TFM 201 Series
Vortex Flowmeter

Quick User Manual

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Thanks for choosing our flowmeter products. Please read this manual carefully to learn how to install and use this product to ensure best performance.

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1 General

Each TFM201 vortex flowmeter is carefully inspected before delivery.

Please carefully check if there is any damage to the package or the product upon arrival.

Please check if the package contains all the accessories according to or your purchase order.

Please carefully read this manual and understand the operation prior to the use of the Vortex Meter.

1.1 Measuring principle:

Vortex flowmeter measures the flow by measuring the vortices, known as"Von Karman Vortex Street", shed from a shedder bar in the flow path, vortices are alternately shed on each side as shown in FIgure 1.2

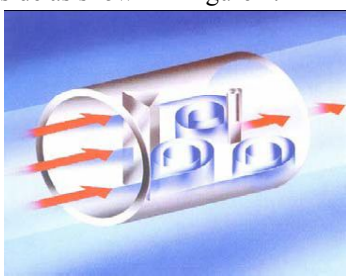


Figure 1.2 Von Karman vortices

The frequency of vortices (f) is directly proportional to the flow velocity (v) and in inverse ratio to the width of shedder bar, which is considered an obstacle of width (d).

$$f=St*v/d \quad \text{(formula 1)}$$

$$v=fd/St \quad \text{(formula 2)}$$

The Strouhal Number, St, is a dimensionless constant related to shape of the shedder bar, which is determined in the calibration process.

Because d and St are both contestants, the flow velocity (v) and average velocity (v0) have known relationships ($v0=v/(1-1.25d/D)$). We therefore measure the value v0 by measuring the simple vortex shedding frequency (f). With that value we can indicate the mass flow when we know the temperature and pressure of the fluid. The ratio between the quantity of vorticies shed in a certain period of time and the volume of the flow during that period is called the Instrument coefficient (K)

$K=N/V$ (formula 3)

TFM201 series digital vortex flowmeters are designed to provide the most reliable performance. The advanced circuitry uses signal isolation as well as self-diagnostic technology to remove sensitivity to external vibration sources. TFM201 series flow meters utilize digital spectrum analysis that allows the system to measure very low velocities compared to conventional Vortex meters. As well, this system utilizes advanced digital signal processing to remove the sensitivity to external vibration that could be transmitted along the installation piping system. This is accomplished using flow body vibration sensing circuitry

that allows the external vibrations to be measured and subtracted from the vortex shedding frequency. This system provides for an extremely stable reading even at very low velocities. TFM201 has an optional density calculation capability (Measuring pressure and temperature), which allows it to calculate the density and therefore the measure mass flow rate of air/saturated steam/superheated steam without secondary devices or pipe penetrations and thereby greatly reduces the total installed cost.

2 Installation

2.1 Select the Most Suitable Location

(1) Ambient temperature

Do not install the flowmeter in a location where the temperature dramatically changes over time. If the meter is in close proximity to any radiating source, please utilize effective radiative heat insulation as well as a cooling method, such as a fan.

(2) Atmosphere

Do not install the meter at a location with a high level of corrosive materials, such as H2S. If you cannot install the meter in an ideal location, ensure there is sufficient ventilation.

(3) Vibration

Do not install the meter in at a location where there is excessive vibration. If the mounting location has high vibration energy the pipeline should be held steady using a support racking system.

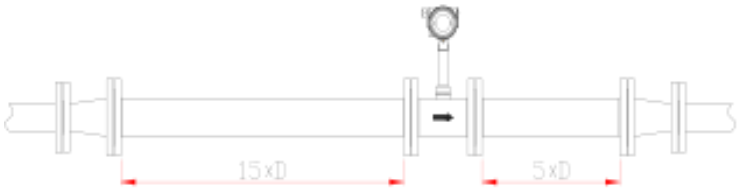
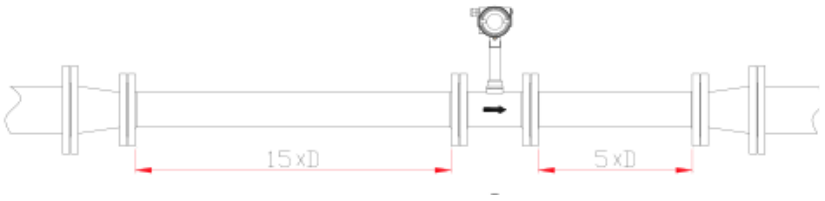
(4) Caution

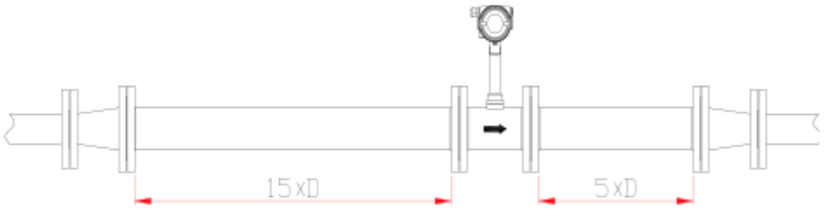
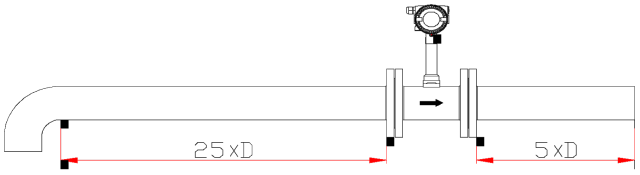
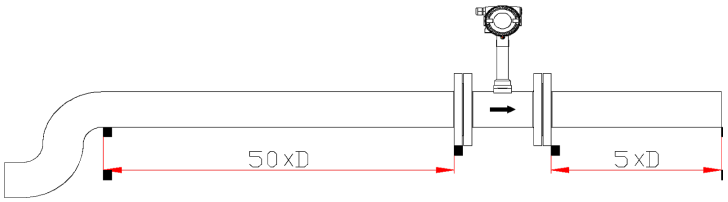
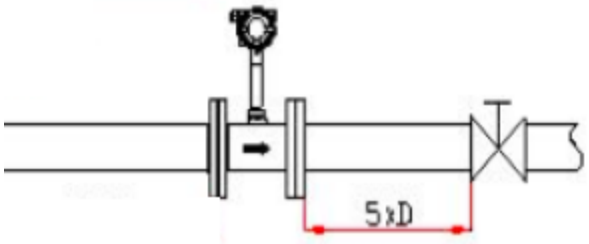
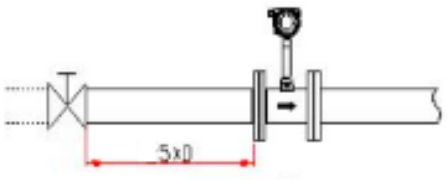
(a) All enclosure, screws, nuts, and bolts should be properly tightened before using the meter.

