

LoRaWAN



Medical Oxygen Flow Meter VA.3.01

Model MF5806E1



Medical Oxygen Flow Meter

Enabled with IoT (LoRaWAN)

MF5806E1

User Manual

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Attention!

- Please carefully read this manual before operating this product.
- Do not open or modify any hardware that may lead to irrecoverable damage.
- Do not use this product if you suspect any malfunctions or defects.
- Use this product only for medical oxygen and do not use it in a strong vibrational and electromagnetic environment.
- Use this product according to the specified parameters.
- Only the trained or qualified personnel shall be allowed to perform product services.

Use with caution!

- Be cautious of electrical safety, even if it operates at a low voltage; any electrical shock might lead to some unexpected damage.
- The gas to be measured should be medical oxygen. Do not apply this meter for any other purpose.
- This product is designed for fully automatic oxygen therapy. It is intended to have the operation as simple as possible. However, training of the operator should be performed before use.
- LoRaWAN wireless is a local network, excellent for data safety and reliability. Some knowledge of the system is required for communication.

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1. Overview

All contact information can be found at the end of this manual.

This manual provides essential information for the MF5806E1 medical oxygen mass flow meters for hospital and home care oxygen therapy applications. The product performance, maintenance, troubleshooting, information for product orders, technical support, and repair are also included.

Oxygen therapy, which dates back to 1887, has been used for several cases of respiratory-related diseases. Today, the control of oxygen delivery is via pure mechanical rotameters based on volumetric metrology and has very low accuracy. In addition, it requires significant administrative effort, often by a nurse, to initialize, monitor, and conclude the process, which is all done manually.

The MF5806E1 is designed to significantly improve the oxygen therapy process into a fully automatic one with remote data and execution. The precision control via an oxygen mass flow meter is enabled with the Company's proprietary MEMS (micro-electro-mechanical systems) thermal calorimetric sensing technology. The wetted materials of the products are compatible with medical oxygen. The current model is the 3rd generation of the product, having upgraded features since its first release in 2014. The upgrade includes much-improved accuracy and integrated LoRaWAN wireless data. The software running over the LoRaWAN network provides monitoring and control, as well as data safety and reliability. Siargo is committed to continuous product innovation while offering the best value to our customers.

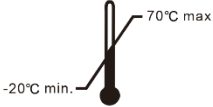
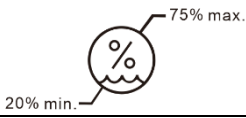
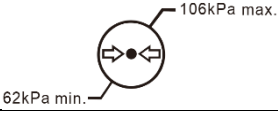
Siargo also offers a broad spectrum of off-the-shelf and customized flow, pressure, temperature /humidity, and gas concentration sensing products and provides integration and turn-key solutions to our customers. Please get in touch with the manufacturer for additional information.

Applications

- Hospital medical oxygen (gas) cylinder;
- Homecare oxygen therapy applications.

Symbols description

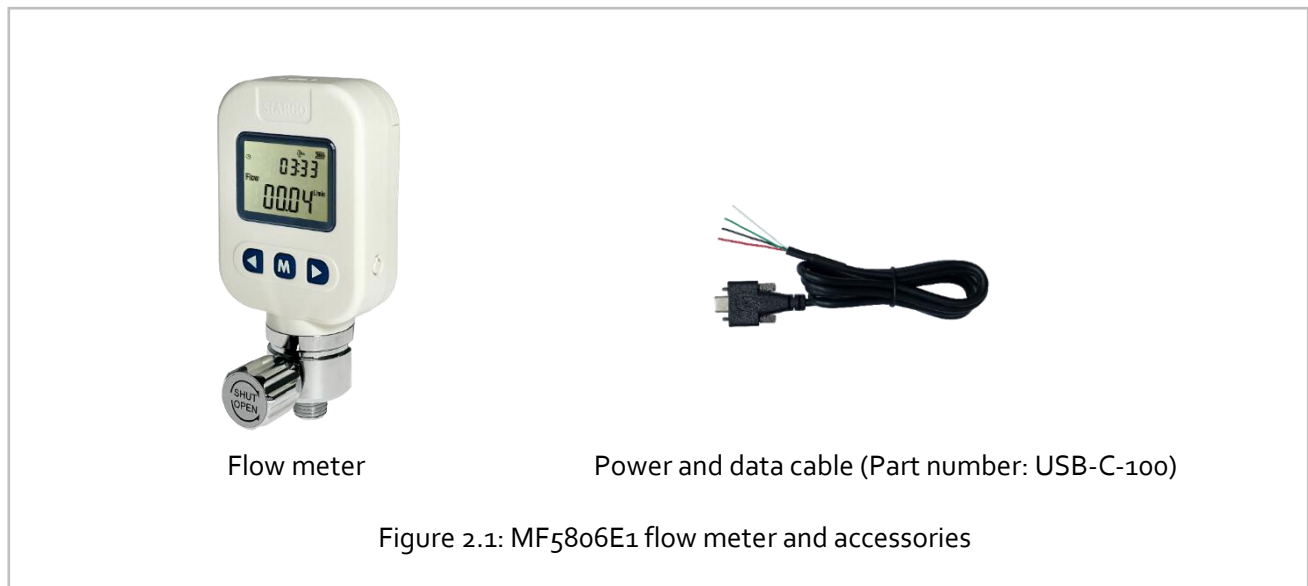
Table 1.1: Symbols description of the package and label

	Caution in USE.
	The product complies with Directive 2014/53/EU.
	The product should be disposed of under the Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC).
	Refer to the instruction manual.
	Indicates the product manufacturer's name and address.
	Indicates the authorized representative in the European Union.
	Correct the proper position of the package.
	The contents of the package are fragile; therefore, it shall be handled with care.
	The package shall be kept away from rain.
	Maximum 6/12 identical packages, which may be stacked on one another.
	The temperature limits are -20 °C ~ 70 °C, within which the transport package shall be stored and handled.
	The humidity limits are within 20%RH ~ 75%RH, within which the transport package shall be stored and handled.
	The atmospheric pressure limits are within 62 kPa ~ 106 kPa, within which the transport package shall be stored and handled.

2. Receipt / unpack of the products

Upon receipt of the products, please check the packing box before dismantling the packing materials. Ensure no damage during shipping. If any abnormality is observed, please contact and notify the carrier who shipped the product, and inform the distributors or sales representatives if the order is not placed directly with the manufacturer. Otherwise, the manufacturer should be notified as well. Please refer to the return and repair section in this manual for any further actions.

If the packing box is intact, open it to find the flow meter, power, and data cable, as shown below. Some parts may or may not be included in your order.



Please check immediately for the integrity of the product and the accessories listed above. If any abnormality is identified in your order, please notify the distributor/sales representative or manufacturer as soon as possible. If any defects are confirmed, an exchange shall be arranged immediately via the original sales channel. (Note: the LCD screen shall not be lit until the battery is installed or the power cable is plugged in.) This user manual shall also be included in the packing box or via an online link for an electronic version. In most cases, this manual shall be made available to the customer before the actual order.

The meter is designed to operate on low power, utilizing 3 AA rechargeable batteries. The batteries must have a safety verification (IEC 62133); details are shown in section 4.2. A power adapter must have a safety certification (IEC 60601-1) for use with this meter. The external power/data connector is a Type-C USB. See the detailed requirements in the operation section.

3. Knowing the products

3.1 Product description

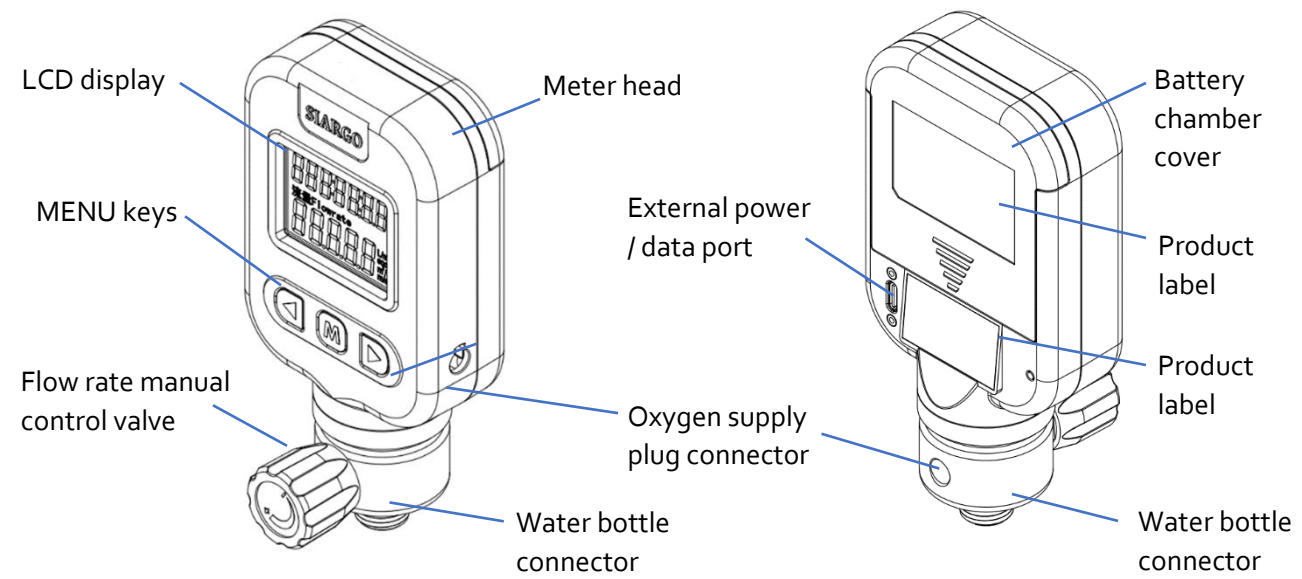
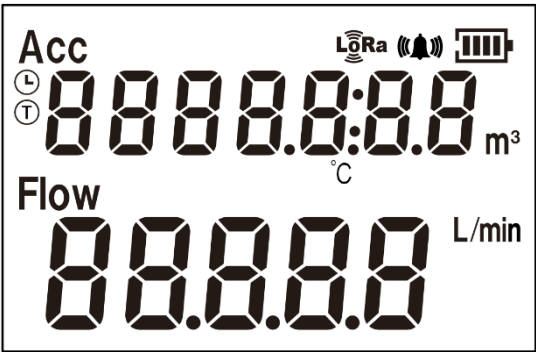


Figure 3.1: MF5806E1 parts description

3.2 LCD description



The LCD displays all the information measured by the product. The following table details the meaning of each of the symbols.

