Electromagnetic Flow Meter

QUICK User Manual

Take 5, Inc.
22642 Indian Springs Road
Salinas, CA 93908
Dave.Korpi@TacticalFlowMeter.com
Call 831-455-0418

CONTENTS

Electromagnetic Flow Meter

QUICK Instruction Manual

Features

- Low-frequency square-wave excitation, excitation frequencies：1/16 power frequency、1/20power frequency、1/25 power frequency;
- High-frequency square-wave excitation, excitation frequency：1/2 power frequency
- Excitation current may be selected for the following currents: 125mA, 187.5mA, 250mA, or 500 mA ;
- Velocity range：0.1 to 15m/s, velocity resolution：0.5mm/s;
- AC high-frequency switching power, AC voltage range：85VAC to 250VAC;
- DC 24V switching power, DC voltage range：20VDC to 36VDC ;
- Communication Protocol：MODBUS RTU
- Three totalizers: Forward total, reverse total, and negative total.
- DC Power Model 20VDC to 36VDC Power consumption < 20 W
- Normal operating conditions

  Ambient Temperature Range：–10 to +60 °C;

  Relative Humidity：5% to 90%;

Circuit Overview:

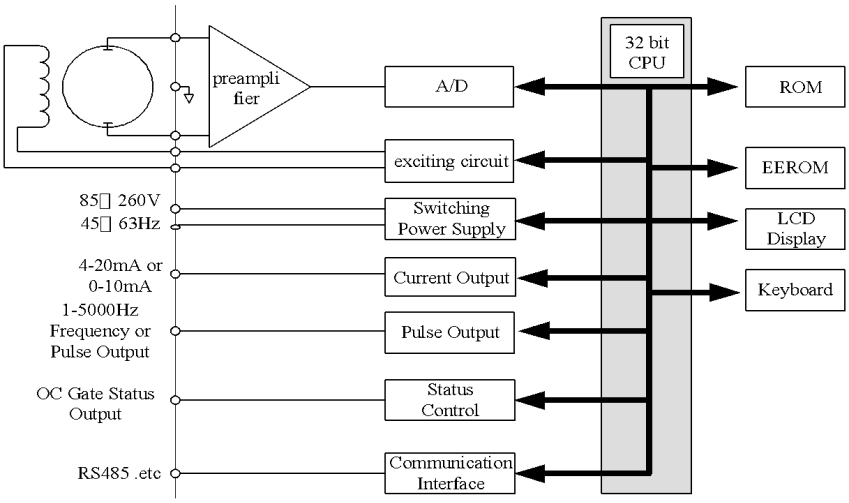


Fig.2. 1 MAG Meter Circuit

3.2.3 Range and Accuracy:

Table 3.1 V_S : Velocity range, meters/second (m/s)

Diameter “ [mm]	Range (m/s)	Accuracy
0.13” [3] - 0.80” [20]	≤0.3	±0.25%FS
	0.3 to 1	±1.0R
	1 to 15	±0.5%R
1.0” [25]- 24” [600]	0.1 to 0.3	±0.25%FS
	0.3 to 1	±0.5%R
	1 to 15	±0.3%R
28” [700] – 124” [3000]	≤0.3	±0.25%FS
	0.3 to 1	±1.0%R
	1 to 15	±0.5%R
%FS : for relative ranges ; %R : for relative value of measurement		

4-20 4-20 mA Input Load resistor: 0 to 750Ω (4~20mA).

Basic measurement errors: 0.1%±10μA.

3.2.5 Digital frequency output

Frequency output range: 1 to 5000Hz ;

Output electric isolation: Photoelectric isolation. Isolation voltage: > 1000VDC ;

Frequency output drive: output using field-effect transistors, the maximum voltage is 36VDC, maximum output current is 250 mA.

3.2.6 Digital pulse output

Pulse output range: 0 to 100 pulse/s.

Pulse output value: 0.001 to 1.000 m^3 / cp 0.001 to 1.000 Ltr / cp 0.001 to 1.000 USG / cp、0.001 to 1.000 UKG / cp;

Pulse output width: 50ms,

Pulse output isolation: photoelectric isolation. Isolation voltage: > 1000VDC ;

Pulse output drive: output using field-effect transistors, maximum voltage: 36VDC, maximum output current: 250 mA.

3.2.7 Alarm output

Alarm output junction : ALMH--- upper limit; ALML--- lower limit;

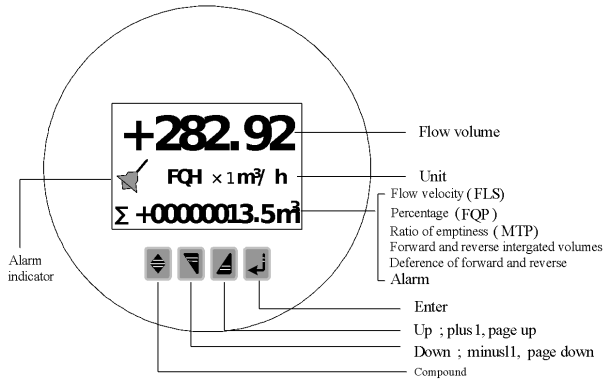
Output isolation: photoelectric isolation. Isolation voltage: > 1000VDC;

Alarm output drive: output using Darlington Pair Transistor, maximum voltage: 36VDC, maximum current: 250 mA.