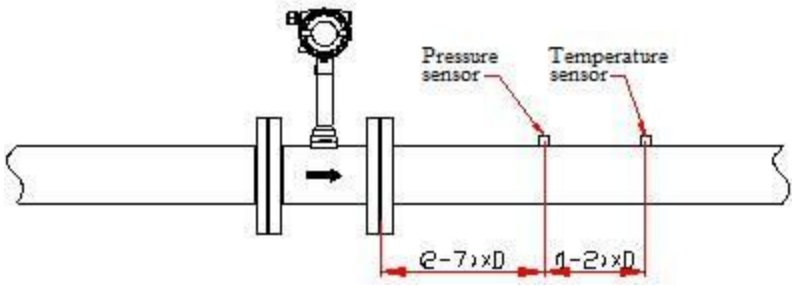
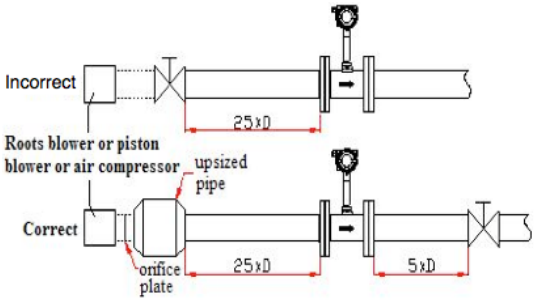
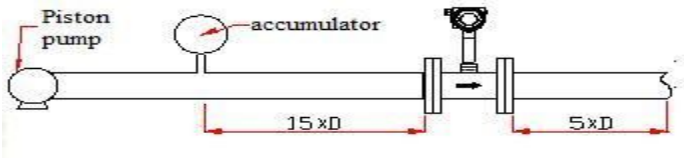
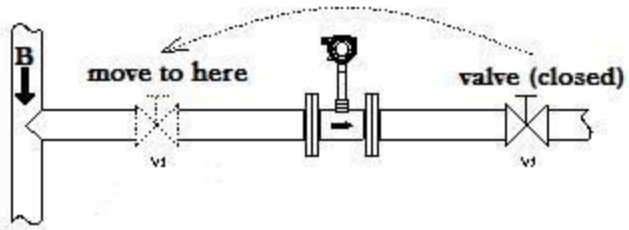
(b) Ensure there are no leaks in any of the connection points, including the electronics.

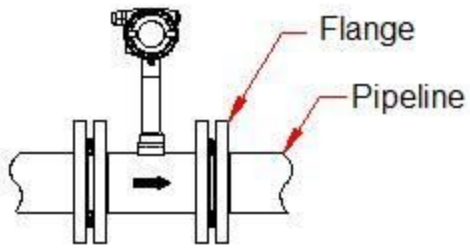
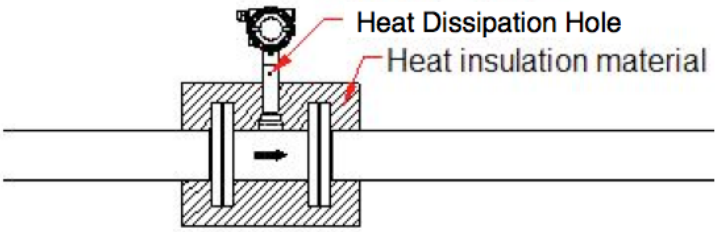
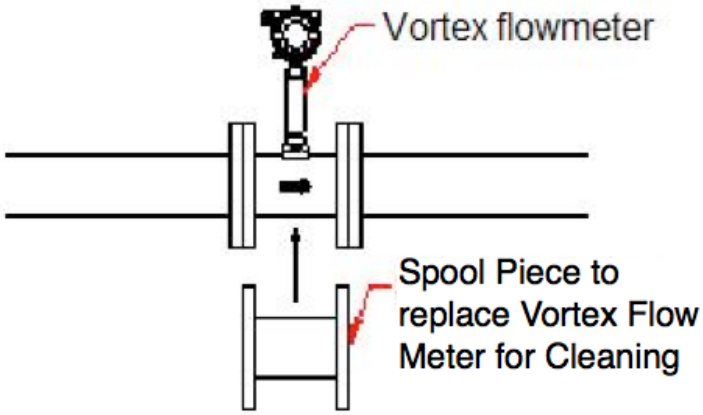
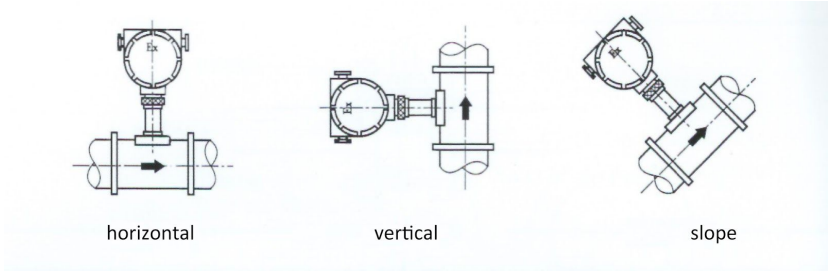
(c) Ensure the process pressure is LESS than the meter's rated pressure.

