
Slurry-type Electromagnetic Flow Converter Manual

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Silver Automation Instruments

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1. Function Introduce

Slurry-type electromagnetic flowmeter is designed to measure the speed of special slurry fluid such as pulp, mud, and coal-water slurry. With high-low frequency mixer excitation technology and proprietary slurry-noise reduction technology, slurry-type electromagnetic flowmeter can accurately measure the speed of slurry fluid with good stability and fast response. This flowmeter can even measure fluid with concentrations up to 85% (solid).

The key technology to measure slurry fluid is to remove the slurry-noise (at least five different characteristics) and recover real flow signal from complicated noise.

Based on theory analysis and a large number of experiments, we adopt high-low frequency mixer excitation technology. From lots of experiments data, we build mathematical models of slurry fluid flow signals. Based on the mathematical models, we utilize multiple digital filters, Wavelet transform and dynamic approximation of signal processing method to process raw signals and then recover real flow signals.

Below figures show the processing of the $1/f$ noise. Figure 1 shows the waveform of flow signals with slurry noise. Figure 2 shows the waveforms of flow signals after signal processing.

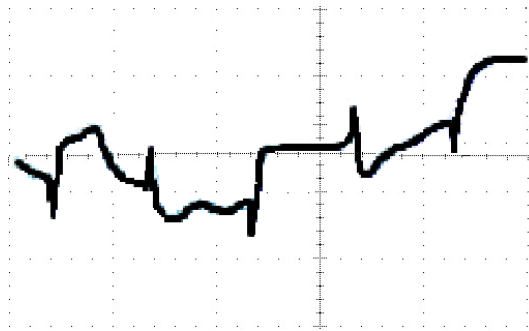


Figure 1 Flow signals with slurry noise

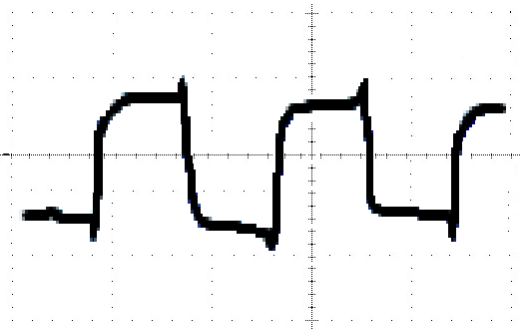
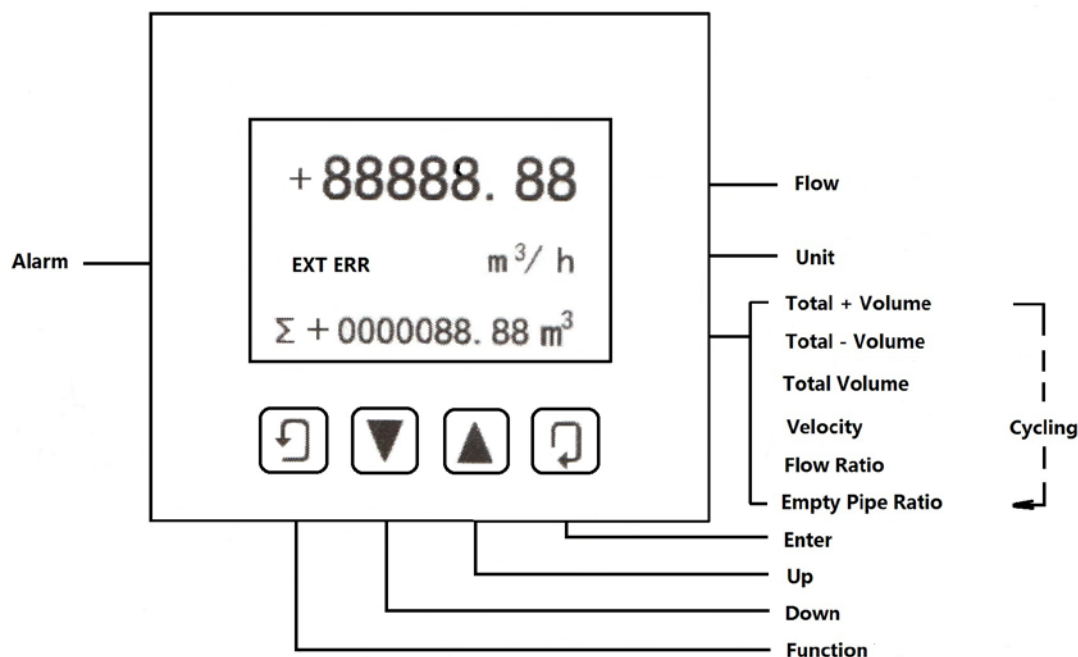


Figure 2 Flow signals after signal processing

2. Display and Keyboard



The electromagnetic flow converter enters into the automatic measurement status after power on. All of measurement functions are ready and measurement data is displayed.

