TACTICAL FLOWMETER

Tactical Flow Meter
22642 Indian Springs Road
Salinas, CA 93908
email: Dave@TacticalFlowMeter.com

**Call (831) 455-0418
Pacific Time**

Quick User Manual

Low Flow Battery Powered Mass Flow Meters

TacticalFlowMeter.com

MF5100 Series USER MANUAL   **Rev 9.0**

Web Page QR Code

CE

Low Flow Battery Powered Mass Flow Meter

MF5100 Series

User Manual

Document No.   09-2020-07
Issue date: Sept 1, 2020
Revision: V8

TFM | TACTICAL FLOWMETER

Tactical Flow Meter
22642 Indian Springs Road
Salinas, CA 93908
email: Dave@TacticalFlowMeter.com

Call (831) 455-0418
Pacific Time

RESTRICTIONS ON USE

1. This meter is manufactured for general purpose industrial applications for flow measurements. Do not alter any hardware and software of the product. Any modifications might cause damage and unexpected events.

2. All practices for electronic device safety should apply.

3. Do not use this product in any environments where human safety may be at risk.

4. Only a qualified person from Tactical Flow Meter or a person who is accredited by Tactical Flow Meter can perform troubleshooting services to the product, Tactical Flow Meter is otherwise not liable for any consequences thereafter.

⚠ SAFETY PRECAUTIONS

1. The product can be utilized to measure and/or monitor in-line mass flow rate of any clean, dry and preferably constant concentration gases in industrial applications. For other special gases or variable concentration gases, the product may not function properly or even can be damaged. Please contact Siargo for further information.

2. The operational environments of the product are illustrated in the section of product specifications. If the product is used for other circumstances, the product may not function properly or even can be damaged.

3. Operation, installation, storage, and maintenance of the product must strictly follow the instructions illustrated in this user manual. Otherwise, unpredicted damage and even injuries or other severe situations could be induced. All the installation, storage, and maintenance of the product must be performed by skilled workers. This user manual should be placed near the product for easy access.

4. Before using the product, the user should read this user manual completely and in details so that the user is well understand all the important instructions.

   It is recommended that the product should be re‑calibrated and serviced in every two years or at a time of desire.

Low Flow Mass Flow Meter

MF5100 Series

This product is designed with the Company's proprietary stat-of-the -art MEMS mass flow sensing technology with the limited gas automatic recognition capability and battery power option as well as an extended large dynamic range with high accuracy. It provides varieties of output options with further customization available.

Specifications

Model	MF5106	MF5108	MF5110	MF5112	MF5119	
Flow range	0 - 30	0 - 50	0 -100	0 -300	0 -800	SLPM
Accuracy [1]			± 1.5			%Reading
Repeatability			± 0.5			%Reading
Turn-down ratio			100:1			
Initial flow reading	0.01	0.01	0.01	0.05	0.05	SLPM
Response time [2]			250			msec
Pressure rating [3]			0 ~ 1.0			MPa
Working temperature			−10 - +55			$^{\circ}$C
Humidity			<95			%RH
Storage temperature			−10 - +65			$^{\circ}$C
Long term stability			<1.0			%Reading/year
Wetted materials		Stainless steel, silicon nitride				
Power supply		D cell lithium ion battery				
Battery life		>2 years				
Output		Instant/Accumulated flow (LCD), Pulse for instant flow (3V) RS485 (Modbus) with 12 - 24Vdc ext power 4 -20 mA and 0 -5Vdc analog output with 12 - 24Vdc ext power				
Calibration [4]		Air @ 20°C; 101.325 kPa, 29.92 In Hg, 760 mmHg				
Flow Threaded connection [5]		3/8", 1/2", or 3/4 NPT Male See below				
Weight	2.2 Lb, 1 Kg					
Dimensions	5.12 [132](L)x 1.61 [41](W)x 5.28 [134] (H)					in [mm]
Maximum Overflow	100	200	300	450	1200	SLPM
Maximum Flow Change	15	30	45	60	150	SLPM/sec