2.2 Plumbing requirements

Same pipe ID	
Reducer inlet and outlet	

Expansion	
90 Degree Elbow Inlet	
Double 90 Degree Inlet out of plane	
Downstream Valve	
Upstream Valve	

External Pressure sensor location:2 - 7 D downstream of flowmeter **Temperature sensor location: 1 - 2 D downstream of pressure sensor**	
Compressor or Roots Blower Upstream	 Compressor or Roots Blower upstream may cause vibration of the fluid itself. To eliminate this vibration, install an orifice plate or a expansion pipe at about 25D upstream of the meter. Any valves should be located downstream the flowmeter for this condition. Note the TOP drawing is Incorrect.
Piston Pump upstream	 Please install an accumulator to reduce the vibration
T type pipeline in upstream	 When using a T type pipeline installation the valve must be located downstream.

Ensure flange gaskets do not protrude into the flow area.	
Heat insulation: If the fluid is at a high temperature ensure the heat insulation material does not cover the heat dissipation hole on flow meter	
Cleaning: If the pipeline needs to be cleaned ensure a spool piece is put in place of the flow meter to avoid damage to the shedder bar and sensor.	
The flow should be going UP as shown for either a vertical or slope mount for liquids so the fluid completely fills the pipe.	

3 Vortex Meter Wiring

The TFM201 vortex flowmeter has a terminal board for the user connections of 24 VDC, the 4-20 mA output, ModBus, and the Frequency Output.

The 3.6 VDC Lithium Battery is shown installed and is optional and will provide operation of the LCD but not the 4-20 mA or ModBus or Frequency output.

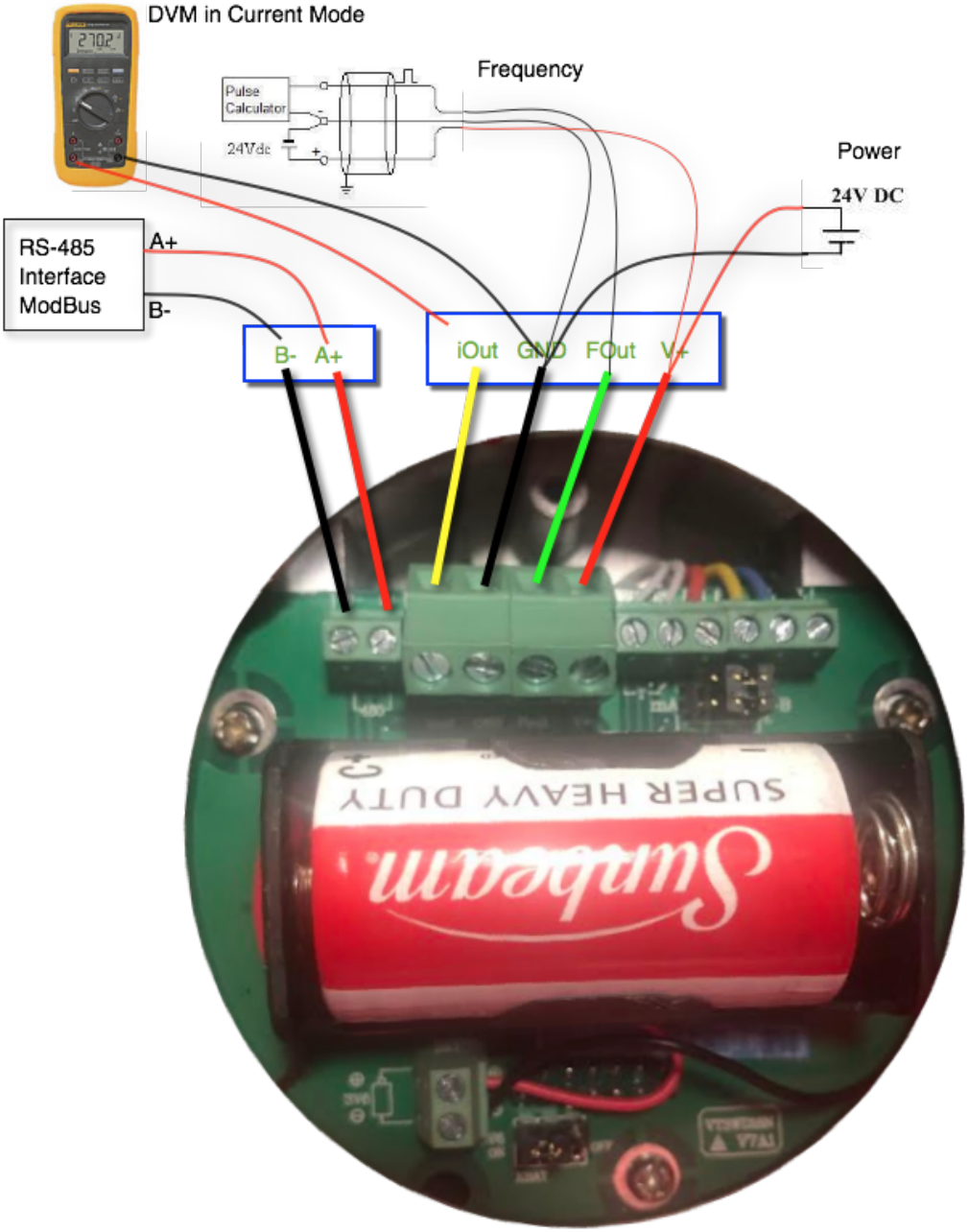
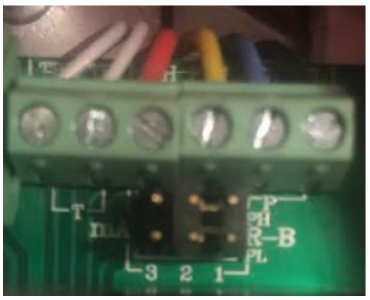


Figure. 3.1 Wiring guidelines for the 4-20, Frequency and ModBus. The 4-20 is a POWERED 4-20 and connection to a 4-20 input device is ideal. As well, the user may elect to place a 250 Ohm resistor across iOut and V+ and read 1 -5 VDC for 0 to Full Scale as a voltage.