3. Keyboard

The transmitter enters the automatic flow measurement mode after power on. All of measurement functions are ready and measurement data are displayed. The parameters can be setup and displayed by pressing four keys: Up key, Down key, Function key, and Enter key.

Up key	Plus 1 for the selected digit, or go back to the previous item
Down key	Minus 1 for the selected digit, or enter the next item
Function key + Up key	Move cursor to right
Function key + Down key	Move cursor to left
Function key + Enter key	Select the password menu, enter the password, then go to the lower submenu, and save parameters
Enter key	Go back to upper submenu. Pressing and holding for more than two seconds, then releasing it at Level One menu can activate the flow meter automatically go to the measurement mode

Note: Actually pressing and holding the Enter Key for more than two seconds, then releasing it at any time, can activate the flowmeter automatically go to the measurement mode.

4. Password

The converter has three level passwords.

The level one password : only can modify the password of level one;

The level two passwords: can modify the password of level one and level two, also have authority to view password of the level one;

The level three password: can modify the password of level one, level two and level three; also have authority to view password of the level one and level two;

The level one default password is “10000”, and the level two default password is “40000”.

The level three default password is “99999”, this password should only be used by flow meter manufacture.

5. Menu List

The menu list is using structured design. It has reasonable classification, and has very clear hierarchy, also convenient to operate.

The menu list is shown below.

Tab.1 Converter description abbreviation

Abbreviation	Description	Abbreviation	Description
BLKT	Back Light	FREQ	Frequency
NEGF	Negative Flow	ALMH	High Limit Alarm
CAL	Calibration	INIT	Initialization
COEF	Coefficient	ALML	Low Limit Alarm
COD	Code of Production	MAINT	Maintenance
DEC	decimal	PF	Power Frequency
DIR	Direction	THD	Threshold
DOD	Date of Production		
EPD	Empty Pipe Detection		
EXT	Excitation		
POSF	Positive Flow		