Figure 3.2: MF5806E1 LCD contents.

Table 3.1: Symbol descriptions of LCD

ACC	The top row. The default displays the totalized flow rate in m3 (cubic meters).
Flow	The 2nd row. Displays instant flow rate in L/min (liters per minute).
⌚	Indicate that the upper numerical display is time.
Ⓓ	Indicate that the upper numerical display is temperature.
LoRa	The LoRaWAN wireless protocol is enabled when it lights up.
🔔	Reminder.
🔋	Battery status.

3.3 Power and data cable description

Table 3.2: MF5806E1 wire assignment.



Figure 3.3: MF5806E1

Power and data cable

(Part number: USB-C-100, length: 1 m, shielded wire)

Wire	Color	Definition
1	Red	Power supply (+24 Vdc)
2	Black	GND, ground
3	Green	RS485A (+)
4	White	RS485B (-)

3.4 Mechanical dimensions

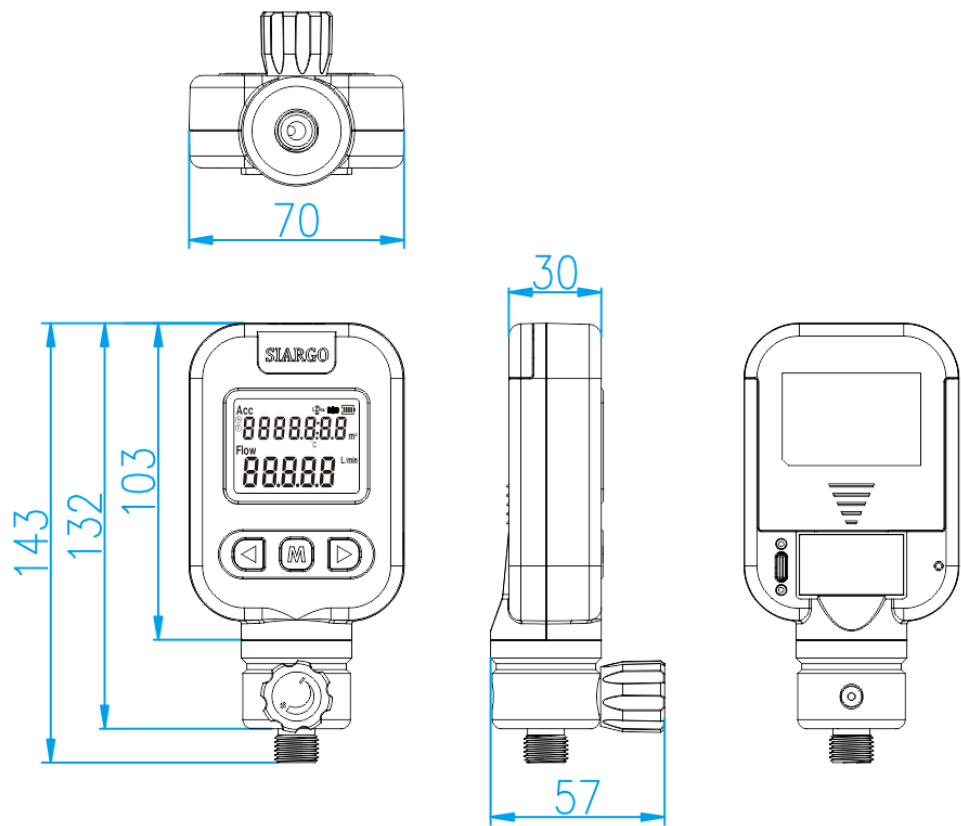


Figure 3.4: MF5806E1 dimensions

4. Installation

4.1 Installation precautions

Do not open or alter any part of the product that would lead to malfunction and irrecoverable damage. It will also forfeit the terms of the warranty and cause liability.

The product at the time of shipment is fully inspected for its quality and meets all safety requirements. Additional safety measures during the installation should be applied. It includes, but is not limited to, the leakage verification procedures, standard EDS (electrostatic discharge) precautions, and DC voltage precautions. Other tasks, such as calibration, part replacement, repair, and maintenance, must only be performed by trained personnel. Upon request, the manufacturer will provide necessary technical support and training for the personnel.

The product features a default DISS connector, designed for easy connection to oxygen supplies found in many hospitals and home care settings. However, there are also many other types of oxygen supply connectors. Please inform the supplier of your oxygen supply's particular type of connector so that the mechanical connection can be configured appropriately during shipping.

Please follow the following steps to complete the installation:

- a) Upon opening the package, the product's physical integrity should be inspected to ensure no visual damage.
- b) Before installing the product, please ensure that the pipe debris, particles, or any other foreign materials are removed.
- c) If the external power supply with data transmission is desired, connect electrical wires per the wire definition in Table 3.2. Please be sure of the power supply range (i.e., 24 VDC) and power supply polarization. Make sure the adapter has a safety certification (IEC 60601-1).
- d) For the communication wire connection, please follow the description in Table 3.2 and ensure the wires are correctly connected to the proper ports on your data device/equipment.
Note: Only the Siargo cable USB-C-100 can be used.
- e) For LoRaWAN wireless communication, please install the gateway and the software first. Depending on the communication frequency you will configure, it is recommended that the external power be used when the communication is enabled.
- f) Once the battery is installed or the external power is successfully connected, the LCD will be lit up and flash for about 2 seconds before the information is displayed correctly.
- g) The above procedure will conclude the installation.



Cautions

- a) The product should not be placed in a position where the disconnection device is challenging to operate.
- b) Don't alter any parts of the product.
- c) The power adapter, power, and data cable should be installed, removed, and replaced by the service personnel designated by the manufacturer.
- d) Ensure the electrical connection is made correctly per the instructions.
- e) Make sure no mechanical stresses in the connections.
- f) The strong electromagnetic interference sources close by or any mechanical shocks at the pipeline may also create malfunctioning of the product.
- g) Use of this equipment adjacent to or stacked with other equipment should be avoided because it could result in improper operation. If such use is necessary, this equipment and the other equipment should be observed to verify that they are operating normally.

4.2 Battery power operation

For battery power options, the meter uses rechargeable batteries. The following precautions should be taken to ensure the safe usage of the product.

- a) The meter uses 3-AA rechargeable batteries: 1.2V, NiMH.
- b) Please do not mix the battery type. Otherwise, it may damage the battery chamber and cause unwanted results.
- c) Please use only the batteries that have safety approval and are from a credible battery manufacturer. Recommended: Duracell HR6 1.2V, 1300mAh.



Cautions

- a) The batteries should be installed, removed, and replaced by the service personnel designated by the manufacturer, because the replacement of the battery by untrained personnel may lead to dangerous situations.
- b) If the meter is unlikely to be used for a period of time, the batteries need to be removed.

4.3 EMC Guidance & Declaration

4.3.1 Guidance and manufacturer's declaration - electromagnetic emissions

The Medical Oxygen Flow Meter is intended for use in the electromagnetic environment specified below. The customer or user of the Medical Oxygen Flow Meter should ensure it is used in an appropriate environment.

Emissions test	Compliance	Electromagnetic environment - guidance
RF emissions CISPR 11	Group 1	The Medical Oxygen Flow Meter uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class B	The Medical Oxygen Flow Meter is suitable for use in all establishments, including domestic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Not applicable	
Voltage fluctuations / flicker emissions IEC 61000-3-3	Not applicable	

4.3.2 Guidance & Declaration - electromagnetic immunity

The Medical Oxygen Flow Meter is intended for use in the electromagnetic environment specified below. The customer or user of the Medical Oxygen Flow Meter should ensure it is used in an appropriate environment.

Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment - guidance
Electrostatic discharge (ESD) IEC 61000-4-2	±8 kV contact ±2 kV, ±4 kV, ±8 kV, ±15 kV air	±8 kV contact ±2 kV, ±4 kV, ±8 kV, ±15 kV air	Floors should be wood, concrete, or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30 %.
Electrical fast transient/burst IEC 61000-4-4	±2kV for power supply lines	Not applicable	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	±0.5 kV, ±1 kV, ±2 kV line to ground	Not applicable	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions, and voltage	<5 % UT (>95% dip in UT.) for 0.5 cycle	Not applicable	Mains power quality should be that of a typical commercial or hospital environment. Suppose the user of the Electronic Stethoscope

variations on the power supply input lines IEC 61000-4-11	<5 % UT (>95% dip in UT) for 1 cycle 70% UT (30% dip in UT) for 25/30 cycles <5% UT (>95 % dip in UT) for 5/6 sec		requires continued operation during power mains interruptions. In that case, it is recommended that the Electronic Stethoscope be powered from an uninterruptible power supply or a battery.
Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	30 A/m	30 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.