Upper right hand connections: Jumpers for the Temperature and pressure transducers as well as the Vortex Sensors. Do not move the jumpers or remove any wires here.	

Lower left connections: Jumper for the 3.6 VDC Lithium Battery. You may have BOTH the battery and 24 VDC plugged in at the same time. The meter may be used with the 3.6 VDC Lithium Battery in the Intrinsically Safe mode that supports driving the LCD but not the ModBus or 4-20 mA Output.	

3.3 Electronics grounding and minimizing electrical interference

The TFM201 digital vortex flowmeter power supply for the signal processing circuit is isolated from the outside power supply by use of an isolation type DC-DC transmitter with advanced grounding technology . The field frequency interference is also well filtered.

The “V-” of power supplier should not be connected directly to ground. When the flow meter is used in an environment with high EMI fields , the electronics should be connected with earth ground through the cable. Do not locate in close proximity to devices such as a VFD.

3.4 Wiring Requirements

1) Only connect wiring when the power is off in an explosive environment.

2) Open the rear cover first, then insert the cable into back of housing through the water-proof cable gland .

3) Conduct wiring according to Figure 3.1.

4) Prepare a wiring “drip loop” wiring to avoid the water entering into the housing through the cable.

4 Display

TFM201 digital vortex flowmeter has a local display to display several variables on the local multifunction LCD display.

4.1 LCD display Introduction

The TFM201 multivariable vortex meter uses and RTD and pressure transmitter to indicate "Temperature" ,"Pressure" "Mass flow", "Total Flow", and a bar graph. Please refer to Figure 4.1 below. Note the password to reset the totalizer is 70.

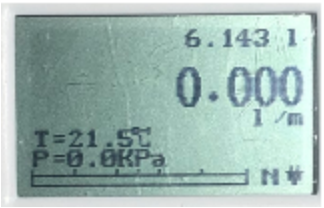


Figure 4.1 LCD display

4.3 Two Button LCD User Interface

TFM201 series digital vortex flowmeters has two buttons on the top and behind the display as follows: ENTER button (on the right at 1 O'Clock) and + Button Please (in the left at 11:00 O'Clock) refer to Figure 4.5 below

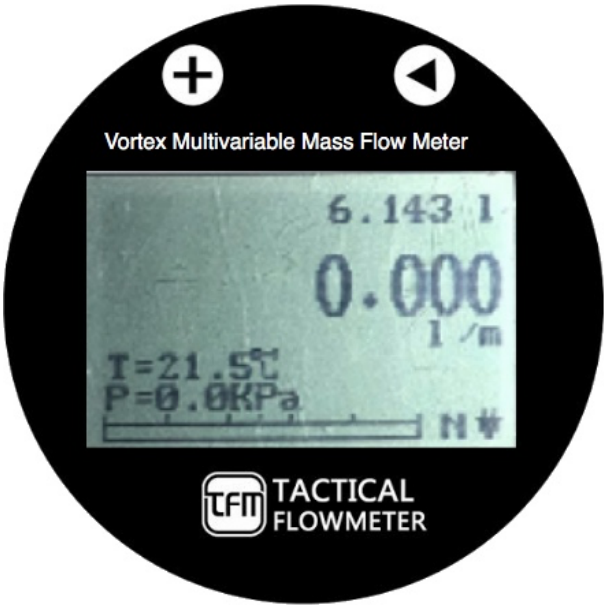


Figure 4.5 buttons

Use the "Enter" to select the display contents, use "+ button" to move to the left and right. Use Long Hold of the + button to allow editing variable. Hit "Enter button" to select or

confirm your choice with a Long Hold. Refer to the setting list below.

4.4 Total flow display

TFM201 can display 9 digits to the left of the decimal point and 3 digits after the decimal point. The password to reset the totalizer is 70.

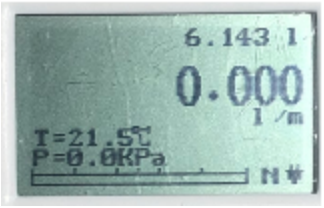


Figure 4.6 Display example

5 LCD Settings (Factory set)

Note: Every TFM201 digital vortex flowmeter has been set up according to your requirements. Please do not change any of the setting variables unless it is necessary and under factory instruction! The most critical is the value shown in the graphic in Figure 5.0