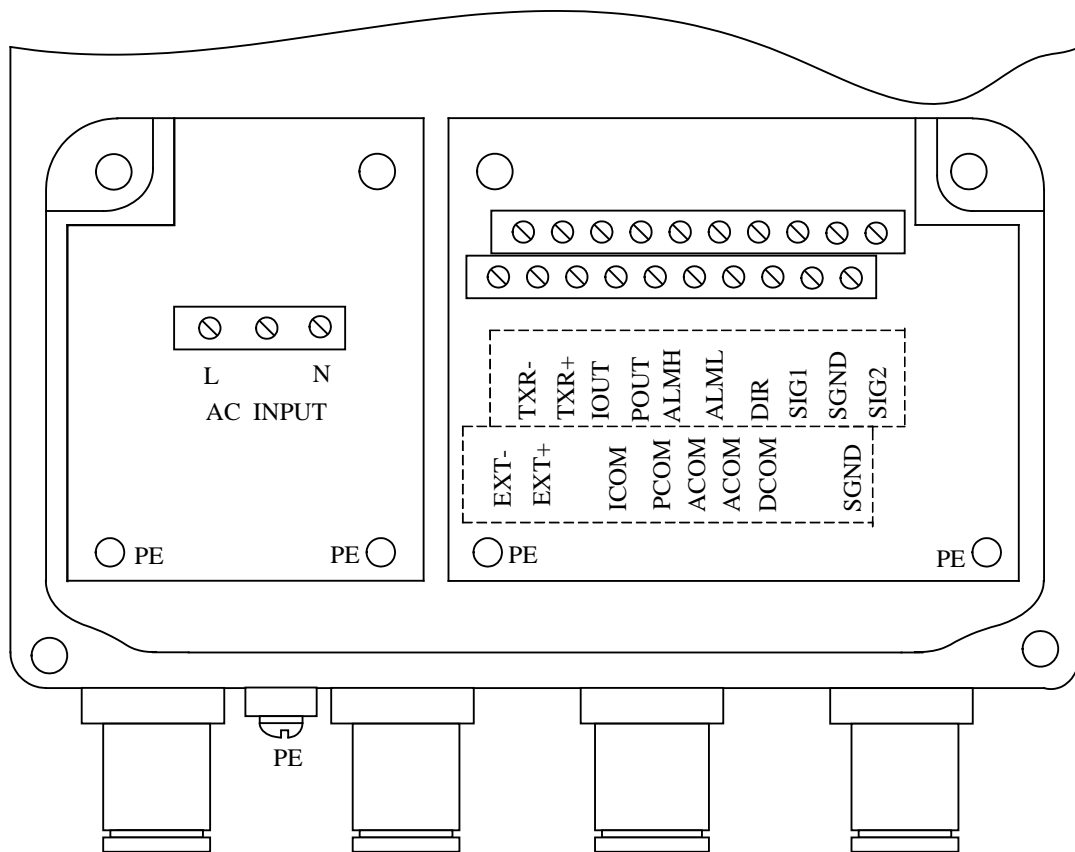
Tab.2 Converter LCD menu list

First Level Menu	Second Level Menu	Third Level Menu
PARAMETER	DIAMETER	3mm~3000mm
	DAMPING TIME	0~50 Sec.
	FLOW UNIT	L/h、 L/m、 L/s、 m ³ /h、 m ³ /m、 m ³ /s
	FLOW DEC SET	Auto Manu
	VOLUME UNIT	0.001m ³ 、 0.01m ³ 、 0.1m ³ 、 1m ³ 、 0.001L、 0.01L、 0.1L、 1L
	MEASURE RANGE	Setting
	EXT FREQ	37.5、 75Hz
	EXT CURRENT	20%、 50%、 80%、 100%
	LIQUID DENSITY	Setting

FUNCTION	MEASURE DIR	FORWARD/BACKWARD	
	NEGF MEASURE	ON/OFF	
	NEGF OUTPUT	ON/OFF	
	LOW FLOW CUTOFF	ON/OFF	
	LOW FLOW VALUE	Setting	
	MEASURING MODE	Setting	
	SPIKE CUT TIME	Setting	
	SPIKE CUT LEVEL	Setting	
	SMART FILTER	ON/OFF	
	FILTER COFF	Setting	
	METER ALARM	ON/OFF	
	EXT ALARM	ON/OFF	
	INNER LINING	Setting	
	EPD ALARM	ON/OFF	
	EPD ALARM THD	Setting	
	ALMH ALARM	ON/OFF	
	ALMH ALARM THD	Setting	
	ALML ALARM	ON/OFF	
	ALML ALARM THD	Setting	
	BAT ALARM	ON/OFF	
BAT VALUE	Value		
COMMUNICATION	MODBUS RTU	BUS ADDRESS	
		BAUDRATE	300,600,1200,2400, 4800,9600,19200, 38400
OUTPUT	OUTPUT MODE	FREQ/PULSE	
	PULSE POLAR	PO/NE	
	PULSE UNIT	SETTING	
	PULSE WIDTH	Setting	
	FREQ RANGE	1~10000Hz	
DIAGNOSTIC	4-20mA TEST	Setting	
	SPEED TEST	Setting	
	PULSE TEST	Setting	
	FREQ TEST	Setting	
RECORD REVIEW	START STOP REC	Start stop record	
	MONTHLY RECORD	Monthly volume record	
	DAILY RECORD	Daily volume record	

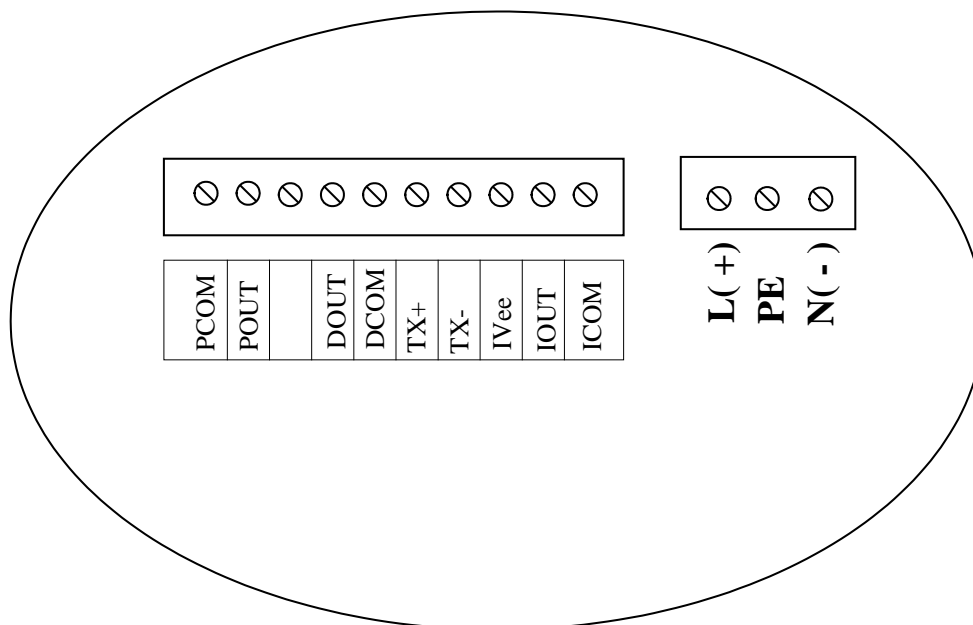
SYSTEM	LAST MAINT DATE	Display the Last Maintenance Date(Adjustable)		
	LCD CONTRAST	Setting		
	RECORD CLEAR	Clear Record		
	POSF SUM PRESET	Setting		
	NEGF SUM PRESET	Setting		
	FLOW SUM RESET	Total Cumulative Flow to be Cleared		
	SHOW PASSWORD	Including three level Password		
	PASSWORD SET	Including three level Password		
	SYSTEM DATE	Display Date (Adjustable)		
	SYSTEM TIME	Display Time (Adjustable)		
	SENSOR DATE	Display Sensor Production Date (Adjustable)		
	SENSOR CODE	Display Sensor Production Code (Adjustable)		
	METER DATE	Display Meter Production Date (Adjustable)		
	METER CODE	Display Meter Production Code(Adjustable)		
LAST CAL DATE	Display the Last Calibration Date(Adjustable)			
CALIBRATION	ZERO CORRECT	Setting		
	SENSOR COEF	Setting		
	NORMALIZED COEF	Setting		
	CORRECT SET	ON/OFF		
	FLOW CORRECT	FLOW CORRECT UNIT	m/s、m ³ /h	
		CORRECT POINT 1	Setting	
		CORRECT COEF 1	Setting	
		CORRECT POINT 2	Setting	
		CORRECT COEF 2	Setting	
		CORRECT POINT 3	Setting	
		CORRECT COEF 3	Setting	
		CORRECT POINT 4	Setting	
		CORRECT COEF 4	Setting	
		CORRECT POINT 5	Setting	
CORRECT COEF 5	Setting			