3.2.8 Digital communication port and protocol

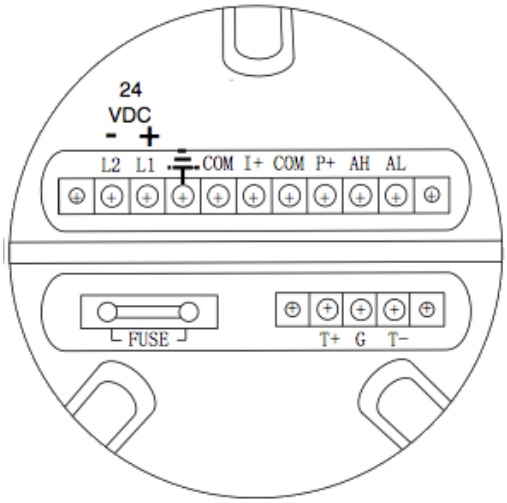
MODBUS RTU

4.1.2.2 Display keys and LCD screen display



LCD display

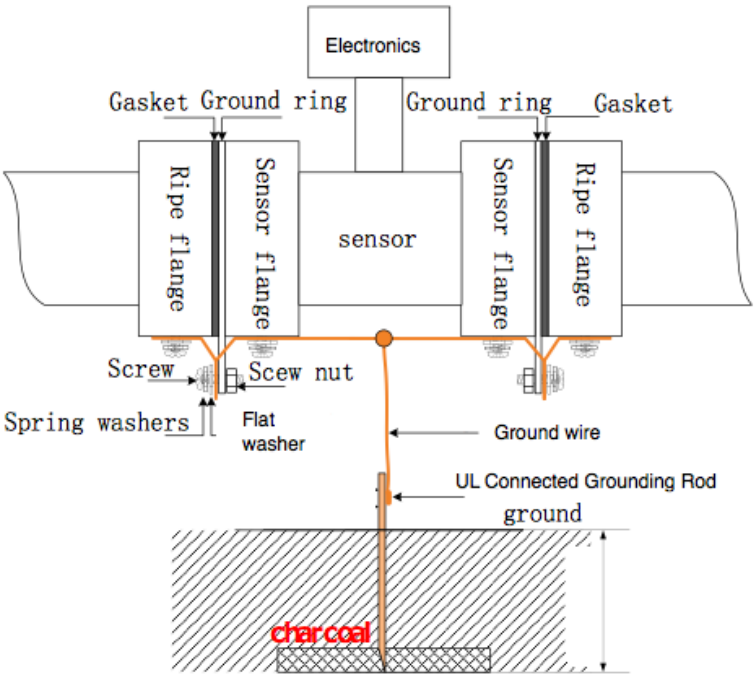
4.3.3 Wiring Diagram



Symbols and Description of Connectors

I+ :	Output Current for Flow Measurement
COM :	Output Current (Ground) for Flow Measurement
P+ :	Frequency (Pulse) Output for Bi-directional Flow
COM :	Frequency (Pulse) Output (Ground)
AL :	Alarm Output for Low Limit
AH :	Alarm Output for Upper Limit
COM :	Alarm Output (Ground)
FUSE :	Fuse for Power Supply
T＋ :	+Communication Input Signal (RS485-A)
T－ :	-Communication Input Signal (RS485-B)
G	RS485 Communication Ground
L_1 :	（+24V SUPPLY）Power Supply
L_2 :	（24V GROUND）Power Supply

Grounding Requirements VERY IMPORTANT!



MAG meter must be properly grounded for a stable reading. Note the orange wires connect the inlet to the outlet on the customer side

Digital output

Digital output can be set to either frequency or pulse output.

4.5.1 Frequency output

Frequency output range is 0 to 5000HZ, and corresponding the percent of full scale.

$$\text{Frequency Output} = \frac{\text{Measured value}}{\text{Full scale value}} \bullet \text{frequency range}$$

The upper limit of frequency output can be 1 - 5000HZ

Frequency output mode is normally used in control application, because it responses the percent Full Scale. Users can choose pulse output when the equipment is connected to a totalizer counter or the like.

4.5.2 Pulse output mode:

Pulse output mainly applies in count mode. A pulse output delegates a unit flow value,

such as 1L or $1M^3$ etc. Pulse output unit can be divided into 0.001L, 0.01L, 0.1L, 1L, $0.001m^3$, $0.01m^3$, $0.1m^3$, 1 m^3 ,0.001UKG, 0.01UKG, 0.1UKG, 1UKG, 0.001USG, 0.01USG, 0.1USG, or 1USG .When choosing the pulse unit you will want to match the Full Scale range of flow meter and pulse unit. For volume flow, the count formula is as follows:

$Q_L=0.0007854\times D^2\times V$ (L/S)

Or $Q_M=0.0007854\times D^2\times V\times 10^{-3}$ (M^3/S)

Note: D-nozzle (mm)

V-velocity of flow (m/s)

The values must be chosen to not over range the pulse output units. Generally, pulse output should be below 3000 P/S. Typical maximum is 1000 P/S for most electronic totalizer counters.

4.5.3 Digital output connection

Digital output has two terminals:

P+ ----- digital output point;

PCOM ----- digital ground point;

P+ is an open collector output, see below.

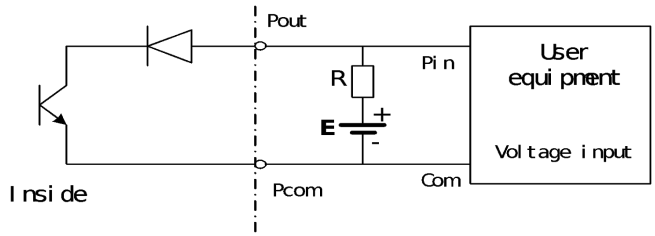


Fig.4.5(a) The connection of digital voltage output

4.5.5 Digital output connection using a galvanic coupling such as a PLC etc.

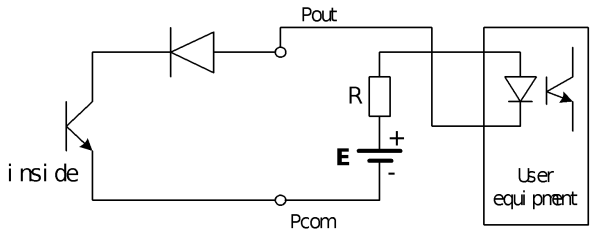


Fig.4.5(b) Digital output connect photoelectric coupling

Common photoelectric coupling current is about 10mA, so about E/R=10mA, E=5 to 24V.

4.5.6 Digital output relay

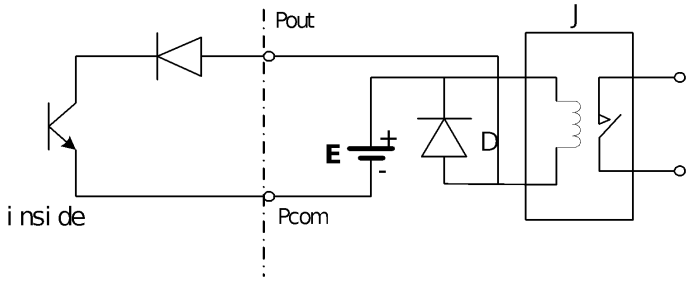


Fig.4.5（c） Digital output connect relay

Commonly relay needs E as 12V or 24V. D is an external diode if the relay does not have the diode built in. This is required to protect the circuit from back emf when the coil collapses.

POUT

Parameter	Test condition	Minimum	Typical	Max	Unit
Voltage	IC=100 mA	3	24	36	V
Current	Vol≤1.4V	0	300	350	mA
Frequency	IC=100mA Vcc=24V	0	5000	7500	HZ
High voltage	IC=100mA	Vcc	Vcc	Vcc	V
Low voltage	IC=100mA	0.9	1.0	1.4	V

4-20 mA signal output and calculation

4.6.1 4-20 mA signal output

The 4-20 mA output is internally tied to 24V to deliver 4~20mA, it can drive up to 750Ω in resistance.

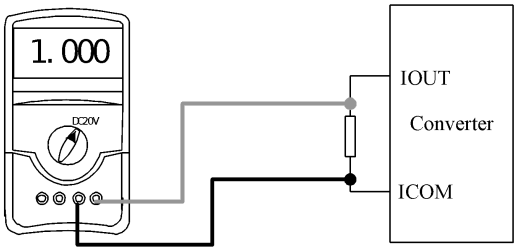
The percent flow of simulation signal output:

$$I_0 = \frac{\text{Measured value}}{\text{Full scale value}} \bullet \text{the scale of current} + \text{the current zero point}$$

The current zero is 4mA when selecting 4 as the zero for 4-20mA.