4.3.3 Guidance & Declaration - electromagnetic immunity (Conducted RF & Radiated RF)

The Medical Oxygen Flow Meter is intended for use in the electromagnetic environment specified below. The customer or user of the Medical Oxygen Flow Meter should ensure that it is used in such an environment.

Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment - guidance
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80 MHz 6 Vrms in ISM bands and amateur radio bands	3 Vrms 150kHz to 80 MHz 6 Vrms in ISM bands and amateur radio bands	Portable RF communications Equipment (including peripherals such as antenna cables and external antennas) should be used no closer than 30 cm (12 inches) to any part of the Medical Oxygen Flow Meter, including cables specified by the manufacturer. Otherwise, degradation of the performance of this equipment could result.
Radiated RF IEC 61000-4-3	10 V/m 80 MHz to 2.7 GHz 385MHz-5785MHz Test specifications for ENCLOSURE PORT IMMUNITY to RF wireless Communication equipment (Refer to table 9 of IEC 60601-1-2:2014+A1:2020)	10 V/m 80 MHz to 2.7 GHz 385MHz-5785MHz Test specifications for ENCLOSURE PORT IMMUNITY to RF wireless communication equipment (Refer to table 9 of IEC 60601-1-2:2014+A1:2020)	

4.3.4 Suggestions to avoid EMC

Installation location:

- a) Place the medical equipment away from sources of strong electromagnetic fields such as large transformers, high-power radio transmitters, and microwave ovens.
- b) Avoid areas with dense wireless signal transmissions, such as near multiple Wi-Fi routers or large numbers of mobile devices.

During operation:

- a) Keep a certain distance between medical equipment and other electronic devices that may generate electromagnetic interference. For example, do not place mobile phones or tablets too close to the medical equipment.
- b) Regularly check and maintain the medical equipment to ensure that its electromagnetic shielding function is in good condition.
- c) Educate users to be aware of potential sources of electromagnetic interference and take preventive measures.



Cautions

- a) If the meter works in an environment where there is communication, microwave, high-frequency electrosurgical knife, etc., the meter may be affected by these external factors, which could potentially lead to inaccurate operation or malfunction. Users and service personnel should be aware of these potential interferences and take appropriate precautions.
- b) Use of accessories, transducers, and cables other than those specified or provided by the manufacturer of this equipment could result in increased electromagnetic emissions or decreased electromagnetic immunity of this equipment, and result in improper operation

5. Operation and MENU description

5.1 Check the product specifications

Before starting to use this product, check the specifications found in this manual or the basic information located on the product's back panel.

Detailed product information can be found in Section 6. Be particularly cautious about the supplied voltage indicated in the specification. A higher voltage may lead to irrecoverable damage, and a lower voltage will not power the product for any desired functions.

For optimal product performance, it is recommended that the gas to be measured be clean and free of particles or other foreign materials.

5.2 Check the leakage

Check for gas leakage before any measurement. Pressurized nitrogen or air can be used for the leakage check.

5.3 Power the meter and digital data connection

Although this product complies with the CE-required EMC regulations, it also requires the product to be used according to the standard electrical device practice. For regular oxygen therapy, the meter can be powered by 4 AA batteries. Be sure to select batteries with safety features and within their expiration dates. Do not use batteries without a known manufacturer and expiration date. It is recommended to have the meter powered with external DC power or an AC-DC adapter for extensive usage. Ensure the output voltage is within the specified range in Section 7. Before connecting the product with the external power, ensure that the standard electrical device precautions, such as EDS (electrostatic discharge) and DC voltage, are observed. Excessive electrostatic discharge may damage the product.

The power and data port is a standard Type-C USB. The manufacturer-supplied Type-C USB cable has a screw-locking fixture. Such a feature is recommended to ensure the cable is engaged correctly and will not be accidentally unplugged.

Half-duplex RS485 Modbus is used for digital data communication. Make sure the wires are correctly connected to the receiver side.

5.4 Meter MENU description

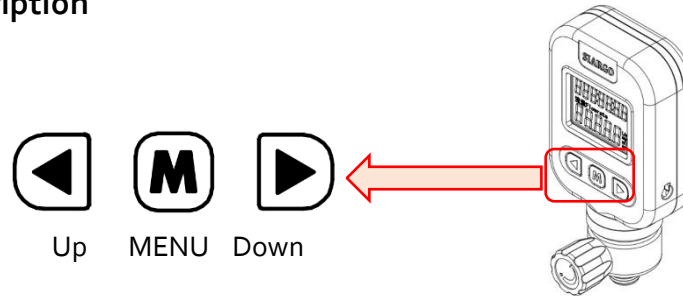


Figure 5.1: MF5806E1 keys description

The meter features a front 3-key board, allowing users to set desired functions, access data, and check the status. The Menu key (M) is at the central position, allowing the user to select a function and confirmation or other related actions that will be detailed below. Use two keys ("Up" and "Down") to choose the menu and sub-menu.

5.4.1 Starting the operation

Once the power is supplied, and no abnormal issues are observed, the product is ready to perform the designed functions. Two displays correspond to the different data acquisition parameters: time-limited therapy; accumulated or totalized mass flow therapy. The user can switch the display by pressing the central MENU key within 0.5 seconds. The default display is for the mass flow measurement, having two numerical lines on the LCD. The upper line is the accumulated or totalized flow rate, and the lower line is the instant flow rate. If the battery symbol turns empty, change the battery or plug in the external power cord.

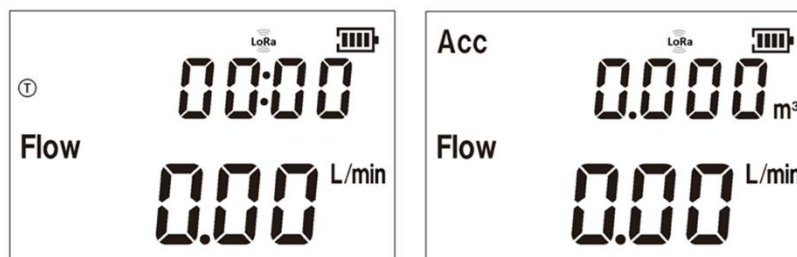


Figure 5.2: MF5806E1 display modes

The above two graphs show the two display modes: the first is the time acquisition mode, for which the upper line displays the totalized time of the oxygen therapy in hh: mm (hours: minutes) format, and the lower line is the instant mass flow rate. On display are also the battery status and LoRaWAN status. The second one is the mass flow acquisition, which shows the totalized /accumulated mass flow rate at the upper line and the instant flow rate at the lower line.

If the battery symbol indicates an empty or near-empty status, change the battery or plug in the external power before proceeding further. When external power is used, the battery mode is automatically switched off, and no battery symbol will be displayed in any of these two modes.

5.4.2 MENU entry with a verified password

In either of the two display modes, press the central “M” MENU key to enter the password setting and verification MENU. The default password is “11111”, and the display will return to the main display if incorrect.



To enter a new password, press the “Up” or “Down” key to change the digit that flashes, and press the “M” key to confirm. Repeat this process for all five digits, and the meter will enter the menu setting interface/screen.

Subsequently, the MENU allows the user to:

- | | |
|----------------|--|
| ➤ F2 - Addr | Set Modbus address; |
| ➤ F3 - bPS | Change communication baud rate; |
| ➤ F11 - oFFST | Reset or calibrate the offset; |
| ➤ F12 - GCF | Enter the gas conversion factor (GCF) |
| ➤ F16 - rESPS | Set response time; |
| ➤ F38 - dISP | Change the display mode; |
| ➤ F39 - LAnG | Change the display language; |
| ➤ F61 - rMd-H | Set upper flow rate limit reminder; |
| ➤ F62 - rMd -L | Set lower flow rate limit reminder; |
| ➤ F63 - rMd -A | Set totalized or accumulated flow rate reminder; |
| ➤ F91 - PASS | Change the default password; |
| ➤ F92 - CLr-A | Clear or reset the totalizer or accumulated flow rate; |
| ➤ F93 - CLr-T | Reset the time counter; |
| ➤ F99 - qUIT | Exit from the MENU. |

Note: During this process, the meter will continue to measure the flow without interruption.

5.4.3 Set the RS485 Modbus address

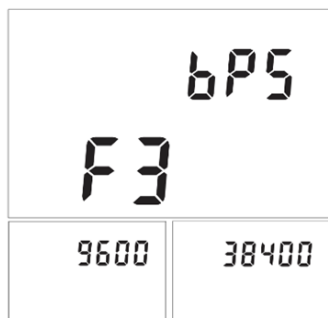


After the password is verified and entered into the MENU settings, press the “Up” or “Down” key until the screen shows the F2-Addr as indicated to the left.

The Modbus address has three digits, which can be any number between 001 and 247. **(Note: The default Modbus address is 001).** Press the “M” key to enter the change address screen. Press the “Up” or “Down” key to change the flashing digits, and then press the “M” key to confirm. After the address is set, the display will return to F2 -

Addr, which indicates the task is completed. Press the “Up” or “Down” key to select F99 - qUIT and the “M” key to exit the MENU and return to the Main Display screen.

5.4.4 Set the RS485 communication baud rate

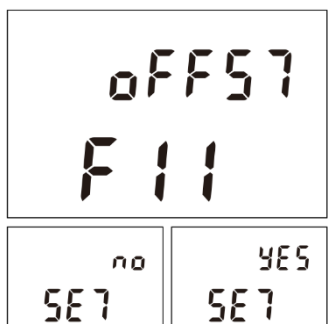


Following the steps mentioned above, at the MENU setting screen, use the "Up" or "Down" key to select F3-bPS and then press the "M" key to set the RS485 communication baud rate.