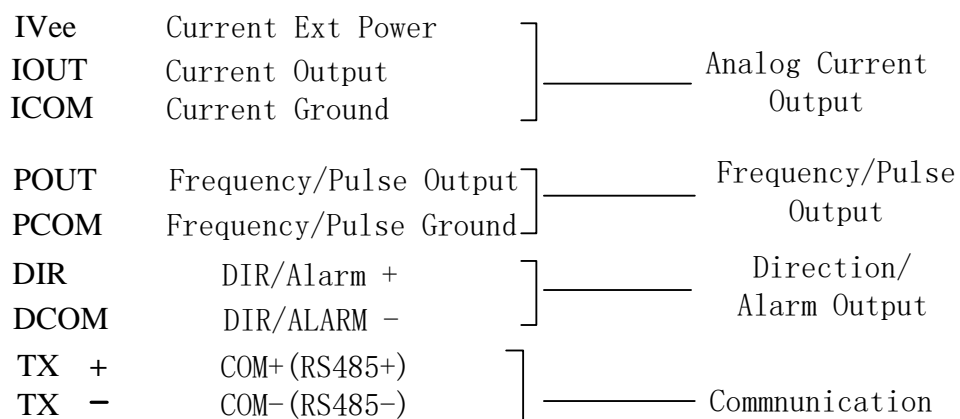
6. Squad model wiring diagram and signal definitions



SIG 1	Signal 1	}	To Sensor
SGND	Signal Ground		
SIG 2	Signal 2		
EXT +	Excitation Current +	}	
EXT -	Excitation Current -		
IOUT	Current Output (4~20mA)	}	Analog Current Output
ICOM	Current Ground		
POUT	Frequency/Pulse Output	}	Frequency/Pulse Output
PCOM	Frequency/Pulse Ground		
DIR	Flow Direction Output	}	Flow Direction Output
DCOM	Flow Direction Ground		
ALMH	High Limit Alarm Output	}	High/Low Limit Alarm Output
ALML	Low Limit Alarm Output		
ACOM	Alarm Ground		
TXR +	COM+(RS485+)	}	Communication Interface
TXR -	COM-(RS485-)		

