employs patented low-voltage multi-pulse excitation circuits which enhance the susceptibility magnificently so that the device operates reliably even under harsh industrial environments. With high-performance wide-band antenna integrated, the NF1 product is an IoT-based smart meter, supporting the Automated Meter Reading (AMR) at integrated wireless metering endpoint through GPRS, NB-IoT and LoRaWAN protocols.

The NF1 water meter has two structural options, the **Integral** and **Remote Type**. The NF1 Integral water meter has the transducer mounting on the sensor in one piece, while the NF1 Remote water meter mounts a junction box on the sensor instead, so that the transducer can be placed away from the sensor spot. Both adopt the same principle of measurement.

2.2 Product Highlights

- Combined the state-of-the-art digital signal processing technology with the high-SNR flow sensor.
- Low-power excitation circuits, reducing energy consumption while maintaining accuracy.
- User-friendly interface with comprehensive functions.
- Different structural options to match various situations of the metering site.

2.3 Principle of Measurement

The NF1 electromagnetic water meter is designed to measure the fluid velocity of liquid within a closed conduit. The product comes with a well-designed sensor, which will provide the benefits of high SNR sensing and low installation requirements.

By Faraday's law of electromagnetic induction, the voltage, E, induced across a length, L, of the flowing fluid moving at velocity, v, in a magnetic field of flux density, B, is given by:

$$E = BLv$$

As shown in *Figure 1*, L is the distance between the electrode, which is the diameter, D,of the tube, and B is a known constant by setting the excitation voltage. Hence, measurement of the output voltage E induced across the electrodes allows the calculation of flow velocity v.

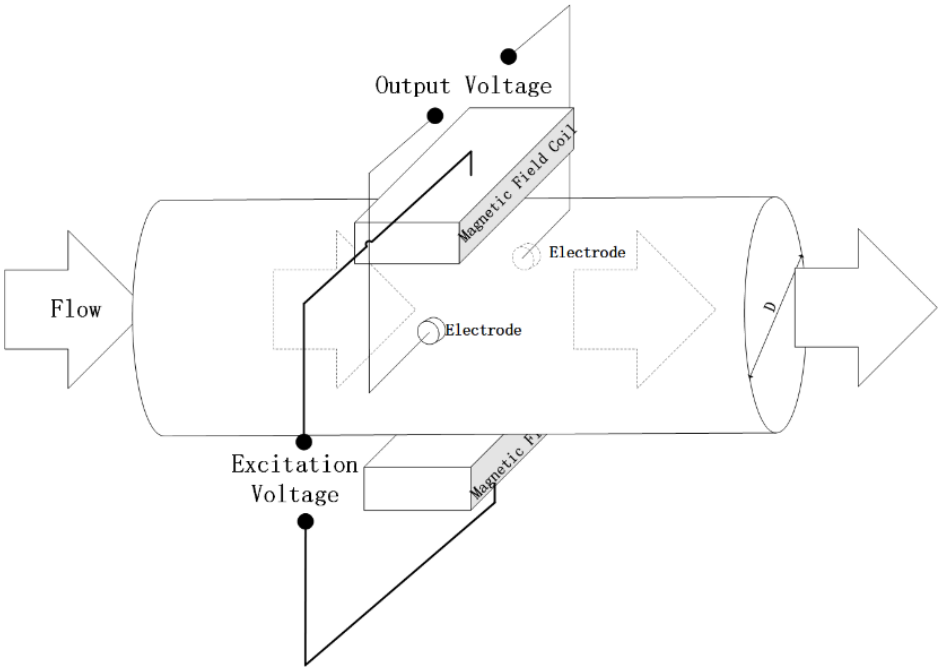

Figure 1 Principle of Ultrasonic Flow Measurement

2.4 Features and Application

Table 1 Technology Features

Operating Power Supply	Internal Battery Pack	3.6 V DC, 5 mW maximum power
	External Power Input	8-32 V DC, 40 mW maximum power
Measurement	Accuracy Class	Class I and Class II (under ISO 4064)
	Repeatability	≤0.2%
Operation Conditions	Temperature Class	T50
	Mechanical Environment	Class C
	Electromagnetic	Class E2
	Maximum Allowable Pressure	16 bar
	Protection Level	IP68
	Minimum Conductivity	50 μS/cm
Output	Pulse Output	Passive, Opto-MOS, 1500 V_{rms} Input/Output Isolation
	Frequency Output	0-1000 Hz, with adjustable duty cycle
	MODBUS Protocol	RS485
	Wireless IoT Protocols	GSM, LoRaWAN, NB-IoT
Process Connection	EN 1092 Flange	PN 10, PN 16, PN 25
	ASME B16.5 Flange	Class 150, Class 300, Class 600
	JIS B2220 Flange	JIS 5K, JIS 7.5K, JIS 10K
	AS 2129 Flange	Table D, Table E
	AS 4087 Flange	PN 16

Table 2 Measurement Range

DN	Q3 (m^3/h)	Q1 (m^3/h)	
		Class 2	Class 1
40	25	0.06	0.10
50	40	0.10	0.16
65	63	0.16	0.25
80	100	0.25	0.40
100	160	0.40	0.64
125	160	0.40	0.64
150	400	1.00	1.60
200	630	1.58	2.52
250	1000	2.50	4.00
300	1600	4.00	6.40

Table 3 Nominal Battery Lifetime

Communication Option	Battery Capacity	Nominal Battery Lifetime
Basic	76 Ah	6 years
Cat-M1	95 Ah[1]	5 years
LoRaWAN		6 years
NB-IoT		6 years

Test Conditions:

- Acquisition = 1 second
- Pulse output = 2 Hz @ 5 ms
- Logger rate = 1 minute
- Integral verification self check = 1 hour
- Ambient temperature = 20 ℃
- Wireless IoT Signal condition = Good (10 m distance between meter antenna and receiver, no shielding or interference)

Battery capacity and life are significantly shortened:

- When the operating environment temperature ranges between -20 and 0℃or 50 and 70℃.
- When data acquisition is less than 15 seconds.
- When pulse output width more than 5 ms and output frequency is set high
- When the wireless IoT signal condition is poor

[1] Wireless IoT models (i.e., Cat-M1, LoRaWAN and NB-IoT models) are equipped with an extra RF battery pack.

3 Installation

3.1 Unpack Checking

Check whether all parts are complying with packing list and if there is any damage to the enclosure during transportation. If anything is missing or misplaced, please contact customer service.

3.2 Power Supply and Cable Set

CAUTION

The NF1 water meter cannot be powered by AC line.

The signal and data cables are specially designed for harsh environment. Original cables are mandatory for the normal operation of the water meter. If application requires using aftermarket cable other than original, please consult the manufacturer before commissioning.

3.3 Installation Condition Requirement

3.3.1 Installation Location Selection

Accurate flow measurement results depend on the correct installation of the flowmeter. This product is designed with a mechanism to generate an empty pipe alarm when one or more electrodes are exposed to air. Air bubbles, deposits, and other solids in the flowtube can also cause erroneous or erratic readings.

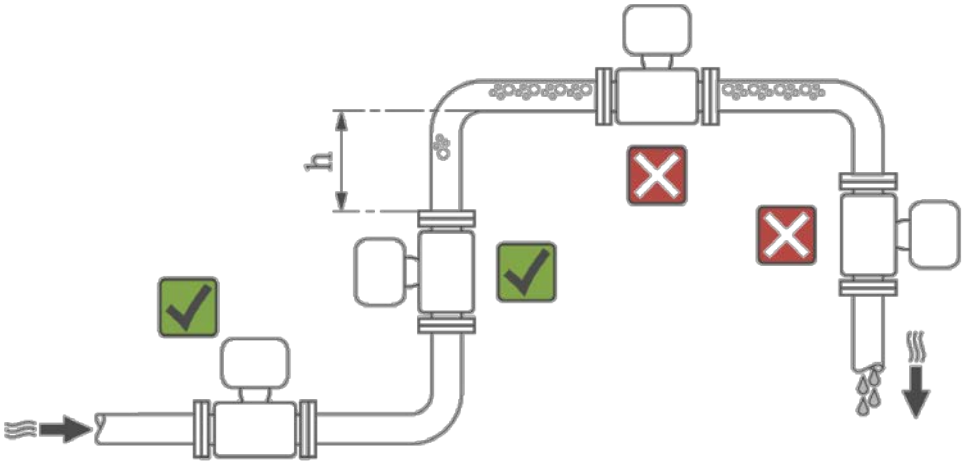

Figure 2 Correct and Incorrect Metering Installation

As shown in *Figure 2*, it is suggested to install the sensor horizontally in low position, or vertically in the upstream. These installation positions can reduce the chances of air bubbles. For a partially-filled water pipe, the water meter shall be installed as shown in *Figure 3*. For open channels or half-full pipes, the transducers should be installed at the bottom of a U-shaped section.