There are six baud rates selectable, depending on your system requirements: 4800, 9600, 19200, 38400, 57600, and 115200. **(Note: The default baud rate is 9600).** Use the "Up" or "Down" key to select the desired one and press the "M" key to confirm. The display will then return to the F3-bPS screen, which indicates the task is

completed. Use the "Up" or "Down" key to select F9g - qUIT and the "M" key to exit the MENU and return to the Main Display screen.

5.4.5 Reset or calibrate the offset



After a specific usage time, the meter's offset (zero flow rate) might not have a slight shift. When applying the meter to different gases, the offset might shift. The meter's offset needs to be reset or calibrated to ensure measurement accuracy. Following the steps mentioned above, use the "Up" or "Down" keys at the MENU setting screen to select F11 - oFFST. Before performing the task, ensure that there is no flow in the flow channel. Otherwise, it will create even bigger erroneous measurement results.

Press the "M" key to confirm the task, and it will open the sub-MENU asking you to confirm. Use the "Up" or "Down" key to select the desired one and press the "M" key to confirm. The display will then return to the F11 - oFFST screen, which indicates the task is completed. Use the "Up" or "Down" key to select F9g - qUIT and the "M" key to exit the MENU and return to the Main Display screen.

5.4.6 Gas conversion factor (GCF) for different gas measurements



For the general purpose of the application, a gas conversion factor (GCF) can be applied to measure the gas differently from the default one or the one used for calibration. The GCF is determined by the thermal calorimetric sensing principle, as well as the meter fluidic dynamic design and the control circuitry. Contact the manufacturer to obtain the values corresponding to the correct models.

The GCF for air is 1000.

Note: If the meter is required with a special real gas calibration, contact the manufacturer before placing the order.

Following the steps mentioned above, at the MENU setting screen, use the "Up" or "Down" key to select F12 - GCF. Press the "M" key to confirm, and it will open the sub-MENU showing the current gas conversion value. Use the "Up" or "Down" and the "M" confirming key to input the desired value, and press the "M" key again to complete the task. The display will then return to the F12 - GCF screen, which indicates the task is completed. Use the "Up" or "Down" key to select F9g - qUIT and the "M" key to exit the MENU and return to the Main Display screen.

5.4.7 Set the response time



Following the steps mentioned above, at the MENU setting screen, use the "Up" or "Down" key to select F16 - rESPS and then press the "M" key to set the response time.

There are six selectable response times: 125, 250, 500, 1000, 2000, and 5000 milliseconds. The default response time is 125 msec. Use the "Up" or "Down" key to select the desired one and press the "M" key to confirm. The display will then return to the F16 - rESPS screen, which indicates the task is completed. Use the "Up" or "Down" key to select F9g - qUIT and the "M" key to exit the MENU and return to the Main Display screen.

5.4.8 Select the display mode



This function sets the display modes, cycle, or fixed display modes. If one likes to switch between these two display modes, following the steps mentioned above, at the MENU setting screen, use the "Up" or "Down" key to select F38 - dISP. Press the "M" key to confirm, and it will open the sub-MENU showing the current display mode. Use the "Up" or "Down" and the "M" confirming key to select the desired one, and press the "M" key again to complete the task. The display will then return to the F38 - dISP screen, which indicates the task is completed. Use the "Up" or "Down" key to select F9g - qUIT and the

"M" key to exit the MENU and return to the Main Display screen.

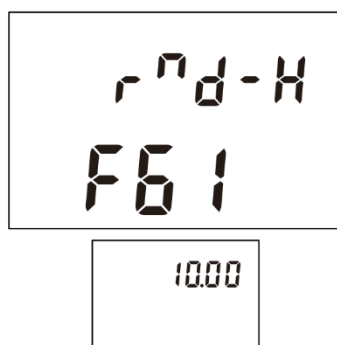
5.4.9 Select the display language



This function is reserved for future upgrades. The current models are configured to be English or Chinese based on the shipping geographic regions. However, if one likes to switch between these two default languages, following the steps mentioned above, at the MENU setting screen, use the "Up" or "Down" key to select F39 - LAnG. Press the "M" key to confirm, and it will open the sub-MENU showing the current language. Use the "Up" or "Down" keys and the "M" confirming key to select the desired option, and press the "M" key again to complete the task. The display will then return to the

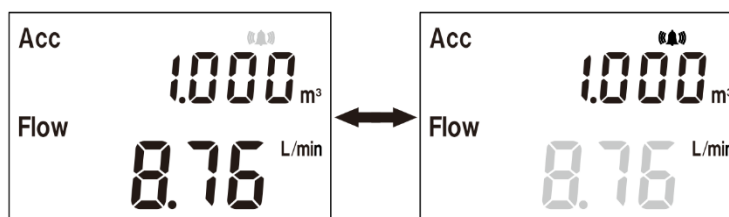
F39 - LAnG screen, which indicates the task is completed. Use the "Up" or "Down" key to select F99 - qUIT and the "M" key to exit the MENU and return to the Main Display screen.

5.4.10 Set the reminder: upper instant flow rate limit



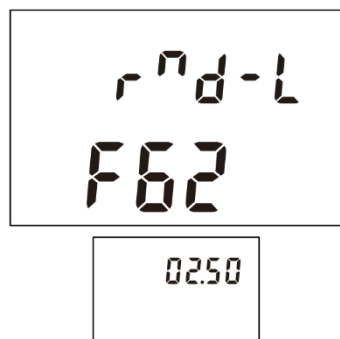
This function allows the user to set the instant flow rate above which the meter will trigger the reminder function. The reminder will be the instant flow rate, and the reminder icon will flash alternately.

- The triggered reminder will not stop the meter from continuous operation, and the reminder will be off once the metering value is below the set value.
- In other key operations, only the reminder icon will flash.
- To cancel the reminder, please see the details in section 5.4.20.



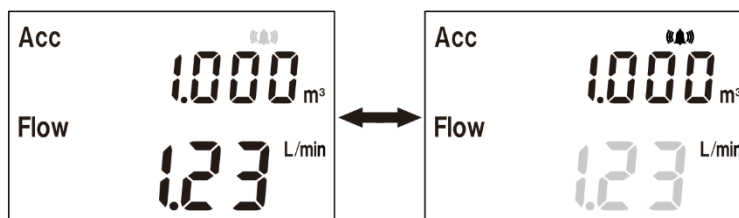
The flow rate has two decimal points with a maximum not over the full-scale flow rate at the order. Following the steps mentioned above, use the "Up" or "Down" keys at the MENU setting screen to select F61-rMd-H. Press the "M" key to confirm, and it will open the sub-MENU showing a default flow rate of 999.99. Use the "Up" or "Down" keys and the "M" confirming key to select the desired option, and press the "M" key again to complete the task. The display will then return to the F61 - rMd -H screen, which indicates the task is completed. Use the "Up" or "Down" key to select F99 - qUIT and the "M" key to exit the MENU and return to the Main Display screen.

5.4.11 Set the reminder: lower instant flow rate limit



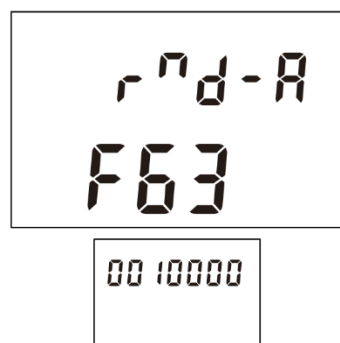
This function allows the user to set the instant flow rate below which the meter will trigger the reminder function. The reminder will be the instant flow rate, and the reminder icon will flash alternately.

- The triggered reminder will not stop the meter from continuous operation, and the reminder will be off once the metering value is below the set value.
- In other key operations, only the reminder icon will flash.
- To cancel the reminder, please see the details in section 5.4.20.



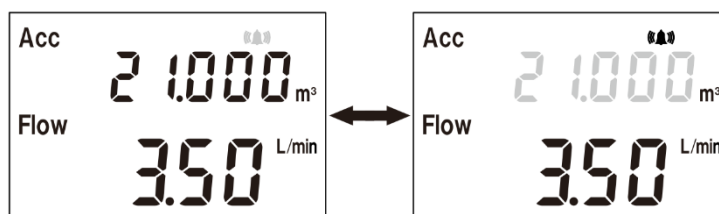
The flow rate has two decimal points with a minimum of 0.00. Following the steps mentioned above, use the “Up” or “Down” keys at the MENU setting screen to select F62-rMd-L. Press the “M” key to confirm, and it will open the sub-MENU showing a default flow rate of 0.00. Use the “Up” or “Down” keys and the “M” confirming key to select the desired option, and press the “M” key again to complete the task. The display will then return to the F62-rMd-L screen, which indicates the task is completed. Use the “Up” or “Down” key to select F99 - qUIT and the “M” key to exit the MENU and return to the Main Display screen.

5.4.12 Set the reminder: accumulated flow rate or totalizer limit



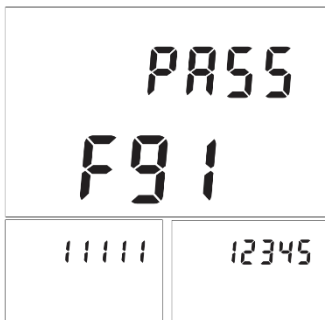
This function allows the user to set the maximum accumulated or totalized flow rate above which the meter will trigger the reminder function. The reminder will be the accrued flow rate or the totalizer, and the reminder icon will flash alternately.

- The triggered reminder will not stop the meter from continuous operation. The reminder will be off by resetting the setting.
- In other key operations, only the reminder icon will flash.
- To cancel the reminder, please see the details in section 5.4.20.