7. Circle-Shaped model wiring diagram and signal definitions

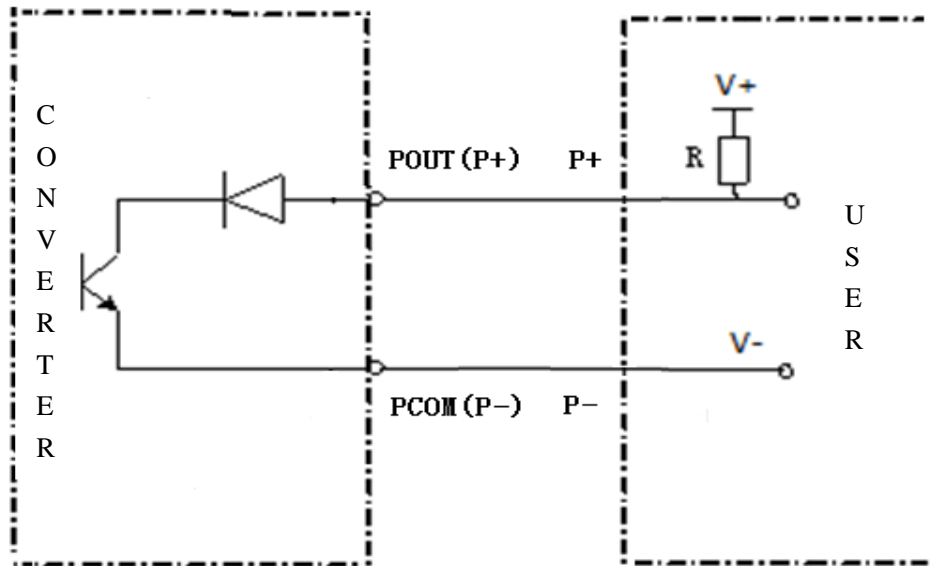




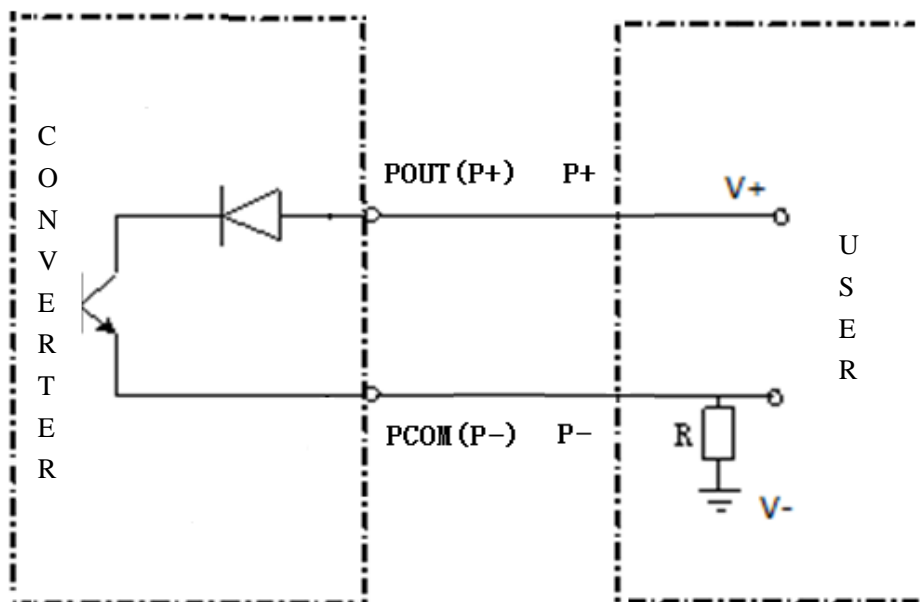
8. Frequency/Pulse Output

The Frequency and Pulse are using the same output interfaces: POUT (P+) and PCOM (P-), and user can select the output mode via the menu. The Frequency/Pulse support 3 connection mode:

Connection Mode 1: External Power Supply with OC Gate

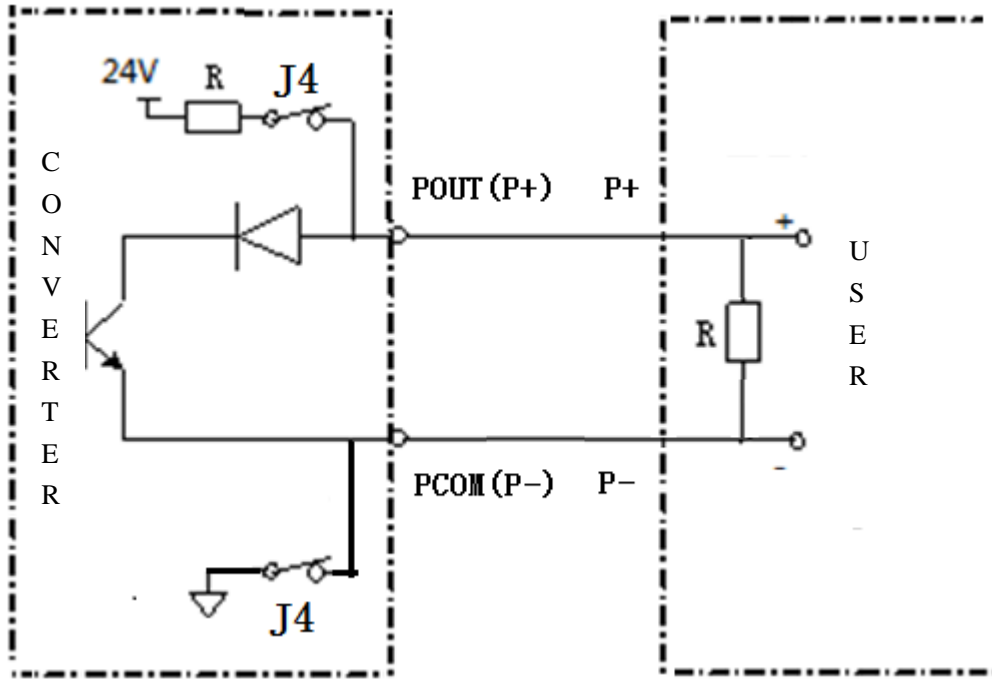


Connection Mode 2: External Power Supply with OC Gate.