The NF1 state-of-the-art sensor design allows the meter to be installed next to an elbow either upstream or downstream (0U0D).

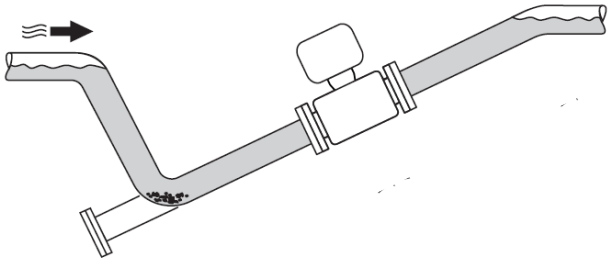

Figure 3 Metering Installation in a Half-Full Pipe

3.3.2 Outdoor Installation Requirements

- The NF1 Transducer shall be installed in the shade.
- Avoid direct sunlight, especially in countries or regions with high temperatures.
- Avoid direct exposure to other severe weather conditions such as blizzard, hailstone, etc.
- Close the lid when not checking the meter.
- The IP68 waterproof meter shall NOT be install more than 2m below the water surface.

If the meter needs to be installed inside a metering chamber or manhole, the chamber should provide enough room for installation.

Inside the chamber, the distance from pipe wall to the chamber wall should be controlled above 600 mm, and the chamber wall-to-wall distance should be at least (D+600*2) mm, and the distance should be greater than (D+700*2) mm for cement pipes. The axial length of the chamber, L, should be greater than (D+1200) mm. See *Figure 4*.

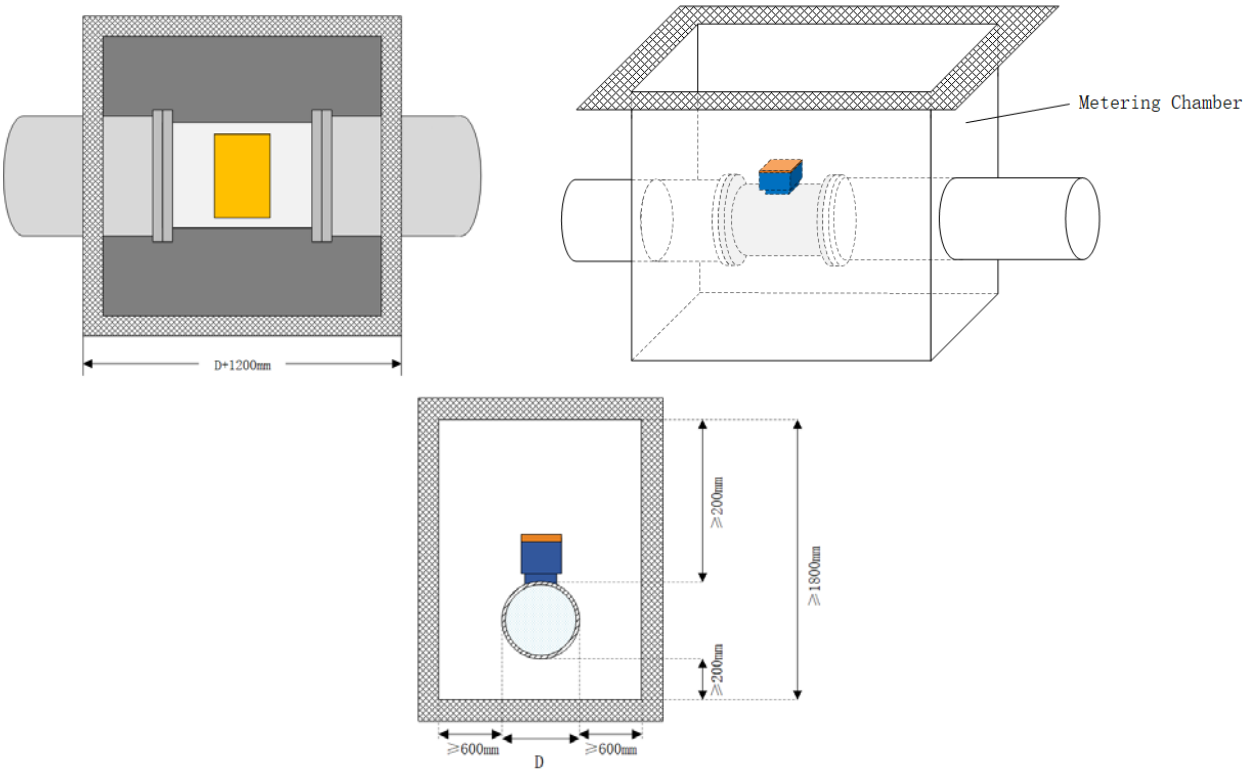

Figure 4 In-Chamber Installation Suggestion

3.3.3 Grounding

NF1 Water Meter provides grounding rings as electronic grounding accessories. When installing the meter, the grounding rings needs to be clamped by the flanges of the NF1 meter sensor and the pipeline. Use grounding cables to connect the meter sensor, the grounding ring and the pipeline, as shown in *Figure 5*.

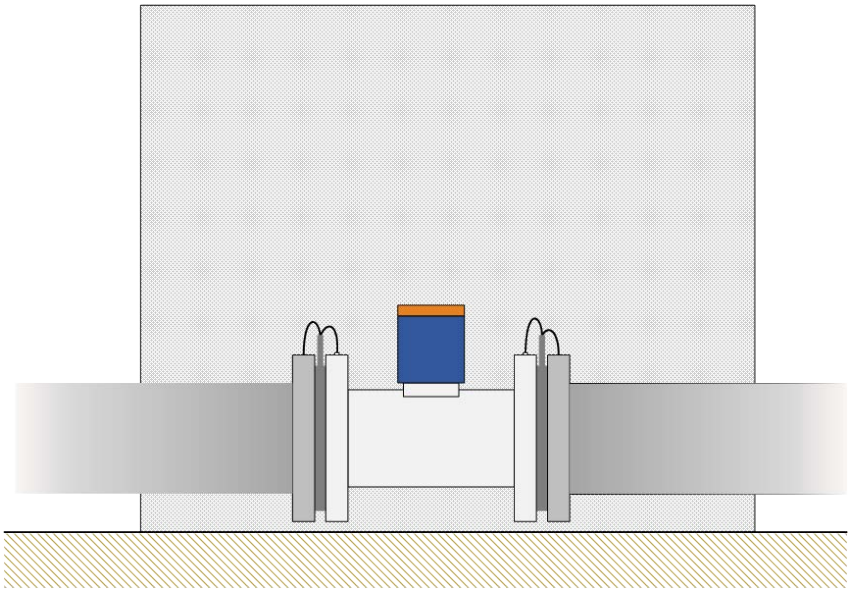

Figure 5 Grounding the meter via pipeline

The NF1 remote-type transducer does not need extra grounding, since the sensor cable provides a grounding wire, which connects the remote-type transducer with the sensor. See *Figure 6*. Read *4.2.3 Sensor Cable Wiring*.