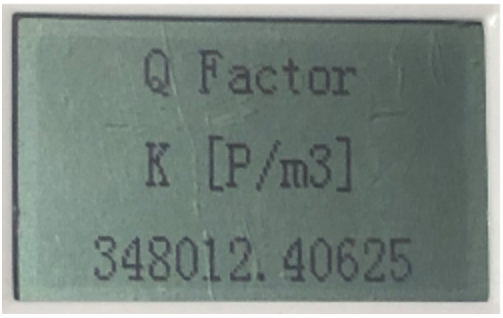
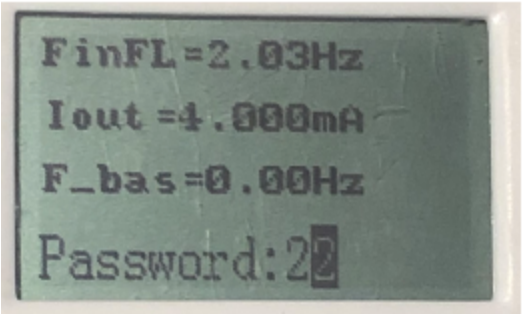
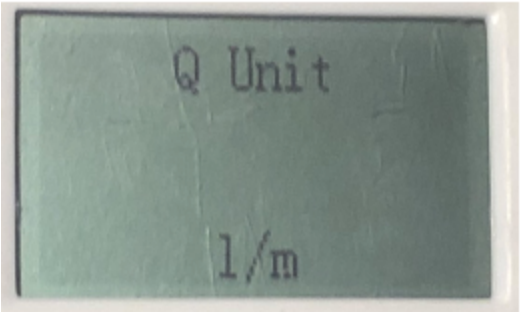
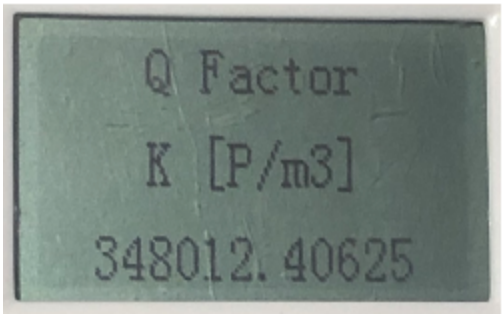
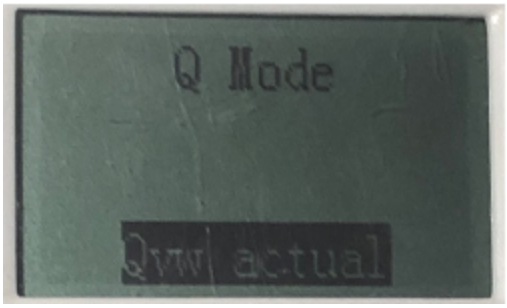
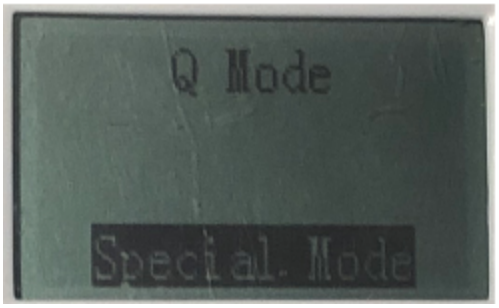


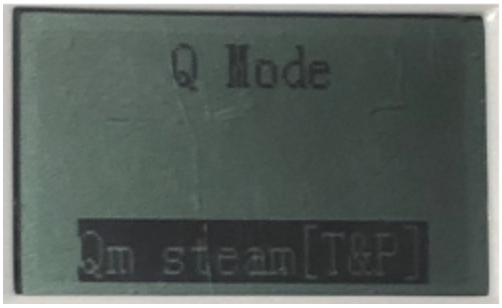
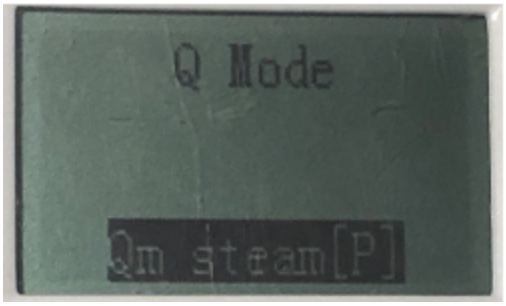
Figure 5.0 do not edit this value. This number will be stamped on the label of the meter and can be recovered should one accidently edit it.

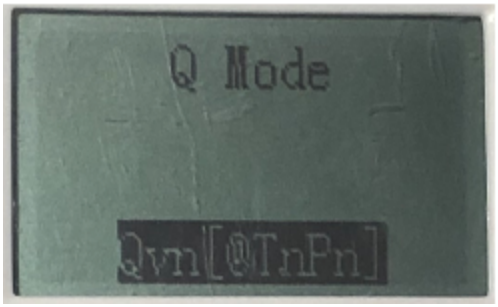
5.2 LCD Settings list

We show each screen accessible by hitting the + button and then holding the ENTER button for 3 seconds, and then use the + to increment the password to 22 and then hold the ENTER button for 3 seconds to scroll thru the list. When you want to edit the value hold the ENTER button for 3 seconds and edit as required. When done hold ENTER for 3 seconds and when done hit the + button for 3 seconds. A video is on the bottom of the website here: https://www.tacticalflowmeter.com/collections/flow-meter/products/1-2-to-4-multivariable-vortex-mass-flow-meter

Main screen showing TOTAL flow on the top, as 6.143 l (liters) The Flow Rate is in large digits in the middle as 0.000 l/m (liters per minute) The temperature is shown at 21.5 Degrees C The pressure is shown as 0.00KPa	
The first line shows the vortex shedding frequency at 2.03 Hz The 4-20 mA output is at 4.0 mA The frequency output is at 0.00 Hz out of 1000 HZ. Toggle between this screen and the screen above with the + button. When on THIS screen hold the ENTER button for 2 or 3 seconds. Advance the digit with the + and tap ENTER to move to the next digit. Hold the ENTER button for 2 or 3 seconds to access the screens below.	 Note: To reset the Total flow the password is 70. Note FinFL and F_bas are factory values for debugging.
Flow Meter units:m3/m, m3/h, kg/m, hg/h, t/m, t/h, l/m, l/h,	

DO NOT EDIT THIS VALUE. This is the value on your meter tag. This describes the calibration coefficient that relates the vortex shedding frequency to the fluid velocity.	
Comm Address, or Slave ID between 1-99 ModBus protocol is 0x03 PLC Mode, Default BAUD is 9600, No Parity, 1 Stop Bit	
One of 8 Multivariable Modes Actual LIQUID VOLUME flow with no Pressure and temperature corrections for l/h and l/m	
Two of 8 Multivariable Modes	

Three of 8 Multivariable Modes Multivariable Superheated Steam with pressure and temperature compensation for mass flow.	
Four of 8 Multivariable Modes Multivariable Saturated Steam with pressure compensation.	
Five of 8 Multivariable Modes Multivariable Saturated Steam with temperature compensation.	
Six of 8 Multivariable Modes Multivariable Gas Mass Flow Rate with temperature and pressure compensation.	