4.6.2 Simulation of 4-20 Signal Output

(1)Allow 15 minutes warm up. Use a 0.1% accuracy ammeter or if you have an exact 250Ω resistor you will want a voltmeter with 0.1% voltage accuracy.

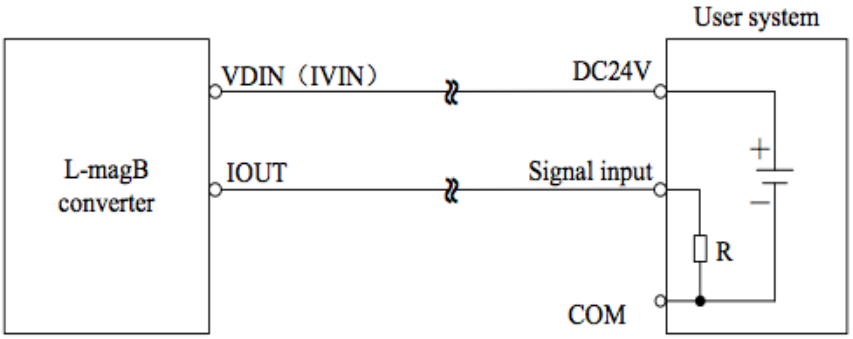


(2)Current zero correct

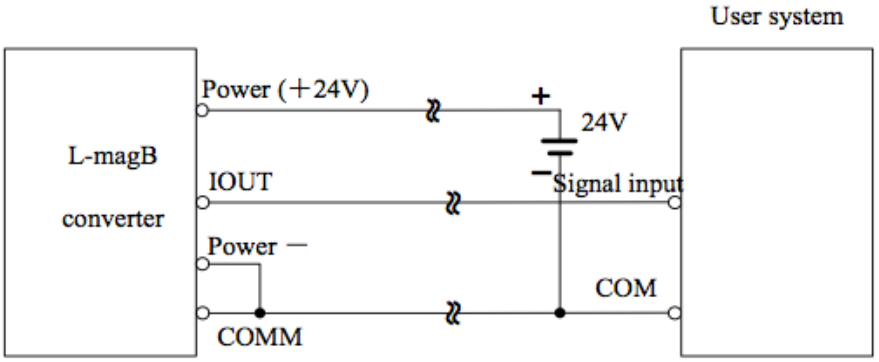
Using "Analog Zero" in the parameter settings enter the reading from the meter. Adjust until the ZERO reading is 4mA(±0.004mA).

(3) 20 mA output validation

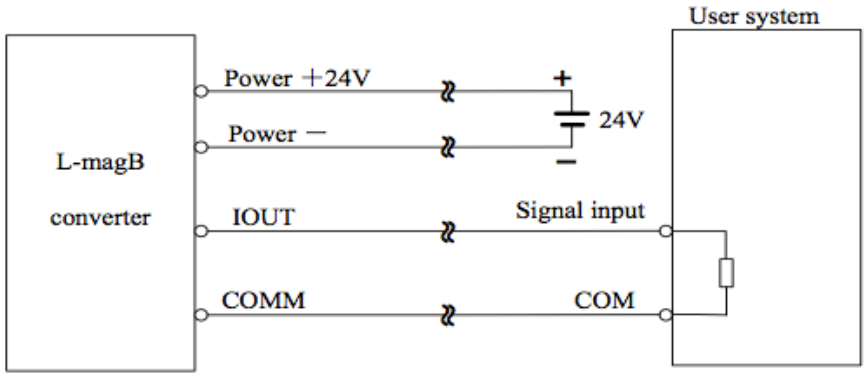
Select "Anlg Range" in meter parameters to adjust the 20 mA to 20mA(±0.004mA)



2 Wire 4-20 mA output connection using customer 24 VDC



3 Wire 4-20 mA Output connection non-isolated



4 Wire 4-20 mA Output isolated wiring

Key functions

a) Key Names

"Down" key: Selects displayed data on lower line;

"Up" key: Selects displayed data on upper line;

"Compound" key + "Enter" key: Enters into parameter settings

"Enter" key: Press to select the function.

Under the measure, you may adjust the LCD contrast with "Compound" key + "Up" key or "Compound" key + "Down" key for several seconds to adjust the contrast to the desired level.

b) Function keys for adjusting parameters

"Down" key: Subtracts1 from the number in cursor area;

"Up" key: Adds 1 to the number in cursor area;

"Compound" key + "Down" key: Cursor moves left;

"Compound" key + "Up" key: Cursor moves right; "Enter" key: In/Out submenu;

"Enter" key: Press for two seconds under any state and the meter will return to normal flow measuring mode.

Note: （1）When using the "Compound" key, you will press "Compound" key and "Up" or

"Down" at the same time;

（2） The Flow Meter will automatically resume the measurement mode after 3 minutes if you abandon any parameter settings;

(3) Direct selection of the zero flow correction is available when you move the

cursor to the left + or - and use “Down” or “Up” to switch;

Parameter Functions

To set parameters, the electronics will be in the parameter setting mode instead of the normal flow measuring mode. In the measuring mode, push “Compound”+“Enter” keys to to select the default password of (0000), and, if necessary, enter the password with the password level provided by manager. Finally, push the “Compound”+“Enter” keys to adjust Parameter Settings.

There are 6 Passwords with 4 for different operator levels and 2 fixed passwords for system operation.

Functions selection menu

Push “Compound”+“Enter” keys to the functions select menu, push the “Up” or “Down” keys to select, there are three functions:

Code	Functions	Notes
1	Set Parameters	Allows user to enter the desired parameter.
2	Clr Total Rec	Allows user to gross reset totalizers.
3	Fact Modif Rec	Select this function to check the factory modification Records

5.2.3.1 Set Parameters

Press, “Compound”+“Enter” key, it displays “Parameter Set” function. Input password. Press, “Compound”+“Enter” key, it getting to Parameter Setting status.

5.2.3.2 Clr Total Rec

To push the “Compound”+“Enter” keys getting to the select of parameter, then push “Up” key to “Clr Total Rec”, input the appropriate password level. The totalizer may be reset with the password “0000”

5.2.3.3 Fact Modif Rec

To push the “Compound”+“Enter” keys getting to the select of parameter, then push “Up” key to “Fact Modif Rec”