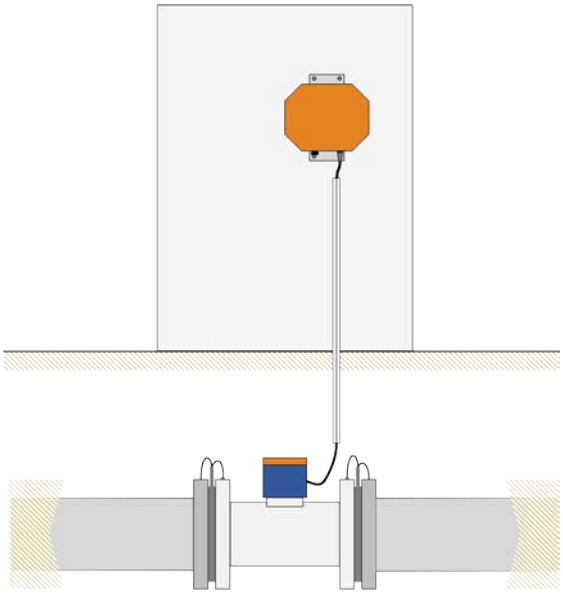

Figure 6 Grounding the NF1 Remote-Type Transducer

3.3.4 Remote-Type Transducer Installation

The NF1 Remote-Type Water Meter separates the transducer from the sensor. The remote-type transducer and the sensor are connected with an IP68 waterproof sensor cable. For hard-to-reach metering site, this meter structure provides a convenient way for users to check the meter operation status.

☑☑ The remote-type transducer is recommended to install 1m above the water surface. The sensor shall NOT be installed more than 2m below the water surface. See *Figure 7*.

The NF1 remote-type water meter comes with an SS304 mounting bracket to mount the transducer on the wall. Check *Figure 14* in *4.1.2 NF1 Remote-Type Water Meter*. When installing, first fasten the four M4 screws to attach the transducer to the bracket, then use the four M10 screws to mount the assembly on the wall.

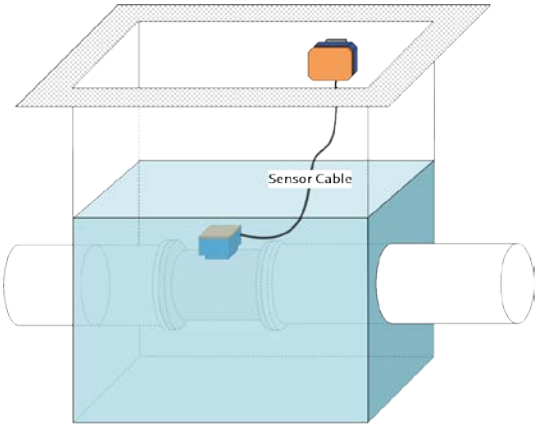

Figure 7 Remote-Type Metering Installation

3.3.5 Remote-Type Antenna Installation

The Remote-Type Antenna design allows placing the antenna away from the metering site, providing better communication performance, especially for manhole meter application. See *Figure 8* and *Figure 9*.

☑☑ It is recommended to dig a 20mm deep antenna chamber on the manhole slab to place the wireless antenna, and open a hole to connect the antenna room with the inside of the manhole for antenna cable wiring.

☑☑ A DN25 PVC conduit is recommended for antenna cable protection in the manhole.

In order to protect the components, when the wiring is complete, the remote-type antenna shall be epoxy potted 10-15mm deep.

Read *4.2.2 Antenna Cable Wiring* for antenna cable wiring instructions.

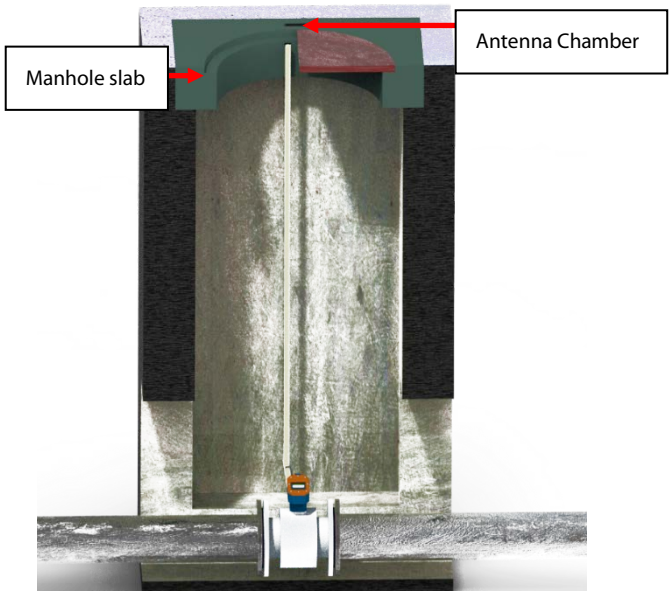

Figure 8 Remote Antenna Installation in a Manhole

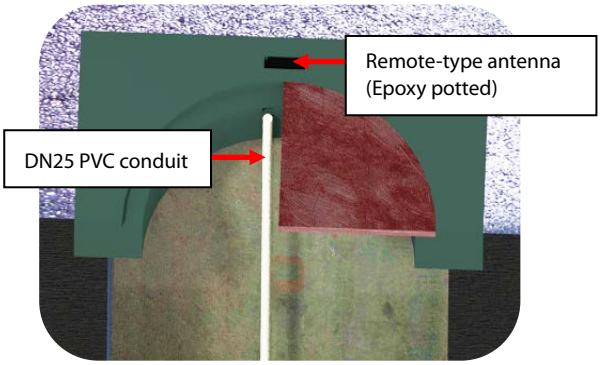

Figure 9 Potting Antenna Chamber

3.4 SIM Card Installation

For Cat-M1 and NB-IoT application, the NF1 meter needs to install a nano-SIM card.

To install the SIM card, unscrew the 6 hex screws first, and remove the transducer cover from the housing. Insert the nano-SIM card into the slot on the top PCB with chip facing **DOWN**. See *Figure 10.*

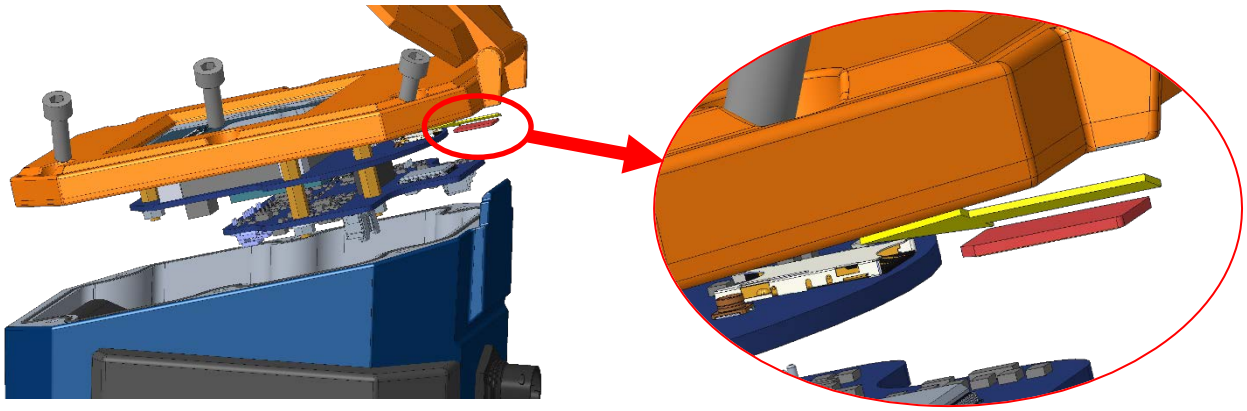

Figure 10 SIM Card Installation

- Do NOT remove the transducer cover forcefully which might damage the connection wires.
- Remove the wires gently for more operation space if needed.
- Check the O-ring position before put back the transducer cover.

4 Dimensions and Wiring Diagram

The NF1 Water Meter has two structure types, Integral-Type and Remote-Type, and three options for antenna, None, Attached and Remote-Type. The Integral-Type meter structure mounts the transducer on the sensor. The Remote-Type meter structure mounts the junction box on the sensor instead, so that the transducer can be placed away from the metering site. For both meter structures, Attached and Remote-Type antennas both have only one size.