The accumulated or totalized flow rate has seven digits with a maximum of 9999999. Following the steps mentioned above, use the “Up” or “Down” keys at the MENU setting screen to select F63-rMd-A. Press the “M” key to confirm, and it will open the sub-MENU showing a default flow rate of 9999999. Use the “Up” or “Down” keys and the “M” confirming key to select the desired option, and press the “M” key again to complete the task. The display will then return to the F63-rMd-A screen, which indicates the task is completed. Use the “Up” or “Down” key to select F99 - qUIT and the “M” key to exit the MENU and return to the Main Display screen.

5.4.13 Change the default password



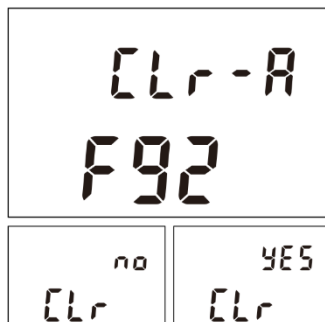
For data safety, it is recommended that the default password of 11111 be changed when this product is first used.

Following the steps mentioned above, use the “Up” or “Down” keys at the MENU setting screen to select F91 - PASS. Press the “M” key to confirm, and it will open the sub-MENU showing the default password of 11111. Use the “Up” or “Down” keys and the “M” confirming key to select the desired option, and press the “M” key again to complete the task. The display will then return to the F91 - PASS screen, which

indicates the task is completed. Use the “Up” or “Down” key to select F99 - qUIT and the “M” key to exit the MENU and return to the Main Display screen.

Note: The password should be changed by the service personnel designated by the manufacturer. Please keep the changed password in a safe yet accessible place. In case it is unrecoverable, please get in touch with the manufacturer to obtain a unique password to access the meter MENU.

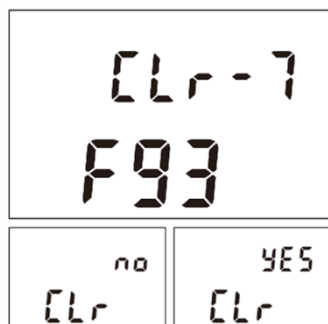
5.4.14 Reset the accumulated or totalized flow rate



As the maximum value of the accumulated or totalized flow rate that the internal register can have is 9999999, the register will stop accumulating once the value is reached. At this time, it is necessary to reset this register. Following the steps mentioned above, use the “Up” or “Down” keys at the MENU setting screen to select F92 - CLr-A. Press the “M” key to confirm, and it will open the sub-MENU for resetting the value. Use the “Up” or “Down” keys to select, and the “M” key to confirm and execute. Press the “M” key again to complete the task. The display will then return to the F92-CLr-A screen, which

indicates the task is completed. Use the “Up” or “Down” key to select F99 - qUIT and the “M” key to exit the MENU and return to the Main Display screen.

5.4.15 Reset the time counter



In the totalized time therapy mode, it may be necessary to reset the timer after each therapy. Following the steps mentioned above, use the "Up" or "Down" keys at the MENU setting screen to select F93 - CLr-T. Press the "M" key to confirm, and it will open the sub-MENU for resetting the value. Use the "Up" or "Down" keys to select, and the "M" key to confirm and execute. Press the "M" key again to complete the task. The display will then return to the F93 - CLr-T screen, which indicates the task is completed. Use the "Up" or "Down" key to select F99 - qUIT and the "M" key to exit the MENU and return to the Main

Display screen.

5.4.16 Exit the MENU



At the MENU settings, use the "Up" or "Down" key to select the F99 - qUIT option and press the "M" confirming key to exit the MENU settings and return to the Main Display screen.

5.4.17 Quick exit the MENU

At any status, press the "M" key > 3 seconds, the meter will return to the Main Display screen.

5.4.18 Sleeping mode

When batteries power the meter, it is necessary to enable the sleeping mode for power saving to allow a longer operation time.

The meter features an automatic sleeping mode that shuts off the display, while the control circuitry operates at minimal power consumption. This mode will be executed when the continuously measured flow rate is zero for 5 minutes.

The meter can also be turned into sleep mode manually by pressing the "Up" key for 3 seconds.

5.4.19 Wake up the meter

When the meter is in sleeping mode, it will automatically wake up if the flow rate in the flow channel is larger than 0.5 L/min for 10 seconds. Alternatively, the meter can be manually activated by pressing any of the three keys on the front meter face.

5.4.20 Cancel the reminder

When the reminder is triggered (5.4.10 upper instant flow rate reminder, 5.4.11 lower instant flow rate reminder, and 5.4.12 accumulated flow rate or totalizer reminder), press the "Up" key and "Down" key at the same time, and the reminder will be permanently canceled. But other reminders will be effective when triggered later.

5.4.21 End to use the meter

To stop using the meter, please follow the steps below:

- a) Turn off the manual control valve, ensure the flow rate shows 0 L/min, and the meter display will be closed in 5 minutes.
- b) If the meter will not be used in the same place, remove the AC-DC adapter power plug.
- c) If the meter is unlikely to be used for a period of time, the batteries need to be removed.

5.4.22 MENU key sequence for the settings

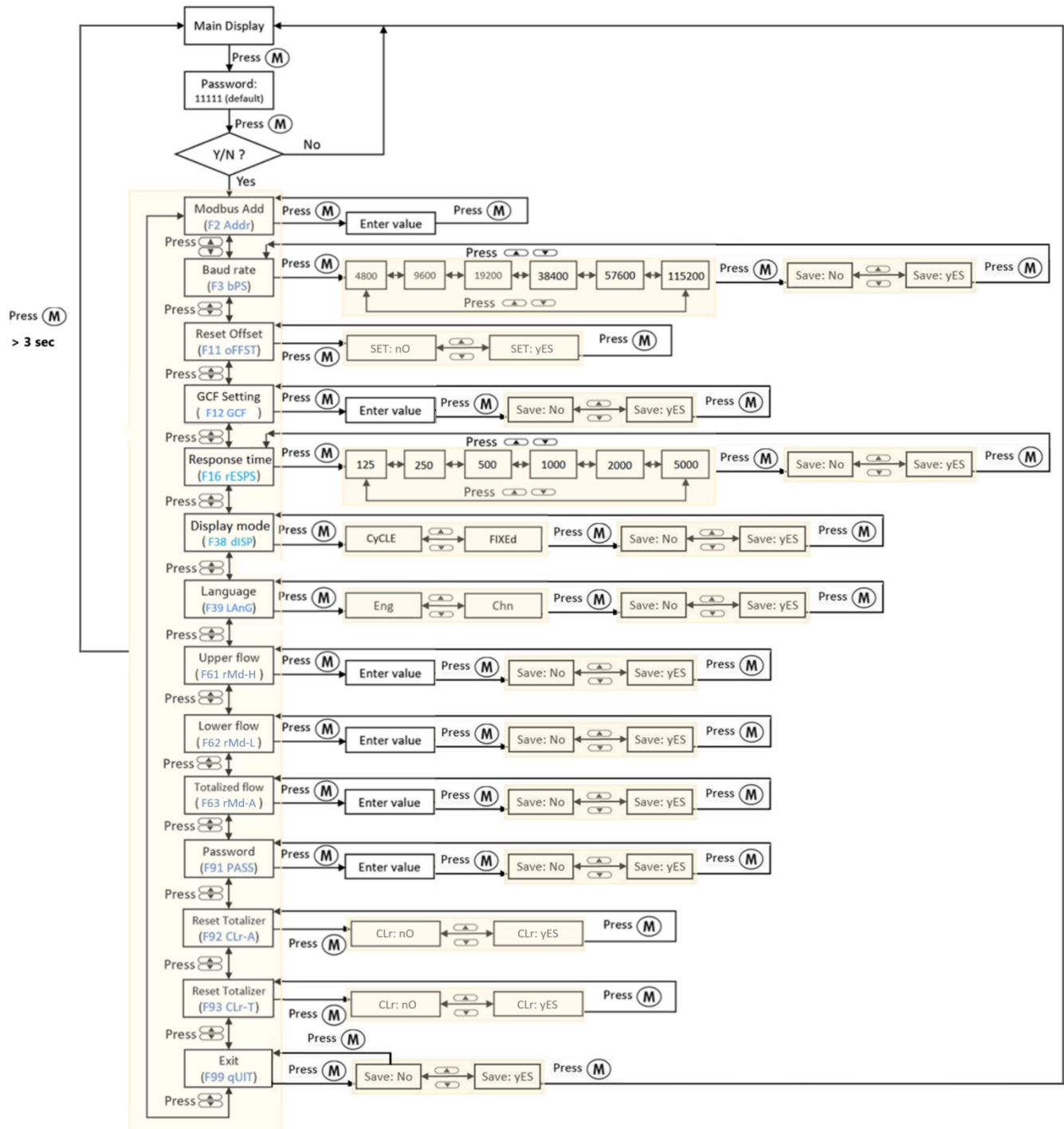


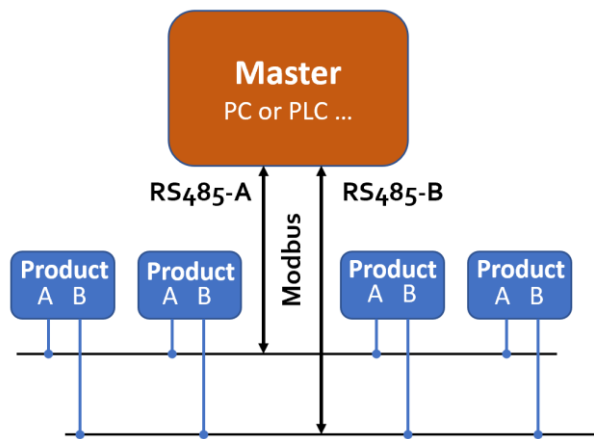
Figure 5.3: MF5806E1 MENU key sequence

5.5 RS485 Modbus communication protocol

The digital communication protocol is based on standard Modbus RTU Half-plex mode. A master (PC or PLC) can communicate with multiple slaves (the current meter) for data exchange and configuration of communication parameters.