Seven of 8 Multivariable Modes Multivariable Gas VOLUME Flow Rate	
Eight of 8 Multivariable Modes Actual LIQUID MASS flow with Pressure and temperature corrections	

ModBus Default Configuration:
Comm Address, Slave ID: 1
BAUD: 9,600
Parity: None
Stop BIts: 1
FCode: 3
PLC Mode
IEEE 752 Float BYTE Order ABCD
LONG BYTE order ABCD

ModBus Register addresses

data	Decimal Address	Hex Address	Type	Bytes
Flow rate	0	0x0000	floating point	4
Working condition flow	4	0x0004	floating point	4
Low level total flow	8	0x0008	Long	4
High level total flow	12	0x000C	Long	4
temperature	16	0x0010	floating point	4

pressure	20	0x0014	floating point	4
frequency	24	0x0018	floating point	4
Current (3W)	28	0x001C	floating point	4
unit Index	32	0x0020	Short	2

Unit index from Register Address 32, 0x0020:

Code	0	1	2	3	4	5	6	7
unit	m3/h	m3/m	l/h	l/m	t/h	t/m	kg/h	kg/m

Units of m3/h, m3/m l/h and l/m are volume measurements that can be corrected to mass flow with pressure and temperature. The STP , Standard Temperature and Pressure may be selected and the DEFAULT STANDARD temperature is 0 Deg C and the r STANDARD eferenge pressure is 1 Atm, or 101.325 kPa

Michael.. These are missing from my menu. How do I set the these in submenu 6 and 7

6	Teperature setting	Teperature setting (default 0.0)	Set the temperature calculated value when choose 02, 03, 04, 06 , unit is ℃
7	Absolute pressure Settings	Set the gas absolute pressure (default 101.325)	Set the gas absolute pressure calculated value when choose 02, 03, 05, 06 , unit is kPa

cc

6 RS485 Modbus RTU Communication

6.1 Modbus Registers & Specifications

- The communication interface is via the RS485 standard, Baud rate is defaulted at 9600 BAUD
- The Modbus RTU wiring terminals are labelled “A” and “B”.
- The communication complies with the MODBUS-RTU standard.

Message Structure: Address code - function code – data segment CRC. The time between two characters should not be longer than the time for one single character, or it will be considered as the beginning of a new message or the end of a old message. The message is comprised of hexadecimal arrays.

ModBus Default Configuration:
Comm Address, Slave ID: 1
BAUD: 9,600
Parity: None
Stop BIts: 1
ModBus FCode: 3
PLC Mode
IEEE 752 Float BYTE Order ABCD
LONG BYTE order ABCD

ModBus Register addresses

data	Decimal Address	Hex Address	Type	Bytes
Flow rate	0	0x0000	floating point	4
Working condition flow	4	0x0004	floating point	4
Low level total flow	8	0x0008	Long	4
High level total flow	12	0x000C	Long	4
temperature	16	0x0010	floating point	4
pressure	20	0x0014	floating point	4
frequency	24	0x0018	floating point	4
Current (3W)	28	0x001C	floating point	4
unit Index See Fig 6.1	32	0x0020	Short	2

Unit index from Register Address 32, 0x0020 shown below in Fig 6.1

Code	0	1	2	3	4	5	6	7
unit	m3/h	m3/m	l/h	l/m	t/h	t/m	kg/h	kg/m

Figure 6.1: Units of m3/h, m3/m l/h and l/m are volume measurements that can be corrected to mass flow with pressure and temperature. The STP , Standard Temperature and Pressure may be selected and the DEFAULT STANDARD temperature is 0 Deg C and the r STANDARD Reference pressure is 1 Atm, or 101.325 kPa