4.1 Dimensions

4.1.1 NF1 Integral-Type Water Meter

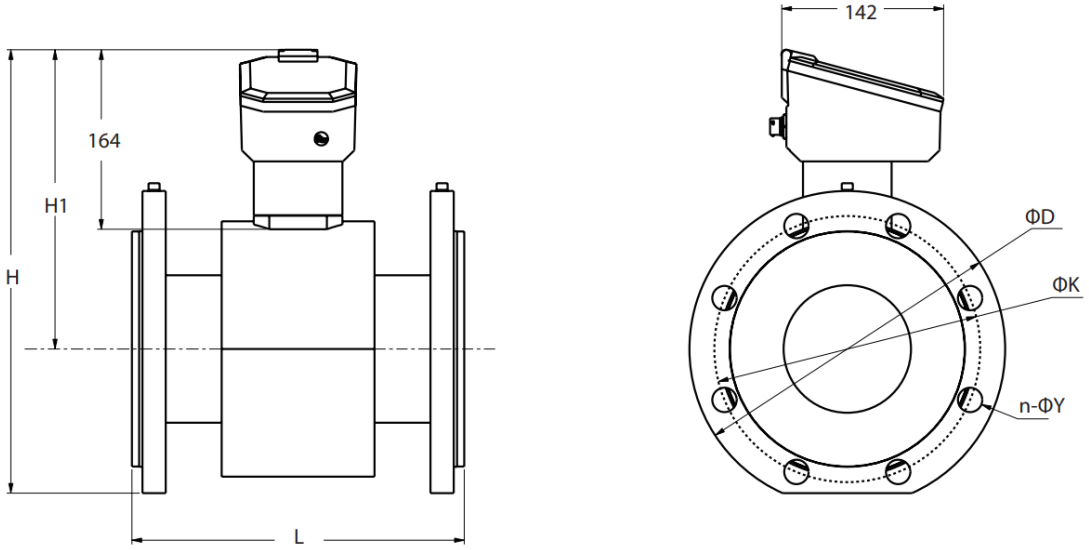

Figure 11 Dimensions of NF1 Integral-Type Water Meter

Table 4 Dimensions of NF1 Integral-Type Water Meter

Size [mm]	Dimensions [mm]			Flange[2]			Approx. Weight [kg]
	H	H1	L	D	K	n-ΦY	
40	285	217	200	150	110	4-Φ18	12
50	290	220	200	165	125	4-Φ18	14
65	314	231	200	185	145	8-Φ18	16
80	331	240	200	200	160	8-Φ18	19
100	347	245	250	220	180	8-Φ18	29
125	371	255	250	250	210	8-Φ18	33
150	400	270	300	285	240	8-Φ22	38
200	447	287	350	340	295	12-Φ22	50
250	493	303	450	405	355	12-Φ26	63
300	543	328	500	460	410	12-Φ26	80

[2] The flange dimensions in *Table 1* and *Table 2* are correspond to EN BS1092.

4.1.2 NF1 Remote-Type Water Meter

- Transducer with Attached Antenna Box

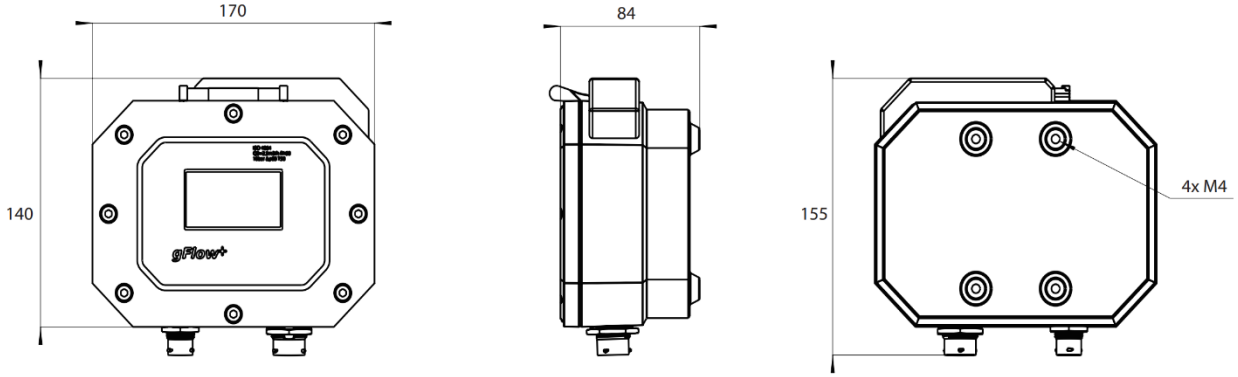

Figure 12 Dimensions of the NF1 Remote-Type Transducer with Attached Antenna

- Transducer with Remote-Type Antenna

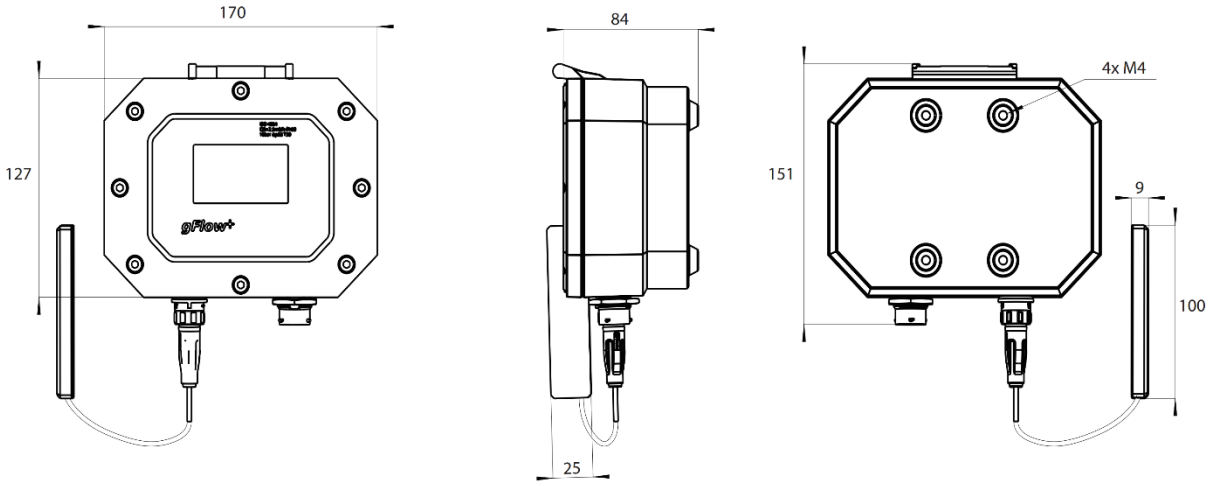

Figure 13 Dimensions of the NF1 Remote-Type Transducer with Remote-Type Antenna
Note that the cable length in the drawing is shortened.

The transducer can be mounted on the wall (see *Figure 6*) with an SS304 mounting bracket (see *Figure 14*).