1, $\pm$1%Reading requires special calibration;
2, Response time of 250 msec with 12~24Vdc ext power supply;
3, Proof pressure: 1.2 MPa, burst pressure: 1.5 MPa;
4, Other calibration conditions are available upon request;
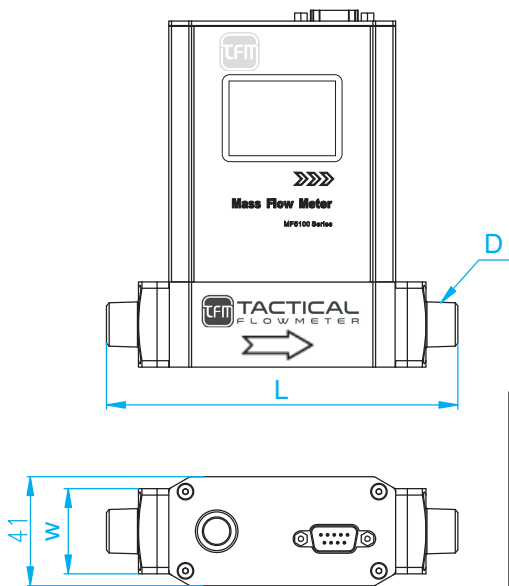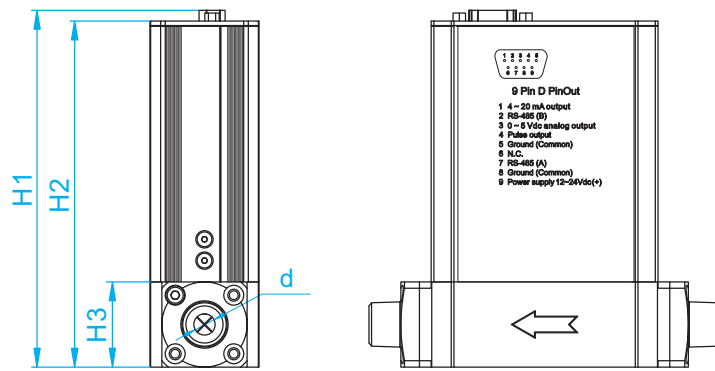5, Other mechanical threads available.

Dimensions and Descriptions

9 Pin D PinOut
1 4 ~ 20 mA output
2 RS-485 (B)
3 0 ~ 5 Vdc analog output
4 Pulse output
5 Ground (Common)
6 N.C.
7 RS-485 (A)
8 Ground (Common)
9 Power supply 12~24Vdc(+)

Fig-1

Model	D	L	H1	H2	H3	W	d
MF5106	NPT- M 3/8"	132	134	130	32	32	Φ3
MF5108	NPT- M 3/8"	132	134	130	32	32	Φ6
MF5110	NPT- M 3/8"	132	134	130	32	32	Φ8
MF5112	NPT- M 1/2"	150	142	138	40	40	Φ12
MF5119	NPT- M 3/4"	182	142	138	40	40	Φ19

Fig-1a

Model	D	L"	H1"	H2"	H3"	W"	d"
MF5106	NPT- M 3/8"	5.12	5.27	5.11	1.26	1.26	Φ. 12
MF5108	NPT- M 3/8"	5.12	5.27	5.11	1.26	1.26	Φ. 23
MF5110	NPT- M 3/8"	5.12	5.27	5.11	1.26	1.26	Φ. 31
MF5112	NPT- M 1/2"	5.91	5.59	5.43	1.58	1.58	Φ.47
MF5119	NPT- M 3/4"	7.17	5.59	5.43	1.58	1.58	Φ.75

Figure-1&1a Mechanical dimensions in mm and inches (D is in Male NPT Specs)

Power switch

Digital output with external power option

Display： instant flow and Total flow

3/8" NP T connector

Figure-2   Description of basic functions

Operation and Communication

Cable Nomenclature

The electrical interfaces are defined as Figure-3:

Pin	Definition	Color
1	4~20mA output	Purple
2	RS485(B)	Brown
3	0~5Vdc analog output	Colorless
4	Pulse output	Yellow
5	Ground (Common)	White
6	N.C.	N.C.
7	RS485 (A)	Green
8	Ground (Common)	Black
9	Power supply (+)	Red

User Interface DB-9 (Male)
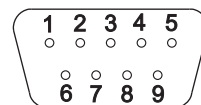
Figure-3 User Interface

LCD Display
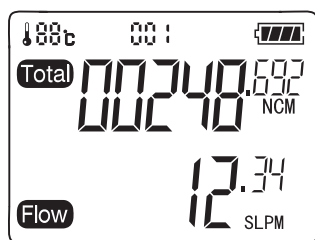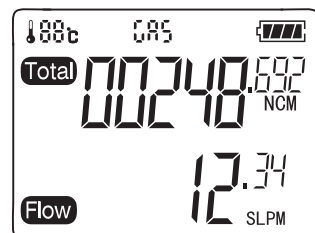

Figure-4 Display

Figure-5 Gas identification

Displayed information includes instant flow, accumulated flow, temperature, meter address (or GAS) and battery status; See Figure-4 and Figure-5 for details.

a. Temperature: current temperature;

b. Meter address: current address. When other gas was identified, "GAS" will be shown instead of meter address;

c. Battery status: when battery display turns into , the battery should be changed immediately or switch to external power;

d. The unit for totalized or accumulated flow: NCM (normal cubic meters per minute);

e. The unit for instant flow: SLPM (standard liter per minute).