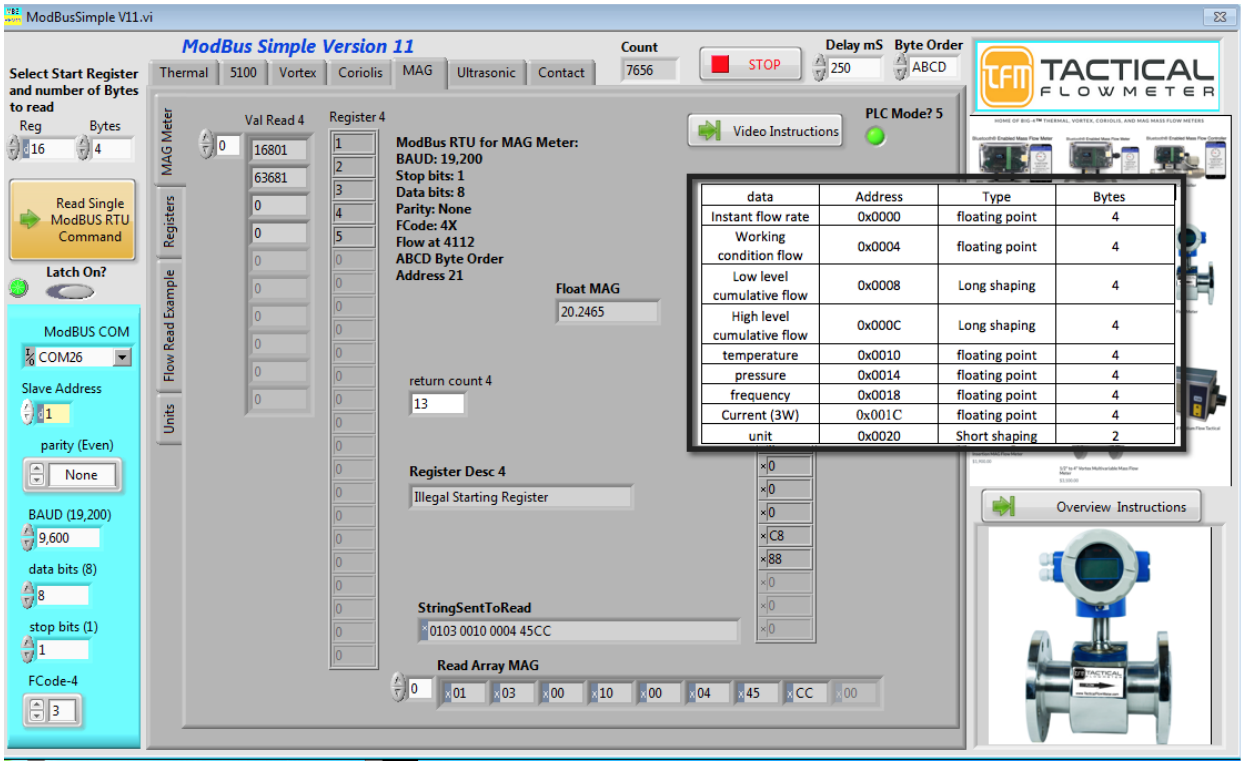


Figure 6.2: Example of a ModBus Terminal reading the Vortex Meter.

6.3 CRC and parity code Calculation.

Request	Response
01 : Address	N1 CRC=0FFFFH is initial value
10 : Function code	N2 XOR operation the CRCL and N1
00 : Register address higher	N3 CRC move 1 bit right , if move out is 1 bit
01 : Register address lower	N4 CRC=CRC XOR A001H
00 : Register quantity higher	N5 if move out is 0 , CRC=CRC
04 : Register quantity lower	N6 Move right for 8 times to finish the N1 calculation
04 : Date quantity	N7 …
80 : Data 1	N8 XOR operation the CRCL and N11
04 : Data 2	N9 CRC move 1 bit right , if move out is 1 bit
80 : Data 3	N10 CRC=CRC XOR A001H
80 : Data 4	N11 if move out is 0 , CRC=CRC
CRCL : CRC Parity code lower	Move right for 8 times to finish the N11 calculation
CRCH ： CRC Parity code higher	Get the CRC calibration value

6.4 Float data format

The 4 byte float format is as below:

Address: 0 1 2 3

Content: MMMMMMMM MMMMMMMM EMMMMMMM SEEEEEEE

Use IEEE standard method, if top digit is 1we represent a negative number; if the top digit is 0, we represent a positive number. The 23 bit mantissa and a 1 on top the digit, which is hidden, constitute a 24 bits fixed point true form decimal. The lowest 8 bits are exponent-marker using the IEEE shift code method. The exponent marker equals to the actual value minus 127. For example: 7=86H-7FH, -10=75H-7FH

e.g.: 100=0x00,0x00,0x42,0xc8

-100=0x00,0x00, 0xc2,0xc8

0=0x00.0x00.0x00.0x00 (exponent-marker is 0, the number is 0)

6.5 Float byte order

ABCD

9 Troubleshooting and repair

9.1 Safety Information

Do not open ANY covers on the enclosure if in a explosive environment.

When wiring the power, frequency, 4-20 mA or an RS485 device, make sure that the process of wiring the device into the loop complies with best practices safety requirements. It is best practices to complete the wiring in a non-explosive environment.

BEFORE power is connected, make sure the front and rear electronics covers are properly secured and closed.

9.2 Troubleshooting and repair

Symptom	Reason	Troubleshooting	repair
No display	Power supply failure	Test the voltage on the power source with a universal meter	Rewire the power or use a new power supply
	Power is not wired	Test the voltage on the power source with a universal meter	Wire the power
	Cable if broken	Check if there is break in the cable	Check the cable and re-wire
	Wrong wiring	Check if wiring to the correct terminal	Rewire
Displayed flow rate is 0 while there is flow in the pipe	Flow rate is less than the meter's lower limit	Increase the flow rate to check	Increase the flow rate or replace.
	The flow rate of small signal cut off function is set too high	Check the small signal cut off setting	Set the small signal cut off to a proper value
	Energy threshold value is too high	Check if the Energy threshold value is too high in the spectrum analyzing checking mode	Set the Energy threshold value to a proper value (Please reference to Note 1 for how to set)
	Transmitter function failure	Replace the transmitter with another transmitter of same type to check	Replace the transmitter
	Sensor is damaged	Increase the flow rate to check first, then install the transmitter with another flowmeter of the same type to check.	Replace the sensor
	Pipeline blocked or sensor jammed.	If all above possibilities are eliminated, please check the pipeline and installation.	Re-install the flowmeter
The flowmeter has flow reading while there is no flow in the pipe	Power frequency interference	Check the frequency display on meter is stable at the value that same as the power frequency	Rewire the meter with shielded cable according to requirement.
	There is high voltage instrument or high frequency interference close to the flowmeter	k if there is high voltage instrument or high frequency interference close to the flowmeter	Re-locate the flowmeter
	There is heavy vibration on the pipeline	Sense the vibration on the pipe line by touch it with hand	Tighten the pipeline where the flowmeter is installed
	Valve is not closed properly that there flow leak into the pipe	Check pressure and check if valve is closed and sealed	Repair the valve
The flow rate reading fluctuate significantly	The gasket and the pipe are not concentric	Check the position of the gasket	Re-install the gasket
	The flowmeter pipe body and the pipeline are not concentric	Check if the flow meter pipe body and the pipeline are not concentric	Re-install the meter