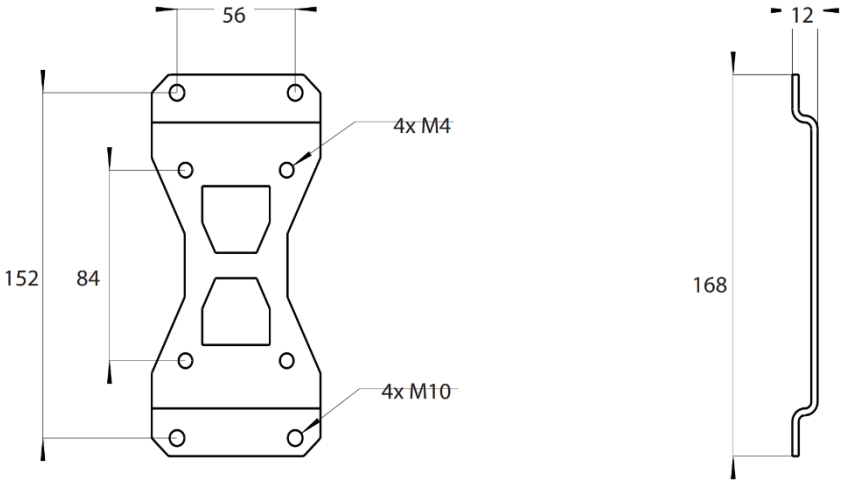

Figure 14 Dimensions of the Mounting Bracket

- Sensor with the Junction Box

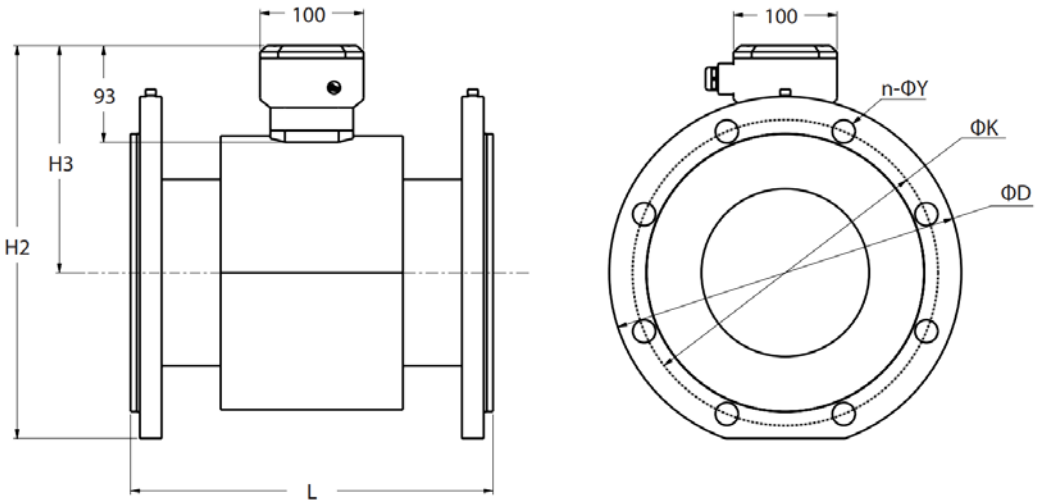

Figure 15 Dimensions of the Sensor with a Junction Box

Table 5 Dimensions of NF1 Remote-Type Sensor with the Junction Box

Size [mm]	Dimensions [mm]			Flange			Approx. Weight [kg]
	H2	H3	L	D	K	n-ΦY	
40	218	150	200	150	110	4-Φ18	10
50	271	153	200	165	125	4-Φ18	12
65	247	164	200	185	145	8-Φ18	14
80	264	173	200	200	160	8-Φ18	17
100	280	178	250	220	180	8-Φ18	27
125	304	188	250	250	210	8-Φ18	31
150	333	203	300	285	240	8-Φ22	36
200	380	220	350	340	295	12-Φ22	48
250	426	236	450	405	355	12-Φ26	61
300	477	262	500	460	410	12-Φ26	78

4.2 Wiring Instructions

The NF1 Water Meter series products adopt different wiring options for various meter structures and antenna types. Check *Table 6*.

Table 6 Connectors and Cables

Meter Structure	Antenna Type	Wiring Options		
		I/O Cable	Antenna Cable	Sensor Cable
Integral-Type	None	✔		
	Attached	✔		
	Remote-Type		✔	
Remote-Type	None	✔		✔
	Attached	✔		✔
	Remote-Type		✔	✔

The I/O cable is for data transmission, meter reading and external power supply. Antenna cable is used to transfer RF signal between the meter and remote-type antenna. Sensor cable connects a remote-type transducer and its junction box for signal transmission and power supply. As shown in *Table 6*, I/O Cable and Antenna Cable can be applied to both meter structure depending on the antenna type, while Sensor Cable (to connect junction box and transducer) is for NF1 Remote-Type Water Meter only.

4.2.1 Data Cable Wiring Instruction

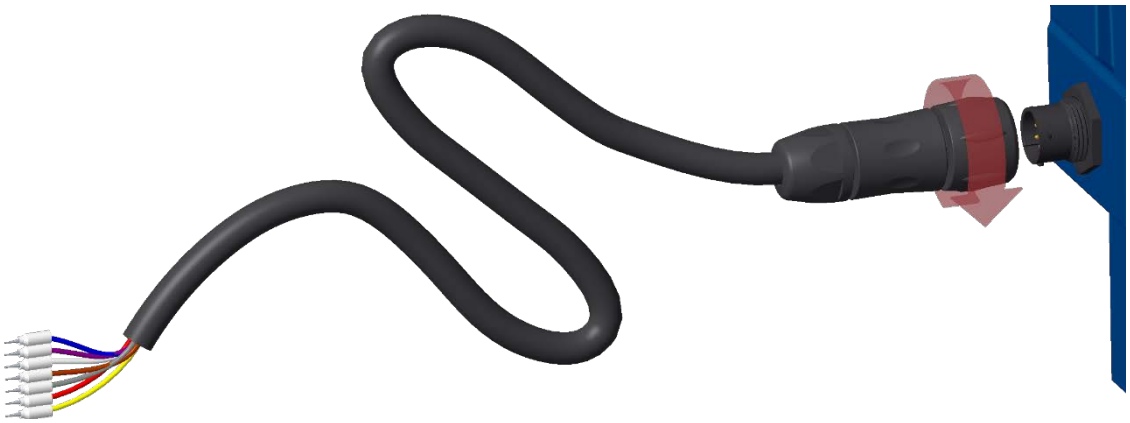

Figure 16 Wiring the Data Cable to the 7-Pin Connector

The I/O Cable is used to connect the NF1 water meter to the supporting devices[3] for data transmission, meter reading and external power input. The cable adopts a quick connector (comply to MIL-C-26482) to match the 7-pin connector socket on the NF1 meter, as shown in *Figure 16*. On the device side, the data cable offers 7 tube terminals. **When coupling, make sure the primary notch of the connector is matched, and turn coupling ring until you hear a 'click'.** *Table 7* gives the definition of terminals.

For instructions on wired data transmission, read *6 Pulse/Frequency Output*.

Table 7 Terminal Definition of the Data Cable

Terminal Name	Wire Color	Terminal Definition
Pulse Forward	Blue	Pulse output for the forward flow
Pulse Reverse	Purple	Pulse output for the reverse flow
485 A	White	Terminal A for RS-485 communication
485 B	Brown	Terminal B for RS-485 communication
Pulse Common	Grey	Common pin for the pulse output
DC +	Red	Positive pin of 8-32 V DC power input
DC -	Yellow	Ground pin of 8-32 V DC power input

[3] The supporting devices for NF1 water meter include metering reading device, PC, PLC, etc.

4.2.2 Antenna Cable Wiring

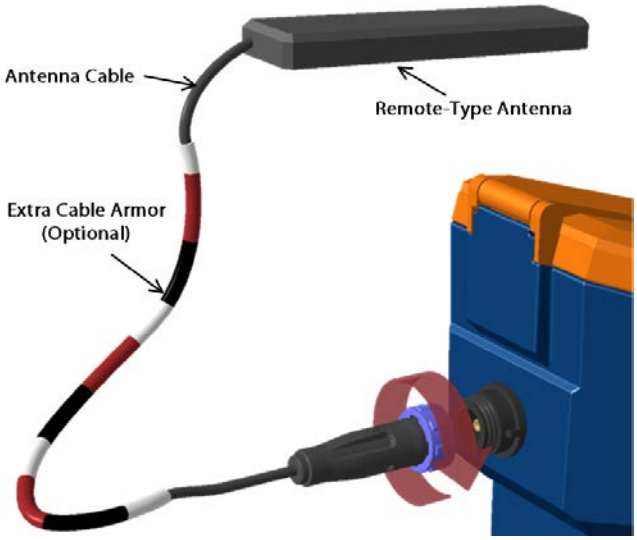

Figure 17 Wiring Antenna Cable

The Antenna Cable is used to transfer RF signal between the NF1 water meter and the remote-type antenna. The cable adopts an IP68 waterproof connector to match the antenna cable socket on the NF1 meter, as shown in *Figure 17*. Ended with a Remote-Type Antenna, the cable can be customized up to 10 m long from the meter. **When coupling, align the connector with the socker, insert the connector into the socket and turn coupling ring until fully tightened.**

NOTICE When placing the remote-type antenna, avoid metal shielded environment for better signal reception.