RS485 (Modbus) Communication

For purposes of computer control and networking, the RS485 is used for communication with the following settings(an external power supply is required.):

Baud rate (Bits per second):	9600
Date bits:	8;
Stop bits:	1;
Parity:	None;
Flow control	None;

4~20mA Output

For customers using 4-20mA output, an external power supply is required. The connection of the loop load resistor is illustrated as Figure-6: R_L（max）=850Ω (24Vdc power supply)
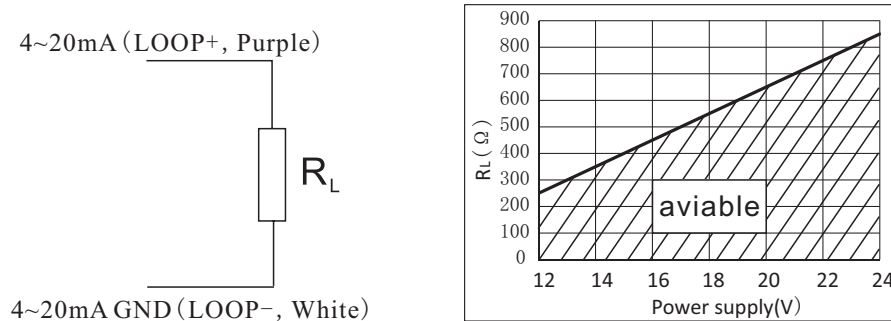

Figure-6 4-20mA External Connection

0~5Vdc Analog Output

For customers using 0~5Vdc output, an external power supply is required. The connection to the analog output is illustrated as Figure-7. The 0-5 is not available with the battery power alone.
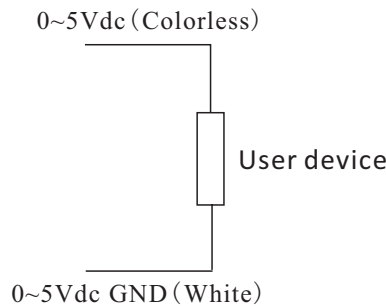