Connection Mode 3: Internal Power Supply with OC Gate.

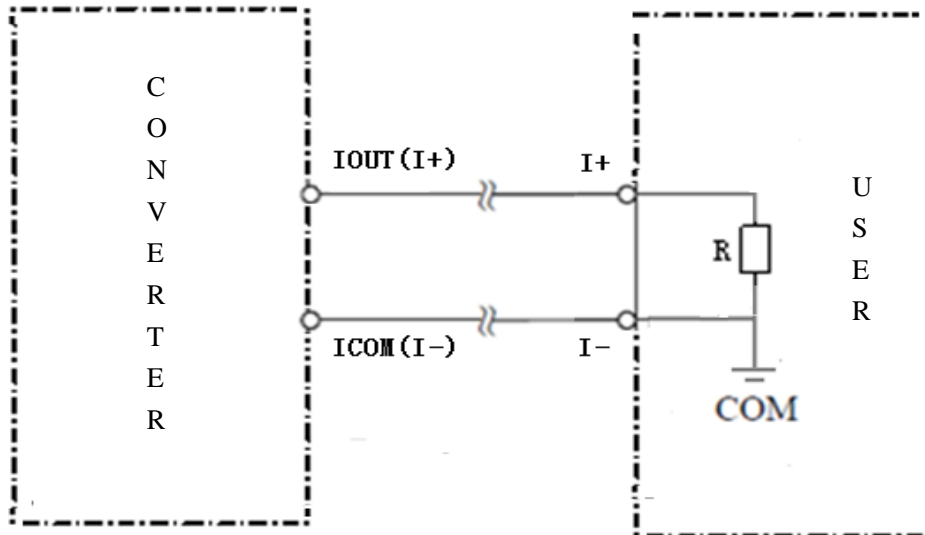
In this mode, user should plug in the jumper of internal power supply inside the converter.



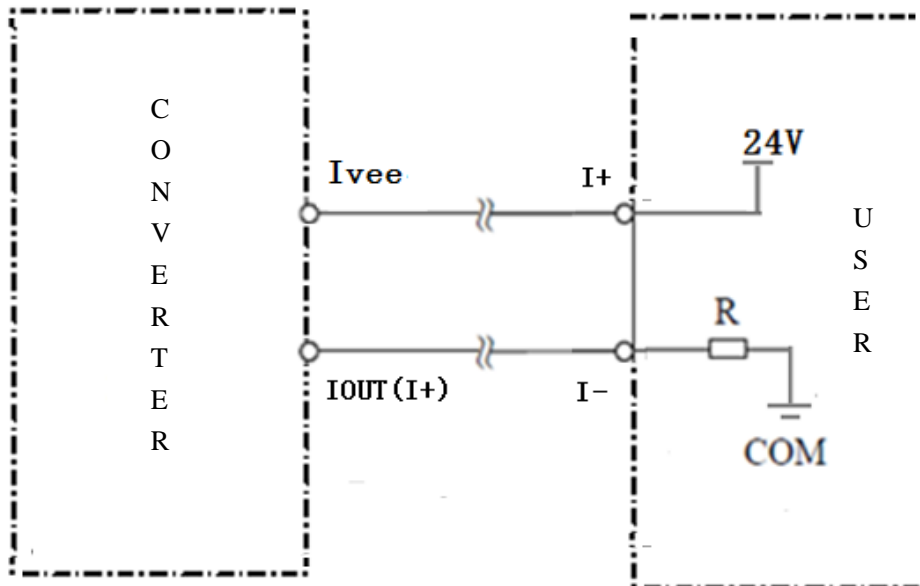
9. 4~20mA Current Output

There are 3 interfaces of the current output: IOUT(I+), ICOM (I-) and IVee (External Power), which can support 2 connection modes: Internal Power Supply and External Power Supply.

Connection Mode 1: Internal Power Supply Mode



Connection Mode 2: External Power Supply Mode



Appendix 1 Basic Parameters

PARAMETER SETTING:

➤ **DIAMETER:**

The converter can be equipped with different sensors that have different diameter of measuring pipes from 3mm to 3000.

➤ **DAMPING TIME:**

It means time of filter measure value. The long one can enhance the stability of flow display and output digital, and fits for gross add up of pulse flow; the short one means fast respond rate, and fits for production control.

➤ **FLOW UNIT:**

The flow unit can choose from the parameters (L/s、L/m、L/h、m³/s、m³/m、m³/h),and the user can choose the proper unit according to the technological requirement and using habit.