4.2.3 Sensor Cable Wiring

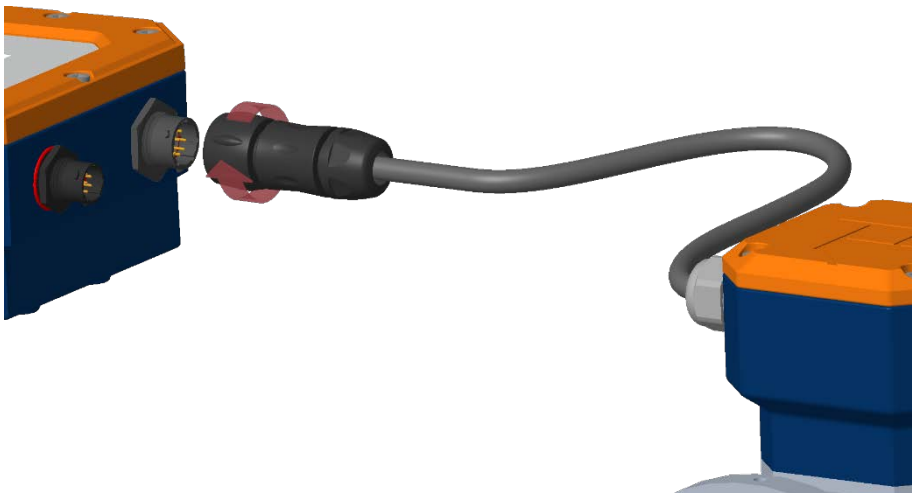

Figure 18 Wiring Signal Cable

The Sensor Cable is used to carry flow signal between the junction box and the transducer, and to supply excitation voltage from the transducer to the sensor. The cable comes together with the NF1 junction box (mounted on the sensor). It adopts a IP68 quick connector (comply to MIL-C-26482) to match the 8-pin connector socket on the NF1 remote-type transducer, as shown in *Figure 18*. **When coupling, make sure the primary notch of the connector is matched, and turn coupling ring until you hear a 'click'.**

5 Operations

5.1 Interaction Operations

The NF1 Series Water Meter carries a 128x64 pixel ultra-low-power LCD with wide-view angle. To optimize battery efficiency, the display will remain off until receive user commands.

All NF1 Electromagnetic Water Meters trigger interaction by turning the protection cover of the meter transducer back and forth (see *Figure 19*). *Table 8* shows the interactive commands that NF1 offers.

In order to ensure effective triggering, the protection cover needs to touch the meter edge during the process, the turning range needs to exceed 45 degrees, and the interaction of a single command should be completed within 3 seconds, while the command should be given at least 3 seconds later than the previous command.

Figure 19 Turn the cover back and forth to interact with NF1

Table 8 NF1 Interaction Commands

Interaction Operations	Command
Flip open the protection cover	Turn on the LCD display and display flow metering information
Flip back and forth **1** time	Switch the units of cumulative and instantaneous measurement
Flip back and forth **2** times	Run the functionality test of the LCD display
Flip close the protection cover	Turn off the LCD display after 10 seconds

- Switching the Measurement Units

The NF1 Water Meter supports multiple measurement units, including:
m^3 (default), k m^3 , L, gal and k gal for cumulative flow measurement,
m^3 /h (default), m^3 /min, L/min, L/s, gal/min and gal/s for instantaneous flow measurement.

- Running Functionality Test

NOTICE The LCD Functionality Test is to check whether there are dead pixels in the display screen. During the test, the display screen will be divided into 8 columns, and the odd and even columns will light up alternately three times for two seconds each time. Any pixel failing to follow in the test might result in misreading in the metering information interface. See *Figure 20* and *Figure 21.*

Figure 20 Unlit Display Screen

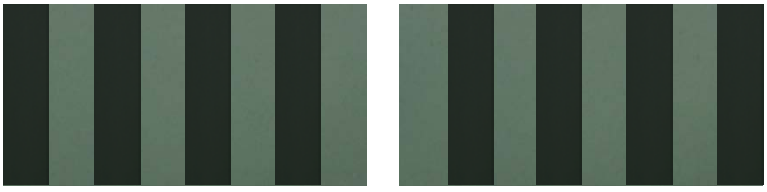

Figure 21 Screen under a Functionality Test

5.2 Elements of the Display Information

The 128x64 pixel LCD presents various meter operating information, including flow metering, battery status, local time, etc. As shown in *Figure 22*, the screen can be divided into five areas.

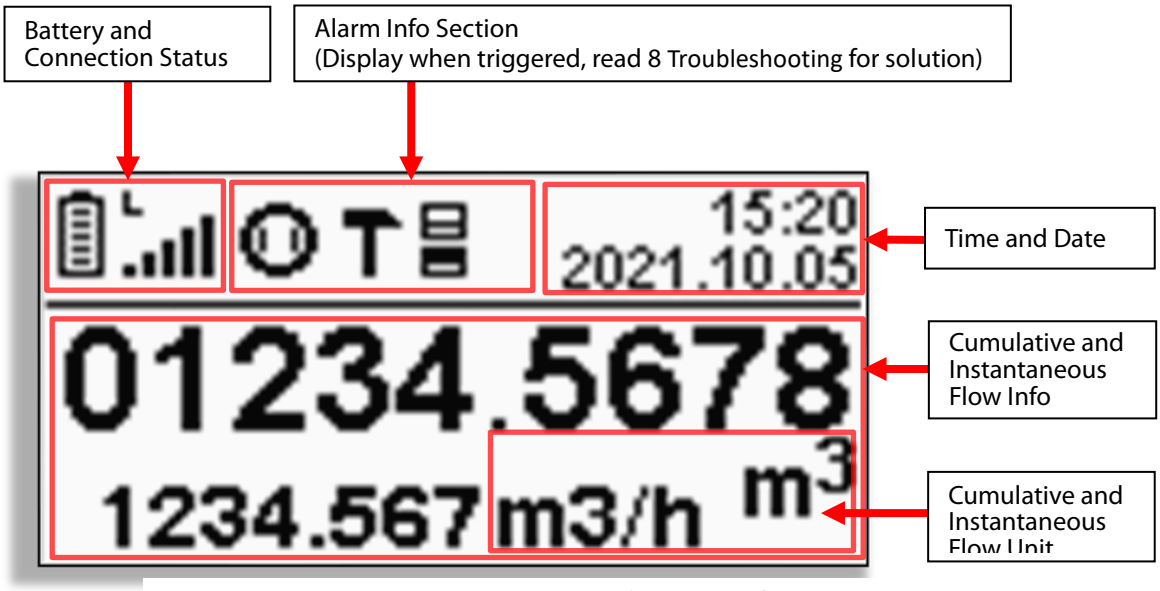

Figure 22 Meter Operating Information Display

NOTICE Note that when the totalizer reaches the maximum value (i.e., 99999.9999), it will continue measuring starting from **zero**.

According to the actual condition of the water meter, different icons will appear in the related areas. See *Table 9*.

Table 9 Meaning of the Display Icons

Type	Name	Icon	Meaning
Battery Status	Battery Power		The meter is powered by the internal battery pack. Low Battery icon appears when the battery life is less than one month.
	External Power Input		The meter is powered by external DC power.
Connection Status	Cat-M1 Connection		The latest data transmission is done via the Cat-M1 protocol at the displayed signal strength. Failure Transmission icon appears when the latest data failed to uplink via Cat-M1.
	LoRaWAN Connection		The latest data transmission is done via the LoRaWAN protocol at the displayed signal strength. Failure Transmission icon appears when the latest data fails to uplink via LoRaWAN.
	NB-IoT Connection		The latest data transmission is done via the NB-IoT protocol at the displayed signal strength. Failure Transmission icon appears when the latest data fails to uplink via NB-IoT.
Alarm	Empty Pipe Alarm		This icon appears when there is the pipe is not filled completely.
	Tampering Alarm		This icon appears when there has occurred a tampering situation that the transducer has been opened illegally.
	Excitation Status		The icons represent if the sensor excitation is functional. The Excitation Error icon appears when the excitation is not working correctly.
	Reverse Flow Alarm		This icon appears when the flow is running reversely now.

6 Pulse/Frequency Output

Nautiflow NF1 Water Meter implements dual optical galvanically isolated relay as digital pulse/frequency output to connect with user's meter reading device or Programmable Logic Controller (PLC), as shown in *Figure 23*.