5.5.1 Hardware connection

The hardware layer is TIA/EIA-485-A, as illustrated below. In this configuration, the meter (MF5806E1) is a slave.



5.5.2 Communication parameters

The PC UART communication parameters are listed in the following table.

Parameters	Protocol
	RTU
Baud rate (Bits per second)	9600 bps
Start bits	1
Data bits	8
Stop bits	1
Even/Odd parity	None
Bits period	104.2 μ sec
Bytes period	1.1458 msec
Maximum data length	20
Maximum nodes	247

5.5.3 Frame

The frame function is based on the standard Modbus RTU framing:

Start_bits	Address	Function codes	Data	CRC	Stop_bits
T ₁ -T ₂ -T ₃ -T ₄	8 bit	8 bit	N 8 bit (20≥n≥0)	16 bit	T ₁ -T ₂ -T ₃ -T ₄

Start_bits: 4 periods bit time, for a new frame.

Address: The address can be set from 1 to 247 except for 157 (0x9d).

Function codes: Define the meter (MF5806E1)'s functions/actions (slaves), either execution or response.

Data: The address of the register, the length of data, and the data themselves.

CRC: CRC verification code. The low byte is followed by the high byte. For example, a 16-bit CRC is divided into BYTE_H and BYTE_L. The BYTE_L will come first in the framing, followed by the BYTE_H. The last one is the STOP signal.

Stop_bits: 4 periods bit time, for ending the current frame.

5.5.4 Function codes

The Modbus function codes applied for the product are a subclass of the standard Modbus function codes. These codes are used to set or read the registers of the product:

Code	Name	Functions
0x03	Read register	Read register(s)
0x06	Set a single register	Write one single 16-bit register
0x10	Set multiple registers	Write multiple registers

5.5.5 Registers

The meter (MF5806E1) has multiple registers to assign the various functions. With these functions, the user can obtain the data from the meters, such as *meter address* and *flow rates* from the registers, or set the meter functions by writing the corresponding parameters.

The currently available registers are listed in the following table, and the registers may be customized upon contacting the manufacturer. Where R: read; W: write-only; W/R: read and write.

Note: At the time of shipping, the write protection function is enabled except for the address and baud rate. Once the user completes the register value change, the write protection will be automatically enabled again to prevent incidental data loss.

Functions	Description	Register	Modbus reference
Address	Meter address (R/W)	0x0081	40130 (0x0081)
Serial number	Serial number of the meter	0x0030 ~ 0x0035	40049 (0x0030)
Flow rate	Current flow rate (R)	0x003A~0x003B	40059 (0x003A)
Accumulated flow	Accumulated or totalized flow rate (R)	0x003C~0x003E	40061 (0x003C)
Baud rate	Communication (R/W)	0x0082	40131 (0x0082)
Response time	Set the response time (R/W)	0x008D	40142 (0x008D)
Totalizer reminder	Accumulated/totalized flow rate reminder (R/W)	0x0096~0x0097	40151 (0x0096)
Upper flow reminder	Upper flow rate limit reminder (R/W)	0x0098~0x0099	40153 (0x0098)
Lower flow reminder	Lower flow rate limit reminder (R/W)	0x009A~0x009B	40155 (0x009A)
Password	Password change (R/W)	0x00AE~0x00AF	40175 (0x00AE)
Offset calibration	Offset reset or calibration (W)	0x00F0	40241 (0x00F0)
Reset totalizer	Reset accumulated or totalized flow rate (W)	0x00F2	40243 (0x00F2)
Reset timer	Reset meter timer (W)	0x00F2	40243 (0x00F2)
Write protection	Write protection of selected parameters (W)	0x00FF	40256 (0x00FF)

The detailed information of each register is described below: Y: enabled; N: disabled

Flowmeter address	0x0081	Write	Y
		Read	Y
Description	Address of the meter		
Value type	UINT 16		
Notes	Values range from 1 to 247, excluding 157 (0x9d).		

SN, Serial number	0x0030 ~ 0x0035	Write	N
		Read	Y
Description	Series Number of the meter, SN		
Value type	ASCII		
Notes	SN= value(0x0030), value(0x0031),...,value (0x0035). Receiving 12 bits as 2A 47 37 41 45 49 30 32 30 35 38 2A, the corresponding Serial Number is *G7AE1o2o58*.		

Current flow rate	0x003A ~ 0x003B	Write	N
		Read	Y
Description	Current flow rate		
Value type	UINT 32		
Notes	Flow rate = [Value (0x003A)*65536 + value (0x003B)]/1000 e.g., for a flow rate of 20.340 SLPM, the user will read "0" from register 0x003A and "20340" from register 0x003B, therefore Current flow rate = (0*65536+20340)/1000 = 20.340		

Accumulated flow rate	0x003C ~ 0x003E	Write	N
		Read	Y
Description	Accumulated or totaled flow rate		
Value type	UINT 32 + UINT 16		
Notes	Accumulated or totaled flow rate $\text{= Value (0x003C) * 65536 + Value (0x003D) + Value (0x003E)/1000}$ e.g.: for an accumulated flow rate of 3452.245 m ³ , the user will read "0" from register 0x003C; "3452" from register 0x003D, and "245" from register 0x003E. Then, the accumulated flow rate = 0 + 3425 + 245/1000=3425.245 m ³ .		

Baud rate	0x0082	Write	Y
		Read	Y
Description	Communication baud rate with a PC		
Value type	UINT 16		
Notes	0 - 4800; 1 - 9600; 2 - 19200; 3 - 38400; 4 - 57600; 5 - 115200. The default value is 1; the baud rate is 9600. For example, when the user reads "2" from register 0x0082, the baud rate is 19200.		

Response time	0x008D	Write	Y
		Read	Y
Description	Set response time		
Value type	UINT 16		
Notes	125, 250, 500, 1000, 2000, or 5000 units are in milliseconds. The default value is 125 msec. For example, when the user reads "2000" from register 0x008D, the response time is 2000 msec (2 sec).  Note: the write protection must be disabled.		

Reminder: Accumulated flow rate	0x0096 ~ 0x0097	Write	Y
		Read	Y
Description	The reminder is set for the maximum value of an accumulated flow rate.		
Value type	UINT 32		
Notes	Reminder values = Value (0x0096)*65536 + Value (0x0097) When the set value is reached, a reminder will be triggered.		

Reminder: Flow rate upper limited	0x0098 ~ 0x0099	Write	Y
		Read	Y
Description	Set a reminder value for an upper flow rate limit.		
Value type	UINT 32		
Notes	Reminder values = $[\text{Value}(0x0098) * 65536 + \text{Value}(0x0099)] / 1000$ A reminder will be triggered when the flow rate is above a set value. e.g., for a reminder value of 5.000 SLPM, the user will read "0 (0x0000)" from register 0x0098 and "5000 (0x1388)" from register 0x0099, therefore Current flow rate = $(0 * 65536 + 5000) / 1000 = 5.000$.		

Reminder: Flow rate lower limit	0x009A ~ 0x009B	Write	Y
		Read	Y
Description	Set a reminder value for a lower flow rate limit.		
Value type	UINT 32		
Notes	Reminder values = $[\text{Value}(0x009A) * 65536 + \text{Value}(0x009B)] / 1000$ A reminder will be triggered when the flow rate is below a set value. e.g., for a reminder value of 1.500 SLPM, the user will read "0 (0x0000)" from register 0x009A and "1500 (0x05DC)" from register 0x009B, therefore Current flow rate = $(0 * 65536 + 1500) / 1000 = 1.500$.		

Change password	0x00AE ~ 0x00AF	Write	Y
		Read	Y
Description	Change the default password.		
Value type	UINT 32		
Notes	Password values = $\text{Value}(0x00AE) * 65536 + \text{Value}(0x00AF)$ Available: 00000 ~ 99999		

Offset calibration	0x00Fo	Write	Y
		Read	N
Description	Reset or calibrate the offset.		
Value type	UINT 16, Fixed value 0xAA55		
Notes	To reset or calibrate the offset, write 0xAA55 to register 0x00Fo.  Note: When executing this function, ensure there is NO flow in the flow channel.		

Reset the accumulated flow rate	0x00F2	Write	Y
		Read	N
Description	Reset the accumulated or totalized flow rate value.		
Value type	UINT 16, Fixed value 0x0001		
Notes	To reset the accumulated or totalized flow rate value, write 0x0001 to register 0x00F2.  Note: the write protection must be disabled.		

Reset timer	0x00F2	Write	Y
		Read	N
Description	Reset the meter timer.		
Value type	UINT 16, Fixed value 0x0003		
Notes	To reset the accumulated therapy time/duration timer.  Note: the write protection must be disabled.		

Write protection	0x00FF	Write	Y
		Read	N
Description	Write protection disabler for a set value to a specific register.		
Value type	UINT 16, Fixed value 0xAA55		
Notes	This function is enabled at the time of meter shipment. To enable the write function of a specific parameter, such as offset calibration, reset accumulated flow rate, or reset the timer, the user needs to send 0xAA55 to the register 0x00FF, and then the write function will be enabled (write protection is disabled). After the write execution is completed, the firmware will automatically re-enable the write protection.		