➤ **VOLUME UNIT:**

Converter display is counter with 9 bits, and the max is 999999999.

Integrator units are L, m³(liter, stere). It is accordant with flow unit and is set automatically.

This is the same to flow unit. When the flow unit is L/h, L/m and L/s the integrator unit is liter, when the flow unit is m³/h,m³/m and m³/s the integrator unit is stere.

Flow integrator value: 0.001L、 0.010L、 0.100L、 1.000L
0.001m³、 0.010m³、 0.100m³、 1.000m³ ;

➤ **MEASURE RANGE:**

Flow range means upper limit value, and lower limit value is set “0” automatically. So, it makes the range, and makes the relation of percent display, frequency output and current output with flow:

$$\text{percent display} = (\text{flow measure} / \text{measure range}) * 100 \%;$$

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

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

pulse output will not affect.

➤ EXT FREQ

This function enables customer to select the frequency for the excitation coil.

Normally 1/8 or 1/16 (of power frequency) is selected.

➤ EXT CURRENT

This function enables customer to select the current for the excitation coil.

FUNCTION SETTING:

➤ MEASURE DIR:

If users think the direct and design are differ, just change the direct parameter is OK, but not change exciting or signal.

➤ LOW FLOW CUTOFF:

This function is selectable: ON/OFF

In “ON” mode, when flow ratio is less than the low flow cut-off value, it will be cut off and the LCD display indicates “0”;

In “OFF” mode, no matter what the flow ratio is, no any flow value is cut off.

➤ LOW FLOW VALUE:

This function serves user to set the minimum flow that the flowmeter will react on.

It is expressed in percentage, such as 0.5%, 2%, 5%, etc.

➤ SMART FILTER:

This function is selectable: ON/OFF

In “ON” mode, the flowmeter automatically starts the built-in low-pass filter algorithm, making the flow measurement with better stability. We recommend set it up under the guidance of the manufacturer.

➤ **METER ALARM:**

This function is selectable: ON/OFF

In “ON” mode, the flowmeter works according to all alarm setting status;

In “OFF” mode, the flowmeter turns off all alarm status.

➤ **EPD ALARM THD:**

In “ON” mode, the user should setup the threshold value so that the flowmeter can detect the empty pipe status.

Keep liquid full of the pipe

Keep liquid with no movement

Based on the record of previous settings

Setup a new threshold value

COMMUNICATION SETTING:

➤ **MODBUS**

● **BUS ADDRESS:**

It means this instrument’s address when communicates with many, and has 01~99, holding the 0.

● **BAUDRATE:**

Baudrate: 300、600、1200、2400、4800、9600、19200、38400。

OUTPUT SETTING:

➤ **OUTPUT MODE:**

Two kinds of Outputs are can be chosen: Frequency Output and Pulse Output. Frequency Output is continuous square waveform and

Pulse output is a serial wave of square wave. Frequency output is mainly used for instant flow and total integrated flow in short time measurement. Frequency output can be chosen in equivalent frequency unit and volume of integrated flow can be displayed. Frequency Output can be used in long time measurement for total integrated flow with volume units.

Frequency output and pulse output are usually from OC gates so that DC power supplies and load resistors have to be required.

➤ **PULSE UNIT:**

Pulse Unit is referred to one pulse for value of flow.

Under the same flow, the smaller pulse, the higher frequency output, and the smaller error will be.

➤ **PULSE WIDTH:**

Set the Pulse width from 0.1ms to 100ms.

➤ **FREQ RANGE:**

Frequency output range is as the upper limit of flow measure, just the percent flow 100%. Frequency output upper limit can be selected between 1~10000Hz.

DIAGNOSTIC TEST:

➤ **4-20mA TEST**

➤ **FREQ TEST**

➤ **PULSE TEST**

➤ **SPEED TEST**

SYSTEM SETTING:

➤ **LANGUAGE:**

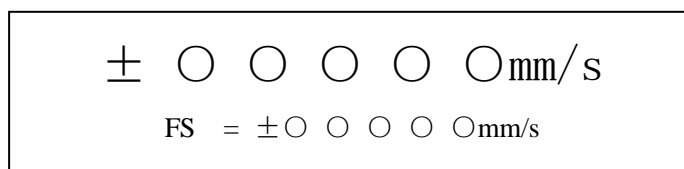
There are 2 languages for converter operation. They can be set by users according to the users' needs.

CALIBRATION SETTING:

➤ ZERO CORRECT:

Make sure the sensor is full of flow, and the flow is stillness. Flow zero is shown as velocity of flow, mm/s.

Converter's zero-flow correction displays like this:



* Upper large words: correction value of zero;

* Lower small words: FS means measure value of zero;

* Note: Just make the Upper words equal to the lower words with different direction.