Figure-7 0-5Vdc External Connection

Pulse Output

The pulse output is in the form of even square wave that is comprised of 3V signal high and 0V signal low（Figure-8）, and each pulse can be programmed to 0.1 SmL, 1 SmL, 10 SmL, 100 SmL or 1 SL, respectively. (default is 10 SmL) .
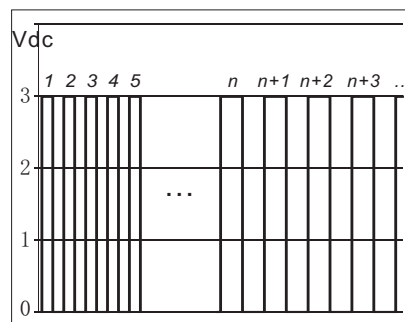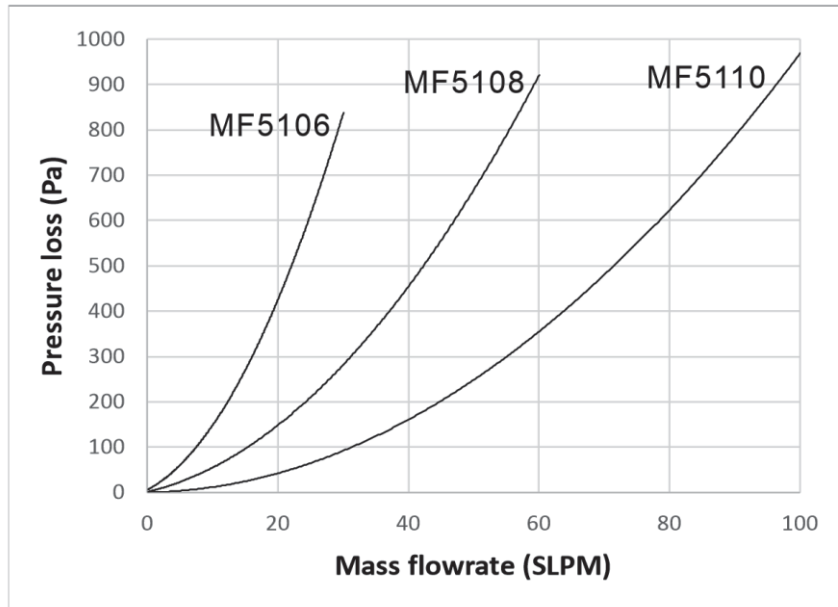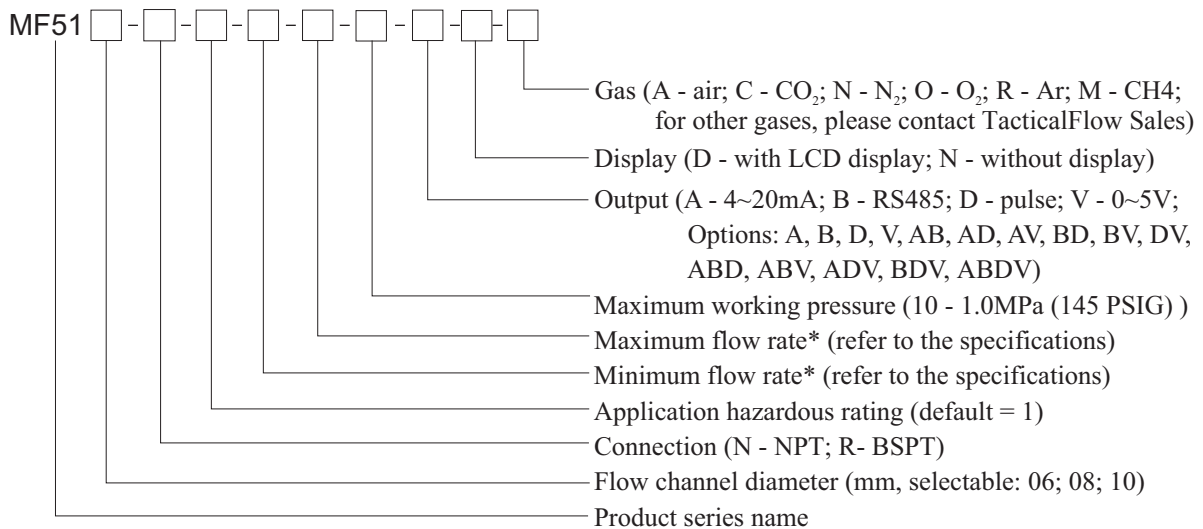

Figure-8 Square wave of total or accumulated flow

Pressure loss

Models and Selection

Standard Model Number format. Custom meters available, Inquire Tactical Flow Sales.

MF51☐ – ☐ – ☐ – ☐ – ☐ – ☐ – ☐ – ☐ – ☐

Gas (A - air; C - CO_2; N - N_2; O - O_2; R - Ar; M - CH4;
    for other gases, please contact TacticalFlow Sales)

Display (D - with LCD display; N - without display)

Output (A - 4~20mA; B - RS485; D - pulse; V - 0~5V;
    Options: A, B, D, V, AB, AD, AV, BD, BV, DV,
    ABD, ABV, ADV, BDV, ABDV)

Maximum working pressure (10 - 1.0MPa (145 PSIG))

Maximum flow rate* (refer to the specifications)

Minimum flow rate* (refer to the specifications)

Application hazardous rating (default = 1)

Connection (N - NPT; R- BSPT)

Flow channel diameter (mm, selectable: 06; 08; 10)

Product series name

* The flowrate is set to be in SLPM. If other unit is desired, please contact the manufacturer.

Installation Instructions

Installation

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

Do not alter any part of the product. Any such actions will forfeit the terms of the warranty an d cause the liability to any damages thereafter.

The product is preferably to be installed horizontally. Flow direction should be aligned with the arrow mark on the meter body. If the flow fluid may have particles or debris, a filter (e.g. 0.1μm) is strongly recommended to be installed upstream of the meter.

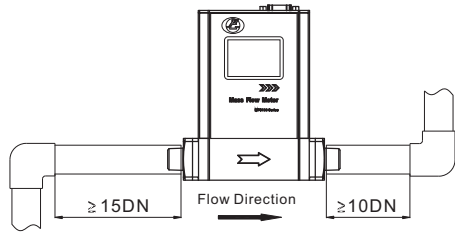Please follow the following steps to complete the installation:

a) Upon opening the package, the product physical integrity should be inspected to ensure no visual damage;

b) Before installation of the product, please ensure that the pipe debris or particles or any other foreign materials are completed removed;

c) Cautions during installation:

(I) The upstream straight pipe and downstream straight pipe should have same inner diameters with the MF5100 meter, see detailed dimensions in section *Dimensions and Descriptions*.
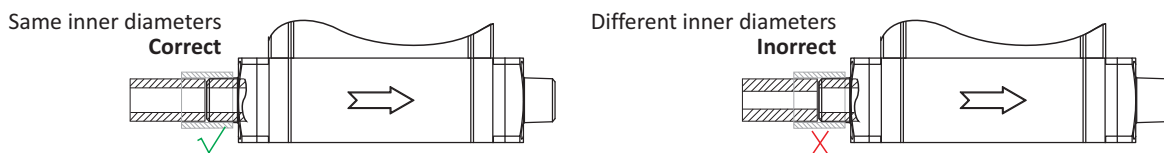
(ii) It is preferably to first install the inlet end of the meter and then the outlet end of the meter; To ensure the measurement accuracy, an upstream straight pipe of length no less than 10DN and a downstream straight pipe of length no less than 5DN should be in place;
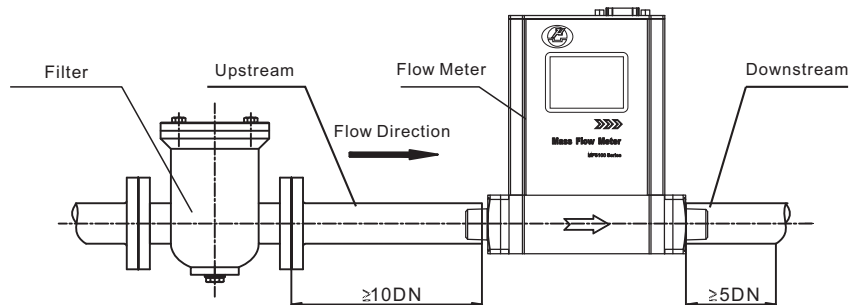
(iii) If there is requirement of different pipe size at either upstream or downstream, the size of the pipe diameters should be larger than that of the selected meters. Please see details below:

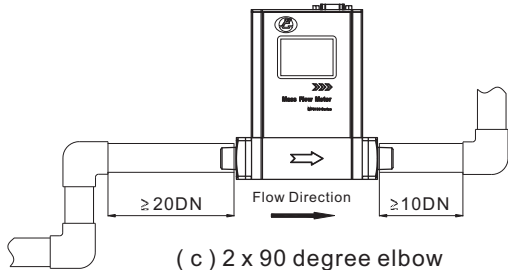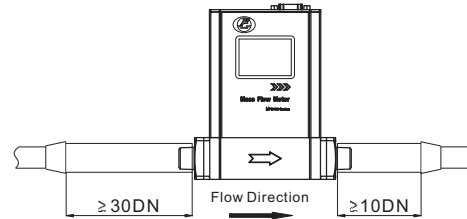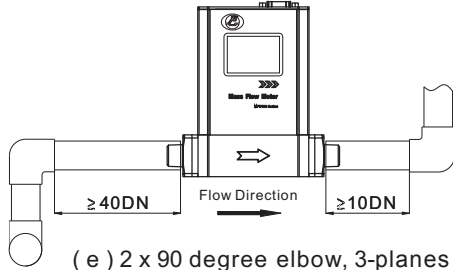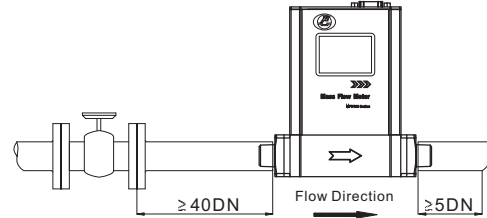(a) 90 degree elbow or T-piece   (b) Reduction
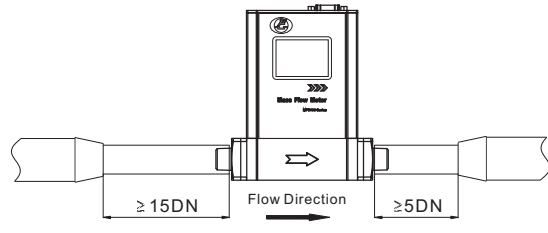
≥ 15DN   Flow Direction   ≥10DN   ≥ 15DN   Flow Direction   ≥5DN

(c) 2 x 90 degree elbow   (d) Expansion

≥ 20DN   Flow Direction   ≥10DN   ≥ 30DN   Flow Direction   ≥10DN

(e) 2 x 90 degree elbow, 3-planes   (f) Control valve

≥ 40DN   Flow Direction   ≥10DN   ≥ 40DN   Flow Direction   ≥5DN

(iv) During installation, please make sure no any foreign materials (such as water, oil, dirty, particles, etc.) are permitted to enter the flow meter or pipe;

d) Connect electrical wires for LCD, and then electrical wires for inputs/outputs. Please pay special attention to power supply range (+12~+24 VDC) and power supply polarization (see the description on Electrical Interfaces in this manual);

e) When connecting the communication wires, please make sure that the wires are correctly connected to the proper ports on your data device/equipment;

f) Turn on the power supply, and make sure that the LCD works correctly;

g) Slowly open the valves at the both ends of the pipeline, and the meter should then start to measure the flow in the pipeline;

h) Completion of the installation.