Parameter Setting Codes

Setting Parameters in Menu

Code	Parameter	Method	Password Level	Range
1	Language	Select	2	English
2	Comm Slave Address	Set count	2	0 to 99
3	Baud Rate	Select	2	300 to 38400
4	Snsr Size	Select	2	3 to 3000
5	Flow Unit	Select	2	L/h、L/m、L/s、m^3/h、m^3/m、m^3/s 、UKG、USG
6	Flow Range	Set count	2	0 to 99999
7	Flow Rspns	Select	2	1 to 50
8	Flow Direct	Select	2	Plus/ Reverse
9	Flow Zero	Set count	2	0 to ±9999
10	Flow Cutoff	Set count	2	0 to 599.99%
11	Cutoff Ena	Select	2	Enable/Disable
12	Total Unit	Select	2	$0.001m^3$ to $1m^3$ 、0.001L to 1L、0.001UKG to 1UKG, 0.001USG to 1USG,
13	SegmaN Ena	Select	2	Enable/Disable
14	Analog Type	Select	2	4 to 20mA/4mA
15	Pulse Type	Select	2	Frequency / Pulse
16	Pulse Fact	Select	2	$0.001m^3$ to $1m^3$ 、0.001L to 1L、0.001UKG to 1UKG, 0.001USG to 1USG,
17	Freque Max	Select	2	1 to 5999 HZ
18	Mtsnsr Ena	Select	2	Enable/Disable
19	Mtsnsr Trip	Set count	2	59999 %
20	Alm Hi Ena	Select	2	Enable/Disable
21	Alm Hi Val	Set count	2	000.0 to 599.99 %
22	Alm Lo Ena	Select	2	Enable/Disable
23	Alm Lo Val	Set count	2	000.0 to 599.99 %
24	Sys Alm Ena	Select	2	Enable/Disable
25	Clr Sum Key	Set count	3	0 to 99999
26	Snsr Code1	User set	4	Finished Y M
27	Snsr Code2	User set	4	Product number

28	Field Type	Select	4	Type 1,2,3
29	Sensor Fact	Set count	4	0.0000 to 5.9999
30	Line CRC Ena	Select	2	Enable/Disable
31	Lineary CRC1	User set	4	Set Velocity
32	Lineary Fact 1	User set	4	0.0000 to 1.9999
33	Lineary CRC2	User set	4	Set Velocity
34	Lineary Fact 2	User set	4	0.0000 to 1.9999
35	Lineary CRC3	User set	4	Set Velocity
36	Lineary Fact 3	User set	4	0.0000 to 1.9999
37	Lineary CRC4	User set	4	Set Velocity
38	Lineary Fact4	User set	4	0.0000 to 1.9999
39	FwdTotal Lo	Correctable	5	00000 to 99999
40	FwdTotal Hi	Correctable	5	00000 to 9999
41	RevTotal Lo	Correctable	5	00000 to 99999
42	RevTotal Hi	Correctable	5	00000 to 9999
43	PlsntLmtEna	Select	3	Enable/Disable
44	PlsntLmtVal	Select	3	0.010 to 0.800m/s
45	Plsnt Delay	Select	3	400 to 2500ms
46	Pass Word 1	User correct	5	00000 to 99999
47	Pass Word 2	User correct	5	00000 to 99999
48	Pass Word 3	User correct	5	00000 to 99999
49	Pass Word 4	User correct	5	00000 to 99999
50	Analog Zero	Set count	5	0.0000 to 1.9999
51	Anlg Range	Set count	5	0.0000 to 3.9999
52	Meter Fact	Set count	5	0.0000 to 5.9999
53	MeterCode 1	Factory set	6	Finished Y /M
54	MeterCode 2	Factory set	6	Product Serial No
55	CheckMode	Select	2	No Parity/Odd Parity/Even Parity

There are 6 levels of passwords for setting parameters. Grade 1 to grade 5 are for users and Level 6 of password is reserved for manufacturer. Users can reset the passwords of grades 1-4 using Level 5.

Users can READ parameters using any grade of password. Changing or writing new values are available using the following password levels.

Level 1 Password = 00521: users can only read parameter.

Level 2 Password = 03210): users can change parameters 1-24.

Level 3 Password = 06108): users can change parameters 1-25.

Level 4 Password = 07206): users can change parameters 1-38.

Level 5 Password = (FACTORY ONLY): users can change parameters 1-52.

Password Level 5 can only be set by skilled users. Level 4 is mainly used for resetting total volume. Levels 1-3 can be shared with users with various levels of skill.

Parameter Details

5.3.2 Comm Address

01 to 99.

5. 3.3 Baud Rate

300, 1200, 2400, 4800, 9600, and 38400, BAUD.

5. 3.4 Parity CheckMode

The standard MODBUS communication for L-magB is 8 bit No Parity; users can choose 8 bit odd parity or 8 bit even parity.

5.3.5 Sensor Size

L-magB converters can be equipped with different sensors for different pipe diameters from 0.125" to 124" (10') and are entered in mm for highest resolution.

5.3.6 Flow units

Available flow units: (L/h、L/m、L/s、m^3/h、m^3/m、m^3/s、UKG、USG)

5.3.7 Flow Range

Lower limit value is set to "0" by default. The range for percent display, frequency output, and current outputs are as follows:

percent display = (measured flow / measured range) * 100 %;

frequency output = (measured flow / measure range) * frequency full Scale;

current output = (measured flow / measure range) * current full Scale + base point;

Note: pulse output has no range adjustment.

5.3.8 Flow Filter

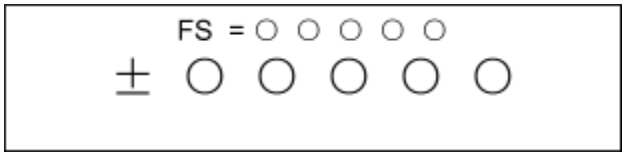
Long filter times are good for installations that have "noisy" flow and short filter times are good when the user wishes to study the flow over very short periods of time.

5.3.9 Flow Direction

Select the flow direction if the flow reverses from the original installation.

5.3.10 Zero Flow

Make sure the sensor is full of fluid, and the flow is at ZERO. Flow zero is shown as a ZERO velocity for flow, mm/s.



Zero-flow correction display:

Top Line: FS indicates the CURRENT measurement for the value at zero flow;

Bottom Line: This is where you enter the OPPOSITE sign of the value in the Top Line to REMOVE any undesirable ZERO indication.

5.3.11 Low Flow cutoff

Flow cutoff is set in percentage of Full Scale that will be used to indicate a Zero flow for any value BELOW the Low Flow Cutoff value. This value applies to the 4-20 mA current output signal, velocity, percentage, and the frequency (pulse) output.

5.3.12 Totalizer Units

Converter display uses a 9-bit counter, max is 999999999.

Integrator units are L, m^3 (liter, cubic meters,).

Flow integrator scaling values: 0.001L、 0.010L、 0.100L、 1.000L

0.001m^3、 0.010m^3、 0.100m^3、 1.000m^3;

0.001UKG、0.010UKG、0.100UKG、1.000UKG,

0.001USG、0.010USG、 0.100USG、1.000USG

5.3.13 SegmaN Ena

When “SegmaN Ena” is “enabled”, the sensor will output pulse and current。When it is in the “disable” setting, the sensor will output a pulse as “0” and current as “0”(4mA or 0mA) when the flow reverses.

5.3.14 Analog Output

4~20mA.

5.3.15 Pulse Output

The meter can have either a Frequency Output or a Pulse Output. Frequency Output is a continuous square waveform and Pulse output is a serial square wave. Frequency output is

mainly used for flow RATE indication and the total integrated flow for short periods of time. The Frequency output us usually chosen when the equivalent frequency unit and volume of integrated flow is to be collected. Frequency Output can be used for long time measurement for total integrated flow with volume units.