Flow zero is the compound value of the sensor, and should be recorded in sensor list and band. The unit will be mm/s, and the sign will be opposite with correction value.

➤ SENSOR COEF:

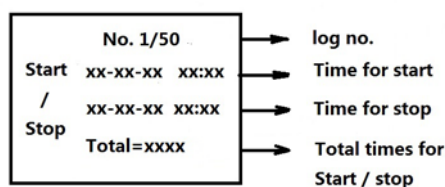
“Sensor Coefficient” is printed on the Label of the sensor when it is made in factory. The “sensor coefficient” has to be set into Sensor Coefficient Parameter when it runs with converter.

Appendix 2 Flow data-logging

A. Start/stop data logging

The transmitter can store the latest 50 history records for “Start/stop data-logging”. It’s convenient for users to view. The specific methods of operation are as follows:

In the measurement mode, go to the Enquiry menu first and then go to the "start/stop settings" sub-menu, you’ll browse the “Start/stop” records.

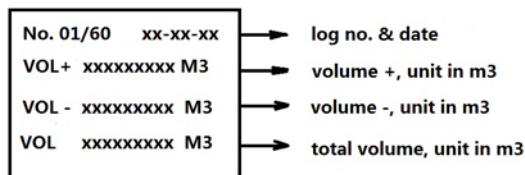


Note: The data logging number displays up to 50 records from No. 1 to No. 50. The user can browse through the arrow keys. The time format is "YY - MM - DD hr: mi". The total “start/stop” records are up to 9999.

B. Daily data logging for volume

The transmitter can store the latest 60 history records for “Daily data logging for volume”. It’s convenient for users to view. The specific methods of operation are as follows:

In the measurement mode, go to the Enquiry menu first and then go to the "Daily data logging for volume" sub-menu, you’ll browse the “Daily data logging for volume” records.

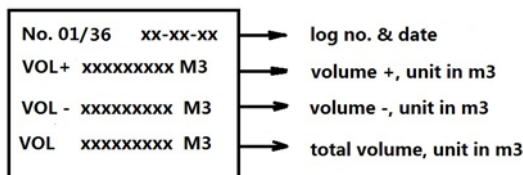


Note: The data logging number displays up to 60 records from No. 1 to No. 60. The user can browse through the arrow keys. The time format is "YY - MM - DD".

C. Monthly data logging for volume

The transmitter can store the latest 36 history records for “Monthly data logging for volume”. It’s convenient for users to view. The specific methods of operation are as follows:

In the measurement mode, go to the Enquiry menu first and then go to the "Monthly data logging for volume" sub-menu, you’ll browse the “Monthly data logging for volume” records.



Note: The data logging number displays up to 36 records from No. 1 to No. 36. The user can browse through the arrow keys. The time format is "YY - MM - DD".

Appendix 3 Notes to flow correction

Flowrate correction is mainly suitable for different flow segments for non-linear correction. The measurement range is divided into five correction points and five correction factors.

Flow correction factor is setup based on the original meter coefficient. Therefore, turn off the correction function first, and then turn it on to enable the correction function. According to the nonlinear flow segment, user should set up the flow correction point and its factor. If the setting values are appropriate, the flowmeter won't need to be re-calibrated.

The original velocity comes from the meter coefficient calculation. The corrected velocity forms from the flowrate correction. The corrected velocity corresponds to the followings:

- ✓ **correction point 1** < original velocity < **correction point 2**
Corrected velocity = correction factor 1 * original velocity
- ✓ **correction point 2** < original velocity < **correction point 3**
Corrected velocity = correction factor 1 * correction point 1 + correction point 2 * (original velocity - correction point 1)
- ✓ **correction point 3** < original velocity < **correction point 4**
Corrected velocity = correction factor 1 * correction point 1 + correction point 2 * (correction point 2 - correction point 1) + correction point 3 * (original velocity - correction point 3)
- ✓ **correction point 4** < original velocity < **correction point 5**
Corrected velocity = correction factor 1 * correction point 1 + correction point 2 * (correction point 2 - correction point 1) + correction point 3 * (correction point 3 - correction point 2) + correction point 4 * (original velocity - correction point 4)
- ✓ **correction point 5** < original velocity
Corrected velocity = correction factor 1 * correction point 1 + correction point 2 * (correction point 2 - correction point 1) + correction point 3 * (correction point 3 - correction point 2) + correction point 4 * (correction point 4 - correction point 3) + correction point 5 * (original velocity - correction point 5)

Note: When setup correction point, user should keep the following relationship:

Correction point 1 < correction point 2 < correction point 3 < correction point 4 < correction point 5

The median value of the correction factor is 1.0000. If the correction factor is greater than the median value it is a positive factor; if the correction factor is less than the median value, it is a negative correction factor.