Precaution s and notices

a) Welding the pipe while the meter is installed is prohibited;

b) Any foreign materials in the pipeline after installation may cause irreversible damage;

c) Seal gaskets must not block flow channel otherwise accuracy cannot be met;

d) The meter should be properly safety grounded via the electrical connection;

e) After installation, severe force applied to the meter may cause damage;

f) Severe vibration or very strong magnetic field may cause meter malfunctions.

Important Notices

Wetted Materials and Compatibility

The meter body is made of stainless steel (SUS304). The sensor chip comprises of silicon, silicon nitride and silicon dioxide and the sensor chip surfaces are passivated with silicon nitride and silicon dioxide. The electronic sealing is provided by RTV (room temperature vulcanizing) epoxy. Other wetted materials may be exposed are Pyrex glass, alumina ceramics, gold, aluminum, nickel, FR-4, Pb-free solder.

Cautions for Handling and Installations

The product at the time of shipment is fully inspected for product quality and meets all safety requirements. Additional safety measures during handling and installation should be applied. To prevent ESD (electrostatic discharge) damage and /or degradation, take customary and statutory ESD precautions when handling. Please power the product with the correct polarity, voltage & amperage. All precautions and measures for electrical voltage handling must apply. The product sealing is ensured to work under working pressure as specified and is leakage proof before the shipment. But cautions and further leakage test are important at installation as well since any leakage could cause severe safety issue.

This product contains no user serviceable components. Do not attempt to disassemble, substitute parts or perform unauthorized modifications to the product. Doing so will forfeit the terms of the warranty and cause the liability to any damages thereafter. It should only be serviced by authorized personnel. Upon requests, Siargo will provide necessary technical support and/or training of the personnel.

Cautions for Product Applications

The product is designed for use with general purpose gases such as air and nitrogen. It is advised that the products are best used for non-corrosive clean gases. The sensors cannot be used for gas metrology of fluoride or fluoride-containing gases. For updates of the product certification information, please contact the manufacturer. Use for other medium such as corrosive and toxic gases may cause the product malfunctioning or even severe damages.

Don't expose the product's electronics other than the inner flow channel to any liquids, the unit does not have a water proof electronics. For medical sterilization procedure, please consult the manufacturer. Don't flow gas in conditions that can cause condensing water vapor to be trapped inside the unit during operation as the accuracy could be significantly influenced.

It is suggested to design your application so that nominal flow rate is approximately 70% of the full scale specified. Don't use a sensor with a flow range at the extreme cases, for instance, don't use a 200 SLPM sensor for a 2 SLPM application.

Warranty and Liability

(Effective January 2010)

TacticalFlowMeters,TFM, warrant the products sold hereunder, properly used and properly installed under normal circumstances and service as described in this user manual, 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. Any repair or replacement serviced product shall bear the same terms in the warranty.

TFM makes no warranty, representation, or guarantee and shall not assume any liability regarding the suitability of the products de scribed in this manual for any purposes that are not specified in this manual. The user shall be held for full responsibility for validating the performance and suitability of the products for their particular design and applica tions. For any of the misusage of the products out of the scope described herein, the user shall id emnify and hold TFM and its officers, employees, subsidiaries,

affiliates and sales channels harmless against all claims, costs, damages, and expense or reasonable attorney fee from direct or indirect sources.

TFM 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 or any other 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 TFM's liability for any and all losses, injuries or damages concerning the products including claims based on contract, negligence, tort, strictly liability or otherwise shall be the return of products to TFM, and upon verification of TFM to prove to be defective, at its sole option, to refund, repair or replacement of the products. No action, regardless of form, may be brought against Siargo more than 365 days after a cause of action has accrued. The products returned under warranty to TFM shall be at user or purchaser's risk of loss, and will be returned, if at all, at TFM'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, and it shall not be amended, modified or its terms waived except by Siargo's sole action.

The product information provided in this manual is believed to be accurate and reliable at the time of release to or made available to the users. However, TFM shall assume no responsibility for any inaccuracies and/or errors and reserves the rights 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 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) TFM does not provide any warranty on finished goods manufactured by others. Only the original manufacturer's warranty applies;

(3) Products re-sold to the third parties.