Frequency output and pulse output are usually from Open Collector transistors so that DC power supplies so load resistors are required for proper operation.

5.3.16 Pulse Output Factors

Equivalent pulse Unit is referred to one pulse for ONE unit of flow. The range of pulse equivalents can be chosen as shown below:

Pulse Equivalent	Flow	Pulse Equivalent	Flow
1	0.001L/cp	9	0.001USG/cp
2	0.01L/cp	10	0.01 USG /cp
3	0.1L/cp	11	0.1 USG /cp
4	1.0L/cp	12	1.0 USG /cp
5	0.001m3/cp	13	0.001UKG/cp
6	0.01m3/cp	14	0.01 UKG /cp
7	0.1m3/cp	15	0.1 UKG /cp
8	1.0m3/cp	16	1.0 UKG /cp

Under the same flow, the smaller the pulse is, the higher the frequency output is, resulting in the smallest error. The highest pulse output is 100cp/s, Note: most mechanical electromagnetic counters can attain a maximum of 100 pulses/sec.

5.3.17Freque Max, Frequency Maximum

Frequency output range is as the upper limit of the measured flow, or the percentage of the flow. Frequency output can be selected from 1 to 5000Hz.

5.3.18Mtsnsr Ena

If the flow meter has no fluid in it there is an Empty Pipe Alarm, where the analog and digital outputs will be driven zero as well as displayed on the LCD.

5.3.19Mtsnsr Trip

When the pipe is full of liquid (whether flowing or not), the parameter of “Mtsnsr” could be modified more easily. The parameter displayed upper line is real MTP, and the

parameter displayed below is the “Mtsnsr trip” that should be set. When setting “Mtsnsr trip," you could be according to the real MTP, the value that should be set is usually three to five times of real MTP.

5.3.20 Alm Hi Ena

Users can choose “Enable” or “Disable”.

5.3.21 Alm Hi Val

The parameter of upper limit alarm is percentage of flow range and can be set in the way of setting one numerical value between 0%~199.9%. When the value of flow percentage is larger than the value of setting value, the converter outputs the alarm signal.

5. 3.22Alm Lo Val

Same as upper limit alarm.

5.3.23 Sys Alm Ena

Selecting Enable will have the function, and selecting Disable will cancel the function.

5.3.24 Clr Sum Key

Use more than level 3-password code to enter, then set this password in Clr Total Rec.

5.3.25 Snsr Code

It is referred to the production date of sensor and the serial number of meter that ensures the sensor coefficient is accurate.

5.3.26 Sensor Fact

“Sensor Coefficient” is printed on the Label of the sensor. The “sensor coefficient” must be set into Sensor Coefficient Parameter to operate properly and is entered at the factory.

5.3.27 Field Type

L-magB affords three excitation frequency types: 1/16 frequency (type 1), 1/20frequency (type 2), 1/25 frequency (type 3)。 The small-bore meters use 1/16 frequency, and large-bore meters use 1/20 or 1/25 frequency. These values are set at the factory and should not be altered. When adjusting, select type 1 first, if the zero velocity is too high, select the type 2 or type 3.

5.3.28 FwdTotal Lo、hi

Positive total volume high byte and low byte can change forthcoming and reverse total

value, and be used to maintenance and instead.

User use 5 byte code to enter, and can modify the positive accumulating volume (∑+). Usually, it is unsuitable to exceed the maximum the counter set（999999999）.

5.3.29 RevTotal Lo、hi

User use 5 byte code to enter, and can modify the negative accumulating volume (∑-). Usually, it is unsuitable to exceed the minimum the counter set（999999999）.

5.3.33User's password 1-4

Users have 5 grades of passwords for the highest level of security.

5.3.34 Analog Zero

Output current ZERO is set to either 0 or 4 mA with 4 mA being the standard for 0 flow.

5.3.35 Angle Range

The full-scale range of the mA output can be either 10 or 20 mA.

5.3.36Meter Fact

This factor is factory set to allow sensor interchange within 0.1%.

5.3.37 MeterCode 1 and 2

Electronics code indicates the manufacture date and the meter serial number.

Self-Diagnostics: All meters feature a self-diagnostic function. Normal operation displays this:  on the left of LCD.

Errors are shown as follows:

FQH ---- Flow high limit alarm; FQL ---- Flow low limit alarm;

FGP ---- Flow empty pipe alarm; SYS ---- System exciting alarm.

UPPER ALARM ---- Flow high limit alarm;

LOWER ALARM ---- Flow empty pipe alarm;

LIQUID ALARM ---- Flow empty pipe alarm ;

SYSTEM ALARM ---- System exciting alarm.

Troubleshooting Guide

No LCD display:

a) Check the power supply connection;

b) Check the power fuse;

c) Check the contrast of LCD and adjust if necessary;

Alarms indicating an alarm condition

a) Check if the excitation cables EX1 and EX2 are connected;

b) Check if the total resistance of sensor's excitation coils resistances less than 150Ω;

c) If a) and b) are OK, the electronics may have failed or a connection has failed.

No Fluid in flow body alarm

* Ensure flow body if full of fluid with no air bubbles;

* If you can short circuit the three connectors SIG 1, SIG 2, SGND of converter, and no "Empty Alarm" is displayed then the electronics is OK. If this is the case, it is possible that conductivity of fluid is too low or the empty threshold of empty flow body and range of empty flow body are set too low or too high.

* Check if the signal cables are OK;

* Check if the sensor connections are OK.

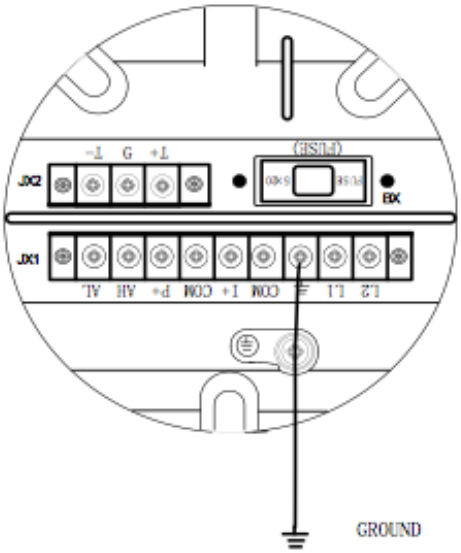
Create the ZERO FLOW condition and the displayed flow should indicate less than 100%.

Ensure resistances of SIG1 to SGND and SIG2 to SGND are all less than 50kΩ (conductivity of water) during measurement operation.

* The DC sensor voltage should be less than 1Volt between DS1 and DS2. If the DC voltage is greater than 1V, the sensor connections should be cleaned and reset.

Lightning protection notes

When installing, users must connect the electronics earth terminal with the enclosure, and then connecting according to UL safety standards. Connect the ⏚ terminal as shown.



MAG Meter ModBus RTU Specification

1. Introduction

The MAG meter uses the standard ModBus communication protocol and supports baud rates of 1200, 2400, 4800, 9600, and 19200. Using the ModBus communication network, the host can read instantaneous flow, instantaneous velocity, temperature, pressure, and total or cumulative flow as well as other parameters.