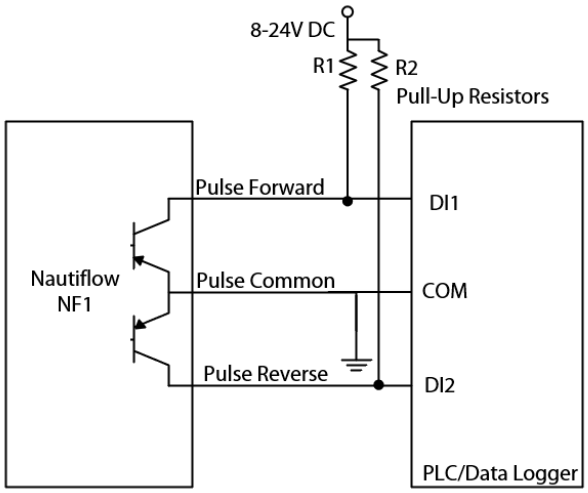

Figure 23 Typical Pulse Output Connection

Refer to *Table 7* for output's function description. Check *Table 10* for the default k Value. The outputs are dry type (passive) relay with following electrical rating:

Minimum voltage (V_{ce}):	2.7V DC
Maximum voltage:	24V DC
Galvanic isolation voltage:	1500 Vrms
Maximum frequency:	1000 Hz
Pulse width:	5ms (Battery mode)
Duty cycle of frequency:	20%

For the application where the instantaneous flow rate needs to be transmitted to the value reading devices (e.g., PLC, pump controller), frequency output mode can be triggered once the meter enters external power mode. The instantaneous flow rate range is mapping with the frequency range from 0 to 1000 Hz in the frequency mode.

Table 10 Default k Value for Pulse Output

DN	Default k Value (L per pulse)	
	Class 1	Class 2
40	0.2	0.3
50	0.4	0.5
65	0.7	1
80	1	1
100	1	1

DN	Default k Value (L per pulse)	
	Class 1	Class 2
125	1	1
150	4	5
200	7	10
250	10	10
300	10	10

7 Communication

NF1 Water Meter provides various communication methods, including wired communication with I/O cable in MODBUS Protocols, near-field Bluetooth connection and wireless IoT protocols (i.e., GSM, LoRaWAN and NB-IoT). This section focuses on the communication protocols of MODBUS, GSM, LoRaWAN and NB-IoT.

7.1 MODBUS Protocol via RS-485

The MODBUS transmission protocol is mainly used for wired communication connected to meter reading devices through the I/O cable. NF1 RS485 MODBUS option implements the MODBUS over Serial Line protocol described in the following MODBUS publications:

- MODBUS Over Serial Line -Specification and Implementation Guide V1.02. Dec 20, 2006.
- MODBUS Application Protocol Specification V1.1b. Dec 28, 2006.

Section 6.1.1 provides specific NF1 MODBUS implementation information and Section 6.1.2 provides an overview of the NF1 MODBUS Register mapping.

7.1.1 MODBUS Implementation Information

The following information should be considered when implementing a MODBUS master to communicate with NF1 Water Meter.

Transmission Mode:	Remote Terminal Unit (RTU) slave.
Response Time-Out:	1 s
Turnaround Delay:	800 ms

7.1.2 NF1 MODBUS Register Mapping

The mapping of NF1 MODBUS Data Type to MODBUS Function Codes and Register Items is as shown in *Table 11*. Details of Register item are presented in *Table 12.*

Table 11 Mapping Table of NF1 MODBUS Registers

Data Type	Applicable Function Codes	Register Items	Description
RO FLOAT	03 Read Holding Registers	0-1, 18-23	Read access to 4-byte float types
RO SHORT	03 Read Holding Registers	2, 7, 12-17	Read access to 2-byte types
RO DOUBLE	03 Read Holding Registers	3-6, 8-11	Read access to 4-byte types
RW FLOAT	03 Read Holding Registers 06 Write Single Registers	24-25, 31-32, 34-37, 42-43, 46-55, 62-81, 87-90	Read/write access to 4-byte float types
RW SHORT	03 Read Holding Registers 06 Write Single Registers	26-30, 33, 38-41, 56, 61, 86, 91, 93	Read/write access to 2-byte short types
RW LONG	03 Read Holding Registers 06 Write Single Registers	44-45, 57-60, 82-85, 94-97	Read/write access to 4-byte long types
WO SHORT	06 Write Single Registers	92	Write access to 2-byte short types

Table 12 Description of Registers

Item	Description	Registers		Data Type	Length (Byte)
		DEC	HEX		
1	Flow rate	0	0	RO FLOAT	4
2	Flow rate unit	2	2	RO SHORT	2
3	Forward totalizer integral part	3	3	RO DOUBLE	4
4	Forward totalizer fractional part	5	5	RO DOUBLE	4
5	Forward totalizer unit	7	7	RO SHORT	2
6	Reverse totalizer integral part	8	8	RO DOUBLE	4
7	Reverse totalizer fractional part	10	A	RO DOUBLE	4
8	Reverse totalizer unit	12	C	RO SHORT	2
9	Excitation alarm status	13	D	RO SHORT	2
10	Low battery alarm	14	E	RO SHORT	2
11	Empty pipe alarm status	15	F	RO SHORT	2
12	Upper limit alarm status	16	10	RO SHORT	2
13	Lower limit alarm status	17	11	RO SHORT	2
14	Flow speed	18	12	RO FLOAT	4
15	Flow rate percentage	20	14	RO FLOAT	4
16	Electrode resistance	22	16	RO FLOAT	4
17	Meter size	24	18	RW FLOAT	4
18	Language	26	1A	RW SHORT	2
19	Communication address	27	1B	RW SHORT	2
20	Baud rate	28	1C	RW SHORT	2
21	Communication interval	29	1D	RW SHORT	2
22	Flow unit	30	1E	RW SHORT	2
23	Meter span setup	31	1F	RW FLOAT	4
24	Flow direction	33	21	RW SHORT	2
25	Zero point	34	22	RW FLOAT	4
26	Low flow cut-off	36	24	RW FLOAT	4
27	Damping time	38	26	RW SHORT	2
28	Flow engineering unit	39	27	RW SHORT	2
29	Reverse flow measurement enable	40	28	RW SHORT	2
30	Pulse output type	41	29	RW SHORT	2
31	K factor	42	2A	RW FLOAT	4
32	Pulse width selection	44	2C	RW LONG	4
33	Frequency output span	46	2E	RW FLOAT	4
34	Frequency output duty cycle	48	30	RW FLOAT	4
35	Empty pipe alarm threshold	50	32	RW FLOAT	4
36	Sensor factor	52	34	RW FLOAT	4
37	User factor	54	36	RW FLOAT	4
38	Excitation model	56	38	RW SHORT	2
39	Sensor serial number low	57	39	RW LONG	4

Item	Description	Registers		Data Type	Length (Byte)
		DEC	HEX		
40	Sensor serial number high	59	3B	RW LONG	4
41	Linearization enable	61	3D	RW SHORT	2
42	x1	62	3E	RW FLOAT	4
43	y1	64	40	RW FLOAT	4
44	x2	66	42	RW FLOAT	4
45	y2	68	44	RW FLOAT	4
46	x3	70	46	RW FLOAT	4
47	y3	72	48	RW FLOAT	4
48	x4	74	4A	RW FLOAT	4
49	y4	76	4C	RW FLOAT	4
50	x5	78	4E	RW FLOAT	4
51	y5	80	50	RW FLOAT	4
52	Forward total H/L	82	52	RW LONG	4
53	Reverse total H/L	84	54	RW LONG	4
54	Measurement interval	86	56	RW SHORT	2
55	Flow threshold	87	57	RW FLOAT	4
56	Transmitter factor	89	59	RW FLOAT	4
57	Meter Sleep on/off	91	5B	RW SHORT	2
58	Password for parameter setting	92	5C	WO SHORT	2
59	Password for totalizer reset	93	5D	RW SHORT	2
60	Transmitter serial number low	94	5E	RW LONG	4
61	Transmitter serial number high	96	60	RW LONG	4

7.2 IoT Protocol

For different IoT communication methods NF1 products provide, the bottom-layer wireless data packets can be decrypted under the same IoT data packet protocol as the following example.