Customer Service and Order Information

Tactical Flow Meter nakes every effort to ensure the quality of the products. In case of questions, and or product supports, please contact customer service at the address listed below. We will respond your request in a timely fashion and will work with you toward your complete satisfaction.

Customer service and all orders should be addressed to

Headquarters

Tactical Flow Meter
22642 Indian Springs Road
Salinas, CA 93908
email: Dave@TacticalFlowMeter.com

Call (831) 455-0418
Pacific Time

For orders, please provide accurate and full shipping address. We will not ship to P.O. Boxes or via a third party.

For further information and updates, please visit **www.TacticalFlowMeter.com.**

Appendix I. Modbus RTU Protocol

1 Hardware connection

The MF5100 protocol is based on standard Modbus RTU mode. A master (PC or PLC) can communicate with several slaves (MF5100), setting parameter or getting data.

The hardware layer is TIA/EIA-485-A.

2 UART communication parameters

Table-A1   Modbus communication parameters

Communication parameter	Protocol
	RTU
Baud rate(Bits per second)	9600 bps
Start bits	1 bit
Data bits	8 bits
Stop bits	1 bits
Even/Odd parity	None
Bits period	104.2μs
Bytes period	1.1458ms (11 bits)
Maximum data length	20
Maximum node	247

3 Frame

The framing functions are in compliance with the standard Modbus RTU framing:

Start_bits	Address	Function code	Data	CRC	Stop_bits
T1-T2-T3-T4	8Bit	8Bit	N 8Bit (20≥n≥0)	16Bit	T1-T2-T3-T4

Start_bits: 4 periods bit time for a new frame.

Address: The address can be set to 0 to 247. 0 is the broadcast address.

Function code: Define the actions that MF5100 takes, or the code that MF5100 response.

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

CRC: CRC verification code where the low byte is followed by high byte. For example, the 16bit CRC code is divide as BYTE_H BYTE_L, in the frame, the BYTE_L comes first, then the BYTE_H, and finally comes the stop signal.

Stop_bits: 4 periods bit time that indicates the end of the current framing.

4 Function code

The MF5100 Modbus Function-code is a subclass of Standard Modbus Function-Code .By using these function codes, one can set or read the registers of the MF5100 Flow Meter.

The function codes are shown in Table A2:

Table A2 Modbus function code

0x03	Read register	int, char, float	Read one or more registers
0x06	Set single register	int, char, float	Write one signle 16bit register
0x08	CRC verification	int	Check the communication
0x16	Set multiple registers	int, char, float	Write multiple registers

5 Registers

The MF5100 series MEMS gas flow meter has several registers. The information (such as "address", "flowrate" etc.) can be obtained from reading these registers. And the parameters can be set by writing the codes into the registers.

Table A3 Summary of the registers

	Description	Registers
Address	The address of the meter (W/R)	0x0001
Flowrate	The instant flowrate (R)	0x0002, 0x0003
Totalized flowrate	The totalized flowrate (W/R)	0x0004,…0x0006
SN	Serial number of the meter (R)	0x0007,…0x000C
Maximum flowrate	Maximum flowrate setting (W/R)	0x000F,…0x0010
GC-gas	Gas identification function (R)	0x0011
K-factor	Gas conversion factor (W/R)	0x0012
GC_air	Gas identification for air (W/R)	0x0013
GC_threshold	Gas identification threshold factor (W/R)	0x0014
Pulse	Pulse for totalized flowrate (W/R)	0x0015
Write-protect	Write-protect for setting operation (W)	0x00FF

* W/R - write and read; R - read only.

Table A4 Descriptions of registers

| (1) Address	0x0001	WRITE	A
		READ	A
Description	The address of the flow meter		
Value type	Unsigned int		
Explanation	Values are from 1 to 247, and 0 is for the broadcast address only.		

(2) Flowrate	0x0002~0x0003	WRITE	N
		READ	A
Description	The instant flowrate		
Value type	Unsigned long int		
Explanation	Flowrate =(value(0x0002)*65536+value(0x0003))/1000 Example: If the LCD displays 20.34 SLPM, the data from Register 0x0002 and 0x0003 shall be "0" and "20340", respectively. Therefore, the current flowrate=(0*65536+20340)/1000=20.340		

(3) Totalizer	0x0004~0x0006	WRITE	A
		READ	A
Description	The totalized or accumulated flowrate		
Value type	Unsigned long int + Unsigned int		
Explanation	Totalized flowrate=value(0x0004)*65536+value(0x0005)+value(0x0006)/1000 Example: If the LCD displays 3452.245NCM, the data from Register 0x0004, 0x0005, and 0x0006 shall be "0", "3452" and "245", correspondingly. Therefore, the totalized flowrate=0*65536+3452+245/1000=3452.245		