The MAG Meter uses the following serial port parameters: 1 start bit, 8 data bits, 1 stop bit, and the none parity bit.

The MAG Meter ModBus communication ports isolation voltage is 1500V and features ESD protection. Thus it can overcome various interferences from industrial installations to ensure the reliability of the communication network.

2. MAG Meter ModBus RTU network

The MAG Meter's standard ModBus communication network is a bus network. It can support from 1 to 99 MAG flowmeters, or other devices, in a network installation. Note: the most distant MAG flowmeter, or device, in the network, normally requires the use of a 120 Ohm matched termination resistor to connect the two sides of communication wire in parallel. The standard communication connection practice is to use shielded twisted pair.

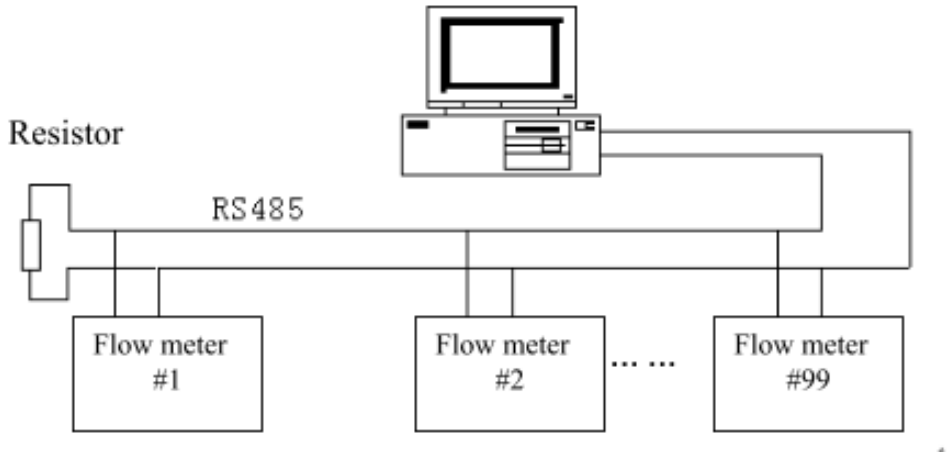


Figure-1 MAG Meter network configuration

3. ModBus RTU frame format

ModBus protocol is a master-slave communication. Communication is initiated from the master and the slave then responds to the master's request by sending back the requested data.

The MAG Meter uses the ModBus RTU frame format (hexadecimal format). The frame format is shown below in figure2.

1. Master order frame structure

Start	Device address	Function code	Register address	Register length	CRC	Stop
T1-T2-T3-T4	8Bits	8Bits	16Bits	16Bits	16Bits	T1-T2-T3-T4

Figure-2 Master RTU message frame

2124488232. Slave response frame structure

Start	Device address	Function code	Data	CRC	Stop
T1-T2-T3-T4	8Bits	8Bits	n 8Bits	16Bits	T1-T2-T3-T4

Figure-3 Slave RTU message frame

Note:

- T1-T2-T3-T4 is the start or stop frame. ModBus protocol requires every two frames must have a minimum 3.5 char delay as shown below in figure-4.

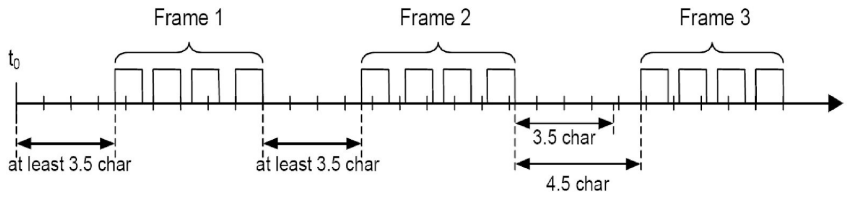


Figure-4 ModBus frame interval

- Device address: MAG meter Slave ID or communication address.
- Function code: Set by the desired ModBus protocol. The MAG Meter uses the Function code 4 which realizes the collecting function through reading input register.
- Register address and register number: The start address of register to read or write.
- Slave response data: Byte number and N bytes data.

4. MAG Meter ModBus Function Codes

Table-1

Function code	name	function
01	Read coil status	reserved
02	Read input status	reserved
03	Read holding registers	reserved
04	Read input register	read real-time information
05	Strong set single coil	reserved
06	Preset single register	reserved
07	read abnormal status	reserved
08	Loopback diagnostic check	reserved
09	Program	reserved
10	Control exercise	reserved
11	Read events count	reserved
12	Read communication events record	reserved
13	Program	reserved
14	Inquire	reserved
15	Strong multi-coil set	reserved

5. MAG Meter ModBus register Addresses

Table-2

Protocol Addresses （Decimal）	Protocol Addresses （HEX）	Data format	Resister definition
4112	0x1010	Float Inverse	Instantaneous flow float representation
4114	0x1012	Float Inverse	Instantaneous velocity float representation
4116	0x1014	Float Inverse	Float representation of the flow percentage (battery-powered only)
4118	0x1016	Float Inverse	Floating representation of fluid conductivity ratio
4120	0x1018	Long Inverse	Integer part of the cumulative positive value
4122	0x101A	Float Inverse	Decimal part of the cumulative positive value
4124	0x101C	Long Inverse	Integer part of the cumulative negative value
4126	0x101E	Float Inverse	Decimal part of the cumulative negative value
4128	0x1020	Unsigned short	Instantaneous flow unit (table-3)
4129	0x1021	Unsigned short	Cumulative total units (table-4 or table-5)
4130	0x1022	Unsigned short	Upper limit alarm
4131	0x1023	Unsigned short	Lower limit alarm
4132	0x1024	Unsigned short	Empty pipe alarm
4133	0x1025	Unsigned short	System alarm

1. **Data Formats**

- Float format:

The MAG Meter ModBus uses IEEE754 which is a 32 bit float format. The structure is shown as follows: (Instantaneous flow as an example)

0X1010（34113）		0x1011（34114）	
BYTE1	BYTE2	BYTE3	BYTE4
S EEEEEEE	E MMMMMMM	MMMMMMMM	MMMMMMMM

S- Mantissa symbol; 1=negative, 0=positive.

E- Exponent; expressed by the difference between decimal number 127.

M- Mantissa; low 23 bits and the decimal part.