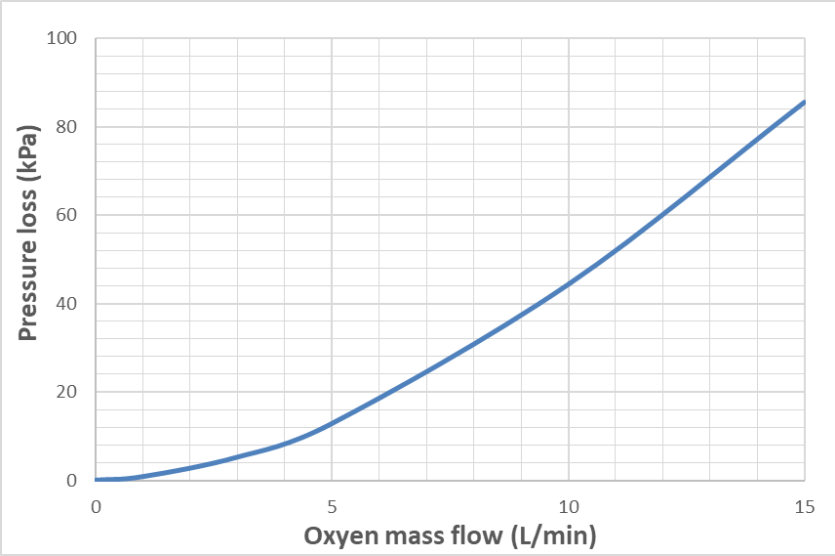
6. Technical specifications

6.1 Specifications

Unless otherwise noted, all specifications listed in the following table apply for calibration conditions at 20°C and 101.325 kPa absolute pressure with air. The meter is horizontally mounted during calibration.

	Value	Unit
Flow range	0.3 ~ 15	L/min
Accuracy	±2.0	%FS
Repeatability	0.5	%FS
Response time	<2.0 (on battery)	sec
Power supply	3-AA rechargeable batteries / 8 ~ 24 Vdc	
Digital output	RS485 Modbus	
Wireless output	LoRaWAN	
Display	LCD	
Flow resolution	0.01 L/min (instant) / 0.001 m ³ (accumulated)	
Timer resolution	1 min	
Working temperature	-5 ~ +40	°C
Working pressure	<0.5	MPa
Working humidity	<95%RH, no condensation	
Working altitude	-400 ~ +4000 (62 ~ 106)	m (kPa)
Storage temperature	-20 ~ +70	°C
Storage humidity	20 ~ 75	%RH
Storage pressure	62 ~ 106	kPa
Maximum overflow	50	L/min
Maximum flow change	15	L/min/sec
Pressure loss	44.3 (@10 SLPM)	kPa
Power consumption	>60 (on batteries)	day
Reference conditions	20°C, 101.325 kPa, air	
Power/data interface	USB Type-C	
Mechanical connection	DISS or customer specified	
Fluid compatibility	Oxygen	
Protection	IP50	

6.2 Pressure loss



The pressure loss is measured at about 400 kPa working pressure, and oxygen flow.

Flow (L/min)	Pressure loss (kPa)
0.0	0.0
1.0	0.8
3.0	5.2
5.0	12.8
10.0	44.3
15.0	85.6

6.3 Wetted materials and compatibility

The product flow channel is made of medical-grade oxygen-compatible copper. Flow conditioner is made of Acrylonitrile Butadiene Styrene (ABS). The sensing element comprises silicon, silicon nitride, and silicon dioxide. The sensor chip surfaces are passivated with silicon nitride and silicon dioxide. The electronic sealing is provided by LOCTITE Ablestik 84-3J. Another wetted material that may be exposed is FR-4.

7. Technical notes for the product performance

7.1 Measurement principle

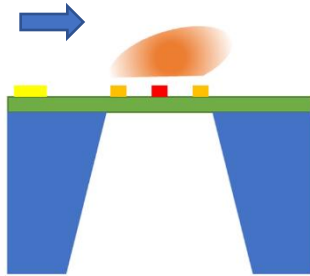


Figure 8.1: Measurement approach illustration.

The products utilize the Company's proprietary micro-machined (MEMS) thermal calorimetric sensing technology. A thermal signal generator (microheater) is made on a thermally isolated membrane. Two thermistors are placed symmetrically with respect to the micro heater. The flowing fluid carries away the heat from the microheater, causing a redistribution of the temperature field registered by the thermistors. The amount of heat carried by the flowing fluid depends on the fluid's mass and thermal properties. By precisely gauging the change in the temperature field with a metrological reference standard, the fluid's mass flow rate can be established and reproduced.

After the circuitry temperature compensation and with the proper design of the MEMS sensing chip by adding the pressure balancer that allows the flatness of the membrane at various fluidic pressure conditions, the calorimetric thermal sensing will guarantee a pressure and temperature-independent mass flow data acquisition. The MEMS technology also allows the mass production of the sensing elements, significantly reducing the cost compared to a traditional thermal mass flow sensing element. It enables the current offer to provide superior value to users. For additional information, please refer to the Company's US patents and other publications made available to the public.

7.2 Comparison with a third-party reference meter

Commonly, a user may compare the data from the product with a third-party reference meter, and in many cases, there could be some discrepancies.

It should be noted that the current sensing technology is a mass flow independent of oxygen pressure and temperature changes. In contrast, the commonly used oxygen flow meter is a variable-area technology that is not directly associated with the mass metering approach. The discrepancy could exist in the direct comparison.

When performing a comparison, please note that the reference meter should have a better-specified accuracy (about 1/3 of the product), and pay special attention to the differences in the reading accuracy and full-scale accuracy.

A full-scale accuracy = reading accuracy x (full-scale flow rate/ set point (current) flow rate)

Another critical point to comparing the different flow meters is that as long as the fluidic flow is a continuous flow without pulsation, then the fluid dynamics will have the system following the Bernoulli equation:

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho gh_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho gh_2$$

Where ρ is the fluid density, g is the acceleration due to gravity, P_1 is the pressure of the reference meter, P_2 is the pressure at the test meter, v_1 is the velocity of the reference meter, and v_2 is the velocity of the test meter. h_1 and h_2 are the corresponding heights for the meters, which are generally the same in the system. Therefore, it would be critical to design the system to prevent pressure variation. (This explains our recommendations for the installations in Section 4). Also, the meter measurement principle is often very important for understanding any discrepancies.

8. Troubleshooting

Phenomena	Possible causes	Actions
No signal/display	The power is not connected; the battery is empty	Connect the power, check the cable
	Cable connection incorrect	Check the cable.
	No flow or clogging	Check flow and contamination
	Power regulator failure	Return to the factory.
	Sensor failure	Return to the factory.
Significant errors or unexpected flow rate	Particles, fluid type	Check the system.
Erroneous or large noise	Vibration, unstable flow	Check the system.
Offset unstable	Circuitry instability	Check the system, power off
No digital interface	Wrong address, software	Check commands, connection
No wireless	Wrong model, data jam	Check model, power off/on

9. Maintenance

State-of-the-art product maintenance includes corrective, preventive, and predictive maintenance. This section will only address corrective and preventive maintenance, or the recommendations for the checklist before use and periodic services. The other maintenance tasks are irrelevant to this product, and this product is not for tariff or custody transfer. Therefore, metrology maintenance will not be addressed as well.

The correct maintenance of a mass flow meter is essential for its performance. For the specific applications of this product, the application environment is very friendly, as the medical oxygen is usually dry and clean. The product is designed for reliability and robustness, with minimal maintenance requirements throughout its lifetime. This includes precautions for expected mechanical degradation, such as the connectors.

Corrective maintenance

Corrective maintenance must be performed by personnel with basic training in the product and who have essential knowledge of a mass flow meter. Refer to the troubleshooting and actions listed in Section 8 for the corrective maintenance. The manufacturer will provide circuit schematic diagrams, BOM, maintenance instructions, and calibration instructions to the service personnel for repairing components.

For any doubt, please get in touch with the sales representative or the factory directly to avoid further damage to the product.

Preventive maintenance

Since the application of this product is for medical oxygen therapy, precautionary or preventive maintenance is very important to ensure the product is working correctly at the time of usage. The following recommendations are the primary preventive maintenance of this product. It should be performed from time to time and whenever it is deemed necessary. The frequency is dependent on the usage.

- a) Cleanliness maintenance: keeping the flow meter in a clean and contamination-free container after each use is recommended. Use a clean, damp cloth with mild solutions to clean the outside of the product. Do not use pungent hydrocarbons.
- b) Never submerge the product in any liquid that may cause irrecoverable damage.
- c) Inspect the flow channel connectors, and make sure no foreign materials or particles.
- d) Check the mechanical valve to ensure it runs smoothly and can effectively adjust the flow rate.
- e) Check any leakage by closing all valves and reading the flow rate from the display. The reading should be zero. If any flow rate is present, check leakage from all connections with a soap bubble approach or other practical approaches. If no leakage is observed with all closed

valves, release the regulator valve if the oxygen is supplied by a gas cylinder, and check the control valve leakage. If the leakage is present after excluding the connector leakage, send the meter back to the factory.