	Straight pipe length not enough or the inner diameter of flowmeter pipe body do not match the pipeline	Check the straight pipe length and the diameter of the pipeline	Re-locate the flowmeter
	There is heavy vibration on the pipeline	Sense the vibration on the pipe line by touch it with hand	Tighten the pipeline where the flowmeter is installed
	The fluid has not fill the pipeline fully	Check the fluid status and the location of the meter.	Re-locate the flowmeter
	Two phase flow	Check if there is 2-phase flow according to the pressure and temperature of the fluid.	If the fluid is liquid-solid two phase flow, need to install a filter at upstream of the flow meter. If the fluid is liquid-gas two phase flow, need to install a getter at upstream of the flow meter.
	Transmitter failure	Replace the transmitter with another transmitter of same type to check	Replace the transmitter
There is big difference between the flow reading and the process flow rate	No density compensation for steam measurement	Check the density compensation devices and the setting	Fix density compensation
	The estimated flow rate before using the meter is wrong	Use other flowmeter to confirm the actual flow rate	
	Setting incorrect	Check the settings of meter K factor,upper and lower limit of flow rate	Set the meter correctly

Specifications:

Accuracy

Variables	For gas and steam	Liquid
Flow rate（m3/h）	±1% RD （ Re ≥ 20000 ）	±0.75% RD （ Re ≥ 20000 ）
	±2% RD （ 10000 < Re < 20000 ）	±2% RD （ 10000 < Re < 20000 ）
Mass flow（kg/h）	±1.5% RD （ Re ≥ 20000 ）	±1.0% RD （ Re ≥ 20000 ）
	±2.5% RD （ 10000 < Re < 20000 ）	±2.5% RD （ 10000 < Re < 20000 ）
Temperature（℃）(For multivariable)	±1 ℃	±1 ℃
Pressure（Mpa）(For multivariable)	±0.75% FS	±0.75% FS

Repeatability

Flow rate	±0.3%
Mass flow	±0.3%
Temperature	±0.05 ℃
Pressure	±0.05% FS

Measurement range

Fluid type	Lower limit	Higher limit	Condition
Gas	6m/s, DN15、DN20	60m/s	T=25℃, P=101.325Kpa Air calibrated
	4m/s, DN25、DN32		
	2m/s, DN40~DN300		
Steam	6m/s, DN15、DN20	70m/s	T=25℃, P=101.325Kpa Air calibrated
	4m/s, DN25、DN32		
	2m/s, DN40~DN300		
Liquid	0.3m/s	7m/s	T=25℃ P=101.325Kpa Water calibrated

Temperature range

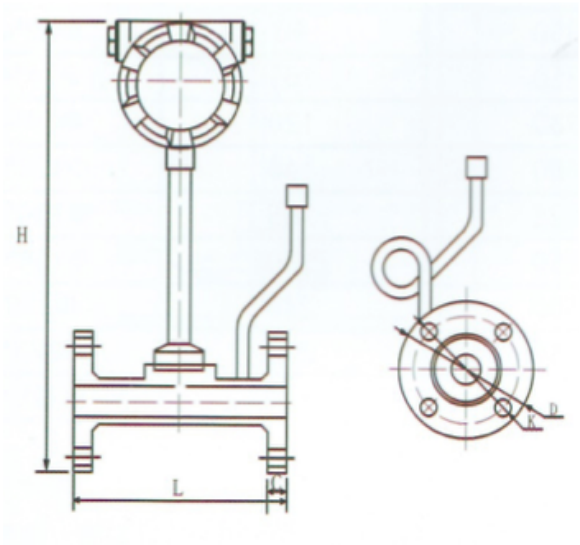
Low temperature version	–180℃~100
Normal temperature version	–40℃~150
Medium temperature version	–40℃~250

High temperature version	–40℃~350

Pressure range

Available pressure rating includes 1.6Mpa, 2.5Mpa, 4.0Mpa, 6.4Mpa. If your application requires a higher pressure rating , please contact us.

Vortex Meter Dimensions



ANSI 150# Flange Size		Flange to Flange (L)		Total height (H)		Flange OD (D)		Flange Thickness(C)		Flange Bolt Circle (K)		Flange Bolt Dia	
mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch
15	½"	180	7.09	415	16.34	95	3.74	14	0.55	65	2.56	14	0.55
20	¾"	180	7.09	420	16.54	105	4.13	16	0.63	75	2.95	14	0.55
25	1"	180	7.09	425	16.73	115	4.53	16	0.63	85	3.35	14	0.55
32	1¼"	180	7.09	435	17.13	140	5.51	18	0.71	100	3.94	18	0.71
40	1½"	180	7.09	435	17.13	150	5.91	18	0.71	110	4.33	18	0.71
50	2"	200	7.87	440	17.32	165	6.50	20	0.79	125	4.92	18	0.71
65	2½"	200	7.87	460	18.11	185	7.28	20	0.79	145	5.71	18	0.71
80	3"	200	7.87	490	19.29	200	7.87	20	0.79	160	6.30	18	0.71
100	4"	200	7.87	510	20.08	220	8.66	22	0.87	180	7.09	18	0.71
125	5"	220	8.66	535	21.06	250	9.84	22	0.87	210	8.27	18	0.71
150	6"	220	8.66	570	22.44	285	11.22	24	0.94	240	9.45	22	0.87
200	8"	220	8.66	625	24.61	340	13.39	24	0.94	295	11.61	22	0.87
250	10"	250	9.84	685	26.97	405	15.94	26	1.02	355	13.98	26	1.02
300	12"	300	11.81	710	27.95	460	18.11	28	1.10	410	16.14	26	1.02

Contact information:

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