When all of the E are not “0” and “1”, the conversion formula between float and the decimal number is:

$$V = (-1)^S 2^{(E-127)}(1+M)$$

- Instantaneous flow units

Code	Unit	Code	Unit	Code	Unit	Code	Unit
0	L/S	3	M3/S	6	T/S	9	GPS
1	L/M	4	M3/M	7	T/M	10	GPM
2	L/H	5	M3/H	8	T/H	11	GPH

- Cumulative flow units Table 4

Code	0	1	2	3
Cumulative unit	L	M3	T	USG

- Alarm

Upper limit alarm, lower limit alarm, empty pipe alarm, system alarm:
0 ------ No alarm; 1------ Alarm

6. Communication data examples

1. **Read instantaneous flow**

Master sends the command (hexadecimal numbers)

01	04	10	10	00	02	74	CE
Device address	Function code	Register high address	Register high address	Register high length	Register low length	CRC high	CRC low

Data that the master receives

01	04	04	C4	1C	60	00	2F	72
Device address	Function code	Data length	4 bytes float (instantaneous flow)				CRC high	CRC low

Float: C4 1C 60 00

1100 0100 0001 1100 0110 0000 0000 0000

float byte 1 float byte 2 float byte 3 float byte 4

S=1: if mantissa symbol is 1, it is a negative.

E=10001000: Exponent is 136

M=001 1100 0110 0000 0000 0000, The mantissa is :

$$V = (-1)^1 2^{(136-127)}(1+\frac{1}{8}+\frac{1}{16}+\frac{1}{32}+\frac{1}{512}+\frac{1}{1024})$$

V = -625.5, yes, the flow can go backwards… In this example, S-Mantissa symbol = 1 which means the number is negative.

2124488328. **Read instantaneous velocity example**

Master sends command (hexadecimal number)

01	04	10	12	00	02	D5	0E
Device address	Function code	Register high address	Register high address	Register high length	Register low length	CRC high	CRC low

Data that the master receives

01	04	04	C1	B0	80	00	A6	5F
Device address	Function code	Data length	4 bytes float (instantaneous velocity)				CRC high	CRC low

Float: C1 B0 80 00

1100 0001 1011 0000 1111 1000 0000 0000

S=1

E= 10000011

M= 011 0000 1111 1000 0000 0000

$$V = (-1)^1 2^{(131-127)}(1+\frac{1}{4}+\frac{1}{8}+\frac{1}{256})$$

= -22.0625

2124488424. **Read cumulative, or total, flow example**

To express the 9 bits that represent the Total or cumulative value of MAG Flow meter requires extracting the integer part and the decimal part of cumulative or total flow. The integer part uses a long variable and the decimal uses a float variable.

Cumulative flow is 1578m³

Master sends command to collect the integer value of cumulative flow

01	04	10	18	00	02	F5	0C
Device address	Function code	Register high address	Register high address	Register high length	Register low length	CRC high	CRC low

Data that the master receives

01	04	04	00	00	70	71	1E	60
Device address	Function code	Data length	4 bytes float (integer value of cumulative flow)				CRC high	CRC low

Integer value of cumulative flow is 28785

Master sends command to collect the decimal value of the total or cumulative flow

01	04	10	1A	00	02	54	CC
Device address	Function code	Register high address	Register high address	Register high length	Register low length	CRC high	CRC low

Data that master receives

01	04	04	3F	00	00	00	3B	90
Device address	Function code	Data length	4 bytes float (decimal value of cumulative flow)				CRC high	CRC low

Float: 3F 00 00 00

0011 1111 0000 0000 0000 0000 0000 0000

S=0

E= 0111111 126

M= 000 0000 0000 0000 0000 0000

$V = (-1)^1 2^{(126-127)} = 0.5$ Therefore, the TOTAL of these two numbers is 28785+0.5 or the cumulative, or total flow is 28785.5

2124488520. **Read instantaneous flow units**

Master sends 8 bytes command to read instantaneous flow unit

01	04	10	20	00	01	34	C0
Device address	Function code	Register high address	Register high address	Register high length	Register low length	CRC high	CRC low

7 bytes data that the master receives from slave

01	04	02	00	05	79	33
Device address	Function code	Data length	2 bytes integer (instantaneous flow unit)		CRC high	CRC low

Flow unit is M^3/H from table-3.

2124488616. **Read the units of the total flow**

Master sends 8 bytes command to read instantaneous flow unit

01	04	10	21	00	01	65	00
Device address	Function code	Register high address	Register high address	Register high length	Register low length	CRC high	CRC low

7 bytes data that the master receives from slave

01	04	02	00	01	78	F0
Device address	Function code	Data length	2 bytes integer (cumulative flow unit)		CRC high	CRC low

Flow unit is M^3 from table-4.

2124488712. **Read alarm status**

Master sends the following 8 byte command to read instantaneous flow unit

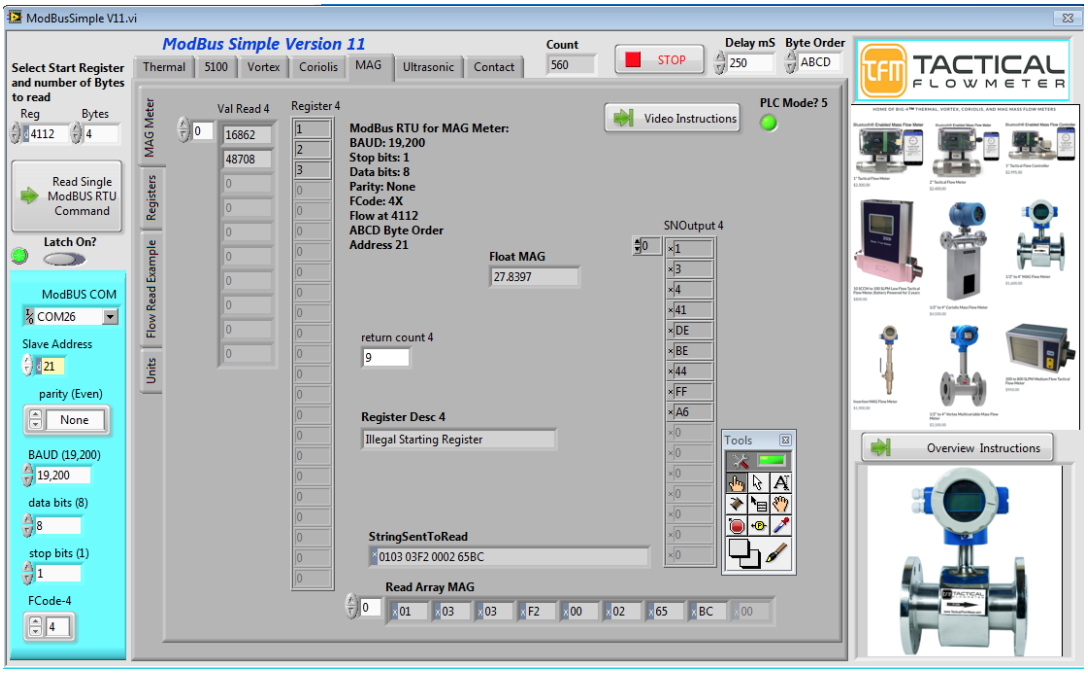
01	04	10	24	00	01	75	01
Device address	Function code	Register high address	Register high address	Register high	Register low	CRC high	CRC low

7 bytes of data that the master receives from slave

01	04	02	00	01	78	F0
Device address	Function code	Data length	2 bytes integer (alarm)		CRC high	CRC low

Empty pipe is in alarm status if status is 1.