- f) For the wall plug models, frequently plugging in and out of the connectors may create some mechanical wear. As the oxygen is supplied under pressure, it is a preventive precaution to change the connectors if any leakage is identified from the connector or by consulting the lifetime of the connectors from its manufacturer. Please make sure the connectors are for oxygen gas before they are exchanged.
- g) For battery models, check the battery status before use, and make sure the battery life is sufficient. Use only batteries with safety features and batteries with an expiration date. If external power is used while the batteries or rechargeable batteries are installed, periodically check the battery status to ensure it is clean and has no abnormal appearance.
- h) Please refer to the troubleshooting section or consult the manufacturer for any other abnormal observations.
- i) It is recommended to check the essential meter functions, including the metrology performance and wireless data rate, every twelve (12) months.
- j) Considering the current oxygen meter lifetime regulatory observation, send the meter back to the factory for service or complete functional and metrological verification.

10. Waste/Residues and End-of-Life Disposal

The handling methods of waste and residues during the use of medical equipment are as follows:

- a) Medical waste and residues should be classified and collected in accordance with relevant regulations. Different types of waste, such as infectious waste, sharp objects, and general waste, need to be placed in separate containers.
- b) Special attention should be paid to the handling of infectious waste to prevent the spread of diseases. It is usually required to be sterilized or disinfected before disposal.
- c) Chemical residues should be dealt with in compliance with environmental protection standards to avoid pollution.

For the disposal of medical equipment and its accessories at the end of their service life:

- a) They should be dismantled appropriately and separated based on the types of materials.
- b) Components that can be recycled should be sent for recycling.
- c) Equipment that cannot be recycled should be disposed of in an environmentally friendly manner in accordance with local regulations and standards.

11. Warranty and Liability

(Effective January 2018)

Siargo warrants that the products sold hereunder will be used appropriately and installed correctly under normal circumstances and service conditions. As described in this user manual, it shall be free from faulty materials or workmanship for 180 days for OEM products and 365 days for non-OEM products from the date of shipment. This warranty period is inclusive of any statutory warranty, and any repair or replacement of a serviced product shall bear the same terms in this warranty.

Siargo makes no warranty, representation, or guarantee and shall not assume any liability regarding the suitability of the products described in this manual for any purposes that are not specified in this manual. The users shall be held fully responsible for validating the performance and suitability of the products for their particular design and applications. For any misuse of the products out of the scope described herein, the user shall indemnify and hold Siargo and its officers, employees, subsidiaries, affiliates, and sales channels harmless against all claims, costs, damages, and expenses or reasonable attorney fees from direct or indirect sources.

Siargo makes no other warranty, express or implied, and assumes no liability for any special or incidental damage or charges, including but not limited to any damages or charges due to installation, dismantling, reinstallation, etc., or consequential or indirect damages of any kind. To the extent permitted by law, the exclusive remedy of the user or purchaser, and the limit of Siargo's liability for any and all losses, injuries, or damages concerning the products, including claims based on contract, negligence, tort, strict liability, or otherwise shall be the return of products to Siargo, and upon verification of Siargo to prove to be defective, at its sole option, to refund, repair or replacement of the products. Regardless of form, no action may be brought against Siargo more than 365 days after a cause of action has accrued. The products returned under warranty to Siargo shall be at the user or purchaser's risk of loss and will be returned, if at all, at Siargo's risk of loss. Purchasers or users are deemed to have accepted this limitation of warranty and liability, which contains the complete and exclusive limited warranty of Siargo. It shall not be amended, modified, or its terms waived except by Siargo's sole action.

This manual's product information is believed to be accurate and reliable at the time of release or when made available to the users. However, Siargo shall assume no responsibility for any inaccuracies and/or errors and reserves the right to make changes without further notice for the relevant information herein.

This warranty is subject to the following exclusions:

- (1) Products that have been altered, modified, or have been subject to unusual physical or electrical circumstances, as indicated, but not limited to those stated in this document or any other actions which cannot be deemed as proper use of the products;

- (2) Products that have been subject to chemical attacks, including exposure to corrosive substances or contaminants. In the case of battery usage, long-term discharge, or leakage-induced damage;
- (3) Products that have been opened or dismantled for whatever reason;
- (4) Products that have been subject to working conditions beyond the technical specification as described by this manual or related datasheet published by the manufacturer;
- (5) Any damages incurred by the incorrect usage of the products;
- (6) Siargo does not provide any warranty on finished goods manufactured by others. Only the original manufacturer's warranty applies.
- (7) Products that unauthorized dealers or any third parties resell.

12. Service/order contact and other information

Siargo Ltd. is making every effort to ensure the quality of its products. For questions or product support, please get in touch with your direct sales representative. If you need additional assistance, please reach out to customer service at the address listed below. We will respond to your request in a timely fashion and work with you toward your complete satisfaction.

For sales or product orders, please get in touch with the local sales representatives or distributors listed on the Company's webpage: www.Siargo.com.

For any returns, please get in touch with your direct sales representative to obtain an RMA. If you require further assistance, please get in touch with info@siargo.com for additional information or a Return Materials Authorization (RMA) before returning the product to the factory for servicing, including calibration. Please specify in your email message that you intend to return the product to the factory and include your shipping address. Be sure to write the RMA on the returned package or have a letter with the RMA information.

Direct customer service request(s) should be addressed to

Siargo (Chengdu) Ltd.
Building 4, No.1-the 2nd South Science Park Road,
Chengdu City 610041, Sichuan Province,
P. R. China
Tel: +86-28-85139315
Email: Info@Siargo.com

For further information and updates, please visit www.Siargo.com.

Appendix I: LoRaWAN connection

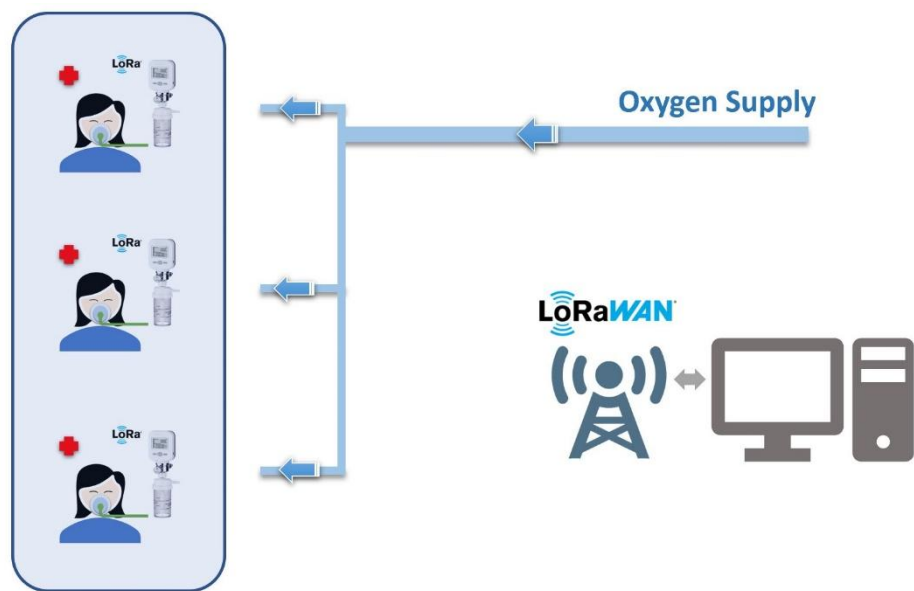


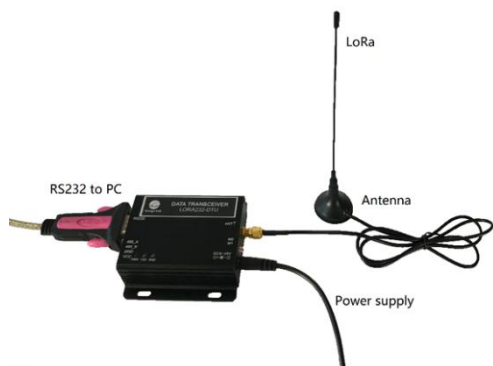
Figure A1: LoRaWAN data system for hospital oxygen delivery.

LoRaWAN provides wireless data transmission with the best data safety, while the data transmission distance is also excellent for this application. For most applications, the data is accessible within the base station. Each oxygen flow meter has a unique address that can be registered with the station, and the remote control is fully enabled.

The advantage of the LoRaWAN data transmission is that it does not require additional or third-party wireless data service providers. Therefore, the system maintains all data within its network, and the user will not be concerned about data safety or system downtime. Any IT personnel could set up and keep the network for regular usage.

LoRaWAN Information

- Frequency band EU863-870MHz ISM Band;
- Modulation mode: LoRa;
- Bandwidth: 125;
- Recommended channels: 868.1, 868.3, and 868.5.
- Effective radiated power: 24 dB.
- Frequency characteristics: good penetration ability and stable transmission.



The optional base station requires a Microsoft Windows 8+ compatible computer with a USB port.

Users can directly plug the station into the computer's USB port, connect the power adapter provided, and place the antenna in an open space without excessive blockage. With the demo software supplied, users can plug and play.

Appendix II: Firmware history

Revision Vo.1.1.9 (January 2024)

- Corrected algorithms for the inaccurate timer.

Revision Vo.1.0.9 (May 2022)

- Added LoRaWAN auto data sending.

Revision Vo.1.1.3 (November 2021)

- Added battery charging status.

Appendix III: Document history

Revision VA.3.01 (August 2025)

- Corrections.

Revision VA.3 (November 2024)

- Revised the reminders.

Revision VA.2 (September 2024)

- Removed the oxygen supply plug.
- Corrections.

Revision VA.1.02 (December 2023)

- Minor corrections.

Revision VA.1.01 (June 2023)

- Updated contact address.

Revision VA.1 (December 2022)

- Added maintenance section.

Revision VA.0.02 (August 2022)

- Added the pressure loss data; added battery power options.

Revision VA.0.01 (July 2022)

- Updated service contract information.

Revision VA.0 (February 2022)

- First released.