- **Data Packet Description**

68	01 69	00 01	01	06	23
Header	Length	Frame No.	Function Code	Total Data Items	Bytes per Item

01	12 34 56 78	B8	67 45 03 00 2C	67450300 2C
Item No.	Flowmeter No.	Voltage	Forward Flow and Unit	Reverse Flow and Unit

26 75 02 00 34	0B69 29 01 00	00 20 03 06 10 17 20	04	00
Instantaneous Flow and Unit	Pressure and Unit	Time and Date	Meter Status	Valve Status

5 Data Items
(6 Items per Packet)

02	12 34 56 78	B8	67 45 03 00 2C	67450300 2C
Item No.	Flowmeter No.	Voltage	Forward Flow and Unit	Reverse Flow and Unit

26 75 02 00 34	0B69 29 01 00	00 20 03 06 10 17 20	04	00
Instantaneous Flow and Unit	Pressure and Unit	Time and Date	Meter Status	Valve Status

.....

06	12 34 56 78	B8	67 45 03 00 2C	67450300 2C
Item No.	Flowmeter No.	Voltage	Forward Flow and Unit	Reverse Flow and Unit

26 75 02 00 34	0B69 29 01 00	00 20 03 06 10 17 20	04	00
Instantaneous Flow and Unit	Pressure and Unit	Time and Date	Meter Status	Valve Status

CS	16
Checksum	End

- **Data Interception/Check Method**

The data packet starts with "68" as header. Length of the packet is indicated in the second byte. Intercept the data packet as the length byte indicated.

Verify if the packet ends with "16", then check if the checksum byte is correct, and finally judge whether the data packet is valid.

- **Data Decoding:**

1. **Length** (in hexadecimal, big-endian)
   High byte: Determined by the data length, e.g., 0x01 means there are 256 data bytes, 0x02 means there are 512 data bytes.
   Low byte: Determined by the data length, e.g., 0x69 means there are 105 data bytes.
   The data byte length represented by the high byte plus the one represented by the low byte is the total data byte length, which starts from the byte after the "length" byte to the byte before the checksum.

2. **Frame No.** (in hexadecimal, big-endian)
   High byte: Determined by the data length, e.g., 0x01 means that 256 frames of data are sent, 0x02 means that 512 frames of data are sent.

Low byte: Determined by the data length, e.g., 0x55 means that 95 frames of data are sent.

The frame number represented by the high byte plus the one represented by the low byte is the total number of the frame sent.

3. **Function Code**

   A fixed value of 0x01, meaning uplink data.

4. **Total Data Items** (in hexadecimal)

   E.g., 0x01 means there is 1 item of data to upload, 0x90 means there are 144 items of data to upload.

5. **Data Items in this Packet** (in hexadecimal)

   E.g., 0x01 means this packet contains 1 item of data, 0x06 means this packet contains 6 items of data.

6. **Bytes per Data Item** (in hexadecimal)

   E.g., 0x23 means each item of data contains 23 bytes.

7. **Item No.** (in hexadecimal)

   This number represents which item of data this is, e.g., 0x01 means the 1st item, 0x0A means the 10th item, 0x80 means the 128th item. The item number in each package is different. The final item number in the final packet corresponds to the total number of data item.

8. **Flowmeter No.** (in Binary-Code Decimal)

   Note that 12345678 in the packet example is already decoded.

9. **Voltage** (in hexadecimal)

   This is the measure voltage inside the meter, calculated as:

   184(as B8 in hexadecimal) * 2/100=3.68V.

10. **Forward Flow** (4 bytes in Binary-Code Decimal, little-endian)

    "67 45 03 00 2C" is decoded as 00034567 in unit m^3 ("2C" in *Table 7*), i.e., 34567 m^3.

    If replace "2C" with "2B" (meaning a unit of 100L), then the result will be 3456.7 m^3.

Table 13 Unit Code for Forward and Reverse Flow

Code	Unit Decoded	Code	Unit Decoded
26	1 mL	2A	10 L
27	10 mL	2B	100 L
28	100 mL	2C	1 m^3
29	1 L		

11. **Reverse Flow** (4 bytes in Binary-Code Decimal, little-endian)

    "67 45 23 00 2C" is decoded as 00234567 in unit m^3 ("2C" in *Table 13*), i.e., 234567 m^3

12. **Instantaneous Flow** (4 bytes in Binary-Code Decimal, little-endian)

    "26 75 02 00 34" is decoded as 00027526 in unit 100L/h ("34" in *Table 14*), i.e., 2752.6 m^3/h.

Table 14 Unit Code of Instantaneous Flow

Code	Unit Decoded	Code	Unit Decoded
2F	1 mL/h	33	10 L/h
30	10 mL/h	34	100 L/h
31	100 mL/h	35	1 m^3/h
32	1 L/h		

13. **Pressure** (4 bytes in Binary-Code Decimal, little-endian)

"0B69 29 01 00" is decoded as 000129 in unit 1kPa ("0B69" in *Table 15*), i.e., 129 kPa, or 1.29bar.

Table 15 Unit Code for Pressure

Code	Unit Decoded	Code	Unit Decoded
0B68	100 Pa (0.001 bar)	0B6A	10 kPa (0.1 bar)
0B69	1 kPa (0.01 bar)	0B6B	100 kPa (1 bar)

14. **Time (7 bytes in Binary-Code Decimal, little-endian)**

"00 20 03 06 10 17 20" is decoded as 20171006032000, i.e., Oct 6th, 2017, 03:20:00.

15. **Meter Status (2 bytes in hexadecimal, big-endian)**

"2 6" is decoded as 0010 0110. According to *Table 16*, this means that the meter is under a low-pressure and empty status, meanwhile the temperature measurement circuit is open.

Table 16 Meter Status Code

"1" in the high	Status Decoded	"1" in the low	Statues Decoded
0001	Reverse flow	0001	Unfunctional
0010	Leaked	0010	Empty
0100	Low pressure	0100	Temperature Circuit Opened
1000	Overflow	1000	Temperature Circuit Shorted

16. **Valve Status**

00 means Not Applicable. This part is reserved for future development.

17. **Default Unit Codes**

Table 17 Default Unit Codes with respect to Flow Meter Diameters

Sensor DN	Flow Info Type	Default Code	Default Unit
DN40	Accumulated	32	1 L
	Instantaneous	29	1 L/h
DN50 to 125	Accumulated	33	100 L
	Instantaneous	2B	10 L/h
DN150 to DN300	Accumulated	34	1 m^3
	Instantaneous	2C	100 L/h

8 Troubleshooting

Nautiflow NF1 has self-diagnosis functions. Once the error condition is detected, the relevant error message will be displayed in the alarm info section of the LCD, as shown in *Figure 22* and *Table 9* from *5.2* Elements of the Display Information.

Hardware self-diagnosis is performed within various interval depending on the priorities. Check *Table 18* for troubleshooting guidelines.

Table 18 Solution to Various Error/Alarms

Error Icon	Icon Name	Causes	Actions
	Low Battery	Minimum battery voltage is reached due to a. low battery capacity b. loosing battery power cable	Confirm the battery power cable is inserted well into the PCB. Replace the battery pack.
	Communication Failure	Failed to transmit data to the receiving server.	Check if the antenna is shielded by metal piece or thick obstacle. Make sure the receiving server is working properly. Check the voltage of internal RF battery pack.
	Empty Pipe	The flowtube is not filled up with flow or the electrode is wrapped by foreign objects.	Check the back pressure inside upstream pipeline. Inspect and clean the electrode inner surface.
	Tampering	The meter transducer has been opened without authorization.	Check the lead seal.
	Excitation Failure	The sensor has no flow signal output due to excitation failure.	Check the sensor line connection. If the icon remains, contact manufacturer.
	Reverse Flow	Reverse flow is detected in the flowtube.	Check whether the meter sensor is installed correctly. For a pipeline allowing reverse flow, this icon shall be treated as a "reminder" instead of an "alarm".

9 Warranty and Service

9.1 Warranty

The manufacturer provides one year warranty on all products, free of charge, but the users should be responsible for the one-way transportation fee from the customer to the factory.

9.2 Service

Manufacturer provides instrument installation for our customers, and the charge will be made according the cost.
For any hardware failure of the instrument, we recommend our customers send back the instrument to our factory for service. Before sending back the instrument, please try to contact the customer first to confirm the RMA.

For other operational problems, please contact our service department by telephone, fax or email and internet. In most cases, the problem could be solved immediately.

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