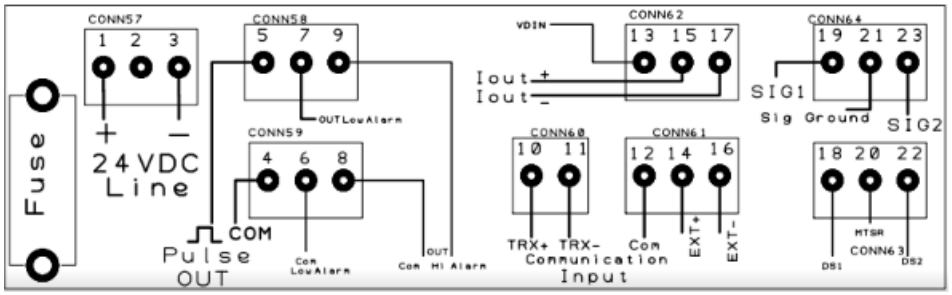
ModBus Simple showing Slave ID 21, 19,200,n,8,1 on Function code 4 for Register 4112 to read flow



Remote Mount Wiring Diagrams:

Remote models have cables that must be connected to the remote electronics. There are TWO cables that must be connected to the Electronics as well as the power for the meter. The graphic below shows the power connection and details the remote cable connection.

Enclosure Electrical Connections.



Electronics Connection Wiring Diagram

Connect 24 VDC @ 500 mA here. The 24V- is the 24 VDC Ground on this single ended 24 VDC Power Connection

Power Terminal

Use the GREEN Highlight

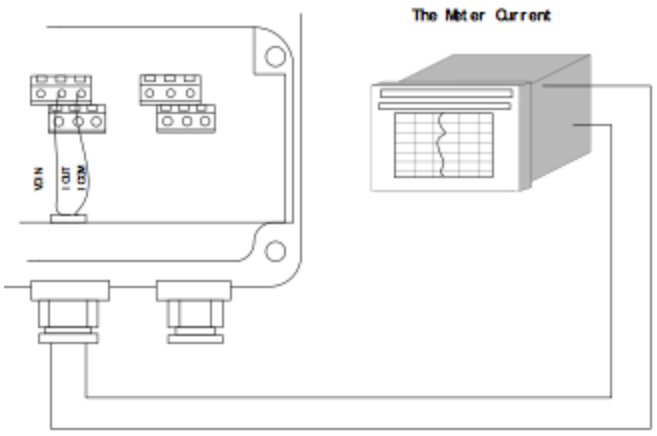
Use the YELLOW Highlight

A -GN : 23, signal - **B -WT : 19 signal +** **C -BK : 21 ground**	**D - WT : 14 exciting current +** **E - GN : 16 exciting current -**

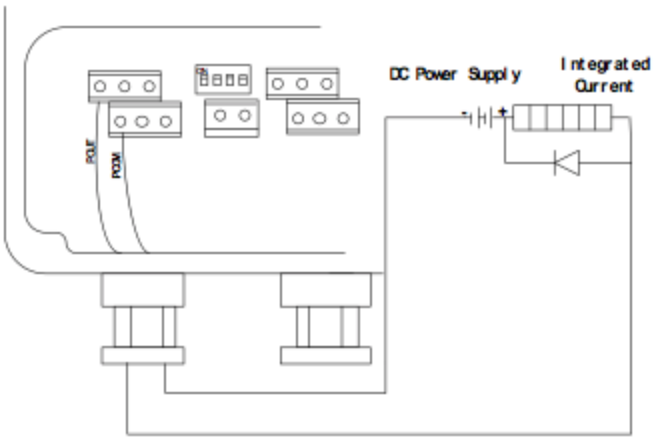
Remote Cable Details

Remote wiring details. Note 2 cables, one with 2 wires (Yellow Highlight) and the other with 3 wires (Green Highlight). The THREE occupy terminals 19,21, and 23 and the TWO wires occupy terminals 14, and 16.

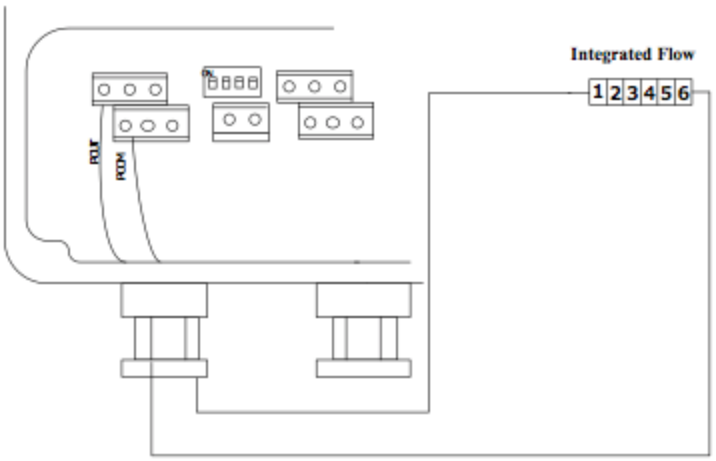
Terminal	Description
1	24 V+ (24 VDC Power+)
2	Not Used
3	24 V- GND (24 VDC GND)
4	PCOM Pulse Common
5	POUT Pulse Out
6	ACOM Low Alarm COM
7	ALML Low Alarm
8	ACOM Hi Alarm COM
9	ALMH High Alarm
10	TRX + 485 +
11	TRX - 485 -
12	COM
13	VDIN
14 (Yellow Highlight)	XT+ D-WT exciting current +
15	IOUT 4 to 20mA signal output +
16 (Yellow Highlight)	XT- E-GN exciting current -
17	ICOM 4 to 20mA signal output -I
18	DS1 B-WT signal +
19 (Green Highlight)	SIG1 B-WT signal +
20	MTSR C-BK signal GND
21 (Green Highlight)	SGND C-BK signal GND
22	DS2 A-GN signal -
23 (Green Highlight)	SIG2 A-GN signal -



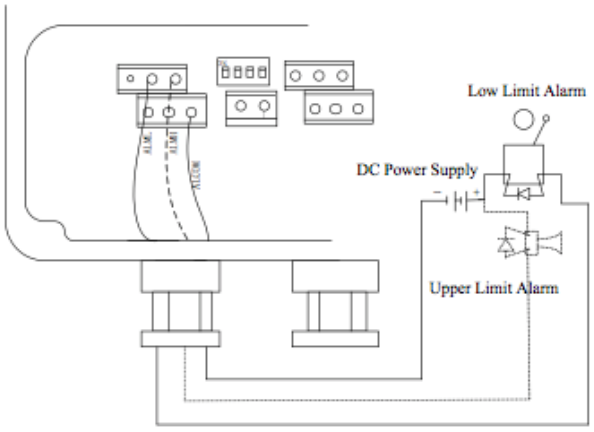
4-20 mA output connection. This is SELF POWERED, like a Fluke Meter. Do not power this output with 24 VDC.



Connection for Totalizer or Pulse Counter



Connection for Electronic Counter



Connection of alarm, showing a bell and horn alarm. Open Collector Configuration shown to the right.