(4) SN	0x0007~0x000C	WRITE	N
		READ	A
Description	The serial number		
Value type	Unsigned char (12bytes)		
Explanation	SN=value(0x0007), value(0x0008)…, value(0x000C). For the 12bytes data 2A 47 37 41 45 49 30 32 30 35 38 2A, the serial number of the product shall be *G7AEI02058*		

(5) Max. flowrate	0x000F~0x0010	WRITE	A
		READ	A
Description	Maximum flowrate setting		
Value type	Unsigned long int		
Explanation	Maximum flowrate=(value(0x000F)*65536+value(0x0010))/1000. Example: For maximum flowrate of 30SLPM, the data from Registers 0x000F and 0x0010 shall be "0" and "30000", respectively; To set the maximum flowrate of 20SLPM, the value of "0" and "20000" shall be write to the Register 0x000F and 0X0010, respectively.		

(6) GC_gas	0x0011	WRITE	N
		READ	A
Description	Gas identification index values		
Value type	Unsigned int		
Explanation	The default value is for air: 32768±200; For CH4, it is 35800±200; and for CO2 it is 29200±200. For other gases, please contact the manufacturer. This function shall enable the meter to automatically switch to the identified gas calibration if a different gas other than the default is identified via these values.		

(7) K-factor	0x0012	WRITE	A
		READ	A
Description	Gas conversion factor		
Value type	Unsigned int		
Explanation	The default value is 830, this factor is reserved for application of the CH4 even the gas identification is disabled.		

(8) GC_air	0x0013	WRITE	A
		READ	A
Description	Air identification index value		
Value type	Unsigned int		
Explanation	The default value is 32768±200. It may be altered when offset is changed.		

(9) GC_threshold	0x0014	WRITE	A
		READ	A
Description	Gas identification index value limit for different gases		
Value type	Unsigned int		
Explanation	The default value is 1000 with maximum value of 10000. If GC_gas≥GC_air+GC_threshold or GC_gas≤GC_air+GC_threshold, then Flowrate_gas=Flowrate_air*K/1000, and LCD will show "Gas" otherwise the meter address will be displayed. If the K-factor is set to be 1000, the calibration will be remained at the original calibration. When the GC_threshold is set to be 10000, the automatic gas identification function will be disabled.		

(10) Pulse	0x0015	WRITE	A
		READ	A
Description	Pulse settings for totalized flowrate		
Value type	Unsigned int		
Explanation	1=0.1mL; 10=1mL; 100=10mL; 1000=100mL; 10000=1000mL; The default value is 100.		

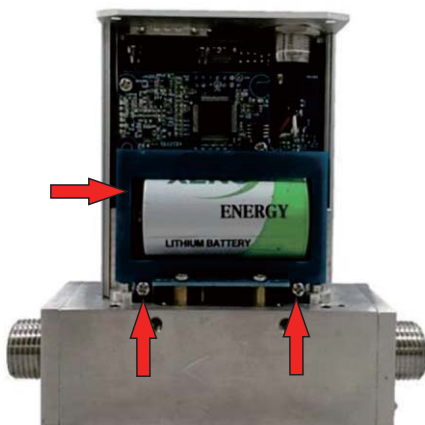| (11) Write-protect	0x00FF	WRITE	A
		READ	N
Description	Write-ptotect for all setting operation		
Value type	Unsigned int, fixed value 0xAA55		
Explanation	Example: When you want to set pulse to 100mL, you need to set fixed value 0xAA55 to register 0x00FF.		

Appendix II. Battery Access/Channging

1. Remove the screws as indicated.
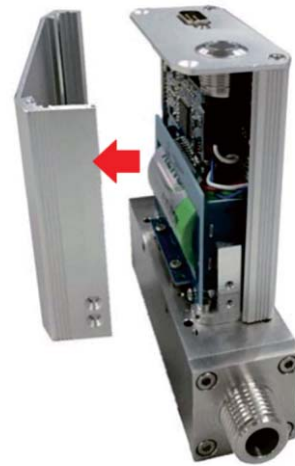
2. Remove the meter head cover.

3. Remove the screws and then change
   the battery.

Note: The battery is a D-cell 3.6V
       lithium ion battery; depending
       on the usage, the battery can
       have a lifetime over 3 years.

Appendix III. Revision History

Revision 8 (September 2020):

- ✎ Updated ModBus data to add Write Protect Reg FF